TOSHIBA

DATA BOOK

MOTOR CONTROL & DRIVER IC SERIES

1992

Taking this opportunity, we express our gratitude for your purchase of Toshiba semiconductor products. We are pleased to inform you that out publication "Toshiba Motor Control & Driver IC Series Data Book (1992)" has been completed.

Precision micro motors and actuators – and as their controls, semiconductors such as IC and LSI — are used in main and auxiliary drive mechanisms. It is no exaggeration to state that these drive mechanisms form the "hearts" of nearly all AV, OA, and FA systems that have been developed and mass-produced recently.

High-accuracy spindles and actuator head drives of laser-use electronic devices such as optical disk drives, compact disk players (CDP), video disk players (VDP) etc., spindles and head drives of high-density recording systems such as floppy disk drives (FDD) and hard disk drives (HDD) –and in particular, driving mechanisms of factory automations, robots, etc.– can be attributed to the collective results of updated control, high-accuracy machining and semiconductor techniques, forming part of "mechatronics," and all-inclusive title concerning interface technology of both mechanical and electronic-controlled systems.

Such driving mechanisms employ DC brush motors, brushless motors, stepping motors, voice coil motors, solenoids and so on in accordance with requirements for them. Toshiba's newly completed Data Book describes IC's for the controls and drives of the systems mentioned above.

The applied circuits and other items displayed in this publication are shown for your reference in practical use. Kindly note that Toshiba Corporation in no case shall be obligated to assume responsibility for the infringement of any third party's patent, or any other rights, resulting from using the circuits displayed in this Data Book. The products described in this document contain strategic products subject to COCOM regulations. They should not be exported without authorization from the appropriate governmental authorities.

How to Use This Data Book

IC's for controlling and driving motors can be classified under two categories–(1) in accordance with motors to be controlled or (2) with equipments to be used. The first category, for example, includes IC's for hall motor drivers, IC's for brush motors, and IC's for stepping motors. In the second category, IC's are listed in accordance with their applications such as IC's for VCR or IC's for HDD.

For the convenience of users, this Data Book contains two indexes–(1) classified according to motors and (2) classified by applications–to enable you to quickly and conveniently find the particular IC wanted. If you have already chosen a motor, the necessary IC can be found by consulting the "Motor Control/Drive Circuit Line Up." If you have decided on an application, the necessary IC for the motor can be found in the Applications.

For the IC found from both indexes, consult the page in the "FUNCTION INDEX,, (Page 7), pages for their data sheets are shown in the Indexes and Sheets.

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1. FUNCTION INDEX (General Information)

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Hall motor driver	TA7245BP/BP (LB)/CP/F	HDIP 14-P-500A HSOP 20-P-450	26V 1.2A	3-phase bi-directional driver, current control type	43
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	TA8416F	SSOP 16-P-225A	8V 0.7A	Same as TA7745P/F, 2-hall sensor type, Vcc opr=1.8 to 7.2V	336
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	TA8434F	HQFP 30-P-1010	18V 0.7A	3-phase bi-directional digital servo-type single-chip driver, semi-linear drive, used for FDD spindle motor	421
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	TD62M3700F	SSOP 16-P-225A	30V 1.5A	Low saturation voltage, 3-phase full-wave connecting multichip IC (2SA1203 x 3, 2SC2883 x 3)	744
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	TA7272P	HSIP 10-P	±18V 1.2A	Dual-power operational amplifier	112
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	TA8410AK	HSIP 10-P	±15V 0.6A	Dual-power operational amplifier	303
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	TA7354P	SIP 9-P-A	18V 0.2A	Single-bridge driver	163
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Equipment	Model	Package	Max. rating	Functions	Page
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	TA8429H	HZIP 12-P-B	30V 3.0A	High voltage large current single-bridge driver, stand-by function incorporated	411
	TA8436AF	SOP 16-P-300A	8V 1.0A	Low On-Resistance MOSFET single-bridge driver	448
	*TA8440H	HZIP 12-P-B	50V 1.5A	High voltage single-bridge driver (PWM Type)	458
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	TD62M4700F	SSOP 16-P-225A	10V 2A	Low saturation voltage H-bridge (RN6006 x 2, RN5006 x 2)	757
	TD62M2701F	SSOP 16-P-225A	10V 2A	H-bridge (2SA1203 x 2 + RN5006 x 2)	728
	TD62M2702F	SSOP 16-P-225A	10V 2A	H-bridge, provided with Schottky diode (RN6006 x 2 + 2SC2982 x 2 + U1FWJ49 x 2)	733
Stepping motor driver	TA7289P/F	HDIP 14-P-500A HSOP 20-P-450	30V 0.7A	PWM type bi-directional drive, 4-bit buit-in DAC, constant current type	146
	TA7774P/F	DIP 16-P-300A HSOP 16-P-300	17V 0.35A	2-phase bi-directional drive, power saving and stand-by functions incorporated	240
	TB6500AH	HZIP 25-P	30V 0.8A x 2 0.6A x 1	Facsimile system driver (serial input type PWM control), driving two 2-phase bi-directional stepping motors and one DC motor	565
	TA8415P	DIP 16-P-300A	28V 0.4A	3-phase/4-phase unipolar drive 1-phase, 2-phase and 1-2 phase excitation possible	326
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	TA8430AF	HSOP 16-P-300	8V 0.4A	2-phase bi-directional drive, 5V Single Powered Power saving and stand-by functions incorporated	416
	TA8435H	HZIP 25-P	40V 1.5A	Same as TA8425H, provided with reset terminal and monitor terminal	427
	TA8437F	SOP 20-P-300A	7V 0.3A	Low-voltage Low On-Resistance MOSFET 2-phase bi-directional stepping motor driver	453
	TA8459F	SOP 20-P-300A	6V 0.3A	Low-voltage Low On-Resistance MOSFET 2-phase bi-directional stepping motor driver	503
	TA8529F	HSOP 20-P-450	17V 0.5A	2-phase bi-directional drive, Law Satulation voltage	558
	TB6504F	SSOP 24-P-300	10V 0.15A	Same as TA8435H, Iout=0.15A	583

Equipment	Model	Package	Max. rating	Functions	Page
Stepping motor driver	TD62064P/F /AP/BP-1	DIP 16-P-300A HSOP 16-P-300	P/F=35V AP=50V BP-1=80V 1.5A x 4	4-channel NPN Darlington transistor array (for unipolar motor)	667
	TD62083AP	DIP 18-P-300D	50V 0.5A x 8	8-channel NPN Darlington transistor array (for unipolar motor)	679
	TD62164 /AP/BP/AF	DIP 16-P-300A HSOP 16-P-300	AP/AF=50V BP=80V 0.7A x 4	4-channel NPN transistor array (for unipolar motor)	687
	TD62308AP /BP-1/F/AF	DIP 16-P-300A HSOP 16-P-300	F=35V AP/AF=50V BP-1=80V 1.5A x 4	4-channel NPN Darlington transistor array, PNP transistor input (for unipolar motor)	699
	TD62318AP /BP/AF	DIP 16-P-300A HSOP 16-P-300	AP/AF=50V BP=80V 0.7A x 4	4-channel NPN transistor array, PNP transistor input (for unipolar motor)	710
	TD62803P	DIP 16-P-600	28V 0.4A	Same as TA8415P (different package)	722
Other IC's	TA7363AP	SIP 7-P-A	—	Oil pump controller, auto-stop possible	167
	TA7768F	SOP 8-P-225	6V 0.75A	Electronic governor, Vcc opr=1.0 to 5.0V	237
	TD6303F	SSOP 16-P-300	7V 10mA	Low-voltage F-servo single-chip brush motor controller Vcc opr=1.8 to 6V	657

*Under development.

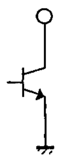
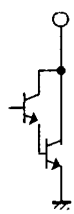
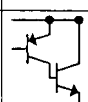
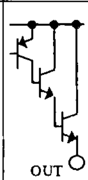
2. MOTOR CONTROL/DRIVE CIRCUIT LINE UP

2. MOTOR CONTROL/DRIVE CIRCUIT LINE UP

2-1 Solenoids/Actuator Driver IC's

Various power operational amplifiers are available as linear actuator drivers for driving VCM, etc. Transistor arrays for driving solenoids and relays as reactance loads.

- Bipolar transistor array series

				LOW LEVEL INPUT ACTIVE			HIGH LEVEL INPUT ACTIVE		
			Io (mA)	INPUT			INPUT		
OUTPUT (SINK)	SINGLE	OUT 	~ 500		TD62603P/F TD62604P/F	TD62382AP/F/AF	TD62551S ~ TD62555S	TD62501P/F ~ TD62507P/F TD62301P/F TD62302P/F TD62306P/F TD62307P/F TD62601P/F TD62602P/F	TD62583AP/F/AF TD62380P TD62591AP ~ TD62594AP TD62595AP/AF ~ TD62598AP/AF
			500 ~ 700			TD62383P		TD62303P/F TD62309P/F	TD62381P/F
	DARLINGTON	OUT 	~ 500					TD62006P/F TD62007P/F TD62008AP/P/AF	TD62081CP ~ TD62084CP
			500 ~ 700		TD62304P/AP/AF/F TD62305P/AP/AF/F	TD62384AP/F/AF TD62385AP/F/AF		TD62001P/AP/F/AF ~ TD62004P/AP/F/AF TD62101P/F ~ TD62105P/F	TD62081AP/F/AF ~ TD62084AP/F/AF
			700 ~ 1500	TD62318AP/AF/BP TD62308AP/BP-1/F/AF			TD62164AP/AF/BP TD62064P/AP/F/BP-1 TD62074P/AP/F/AF TD62107P/BP/F		
OUTPUT (SOURCE)	SINGLE	 OUT	~ 500		TD62703P/F			TD62705P/F TD62706P/F	
			500 ~ 700			TD62785P/F			
	DARLINGTON	 OUT	~ 500					TD62771AP	TD62781AP/F/AF TD62782AP/F/AF
			500 ~ 700			TD62786AP/F/AF TD62787AP/F/AF			TD62783AP/F/AF TD62784AP/F/AF
			700 ~				*TD62707AP		
				4	5 ~ 7	8	4	5 ~ 7	8
				Number of circuit			Number of circuit		

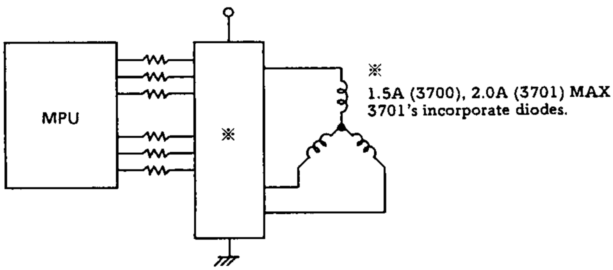
- Multichip transistor array series

	H-bridge connection	3-phase connection	4-channel	8-channel
Source	–	TD62M3600F (10V, 2.0A)	TD62M4600F (10V, 2.0A)	TD62M8600F (10V, 2.0A)
	–	TD62M3601F (30V, 1.5A)	TD62M4601F (20V, 2.0A)	TD62M8601F (20V, 2.0A)
	–	–	TD62M4501F (20V, 2.0A)	TD62M8603F (30V, 1.5A)
Sink	–	–	TD62M4500F (10V, 2.0A)	TD62M8500F (10V, 2.0A)
	–	–	TD62M4501F (20V, 2.0A)	TD62M8501F (20V, 2.0A)
Full-wave (bipolar) type	TD62M4700F (10V, 2.0A)	TD62M3700F (30V, 1.5A)	–	–
	TD62M2701F (10V, 2.0A)	TD62M3701F (10V, 2.0A)		
	TD62M2702F (10V, 2.0A)	TD62M3702F (15V, 2.0A)		
	–	TD62M3704F (10V, 2A/5A)		

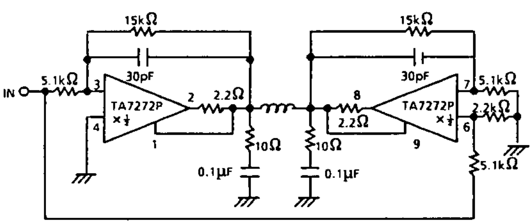
- Power operational amplifier series

Number of circuit	Model	Max. rating	
		Vcc (V)	Io (A)
Dual	TA7256P	±18	0.5
	TA8406P		
	TA8406F		
	TA7272P	±18	1.2
	TA8407P		
	TA8407F		
	TA8102P	15	1.0
	TA8410P	±9, ±15	0.6
	TA8410F		
	TA8410K/AK		
	TA8461F	±15	1.5
	TA8464K	±18	1.2
Quad	TA8212F	14.5	0.7
	TA8449P	±15	0.6

(1) 3-phase full-wave high-efficiency driver circuit (TD62M3700F, TD62M3701F)

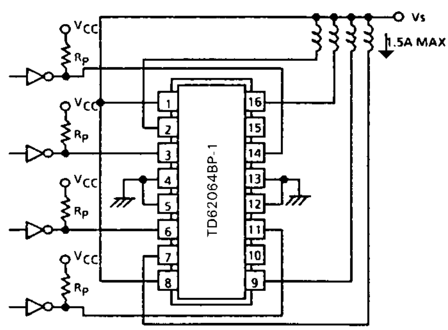


(2) VCM driver circuit (TA7272P)

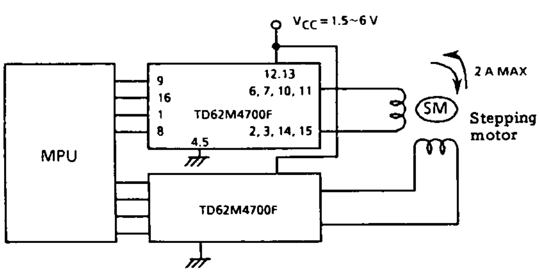


*Flat-type TA8407F also available.

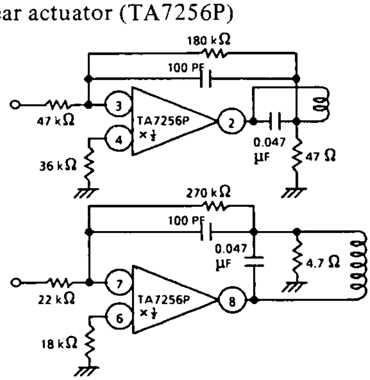
(3) Relay driver circuit (TD62064BP-1)



(4) Camera auto-focus actuator (TD62M4700F x 2)

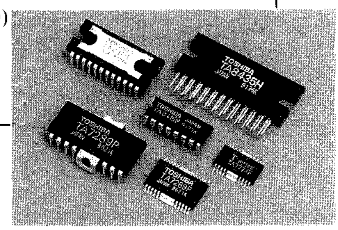


(5) Linear actuator (TA7256P)



2-2 Stepping Motor IC's

TA8425H	PWM chopper type 2-phase full-wave quasi-sinusoidal, microstep, 40V, 1.5A
TA8435H	Same as TA8425H, provided with reset and monitor terminals
TB6504F	Same as TA8435H, 10V, 150mA
TA8411L	PWM chopper-type 2-phase full-wave system driver (2 × stepping motor, 1 × DC motor control), 27V, 0.8A × 2, 27V, 0.6A × 1
TB6500AH	Same as TA8411L
TA7289P/F	PWM chopper-type driver with 4-bit DAC, 30V, 0.7A
TA7774P/F	2-phase full-wave dual-powered driver, provided with power saving function, 7-17V, 0.35A (for FDD)
TA8430AF	2-phase full-wave, low-voltage driver, 8V, 0.6A (for FDD)
TA8437F	2-phase full-wave, smart MOS, 6V, 0.3A × 2
TA8459F	2-phase full-wave, smart MOS, 6V, 0.3A × 2
TA8529F	1-, 2-, 1-2 phase excitation bipolar, 5V/12V, 0.4A × 2



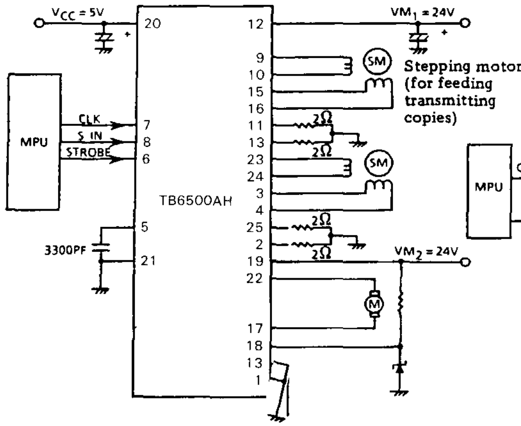
System driver

Controller | Driver

TD62803P	3-/4-phase, 1-, 2-, or 1- 2-phase excitation unipolar controller driver, 7 or 28V, 0.4A
TA8415P	Same as TD62803P

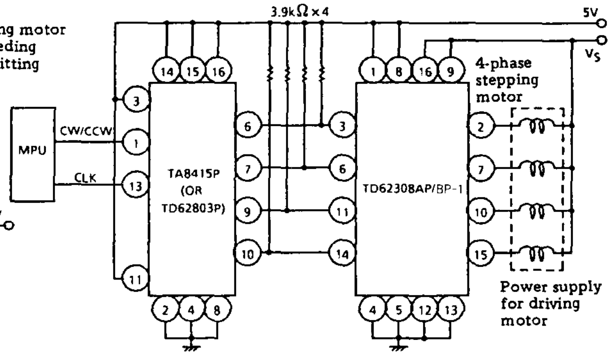
TD62064BP-1	80V, 1.5A, 4-channel transistor array	Used for unipolar motor
TD62164BP	80V, 0.7A, 4-channel transistor array	
TD62308BP-1	80V, 1.5A, 4-channel transistor array	
TD62318BP	80V, 0.7A, 4-channel transistor array	
TD62081～4AP/AF	50V, 0.5A, 8-channel transistor array	
TD62386～8AP/AF	50V, 0.5A, 8-channel transistor array	
TD62C851P	50V, 0.2A 8-channel shift-register latch driver	
TD62C852P	50V, 0.5A 8-channel shift-register latch driver	
TD62M4700F	10V, 2A transistor array	Used for bipolar motor
TD62M2702F	10V, 2A transistor array	
TA7257P	25V, 1.5A bridge driver	
TA7267BP	25V, 1.0A bridge driver	
TA8409S/F	25V, 0.4A bridge driver	
TA7291P/F/S	25V, 1.0A bridge driver	
TA7279AP	25V, 1.0A bridge driver (dual)	
TA8428K	30V, 1.5A bridge driver	
TA8429H	30V, 3.0A bridge driver	

(1) Stepping motor system driver for facsimile and word processor (TB6500AH), PWM chopper type

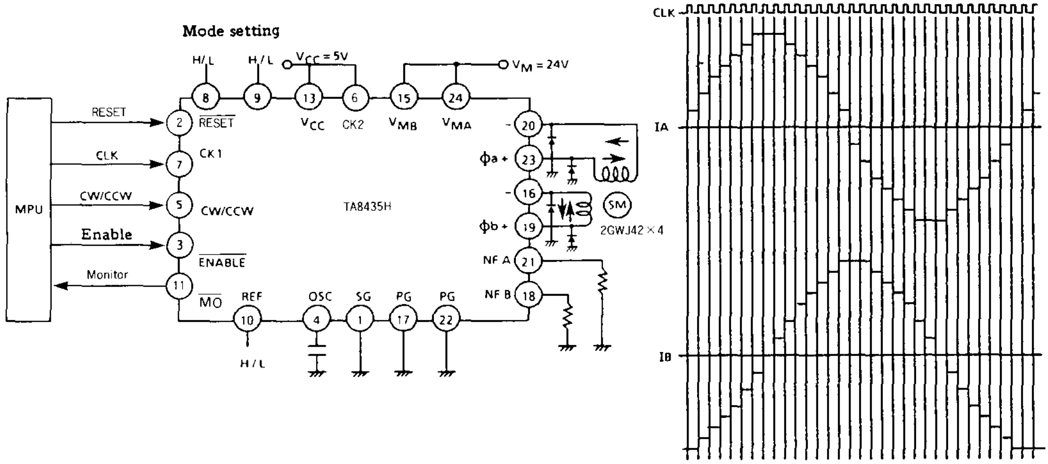


* Similar models can be developed by Toshiba.

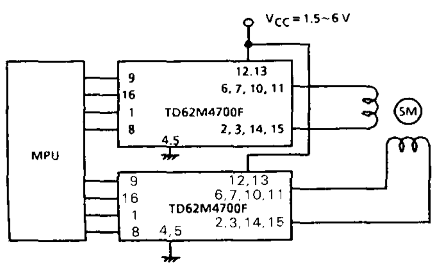
(2) General-use stepping motor drive circuit (TA8415P + TD62308AP/BP-1)



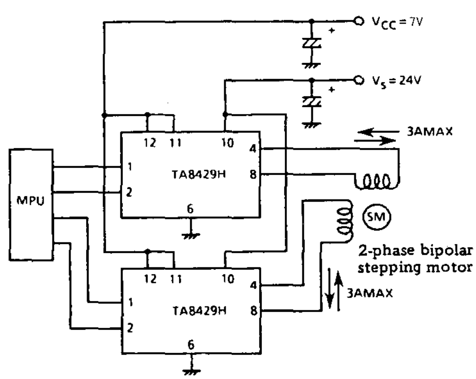
(3) Micro step driver for PPC and printer (TA8435H), PWM chopper type



(4) Low-voltage high-efficiency stepping motor drive circuit (TD62M4700F × 2)

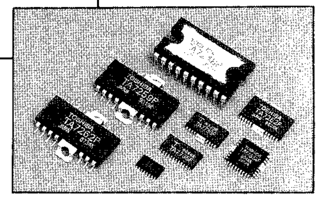


(5) Large-current stepping motor drive circuit (TA8429H × 2)



2-3 Hall Motor IC's

TA8434F	Single-chip IC for FDD spindle (FLL)
TA7284P/F	2-phase full-wave F-servo single-chip IC



Hall sensor

THS100 series

System driver

Sensor | Controller | Driver | Module

Controller

TA7712P	3-phase controller
TA8412P/F	3-phase controller
TA8413P	3-phase controller
TA7759P	4-phase controller
TC9142AP	PLL controller
TC9193AP/AF	PLL controller
TC9203AP/AF	PLL controller (300/360 rpm)
TC9192AP/AF	Double-PLL controller
TA7715P	F/V converter
TA8443F	PWM/PLL motor controller

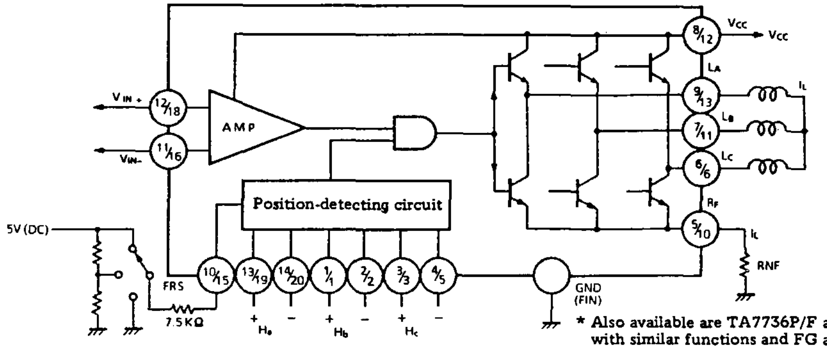
Module

TD62M3700F	3-phase full-wave module, 30V, 1.5A
TD62M3701F	3-phase full-wave module, 30V, 1.5A
MP3000/4000/6000 series	
GTR module series	
IGBT module series	

Driver

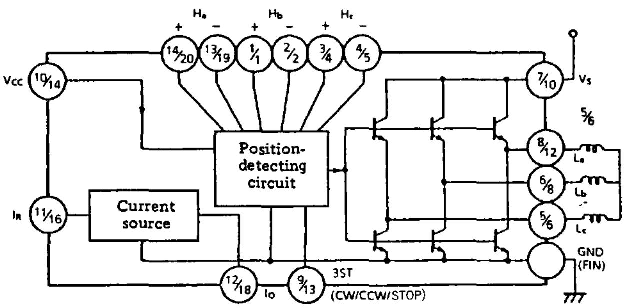
TA7259P/F	3-phase full-wave current control type	26V, 1.2A
TA7262P/F	3-phase full-wave voltage control type	25V, 1.5A
TA7736P/F	3-phase full-wave current control type	26V, 1.0A
TA8402F	3-phase half-(full-)wave voltage control type	18V, 1.0A
TA7745P/F	3-phase half-(full-)wave voltage control type	18V, 1.0A
TA8423P/F	3-phase full-wave current control type, less external component type	18V, 1.2A
TA8424F	3-phase full-wave low-noise current control type, with FG amplifier	18V, 1.2A
TA7247AP	3-phase full-wave voltage control type, SW regulator controller incorporated	38V, 1.5A
TA7248P	3-phase full-wave current control type	35V, 0.9A
TA7260P	2-phase full-wave current control type	35V, 0.9A
TA7261P	2-phase full-wave current control type	25V, 0.6A
TA7735F	3-phase half-wave sensorless driver, SW regulator incorporated	18V, 1.2A
TA8414P/F	2-phase half-wave fan motor controller (automatic reset-type burning-proof circuit incorporated)	33V, 0.1A
TA8420, 1AF	2-phase half-wave fan motor driver (automatic reset-type burning-proof circuit incorporated)	30V, 1.0A
TA8422F	2-phase half-wave low-noise driver	8V, 0.5A
TA8466F	3-phase full-wave low-noise current control type, less external component type	18V, 0.7A

(1) Current control type motor driver (TA7259P/F)

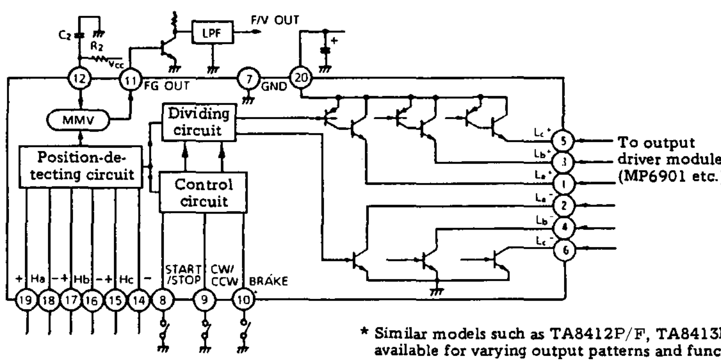


* Also available are TA7736P/F and TA8423P/F with similar functions and FG amplifier-incorporated low-noise TA8424F.

(2) Voltage control-type motor driver (TA7262P/F)

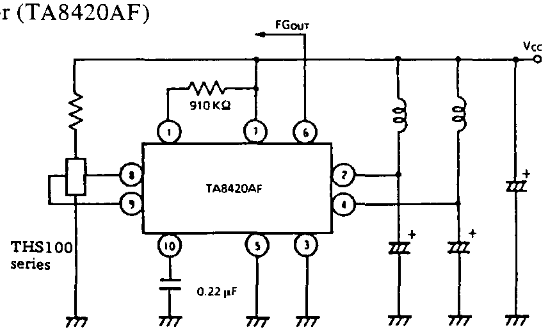


(3) Motor controller (TA7712P)



* Similar models such as TA8412P/F, TA8413P, and TA7713P are available for varying output patterns and functions.

(4) Fan motor (TA8420AF)

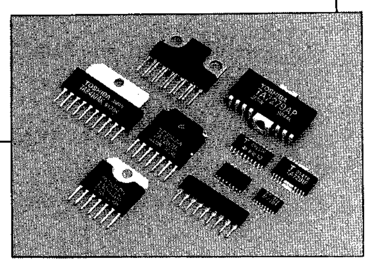


* Also available are TA8414P, an external output transistor type,

2-4 Bridge Driver IC's

TA7354P	18V, 0.2A, single
TA7733F	18V, 0.5A, low-voltage, single
TA7291P/S/F	25V, 1.0A, output voltage adjustable, single
TA8409S/F	25V, 0.4A, output voltage adjustable, single
TA7267BP	25V, 1.0A, single
TA8102P	15V, 1.0A, low-voltage dual-power operational amplifier with boot strap
TA7288P	25V, 1.0A x 2, output voltage adjustable, sequential dual
TA7279AP	25V, 1.0A x 2, dual
TA7257P	25V, 1.5A, single
TA7256P	±18V, 0.5A, dual-power operational amplifier
TA8406P/F	±18V, 0.5A, dual-power operational amplifier
TA8410P/K/F	±9V, 0.6A, dual-power operational amplifier
TA8410AK	±15V, 0.6A, dual-power operational amplifier
TA8428K	30V, 1.5A, single, overcurrent protector circuit incorporated
TA8429H	30V, 3.0A, single, overcurrent protector circuit incorporated
*TA8440H	50V, 1.5A, single
TA8436F	7V, 1.0A, single, smart MOS H-switch
TA8437F	6V, 0.3A x 2, dual, smart MOS H-switch
TA7272P	±18V, 1.2A, dual-power operational amplifier
TA8407P/F	±18V, 1.2A, dual-power operational amplifier
TA8212F	14.5V, 1.2A, quad-power operational amplifier
TA8449P	±15V, 0.6A, quad-power operational amplifier
TA8464K	±18V, 1.2A, dual-power operational amplifier, high slew rate.
TA8459F	6V, 0.3A × 2, dual smart MOS H-switch
TA8460F	6V, 0.3A × 2, dual smart MOS H-switch, with PWM pre-driver
TB6501F	20V, 0.4A, single with rotation detector
TA8461F	±15V, 1.5A, dual-power operation amplifier

* Under development

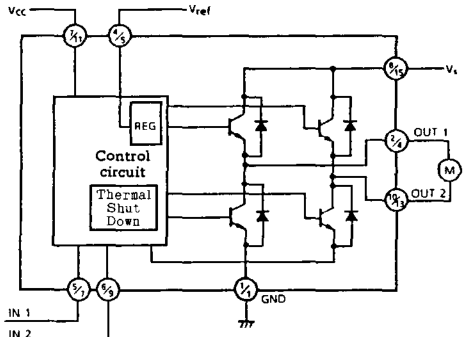


Driver IC

Controller | Transistor array, module

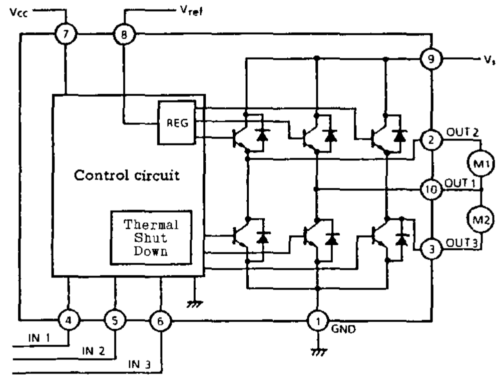
TD62M4700F	10V, 2A Low-voltage drive, low-saturation voltage bridge driver
TD62M2701F	10V, 2A Low-voltage drive, low-saturation voltage bridge driver
TD62M2702F,	10V, 2A, Low-voltage drive, low-saturation voltage bridge driver
MP4500 series	Power transistor module
MG15G4GL1 and others	Giant transistor module
MG15D4GM1 and others	Giant transistor module

(1) Output voltage adjusting-type single-bridge driver (TA7291P/F)

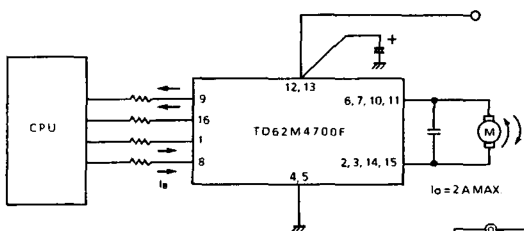


* TA7291S of SIP 9-pin type and improved TA8409S/F are also available.

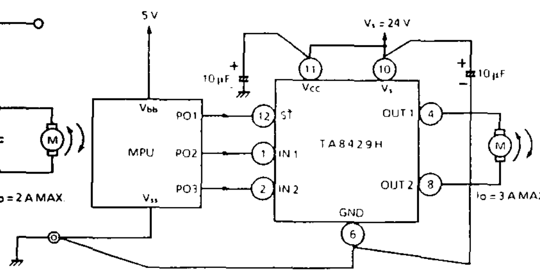
(2) Output voltage adjusting-type sequential dual-bridge driver (TA7288P)



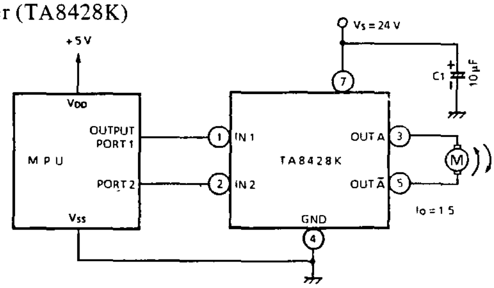
(3) Low-voltage (less than 3V) large current (2A) miniature bridge driver (TD62M4700F)



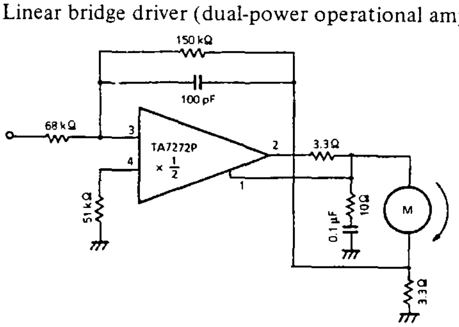
(4) Large current single-bridge driver (TA8429H)

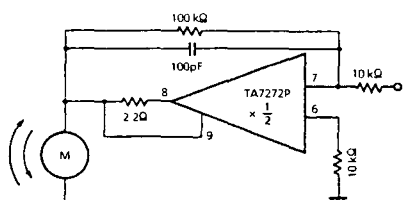


(5) Single-bridge driver (TA8428K)



(6) Linear bridge driver (dual-power operational amplifier) (TA7272P)

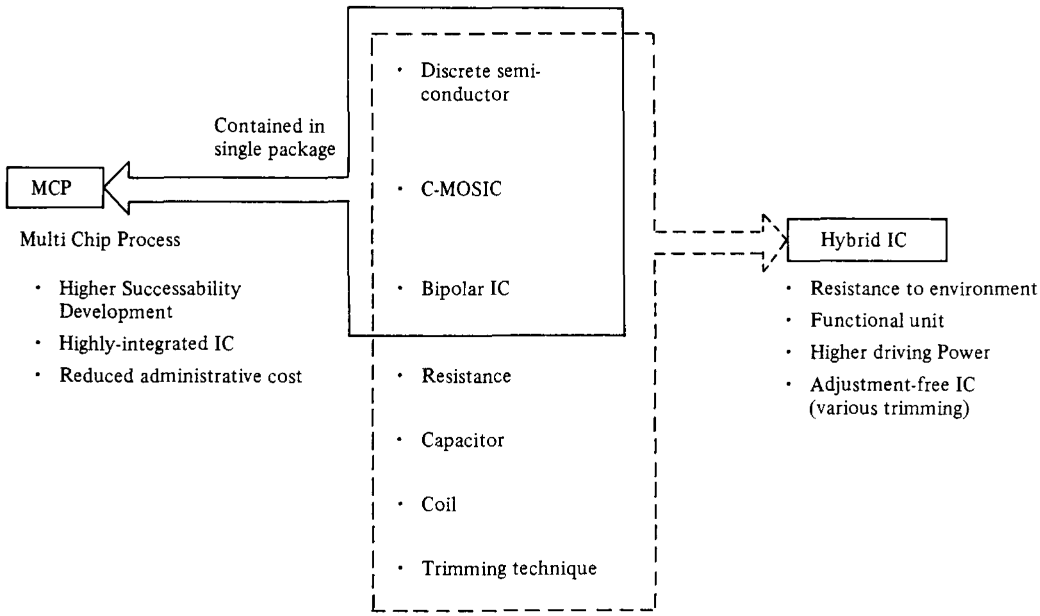




* TA8407P/F, TA8406P/F, TA7256P, TA8410K/P/F, TA8410AK etc. are available for various maximum ratings and packages. High slew rate type TA8464K is available.

2-5 Hybrid IC's and Multichip IC's

Demands for increased compactness, lighter weight, and further enhanced reliability of devices are stimulating efforts to achieve higher densities of semiconductors. There are also calls for stable operations under unfavorable conditions such as high temperature and high humidity. Properties for system parts and functional units are required of hybrid IC's. Also, increased integration can be achieved by using the MCP (multichip process), a technique for packaging a discrete transistor, diode, C-MOS IC, and bipolar IC chips into one IC package.



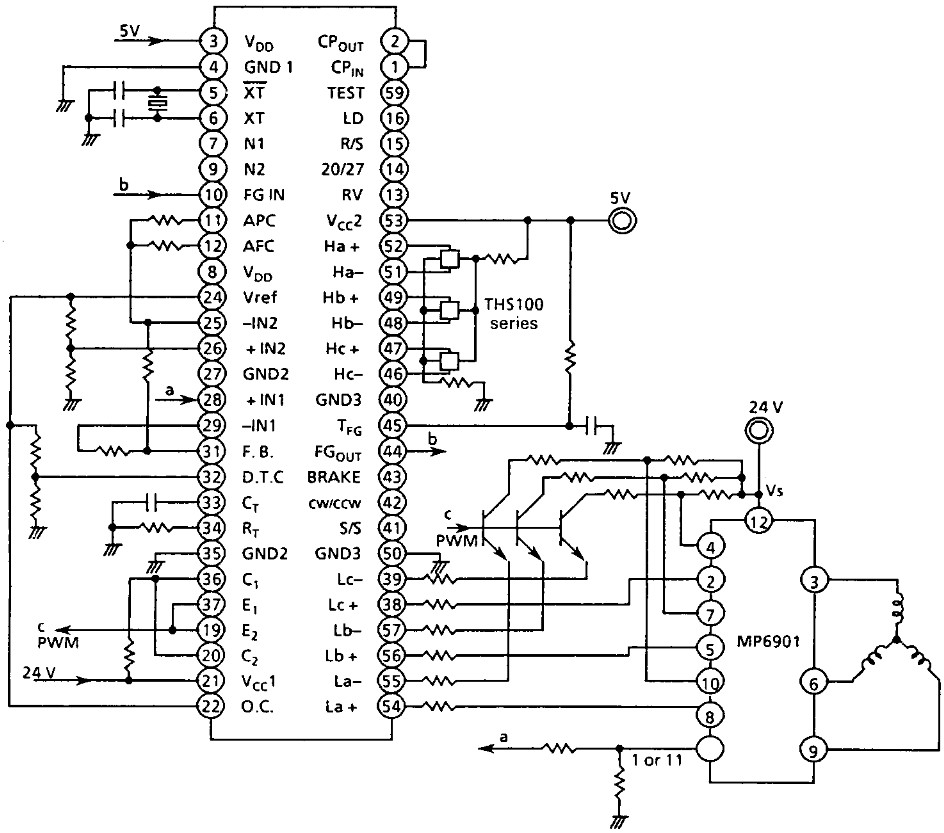
○ Features

- Hybrid and multichip IC's are applicable to ASIC, permitting various applications in accordance with user's needs.
- If the IC's, transistors, and diodes are Toshiba semiconductors, they are applicable, except for certain ones that cannot be contained in single packages for reasons involving manufacturing technique.
- For multichip IC's, all Toshiba packages, except for certain ones already on the market, can be used. For packages, refer to the Package Manual issued by Toshiba.
- For multichip IC's, for motors, not only those for ASIC, but also general-purpose models such as the transistor array series (TD62MXXXX series) having several discrete transistors packed in each IC package, as well as PLL-PWM motor controllers, TA8443F, are available on the market.

○ Multichip IC's and hybrid IC's for motor control

For PLL-PWM motor control, TA8443F is being marketed. The former contains TC9203P (PLL IC), TA7649P (for PWM switching regulator IC), and TA7712P (for 3-phase hall motor control) in one package.

○ PLL-PWM motor drive circuit for PPC (TA8443F)



○ Multichip transistor array series

		H-bridge connection	3-phase connection	4-channel	8-channel
Single type	Source	–	TD62M3600F (10V, 2.0A)	TD62M4600F (10V, 2.0A)	TD62M8600F (10V, 2.0A)
		–	TD62M3601F (30V, 1.5A)	TD62M4601F (20V, 2.0A)	TD62M8601F (20V, 2A)
		–	–	–	TD62M8603F (30V, 1.5A)
	Sink	–	–	TD62M4500F (10V, 2.0A)	TD62M8500F (10V, 2.0A)
		–	–	TD62M4501F (20V, 2.0A)	TD62M8501F (20V, 2.0A)
	Bipolar type	TD62M4600F (10V, 2.0A)	TD62M3700F (30V, 1.5A)	–	–
		TD62M2701F (10V, 2.0A)	TD62M3701F (10V, 2.0A)		
		TD62M2702F (10V, 2.0A)	TD62M3702F (15V, 2.0A)		

* Incorporated several discrete transistor chips with excellent properties in one package. Ideal for circuits requiring low-saturation properties.

3. APPLICATIONS

3. APPLICATIONS

3-1 Applications List

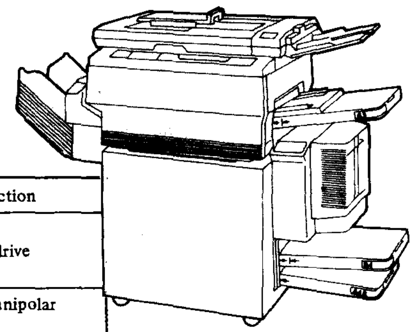
Electronic equipments contains their own main and auxiliary drives; their motor types and drive circuits are selected in accordance with the necessary properties for such parts.

The following are application circuits considered most common, listed for devices.

	Equipment	Function	IC used	Recommendable IC's
OA	Floppy disk drive (FDD)	Controller	Mechanism controller	TC8605F(C), TC8615F-002 TC8606F-000, TC8616F-002
		Spindle	Single chip	TA8434F, TA8463F
			Servo	TC9142AP, TC9203AP/AF(PLL), TA7715P(F servo)
			Hall motor	TA7736P/F (3.5), TA7259P/F (5.25), TA8424F
		Head	Stepping motor	TA7774P/F, TA8430AF, TA62003F
			Voice coil motor	TA7256P, TA7272P, TA8406P/F, TA8407P/F
	Hard disk drive (HDD)	Controller	Mechanism controller	TC8561F
		Spindle	Single chip	TA8434F
			Servo	TC9193AF, TC9142AP, TC9203AP/AF
			Hall motor	TA7736P/F (3.5), TA7259P/F (5.25), TA8423F
		Head	Stepping motor	TA7774P/F, TA7289P/F
			Voice coil motor	TA7272P, TA8407P/F
	Printer	Carriage	Stepping motor	TD62803P, TA7289P/F, TA8425H, TA8435H
		Feed (paper, typing ribbon)	Stepping motor	TD62803P, TA7289P/F, TA8425H, TA8435H
		Daisy wheel drive	Stepping motor	TA7289P/F, TA7774P/F, TA8430AF
		Polygon mirror drive (for laser printer)	Servo	TC9142AP, TC9203AP/AF
			Hall motor	TA7248P, TA7259P
	Optical disk	Spindle	Servo	TC9142AP, TA9203AP/AF
			Hall motor	TA8423P/F, TA7259P/F
	Facsimile (FAX)	Feed	Stepping motor	TA7289P/F, TB6500AH(system driver)
		Cutter	Bridge driver	TA7279AP, TA7267BP
	Electronic typewriter	Carriage	Stepping motor	TA7289P/F, TA8415P, TA8425H, TA8435H
		Ribbon feed	Stepping motor	TA7289P/F, TA7774P, TA8415P
		Paper feed	Stepping motor	TA7289P/F, TA7774P/F, TD62803P, TA8425H
			Bridge driver	TA7279P, TA7267BP, TA7291P
		Daisy wheel	Stepping motor	TA7289P/F, TB6500AH(system driver)
	Copier	Drum	Hall motor	TA8443F, TA8412P, TA7712P
		Lens, mirror	Stepping motor	TA7289P/F, TA8425H, TB6500AH, TA8415P
			Hall motor	TA7712P, TA8412P
		Scanner	Stepping motor	TD62803P, TA7289P/F, TA8415P
		Toner hopper	Bridge driver	TA7291P
		Heat roller	Hall motor	TA7712P, TA8412P, TA8443F,
		Fan	Hall motor	TA7247AP, TA7284P/F, TA8414P/F, TA8420AF
		Paper feed	Hall motor	TA7712P, TA8412P
			Stepping motor	TD62803P, TA7289P/F, TA8415P
	Wordprocessor	Printer	Stepping motor	TB6500AH(system driver)
	Fan motor	Fan	Hall motor	TA8420AF, TA8414P/F, TA7247AP
Electric home equipment	Camera	Film feed, lens control	Bridge driver	TA7733F, TA8401F, TD62M4700F
	Air conditioner	Fan	Hall motor	TA7247AP, TA8414P/F
	Fan heater	Fan	Hall motor	TA7284P, TA7247AP
	Sewing machine	Stitching, cloth feed	Stepping motor	TA8415P, TA7289P, TB6500AH

	Equipment	Function	IC used	Recommendable IC's
AV	Video cassette recorder (VCR)	Controller	Servo	TD6360N/F, TD6320N
		Capstan	Hall motor	TA7259P/F, TA7745P/F, TA7262P/F, TA8402F, TA8423P/F, TA8424F, TA8416F
		Drum	Hall motor	TA8402F, TA7259F, TA7736P/F, TA7735F, TA8423P/F, TA8424F, TA8416F
		Reel	Hall motor	TA7259P/F, TA7262P/F, TA8423P/F
		Loading	Bridge driver	TA7288P, TA7279P/AP, TA7291P/S, TD62M4700F
	Compact disk player (CDP)	Spindle	Bridge driver	TA7256P, TC9201F
		Focus, tracking	Bridge driver	TA7256P, TA8102P, TA8406P/F, TA8410P/K
		Carriage	Bridge driver	TA7256P, TA7267BP, TA8406P/F, TA7291P/S
	Video disk player (VDP)	Spindle	Hall motor	TA7713P, TA7248P, TA8413P
		Loading	Bridge driver	TA7267BP, TA8419P, TA7291P/F
	Tape recorder (ATR)	Capstan	Hall motor	TA7260P, TA7715P (servo)
		Reel	Bridge driver	TA7291P/S/F
	Disk player (ADP)	Spindle	Hall motor	TA7260P, TC9142AP(PLL)
		Arm drive	Hall motor	TA7256P, TA8406P/F, TA8410P/F/K
	Cassette tape recorder		Hall motor	TA8416F, TA8422F
	Fan motor	Fan	Hall motor	TA8420, 21AF, TA8414P, TA7247AP
FA	Robot and various automatic machines		Hall motor	TA7712P, TA8412P, TA8443F
			Bridge driver	TA8428K, TA8429H, TA7279P, TA7291P
			Stepping motor	TA7289P, TA8415P, TA7774P, TA8425H, TA8435H

3-2 PPC, Facsimile, Printer, and Electronic Typewriter

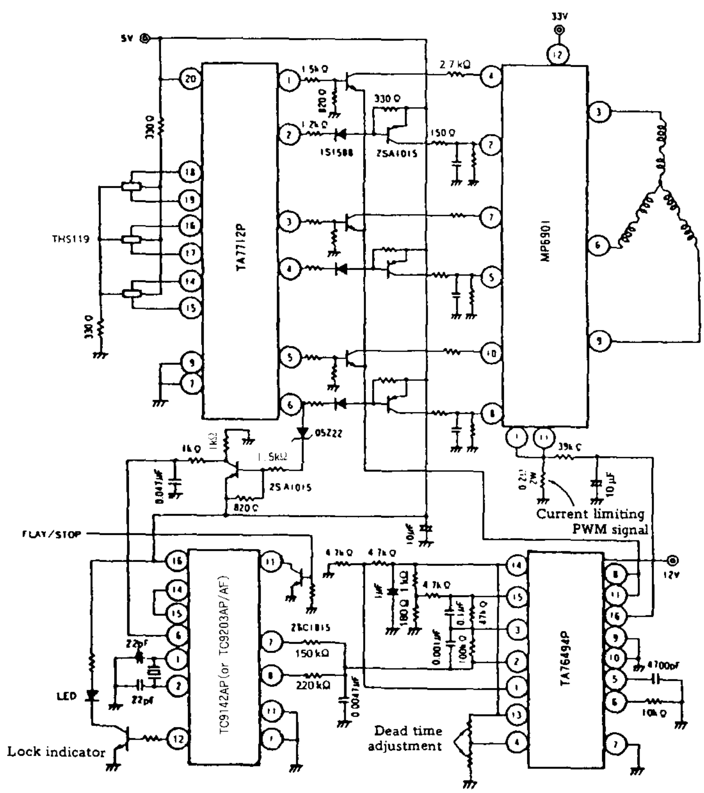


PPC

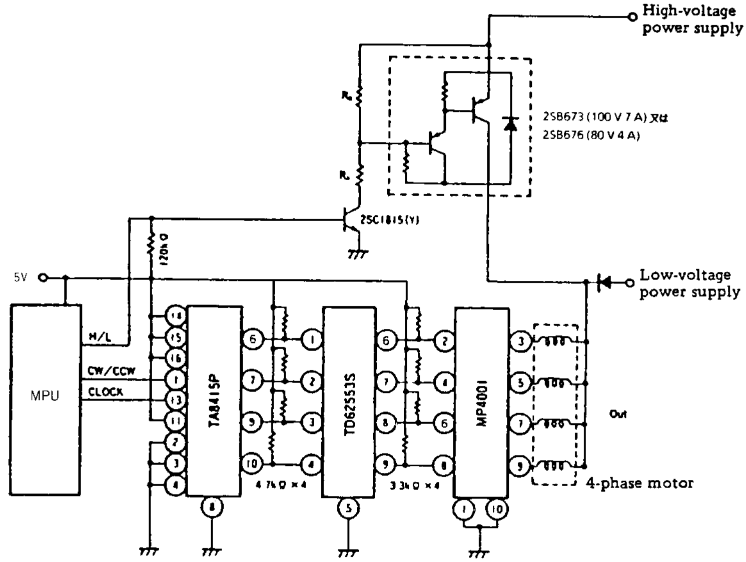
Drive	Motor	Model	Function
Developer/ Heat Roller	Hall motor	TC9142AP(TC9203AP/AF) + TA7712P + TA76494P + MP6901	PLL/PWM drive
		TA8443F + MP6901	
Mirror, scanner, lens	Stepper	TA8415P + MP4001 or TD62308BP-1	3-/4-phase unipolar drive
		TA8425H, TA8435H	PWM chopper, quasi sinusoidal micro step
		TA8411L, TB6500AH	PWM chopper, system drive
Paper feed	Stepper	TA8415P + MP4001 or TD62308BP-1	3-/4-phase unipolar drive
Fan	Hall motor	TA7247P	3-phase bipolar drive
		TA8414P/F + 2SC2883 (Y) x 2	2-phase unipolar drive
		TA8420AF	
Polygon Mirror	Hall motor	TA8453AF	Driver with PLL Controlar
		TA8434F	Driver with FLL Controlar

* Under development

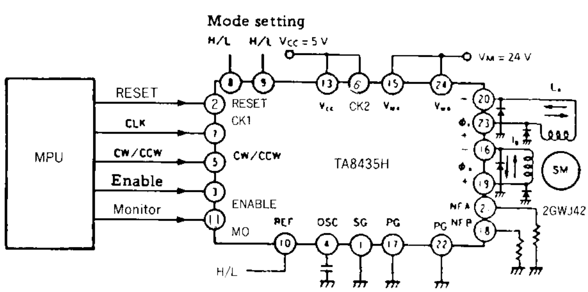
1) Motor drive circuit for PPC developer and heat roller (TA7712P, TC9142AP, TA76494P, MP6901)



2) Motor drive circuit for PPC paper feed and carriage (TA8415P, TD62553S, MP4001)

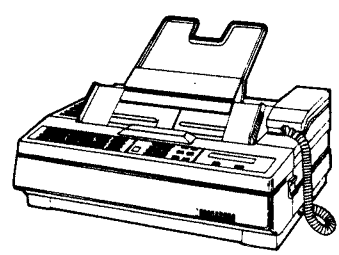


3) Quasi sinusoidal micro step stepping motor drive circuit for PPC (TA8435H)

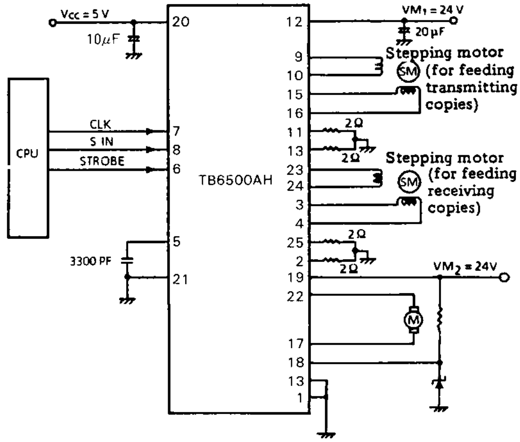


Facsimile

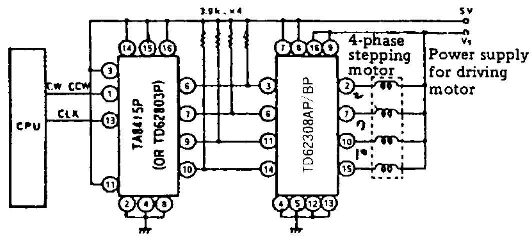
Drive	Motor	Model
Feed	Stepping	TA8415P x 2 + TD62083AP TA7289P/F x 2 TD62064AP BP-1 AF TD62164AP BP AF TD62308AP BP-1 AF TD62318AP AF
Paper Cut	DC	TA7267BP TA7291P/F TA8428K
System driver		TA8411L TB6500AH



1) System driver for Facsimile, printer, and electronic typewriter (TB6500AH)



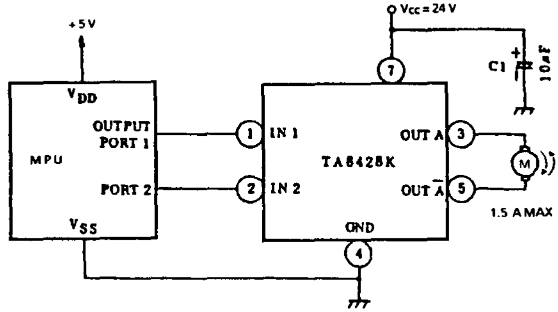
2) General-use paper feed motor drive circuit (TA8415P, TD62308AP/BP)



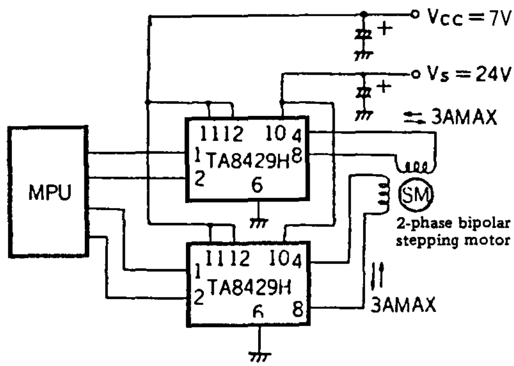
○ Printer and electronic typewriter

Drive	Motor	Model	Max. rating		Package	Function
			Vcc (V)	Io (A)		
Carriage	Stepper	TA7289P/F	30	0.7	HDIP14-P-500A/HSOP20-P-450	PWM chopper type, built-in 4-bit DAC
		TD62803P	7.28	0.4	DIP 16-P-600	3-/4-phase, 1-, 2-, or 1-2-phase excitation
		TA8415P			DIP 16-P-300A	Unipolar driver
		TA8425H	5.5, 40	1.5	HZIP25-P	PWM chopper type, micro step, quasi-sinusoidal system driver
		TA8435H				
	DC motor	TA7257P	25	1.5	HSIP7-P	Single-bridge driver
		TA7279P/AP	20, 25	1.0 x 2	HDIP14-P-500A	Dual-bridge driver
		TA8428K	30	1.5	HSIP7-P	Single-bridge driver
		TA8429H	30	3.0	HZIP12-P-B	
		TA8412P	18	100mA	DIP20-P-300A	Hall motor controller
		TA7712P	8	25mA		
		TA8443F	–	–	QFP60-P-1414F	PLL/PWM motor controller (for hall motor)
Paper feed	Stepper	TD62803P	7.28	0.4	DIP 16-P-600	3-/4-phase, 1-, 2-, or 1-2-phase excitation
		TA8415P			DIP 16-P-300A	Unipolar driver
		TD62064P/AP/BP-1	35/50/80	1.5	DIP-16-P-300A	4-channel NPN Darlington transistor array
Daisy wheel	Stepper	TA7289P/F	30	0.7	HDIP14-P-500A/HSOP20-P-450	PWM chopper type, built-in 4-bit DAC
		TA7774P/F	7.17	0.35	DIP16-P-300A/HSOP16-P-300	2-phase bipolar dual-powered driver
	DC motor	TA7279P/AP	20/25	1.0 x 2	HDIP14-P-500A	Dual-bridge driver
Ribbon feed	DC motor	TA7291P/S	25	1.0	HSIP10-P/SIP9-P-A	Single-bridge driver
	Stepper	TA7774P/F	7, 17	0.35	DIP16-P-300A/HSOP16-P-300	2-phase bipolar dual-powered driver
Polygon mirror drive (for laser printer)	DC motor (hall motor)	TA8453AF (TC9203AF + TA7259P)	–	–	HQFP30-P-1010	PLL hall motor drive
System driver	Stepper DC motor (solenoid)	TA8411L TB6500AH	27	0.8 x 2 (stepper) 0.6 (DC motor)	HDIP24-P-500 HZIP25-P	2 stepper motors and one DC motor, or a solenoid are controlled by 12-bit serial signals.

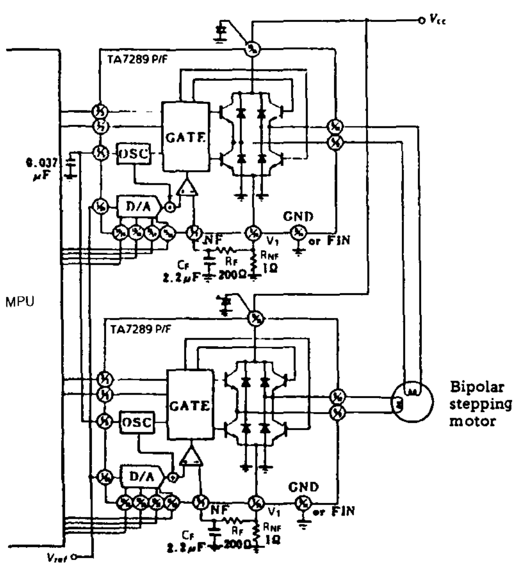
(1) PPC/printer DC motor drive circuit by bridge driver (TA8428K)



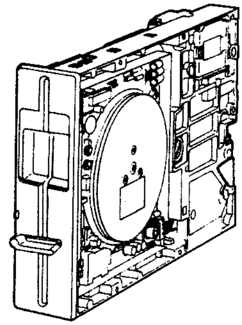
(2) PPC/printer large-current stepping motor drive circuit by bridge driver (TA8429H)



(3) Printer stepping motor drive circuit by PWM chopper type driver (TA7289P/F)

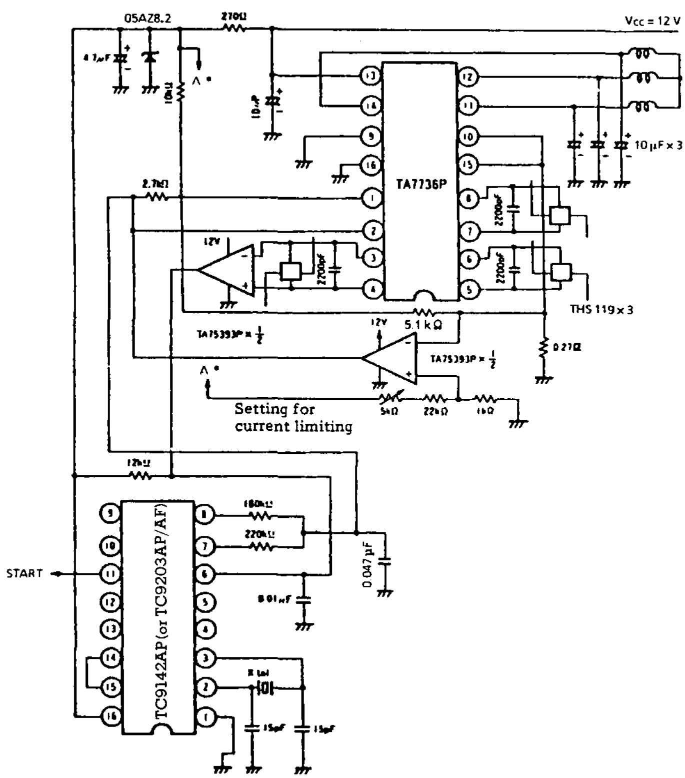


3-3 FDD, HDD, and Optical Disk



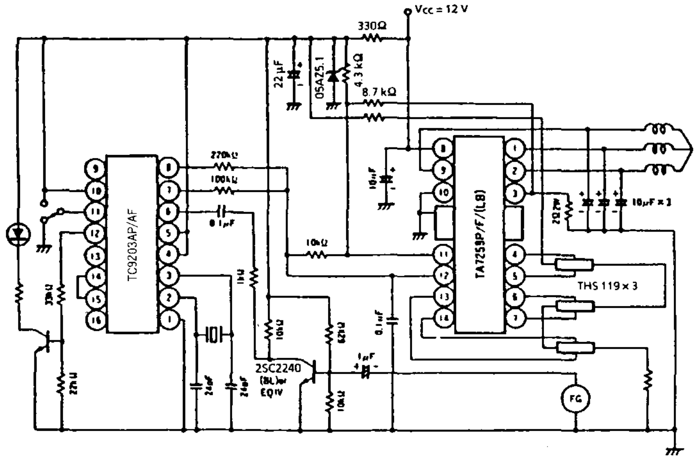
			Model
HDD	HDC		T7518, TC8561F
	Spindle motor drive		TC9142AP(or TC9203AP/AF)+TA7259P/F(5.25,PLL) TC9142AP(or TC9203AP/AF)+TA7736P/F(3.5,PLL) TA8453AF
	Head motor drive	Stepping Motor	TA7289P/F (PWM chopper micro step) TA7774P/F, TA8430AF
		Voice coil motor	TA7272P (or TA8407P/F), TA8410AK
FDD	FDMC		TC8605F(C), TC8615F-002, TC8606F-000, TC8616F-002
	Spindle motor drive		TC9142AP(or TC9203P/F) + TA7259P/F(5.25, PLL) TC9142AP(or TC9203P/F) + TA7736P/F(3.5, PLL) TA8434F(FLL 1 chip, 5/12V), TA8463F(FLL 1Chip, 5V)
	Head motor drive (stepping motor)		TA7774P/F (Dual-powered, power-saving function provided)
			TA8430AF
			TA8437F, 6V, 0.3A smart MOS IC

(1) PLL spindle motor drive circuit for 3.5-inch HDD (TC9142AP + TA7736P)

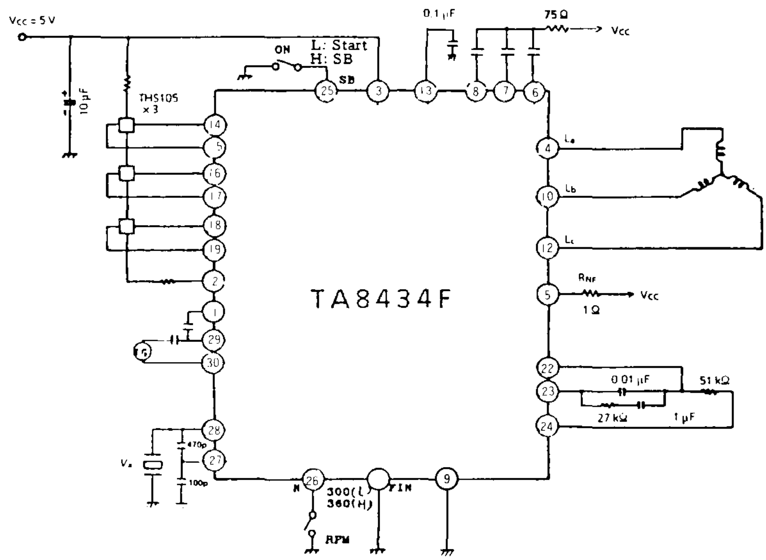


* 3.5-inch HDD can be also driven by output driver TA7259P/F. Flat-type TA7736F is also available instead of TA7736P.

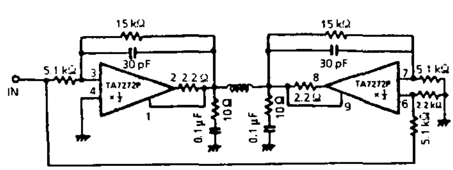
(2) PLL spindle motor drive circuit for 5.25-inch FDD (TC9203AP/AF + TA7259P/F)



(3) Spindle motor drive circuit for 3.5-inch and 5.25-inch FDD (TA8434F)

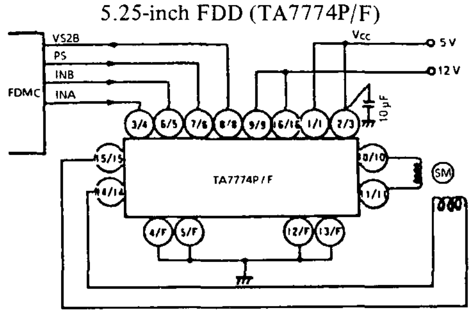


(4) HDD voice coil motor drive circuit (TA7272P)



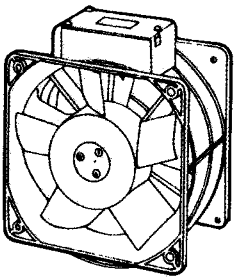
* Flat-type TA8407F is also available.

(5) Head motor drive circuit for 3.5-inch and 5.25-inch FDD (TA7774P/F)



* Low-voltage TA8430AF is being produced. Smart MOS IC TA8437F is being marketed.

3-4 Fan Motor

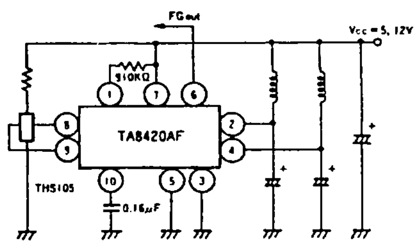


Recommendable IC's

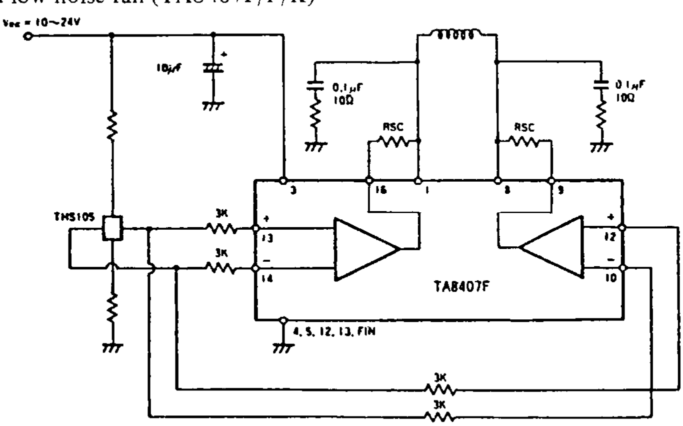
	Recommendable IC			Output configulation
	Hall sensor	Controller	Output driver	
DC fan (supermicro-size)	THS100 Series	TA8420, 1AF (30V, 1.0A)		2-phase, unipolar
		*TA8473F (30V, 1.2A)		2-phase, unipolar low noise, speed change
		TA8462F (35V, 1.5A)		2-phase, unipolar, low noise
		TA8414F/P	2SC2883 (or EQIV)	2-phase, unipolar, Single-phase, bipolar
	THS100 Series	TA8407P/F (36V, 1.2A)		Single-phase, bipolar
DC fan (micro-size)	THS100 Series	TA7259P/F (26V, 1.2A)		3-phase, bipolar
		TA7284P/F (24.5V, 0.6A)		2-phase, bipolar
		TA7247AP (38V, 1.5A)		3-phase, bipolar
DC fan (medium size)	THS100 Series	TA7247AP TA7712P/F TA8412P	MP6901 or MP3003 + MP3007 (80V, 4A)	3-phase, bipolar
		TA7759P	MP4001 (60V, 4A)	4-phase, unipolar

*Under development

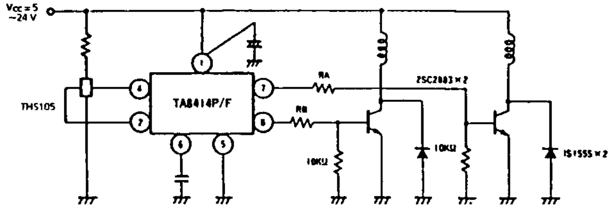
(1) Supermicro-sized fan (TA8420AF)



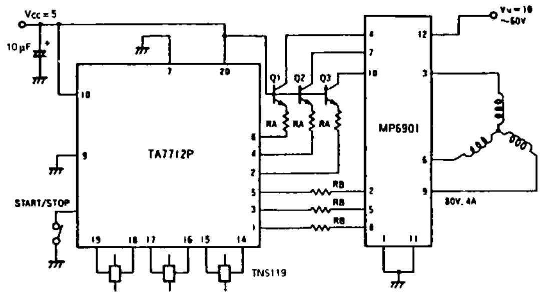
(2) Micro-sized low-noise fan (TA8407P/F/K)



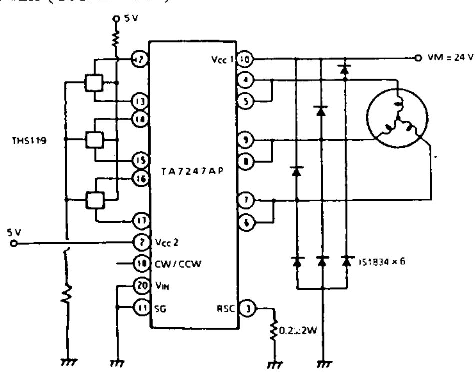
(3) Supermicro-sized fan (TA8414P/F + 2SC2883)



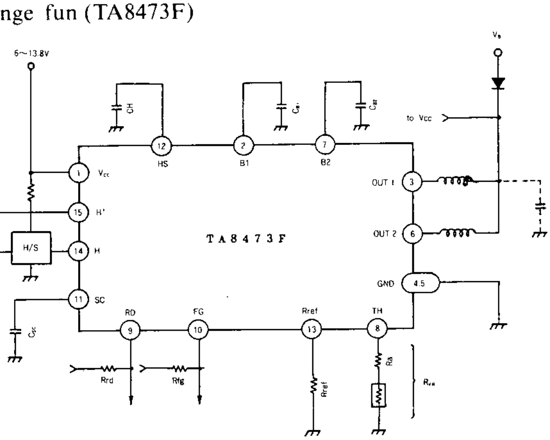
(4) Medium-sized fan



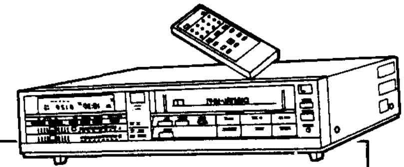
(5) Medium-sized fan (TA7247AP)



(6) Speed change fun (TA8473F)

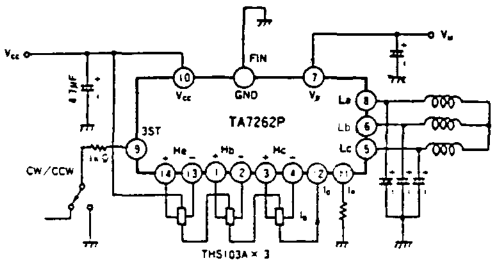


3-5 VCR

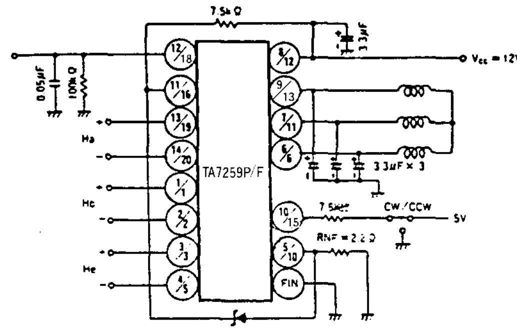


Category	Model	Characteristics	Max. rating		Package	Application
			VCC(V)	IO(A)		
Drive for capstan/ head hall motor	TA7259P/F	General-use, 3-phase full-wave current drive	26	1.2	HDIP 14-P-500A/ HSOP 20-P-450	For home use-type capstan/head motor
	TA8423P/F	General-use, 3-phase full-wave current drive	18	1.2	DIP 16-P-300A/ HSOP 16-P-300	For home use-type capstan/head motor
	TA8424F	3-phase full-wave current drive, low-noise, built-in FG Amp.	18	1.2	HSOP 20-P-450	For noiseless-type HiFi VCR capstan/head motor
	TA7262P/F	General-use, 3-phase full-wave voltage drive	25	1.5	HDIP 14-P-500A/ HSOP 20-P-450	For home use-type capstan (TA7262P)/head motor (TA7262F)
	TA8416F	3-phase (half-) full-wave voltage drive	8	0.7	SSOP16-P-225A	For low-voltage portable VCR 3-phase hall motor
	TA7745P/F	3-phase (half-) full-wave voltage drive, low-voltage use	18	1.0	HSOP 16-P-300/ SSOP 16-P-225A	For portable VCR capstan/head motor
	TA8402F	3-phase (half-) full-wave voltage drive, low-voltage use	18	1.0	HSOP20-P-450	For portable VCR capstan/head motor (version-up IC of TA7745P/F, built-in control Amp.)
	TA7735F	Hall sensorless, built-in Switching regulator 3-phase half-wave	30	1.2	SSOP 24-P-300	For portable VCR head motor, sensorless and high-efficiency, ideal for motor driver of VHS-C and 8mm VCR
	TA7736P/F	3-phase full-wave current drive	26	1.0	DIP 16-P-300A/ HSOP 16-P-300	Same circuit as that of TA7259P/F, economic type, general-use
	TD62M3700F	3-phase full-wave module	30	1.5	SSOP 16-P-225A	Module based on 2SA1203 and 2SC2883
	TD62M3701F	3-phase full-wave module	10	2.0	SSOP16-P-225A	Built-in diode, based on RN5006 and RN6006
Bridge driver IC for loading	TA7291P/F/S	Output voltage adjustable, single type with stand-by function	25	1.0/ 0.4/ 0.4	HSIP10-P/ HSOP 16-P-300/ SIP9-P-A	Offering a full line of general-purpose peripheral units with various functions (output voltage adjustable, through-current restriction, standby, thermal shut down, permitting choice between TA7291P/S for home use types or TA7291S/F for portable types.
	TA7288P	Output voltage adjustable, sequential dual type	25	1.0	HSIP 10-P	For 2-motor loading drive type VCR (for cassette and tape)
	TA7267BP/ TA8419P	Single type	25	1.0	HSIP 7-P-A/ DIP 16-P-300A	General-use
	TA7279AP	Dual type	25	1.0	HDIP 14-P-500A	General-use, dual type
	TA8400P	Output voltage adjustable, dual type	25	0.4	DIP 16-P-300A	General-use, dual type
	TA8405S	Dual type	25	0.4	SIP9-P-A	General-use, dual type
	TA7733F	Single-type for low-voltage	18	0.5	SSOP 16-P-225A	For loading motor of portable VCR
	TD62M4700F	Super low-voltage, low-saturation voltage, built-in free-wheeling diode	10	2.0	SSOP 16-P-225A	Multichip IC based on low-saturation discrete transistor RN5006 and RN6006, ideal for loading motor of portable VCR
	TA8409S/F	Supermicro-sized type, output voltage adjustable	25	0.4	SIP9-P-A/ SSOP 10-P-225	Similar type of TA7291P/F/S (some functions not provided)
Servo controller	TD6803N	with built-in peripheral amp	5	—	SDIP 42-P-600	Application specified
	*TC9065N	with built-in peripheral amp/fully compatible with VISS and VASS	5	—	SDIP 42-P-600	Application specified
Others	TA8617S TA8618S	FG Amp.	5	—	SSIP 12-P	

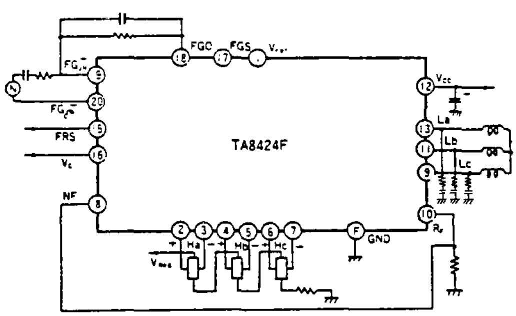
1) Voltage-control type capstan (head) motor drive circuit (TA7262P/F)



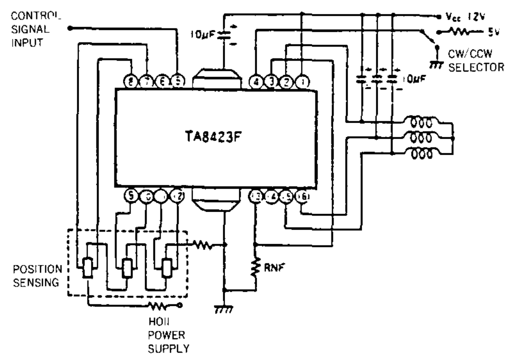
2) Current-control type capstan (head) motor drive circuit (TA7259P/F)



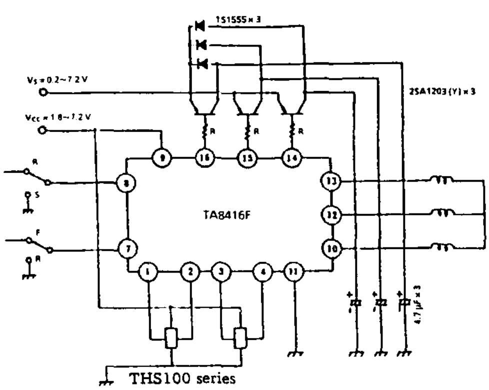
3) Low-noise current-control type capstan (head) motor drive circuit (TA8424F)



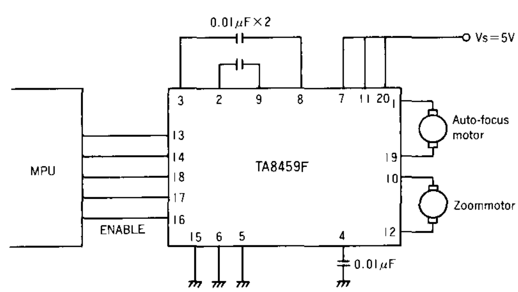
4) Current-control type capstan (head) motor drive circuit (less external component type, TA8423P/F)



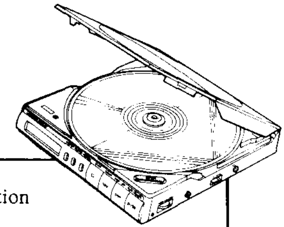
5) Portable VCR head motor drive circuit (TA8416F)



6) Auto-focus/zoom motor driver circuit for movie cameras (Smart MOS TA8459F)



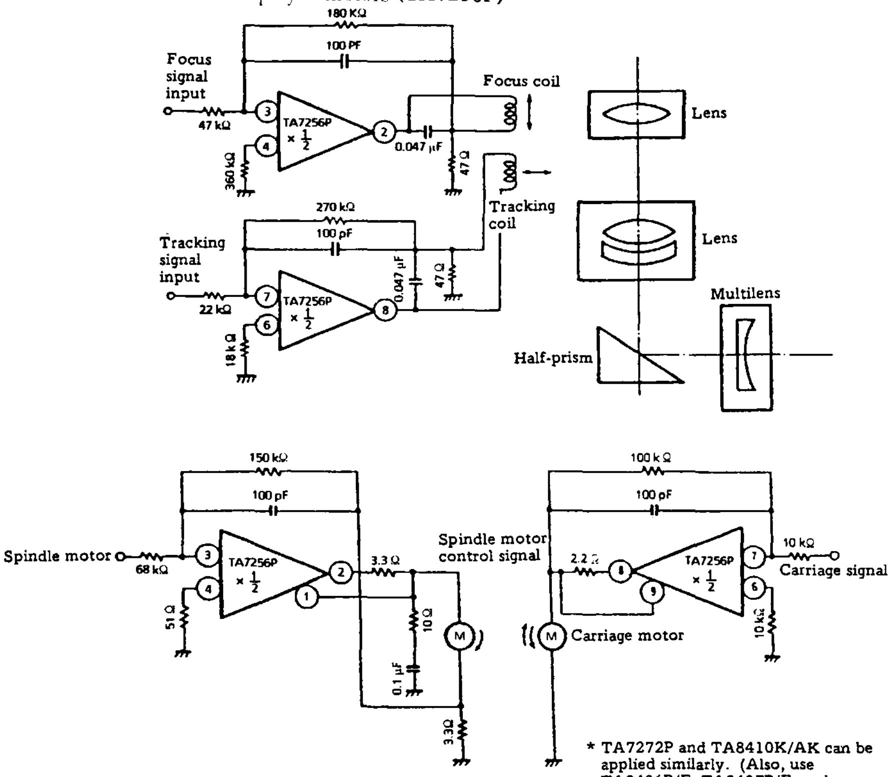
3-6 CDP and Camera



Motor Drive		Model	Max. rating		Envelope	Function
			V_{CC} (V)	t_0 (A)		
Bridge driver (for brush motor)	TA7256P	TA7256P	± 18	0.5	HSIP 10-P	Dual-power operational amplifier
		TA8406P			DIP 16-P-300A	
		TA8406F			HSOP 16-P-300	
	TA7272P	TA7272P	± 18	1.2	HSIP 10-P	Dual-power operational amplifier
		TA8407P			DIP 16-P-300A	
		TA8407F			HSOP 16-P-300	
	TA8102P	TA8102P	15	1.0	DIP 16-P-300A	Dual-power operational amplifier with boot strap, for portable CDP
	TA8212F	TA8212F	14.5	0.7	HSOP 20-P-450	Quad-power operational amplifier
	TA8410P	TA8410P	±9/±15	0.6	DIP 16-P-300A	Dual-power operational amplifier (economy type) TA8401/AK are high-voltage types
		TA8410F			HSOP16-P-300	
		TA8410K/AK			HSIP 10-P	
	TA8449P	TA8449P	± 15	0.6	HDIP 14-P-500A	Quad-power operational amplifier
Hall motor driver (for brushless motor)		TA7745P	18	1.0	DIP 16-P-300A	3-phase half-wave (full-wave) low-voltage motor driver
		TA7745F			SSOP 16-P-225A	
		TA8402F	18	1.0	HSOP 20-P-450	
		TA8422F	8	0.5	SSOP 10-P-225	2-phase half-wave low-noise hall motor driver
		TA8416F	8	0.7	SSOP 16-P-225A	3-phase half-wave low-voltage hall motor driver

- Available are TC9201F for servo processor and TA8101N for sense AMP.

(1) Drive circuit for CD player motors (TA7256P)



* TA7272P and TA8410K/AK can be applied similarly. (Also, use TA8406P/F, TA8407P/F, and TA8410P/ F, with different packages, depending on applications.)
High slew rate type TA8464K is available.

4. DATA SHEETS

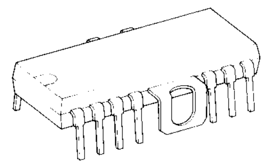
TA7245BP/BP(LB)/CP/F

DC MOTOR DRIVER IC.

The TA7245BP/CP are 3-phase Bi-directional motor driver IC.
It is designed for use VTR, tape deck, floppy disk and record player motor drivers.
It contains output power drivers, position sensing circuits, control amplifier and CW/CCW control circuit.

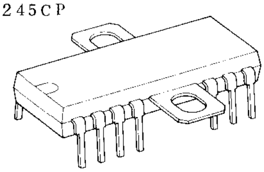
- 3-Phase Bi-Directional Driver and Output Current Up to ±1.2A.
- Few External Parts Required.
- Wide Operating Supply Voltage Range
  : $V_{CC(opr)}$ (MIN.)=7V
- Forward and Reverse Rotation is Controlled Simply by Means of a CW/CCW Control Signal Fed Into 10 PIN.
- High Sensitivity of Position Sensing Amplifier. (V_H=10mV(Typ.), Recommend to Use TOSHIBA Ga-As Hall Sensor "THS" Series.)
- Surge Protect Diode Connected for All Input Terminals. (Position Sensing, Control, CW/CCW Control Inputs.)
- DIP-14F (TOSHIBA 5D14BP-P) Power Package.

TA7245BP



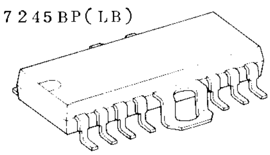
HDIP14-P-500A

TA7245CP



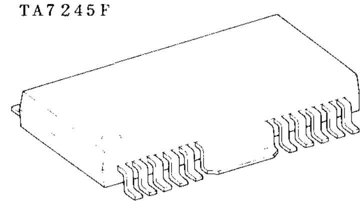
HDIP14-P-500

TA7245BP(LB)



HSOP14-P

TA7245F



HSOP20-P-450

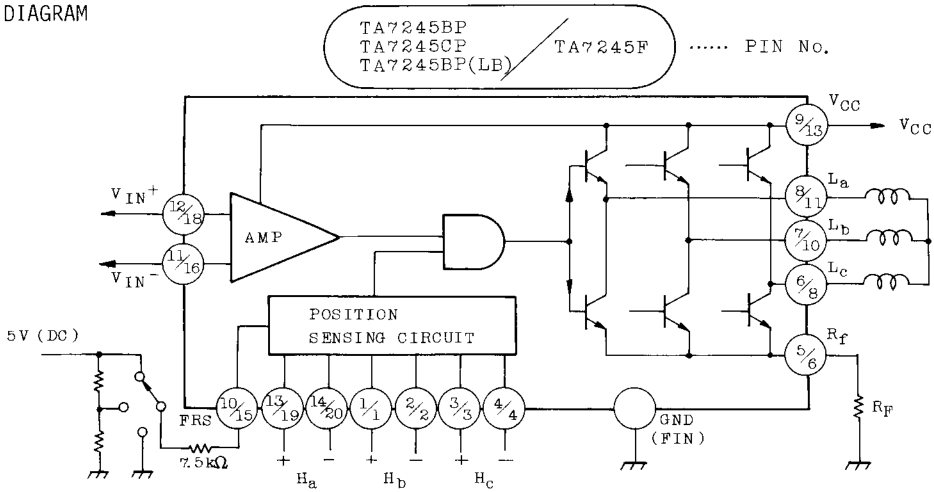
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage	TA7245BP	V_{CC}	26	V
	TA7245CP		30	
	TA7245BP(LB)		26	
	TA7245F		26	
Output Current		$I_{O(AVE)}$	1.2	A
Power Dissipation (Note)	TA7245BP	P_D	2.3	W
	TA7245CP		2.3	
	TA7245BP(LB)		2.3	
	TA7245F		1.0	
Operating Temperature		T_{opr}	-30∿75	°C
Storage Temperature		T_{stg}	-55∿150	°C

Note : Ta=25°C. Without heat sink

Weight:
HDIP14-P-500A: 3.0g (Typ.)
HDIP14-P-500 : 3.0g (Typ.)
HSOP14-P : 3.0g (Typ.)
HSOP20-P-450 : 0.8g (Typ.)

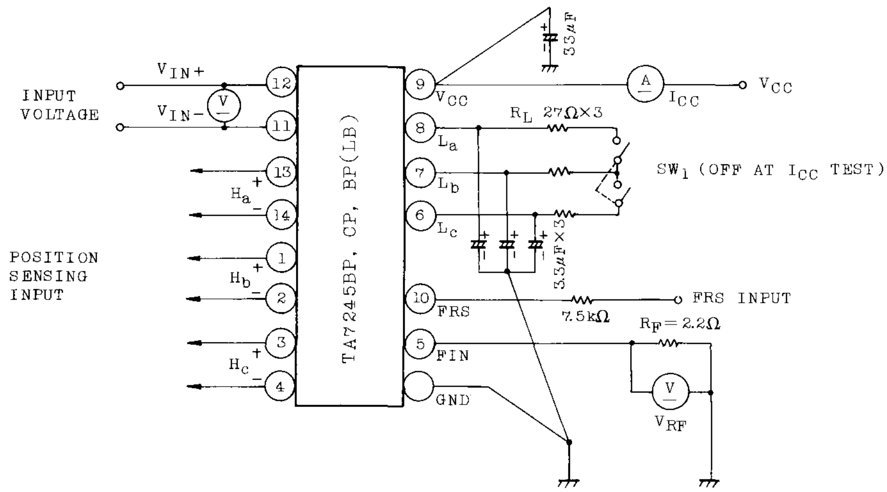
BLOCK DIAGRAM



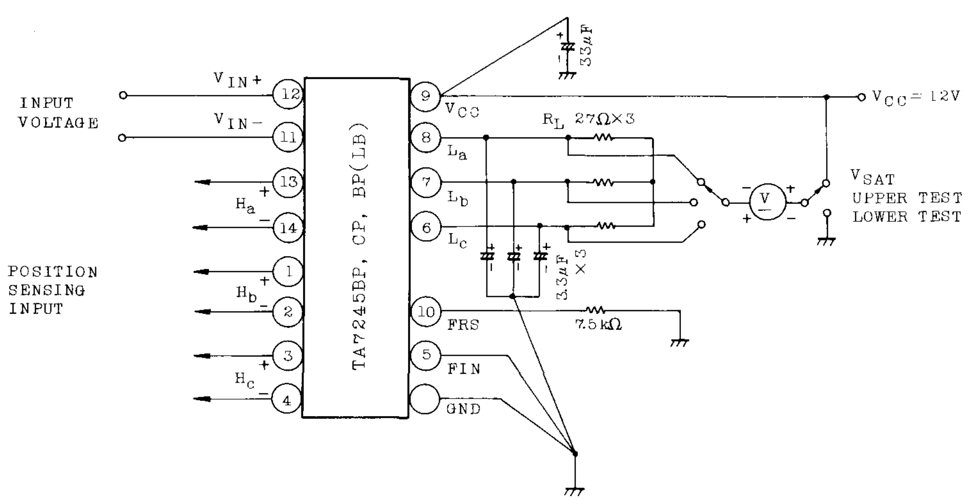
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=12V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC1}	–	FRS Open	2	4	7	mA
		I_{CC2}		FRS=5V	2	5	9	
		I_{CC3}		V_{CC}=22V, FRS=GND	2	5	9	
Input Offset Voltage		V_{IO}	–		–	40	–	mV
Residual Output Voltage		V_{OR}	–	$V_{IN}^{+}=V_{IN}^{-}$=7V	–	0	10	mV
Voltage Gain		G_V	–		–	5.5	–	
Saturation Voltage	Upper	V_{SAT1}	–	I_L=400mA	–	1.0	1.5	V
	Lower	V_{SAT2}			–	0.4	1.0	
Cut-off Current	Upper	I_{OC1}	–	V_{CC}=20V	–	–	20	μA
	Lower	I_{OC2}			–	–	20	
Position Sensing Input Sensitivity		V_H	–		–	10	–	mV
Maximum Position Sensing Input Voltage		$V_{H\ MAX}$	–		–	–	400	mV
Input Operating Voltage	Position	CMR-H	–		2.0	–	V_{CC}-2.5	V
	Control	CMR-C	–		2.0	–	V_{CC}-2.5	
Rotation Control Input Voltage	CW	V_F	–		–	0	0.4	V
	STOP	V_S	–		2.2	2.7	3.2	
	CCW	V_R	–		4.8	5.0	5.8	

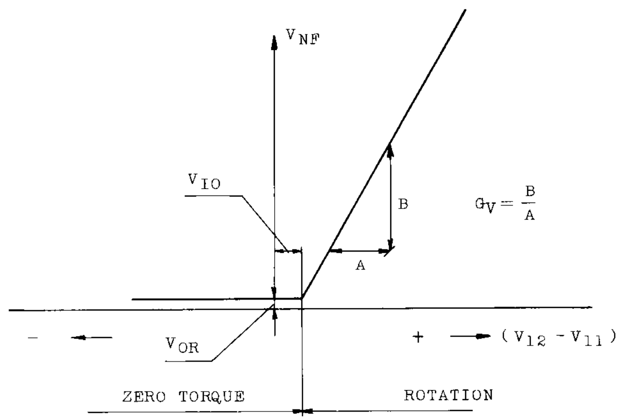
TEST CIRCUIT 1



TEST CIRCUIT 2



INPUT/OUTPUT CHARACTERISTICS

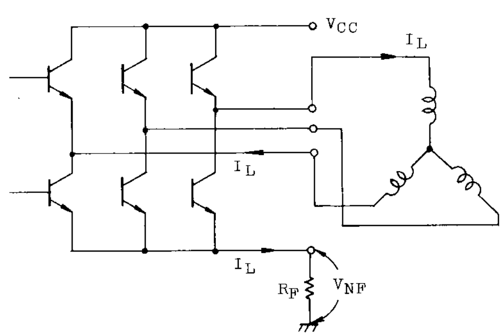


V_{NF} shows voltage drop at R_F.

That is, in the case of star connection, when coil current is I_L'

$$V_{NF}=R_F \cdot I_L$$

See the following circuit.



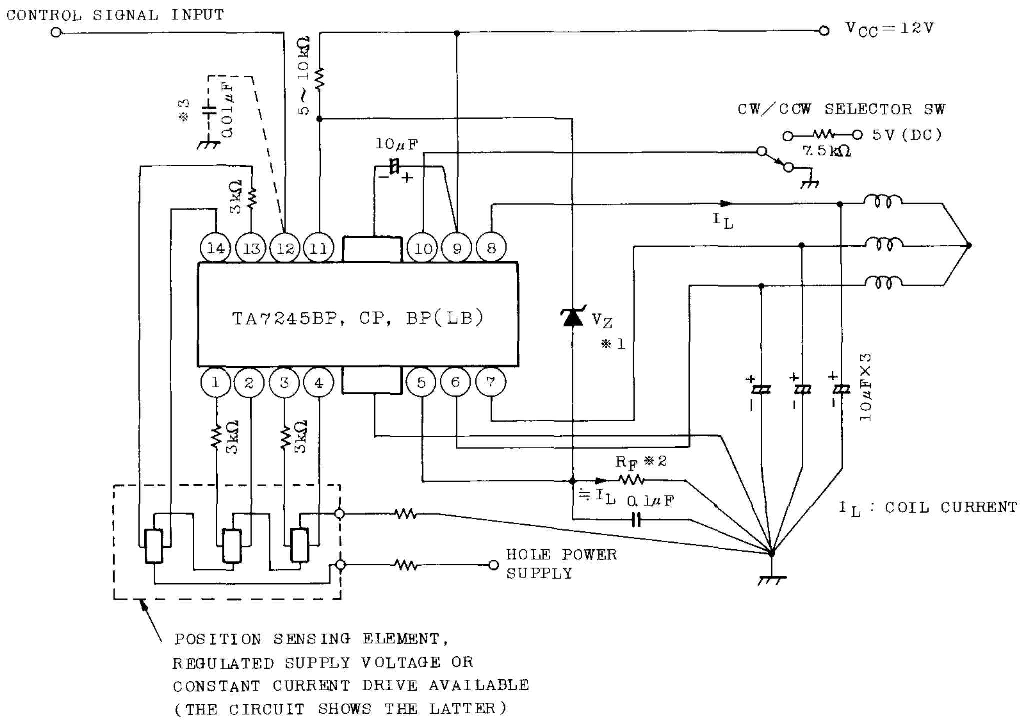
Further, if inputs (11 pin, 12 pin) are shorted or $V_{11} \geqq V_{12}$, torque at the circuit becomes zero. However, this zero torque state also can be obtained by setting FRS input (10 pin) to specified voltage or by placing the circuit in open state and this is rather advantageous as current consumption is less.

FUNCTION

FRS (CW/CCW/STOP) INPUT	POSITION SENSING INPUT			OUTPUT		
	H_a	H_b	H_c	La	L_b	Lc
L	1	0	1	H	L	M
	1	0	0	H	M	L
	1	1	0	M	H	L
	0	1	0	L	H	M
	0	1	1	L	M	H
	0	0	1	M	L	H
H	1	0	1	L	H	M
	1	0	0	L	M	H
	1	1	0	M	L	H
	0	1	0	H	L	M
	0	1	1	H	M	L
	0	0	1	M	H	L
M	1	0	1	High Impedance		
	1	0	0			
	1	1	0			
	0	1	0			
	0	1	1			
	0	0	1			

Note: "1" of the hole element input means that voltage above +10mV is applied to the positive side of each hall element from the negative side and "0" means that voltage above +10mV is applied to the negative side from the positive side.
In this case, needless to say, DC potential must be within the specified common mode voltage range of hall element input.
Further, "H", "M" and "L" of output mean $V_{CC}-V_{SAT1}=1/2\ V_{CC}$ and V_{SAT2}, respectively, and "L", "H" and "M" of FRS input mean application of voltage within specified values of V_F, V_R and V_S, respectively.
Further, by applying required voltage for control input ($V_{IN}+$, $V_{IN}-$), measure the circuit in operating state.

TA7245BP APPLICATION CIRCUIT 1

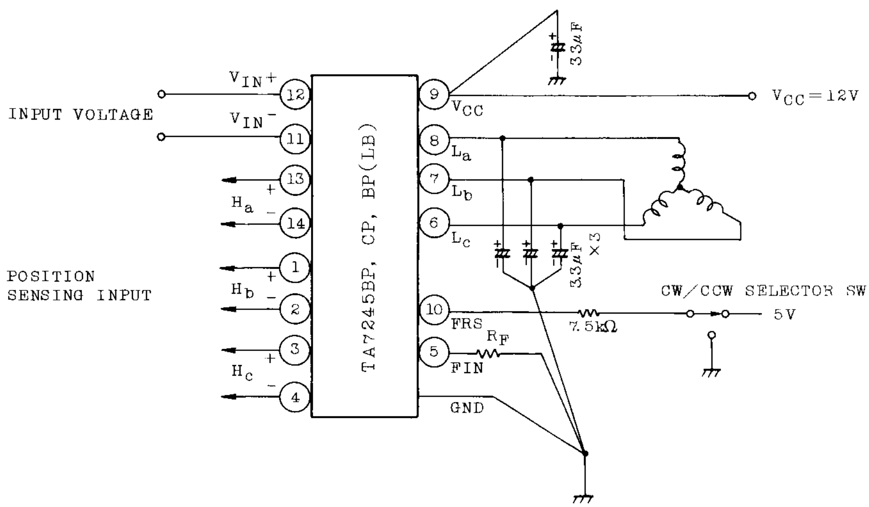


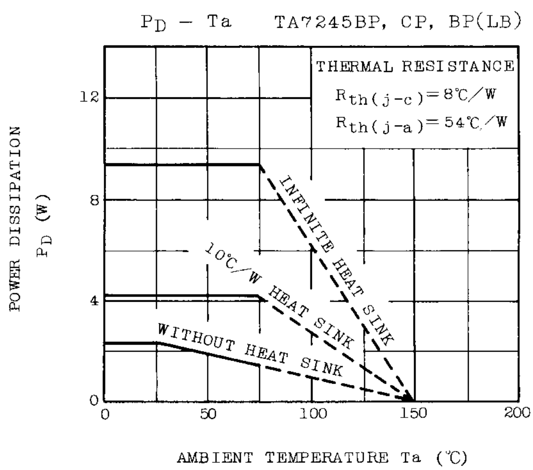
※1 V_Z of a ZENER diode should be decided in accordance with the DC level of control signal input. (V_Z=2.5~9V. If temperature characteristic is to be taken into consideration, 5V is recommended. Further, DC potential at the negative control input 11 pin becomes $V_Z+R_F \cdot I_L$)

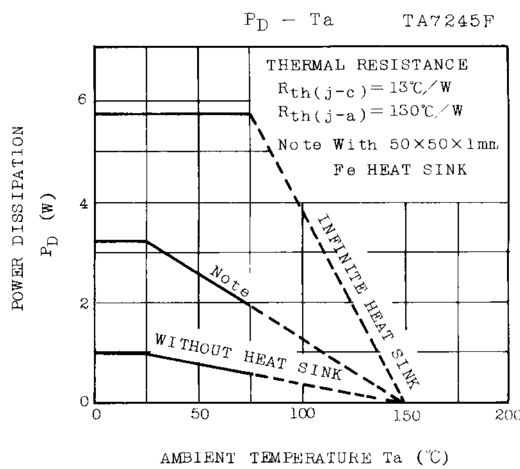
※2 As to R_F, although it should be decided acoording to coil impedance, F/V converted voltage (control input) and required starting torque, it is recommended to set at 0.3~5Ω.

※3 Connect, if required.

APPLICATION CIRCUIT 2







CONTROL SIGNAL INPUT METHOD

Normally, control voltage which is proportional to (or inversely proportional to) rotation speed (F/V converter etc.) is fed into the front stage of the TA7245BP differentially or single polarity. The gain from control input of the TA7245BP to output (at R_F terminal) is 5.5 times as indicated in the specification. It is however possible to improve characteristic of W/F, etc. by reducing the gain with NF applied.
It's application example is shown in the diagram below. Further, when NF is applied (Also, when not applied), it is necessary that DC voltages (V_{11},V_{12}) of control inputs (11 pin, 12 pin) are within the range of values ($2.0 \sim V_{CC}-2.5V$) shown in the standard. In addition, when input DC level and F/V converted output (control output) cannot be matched with IC input, a DC level shift diode and attenuator should be inserted in front of IC input. An example is shown in Fig. 1-c.

a) IN CASE OF POSITIVE INPUT

$(N \propto \frac{1}{V_{cont}})$

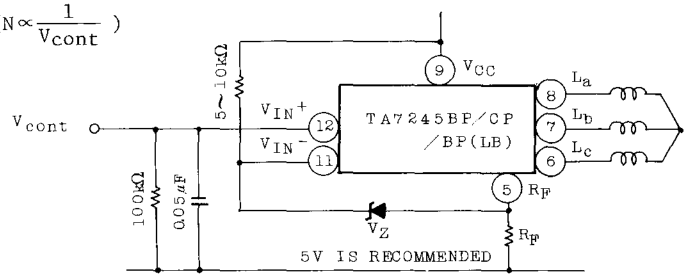


Fig. 1-a

$V_{11} \fallingdotseq V_Z$

$V_{12} \fallingdotseq V_{cont}$

b) IN CASE OF NEGATIVE INPUT

$(N \propto V_{cont})$

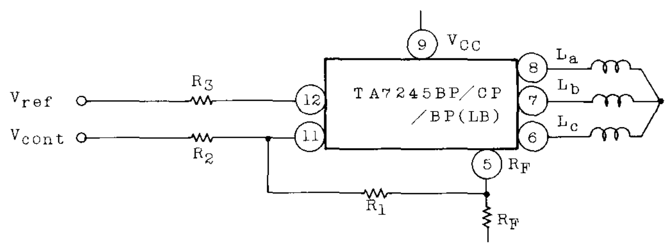
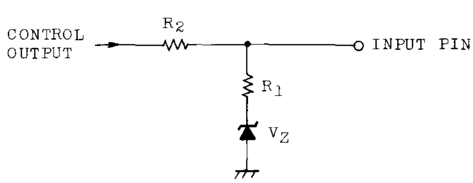


Fig. 1-b

$R_3 \fallingdotseq \frac{R_1 R_2}{R_1 + R_2}$

$V_{12} \fallingdotseq V_{ref}$

$V_{11} \fallingdotseq V_{cont} \cdot \frac{R_1}{R_1 + R_2}$

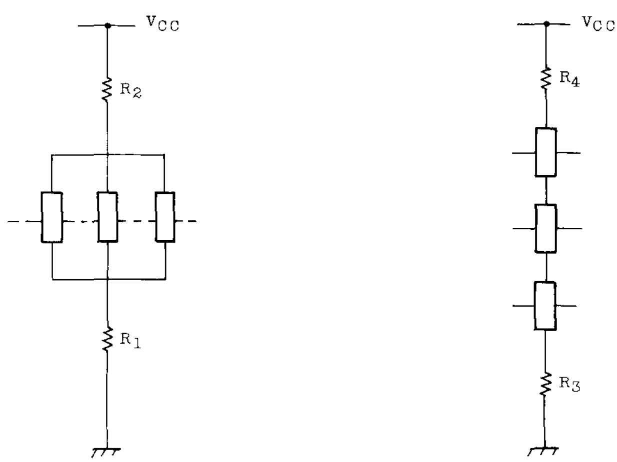


DC level of control output is shifted by a zener diode and control signal output is attenuated by R_1 and R_2.

Fig. 1-c

POSITION SENSING ELEMENT DRIVING METHOD

The TA7245BP has a wide range of common mode voltage range (the specification is 2 to V_{CC}-2.5V and therefore, 2 to 9.5V when V_{CC}=12V) of the position sensing element (generally, a hall sensor) input and therefore, both the constant current drive and constant voltage drive of a hall sensor are applicable.
As a hall sensor, Toshiba Ga-As hall sensor THS series are recommended.
When compared with In-Sb hall sensor, the Ga-As hall sensor has various merits such as excellent mechanical strengths, temperature stability and less saturation characteristic to magnetism and current.
However, it is considered that use of this sensor was so far difficult as it's sensitivity is lower than In-Sb hall sensor. On the TA7245BP in order to make it possible to use the Ga-As hall sensor which has merits on almost all items except sensitibity, sensitivity of the position sensing amplifier has been increased with less offset voltage. Further, if W/F characteristic is poor, increase of hall input may be effective in some cases. (However, be careful not to exceed max. allowable input).



POSITION SENSING ELEMENT DRIVING METHOD (1) (2)

(For details refer to the technical data for Toshiba Ga-As hall sensor THS series.)

CAUTIONS IN APPLICATION

IC for motor drive have several high impedance input terminals such as hall element input, control signal input, etc. and to handle a switched high output current. Because of such a reason. Care should be taken not to make a parasitic oscillation path caused by unnecessary feedback.

Further, as load is a coil, it is necessary to pay attention to prevent destruction by impulse at time of ON/OFF, particularly, application of voltage and current in excess of standard values to the output transistor when supply voltage is at high level (V_{CC}=18V or above). It is recommended to use the TA7245BP at supply voltage below 12V and the TA7245CP at below 18V. If they are used supply voltage above these values, the above-mentioned cautions should be followed.

(1) CAUTIONS FOR RELIABILITY DESIGN

a) Do not into the output transistor inside IC into the high voltage and current operating region.
(Especially, when a motor is locked, V_{CC} is ON/OFF, output is shorted, etc.)

b) It is desirable to design the output ringing absorbing capacitor in capacitance as small as possible (the output transistor may be destructed by charging/dis-charging current of this capacitor in some cases).
If it becomes a problem, it is recommended to review not only capacitance but also connecting point and connecting method (delta or star connection) in addition to taken an oscillation preventing measure described later further-more, to insert resistor (3Ω to 30Ω) in series to the capacitor.

c) In installing to a printed circuit board, be careful not to apply an abnormal force to the fin of IC and moreover, to solder in several seconds (at 260°C).

d) It is an effective method for assuring reliability to provide a large earthing area on a printed circuit board to promote heat-radiation from the soldered fin of IC.

(2) CAUTIONS FOR WIRING

It is recommend to design a print pattern with the following methods taken into consideration in order to prevent parasitic oscillation.

a) The output coil current path line should be provided separately from other earth one because the coil current includes switched high current.
In particular, it is recommended to design a line from R_F terminal (5 pin) to the earth so that it's impedance does not become common to other circuits. (This is especially important.)
If this is not possible or oscillation cannot be eliminated completely, it is adviced to connect a capacitor of 0.001～0.1μF paralelly with R_F.

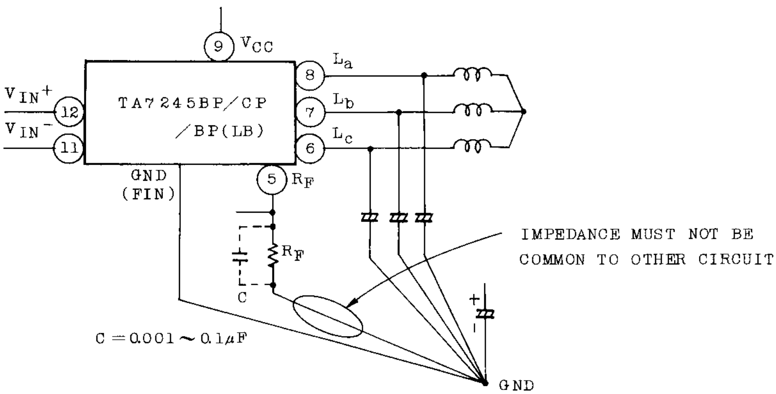


Fig. 2

b) It is also recommended to provide the hall element drive current path independently. (Especially, separately from the output current path)
Further, if plunging input to the position sensing element is expected, it is advised to insert a capacitor of 0.05～1μF between the plus (+) and minus (-) terminals of each position sensing input.
In addition, it should be also consider to insert resistors in series to all hall element inputs. If plunging input to control input is expected, connect a capacitor of 0.001～0.1μF between control terminal and GND.

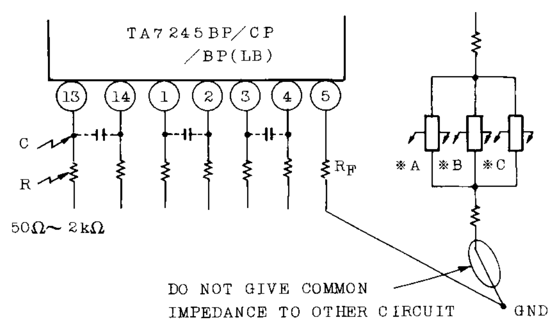


Fig. 3

c) If parasitic oscillation in a high frequency range above 5MHz is observed, commonly connect the capacitors from all coil outputs and connect a capacitor (C=0.01~ 0.1μF) to R_F terminal (5 pin) from this connecting point (Fig. 4-a). Further, it is also recommended to consider a method to connect capacitors to R_F terminal from respective coil outputs separately from the ringing absorbing capacitor (Fig. 4-b).

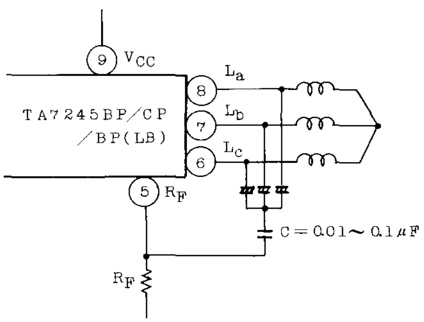


Fig. 4-a

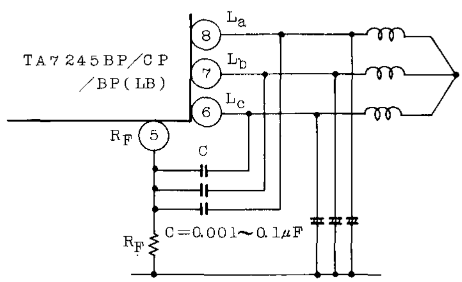


Fig. 4-b

d) It is recommended to connect a path capacitor directly from V_{CC} terminal (9 pin) without giving common impedance to GND. Further, it is also effective to insert C_2 (0.01~ 0.1μF).

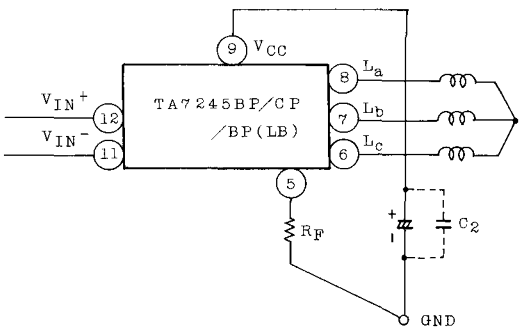


Fig. 5

(3) CONNECTION OF OUTPUT RINGING ABSORBING CAPACITOR

It is advised to connect the output ringing absorbing capacitor to GND from each coil terminal. In addition, it is also advised to consider the following methods from the viewpoint of parasitic oscillation prevention as well as destruction prevention.

a) Change of capacitance
b) Delta connection (Fig. 6-a)
c) Connection to V_{CC} instead of GND (Fig. 6-b). In this case, however, attention should be paid to destruction. If voltage/current locus is outside ASO, it is necessary to connect resistors in series with capacitors.
And propose to connection to R_F terminal.
d) Connect resistors in series with capacitor (Fig. 6-c).
e) Combination of a), b), c) and d).

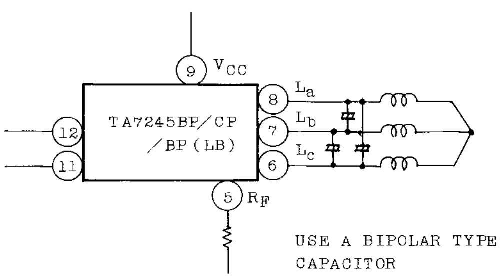


Fig. 6-a

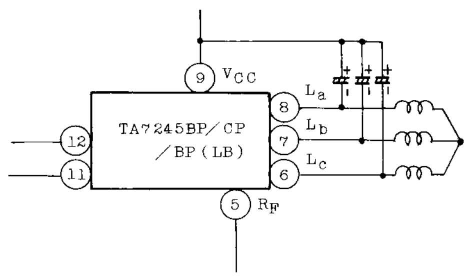


Fig. 6-b

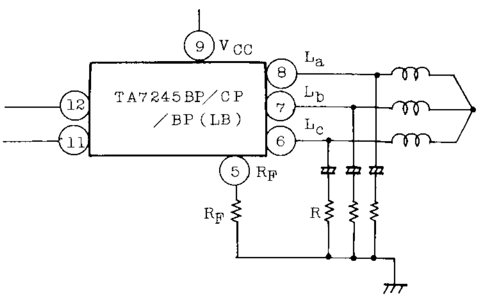


Fig. 6-c

OTHER CAUTIONS

Depending upon capacity and connecting method of the output capacitor, the output transistor inside IC may be destructed in some cases and it is therefore recommended obtain voltage/current locus of the output transistor through the measurement shown below and confirm that the locus is within ASO. (Especially, the measurement at time of SW ON/OFF, CW rotation→CCW rotation→ CW rotation is important).

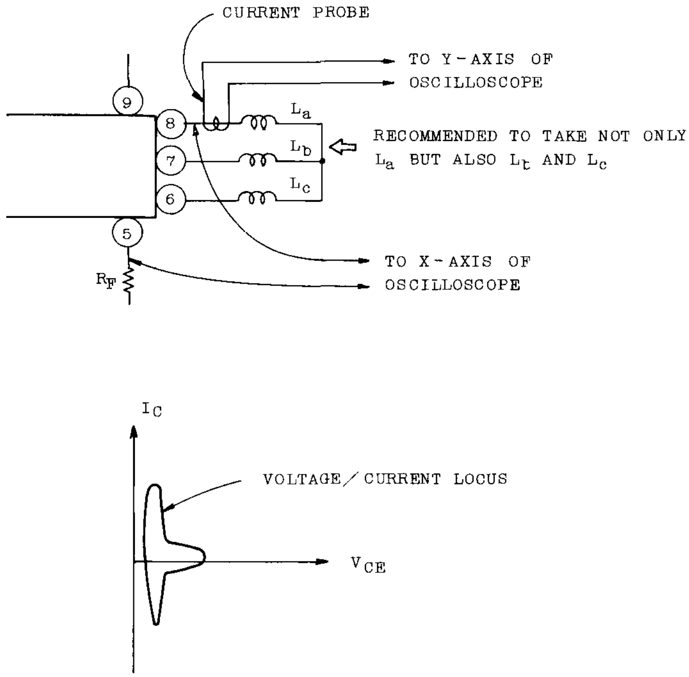
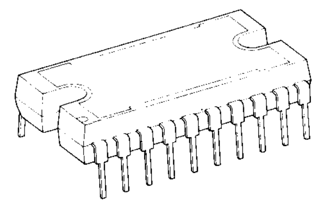


Fig. 7

TA7247AP

DC MOTOR DRIVER.

The TA7247AP is a 3-phase Bi-directional supply-voltage-controlled motor driver IC providing all the active functions necessary for switching-regulator-controlled FAN MOTOR of electrical Air conditionor.
It's designed for especially energy saving air conditionor applications and suitable for use any other motor driver applications.
It contains 3-phase Bi-directional power driver, CW/CCW control circuit, comparator and oscillator for switching regulator, and protect circuits.



HDIP20-P

Weight: 8.2g (Typ.)

FEATURES:

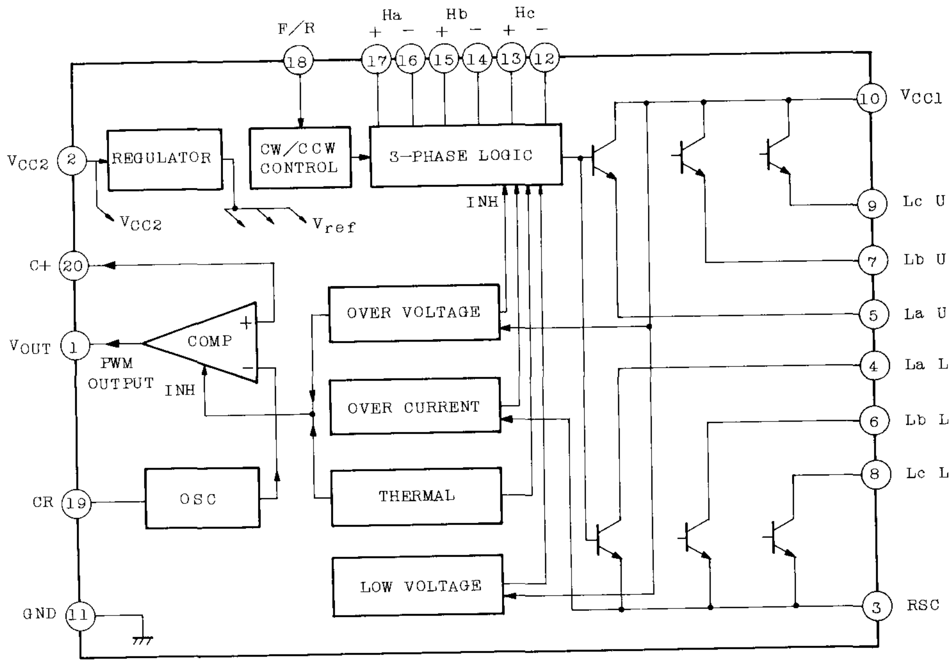
. Voltage Controlled 3-Phase Bi-Directional Motor Power Driver.
. Output Current Up to 1.5A.
. High Sensitivity of Position Sensing Inputs
  : V_H=40mV (Typ.)
. Built in Over Current, Over Voltage, Low Voltage and Thermal Protect Circuit.
. More Power-up Applications with Additional Power Transistors.
. Recommended Supply Voltage : V_{CC1}=30V(Max.)
  V_{CC2}=5V

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage (Motor)	V_{CC1}	38	V
Supply Voltage (Control)	V_{CC2}	7	V
Output Current	$I_{O(AVE)}$	1.5	A
Power Dissipation (Note)	P_D	15	W
Operating Temperature	T_{opr}	-30 ~ 75	°C
Storage Temperature	T_{stg}	-55 ~ 150	°C

Note : Tc=25°C

BLOCK DIAGRAM

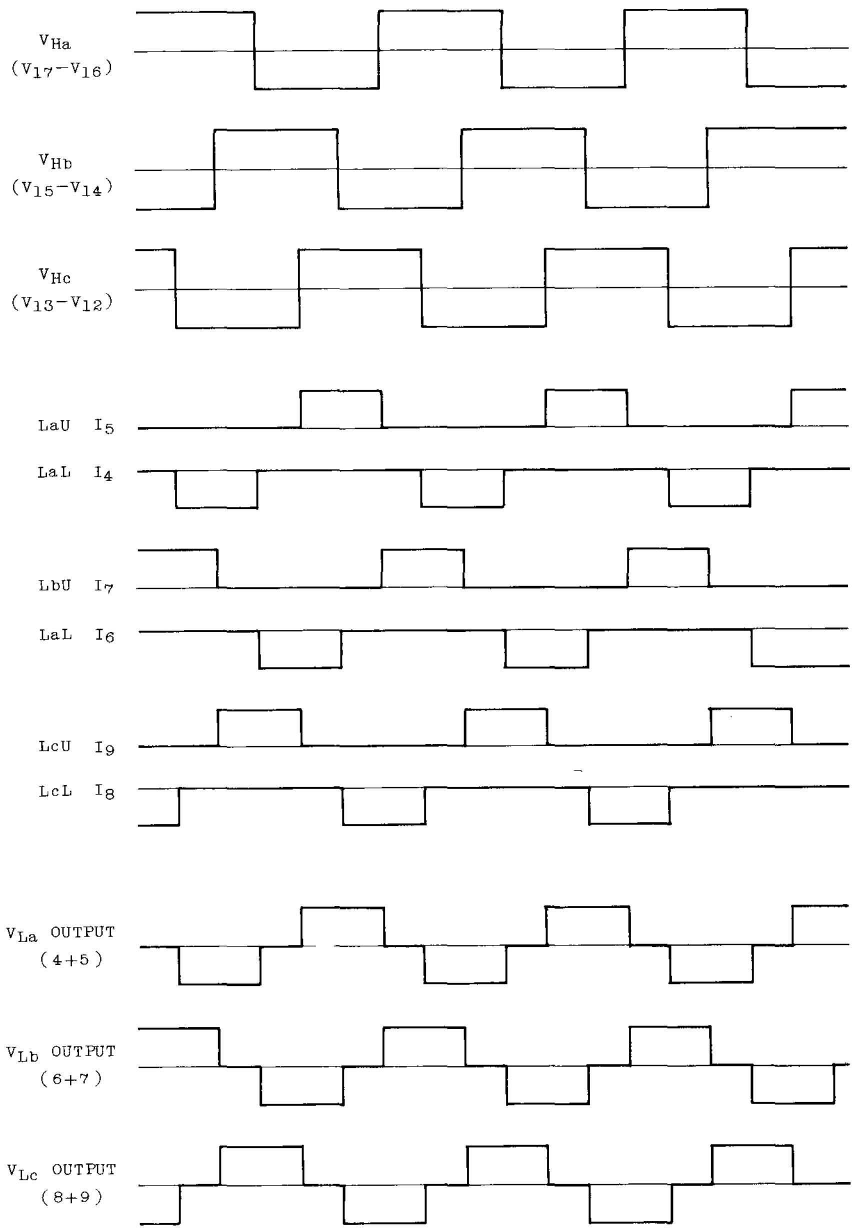


ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC2}=5V, Ta=25°C)

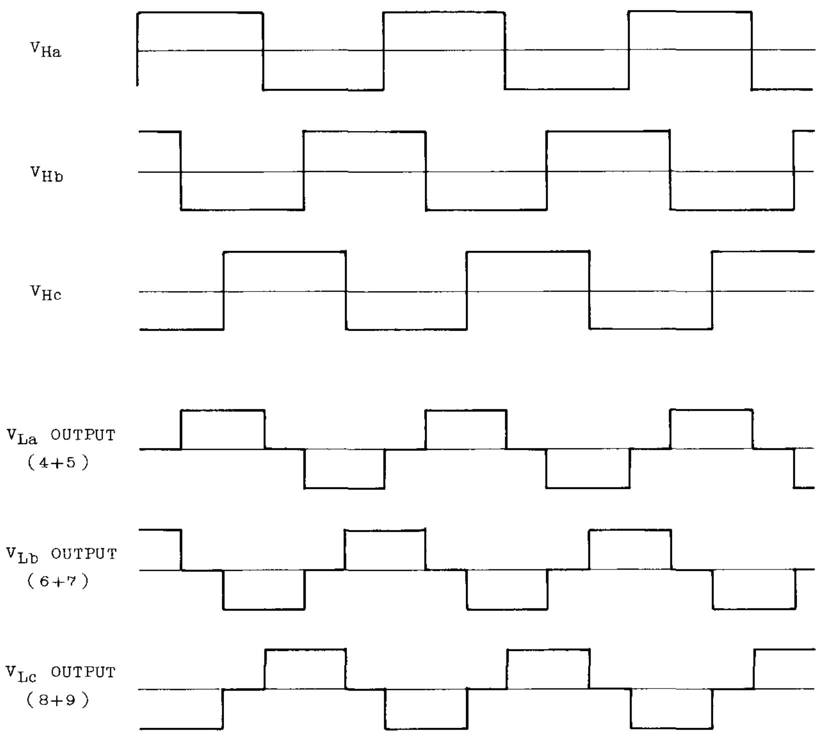
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC}	-	I_O=0.75A	-	15	20	mA
Saturation Voltage	Upper Side	V_{SAT1}	-	I_O=0.75A	-	1.5	2.1	V
				I_O=0.9A	-	1.7	2.4	
				I_O=1.2A	-	1.9	-	
	Lower Side	V_{SAT2}	-	I_O=0.75A	-	1.4	2.0	
				I_O=0.9A	-	1.5	2.3	
				I_O=1.2A	-	1.7	-	
Leak Current	Upper Side	$I_{L\ U}$	-		-	-	100	μA
	Lower Side	$I_{L\ L}$			-	-	100	
Current Limitter Sensitivity		V_{RSC}	-	R_{SC}=0.2Ω	180	220	300	mV
Over Voltage Protector Operating Voltage		$V_{H \cdot SE}$	-		38	-	-	V
Thermal Shut-down Operating Temperature		T_{TSD}	-		150	-	-	°C
Low Voltage Protector Operating Voltage		$V_{L \cdot SE}$	-		-	5.7	-	V
Position Sensing Input Sensitivity		V_{th}	-	Sine wave (100mV_{peak}, 30Hz)	-	20	-	mV
Oscillator	Frequency	f_o			-	30	-	kHz
	Amplitude	A_o	-		-	1.2	-	V_{p-p}
	Temperature-Coefficient	$T_{CVO}\ f_o$	-		-	0	-	Hz/°C
Comparator	Output Current	I_{COM}	-		-	-	5	mA
	Saturation Voltage	$V_{SAT\ COM}$	-	V_{20}=0V	-	0.5	-	V
	Turn-ON Time	t_r	-		-	0.5	-	μs
	Turn-OFF Time	t_f	-		-	0.5	-	μs
	Duty Ratio	D_y	-	V_{20}=2V	-	50	-	%
	Duty Ratio Temperature Coefficient	$T_{CVO}\ D_y$	-		-	0	-	%/°C
V_{CC2} Operating Voltage		$V_{CC2\ opr}$	-		4.5	5.0	5.5	V

FUNCTION

a) FORWARD ROTATION MODE (PIN 18 Open or 2.5V Min.)



b) REVERSE ROTATION MODE (PIN 18 GND or 0.4V Max.)



APPLICATION OF TA7247AP

(1) DESIGN METHOD OF SWITCHING REGULATOR OSCILLATION CIRCUIT (PWM generating circuit).

The PWM wave generating circuit that controls the switching regulator output switching transistors is shown in Fig. 2.

The circuit consists of a triangular waveform generating circuit that generates a comparison signal and a comparator that compares the comparison signal from the triangluar waveform generating circuit with output voltage from the switching regulator. (In the example shown in Fig. 2, output level is such that "H" level is at V_{CC2} level (≑5V) and "L" level is typically at 0.5V as specified in the standard.)

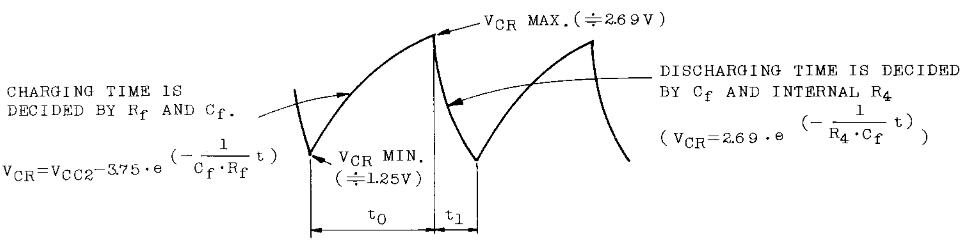
In this oscillation circuit, positive feedback is added to the differential comparator to provide hysteresis. "H" and "L" levels of triangular waveform output are expressed, respectively, by the following equations:

$$V_{CR}\ MAX. = \frac{R_2+R_3}{R_1+R_2+R_3} \cdot V_{CC2} \fallingdotseq 2.69V$$

$$V_{CR}\ MIN. = \frac{R_2}{R_1+R_2} \cdot V_{CC2} \fallingdotseq 1.25V$$

Q_1 shown in Fig. 2 is for a discharge path and R_4 decides discharging time constant together with an external capacitor C_f.

Fig. 1 TRIANGULAR WAVEFORM GENERATING CIRCUIT OUTPUT WAVEFORM (Pin (19))



Further, oscillation periods to and t_1 are decided by the following equations:

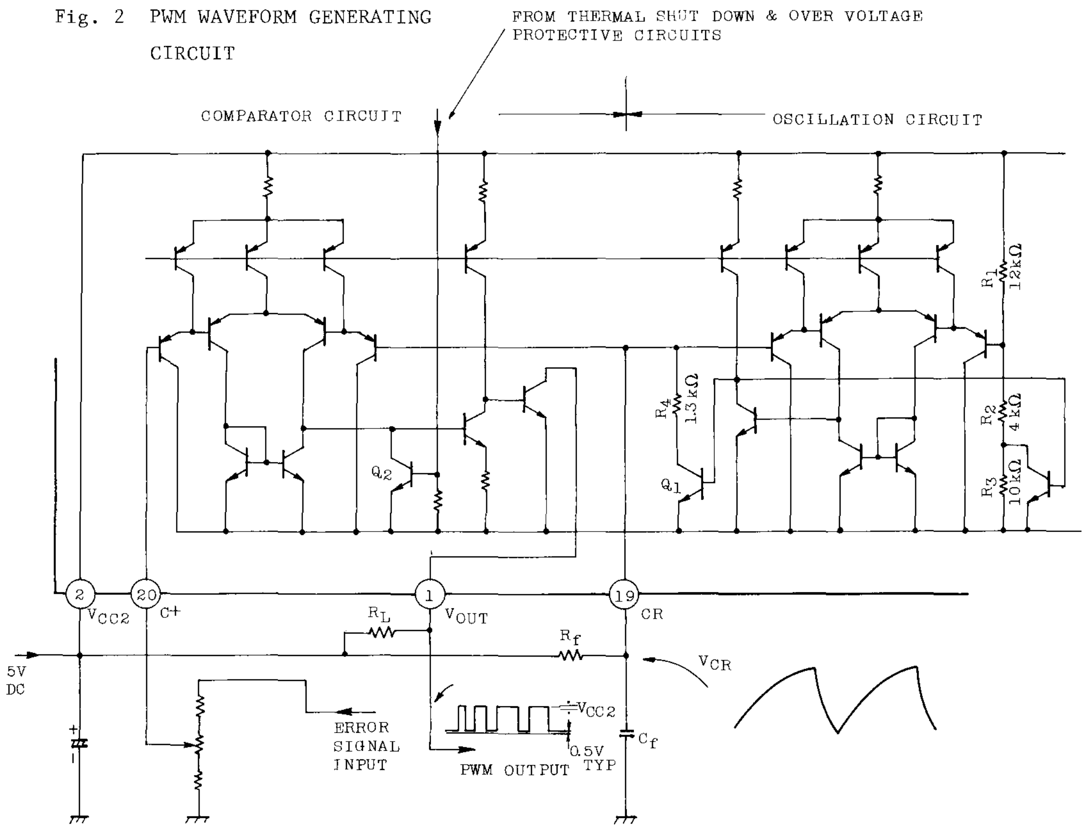
$t_0 \fallingdotseq 0.4845\cdot C_f\cdot R_f$ (sec)

$t_1 \fallingdotseq 0.7664\cdot C_f\cdot R_4$ (sec)

Where, R_4 is an internal resistor (≑1.3kΩ)

Further, as resistance of the resistor R_4 in IC varies by about ±20%, it is recommended to use R_4 in actual application at $R_f \gg R_4$ to suppress internal fluctuation of resistance in IC at the minimum level.

Fig. 2 PWM WAVEFORM GENERATING CIRCUIT



The comparator circuit consists of a differential amplifier which is operated by PNP differential input.

DC level to the C^+ terminal is decided by DC level at the CR terminal (Pin (19)) and required duty ratio.

As DC level at the CR terminal is 1.25 ~ 2.67V as shown in Fig. 1, it is recommended to input DC at a level corresponding to DC level at the CR terminal.

Further, R_f and Triangular waveform oscillation period characteristic is shown in Fig. 3 and PWM output waveform duty ratio vs. (20) pin voltage characteristic in Fig. 4.

Fig. 3 R_f — OSCILLATION PERIOD CHARACTERISTIC

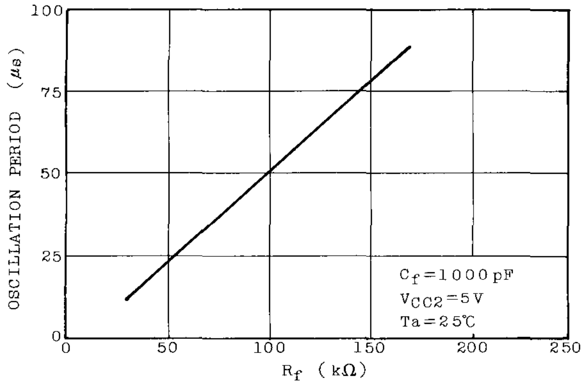
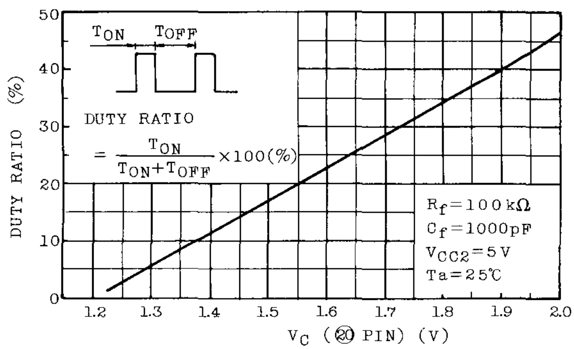


Fig. 4 DUTY RATIO — V_C CHARACTERISTICS



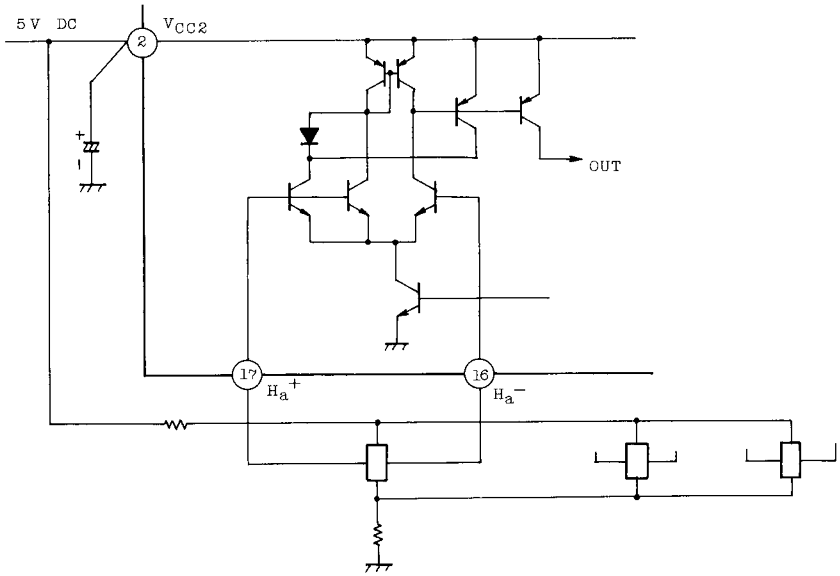
(2) POSITION DETECTING CIRCUIT (Hall element input circuit)

The Position detecting circuit is shown in Fig. 5. This circuit consists of a differential amplifier having hysteresis (≑20mV, typical).

As operating DC level (CMR) is about 1.5V at the lower side and V_{CC}-1.8V at the upper side, it is recommended to input constant voltage drive from V_{CC2} at level higher than hysterisis by 3 times or more (60～70mV).

If the hall element is removed during the rotation, IC can be destructed.

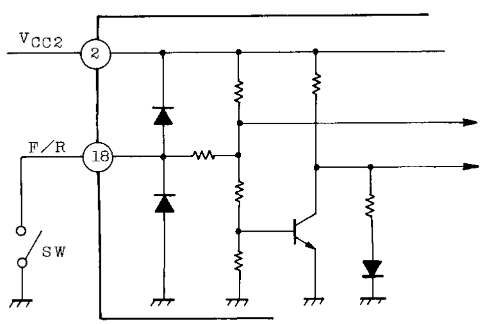
Fig. 5 POSITION DETECTING CIRCUIT (Hall element input)



(3) FORWARD/REVERSE ROTATION SELECTOR CIRCUIT

The forward/reverse rotation selector circuit is shown in Fig. 6. The forward rotation (or reverse rotation) is resulted when Pin (18) is opened (or at 2.5V or above), while the reverse rotation (or forward rotation) is resulted at GND (or at 0.4V or below).

Fig. 6 FORWARD/REVERSE ROTATION SELECTOR CIRCUIT



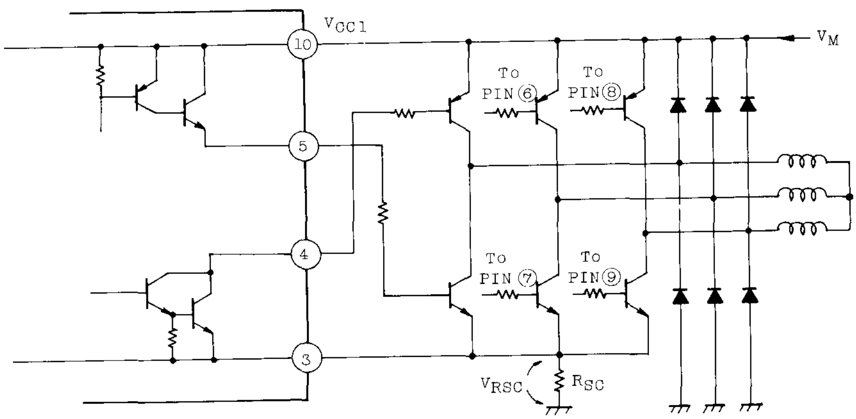
SW ON	SW OFF
L	H
H	L
CCW (R)	CW (F)

(4) OUTPUT CIRCUIT

The output circuit is shown in Fig. 7. The upper side of the circuit (Pins (5), (7) and (0)) is for outlet, whichle the lower side (Pins (4), (6) and (8)) is for intake. When the built-in output transistors are used, Pins (4) and (5), (6) and (7), and (8) and (9) shall be shorted, respectively.

When transistors are externally mounted for increasing the capacity largely, they shall be connected as shown in Fig. 7.

Fig. 7 OUTPUT CIRCUIT



(5) PROTECTIVE CIRCUITS

a) Over Voltage Protective Circuit

If voltage at V_{CC1} terminal exceeds normal voltage (38V), Q_2 in Fig. 2 is ON to inhibit PWM output and at the same time, the output circuit is OFF.

b) Thermal Shut Down Circuit

If temperature at the junction point exceeds specified temperature (150°C), similar to a), above, Q_2 in Fig. 2 in ON to inhibit PWM output and at the same time, the output circuit is OFF.

c) OVER CURRENT PROTECTIVE CIRCUIT

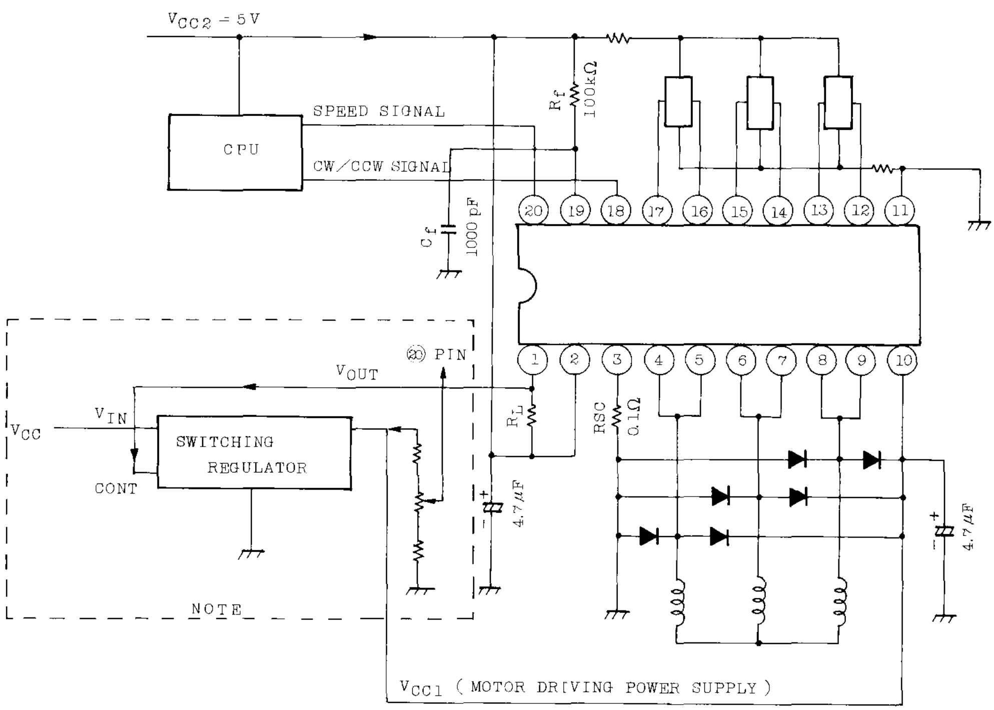
If V_{RSC} in Fig. 7 exceeds specified voltage ($V_{RSC}=R_{SC}\cdot I_{SC}$), the output circuit is OFF.

d) Excessively Low Voltage Protective Circuit

If voltage at V_{CC1}, terminal drops below specified voltage, the output circuit is

OFF. Further, this circuit is a malfunction preventive circuit.

APPLICATION CIRCUIT



Note : In case of the open-loop control by CPU, rotating speed is controlled by the rotation control signal (analog output) from CPU. However, the closed-loop control by the feedback signal taken from the switching regulator output is also possible.

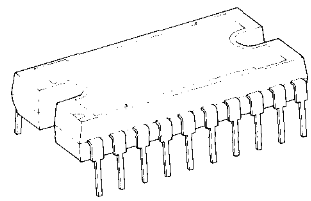
In this case, the connection shall be made as shown in the above circuit diagram.

is

TA7248P

DC MOTOR DRIVER

The TA7248P is a DC motor (3 phase) driver IC.
It contains regulator, position sensing amplifiers, control amplifier, quick stop circuit and drivers.
Maximum output current (Bi-direction) of driver is ±900mA (average).
Hall element is used as a position sensor.
By combining this IC and TA7674P (or TA7715P) F-servo motor driver system is available.



HDIP20-P

Weight: 8.2g (Typ.)

FEATURES:

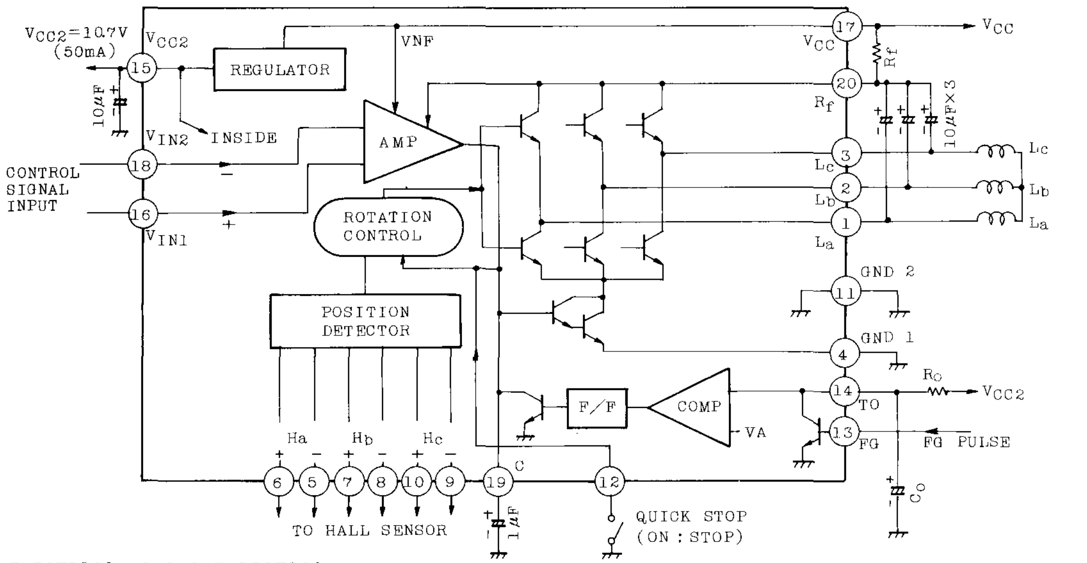
. Driver for Hall Motor (3 phase)
. Large Output Current (Bi-direction)
  : I_O=±900mA (average)
. Built-in Reverse Rotation Detector and Quick Stop Circuit.
. Regulator for External Circuits
  : V_{OUT}=10.7V, I_O=50mA
. Operating Supply Voltage : V_{CC}=16 ~ 32V

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	35	V
Output Current	I_O	900	mA
Regulator Output Current	I_{CC2}	50	mA
Power Dissipation (Note)	P_D	25	W
Operating Temperature	T_{opr}	-15 ~ 75	°C
Storage Temperature	T_{stg}	-55 ~ 150	°C

Note : Tc=75°C, P_D=3W(Max.) at no heat sink (Ta=25°C).

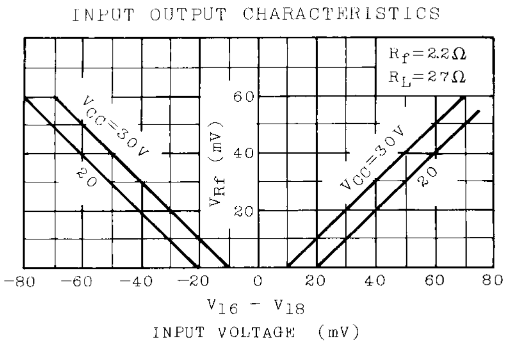
BLOCK DIAGRAM

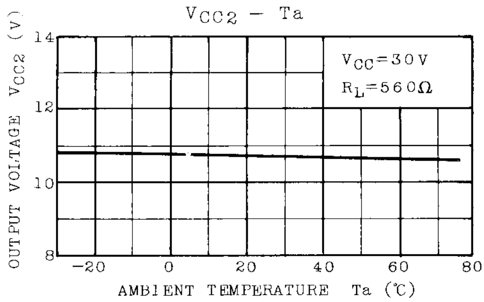


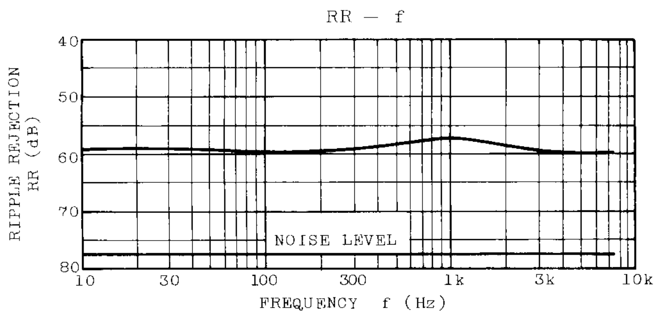
ELECTRICAL CHARACTERISTICS

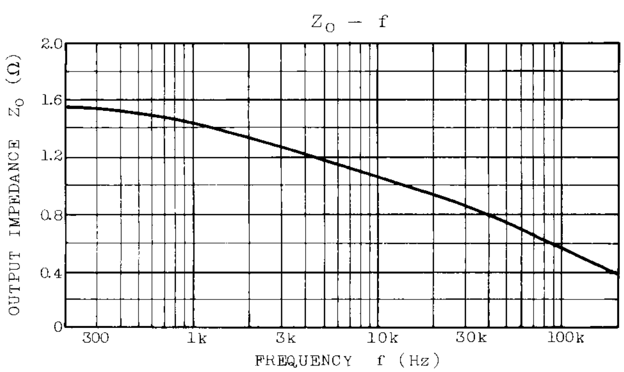
(Unless otherwise specified, V_{CC}=30V, R_L=27Ω, R_f=2.2Ω, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC}	1	-	5.5	-	13	mA
Input Offset Voltage		V_{IO}	2	V_{IN2}=3.5V	-9	-	95	mV
Input Dead Band		V_{ID}	2		22	-	190	mV
Residual Output Voltage		V_{OR}	2		-	-	10	mV
Voltage Gain		GV	2		0.8	-	1.2	
Saturation Voltage	Upper	V_{SAT1}	3	V_{IN1}=4.5V, V_{IN2}=3.5V	-	-	2.1	V
	Lower	V_{SAT2}			-	-	3.8	
Cut-off Current	Upper	I_{OC1}	4	V_{IN1}=4.5V, V_{IN2}=3.5V R_L=100kΩ	-	-	15	μA
	Lower	I_{OC2}			-	-	15	
To Threshold Voltage		V_{TO}	5	-	6.2	-	7.3	V
To Saturation Voltage		$V_{SAT\ TO}$	5	R_L=6kΩ	-	-	2	V
Output Voltage		V_{CC2}	6	R_L=560Ω	10.2	10.7	11.2	V
Load Regulation Voltage		ΔV_{CC2}	6	R_L=560Ω~∞	-	-	60	mV
Ripple Rejection		RR	6	R_L=560Ω, f=1kHz	50	-	-	dB
Temperature Coefficient		Tc V_{CC2}	6	R_L=560Ω	-2	-	2	mV/deg

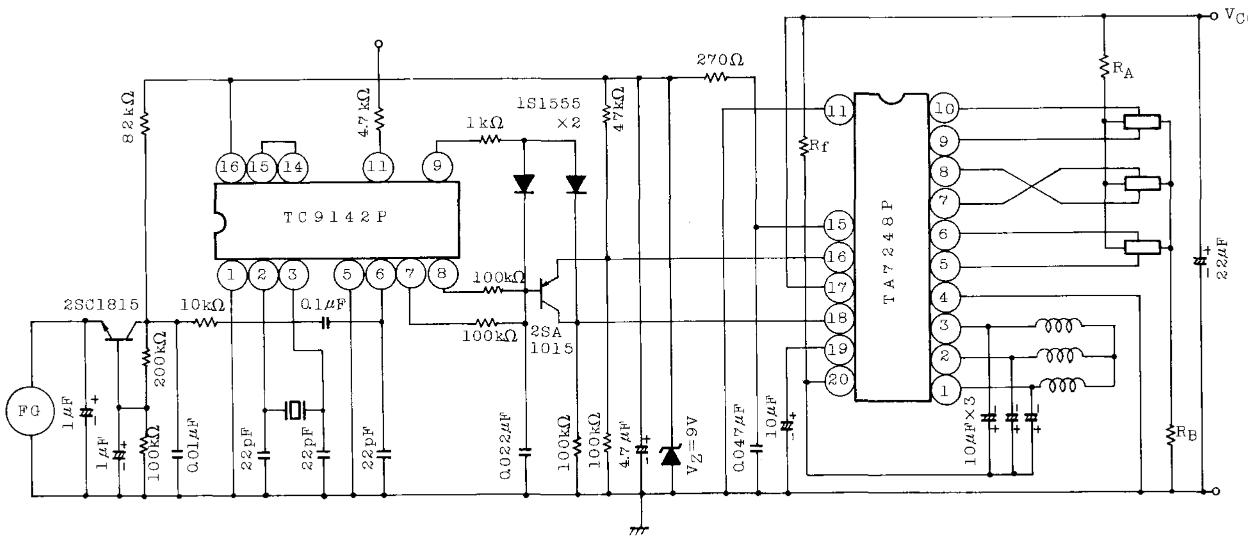

INPUT OUTPUT CHARACTERISTICS
Rf=2.2Ω
RL=27Ω
VCC=30V
20
VRf (mV)
60
40
20
-80 -60 -40 -20 0 20 40 60 80
V16 - V18
INPUT VOLTAGE (mV)


VCC2 - Ta
VCC=30V
RL=560Ω
OUTPUT VOLTAGE VCC2 (V)
14
12
10
8
-20 0 20 40 60 80
AMBIENT TEMPERATURE Ta (℃)


RR - f
RIPPLE REJECTION RR (dB)
40
50
60
70
80
NOISE LEVEL
10 30 100 300 1k 3k 10k
FREQUENCY f (Hz)


Zo - f
OUTPUT IMPEDANCE Zo (Ω)
2.0
1.6
1.2
0.8
0.4
0
300 1k 3k 10k 30k 100k
FREQUENCY f (Hz)

APPLICATION CIRCUIT

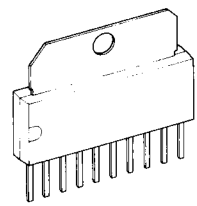


R_A and R_B should be determined by characteristic of hall sensor.

TA7256P

DUAL POWER OPERATIONAL AMPLIFIER.

TA7256P is a dual power operational amplifier. It is intended for use especially DC MOTOR positioning system applications such as, Arm Driver (for Audiodisk Players), head or voice coil motor drivers (for Floppy and Winchester Disk Drivers) and any other power driver applications.



HSIP10-P

Weight: 2.47g (Typ.)

FEATURES:

. HSIP 10 Pin Power Package Capsealed.
. Built-in Over Current Protector.
. Few External Parts Required.
. Output Current Up to 0.5 A.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}, V_{EE}	±18	V
Output Current	$I_{O(AVE)}$	0.5	A
Power Dissipation (Note)	P_D	12.5	W
Operating Temperature	T_{opr}	-30 ~ 75	°C
Storage Temperature	T_{stg}	-55 ~ 150	°C

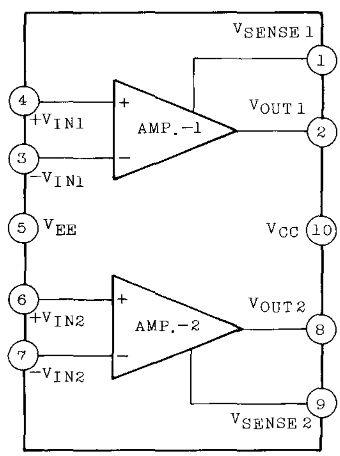
Note : Tc=25°C.

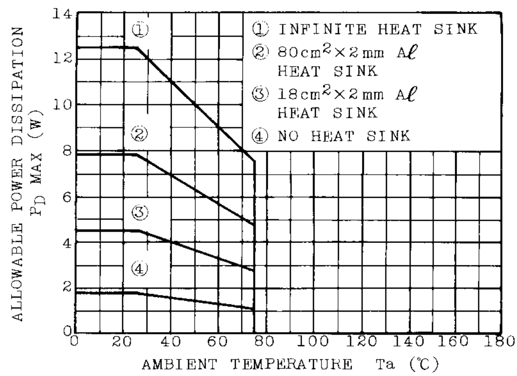
ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=15V, V_{EE}=-15V, Ta=25°C)

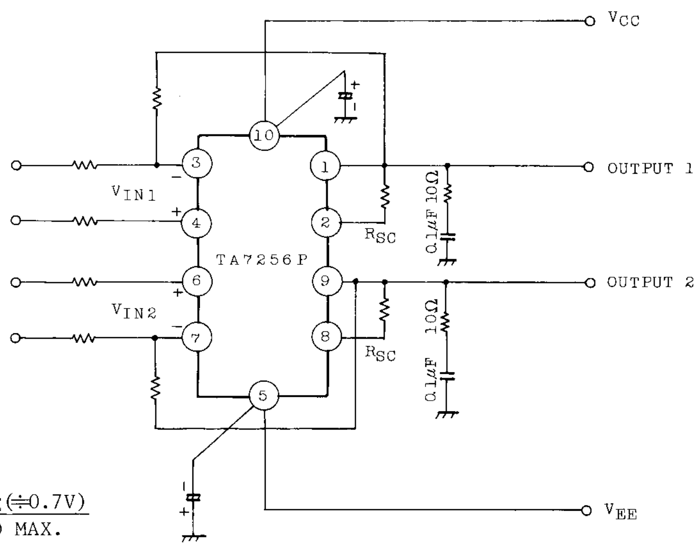
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC}			-	10	20	mA
Input Off Set Current		I_{IO}			-	10	200	nA
Input Bias Current		I_I			-	100	700	nA
Input Off Set Voltage		V_{IO}			-	2	7	mV
Output Voltage Swing	Upper	V_{OH}		R_L=33Ω	12.0	13.0	-	V
	Lower	V_{OL}			-12.0	-13.0	-	
Open Loop Gain		G_{VO}			-	100	-	dB
Input Common Mode Voltage Range		CMR			±12	±14	-	
Common Mode Rejection Ratio		CMRR			70	90	-	dB
Supply Voltage Rejection Ratio		SVRR			-	50	150	μV/V
Slew Rate		SL		G_V=0, R_L=33Ω R=10Ω, C=0.1μF	-	0.15	-	V/μsec
Short Circuit Current		I_{SC}		R_{SC}=2.2Ω	-	0.35	-	A
Cross Talk		CT		R_L=33Ω, V_{OUT}=1Vp-p	-	60	-	dB

BLOCK DIAGRAM





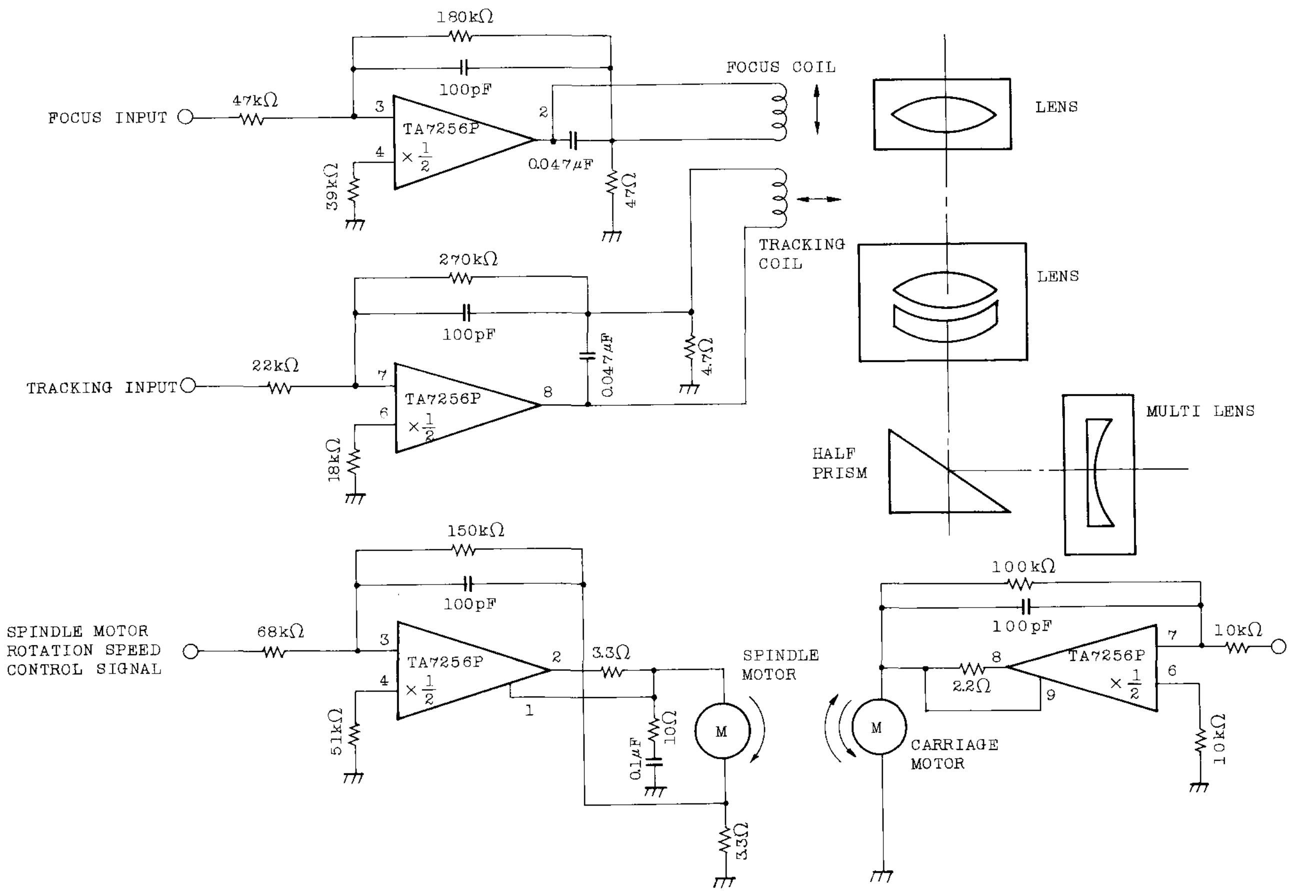
APPLICATION CIRCUIT 1



$$R_{SC} = \frac{V_{BE}(\fallingdotseq 0.7V)}{I_O\ MAX.}$$

APPLICATION CIRCUIT 2

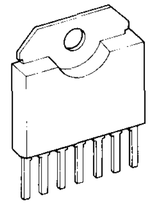
(Compact Disk Player Use Actuator System)



TA7257P

BRIDGE DRIVER

The TA7257P is a Full Bridge Driver for blashed DC Motor Rotation control.
Forward Rotation, Reverse Rotation, Stop and Braking operations are available.
It's designed for Loading and Reel Motor driver for VTR and Tape Deck, and any other consummer and industrial applications.
TA7257P has Operation Supply Voltage terminal and Motor Driving Supply Voltage terminal independently therefore Servo control operation is applicable.



HSIP7-P

Weight: 1.9g (Typ.)

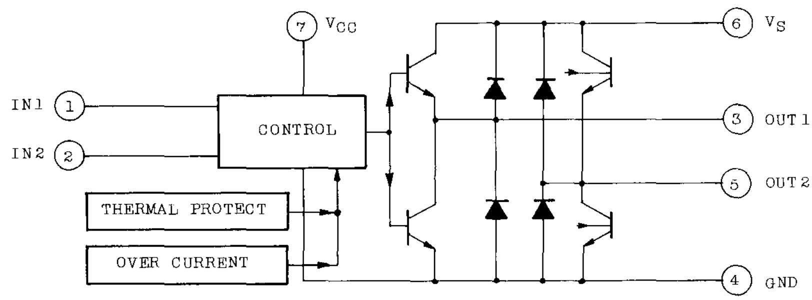
FEATURES:

. Output Current Up to 1.5A(AVE.), and 4.5A(PEAK).
. 4 Function Modes (CW, CCW, STOP and Brake) are Controlled by 2 Logic Signals Fed into 2 Input Terminals.
. Built-in Over Current Protector and Thermal Shut Down Circuit.
. Operating Voltage Range : $V_{CC}=6 \sim 18V$

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Peak Supply Voltage	V_{CC} MAX	25	V
Operate Supply Voltage	$V_{CC(opr)}$	18	V
Output Current	I_O (AVE)	1.5	A
Peak Output Current	I_O (PEAK)	4.5	A
Power Dissipation ($Tc=75^{\circ}C$)	P_D	12.5	W
Operating Temperature	T_{opr}	$-30 \sim 75$	$^{\circ}C$
Storage Temperature	T_{stg}	$-55 \sim 150$	$^{\circ}C$

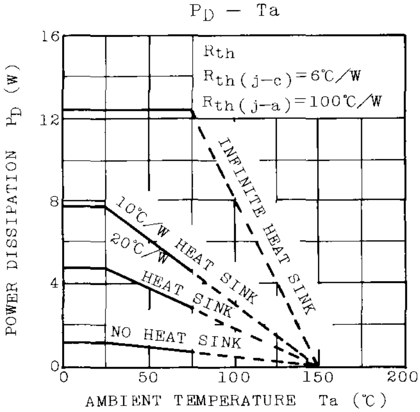
BLOCK DIAGRAM

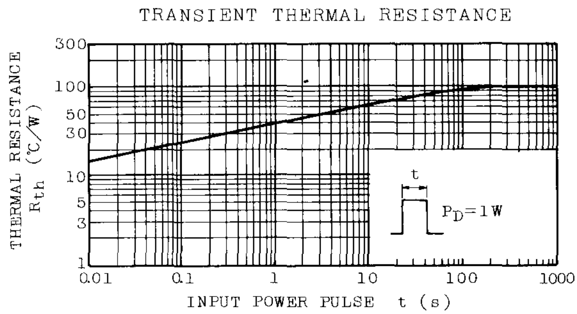


IN1	IN2	OUT1	OUT2	MODE
1	1	L	L	Brake
0	1	L	H	CW/CCW
1	0	H	L	CCW/CW
0	0	High Impedance		Stop

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}		V_{CC}=18V OUTPUT OFF STOP MODE	-	6.5	13	mA
		I_{CC2}		V_{CC}=18V, OUTPUT OFF CW/CCW MODE	-	10	20	
Saturation Voltage	UPPER	V_{S1} U		V_{CC}=18V, I_O=0.1A	-	0.7	1.0	V
	LOWER	V_{S1} L			-	0.6	0.9	
	UPPER	V_{S2} U		V_{CC}=18V, I_O=1.1A	-	1.0	1.4	
	LOWER	V_{S2} L			-	0.9	1.3	
Leakage Current	UPPER	I_L U		V=18V	-	-	100	μA
	LOWER	I_L L			-	-	100	
Input Voltage 1,2		$V_{IN(H)}$		T_j=25°C 1 PIN AND 2 PIN	3.0	-	-	V
		$V_{IN(L)}$			-	-	0.8	
Diode Forward Voltage	UPPER	V_F U		I_F=1.0A	-	2.0	-	V
	LOWER	V_F L			-	1.25	-	
Limitting Current		I_{SC}		-	-	3.5	-	A
Input Current		I_{IN}		Input GND	-	1	10	μA



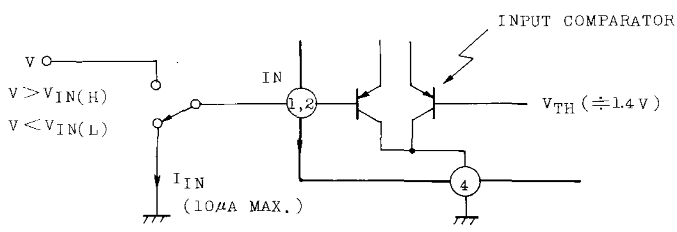


APPLICATION NOTE

(1) INPUT CIRCUIT

Input circuit is shown in Fig-1. It's a "Low active" type voltage comparator that's one input connect to Input terminal (1 , or 2 PIN) and the other to built-in temperature compensated voltage reference (V_{TH}=1.4V Typ.)

If a voltage above $V_{IN(H)}$ fed into the Input Terminal that means "Logic 1" and less than $V_{IN(L)}$ or connect to GND means "Logic 0".



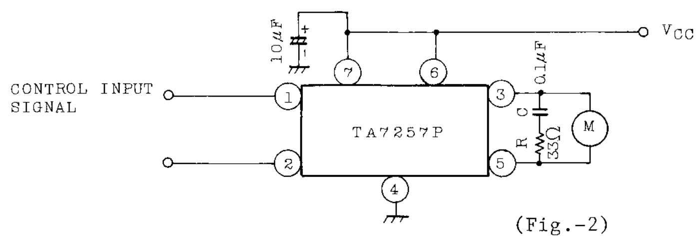
(Fig.-1)

(2) BASIC APPLICATION CIRCUIT

Fig-2 shows the basic application circuit.

Optimum values of the C, R depend on the inherent constant of a motor and parasitic C,R values around the circuit.

Normally, recommended to use 0.1μF and 33Ω.



(Fig.-2)

(3) ADDITIONAL DIODE

I) If the braking operation is so loose, connect a additional diode between each output to GND, (See Fig-3(a))

II) If the back electromotive pulse generated in output coil is so strong. Internally connected back electromotive suppression diode may be damaged by this pulse.
In such a case connect a additional diode between each output to V_{CC}. (See Fig-3-(b))

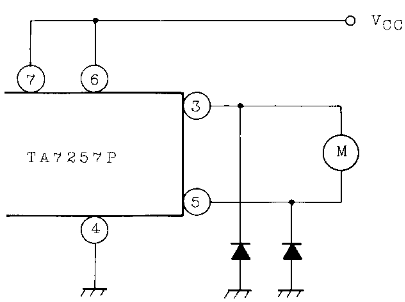


Fig 3-(a)

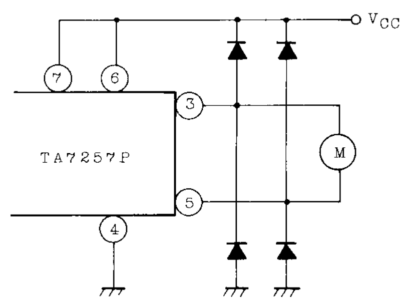


Fig 3-(b)

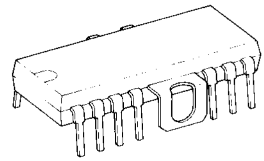
TA7259F/P/P(LB)

DC MOTOR DRIVER IC.

The TA7259P is a 3-phase Bi-directional motor driver IC. It designed for use VTR tape deck, floppy disk and record player moter drivers.
It contains output power drivers, position sensing circuits, control amplifier and CW/CCW control circuit.

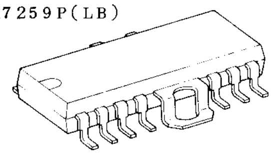
. 3-Phase Bi-Directional Driver and Output Current Up to ±1.2A.
. Few External Parts Required.
. Wide Operating Supply Voltage Range :
: $V_{CC(opr)}$ (MIN.)=7~20V
. Forward and Reverse Rotation is Controlled Simply by Means of a CW/CCW Control Signal Fed Into 10 PIN.
. High Sensitivity of Position Sensing Amplifier. (V_H=10mV(Typ.), Recommend to Use TOSHIBA Ga-As Hall Sensor "THS" Series.)
. Surge Protect Diode Connected for All Input Terminals. (Position Sensing, Control, CW/CCW Control Inputs.)
. DIP-14F (TOSHIBA 5D14BP-P) Power Package.
. Second Version of TA7245BP (It's have a better stability)

TA7259P



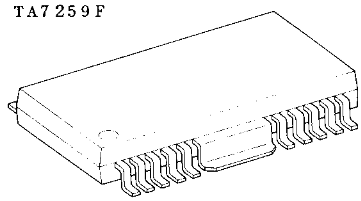
HDIP14-P-500A

TA7259P(LB)



HSOP14-P

TA7259F



HSOP20-P-450

Weight:

HDIP14-P-500A: 3.0g (Typ.)
HHOP14-P : 3.0g (Typ.)
HSOP20-P-450 : 0.8g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

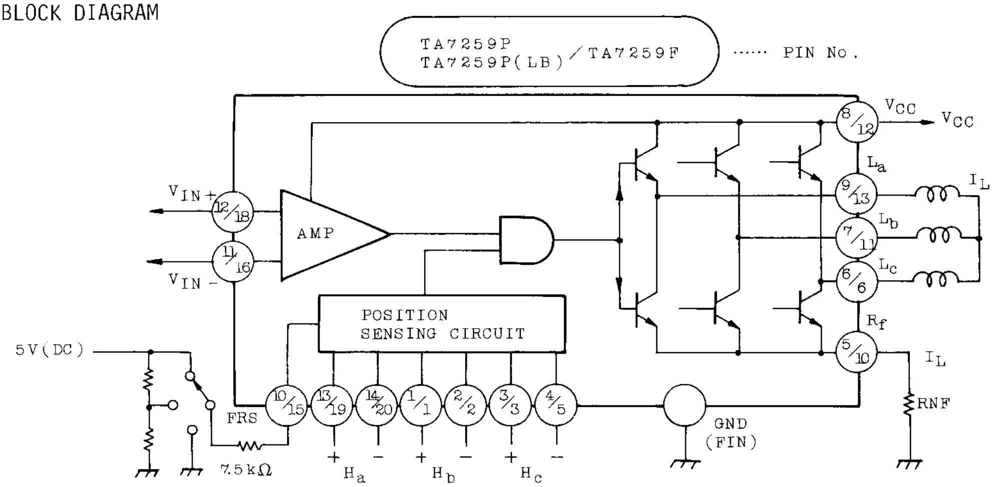
CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	26	V
Output Current		$I_{O(AVE)}$	1.2	A
Power Dissipation (Note)	TA7259P	P_D	2.3	W
	TA7259P(LB)		2.3	
	TA7259F		1.0	
Operating Temperature		T_{opr}	-30~75	°C
Storage Temperature		T_{stg}	-55~150	°C

Note : No heat sink.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=12V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC1}	–	FRS Open	2	4	7	mA
		I_{CC2}		FRS=5V	2	5	9	
		I_{CC3}		V_{CC}=22V FRS=GND	2	5	9	
Input Offset Voltage		V_{IO}	–		–	40	–	mV
Residual Output Voltage		V_{OR}	–	$V_{IN-}=V_{IN+}$=7V	–	0	10	mV
Voltage Gain		G_V	–	R_{NF}=2.2Ω	–	15.0	–	
Saturation Voltage	Upper	V_{SAT1}	–	I_L=400mA	–	1.0	1.5	V
	Lower	V_{SAT2}			–	0.4	1.0	
Cut-off Current	Upper	I_{OC1}	–	V_C=20V	–	–	20	μA
	Lower	I_{OC2}			–	–	20	
Position Sensing Input Sensitivity		V_H	–		–	10	–	mV
Maximum Position Sensing Input Voltage		$V_{H\ MAX}$	–		–	–	400	mV
Input Operating Voltage	Position	CMR-H	–		2.0	–	V_{CC}-2.5	V
	Control	CMR-C	–		2.0	–	V_{CC}-2.5	
Rotation Control Input Voltage	CW	V_F	–		–	0	0.4	V
	STOP	V_S	–		2.2	2.7	3.2	
	CCW	V_R	–		4.8	5.0	5.8	

BLOCK DIAGRAM

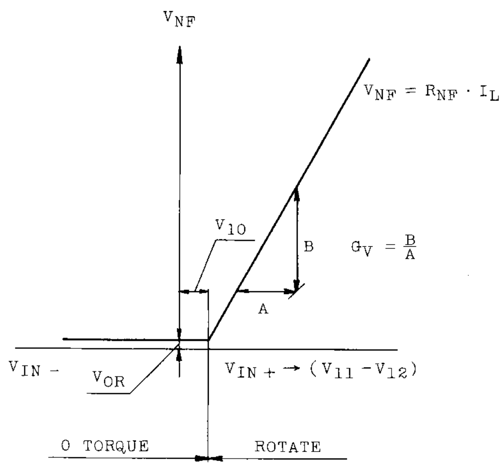


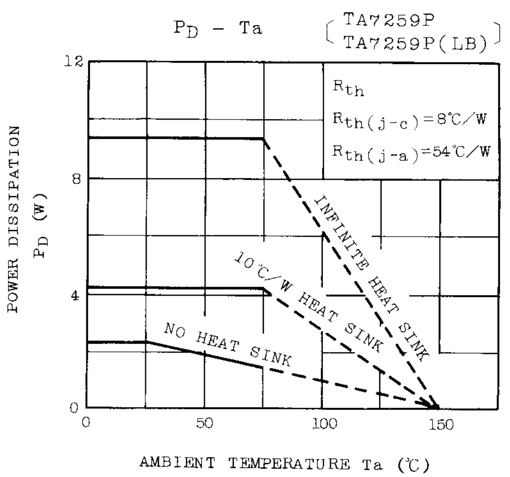
FUNCTION

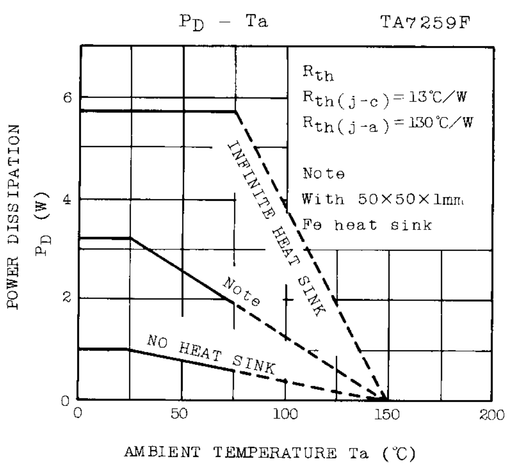
FRS (10 PIN)	POSITION SENSING INPUT			COIL OUTPUT		
	Ha	Hb	Hc	La	Lb	Lc
L	1	0	1	H	L	M
	1	0	0	H	M	L
	1	1	0	M	H	L
	0	1	0	L	H	M
	0	1	1	L	M	H
	0	0	1	M	L	H
H	1	0	1	L	H	M
	1	0	0	L	M	H
	1	1	0	M	L	H
	0	1	0	H	L	M
	0	1	1	H	M	L
	0	0	1	M	H	L
M	1	0	1	High Impedance		
	1	0	0			
	1	1	0			
	0	1	0			
	0	1	1			
	0	0	1			

POWER DISSIPATION

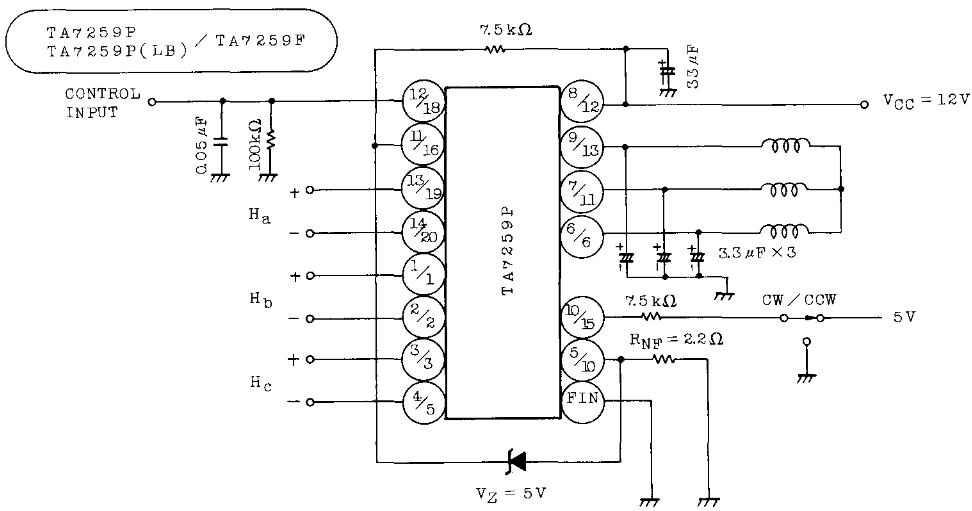
INPUT vs OUTPUT







APPLICATION CIRCUIT

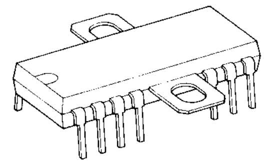


Note : The TA7259P is a second version of TA7245BP.
The main difference are PIN CONNECTION (PIN 8 and PIN 9 only) and stability.
Refer to TA7245BP Techical Data if you need further application data.

TA7260P

DC MOTOR DRIVER (2 PHASE Bi-DIRECTIONAL)

The TA7260P is a 2 Phase Bi-Directional type Motor Driver IC designed for use Floppy Disk, VTR and Tape Deck Motor Drivers.
It contains Output Power Drivers, Position Sensing Amplifiers, Control Amplifier and Voltage Regulator for external circuit.



HDIP14-P-500

Weight: 3.0g (Typ.)

FEATURES:

. Output Current is up to 0.9A(AVE).
. Built in Reverse Rotation Detector.
. Voltage Regulator for External Circuit
  : V_{OUT}=10.7V(Typ.), I_O=50mA(Max.)
. Few External Parts Required.

MAXIMUM RATINGS (Ta=25°C)

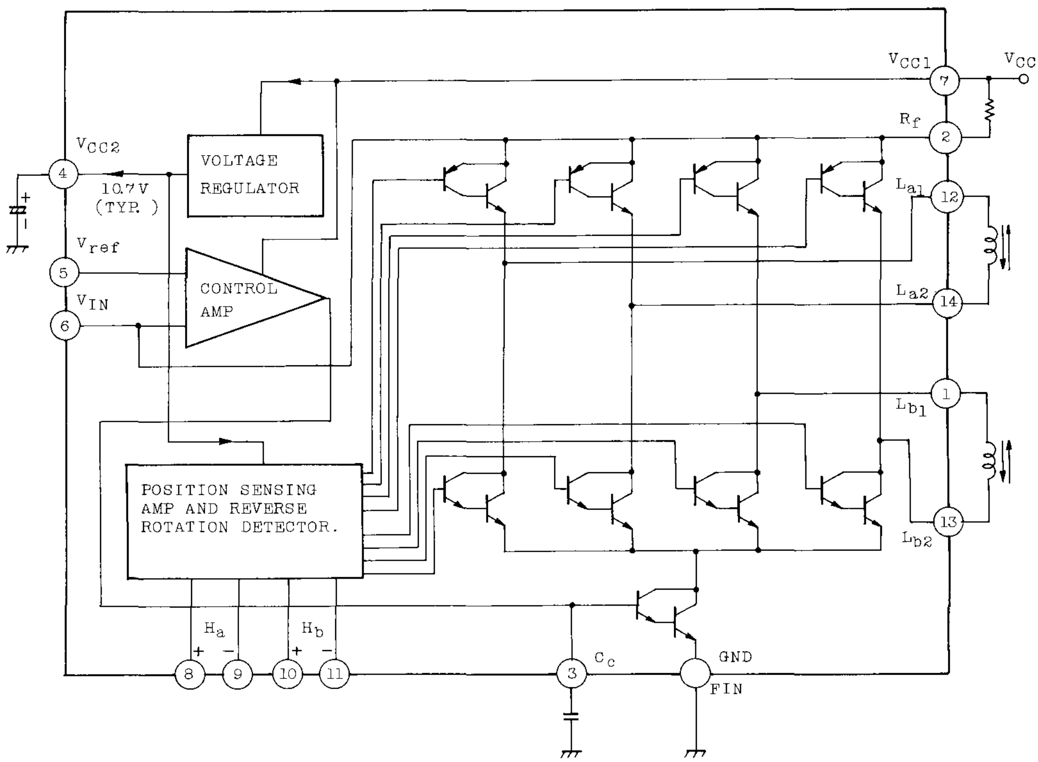
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	35	V
Output Current	I_{OUT}	900	mA
Regulator Output Current	I_{CC2}	50	mA
Power Dissipation	P_D	2.3	W
Operating Temperature	T_{opr}	-30 ~ 75	°C
Storage Temperature	T_{stg}	-55 ~ 150	°C

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=30V, R_f=2.2Ω, R_L=54Ω, Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current			I_{CC}			5	–	20	mA
Input Offset Voltage			V_{IO}		V_{Rf}=20mV	-9	–	200	mV
Input Dead Band			V_{ID}		V_{Rf}=20mV	20	–	300	mV
Residual Output Voltage			V_{OR}			–	–	10	mV
Voltage Gain			G_V			0.85	1.0	1.5	
Saturation Voltage	Upper		V_{SAT1}			–	–	2.5	V
	Lower		V_{SAT2}			–	–	4.0	
Cut-off Current			$I\ell$			–	–	50	μA
Regulator	Output Voltage		V_{CC2}			10.0	10.7	11.4	V
	Load Regulation		ΔV_{CC2}		I_O=0 ~ 20mA	–	5	70	mV
	Temperature Coefficient		Tc V_{CC2}			-2	0	2	mV/deg
Position Sensing Amp	Input Sensitivity		V_H			300	–	–	mV
	Operating DC Level	H_a Side	CMR (H_a)			V_{CC2} +1	–	V_{CC}-1	V
		H_b Side	CMR (H_b)			1	–	V_{CC2} -3.5	V
Operating Input Voltage (DC Level)	V_{IN} Side		CMR (V_{IN})			4	5	9	V
	V_{ref} Side		CMR (V_{ref})			4	5	9	

BLOCK DIAGRAM



TEST METHOD

(1) I_{CC} (Quiescent Current)

Use Measuring Circuit 1, $e_1 \sim e_4$ are specified in Table (Condition 1) e_5, e_6 are in Table 2 (Condition 1).

To measure a supply Current

(2) V_{IO} (Input Offset Voltage), V_{ID} (Input Dead Band), V_{OR} (Residual Output Voltage), G_V (Voltage Gain) (Refer to Input-Output Characteristics)

$e_1 \sim e_4$ are specification in Table 1 (Condition 1) and e_5 is 5.5V DC.

Measuring Procedures are follows.

a) Increase a e_6 voltage gradually from 5V DC, Measure a Input Voltage V_1 when the output voltage V_2 is equal to 120mV.
(In this condition $V_1=E_1$, $V_1=V_6-V_5$, $V_2=V_{Rf}=V_7 \sim V_2$)

b) More Increase the e_6 Voltage
Measure the V_1 when the V_2 is equal to 20mV (In this condition $V_1=E_3$)

c) Increase the e_6 Voltage 25mV above previous condition and measure the Input Voltage V_1. (In this condition $V_1=E_3$)

d) More increase the e_6 voltage gradually and measure the Input Voltage V_1 when the V_2 is equal to 120mV.
(In this condition $V_1=E_4$)

Electrical Characteristics are calculated by following equations.

$$V_{IO}- = E_2$$

$$V_{IO}+ = E_4$$

$$V_{ID} = E_4-E_2$$

$$V_{OR}- = E_3$$

$$G_V- = \frac{100}{E_2-E_1\ (mV)}$$

$$G_V+ = \frac{100}{E_5-E_4\ (mV)}$$

(3) $V_{SAT\ 1}$, $V_{SAT\ 2}$ (Output upper and lower side saturation voltage)
e_5 and e_6 are specified in Table 2 (Condition 2) $e_1 \sim e_4$ and condition of SW_1 and SW_2 are specified in Table 1 (Condition 1, 2, 3, 4) Measure V_3 and V_4 for each specified conditions.

(4) I_L (Leakage Current)
Measure a output transistor leakage current

(5) V_{CC2} (Built in Regulator output voltage)
Measure the V_{CC2} (4 PIN) DC voltage with specified load condition.

TABLE 1

(Unit:V)

	e_1	e_2	e_3	e_4	SW_1	SW_2
1	12.4	12.0	5.4	5.0	a	c
2	12.4	12.0	5.0	5.4	b	d
3	25.0	25.4	5.0	5.4	c	a
4	25.0	25.4	5.4	5.0	d	b

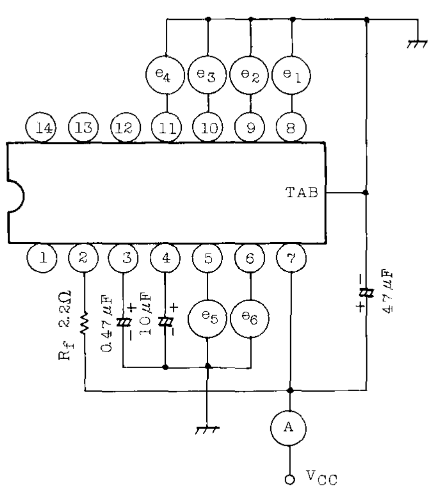
TABLE 2

(Unit:V)

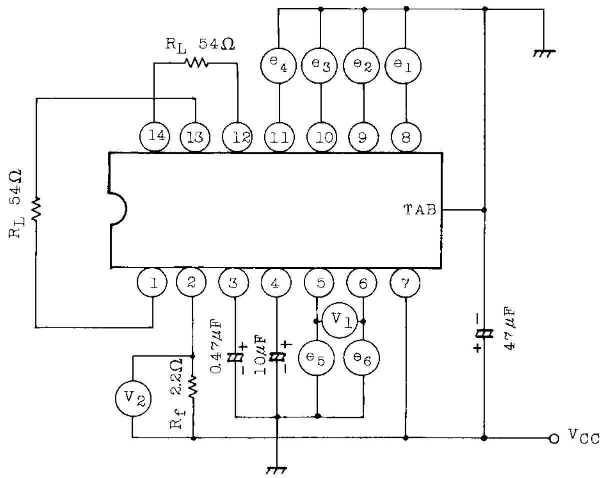
	e_5	e_6
1	5.5	5.5
2	6.5	5.5
2'	5.5	6.5

TEST CIRCUIT

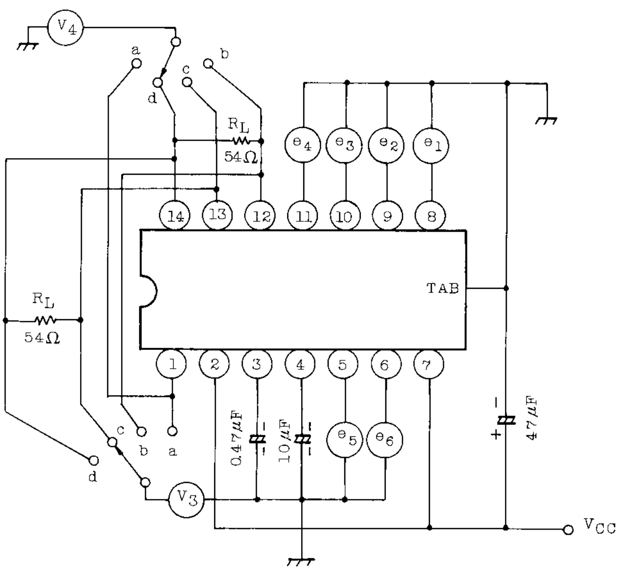
1. I_{CC}



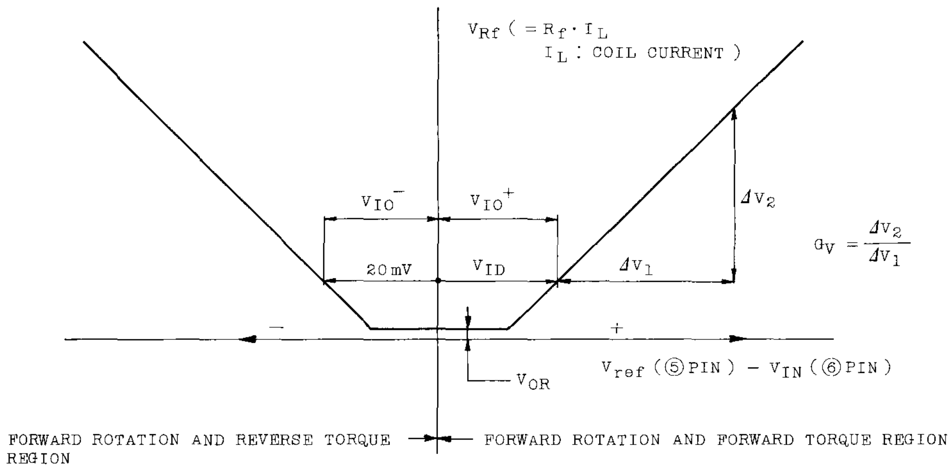
2. V_{IO}, V_{ID}, V_{OR}, G_V, V_{CC2}

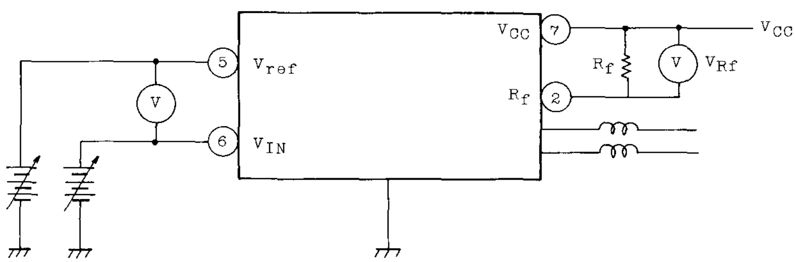


3. $V_{SAT\ 1}$, $V_{SAT\ 2}$



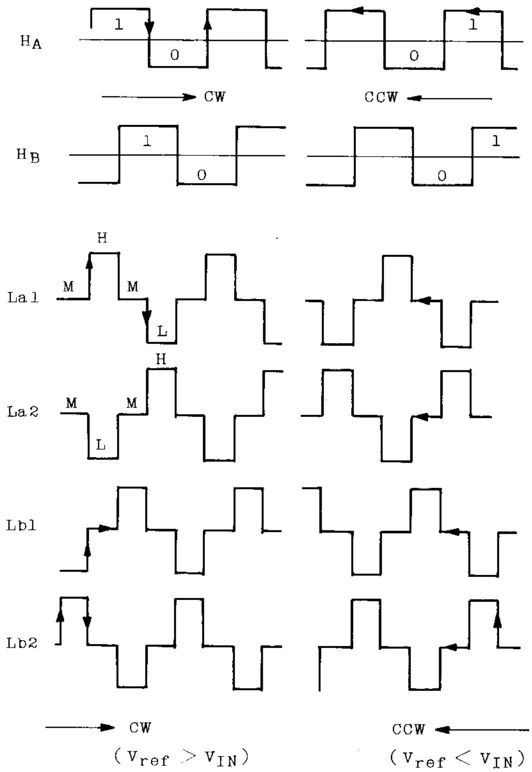
INPUT-OUTPUT CHARACTERISTICS



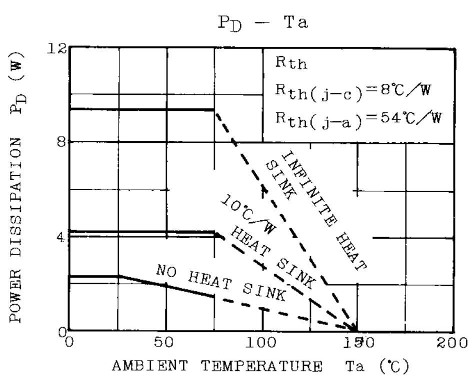


FUNCTION TABLE

	INPUT		OUTPUT			
	H_a	H_b	L_{a1}	L_{a2}	L_{b1}	L_{b2}
$V_{IN}<V_{ref}$	1	0	H	L	M	M
	1	1	M	M	H	L
	0	1	L	H	M	M
	0	0	M	M	L	H
$V_{IN}<V_{ref}$	1	1	M	M	L	H
	1	0	L	H	M	M
	0	0	M	M	H	L
	0	1	H	L	M	M

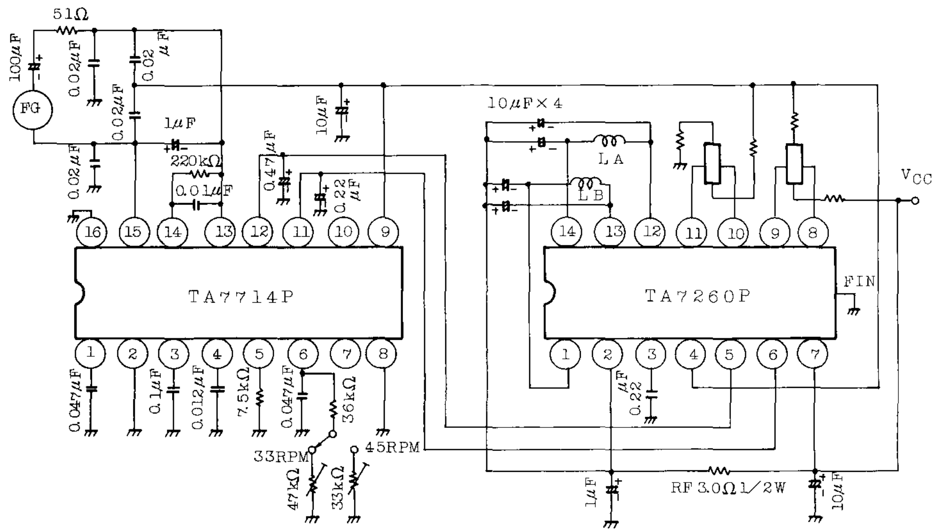


HA
1
0
1
0
1
CW
CCW
HB
1
0
0
1
H
La1
M
M
L
H
La2
M
M
L
Lb1
Lb2
CW
(Vref > VIN)
CCW
(Vref < VIN)



PD − Ta
Rth
Rth(j−c)=8℃/W
Rth(j−a)=54℃/W
INFINITE HEAT SINK
10℃/W HEAT SINK
NO HEAT SINK
POWER DISSIPATION PD (W)
0
4
8
12
0
50
100
150
200
AMBIENT TEMPERATURE Ta (℃)

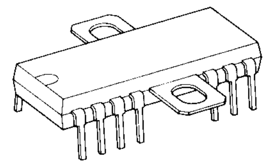
APPLICATION CIRCUIT



TA7261P

DC MOTOR DRIVER (2 PHASE Bi-DIRECTIONAL)

The TA7261P is a 2 Phase Bi-Directional type Motor Driver IC designed for use Tape Deck, VTR and Micro Floppy Disk Motor Drivers.
It contains Output Power Drivers, Position Sensing Amplifiers, Control Amplifier and Voltage Regulator for external circuit.



HDIP14-P-500

Weight: 3.0g (Typ.)

FEATURES:

. Output Current is Up to 0.6A(AVE)
. Voltage Regulator for External Circuit
  : V_{OUT}=10.7V(Typ.), I_O=50mA(Max.)
. Few External Parts Required
. Operating Supply Voltage Range : V_{CC}=15 ~ 22V

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	25	V
Output Current	$I_{O(AVE)}$	600	mA
Regulator Output Current	I_{CC2}	50	mA
Power Dissipation (Note)	P_D	2.3	W
Operating Temperature	T_{opr}	-15 ~ 75	°C
Storage Temperature	T_{stg}	-55 ~ 150	°C

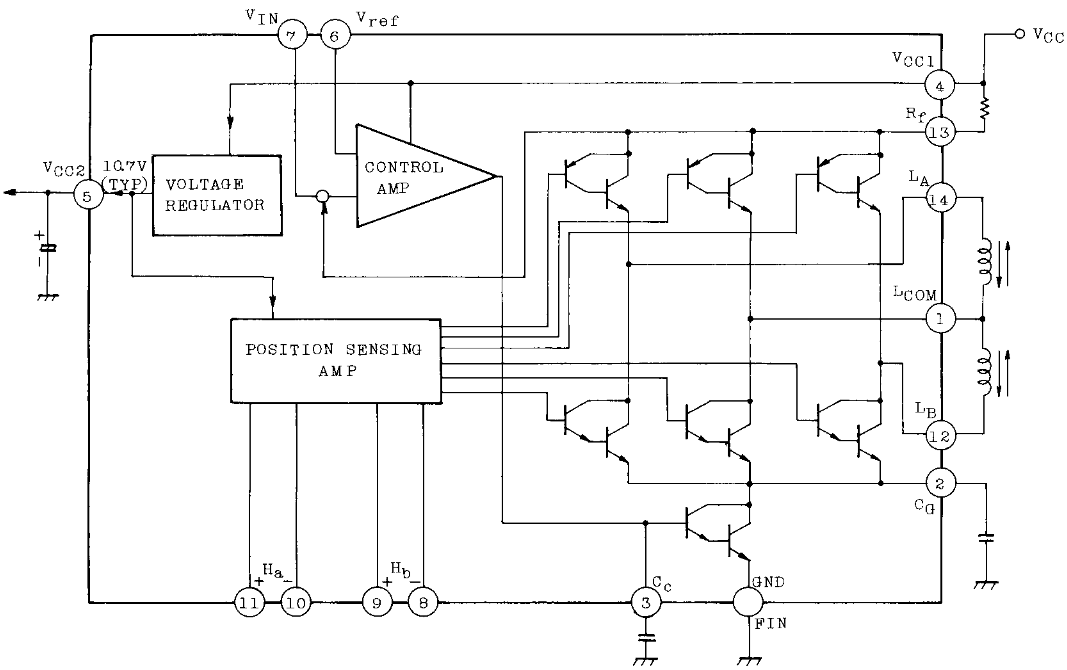
Note : Ta=25°C.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified V_{CC}=20V, R_f=2.2Ω, R_L=44Ω, Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current	I_{CC}	1		–	–	12	mA
Input Offset Voltage	V_{IO}	1	$V_{IN}=V_{ref}$=5V	0	–	200	mV
Voltage Gain	G_V	1	$V_{IN}-V_{ref}$=0 $V_{IN}-V_{ref}$=100mV	0.8	1.0	1.05	
Residual Output Voltage	V_{OR}	1	V_{IN}=5.5V, V_{ref}=5.0V	–	–	20	mV
Saturation Voltage: Upper	V_{SAT1}	1	R_f=0Ω, V_{IN}=4.5V	–	–	2.5	V
Saturation Voltage: Lower	V_{SAT2}	1	R_f=0Ω, V_{IN}=4.5V	–	–	3.7	V
Output Offset Voltage	V_{OO}	1	I_O=100mA, $V_{IN}=V_{ref}$=5V	-20	0	20	mV
Regulator: Output Voltage	V_{CC2}	1	R_L=560Ω	10.0	10.7	11.4	V
Regulator: Load Regulation	ΔV_{CC2}	1	R_L=OPEN/560Ω	–	–	25	mV
Regulator: Temperature Coefficient	Tc V_{CC2}	1		-2	–	+2	mV/deg
Position Sensing Amp: Input Sensitivity	V_H			150	–	–	mV
Position Sensing Amp: Operating Voltage (DC Level), H_a Side	CMR (H_a)			V_{CC2} +1	–	V_{CC}-1	V
Position Sensing Amp: Operating Voltage (DC Level), H_b Side	CMR (H_b)			V_{CC2} +1	–	V_{CC}-1	V
Operating Voltage (DC Level): V_{IN} Side	CMR (V_{IN})			4	5	9	V
Operating Voltage (DC Level): V_{ref} Side	CMR (V_{ref})			4	5	9	V

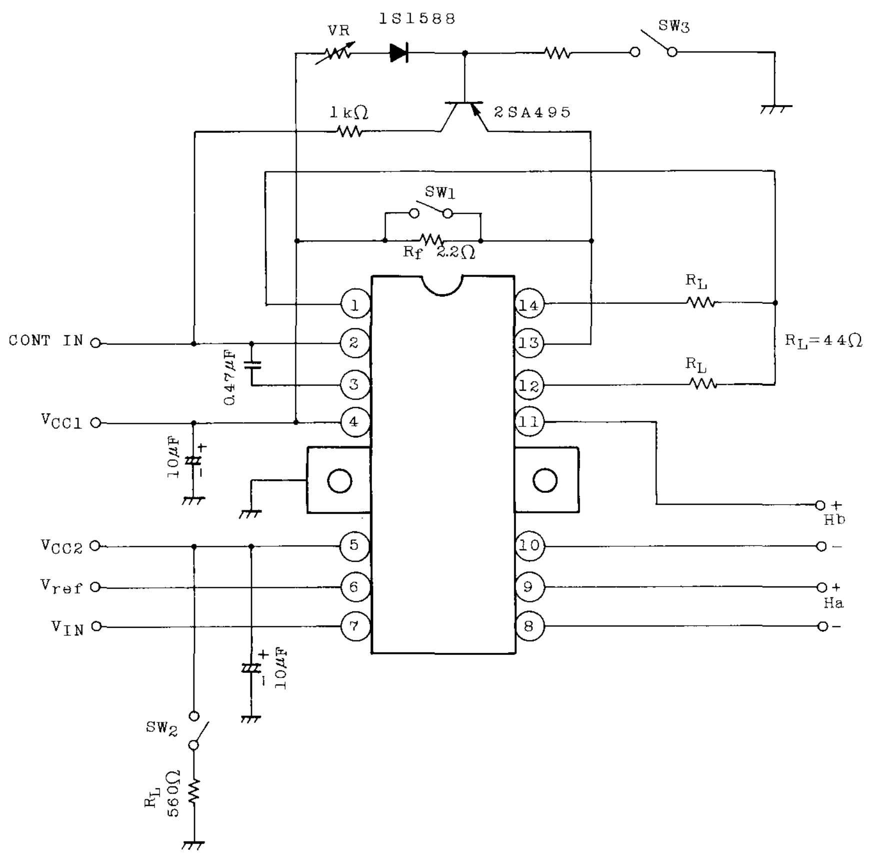
BLOCK DIAGRAM



TEST CONDITION

	V_{CC1}	R_f	R_L	POSITION SENSING INPUT (V)				LOAD OF	V_{IN}	V_{ref}	NOTE
	(V)	(Ω)	(Ω)	H_a+	H_a-	H_b+	H_b-	V_{CC2}	(V)	(V)	
I_{CC}	20	2.2	44	10	10	10	10	Open	5.2	5.0	
V_{IO}	20	2.2	44	10	9.9	10	9.9	Open	5.0	5.0	R_f voltage drop
G_V	20	2.2	44	10	9.9	10	9.9	Open	5.0 →5.1	5.0	R_f voltage drop at $V_{IN}=V_{ref}$ → $V_{IN}-V_{ref}=100mV$
V_{OR}	20	2.2	44	10	9.9	10	9.9	Open	5.5	5.0	R_f voltage drop
V_{SAT1}	20	0		All Function				Open	4.5	5.0	All the transistor (Upper side)
V_{SAT2}	20	0						Open	4.5	5.0	All the transistor (Lower side)
V_{OO}	20	2.2	44					Open	5.5	5.0	
V_{CC2}	20	2.2	44	10	9.9	10	9.9	560Ω	5.0	5.0	V_{CC2} Terminal measure
V_{CC2}	20	2.2	44	10	9.9	10	9.9	Open 560Ω	5.0	5.0	V_{CC2} Terminal measure

MEASURING CIRCUIT

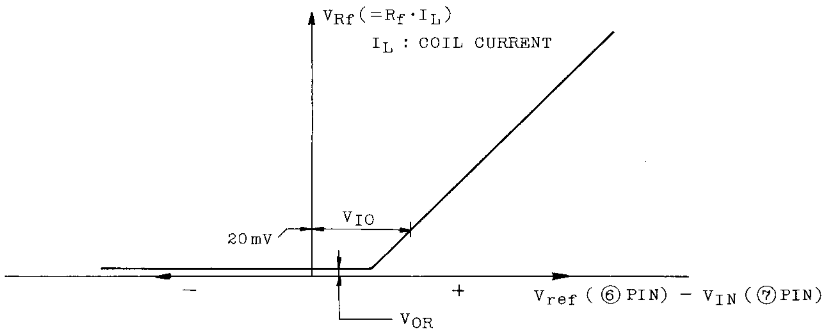


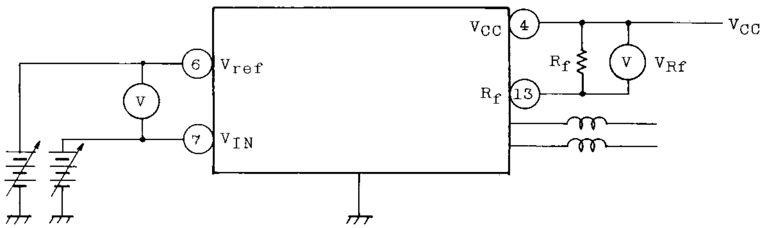
SW1 : When the time of V_{SAT1} and V_{SAT2} measuring "ON".

SW2 : V_{CC2}, ΔV_{CC2} measuring "ON".

SW3 : V_{OO} measuring "ON", adjust the voltage drop of R_f to 200mV by using VR.

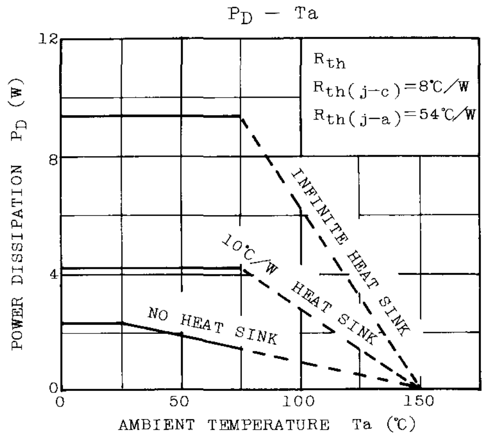
INPUT-OUTPUT CHARACTERISTICS



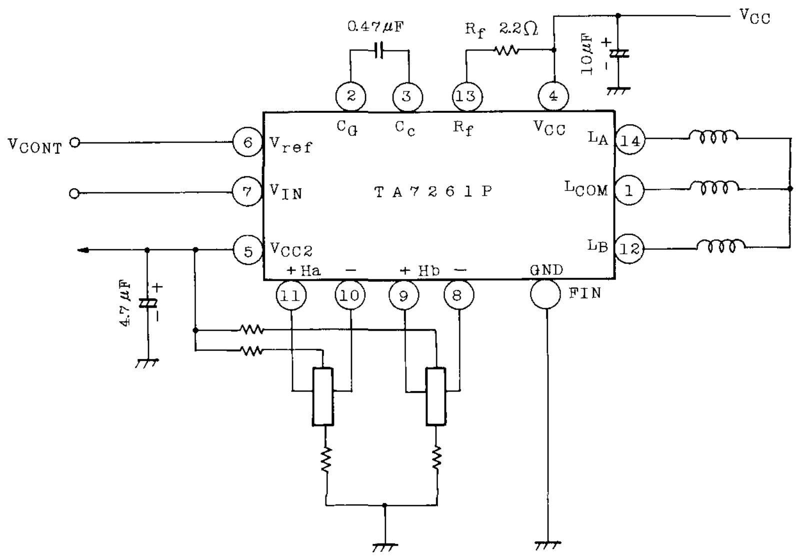


FUNCTION TABLE

	INPUT		OUTPUT		
	H_a	H_b	L_A	L_{COM}	L_B
V_{IN} V_{ref}	1	0	L	L	H
	1	1	L	H	H
	0	1	H	H	L
	0	0	H	L	L



APPLICATION



TA7262F/P/P(LB)

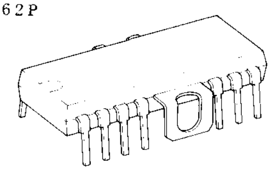
DC MOTOR DRIVER (3 PHASE Bi-DIRECTIONAL)

The TA7262P is a 3 Phase Bi-Directional supply-voltage-control Motor Driver IC. It's designed especially for energy saving Motor Control System. It contains Power Drivers, CW/CCW control circuit position sensing amplifiers and current regulator for external connected position sensing elements.

FEATURES:

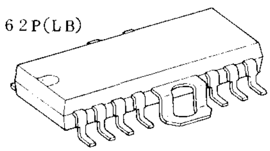
. Output Current is Up to 1.5A (AVE).
. Supply Voltage Control Motor Driver.
. Variable Current Source for Hall Sensor Including.
. Few External Parts Required.
. High Sensitivity of Position Sensing Inputs.

TA7262P



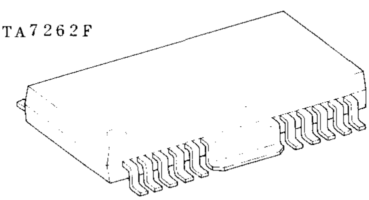
HDIP14-P-500A

TA7262P(LB)



HSOP14-P

TA7262F



HSOP20-P-450

Weight:

HDIP14-P-500A: 3.0g (Typ.)
HSOP14-P : 3.0g (Typ.)
HSOP20-P-450 : 0.8g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage (MOTOR)		V_S	25	V
Supply Voltage (CONTROL)		V_{CC}	25	V
Output Current (MOTOR)		$I_{O(AVE)}$	1.5	A
Output Current (Note 1)		I_{CS}	40	mA
Position Sensing Input Voltage		V_H	400	mV
Power Dissipation (Note 2)	TA7262P	P_D	2.3	W
	TA7262P(LB)		2.3	
	TA7262F		1.0	
Operating Temperature		T_{opr}	-30~75	°C
			-55~150	°C

Note 1 : TA7262P, TA7262P(LB) 12 PIN
TA7262F .... 18 PIN

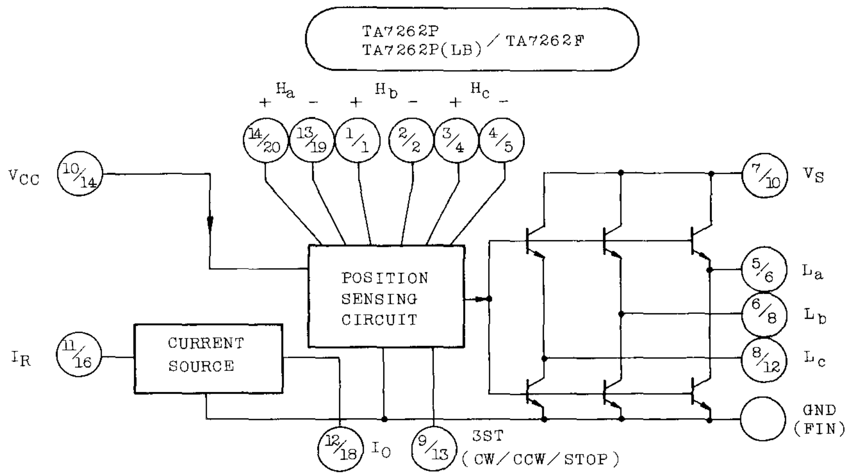
Note 2 : No heat sink

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=9V, V_S=12.8V, R_L=6Ω, V_H=±20mV, Ta=25°C)

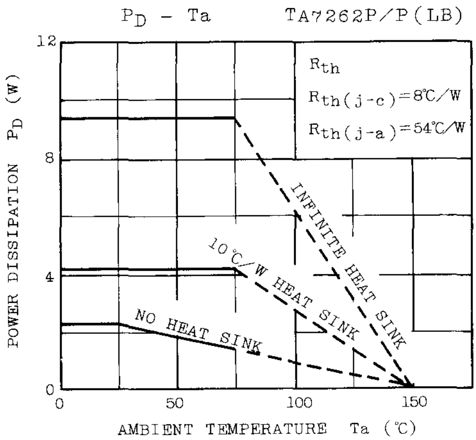
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC1}		V_{CC}=9V, 3ST GND, V_S OPEN	–	5.7	6.5	mA
		I_{CC2}		V_{CC}=25V, 3ST GND, V_S OPEN	–	8.0	11.0	
		I_{CC3}		Stop (3ST=VCC)	–	–	4	
Saturation Voltage		V_{SAT}		I_O=1A	–	–	2	V
Saturation Voltage Differencial		ΔV_{SAT}		I_O=1A	–	100	180	mV
Cut-off Current	Upper	I_{OC-U}		V_S=22V	–	–	50	μA
	Lower	I_{OC-L}		V_S=22V	–	–	50	
Position Sensing Input Voltage	Input Sensitivity	V_H			–	8	20	mV
	Input Offset	V_{OFST}			–	0	5	mV
	Operating DC Level	CMR			2	–	V_{CC}-2	V
CW/CCW Control Operating Voltage	CW	V_{FW}			1.2	–	7.8	V
	STOP	V_{STP}			8.6	V_{CC}	–	
	CCW	V_{RV}			–	0	0.4	
Operating Supply Voltage	V_S	V_{Sopr}			2	–	22	V
	V_{CC}	V_{CCopr}			7	9	22	V
Output Current of Current Source		I_{CS-1}		I_R Open	1.5	2.2	3.0	mA
		I_{CS-2}		I_R=100Ω	3.0	4.4	5.5	

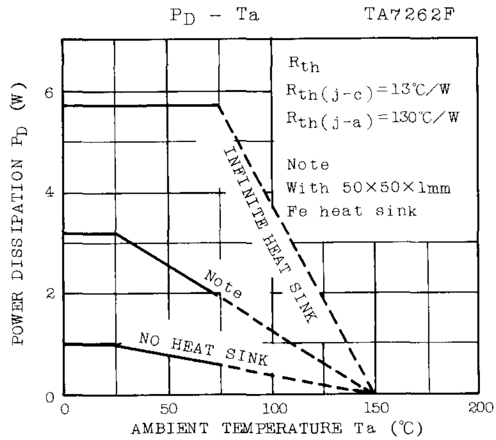
BLOCK DIAGRAM



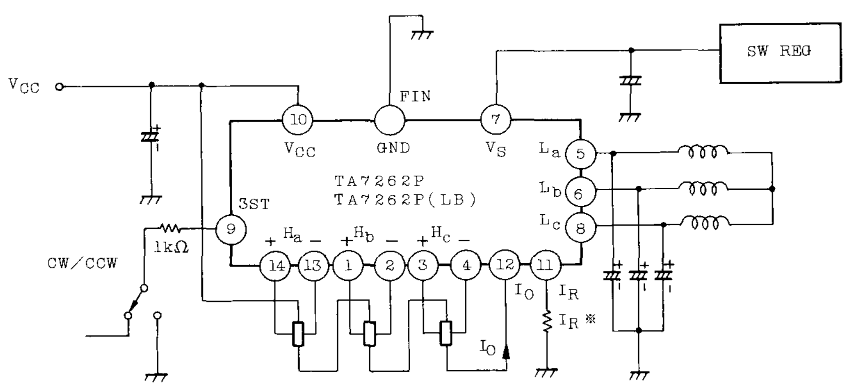
FUNCTION

FRS INPUT	POSITION SENSING INPUT			COIL OUTPUT		
	Ha	Hb	Hc	La	Lb	Lc
CW	1	0	1	H	L	M
	1	0	0	H	M	L
	1	1	0	M	H	L
	0	1	0	L	H	M
	0	1	1	L	M	H
	0	0	1	M	L	H
CCW	1	0	1	L	H	M
	1	0	0	L	M	H
	1	1	0	M	L	H
	0	1	0	H	L	M
	0	1	1	H	M	L
	0	0	1	M	H	L
STOP	1	0	1	High Impedance		
	1	0	0			
	1	1	0			
	0	1	0			
	0	1	1			
	0	0	1			

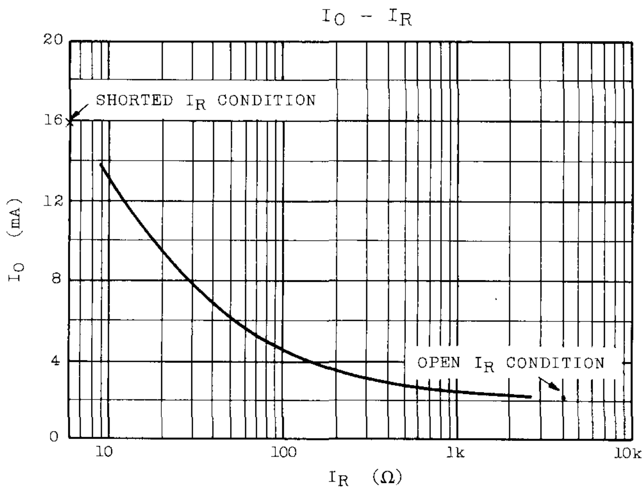




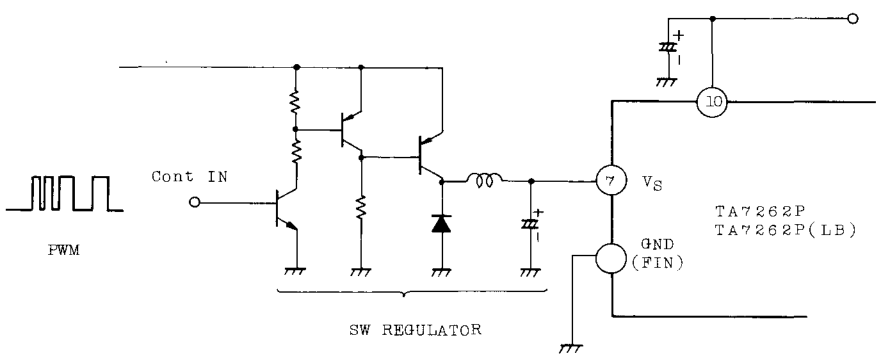
APPLICATION CIRCUIT 1



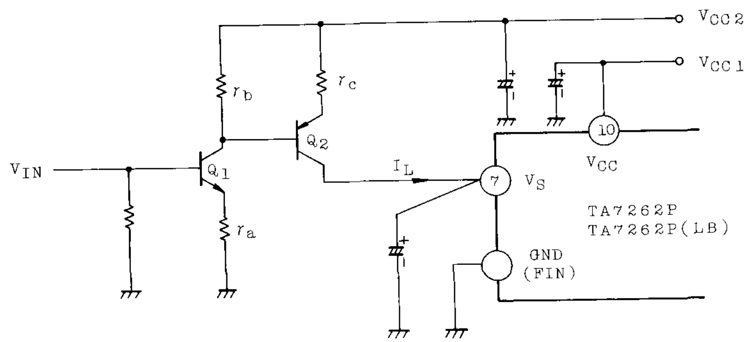
※ Hall sensor driving current (I_O) can be changed by IR.
Refer to I_R vs I_O characteristics.



APPLICATION CIRCUIT 2



APPLICATION CIRCUIT 3



$I_L \doteqdot \frac{b}{\gamma_a \cdot \gamma_c} \cdot V_{IN} - \frac{1}{\gamma_c}\left(\frac{\gamma_b}{\gamma_a} \cdot V_{BE1} + V_{BE2}\right)$

I_L : Motor Coil Current

V_{IN} : Control Voltage

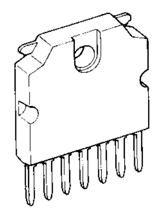
$I_L \doteqdot K_1 \cdot V_{IN} + K_2$ K_1, K_2 = Constant

Q_2 works as a Current Regulator for Output Coil. Therefore, Collector to Emitter Voltage of Q2 is varied in accordance with required coil current.

TA7267BP

BRIDGE DRIVER

The TA7267BP is a Bridge Driver for brushed DC Motor Rotation control.
Forward Rotation, Reverse Rotation, Stop and Braking operations are available.
It's designed for Loading and Reel Motor drover for VCR and Tape Deck, and any other consummer and industrial applications.
TA7267BP have Operation Supply Voltage terminal and Motor Driving Supply Voltage terminal independently, therefore Servo control operation is applicable.



HSIP7-P-A

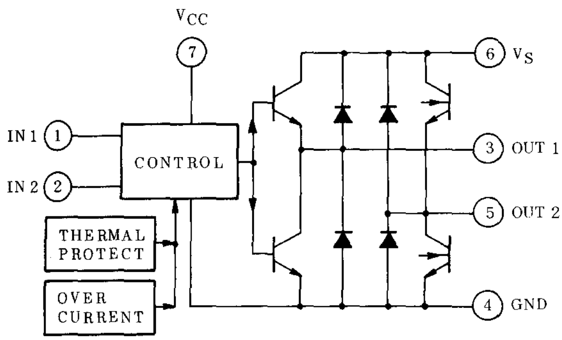
Weight : 2.15g(Typ.)

- Output Current Up to 1.0A(AVE), and 3.0A(PEAK).
- 4 Function Modes (CW, CCW, STOP and Brake) are Controlled by 2 Logic Signals Fed Into 2 Input Terminals.
- Built-in Over Current Protector and Thermal Shut Down Circuit.
- Operating Voltage Range : V_{CC}=6~18V

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Peak Supply Voltage	$V_{CC\ MAX}$	25	V
Operate Supply Voltage	$V_{CC(opr)}$	18	V
Output Current	$I_{O(AVE)}$	1.0	A
Peak Output Current	$I_{O(PEAK)}$	3.0	A
Power Dissipation (Tc=75°C)	P_D	12.5	W
Operating _emperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~150	°C

BLOCK DIAGRAM

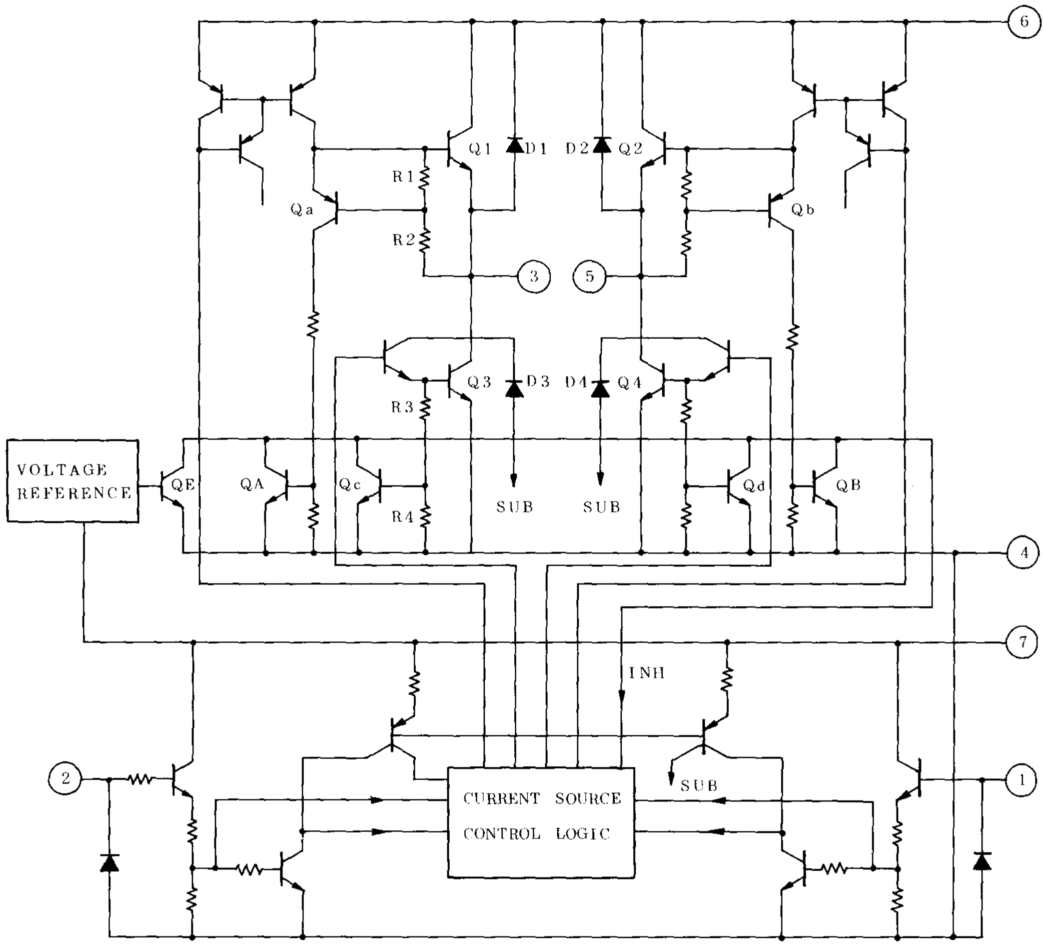


IN 1	IN 2	OUT 1	OUT 2	MODE
1	1	L	L	Brake
0	1	L	H	CW/CCW
1	0	H	L	CCW/CW
0	0	High Impedance		Stop

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}		V_{CC}=18V Output Off, Stop Mode	-	1.8	3.5	mA
		I_{CC2}		V_{CC}=18V, Output Off CW/CCW Mode	-	8.3	12	
		I_{CC3}		V_{CC}=18V, Brake Mode	-	8.5	13	
Saturation Voltage	Upper	V_{S1} U		V_{CC}=18V, I_O=0.1A	-	-	1.1	V
	Lower	V_{S1} L			-	-	1.0	
	Upper	V_{S2} U		V_{CC}=18V, I_O=1A	-	1.2	1.5	
	Lower	V_{S2} L			-	1.05	1.4	
Output Transistor Leakage Current	Upper	I_L U		V=25V	-	-	50	μA
	Lower	I_L L			-	-	50	
Input Voltage	IN1	$V_{IN(H)}$		Tj=25°C	3.0	-	-	V
	IN2	$V_{IN(L)}$		1 Pin and 2 Pin	-	-	0.8	
Diode Forward Voltage	Upper	V_F U		I_F=1A	-	2.0	-	V
	Lower	V_F L			-	1.3	-	
Limitting Current		I_{SC}		-	-	2.5	-	A
Input Current 1,2		I_{IN} 1,2		Tj=25°C 1 Pin and 2 Pin	-	1	30	μA

INTERNAL CIRCUIT

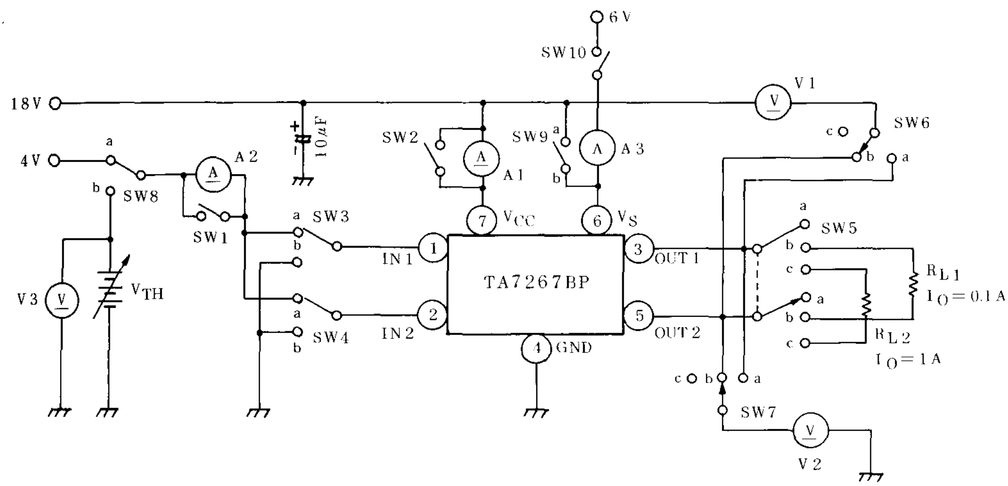


TE

TE

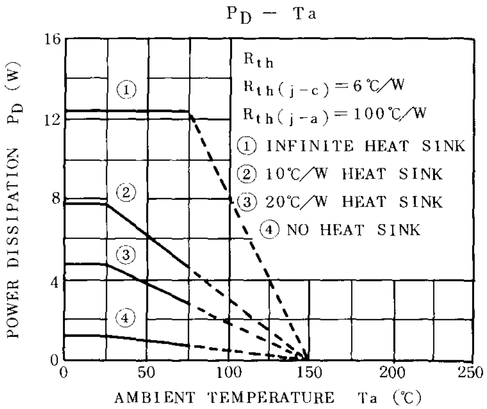
C

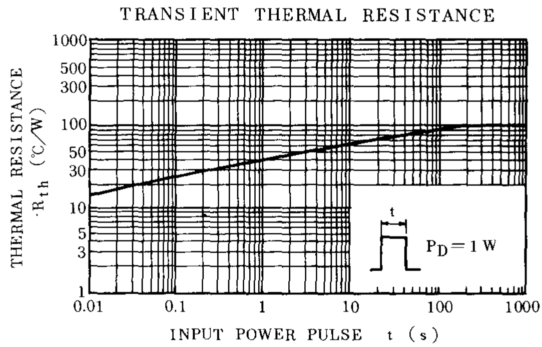
TEST CIRCUIT



TEST METHOD

CHARACTERISTIC	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	TEST METER
I_{CC1}	CLOSE	OPEN	b	b	a	c	c	a	a	A1 Use
I_{CC2}	"	"	a	b	a	c	c	a	a	
I_{CC2}	"	"	b	a	a	c	c	a	a	
I_{CC3}	"	"	a	a	a	c	c	a	a	
V_{S1} U	"	CLOSE	b	a	b	a	c	a	a	V1 Use, I_O=0.1A
V_{S1} U	"	"	a	b	b	b	c	a	a	
V_{S1} L	"	"	b	a	b	c	b	a	a	V2 Use, I_O=0.1A
V_{S1} L	"	"	a	b	b	c	a	a	a	
V_{S2} U	"	"	b	a	c	a	c	a	a	V1 Use, I_O=1A
V_{S2} U	"	"	a	b	c	b	c	a	a	
V_{S2} L	"	"	b	a	c	c	b	a	a	V2 Use, I_O=1A
V_{S2} L	"	"	a	b	c	c	a	a	a	
V_{TH1}	"	"	a	b	b	c	c	b	a	V3 Use
V_{TH2}	"	"	b	a	b	c	c	b	a	Function Check
I_{SC}	"	"	a	b	b	c	c	a	b	A3 Use, SW10=Close
I_{IN1}	OPEN	"	a	b	b	c	c	a	a	A2 Use
I_{IN2}	"	"	b	a	b	c	c	a	a	





APPLICATION NOTE

(1) INPUT CIRCUIT

Input circuit is shown in Fig.1. It's a "High Active" type.
If a voltage above specified $V_{IN(H)}$ value fed into input terminal that means "Logic 1", and the voltage less than $V_{IN(L)}$ or connect to GND means "Logic 0".
And the circuit have a hysteresis for stable operation. (See Fig.2)

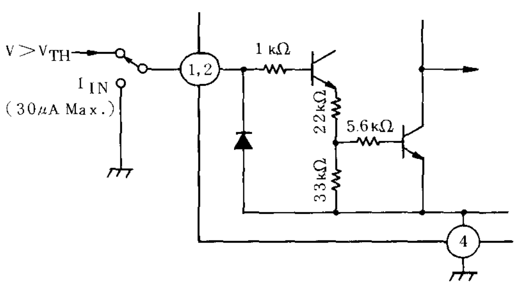


Fig. 1

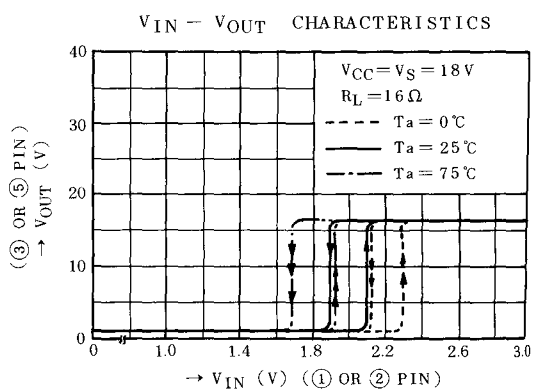


Fig. 2

(2) BASIC APPLICATION CIRCUIT

Fig.3 shows the basic application circuit.

Optimum values of the C,R depend on the inherent constant of a motor and parastic C,R values around the circuit.

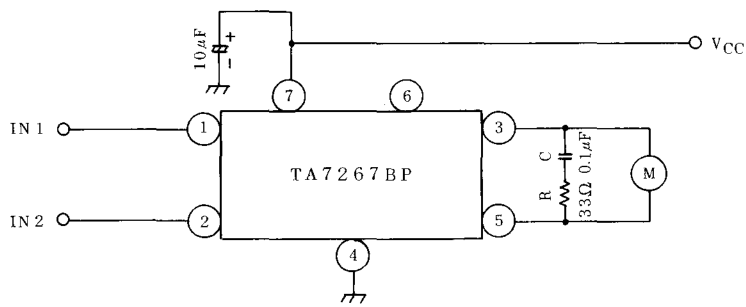


Fig. 3

(3) ADDITIONAL DIODE

I) If the braking operation is so loose, connect a additional diode between each output to GND. (See Fig.4-(a))

II) If the back electromotive pulse generated in output coil is so strong. Internally connected back electromotive suppression diode may be damaged by this pulse.

In such a case connect a additional diode between each output to V_{CC}.
(See Fig.-4(b))

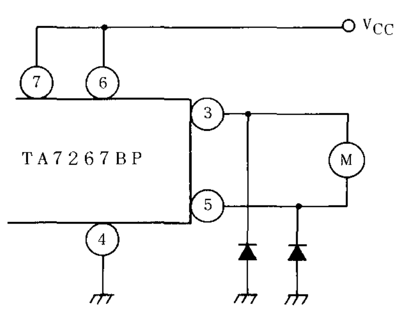


Fig. 4(a)

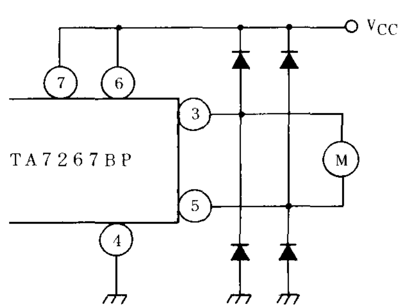
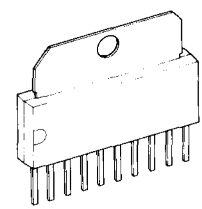


Fig. 4(b)

TA7272P

DUAL POWER OPERATIONAL AMPLIFIER.

TA7272P is a dual power operational amplifier.
It is intended for use especially DC MOTOR positioning system applications, such as Arm Driver (for Audiodisk Players), head or voice coil motor drivers(for Floppy and Winchester Disk Drivers) and any other power driver applications.



HSIP10-P

Weight: 2.47g (Typ.)

FEATURES:

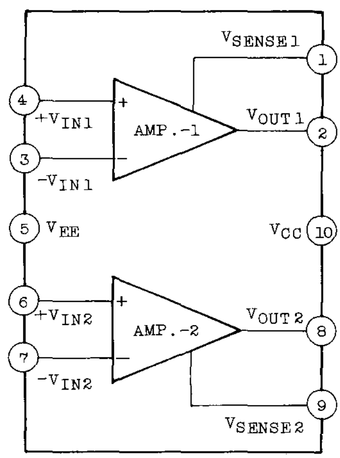
. SIP 10 Pin Power Package Capsealed.
. Build-in Over Current Protector.
. Few External Parts Required.
. Output Current Up to 1.2A Max. (AVE)
. Excellent Crosstalk Characteristics.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}, V_{EE}	±18	V
Output Current (Note 1)	$I_{O(AVE)}$	1.2	A
Power Dissipation (Note 2)	P_D	12.5	W
Operating Temperature	T_{opr}	-30 ~ 75	°C
Storage Temperature	T_{stg}	-55 ~ 150	°C

Note 1. See V_{CC}-$I_{O(AVE)}$ MAX. Characteristics
2. Tc=25°C

BLOCK DIAGRAM

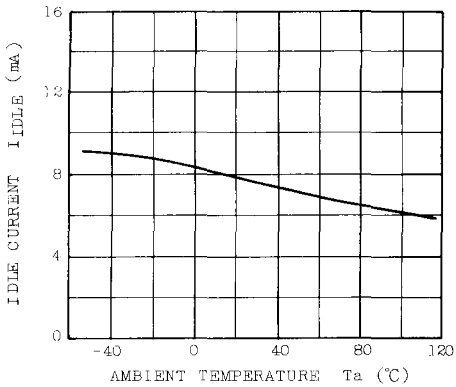


ELECTRICAL CHARACTERISTICS

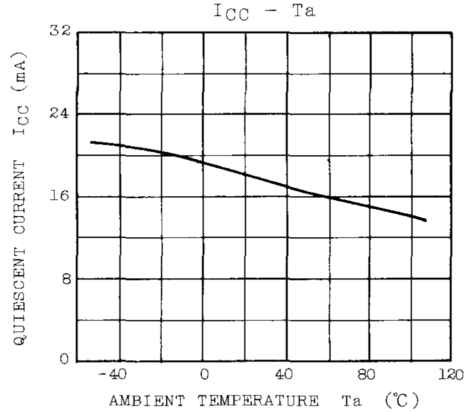
(Unless otherwise specified, V_{CC}=15V, V_{EE}=-15V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC}			-	20	35	mA
Input Off Set Current		I_{IO}			-	2	100	nA
Input Bias Current		I_I			-	50	300	nA
Input Off Set Voltage		V_{IO}			-	1.0	7.0	mV
Output Voltage Swing	Upper	V_{OH}		V_{CC}=±15V, I_O=0.3A	11.5	12.1	-	V
	Lower	V_{OL}			-11.5	-12.3	-	
	Upper	V_{OH}		V_{CC}=±6V, I_O=1A	2.2	3.3	-	V
	Lower	V_{OL}			-2.2	3.7	-	
Open Loop Gain		G_{VO}			-	90	-	dB
Input Common Mode Voltage Range		CMR			±13	±14	-	V
Common Mode Rejection Ratio		CMRR		V_{IN}=-10V~10V	90	95	-	dB
Supply Voltage Rejection Ratio		SVRR		V_{CC}=-V_{EE}=6~15V±1V	-	45	150	μV/V
Slew Rate		SL			-	0.4	-	V/μsec
Short Circuit Current		I_{SC}		R_{SC}=0.68Ω	0.8	1.0	-	A
Cross Talk		CT		V_{IN}=-14V~14V	-	60	-	dB

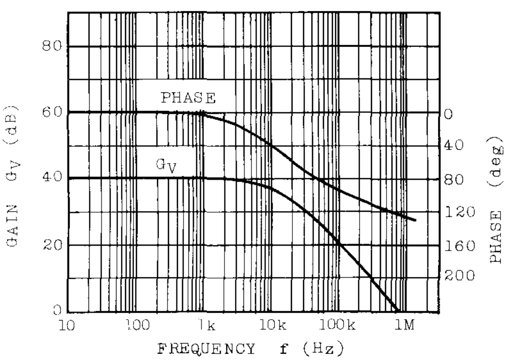
I_{IDLE} – Ta



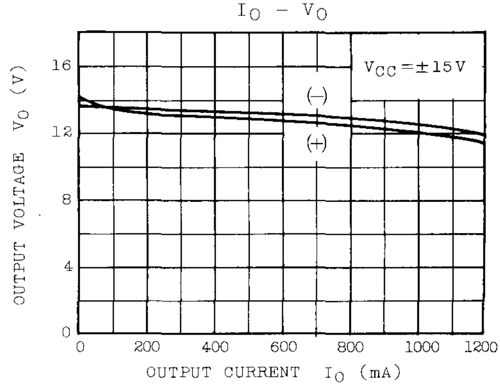
I_{CC} – Ta



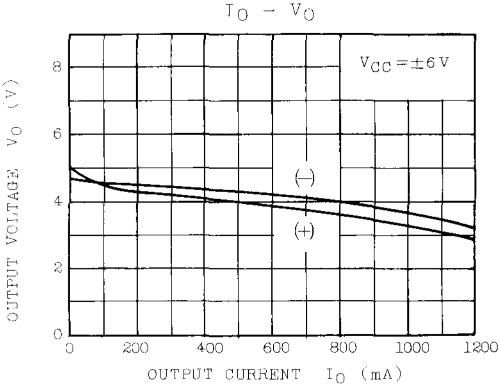
G_V, PHASE – f

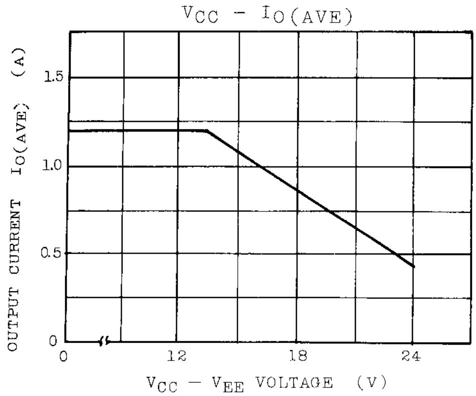


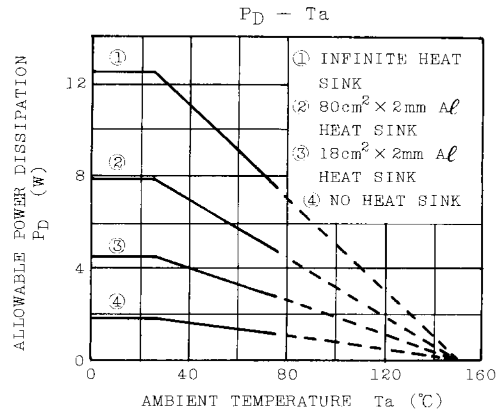
I_O – V_O



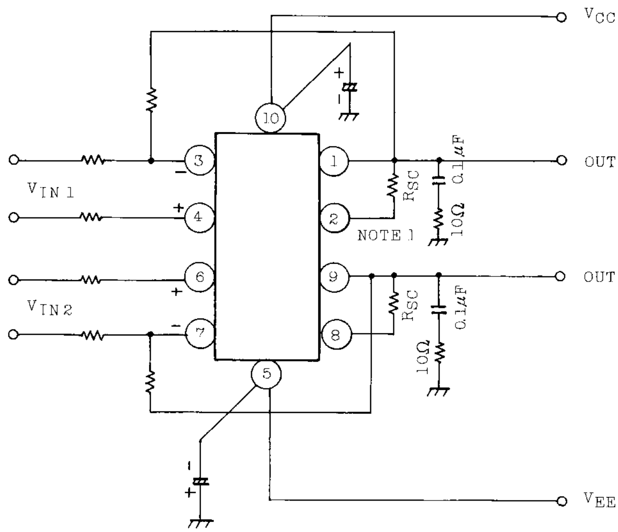
I_O – V_O





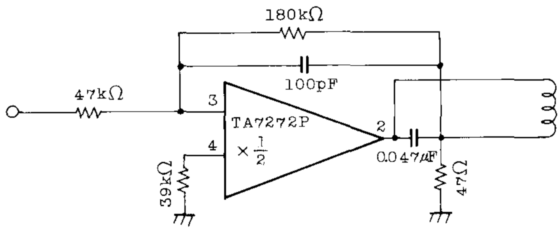


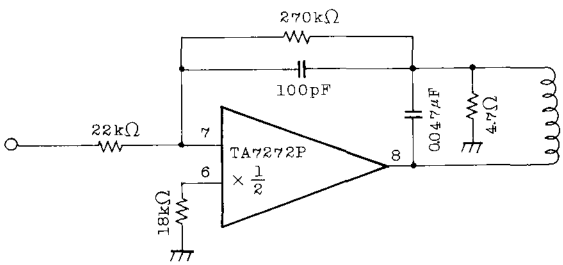
APPLICATION CIRCUIT 1



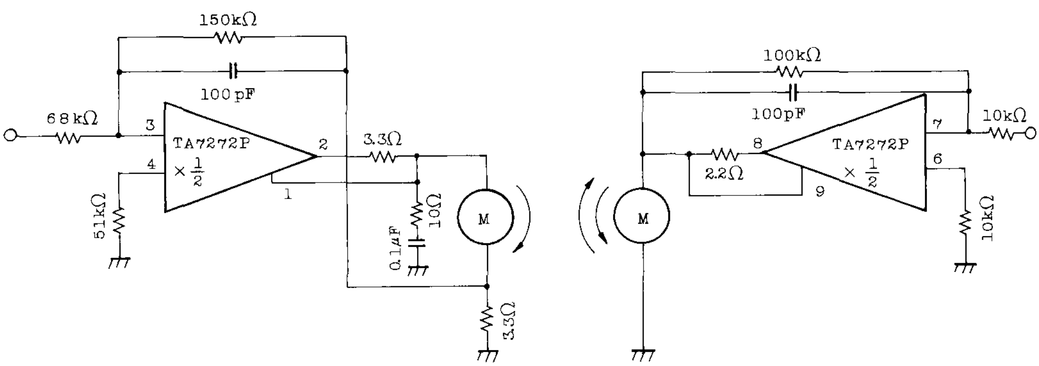
NOTE 1. $R_{SC} \fallingdotseq \frac{0.7(V)}{R_{SC(\Omega)}}$ (A)

APPLICATION CIRCUIT 2 (Actuator)





APPLICATION CIRCUIT 3 (Speed and Carriage Control)

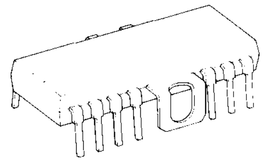


TA7279AP/P

DUAL BRIDGE DRIVER.

TA7279P/AP are dual bridge driver designed for DC motor rotation control.

- Wide Range of Operating Voltage : $V_{CC}(opr)=6\sim18V$ (P, AP), $V_S(opr)=0\sim16V(P)/=0\sim18V(AP)$
- Output Current Up to 1.0A(AVE), 3.0A(PEAK)
- Built-in Thermal Shut Down and Current Limitter
- Input Hysterisis for Stable Operation



Weight: 3.0g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage	AP	V_{CC}	25	V
	P		20	
Motor Drive Voltage	AP	V_S	25	V
	P		18	
Output Current	PEAK	$I_{O(PEAK)}$	* 3.0	A
	AVERAGE	$I_{O(AVE.)}$	1.0	
Power Dissipation		P_D	** 9.4	W
			*** 2.3	
Operating Temperature		Topr	-30~75	°C
Storage Temperature		Tstg	-55~150	°C

* : t=100ms

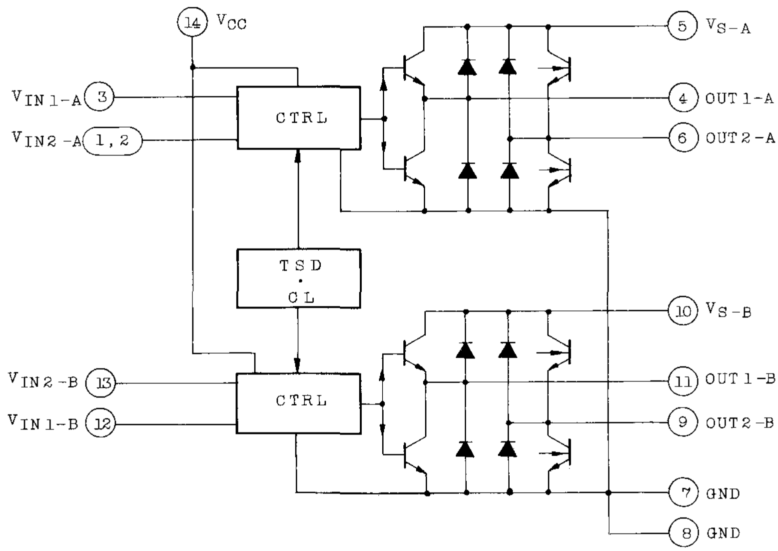
** : Tc=75°C

*** : Ta=25°C No Heat sink

ELECTRICAL CHARACTERISTICS (Ta=25°C)

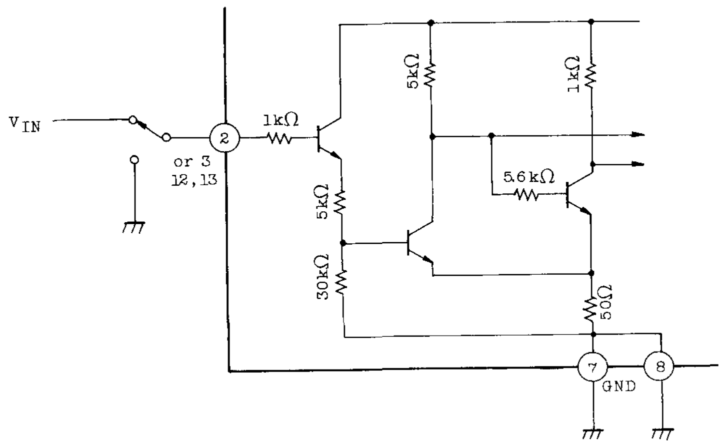
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}	1	V_{CC}=18V, Output off, Stop mode	14	28	41	mA
		I_{CC2}	1	V_{CC}=18V, Output off, CW/CCW mode	10	29	38	
		I_{CC3}	1	V_{CC}=18V, Output off, brake mode	8	20	35	
Input Operating Voltage	1 (High)	$V_{N(H)}$	–	Tj=25°C 2,3,12,13 Pin	3.0	–	V_{CC}	V
	2 (Low)	$V_{N(L)}$	–	Tj=25°C 2,3,12,13 Pin	–	–	0.8	
Input Current		I_{IN}	2	V_{IN}=3V	–	3	10	μA
Output Saturation Voltage	Upper	V_{SATU-1}	3	I_O=0.1A, V_{CC}=V_S=18V	–	–	1.1	V
	Lower	V_{SATL-1}	3	I_O=0.1A, V_{CC}=V_S=18V	–	–	1.0	
	Upper	V_{SATU-2}	3	I_O=1.0A, V_{CC}=V_S=18V	–	1.2	1.5	
	Lower	V_{SATL-2}	3	I_O=1.0A, V_{CC}=V_S=18V	–	1.05	1.4	
Leakage Current	Upper	I_{L-U}	–	V_S=25V(AP), 20V(P)	–	–	50	μA
	Lower	I_{L-L}	–	V_S=25V(AP), 20V(P)	–	–	50	
Diode Forward Drop	Upper	V_{F-U}	4	I_F=1.0A	–	2.5	–	V
	Lower	V_{F-L}	4	I_F=1.0A	–	1.3	–	

BLOCK DIAGRAM



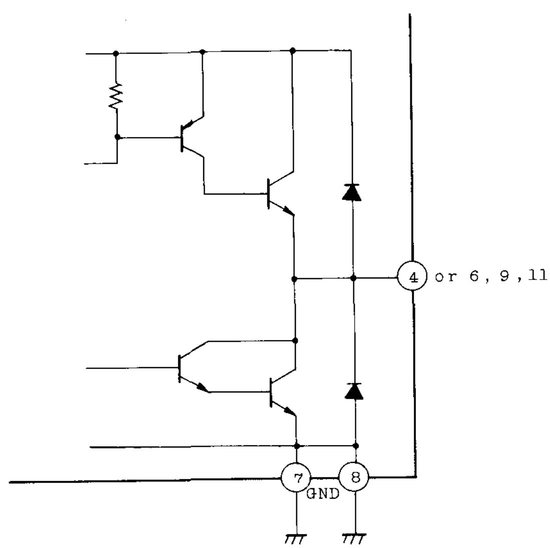
IN 1	IN 2	OUT 1	OUT 2	MODE
1	1	L	L	BRAKE
0	1	L	H	CW/CCW
1	0	H	L	CCW/CW
0	0	High Impedance		Stop

INPUT CIRCUIT

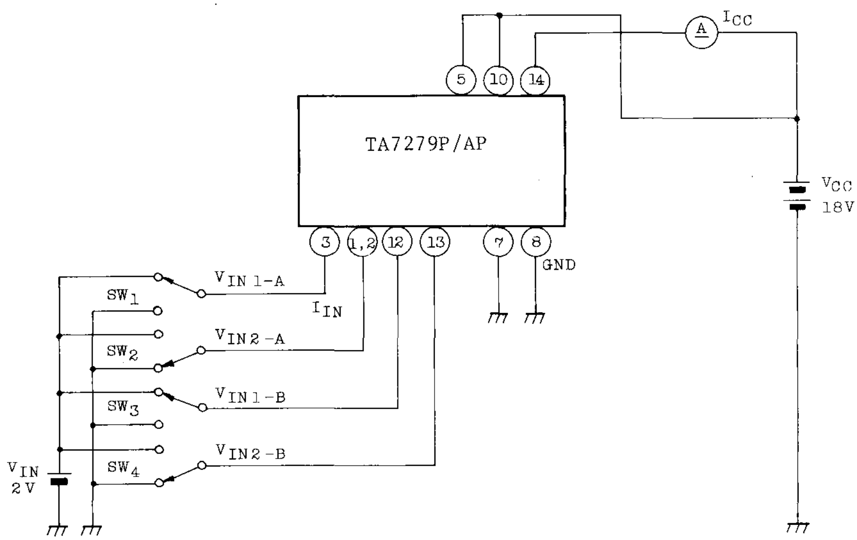


Input terminals of 2,3,12 and 13 Pin are all high active type and have a hysterisis.
3μA Typ of input current is required.

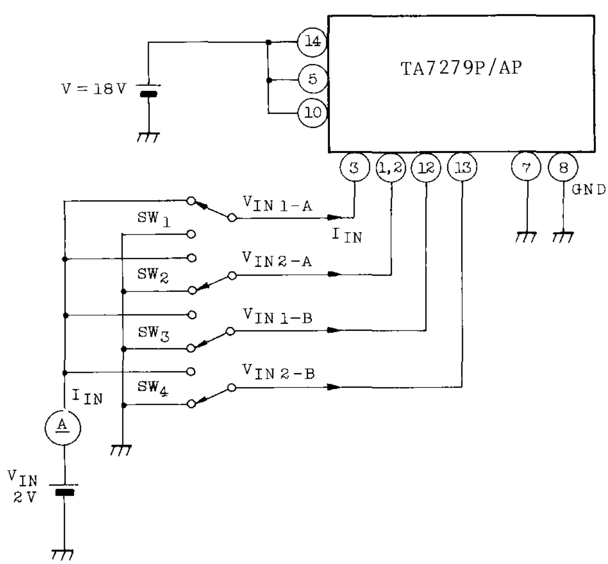
OUTPUT CIRCUIT



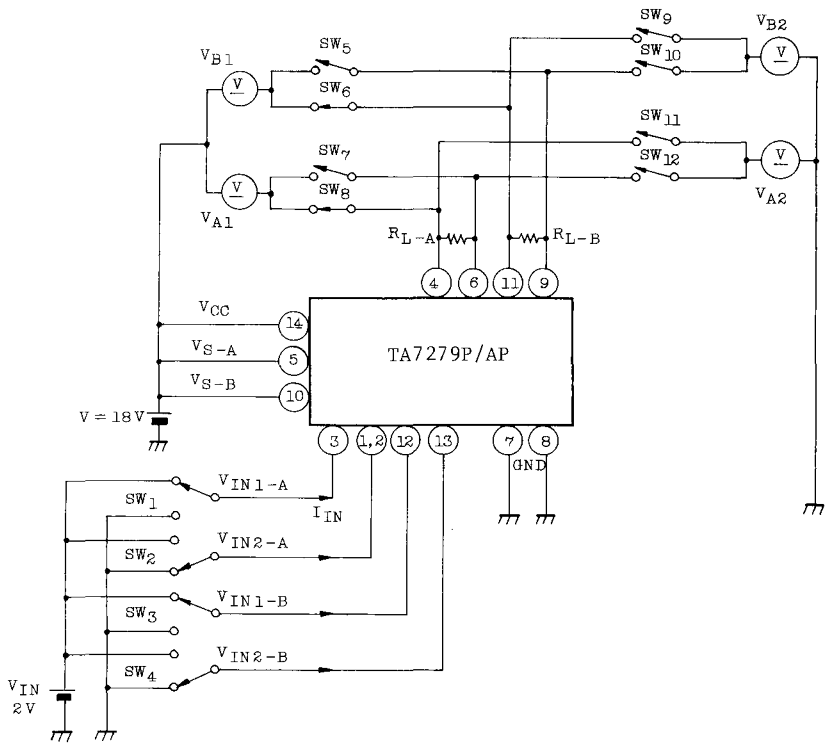
MEASURING CIRCUIT 1. $I_{CC1, 2, 3}$



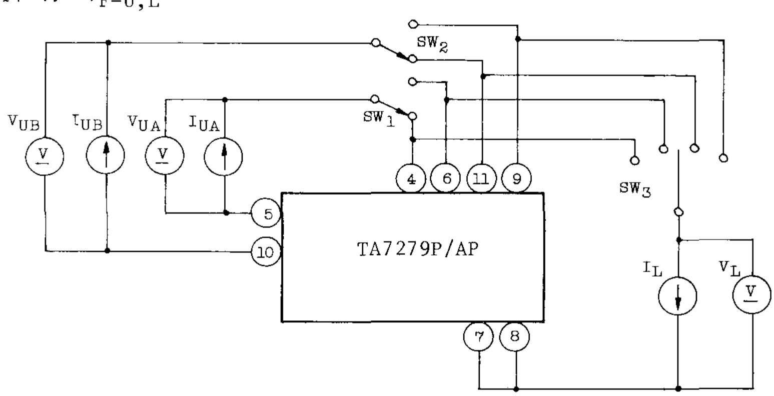
MEASURING CIRCUIT 2. $I_{IN(H),(L)}$



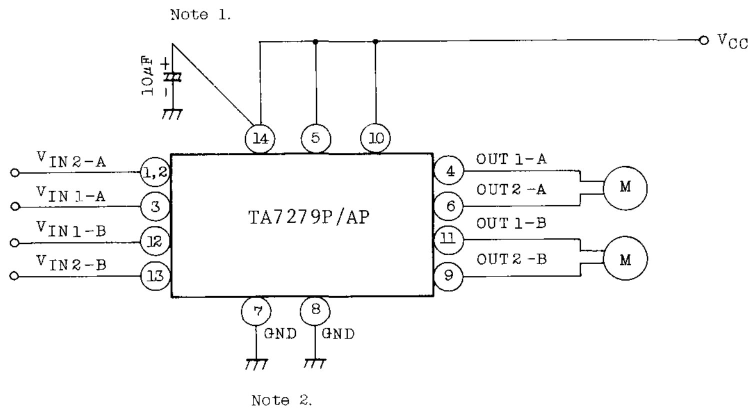
MEASURING CIRCUIT 3. $V_{SATU-1,2/L-1,2}$



MEASURING CIRCUIT 4. $V_{F-U,L}$



APPLICATION CIRCUIT



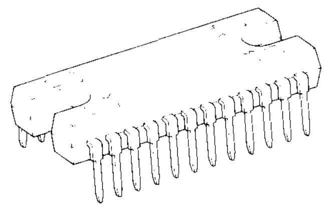
Note 1. Recommend to increase this value for stable operation when a proper PCB patterning is difficult to get.

Note 2. Care should be taken not to have a common impedance with another lines.

TA7284P

DC MOTOR DRIVER

TA7284P is a 1 CHIP MOTOR DRIVER IC designed especially for FDD and WDD Spindle Motor Control. It consists of Position Sensing Circuit, S/H type F/V Conversion Amplifier and 2 phase Bi-directional Power Outputs.



HDIP24-P-500

Weight: 4.3g (Typ.)

FEATURES:

- 2-Phase Bi-directional 1 Chip Motor Driver
- Output Current Up to 0.6A(AVE), 1.5A(PEAK).
- $V_{CC(opr)}=9 \sim 24V$
- Built in Over Current and Thermal Shut Down Circuit
- Regulator for External Circuit Including

MAXIMUM RATINGS (Ta=25°C)

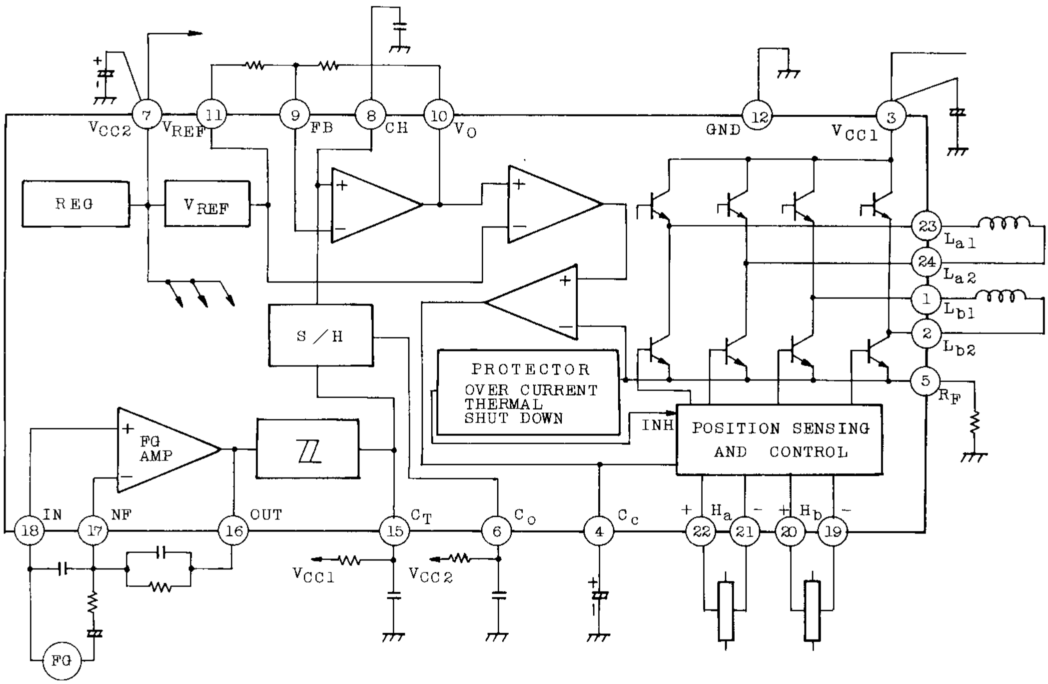
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	24.5	V
Output Current	I_O	0.6	A
Regulator Output Current	I_{CC2}	50	mA
Power Dissipation (Note)	P_D	2.5	W
Operating Temperature	T_{opr}	-30 ~ 75	°C
Storage Temperature	T_{stg}	-55 ~ 150	°C

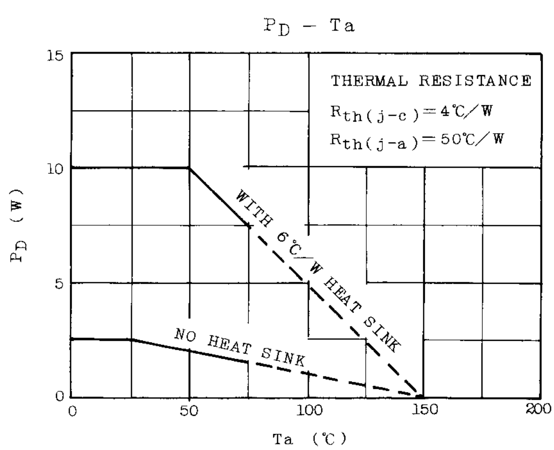
Note : Ta=25°C No heat sink.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC1}=24V, Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current			I_{CC1}		FG=55.5Hz, 50mV$_{rms}$ G_V=40dB STOP MODE	9	12	24	mA
			I_{CC2}		V_{CC1}=12V	-	10	-	
FG AMP	Input Sensitivity		V_{in}		G_V=40dB f=55.5Hz	200	500	1000	μVrms
	Frequency		f_g		G_V=40dB	50	-	1000	Hz
Reference Voltage			V_{ref}			$\frac{1}{2}V_{CC2}$ -0.15	$\frac{1}{2}V_{CC2}$	$\frac{1}{2}V_{CC2}$ +0.15	V
Regulator	Output Voltage		V_{CC2}		V_{CC1}=9 ~ 24V I_{CC2}=0	6.9	7.4	7.9	V
	Load Regulation		Reg L		I_{CC2}=0 ~ 20mA	-	10	50	mV
	Ripple Rejection		RR		f=100Hz I_{CC2}=0	48	55	-	dB
	Output Noise		V_N		I_{CC2}=0	-	2	7	mVrms
	Temperature Coefficient		T_{CVO}			-	-2	-	mV/°C
Output	Saturation Voltage	Upper	V_{SAT} U		I_{OUT}=0.5A	-	1.8	2.5	V
		Lower	V_{SAT} L		I_{OUT}=0.5A	-	0.5	1.0	
	Leakage Current		I_{OL}			-	0	50	μA
Voltage Gain			G			0.85	1.0	1.15	
Co Terminal	Leakage Current		$I_{L\ CO}$		V_{CO}=0	-	-	100	nA
	Saturation Voltage		$V_{SAT\ CO}$		R_L=180kΩ	-	-	70	mV
Position Sensing Input	Operating DC Level		CMR_H			2	-	V_{CC1}-2	V
	Sensitivity		V_H			200	110	-	mV
Thermal Shut-down Temperature			T_{SD}		Tj	-	175	-	°C
Current Limitting Voltage			V_{SC}		R_f terminal	-	0.6	-	V
F/V Conversion	Offset		$V_{F\ OFF}$			-	-	±10	mV
	Noise		V_{nf}			-	-	7	mVrms

BLOCK DIAGRAM





1. INTERNAL REGULATOR

7.4V Output Voltage is delivered for F/V Conversion reference and any other internal and external circuits by using Zener Diode and Power Transistor.
Maximum Output Current for external circuits is up 50mA.

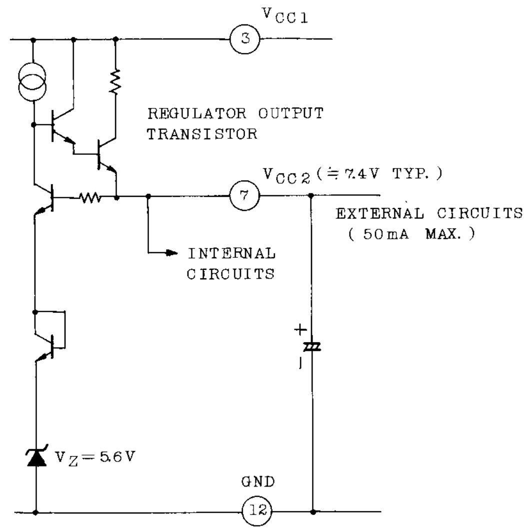


Fig. 1 INTERNAL REGULATOR CIRCUIT

2. FG AMPLIFIER

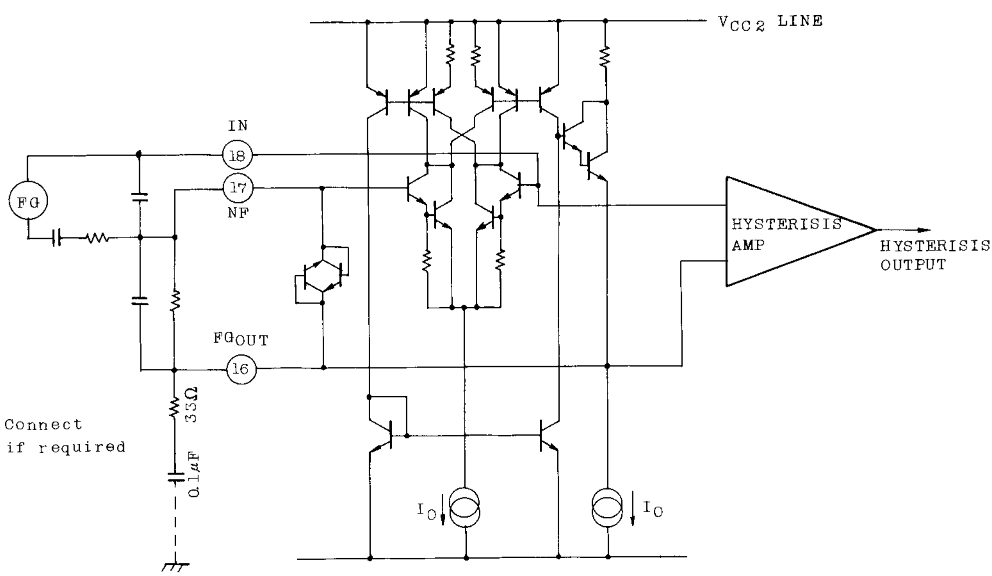


Fig. 2 FG AMPLIFIER CIRCUIT

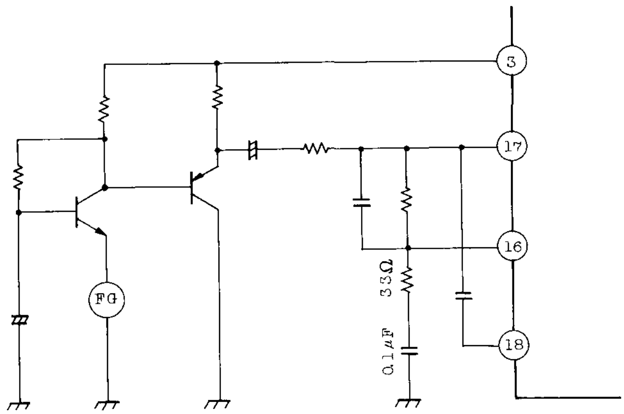


Fig. 3 FRONT AMPLIFIER

Input small FG signal is amplifired to required level by FG Amplifier that has a open loop gain of 85dB(TYP.), and is wave shaped by Hysteresis Amplifier connected following stage. Closed loop gain of FG Amplifier can be changed by changing the value of external resistors. But, it is required to set a closed loop gain less than 40dB when the FG frequency is approximately 50Hz.
FG frequency is approximately 500Hz or so high. In such a case, Closed loop gain is allowed to set less than 50dB. Front Amplifier (Fig.3) is required if the Closed loop gain is not enough. Capacitance and Resistor connecting between PIN 16 and GND is required for more stable operation.
(Connect if required, See Fig.2)

3. POSITION SENSING CIRCUIT

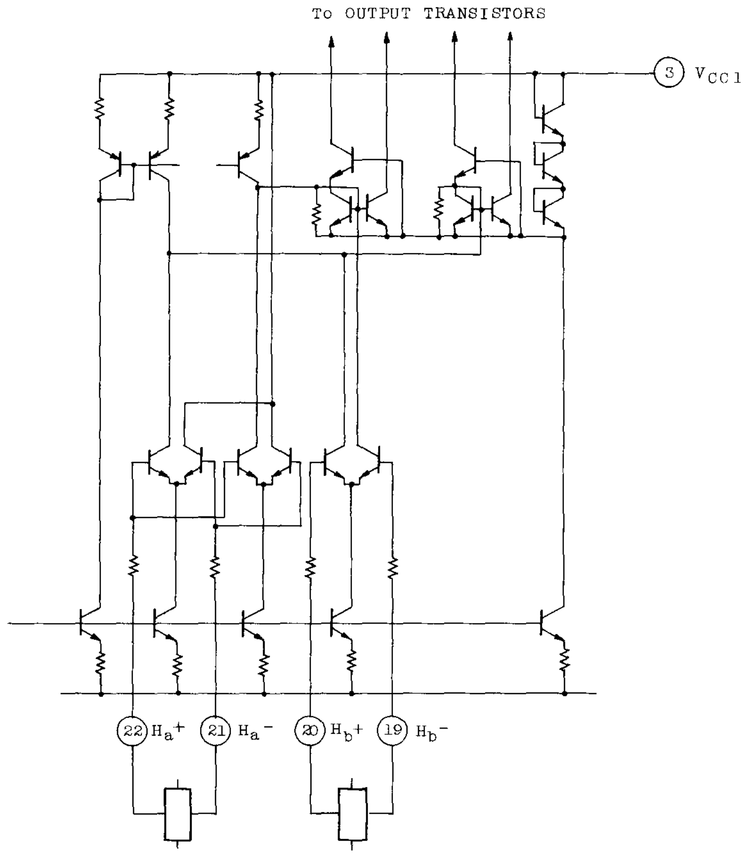
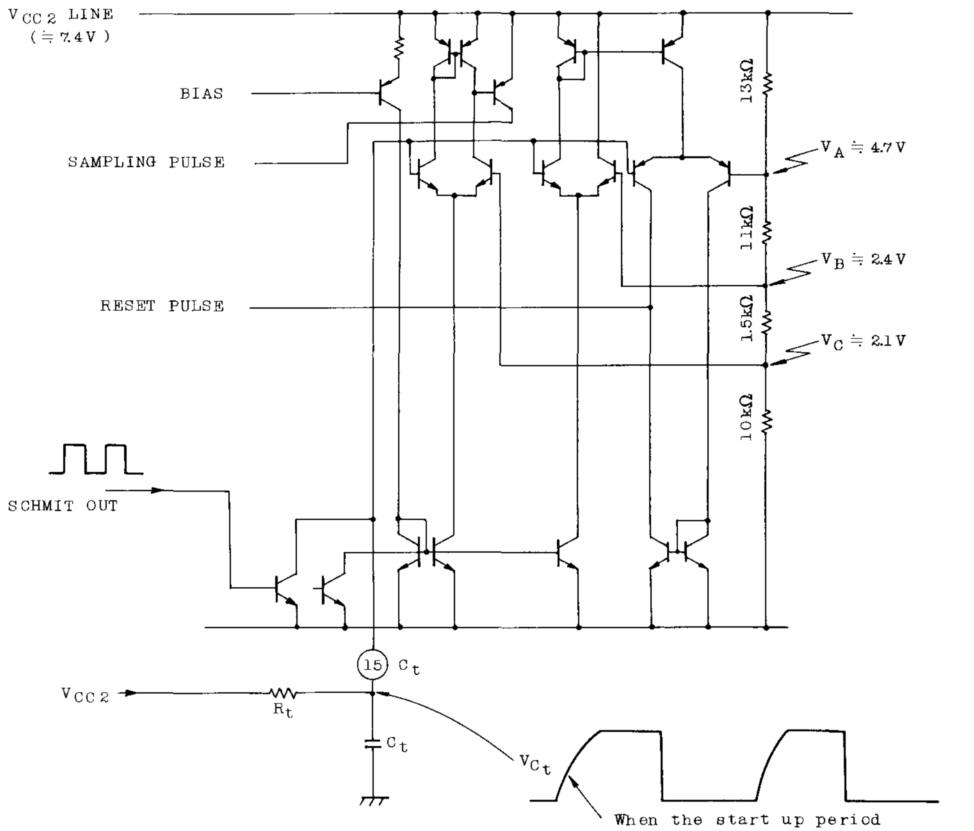


Fig. 4 POSITION SENSING CIRCUIT

This circuit for sensing a relative position between rotor and stator by using Hall Sensor and output signal to Output Transistor circuit. The circuit is Differencial Amplifier that has sensitivity of 200mV(p-p) and CMR (Operating DC Level) of 2 ~ V_{CC1}-2V.

4. CONTROL PULSE GENERATOR



$$V_{C_t} = V_{CC2}\left(1 - e^{-\frac{t}{C_t \cdot R_t}}\right)$$

Fig. 5 CONTROL PULSE GENERATING CIRCUIT

This circuit generates sampling and reset pulse required for Sample and Hold Circuit. The circuit consists of 3 Comparators that's one input is connect commonly to PIN 15 (C_t terminal) and other input to each Threshold Voltage Reference (2.1, 2.4 and 4.7V). Sampling Pulse is generated when the C_t terminal voltage is equal to 2.1V and Reset Pulse is generated when the terminal voltage is equal to 4.7V.

5. SAMPLE AND HOLD CIRCUIT

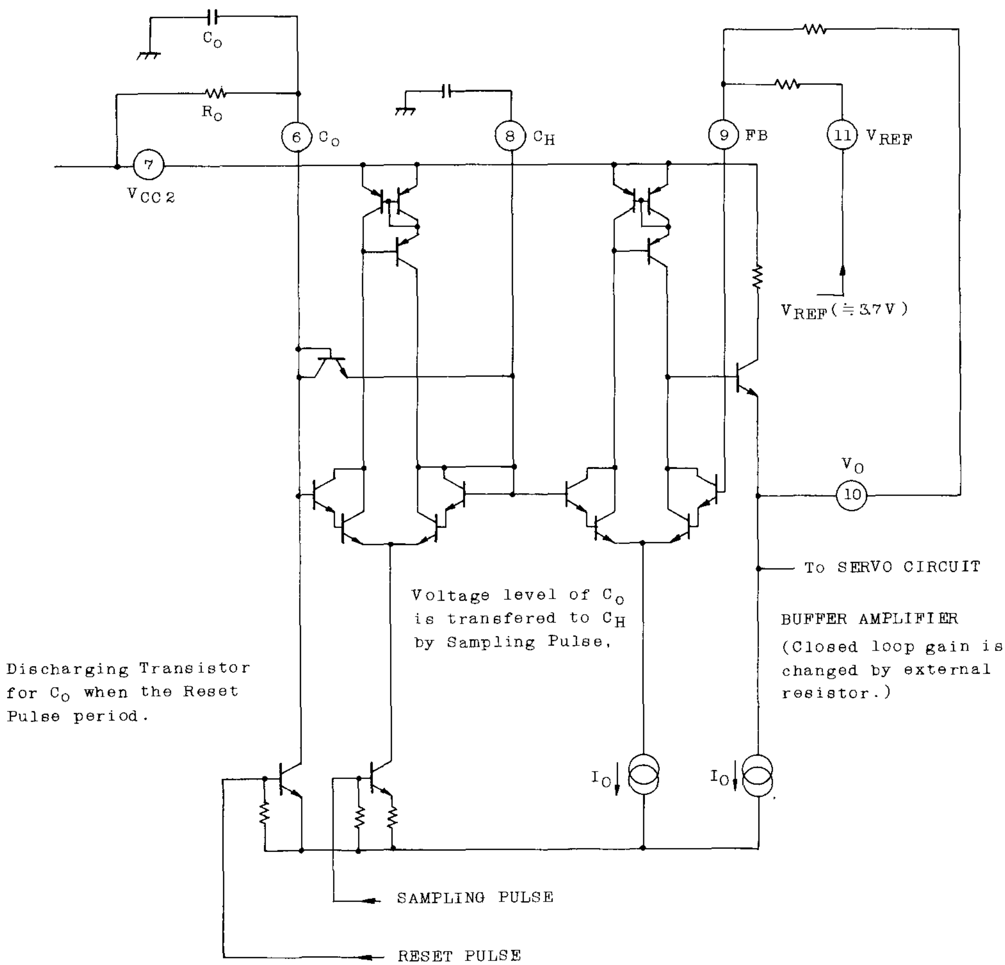


Fig. 6(a) SAMPLE AND HOLD CIRCUIT

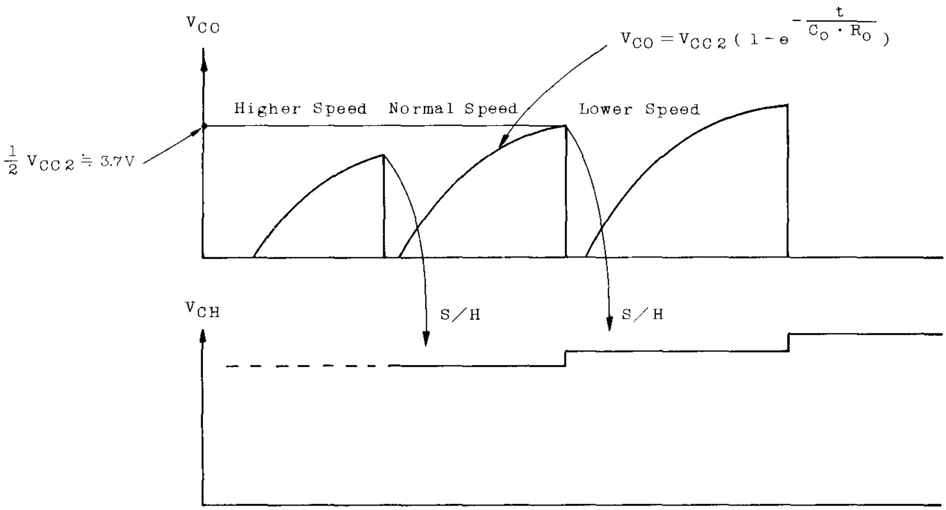


Fig. 6(b) TIMING CHART FO S/H CIRCUIT

This Smaple and Hold Circuit is used for F/V conversion by using Sampling and Reset pulse that generated in control pulse generating circuit.
Sample and Hold Capacitance C_O is charged by V_{CC} through R_O. The C_O Voltage level is transfered to Hold Capacitance C_H when the Sampling Pulse is generated and discharged instantaneously by reset pulse.

6. VOLTAGE REFERENCE

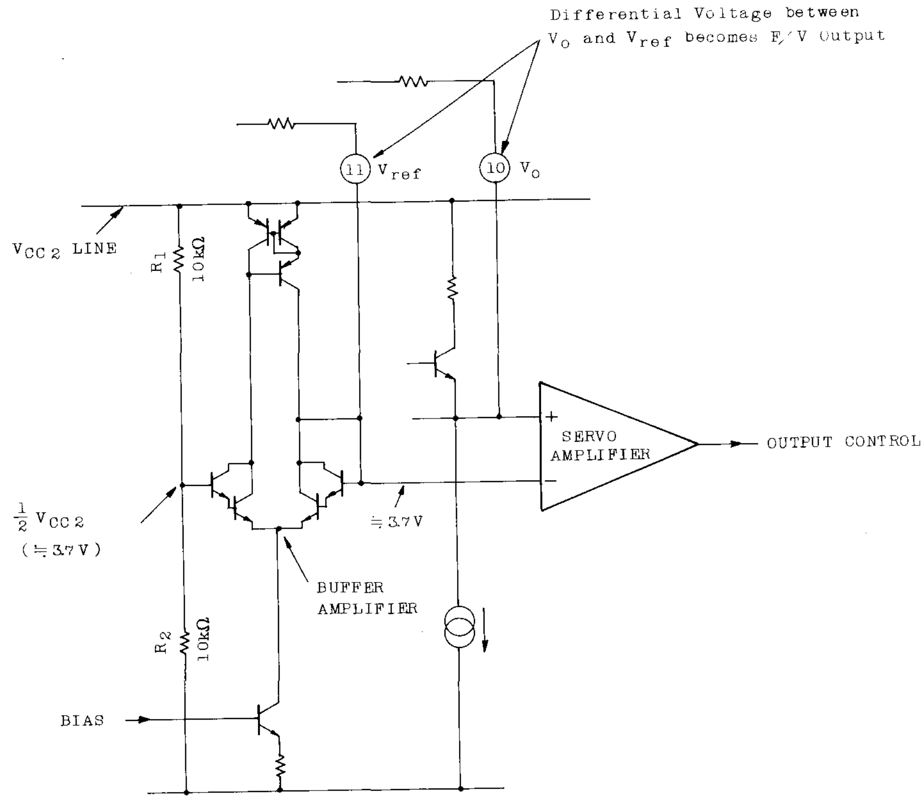


Fig. 7 VOLTAGE REFERENCE

Voltage Reference for Servo Amplifier (=3.7V) is generated by V_{CC2}, dividing Resistors (R_1(10kΩ) and R_2(10kΩ) and Buffer Amplifier. Differential Voltage between V_{ref} (PIN 11 and V_o (PIN 10) become a F/V Output that fed into Servo Amplifier.

7. OUTPUT TRANSISTOR CIRCUIT

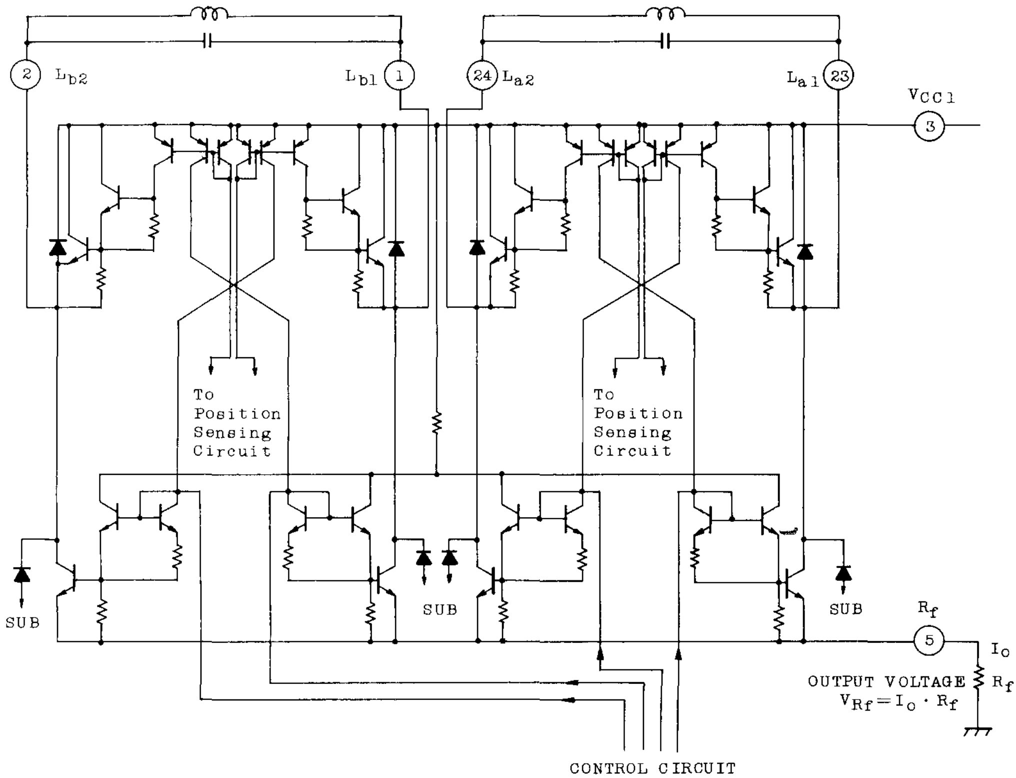


Fig. 8 OUTPUT TRANSISTOR CIRCUIT

2 Phase Bi-directional ($\pi/2$ duty) Output Circuit is constituted by 8 Power Transistors basically that is controlled by control signals from position sensing circuit (switching signal) and Servo Amplifier Output. (rotation speed control signal). Current flow of Rf (equal to Output Coil Current), connect to PIN⑤, cause a voltage drop V_{Rf}(=$I_o \cdot R_f$). V_{Rf} is feed backed to Servo Amplifier. Therefore, Input to Output Characteristics of Output Circuit becomes proportional (shown in Fig. 9). But, because of build in Current Limitting Circuit, V_{Rf} value is limitted internally less then approximately 0.6V. therefore, Output Current is limitted less then 0.6/R_f.

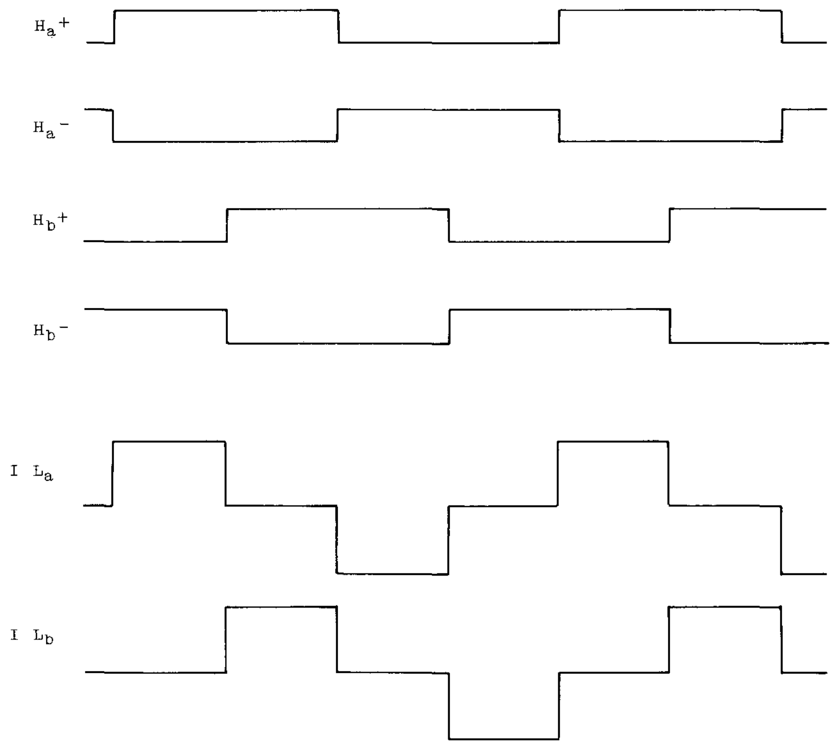


Fig. 9　TIMING CHART OF OUTPUT

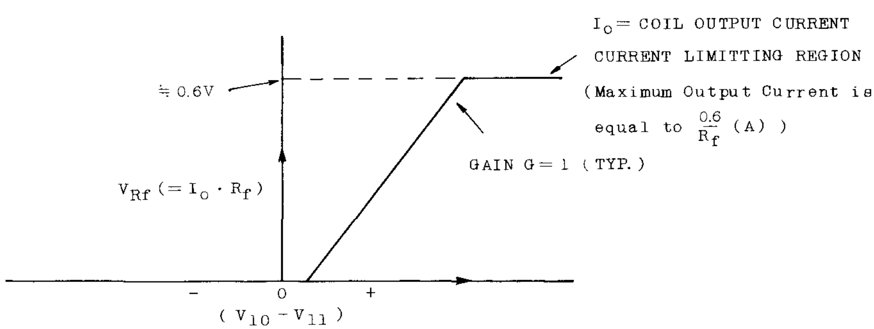


Fig. 10　INPUT TO OUTPUT CHARACTERISTICS OF OUTPUT CIRCUIT

8. TOTAL OPERATION

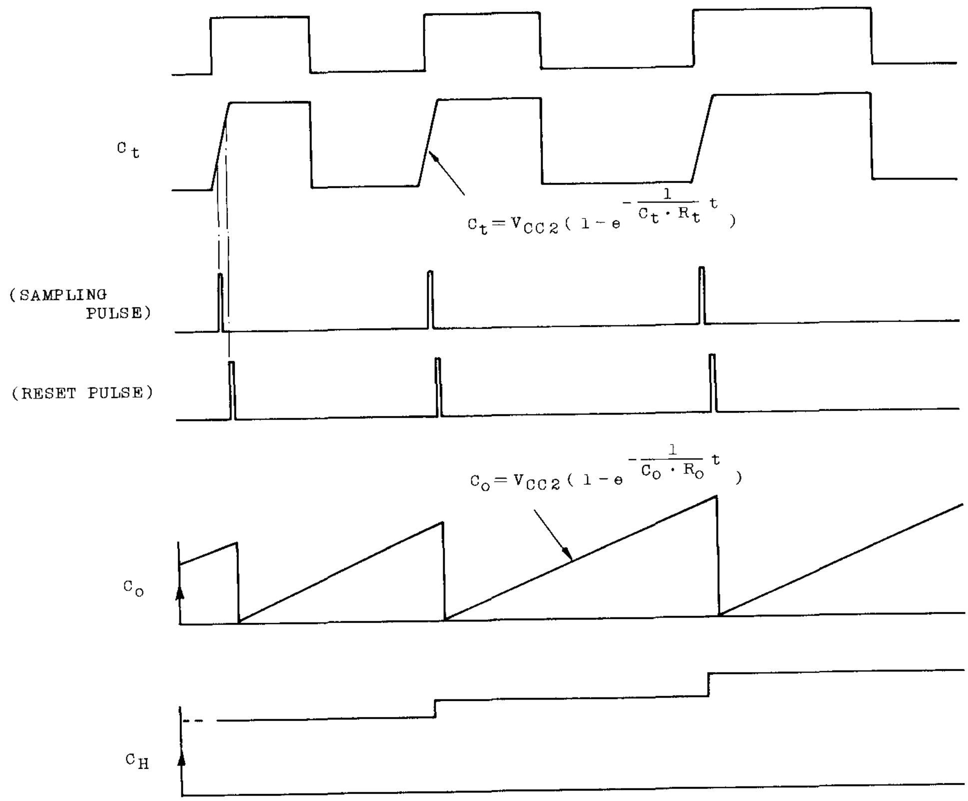


Fig. 11 TIMING CHART

Locking frequency fo is calculated by following equations.

$$1 - e^{-\frac{1}{C_O \cdot R_O} t} = \frac{1}{2}$$

$$t \fallingdotseq 0.6931 \cdot C_O \cdot R_O$$

$$f_O \fallingdotseq \frac{1.44}{C_O \cdot R_O} \ (\mathrm{Hz})$$

$$C_O \cdot R_O \fallingdotseq \frac{1.44}{f_O}$$

C_t and R_t are required for generating Sampling and Reset Pulses only, therefore, not require precise values and any enviromental characteristics. But it is required to make the time constant of Sample and Hold Circuit ($=C_o \cdot R_o$) bigger than ten-times than that of Controle Pulse Generating Circuit ($=C_t \cdot R_t$).

$$C_o \cdot R_o \gg C_t \cdot R_t$$

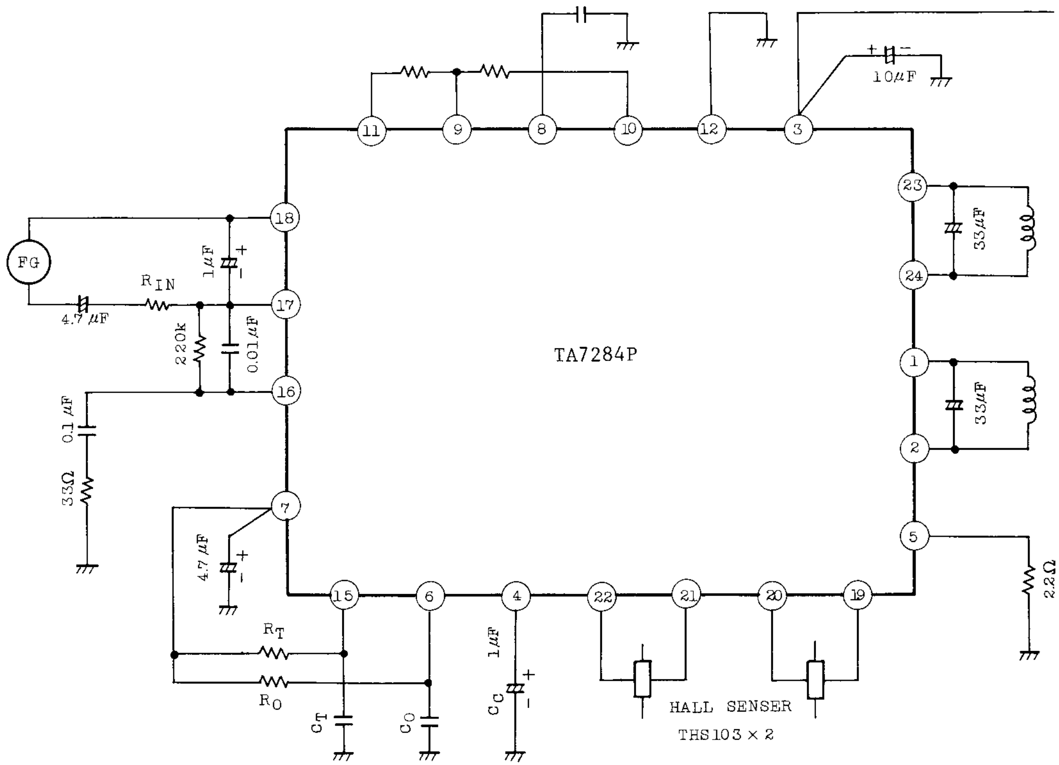
Recommended value of Hold Capacitance C_H are approximately 0.1μF (for FG frequency is round 50Hz) and 0.05μF (for FG frequency is round 500Hz or higher), and recommend to use low leakage current type.

9. ETC

Care should be taken not to connect any other circuit with PIN 13 and PIN 14 .

APPLICATION CIRCUIT

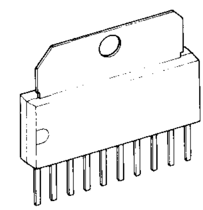
FFD, WDD and AUDIO DISK PLAYER USE MOTOR DRIVER CIRCUIT



TA7288P

DUAL BRIDGE DRIVER

TA7288P is Dual Bridge Driver designed especially for VCR cassette and tape loading motor drives.



HSIP10-P

Weight: 2.47g (Typ.)

FEATURES:

. 4 Modes Available (CW/CCW/STOP/BRAKE)
. Output Current Up to 1.0A (AVE) and 2.0A (PEAK)
. Wide Range of Operating Voltage
  - V_{CC} opr=4.5~18V
  - V_S opr=0~18V
  - V_{ref} opr=0~18V
. Build in Thermal Shutdown, Over Current Protector and Punch-Through Current Restriction Circuit.
. Hysteresis for All Inputs.

MAXIMUM RATINGS (Ta=25°C)

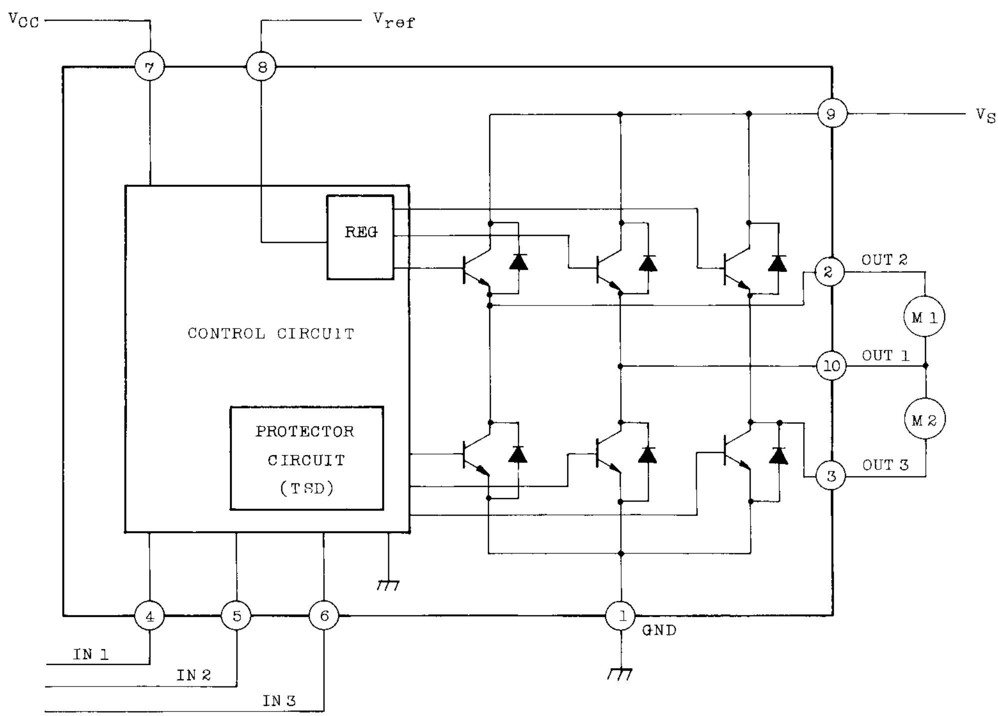
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	25	V
Motor Drive Voltage	V_S	25	V
Reference Voltage	V_{ref}	25	V
Output Current	$I_{O(PEAK)}$	2.0	A
	$I_{O(AVE)}$	1.0	A
Power Dissipation	P_D	*12.5	W
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~150	°C

* Tc=25°C

ELECTRICAL CHARACTERISTICS (Unless otherwise noted, Ta=25°C, V_{CC}=12V, V_S=18V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}	1	Output off CW/CCW Mode	-	17	30	mA
		I_{CC2}	1	Output off, Stop Mode	-	13	25	
Input Operating Voltage	"H"	V_{IN-H}	2	Tj=25°C	3.5	-	5.5	V
	"L"	V_{IN-L}	2	Tj=25°C	0	-	0.8	
Input Current		I_{IN}	2	V_{IN}=3.5V, Sink Mode	-	5	20	μA
Input Hysteresis Voltage		V_{HYS}	2		-	0.7	-	V
Saturation Voltage	Upper	V_{SAT-1U}	3	V_{ref}=V_S, I_O=0.2A	-	0.9	1.2	V
	Lower	V_{SAT-1L}	3	V_{ref}=V_S, I_O=0.2A	-	1.0	1.3	
	Upper	V_{SAT-2U}	3	V_{ref}=V_S, I_O=1.0A	-	1.3	1.6	
	Lower	V_{SAT-2L}	3	V_{ref}=V_S, I_O=1.0A	-	1.8	2.5	
Output Voltage		V_{O-1}	3	V_{ref}=10V, I_O=0.5A Output Measure	10.7	11.0	11.8	V
		V_{O-2}	3	V_{ref}=10V, I_O=1A Output Measure	10.4	10.7	11.5	
Leakage Current	Upper	I_{L-U}		V_S=25V	-	0	50	μA
	Lower	I_{L-L}		V_S=25V	-	0	50	
Diode Forward Voltage	Upper	V_{F-U}	4	I_F=1.0A	-	2.2	-	V
	Lower	V_{F-L}	4	I_F=1.0A	-	1.4	-	
Reference Current		I_{ref}	2	V_{ref}=10V, Source Mode	-	5	30	μA

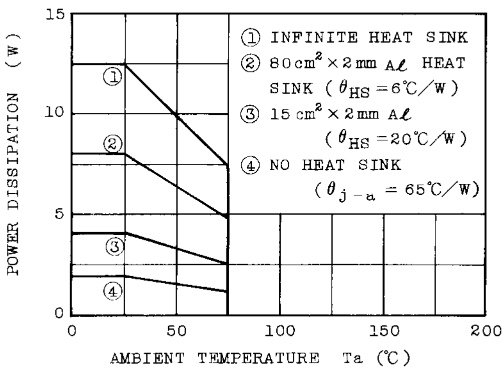
BLOCK DIAGRAM

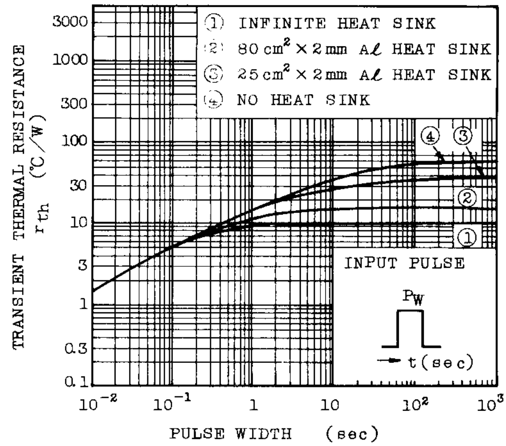


INPUT*			OUTPUT			MODE	
IN 1	IN 2	IN 3	OUT 1	OUT 2	OUT 3	M1	M2
0	0	1/0	L	L	L	BRAKE	BRAKE
1	0	0	H	L	∞**	CW/CCW	STOP
1	0	1	L	H	∞	CCW/CW	STOP
0	1	0	H	∞	L	STOP	CW/CCW
0	1	1	L	∞	H	STOP	CCW/CW
1	1	1/0	L	L	L	BRAKE	BRAKE

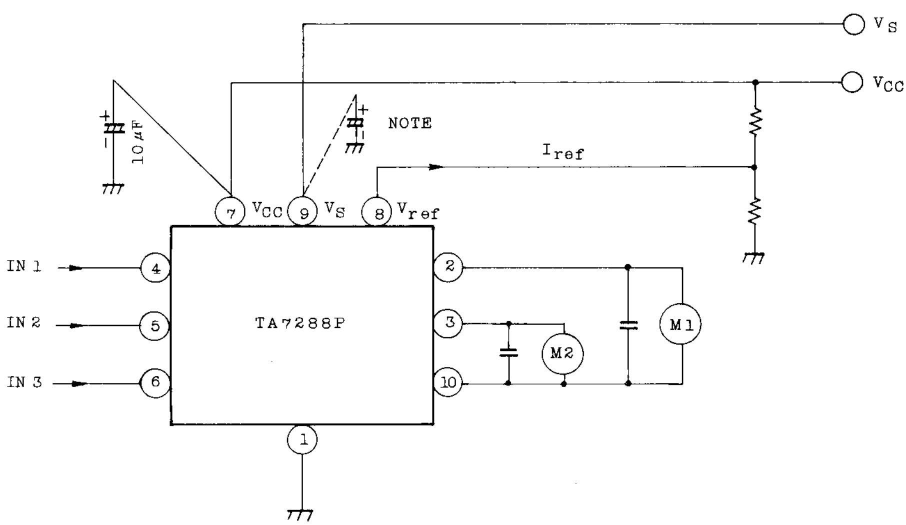
* : Inputs are all high active type.

** : ∞ : High impedance



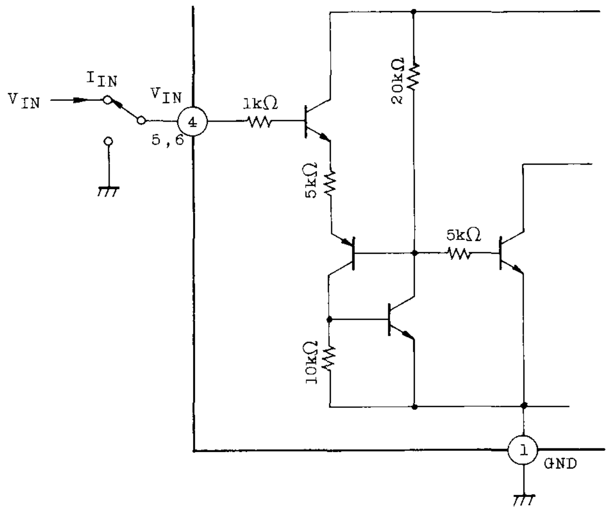


APPLICATION CIRCUIT



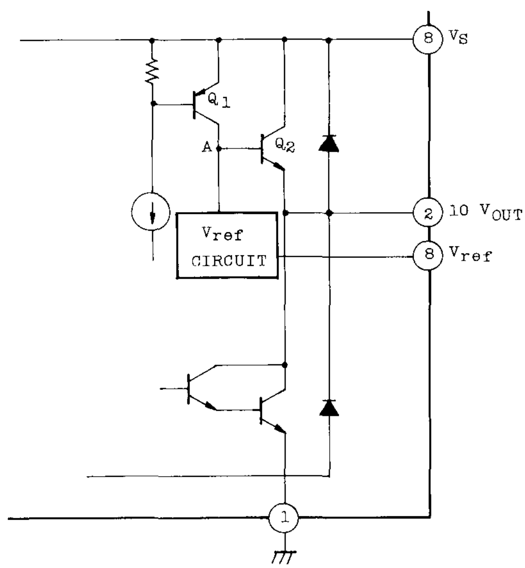
Note: Connect if required

INPUT CIRCUIT



Input terminals of 4.5 and 6 pin are all high active type and have a hysteresis of 0.7V typ. 5μA type of source mode input current is required.

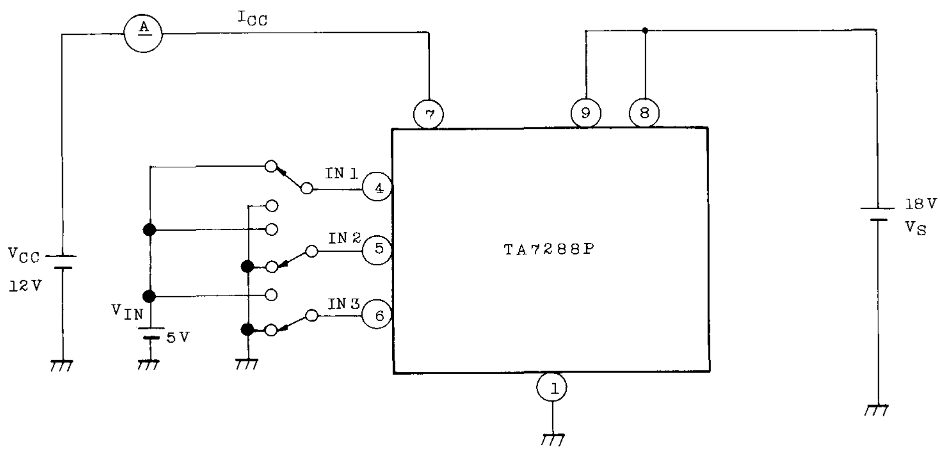
OUTPUT CIRCUIT



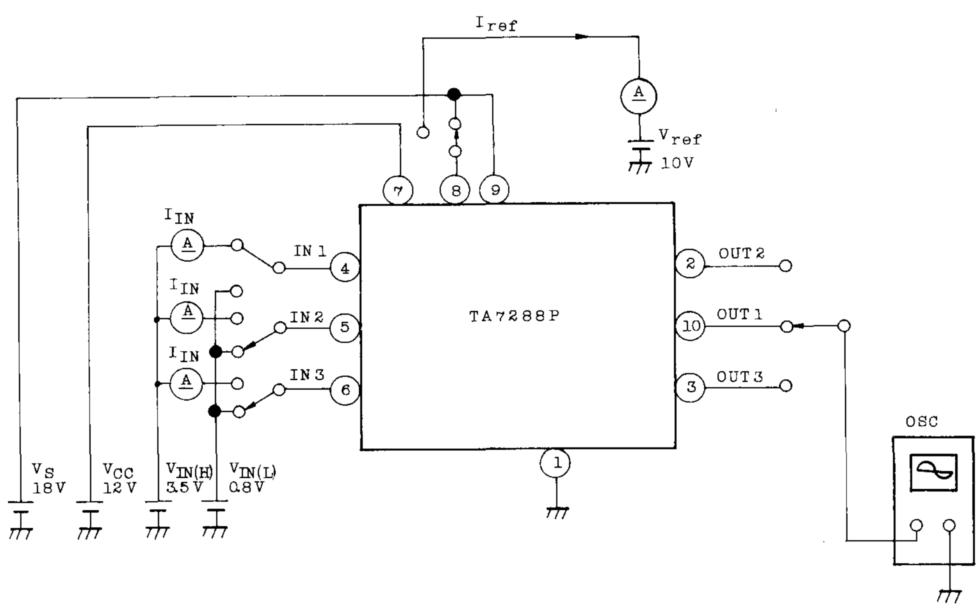
Output voltage is controlled by V_{ref} voltage. Relationship between V_{OUT} and V_{ref} is $V_{OUT}=V_{BE}$ (≑0.7) + V_{ref}

V_{ref} terminal required to connect to V_S terminal for stable operation in case of no requirement of V_{OUT} control.

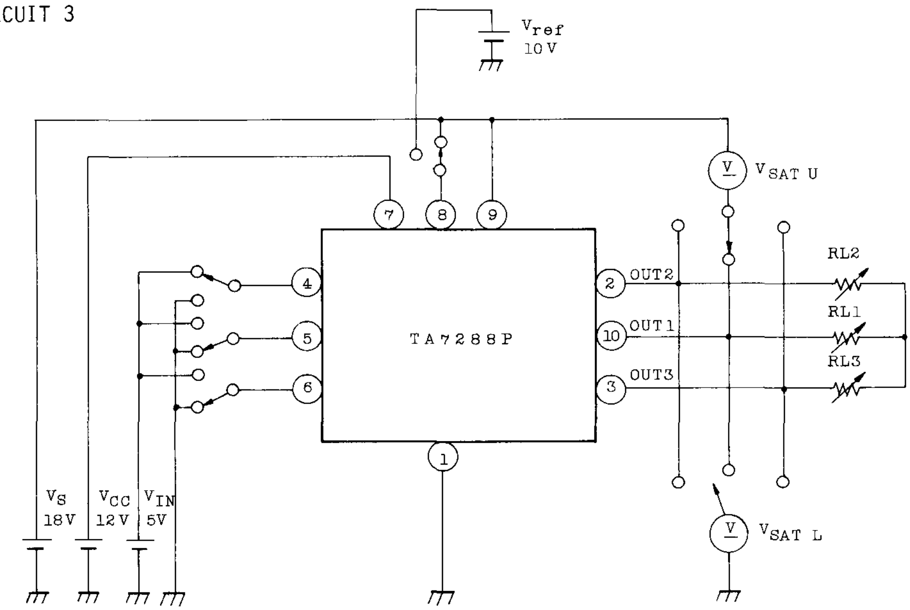
TEST CIRCUIT 1



TEST CIRCUIT 2

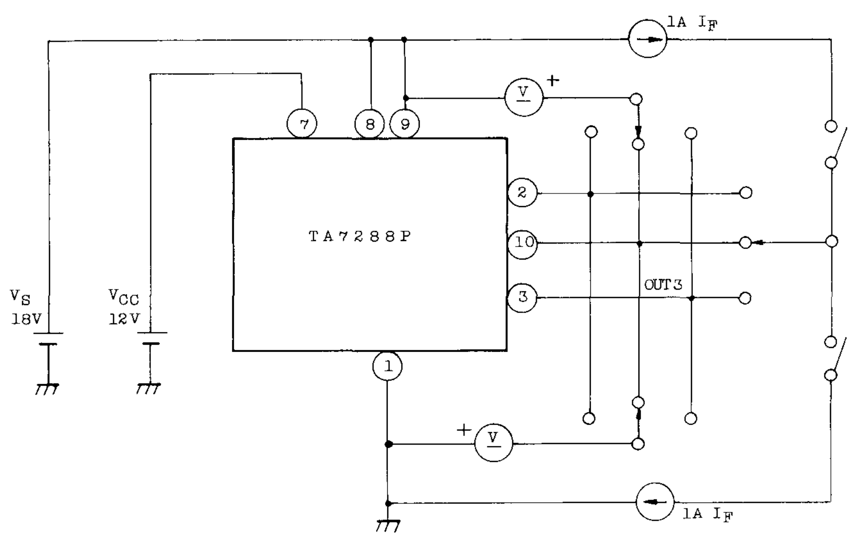


TEST CIRCUIT 3



I_O calibration is required to adjust specified values of test conditions by R_{L1}~R_{L3}.

TEST CIRCUIT 4



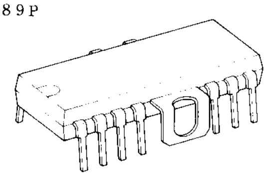
TA7289F/P/P(LB)

PWM STEPPING MOTOR DRIVER

TA7289P/F are PWM solenoid driver designed especially for use high efficiency stepping motor control.
It consist of 1.5A peak current drive capable output full bridge driver, oscillation circuit for PWM switching, 4 bit DAC for output current control and TTL compatible input circuit.

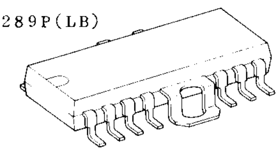
. Wide Range of Operating Voltage: $V_{CC(opr)}$=6~27V
. High Current Capability : I_O Max=1.5A(PEAK)
. LS-TTL Compatible Control Inputs(IN A, IN B)
. Few External Components Required.
. Build-in 4 bit DAC.

TA7289P



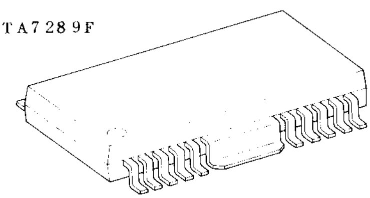
HDIP14-P-500A

TA7289P(LB)



HSOP14-P

TA7289F



HSOP20-P-450

Weight:

HDIP14-P-500A: 3.0g (Typ.)
HSOP14-P : 3.0g (Typ.)
HSOP20-P-450 : 0.8g (Typ.)

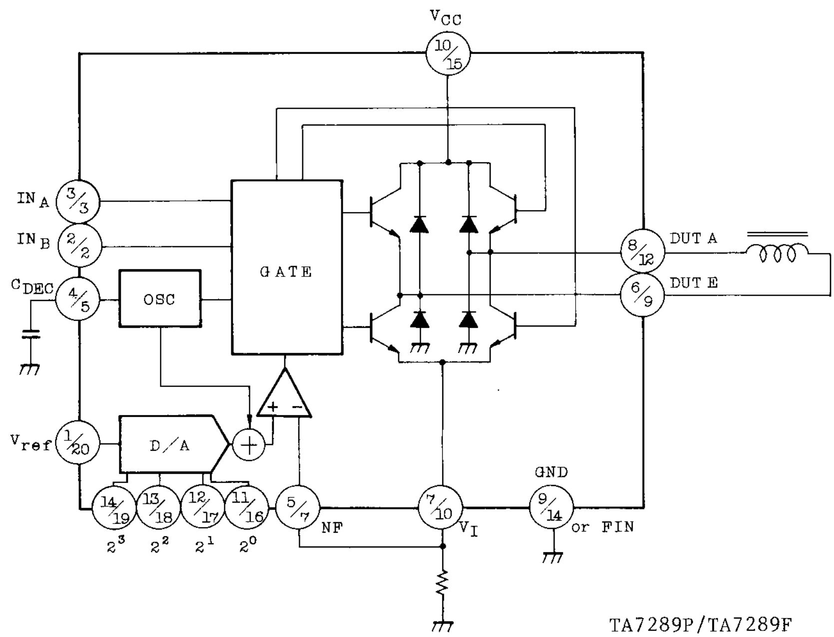
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	30	V
Reference Voltage		V_{ref}	30	V
Output Current	TA7289P	$I_{O(PEAK)}$	1.5	A
	TA7289F		0.8	
	TA7289P	$I_{O(AVE)}$	0.7	
	TA7289F		0.3	
Input Voltage		V_{IN}	7	V
Feed Back Voltage		V_I	2	V
Power Dissipation	TA7289P	P_D	2.3	W
	TA7289P(LB)		2.3	
	TA7289F		1.0	
Operating Temperature		T_{opr}	-30~85	°C
Storage Temperature		T_{stg}	-55~150	°C

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=24V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC1}		Output open CW/CCW mode	12	20	30	mA
		I_{CC2}		Output open brake mode	12	20	30	
		I_{CC3}		Output open CW/CCW mode, 2^0~2^3:H	12	20	30	
		I_{CC4}		Output open CW/CCW mode, 2^0~2^3:L	13	23	32	
Control Input (IN A, IN B)	Operating Voltage	$V_{IN(H)}$			2.0	–	7.0	V
		$V_{IN(L)}$			-0.4	–	0.8	
	Input Current	I_{IN}		V_{IN}=0.8V, Source type	–	25	–	μA
DAC Input (2^3~2^0)	Operating Voltage	$V_{IN(H)DAC}$			2.0	–	7.0	V
		$V_{IN(L)DAC}$			-0.4	–	0.8	
	Input Current	$I_{IN\ DAC}$		$V_{IN\ DAC}$=0.8V Source type	–	160	–	μA
Output Saturation Voltage	Upper Side	$V_{SAT\ U1}$		I_O=0.2A	–	1.1	1.5	V
	Lower Side	$V_{SAT\ L1}$			–	0.8	1.1	
	Upper Side	$V_{SAT\ U2}$		I_O=0.7A	–	1.2	1.7	
	Lower Side	$V_{SAT\ L2}$			–	0.9	1.3	
	Upper Side	$V_{SAT\ U1}$		I_O=1.5A	–	1.8	2.6	
	Lower Side	$V_{SAT\ L2}$			–	1.2	1.9	
Output Leakage Current	Upper Side	I_{L-U}		V_{CE}=30V	–	–	50	μA
	Lower Side	I_{L-L}			–	–	50	
Reference (V_{ref})	Operating Voltage	V_{ref}			0	–	2.0	V
	Input Current	I_{ref}			–	25	–	μA
Control Input Hysterisis Voltage		$V_{IN\ HYS}$		T_j=25°C	–	0.8	–	V
Diode Forward Voltage	Upper Side	V_{F-U}		I_F=1.5A	–	2.6	3.3	V
	Lower Side	V_{F-L}			–	0.8	1.1	

BLOCK DIAGRAM

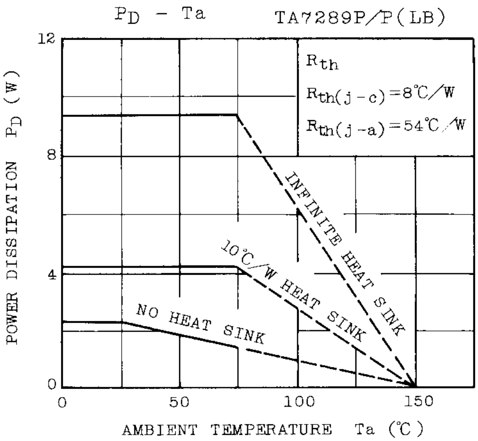


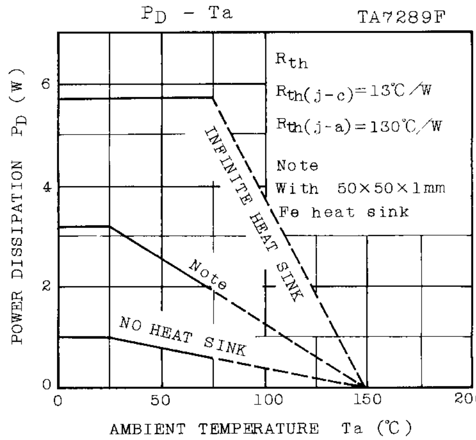
TA7289P/TA7289F

Note : 1,4,6,8,11,13 Pin of TA7289F are all NC (Non-connection)

FUNCTION

IN A	IN B	OUT A	OUT B	MODE
L	L	off	off	∞
H	L	H	L	CW/CCW
L	H	L	H	CCW/CW
H	H	off	off	∞


PD - Ta
TA7289P/P(LB)
Rth
Rth(j-c)=8℃/W
Rth(j-a)=54℃/W
INFINITE HEAT SINK
10℃/W HEAT SINK
NO HEAT SINK
POWER DISSIPATION PD (W)
12
8
4
0
0
50
100
150
AMBIENT TEMPERATURE Ta (℃)


PD - Ta
TA7289F
Rth
Rth(j-c)=13℃/W
Rth(j-a)=130℃/W
Note
With 50×50×1mm
Fe heat sink
INFINITE HEAT SINK
Note
NO HEAT SINK
POWER DISSIPATION PD (W)
6
4
2
0
0
50
100
150
200
AMBIENT TEMPERATURE Ta (℃)

1) INPUT CIRCUIT (IN A, IN B)

Input circuit is shown in Fig.1 IN A and IN B are TTL compatible "Low Active" type and have a hysterisis of 660mV Typ at Tj=25°C.

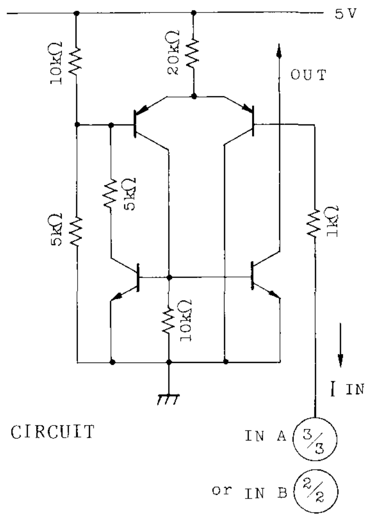


Fig. 1 INPUT CIRCUIT

2) DAC AND V_{ref} CIRCUIT

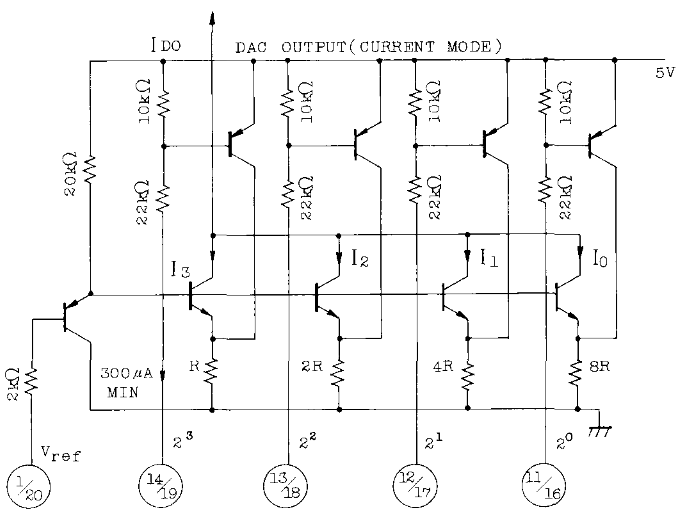


Fig. 2 DAC AND V_{ref} CIRCUIT

(From Build-in Regulator)

$D_O = I_3 + I_2 + I_1 + I_0$

$I_3 = \frac{V_{ref}}{R}$ (2^3 Input open)

$I_2 = \frac{V_{ref}}{2R}$ (2^2 Input open)

$I_1 = \frac{V_{ref}}{4R}$ (2^1 Input open)

$I_0 = \frac{V_{ref}}{8R}$ (2^0 Input open)

$I_{DO} = \frac{V_{ref}}{R}\left(1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8}\right)$

R= 2.5kΩ (TYP.)

I_{DO} of current mode DAC output is proportional to multipled voltage of V_{ref} (PIN ① (or ⑳)) and DAC inputs. DAC inputs are all "low active" type and required input current of 300μA MIN for each input terminal.

3) OSC AND COMPARATOR

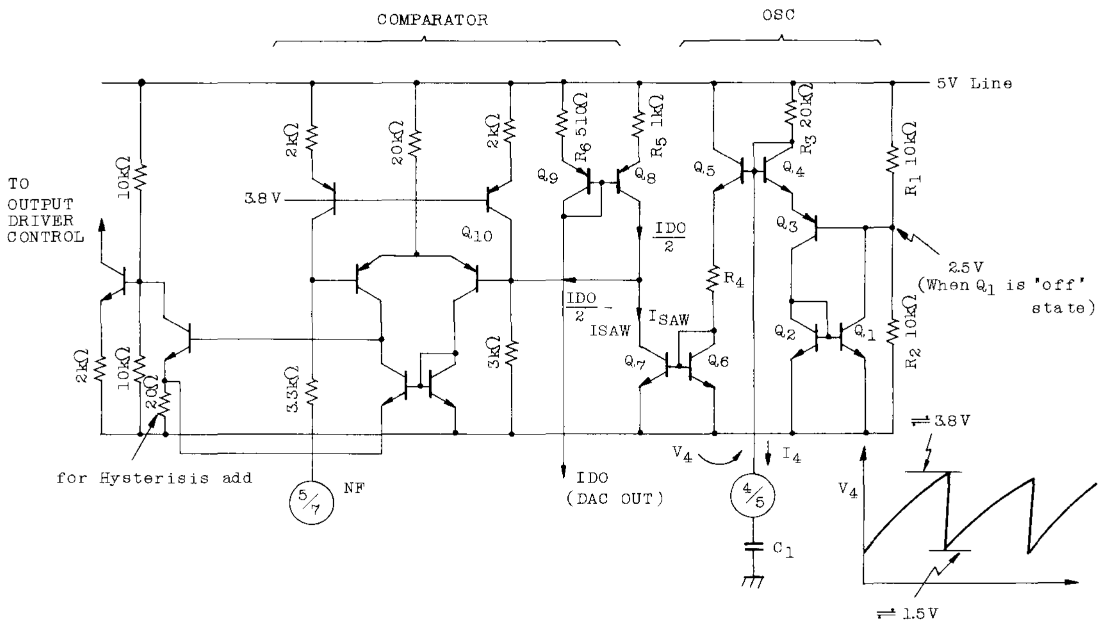


Fig. 3 OSC AND COMPARATOR CIRCUIT

Sawtooth OSC circuit consists of Q1 through Q4 and R1 through R3.

R1 and R2 are voltage divider of 5V build-in regulator.

Q1 is turned "off" when V4 is less than the voltage of 2.5V+V_{BE} Q4+V_{BE} Q3 approximately equal to 3.8V. V4 is increased by C1 charging of I4. Q1 and Q2 are turned "ON" when V4 becomes V4 -H level.

Lower level of V4 (V4 -L) is equal to V_{BE} Q4+V_{BE} Q3+V_{SAT} Q1 approximatelly equal to 1.5V.

V4 is calculated by following equation.

$$V4 - 5 \cdot (1-e^{-\frac{1}{C1 \cdot R3}t}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 1)$$

Assuming that V4=1.5V(t=t1) and=3.8V(t=t2).

C1 is external capacitance connected to Pin ④ (or ⑤) and R3 is on-chip 20kΩ resistor.

Therefore, OSC frequency is calculated as follows.

$$t1 = -C1\ R3\ \ell n\ (1 - \frac{1.5}{5}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 2)$$

$$t2 = -C1\ R3\ \ell n\ (1 - \frac{3.8}{5}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 3)$$

$$f_{OSC} = \frac{1}{t2-t1} = \frac{1}{C1\ (R3\ \ell n\ (1 - \frac{1.5}{5}) - R3\ \ell n\ (1 - \frac{3.8}{5}))}$$

$$= \underline{\frac{1}{21.4\ C1}\ (kHz)} \quad \text{(Unit of C1 is } \mu F)$$

4) OUTPUT CIRCUIT

Fig.4 shows output circuit. Q11 and Q13 are power transistors that have current capability up to 1.5A PEAK.

Q12 and Q14 are driver transistors for each side. Q16 ferforms a inhibiter for lower side power block when upper side block "turned ON". And Q15 is for upper side one when lower side power block "turned ON".

Build-in Fly Diodes (D1 and D2) are connected in prallel with all power transistors.

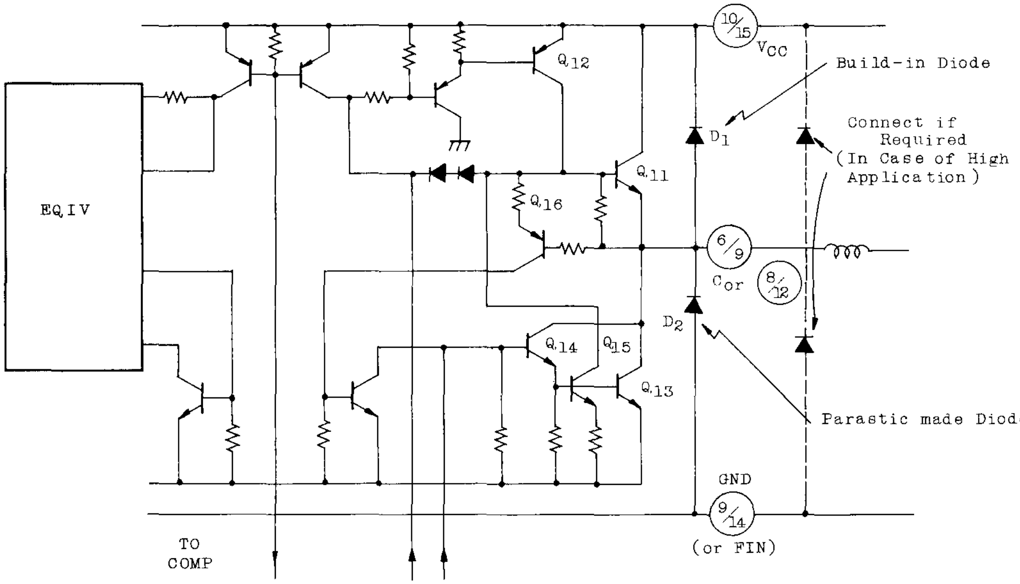
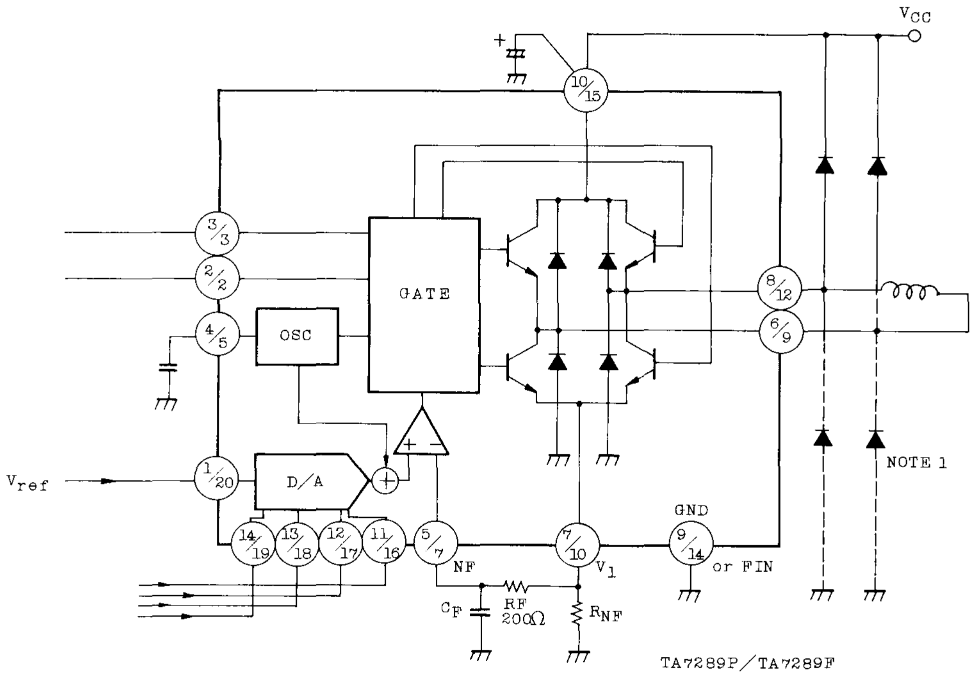


Fig. 4 OUTPUT CIRCUIT

But, Care should be taken not to exceed maximum current value of these diodes. Especially, Upper side diodes are not so strong enough to prevent excess back electromotive force than that of lower side parastic made diodes. In case of low power applications there's no requirment of external Fly back diodes.
But, We recommend to connect external diodes for all output to V_{CC} and GND to outputs terminals and check a V_{CE} and IC locus of output power transistors not to exceed a ASO in any cases for stable and reliable operations in case of high power applications.

APPLICATION CIRCUIT 1



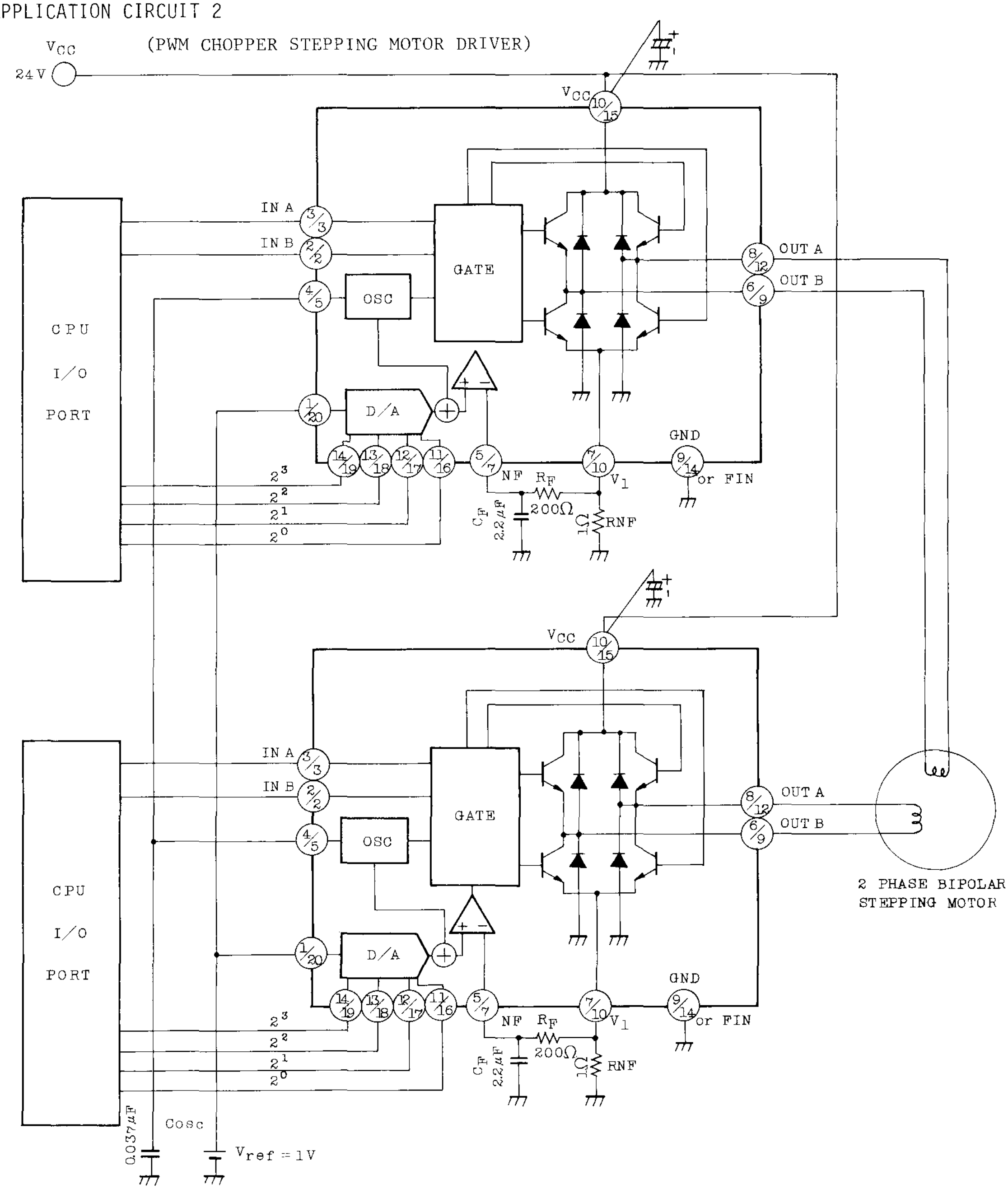
Note 1 : Connect if required.

Note 2 : Recommended R_F value is approximately 200Ω.

And CF value is concerned with the OSC frequency.

We recommend to select optimum value of C_F under the experimental consideration of noise cutting and time delay characteristics.

APPLICATION CIRCUIT 2



TA7291F/P/S

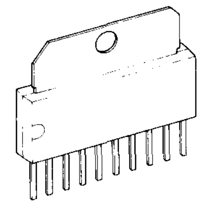
BRIDGE DRIVER

TA7291P/S are Bridge Driver with output voltage control.

FEATURES:

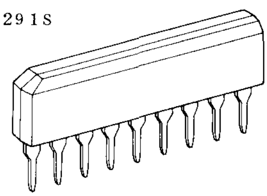
- 4 Modes Available (CW/CCW/STOP/BRAKE)
- Output Current Up to 1.0A(AVE) and 2.0A(PEAK) (TA7291P), and 0.4A(AVE) and 1.2A(PEAK)(TA7291S).
- Wide Range of Operating Voltage: $V_{CC\ opr}$=4.5~20V
  $V_{S\ opr}$=0~20V
  $V_{ref\ opr}$=0~20V
- Built-in Thermal Shutdown, Over Current Protector and Punch=Through Current Restriction Circuit.
- Stand-by Mode Available (STOP MODE)
- Hysteresis for All Inputs.

TA7291P



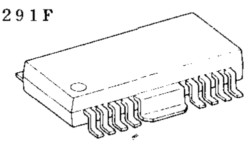
HSIP10-P

TA7291S



SIP9-P-A

TA7291F



HSOP16-P-300

Weight:

HSIP10-P : 2.47g (Typ.)
SIP9-P-A : 0.29g (Typ.)
HSOP16-P-300: 0.5g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	25	V
Motor Drive Voltage		V_S	25	V
Reference Voltage		V_{ref}	25	V
Output Current	TA7291P	$I_{O(PEAK)}$	2.0	A
	TA7291S/F		1.2	
	TA7291P	$I_{O(AVE)}$	1.0	
	TA7291S/F		0.4	
Power Dissipation	TA7291P	P_D	12.5*	W
	TA7291S		0.75**	
	TA7291F		1.4***	
Operating Temperature		T_{opr}	-30~75	°C
Storage Temperature		T_{stg}	-55~150	°C

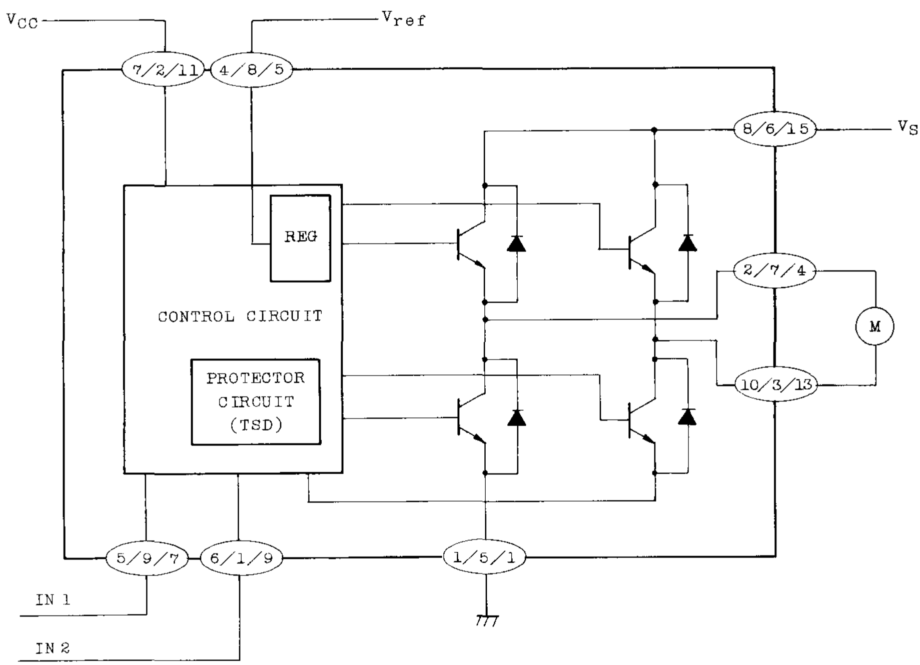
* Tc=25°C
** Ta=25°C
*** PCB (60 ×30 ×1.6mm, occupied copper area in excess of 50%) Mounting Condition.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, Ta=25°C, V_{CC}=12V, V_S=18V)

CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current			I_{CC1}	1	Output off CW/CCW Mode	-	8.0	13.0	mA
			I_{CC2}		Output off, Stop Mode	-	0	0.05	
			I_{CC3}		Output off, Brake Mode	-	6.5	10.0	
Input Operating Voltage		"H"	V_{IN-H}	2	Tj=25°C	3.5	-	5.5	V
		"L"	V_{IN-L}			0	-	0.8	
Input Current			I_{IN}		V_{IN}=3.5V, Sink Mode	-	3	10	μA
Input Hysteresis Voltage			V_{HYS}			-	0.7	-	V
Saturation Voltage	TA7291P TA7291S TA7291F	Upper Side	$V_{SAT\ U-1}$	3	Vref=V_S, V_{OUT}-V_S Measure	-	0.9	1.2	V
		Lower side	$V_{SAT\ L-1}$		I_O=0.2A, CW/CCW Mode	-	0.8	1.2	
	TA7291S TA7291F	Upper Side	$V_{SAT\ U-2}$		Vref=V_S, V_{OUT}-V_S Measure	-	1.0	1.35	
		Lower Side	$V_{SAT\ L-2}$		I_O=0.4A, CW/CCW Mode	-	0.9	1.35	
	TA7291P	Upper Side	$V_{SAT\ U-3}$		Vref=V_S, V_{OUT}-V_S Measure	-	1.3	1.8	
		Lower Side	$V_{SAT\ L-3}$		I_O=1.0A, CW/CCW Mode	-	1.2	1.85	
Output Voltage	TA7291F TA7291S (Upper Side)		$V_{SAT\ U-1'}$	3	Vref=10V, V_{OUT}-GND Measure I_O=0.2A, CW/CCW Mode	-	11.2	-	V
			$V_{SAT\ U-2'}$		Vref=10V, V_{OUT}-GND Measure I_O=0.4A, CW/CCW Mode	10.4	10.9	12.2	
	TA7291P (Upper Side)		$V_{SAT\ U-3'}$		Vref=10V, V_{OUT}-GND Measure I_O=0.5A, CW/CCW Mode	-	11.0	-	
			$V_{SAT\ U-4'}$		Vref=10V, V_{OUT}-GND Measure I_O=1.0A, CW/CCW Mode	10.2	10.7	12.0	
Leakage Current		Upper	I_{L-U}	4	V_S=25V	-	0	50	μA
		Lower	I_{L-L}		V_S=25V	-	0	50	
Diode Forward Voltage	TA7291S/F	Upper Side	$V_{F\ U-1}$	4	I_F=0.4A	-	1.5	-	V
	TA7291P		$V_{F\ U-2}$		I_F=1A	-	2.5	-	
	TA7291S/F	Lower Side	$V_{F\ L-1}$		I_F=0.4A	-	0.9	-	
	TA7291P		$V_{F\ L-2}$		I_F=1A	-	1.2	-	
Reference Current			Iref	2	Vref=10V, Source Mode	-	20	40	μA

BLOCK DIAGRAM



TA7291P ③, ⑨ PIN : NC

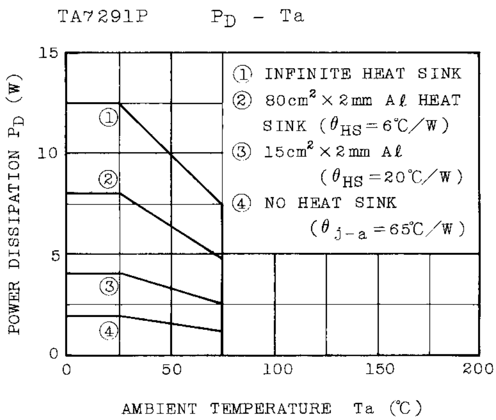
TA7291S PIN : NC

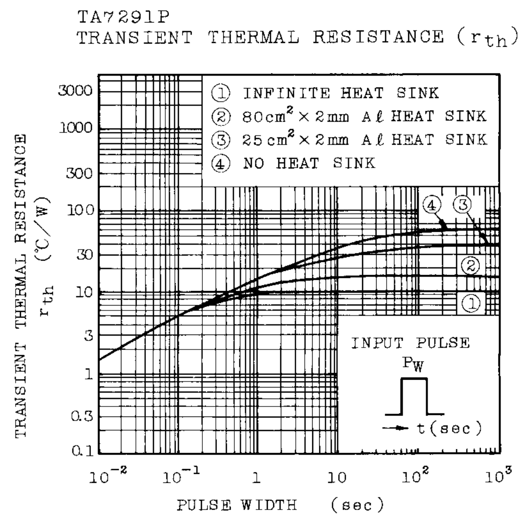
TA7291F ②, ③, ⑥, ⑧, ⑩, ⑫, ⑭, ⑯ : NC

INPUT		OUTPUT		MODE
IN 1	IN 2	OUT 1	OUT 2	
0	0	∞	∞	STOP
1	0	H	L	CW/CCW
0	1	L	H	CCW/CW
1	1	L	L	BRAKE

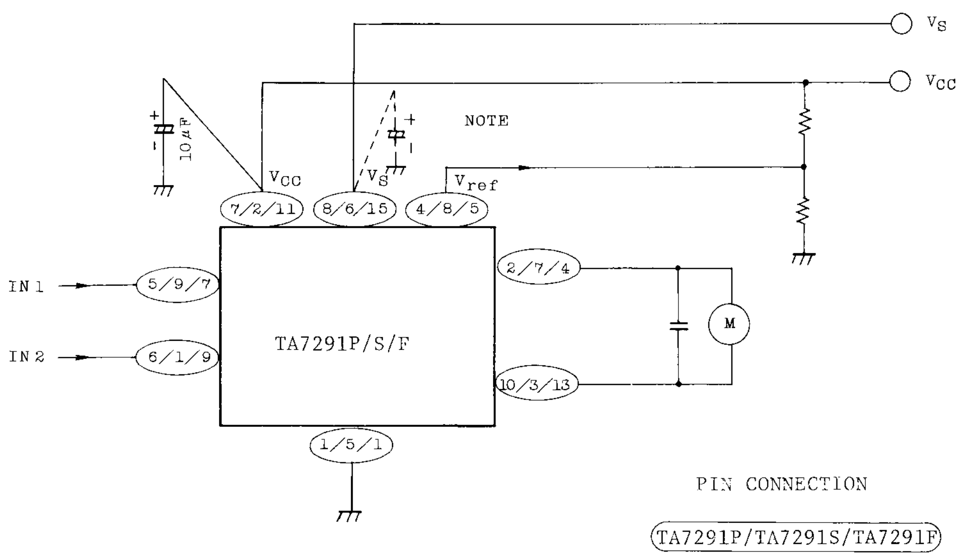
* : Inputs are all high active type.

** : ∞ : High impedance.



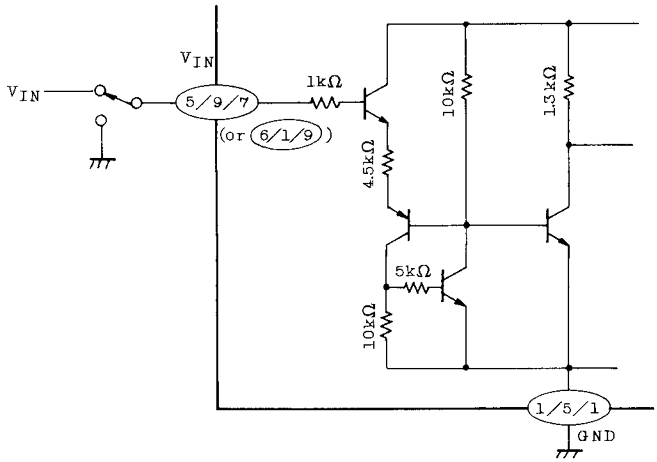


APPLICATION CIRCUIT



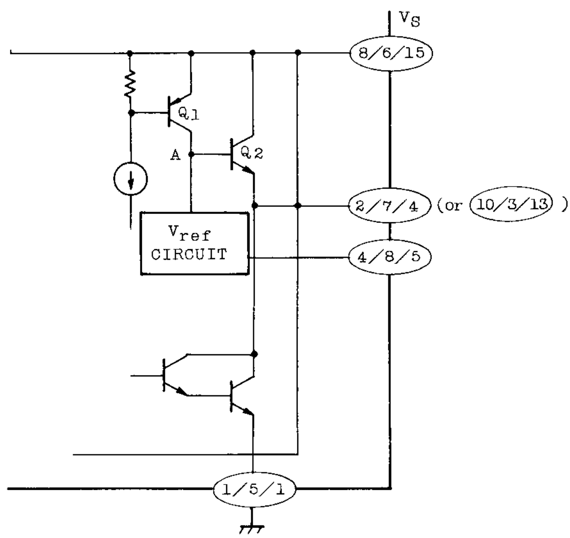
Note: Connect if required.

INPUT CIRCUIT



Input Terminals of 5 and 6 Pin (TA7291P) are all high active type and have a hysteresis of 0.7V typ., 3μA type. of source mode input current is required.

OUTPUT CIRCUIT



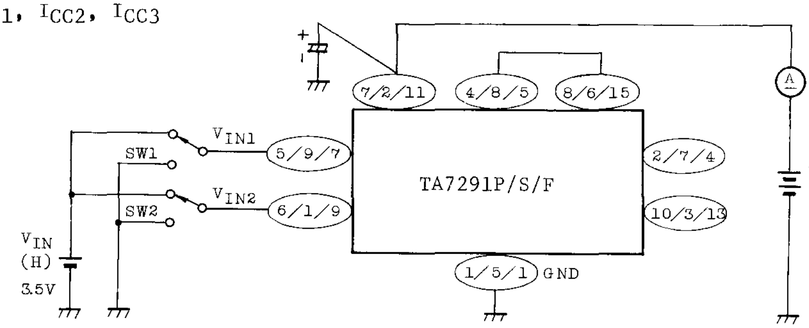
Output voltage is controlled by V_{ref} voltage. Relationship between V_{OUT} and V_{ref} is

$$V_{OUT}=V_{BE}\ (\doteqdot 0.7) + V_{ref}$$

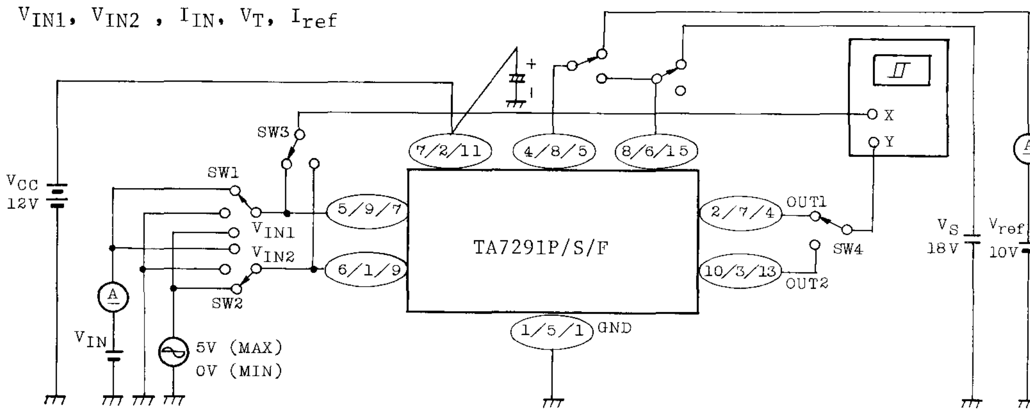
V_{ref} terminal required to connect to V_S terminal for stable operation in case of no requirement of V_{OUT} control.

TEST CIRCUIT

1. I_{CC1}, I_{CC2}, I_{CC3}

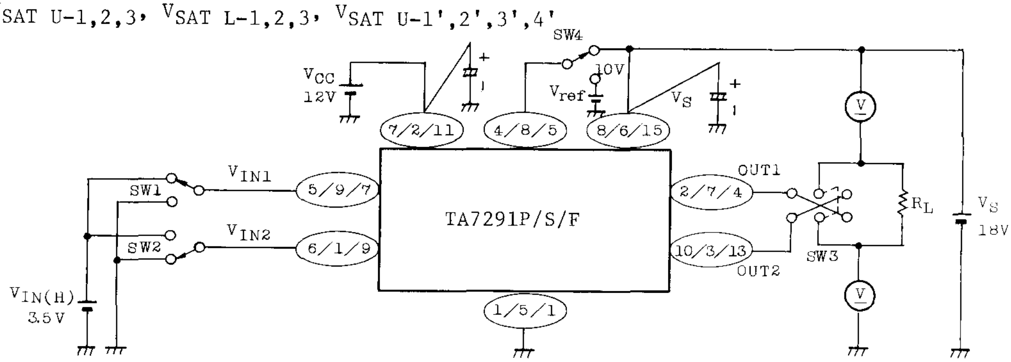


2. V_{IN1}, V_{IN2} , I_{IN}, V_T, I_{ref}

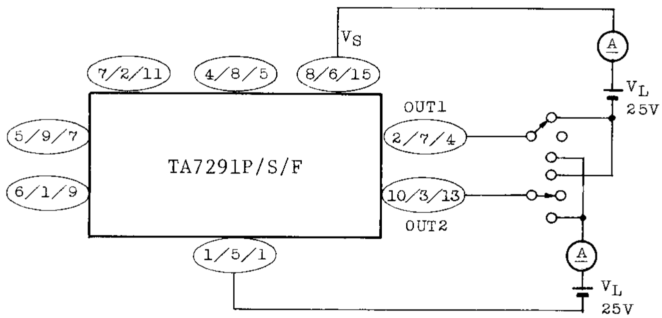


(TA7291P/TA7291S/TA7291F)

3. $V_{SAT\ U\text{-}1,2,3}$, $V_{SAT\ L\text{-}1,2,3}$, $V_{SAT\ U\text{-}1',2',3',4'}$

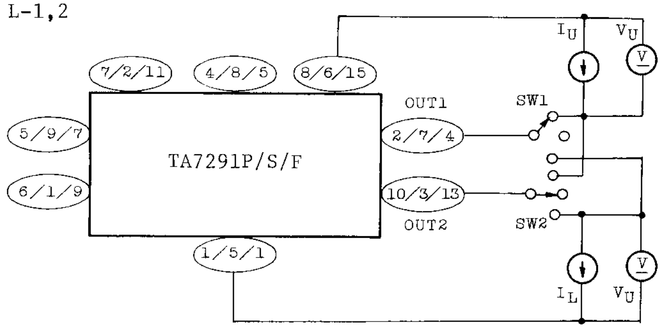


4. $IL_{U,L}$



TA7291P/TA7291S/TA7291F

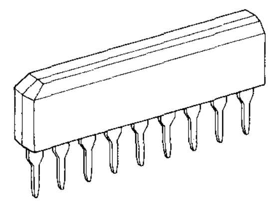
5. $V_{F\ U-1,2}$, $V_{F\ L-1,2}$



TA7291P/TA7291S/TA7291F

TA7354P

BRIDGE DRIVER



Weight: 0.92g (Typ.)

The TA7354P is a Bridge Driver for blashed DC Motor Rotation control.
Forward Rotation, Reverse Rotation, Stop and Braking operations are available.
It's designed for Loading and Reel Motor driver for VTR and Tape Deck, and any other consummer and industrial applications.
TA7354P have Operation Supply Voltage terminal and Motor Driving Supply Voltage terminal independently, therefore Servo control operation is applicable.

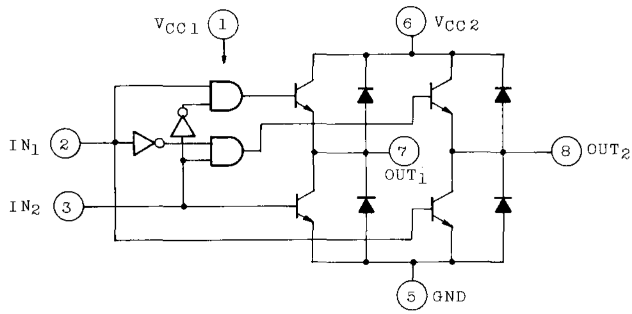
FEATURES:

. Output Current Up to 0.2A(AVE), and 0.6A(PEAK).
. 4 Function Modes (CW, CCW, STOP and Brake) are Controlled by 2 Logic Signals Fed Into 2 Input Terminals.
. Operating Voltage Range : V_{CC}=6～15V

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Peak Supply Voltage	$V_{CC\ MAX}$	18	V
Operate Supply Voltage	$V_{CC(opr)}$	15	V
Output Current	$I_{O(AVE)}$	0.2	A
Peak Output Current	$I_{O(PEAK)}$	0.6	A
Power Dissipation	P_D	0.75	W
Operating Temperature	T_{opr}	-30～75	°C
Storage Temperature	T_{stg}	-55～150	°C

BLOCK DIAGRAM



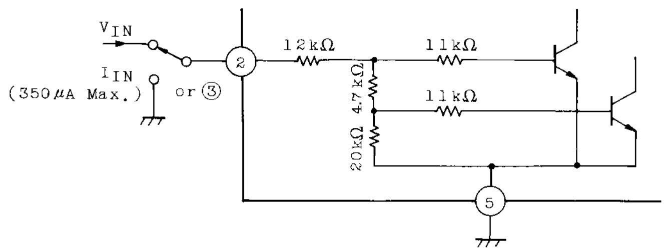
IN_1	IN_2	OUT_1	OUT_2	MODE
1	1	L	L	Brake
0	1	L	H	CW/CCW
1	0	H	L	CCW/CW
0	0	High Impedance		Stop

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}		$V_{CC}=V_S=15V$, $I_O=0.2A$ DRIVE MODE	-	22	33	mA
		I_{CC2}		$V_{CC}=V_S=15V$, BRAKE MODE	-	30	38	
		I_{CC3}		$V_{CC}=V_S=15V$, STOP MODE	-	0.2	1	
Saturation Voltage	UPPER	V_{S1} U		$V_{CC}=15V$, $I_O=0.1A$	-	0.8	1.05	V
	LOWER	V_{S1} L			-	0.15	0.25	
	UPPER	V_{S2} U		$V_{CC}=15V$, $I_O=0.2A$	-	0.9	1.2	
	LOWER	V_{S2} L			-	0.3	0.5	
Leakage Current	UPPER	I_L U		V=15V	-	-	20	μA
	LOWER	I_L L			-	-	20	
Input Voltage 2,3		$V_{IN(H)}$		$T_j=25°C$ 2 PIN AND 3 PIN	2.0	-	-	V
		$V_{IN(L)}$			-	-	0.8	
Input Current 2,3		$I_{IN2,3}$		$V_{IN}=4.5V$	-	-	350	μA
Diode Forward Voltage		V_F U		$I_F=0.2A$	-	1.2	1.6	V
		V_F L			-	1.0	1.3	

APPLICATION NOTE

(1) INPUT CIRCUIT

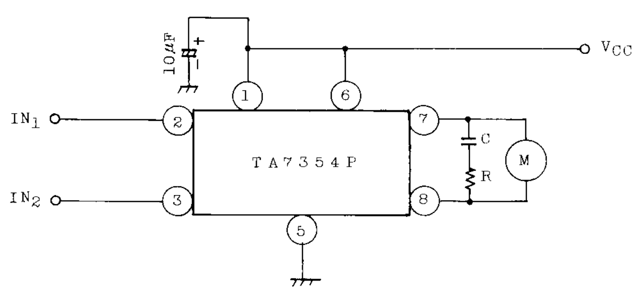


(Fig. 1)

Input circuit is shown in Fig.1. It's a "High Active" type.
If a voltage above specified $V_{IN(H)}$ value fed into input terminal that means "Logic 1", and the voltage less than $V_{IN(L)}$ or connect to GND means "Logic 0". And the circuit have a hysterisis for stable operation. (See Fig.2)

(2) BASIC APPLICATION CIRCUIT

Fig. 2 shows the basic application circuit.
Optimum values of the C, R depend on the inherent constant of a motor and parasitic C, R values around the circuit.



(Fig. 2)

(3) ADDITIONAL DIODE

I) If the braking operation is so loose, connect a additional diode between each output to GND. (See Fig. 3(a))

II) If the back electromotive pulse generated in output coil is so strong. Internally connected back electromotive suppression diode may be damaged by this pulse.
In such a case connect a additional diode between each output to V_{CC}.
(See Fig. 3(b))

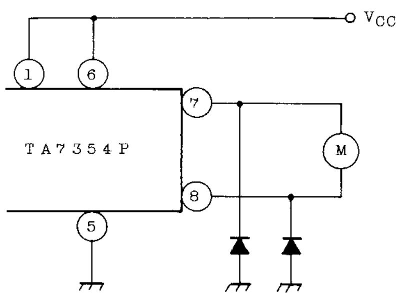


Fig. 3(a)

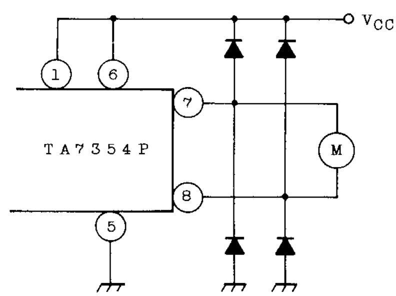


Fig. 3(b)

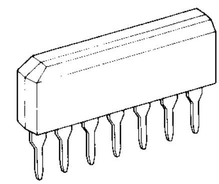
TA7363AP

∘ AUTO STOP MOTOR CONTROLLER FOR OIL PUMP

TA7363AP is Oil Pump Motor Controller with Automatic Stop feature.

∘ Features

- Automatic Stop
- Few External Components required
- SIP7 Small Package Sealded



SIP7-P-A

Weight: 0.7g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	4	V
Power Dissipation	P_D	500	mW
Operating Temperature	T_{opr}	-30~70	°C
Storage Temperature	T_{stg}	-55~150	°C

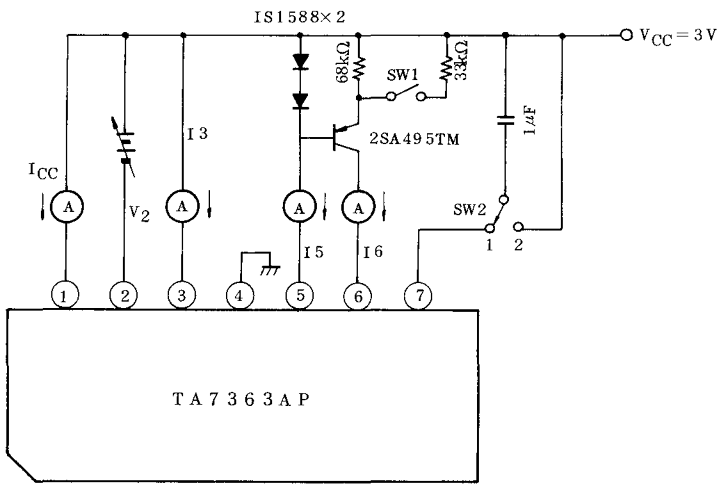
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=3V, Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{CC}	-	V2=0V, SW1=ON, SW2=2→1	12	-	27	mA
Output Current	I3	-	V2=0V, SW1=ON, SW2=2→1	60		180	mA
LED Current	I5	-	V2=0V, SW1=ON, SW2=2→1	2.5		12.0	mA
Stop Voltage	V_{CC} MIN	-	Note 1		1.2		V
Stop Detect Voltage	V_{1-2}	-	Note 2		0.3		V
Auto Stop Detect Current	I6(IN)	-			20		μA
Supply Current (Stop Mode)	I_{CC}(stp)	-	V2=0V, SW1=OFF, SW2=2→1	110		220	μA
Output Leakage Current (Stop Mode)	I3(stp)	-	SW1=OFF, SW2=2→1			10	μA
LED Output Leakage Current (Stop Mode)	I5(stp)	-	SW1=OFF, SW2=2→1			10	μA

Note 1: Sets IC in operation mode and start to decrease V_{CC} from 3V (V2=0V), check the I3 becomes to zero and then measure the V_{CC}.

Note 2: Sets IC in operation mode and start to increase V2 from 0V, check the I3 becomes to zero and the measure the V2.

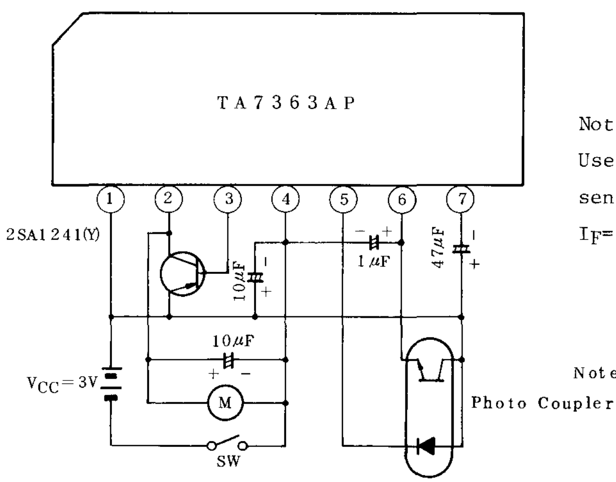
TEST CIRCUIT



SW1: Auto stop detecting current change use.
I6≧10μA (SW1=OFF), 30μA (SW1=OFF)

SW2: Starter switch, 2→1 start

APPLICATION CIRCUIT



Note

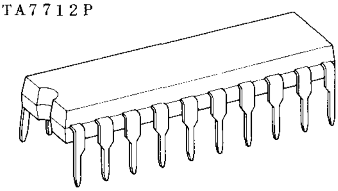
Use photo coupler specified sensitivity of IC≧30μA at I_F=2.5mA.

TA7712F/P

3-PHASE BI-DIRECTIONAL FOR MOTOR CONTROL IC.

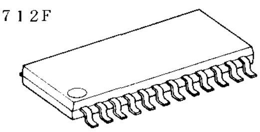
- FG is not required. (System for obtaining rotation signal through position sensing)
- Start/stop, CW/CCW and brake functions are provided.
- Gain of position sensing circuit is high, and hysteresis is provided.
- Rotation signal output is provided. (Frequency signal of three times the position sensing output (hall sensor output) can be obtained.)
- External transistor type.

TA7712P



DIP20-P-300A

TA7712F

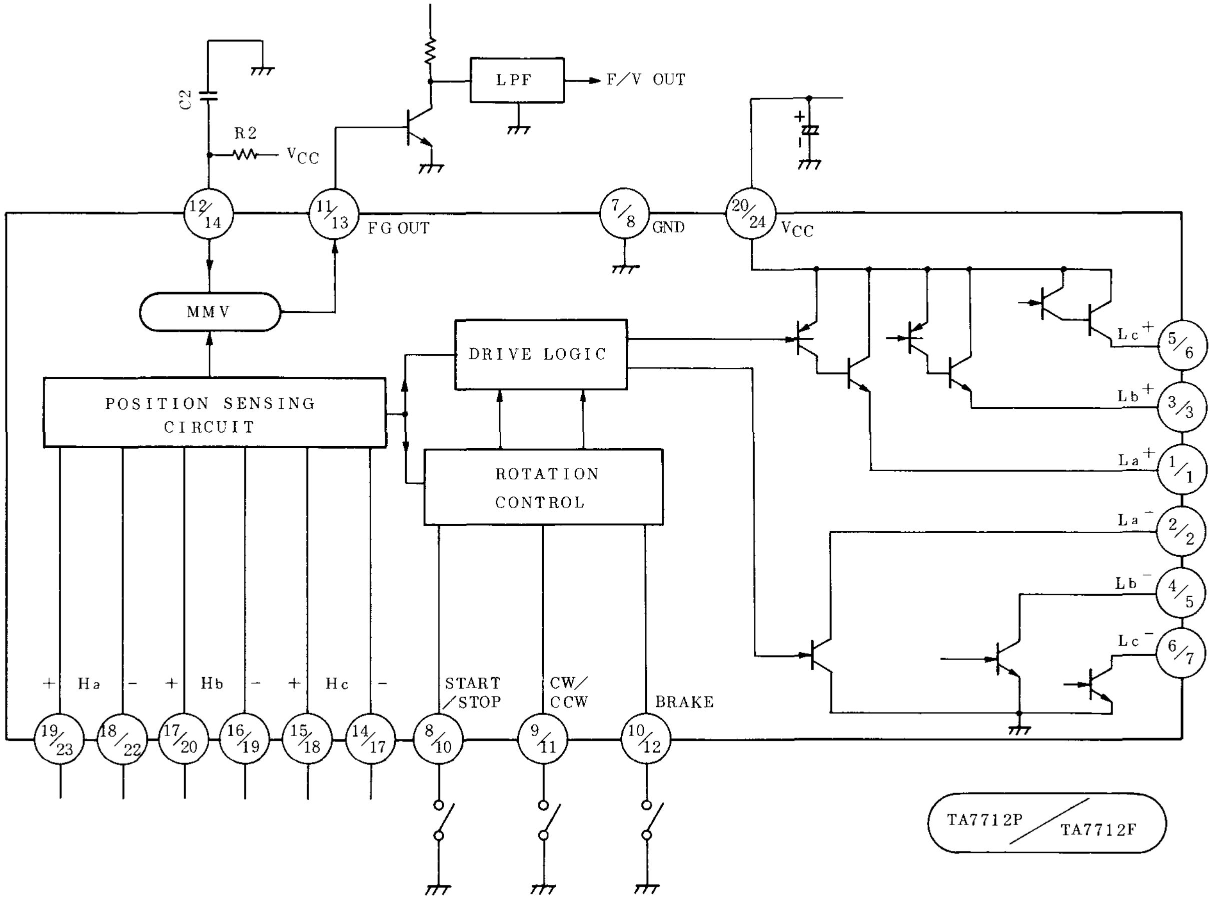


SSOP24-P-300

Weight DIP20-P-300A; 1.48g(Typ.)
SSOP24-P-300: 0.32g(Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Power Supply Voltage		V_{CC}	8.0	V
Output Current		I_O	±25	mA
Position Sensing Circuit Input Voltage (Tj=25°C)		V_H	±500	mV
Power Dissipation (Ta=25°C)	TA7712P	P_D	1.2	W
	TA7712F		0.5	
Operating Temperature		Topr	-30~75	°C
Storage Temperature		Tstg	-50~125	°C

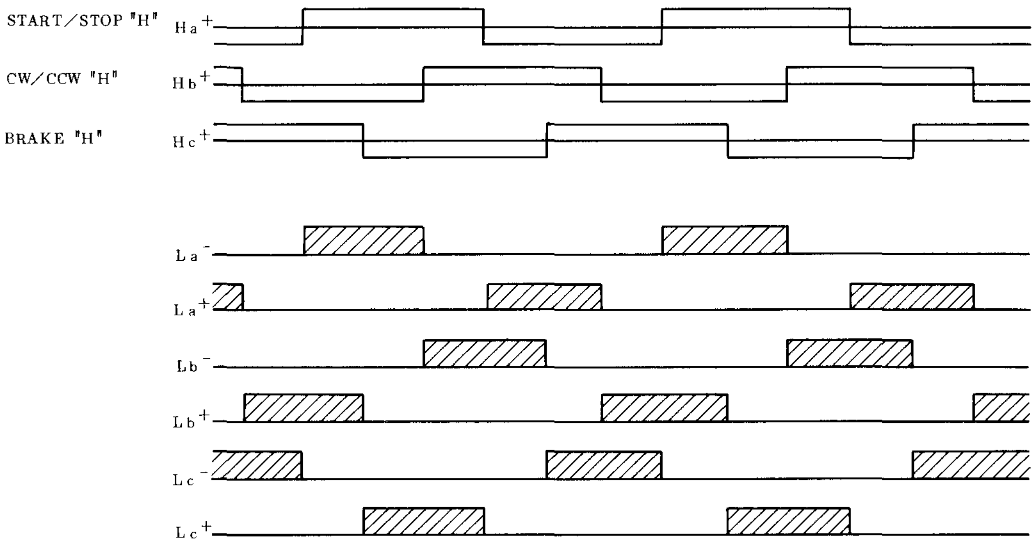

LPF
F/V OUT
C2
R2
VCC
12/14
11/13
FG OUT
7/8
GND
20/24
VCC
MMV
DRIVE LOGIC
POSITION SENSING CIRCUIT
ROTATION CONTROL
Lc+
5/6
Lb+
3/3
La+
1/1
La−
2/2
Lb−
4/5
Lc−
6/7
+ Ha −
+ Hb −
+ Hc −
START /STOP
CW/ CCW
BRAKE
19/23
18/22
17/20
16/19
15/18
14/17
8/10
9/11
10/12
TA7712P / TA7712F

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=5V, Ta=25°C)

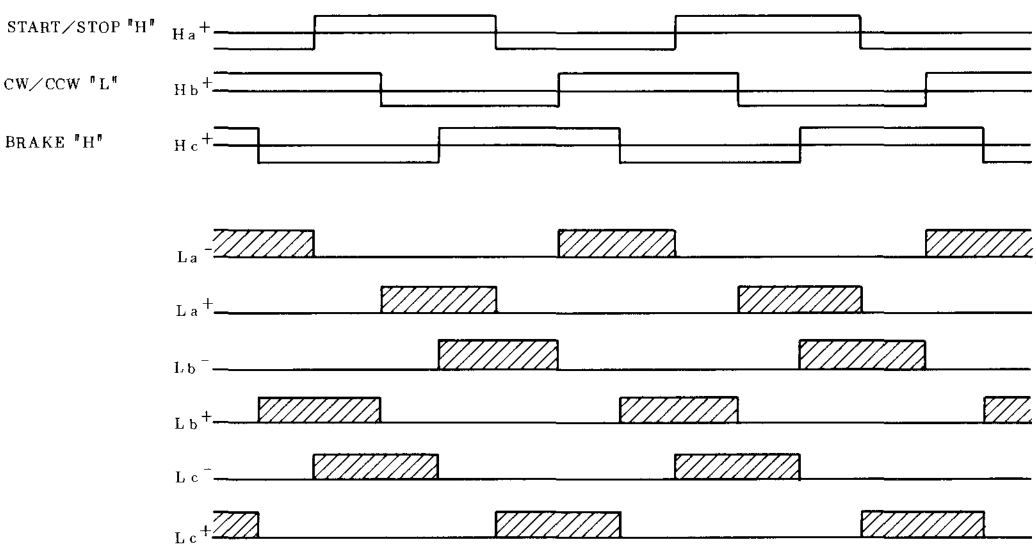
CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage			$V_{CC\ opr}$	–		4.75	5.00	5.25	V
Power Supply Current			I_{CC1}	1	Stop state	–	3.4	6.0	mA
			I_{CC2}		Output open	–	17.0	26.0	
Saturation Voltage	Upper Side		$V_{SAT\ U-1}$	2	R_L=200Ω	–	1.3	2.0	V
			$V_{SAT\ U-2}$		R_L=2kΩ	–	1.0	1.3	
	Lower Side		$V_{SAT\ L-1}$		R_L=200Ω	–	0.8	1.2	
			$V_{SAT\ L-2}$		R_L=2kΩ	–	0.18	0.4	
Leak Current	Upper Side		$I_{L\ U}$			–	–	100	μA
	Lower Side		$I_{L\ L}$			–	–	100	
Position Sensing Input	Common Mode Voltage Range		CMR H	–		2.0	–	4.5	V
	Input Sensitivity		V_H			20	–	–	mV
	Input Hysteresis		V_{H-Hye}			2	7	15	
START Input (RUN)	Input Operating Voltage	"H"	$V_{IN\ R(H)}$	2		4.0	–	–	V
		"L"	$V_{IN\ R(L)}$	2		–	–	1.0	
	Input Current	"L"	$I_{IN\ R}$	2	$V_{IN\ R}$=1.0V	–	–	200	μA
CW/CCW Input (FWD/REV)	Input Operating Voltage	"H"	$V_{IN\ C(H)}$	2		4.0	–	–	V
		"L"	$V_{IN\ C(L)}$	2		–	–	1.0	
	Input Current	"L"	$I_{IN\ C}$	2	$V_{IN\ C}$=1.0V	–	–	200	μA
BRAKE Input (BRAKE)	Input Operating Voltage	"H"	$V_{IN\ B(H)}$	2		4.0	–	–	V
		"L"	$V_{IN\ B(L)}$	2		–	–	1.0	
	Input Current	"H"	$I_{IN\ B}$	2	$V_{IN\ N}$=1.0V	–	–	200	μA
FG Output	Output Current	"H"	I_{FGH}	3		80	–	–	μA
	Output Voltage	"L"	V_{FGL}	3	I_{FG}=0.3mA	–	–	0.4	V
	Pulse Width		τ_{FG}	3	C=0.1μF, R=10kΩ	0.9	1.0	1.1	ms

TIMING CHART

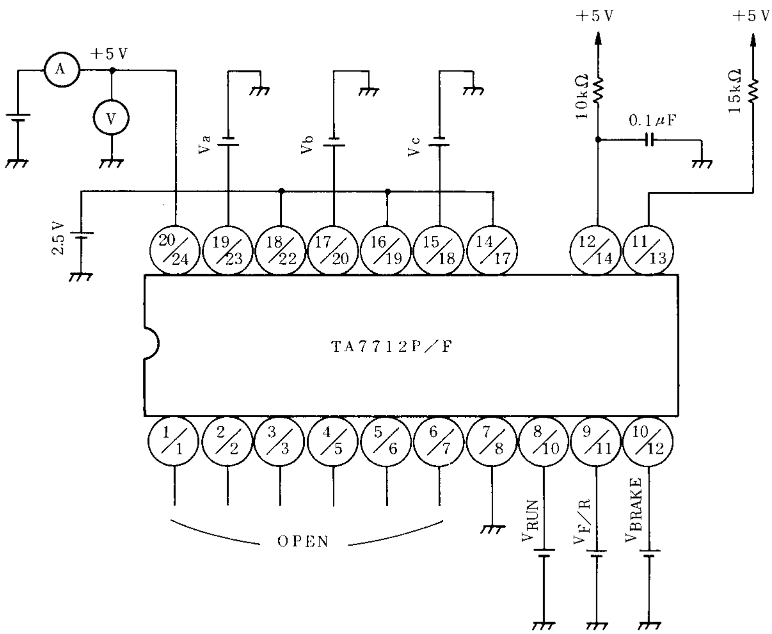
FORWARD ROTATION (Position sensing signal advances Ha → Hb → Hc.)



REVERSE ROTATION (Position sensing signal advances Ha → Hc → Hb.)

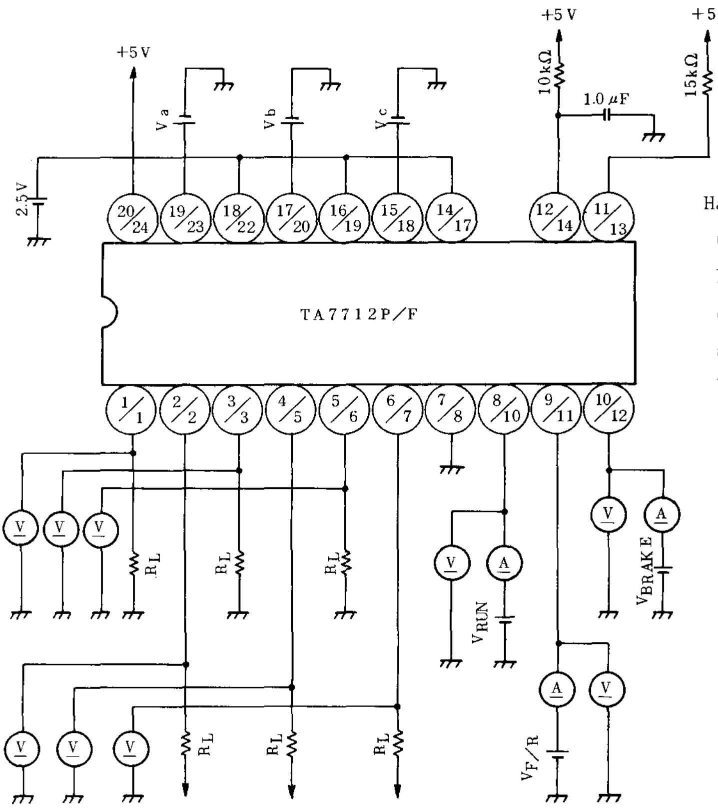


TEST CIRCIUT 1



	V_{RUN}	$V_{F/R}$	V_{BRAKE}	Va	Vb	Vc	REMARKS
I_{CC1}	1.0V	1.0V	1.0V	2.48V	2.48V	2.52V	Reverse sensing must not be made.
I_{CC2}	4.0V	4.0V	4.0V	2.52V	2.48V	2.52V	

TEST CIRCUIT 2



Hall AMP. Input

Checb input sensitivity and input hysteresis with ±20mV by means of confirming that leak current and saturation voltage described below can be measured.

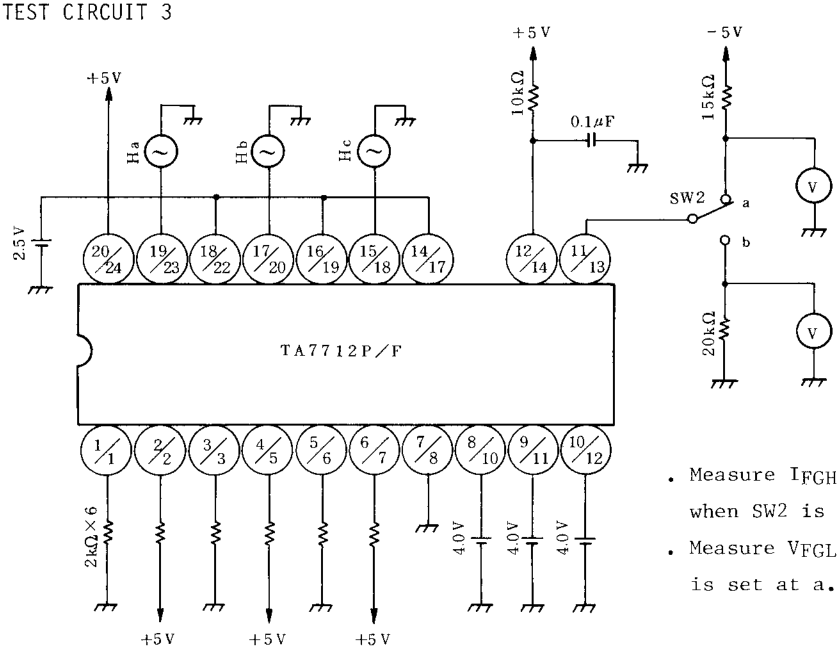
INPUT CONDITION						MEASUREMENT ITEM					
Va	Vb	Vc	RUN	F/R	BRAKE	La^+	La^-	Lb^+	Lb^-	Lc^+	Lc^-
2.52V	2.48V	2.48V	V_{INR}(H)	V_{INC}(H)	V_{INB}(H)	LEAK	SAT	LEAK	LEAK	SAT	LEAK
2.48V	2.52V	2.48V	-	-	-	SAT	LEAK	-	SAT	LEAK	-
2.48V	2.48V	2.52V	-	-	-	-	-	SAT	-	-	SAT

LEAK : Measurement of leak current.

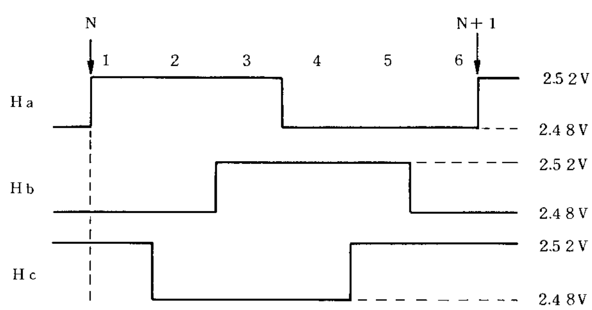
SAT : Measurement of saturation voltage.

Confirm "L" of each V_{INR}, V_{INC} and V_{INB} through reading the output voltage when each thermal is set at 1.0(V).

TEST CIRCUIT 3



- Measure I_{FGH} with the voltage when SW2 is set at b.
- Measure V_{FGL} and τ_{FG} when SW2 is set at a.



TIME CHART FOR FORWARD ROTATION
CLOCK 360Hz

APPLICATION OF TA7712P/F

Like a video disk player, TA7712P/F is provided with the stopping function which in a short time, stops the motor having a large inertia, and makes the quick disk-change possible.
To make the frequency generator (FG) unnecessary which was formerly required for fetching the rotation signal, the signal from the position sensing input is ORed and is output to FG output pin (11/13 pin).
Therefore, for FG output, three position sensing outputs (Ha, Hb, Hc) are ORed, and the rotation speed signal of the frequency of six times that of one output can be fetched resulting in making it possible to obtain a sufficient controlling characteristic with the F/V (Frequency-Voltage) conversion method of mono-stable type.
The difference from TA7713P is that the stop function is automated in TA7713P, however, it is operated by the external signal in TA7712P.
Description is made on the application of TA7713P in the following.

Operation of FG Output (11/13 pin) and T_{FG} (12/14 pin)
In Fig. 1, Q1 and Q2 are the monostable multi-vibrator to which gate (Q2 base) the signal from each position sensing input of Ha, Hb and Hc is input after ORed and shaped in waveform by FF.
The pulse width of MMV made by Q1 and Q2 is determined by R2 and C2 to be connected to T_{FG} (12/14 pin), and the square wave having the pulse width to be determined by C2 and R2 is output.
Of course, this frequency is proportional to the rotation signal and this frequency is six times the frequency of each position sensing. (6 per 1 electrical rotation)
F/V conversion operation is made through connecting FG_O output to LPF for intergration. However, if R2 is made variable, the conversion gain can be controlled.

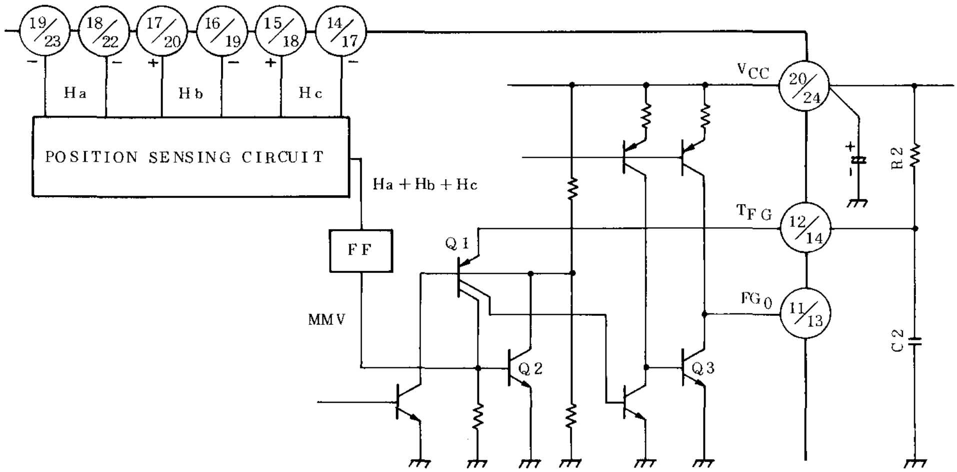


Fig. 1

(2) Each Control Input

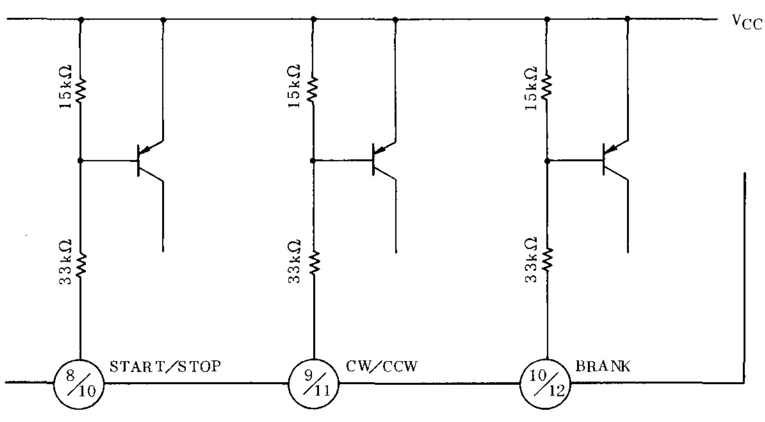


Fig. 2

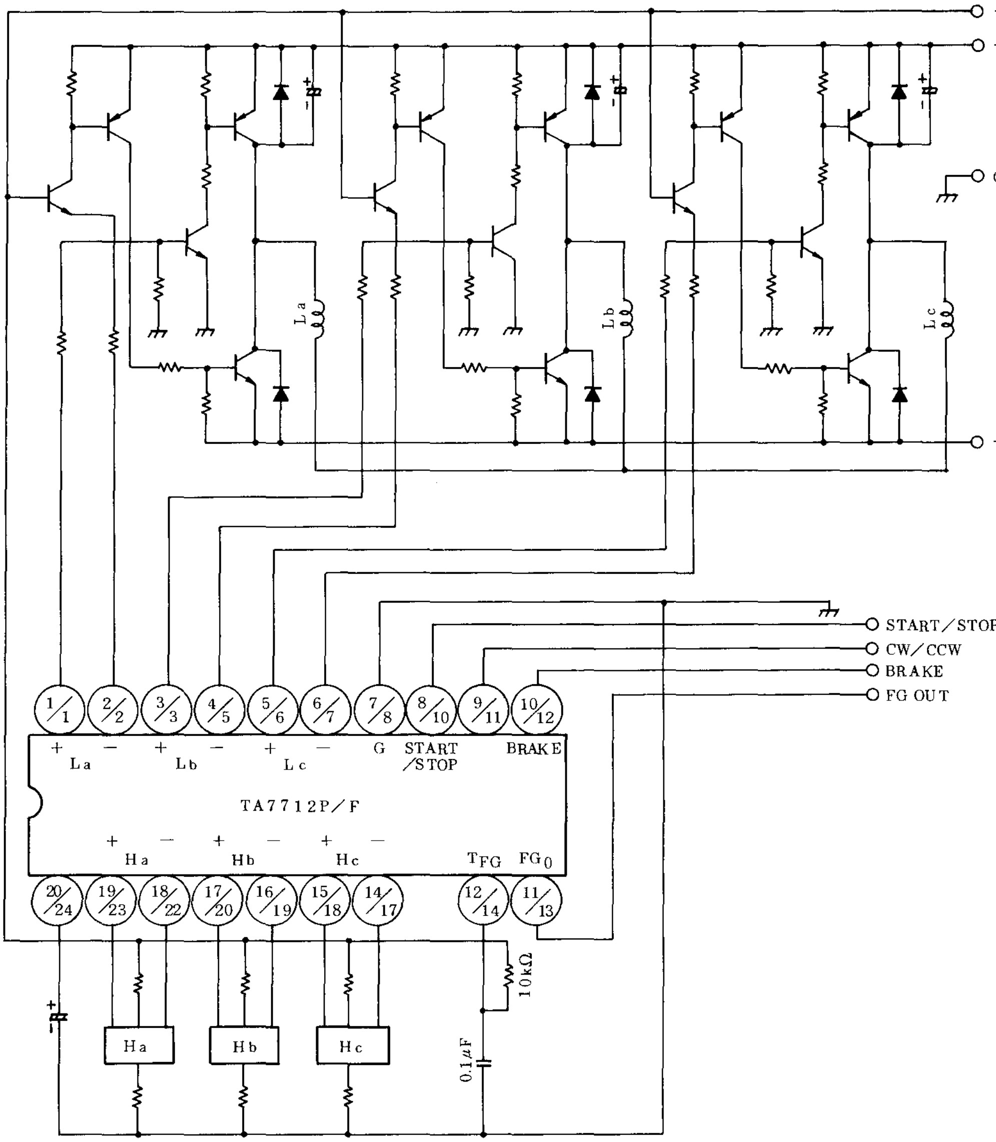
START/STOP	CW/CCW	BRAKE	OUTPUT
H	H	H	Normal torque mode
H	L	H	Reverse torque mode
H or L	H or L	L	BRAKE mode
L	H or L	H	STOP mode

Note: In STOP mode, outputs of La^+~Lc^+ and La^-~Lc^- are all made OFF.
In BRAKE mode, outputs of La^+~Lc^+ are made ON. (source mode)

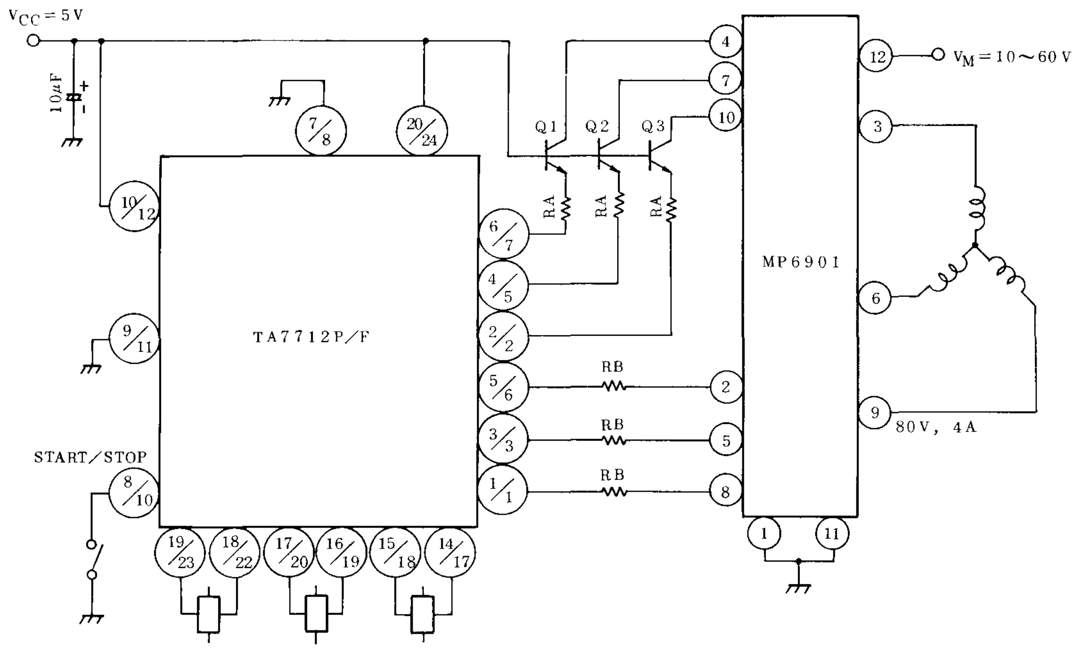
(3) Output Circuit

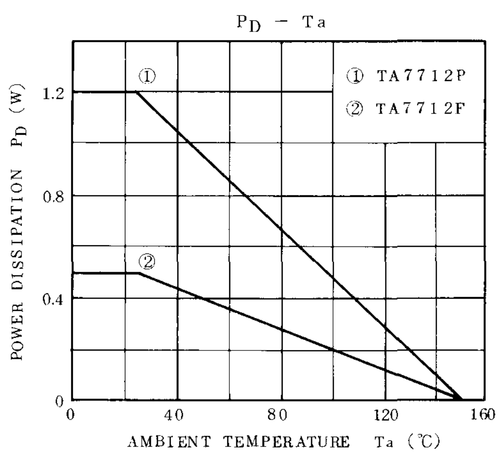
As shown in the block diagram, in the output circuit, the Darlington emitters of PNP and NPN are provided on the upper side, and the lower side is made as the open collector of NPN.

APPLICATION CIRCUIT 1



APPLICATION CIRCUIT 2

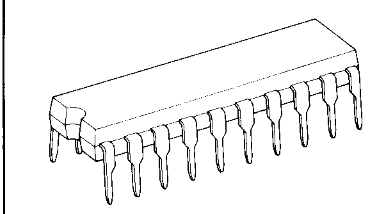




TA7713P

3-PHASE BI-DIRECTIONAL TYPE MOTOR CONTROL IC

- FG is not required. (System for obtaining rotation signal through position sensing)
- Stop function is provided. (Stop speed is selectable.)
- Gain of position sensing circuit is high, and hysteresis is provided.
- Rotation signal output is provided. (Frequency signal of three times the position sensing output (Hall sensor output) can be obtained.)
- External transistor type.



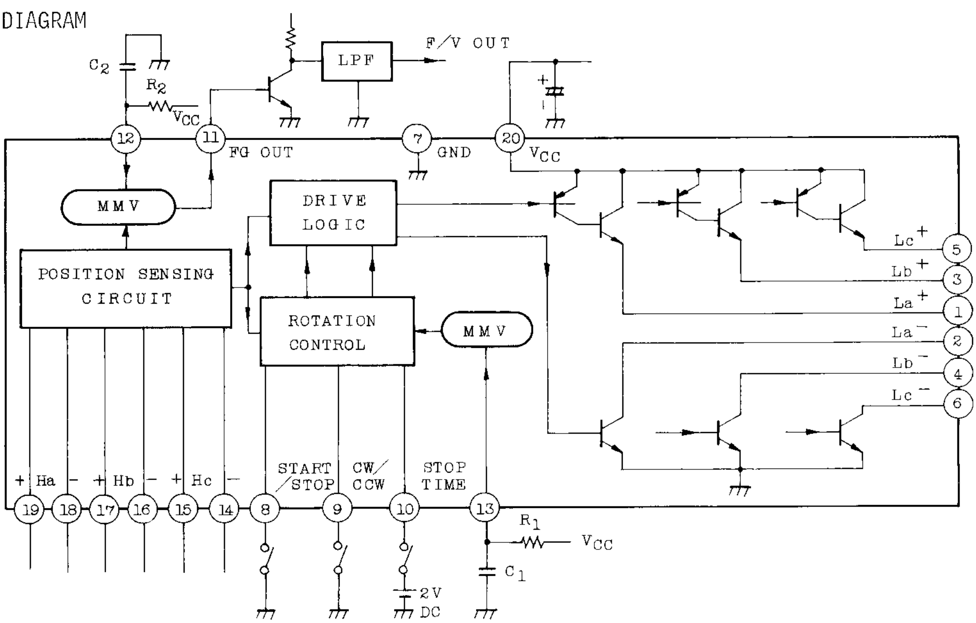
DIP20-P-300A

Weight: 1.4g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{CC}	8.0	V
Output Current	I_O	±25	mA
Position Sensing Circuit Input Voltage (Tj=25°C)	V_H	±500	mV
Power Dissipation (Ta=25°C)	P_D	1.2	W
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-50~125	°C

BLOCK DIAGRAM

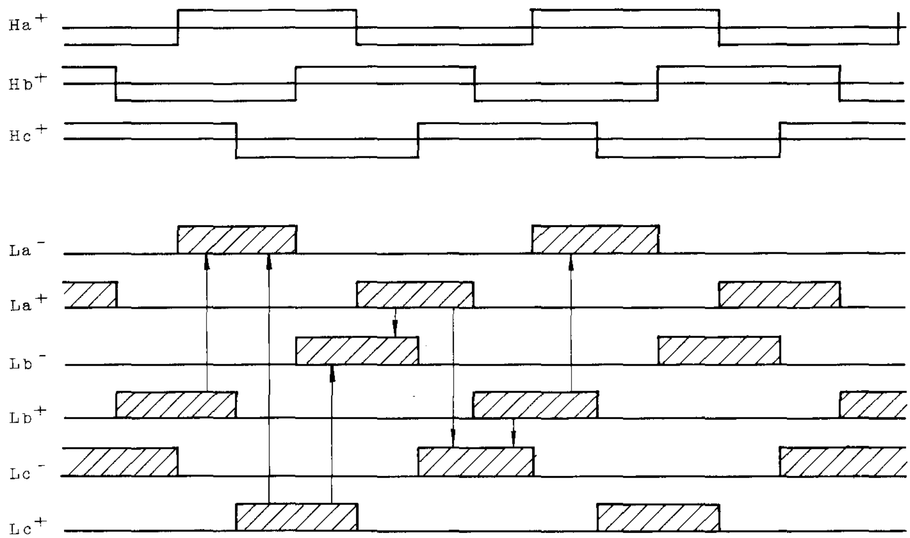


ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=5V, Ta=25°C)

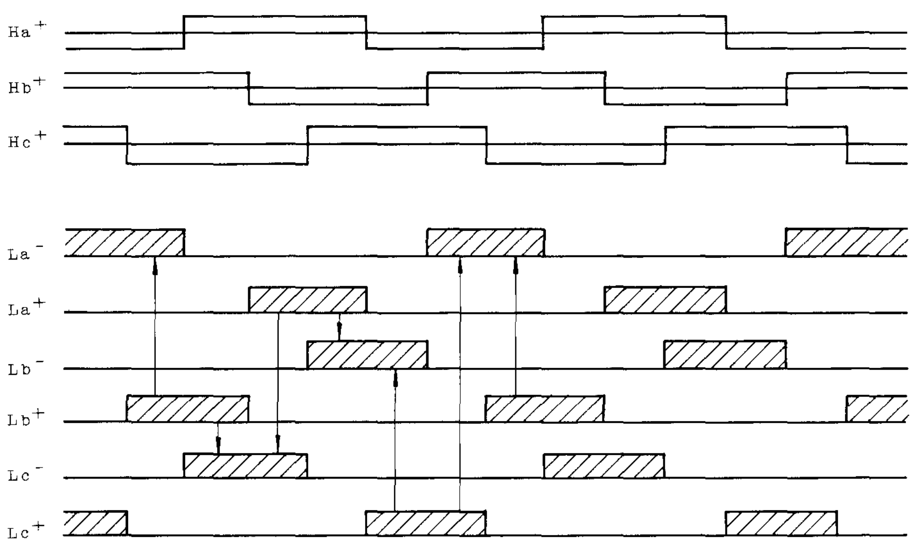
CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage			$V_{CC\ opr}$	-		4.75	5.00	5.25	V
Power Supply Current			I_{CC1}	1	Stop state	-	3.4	6.0	mA
			I_{CC2}		Output Open	-	17.0	26.0	
Saturation Voltage	Upper Side		$V_{SAT\ U-1}$	2	R_L=200Ω	-	1.3	2.0	V
			$V_{SAT\ U-2}$		R_L=2kΩ	-	1.0	1.3	
	Lower Side		$V_{SAT\ L-1}$		R_L=200Ω	-	0.8	1.2	
			$V_{SAT\ L-2}$		R_L=2kΩ	-	0.18	0.4	
Leak Current	Upper Side		$I_{L\ U}$	2		-	-	100	μA
	Lower Side		$I_{L\ L}$			-	-	100	
Position Sensing Input	Common Mode Voltage Range		CMR H	-		2.0	-	4.5	V
	Input Sensitivity		V_H			20	-	-	mV
	Input Hysteresis		V_{H-Hys}			2	7	15	
Start Input (RUN)	Operation Input Voltage	"H"	$V_{IN\ R(H)}$	3		4.0	-	-	V
		"L"	$V_{IN\ R(L)}$	2		-	-	1.0	
	Input Current	"L"	$I_{IN\ R}$	2	$V_{IN\ R}$=1.0V	-	-	200	μA
CW/CCW Input (FWD/REV)	Operation Input Voltage	"H"	$V_{IN\ C(H)}$	3		4.0	-	-	V
		"L"	$V_{IN\ C(L)}$	2		-	-	1.0	
	Input Current	"L"	$I_{IN\ C}$	2	$V_{IN\ C}$=1.0V	-	-	200	μA
Stop-Speed Selection Input (8/12)	Operation Input Voltage	"H"	$V_{IN\ N(H)}$	3		2.0	-	-	V
		"L"	$V_{IN\ N(L)}$	3		-	-	0.5	
	Input Current	"H"	$I_{IN\ N}$	3	$V_{IN\ N}$=1.0V	-	-	150	μA
FG Output	Output Current	"H"	I_{FGH}	4		80	-	-	μA
	Output Voltage	"L"	V_{FGL}	4	I_{FG}=0.3mA	-	-	0.4	
	Pulse Width		τ_{FG}	4	C=0.1μF, R=10kΩ	0.9	1.0	1.1	ms
Monostable Muiti Vibrator (for stop) Output Pulse Width			$\tau_1-2\tau_G$	3	C=10μF, R=16kΩ $V_{IN\ N}$=0.5V	108	120	132	ms
			$\tau_2-2\tau_G$		C=10μF, R=16kΩ $V_{IN\ N}$=2.0V	45	55	61	
			τ_G			18	23	28	

TIMING CHART

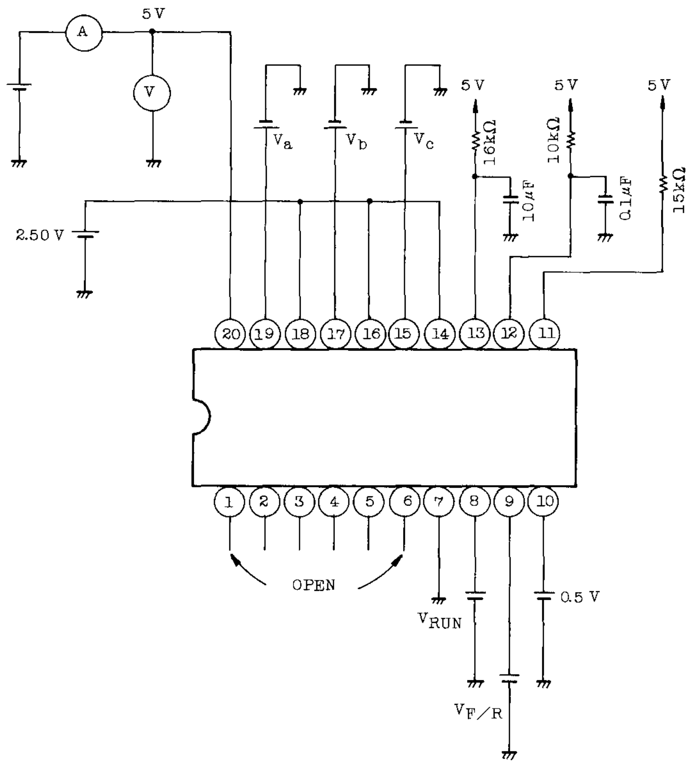
FORWARD ROTATION (Position sensing signal advances Ha→Hb→Hc)



REVERSE ROTATION (Position sensing signal advances Ha→Hc→Hb)



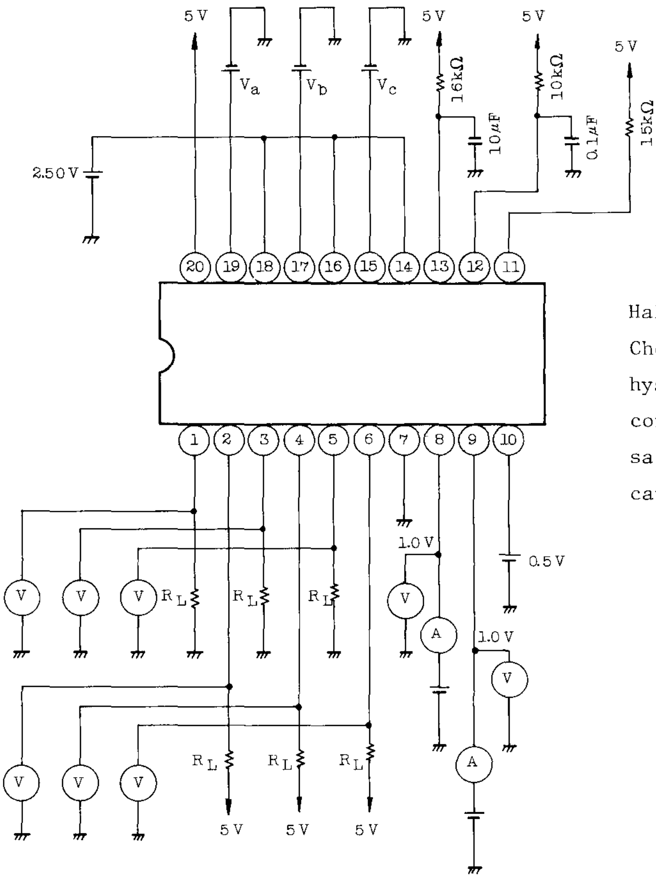
TEST CIRCUIT 1



	V_{RUN}	$V_{F/R}$	Va	Vb	Vc	REMARKS
I_{CC1}	4.0V	4.0V	2.48V	2.48V	2.52V	Reverse sensing must not be made.
I_{CC2}	1.0V	1.0V	2.52V	2.48V	2.52V	

Measure I_{CC1} without fail after setting I_{CC2} measuring logic, and carry out the measurement 200msec after setting I_{CC1} measuring logic.

TEST CIRCUIT 2



Hall AMP. Input

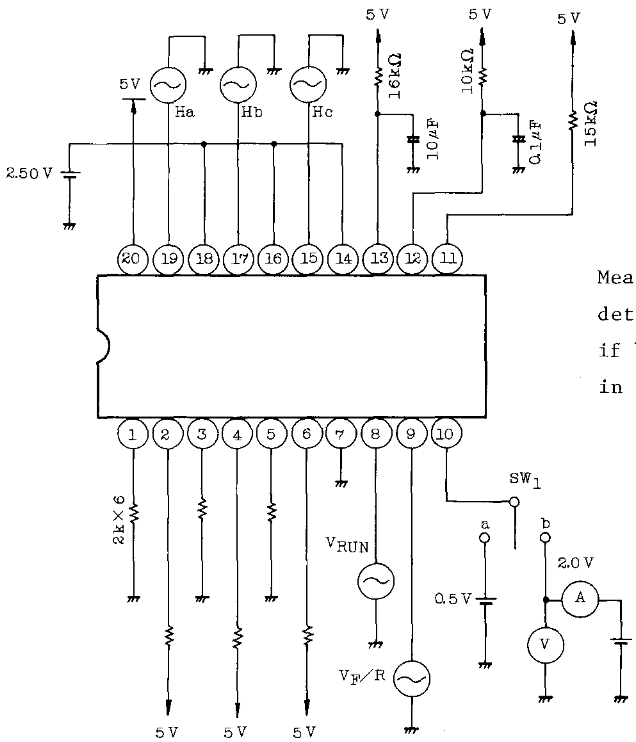
Check input sensitivity and input hysteresis with ±20mV by means of confirming that leak current and saturation voltage described below can be measured.

INPUT CONDITION					MEASUREMENT ITEM					
Va	Vb	Vc	RUN	F/R	La^{+}	La^{-}	Lb^{+}	Lb^{-}	Lc^{+}	Lc^{-}
5.52V	2.48V	2.48V	$V_{INR(L)}$	$V_{INC(L)}$	LEAK	SAT	LEAK	LEAK	SAT	LEAK
2.48V	2.52V	2.48V	–	–	SAT	LEAK	–	SAT	LEAK	–
2.48V	2.48V	2.52V	–	–	–	–	SAT	–	–	SAT

LEAK : Measurement of leak current

SAT : Measurement of saturation voltage

TEST CIRCUIT 3



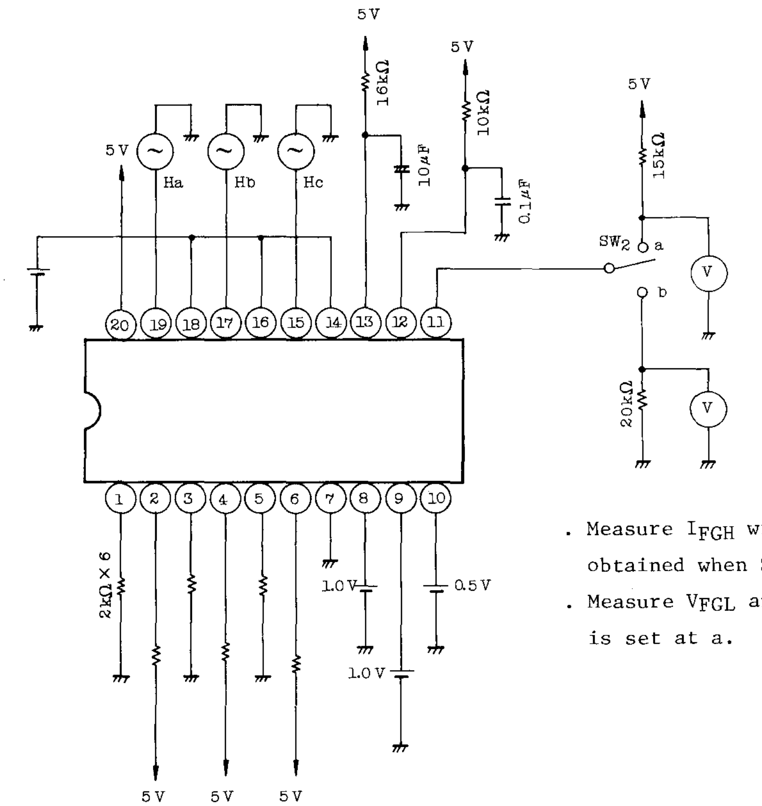
Measurement of V_{IN} R(H) is determined to be acceptable if τ_1 and τ_2 can be measured in the following measurement.

Input Ha, Hb, Hc and V_{RUN}, $V_{F/R}$ made by the oscillator driven with the same clock.

MEASURING METHOD

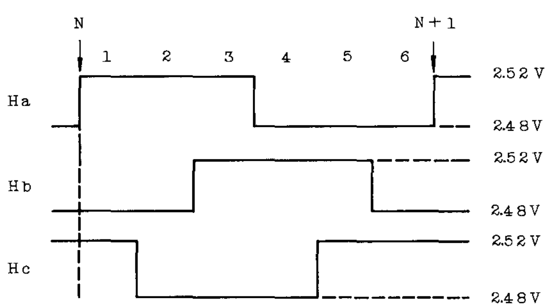
- $V_{INC(H)}$: When $V_{F/R}$ varies from 1.0 to 4.0, confirm that La^+ changes from Ⓛ to Ⓗ.
- τ_1 : Time between fall points of La^+ and Lb^+ when SW_1 is set at a.
  τ_2 : Time between fall points of La^+ and Lb^+ when SW_1 is set at b.
- I_{INN} : Read meter at τ_2 measurement.
- τ_G : Time between fall points of La^+ and Lb^+ when SW_1 is set at a.

TEST CIRCUIT 4



. Measure I_{FGH} with the voltage obtained when SW_2 is set at b.

. Measure V_{FGL} and τ_{FG} when SW_2 is set at a.



TIME CHART FOR NORMAL ROTATION

CLOCK 360Hz

APPLICATION OF TA7713P

Like a video disk player, TA7713P is provided with the stopping function which, in a short time, stops the motor having a large inertia, and makes the quick disk-change possible.

To make the frequency generator (FG) unnecessary which was formerly required for fetching the rotation signal, the signal from the position sensing input is ORed and is output to FG output pin (11 pin).

Therefore, for FG output, three position sensing outputs (Hz,Hb,Hc) are ORed, and the rotation speed signal of the frequency of six times that of one output can be fetched resulting in making it possible to obtain a sufficient controlling characteristic with the F/V (frequency-voltage) conversion method of monostable type.

Description is made on the application of TA7713P in the following.

(1) Operation of FG Output (11 pin) and T_{FG} (12 pin)

In Fig.1, Q_1 and Q_2 are the monostable multivibrator to which gate (Q_2 base) the signal from each position signal input of Ha, Hb and Hc is input after ORed and shaped in waveform by FF.

The pulse width of MMV made by Q1 and Q2 is determined by R2 and C2 to be connected to T_{FG} (12 pin) and the square wave having the pulse width to be determined by C2 and R2 is output. Of course, this frequency is proportional to the rotation speed signal and this frequency is six times the frequency of each position sensing. (6 per 1 electrical rotation.)

F/V conversion operation is made through connecting this FG_O output to LPF for integration. And if R2 is made variable, the conversion gain can be changed.

(2) Stopping Function

For stopping the motor, it is the simplest way to stop the inertia through the friction after turning off the motor driving power supply.

However, since too much time is required for stopping the motor having a large inertia, this method is not suitable to the video disk or audio disk player which requires the disk changed in a short time.

In this case, the motor is changed over to the reverse torque state at the same with the input of the stop signal, and the brake is applied keeping the state of normal rotation with reverse torque as an usual method.

In this method, however, reverse runaway is liable to accur unless the reduction of rotation is detected through a certain measure to stop the reverse torque state at an appropriate time.

(For example, PLL motor controller TC9142P is provided with the circuit by which the reverse rotation signal is output at the same time with the stop signal input, and the reduction of rotation speed in this reverse torque state is detected by FG signal to disconnect the reverse rotation signal when the rotation speed reduced down to $\frac{1}{8}$ the initial speed.)

In case of the motor of high rotation speed and large inertia like the motor for video disk, to perform the quick braking operation, it is necessary to keep this condition of the forward rotation with reverse torque until just before the motor stops in order to reduce the inertia stopping time to the minimum through the friction force.

For this purpose, in TA7713P, the state of forward rotation with reverse torque is kept continued until the motor stops and either of three position sensing signals detects the reverse rotation with the built-in reverse sensing circuit.

(In case of application of TA7713P, there is no problem in the optical system, however, it is of course necessary to put the sensor apart from the disk at the same time with the stop signal input or before the reverse rotation start in VHD CED system.)

At this time, the state of the reverse rotation is max. 60° in electrical angle.

Furthermore, in order to remove the inertia due to this reverse rotation, the inside monostable multi-vibrator generates the time normal torque determined by the state of C_2, R_2 and 10 pin to turn out the inertia-stopped state afterwards.

By means of these functions, the motor can be stopped in 5~8 seconde with the optical system of high rotation speed and in 2~3 seconds with VHD CED system.

Fig. 2 EACH CONTROL INPUT

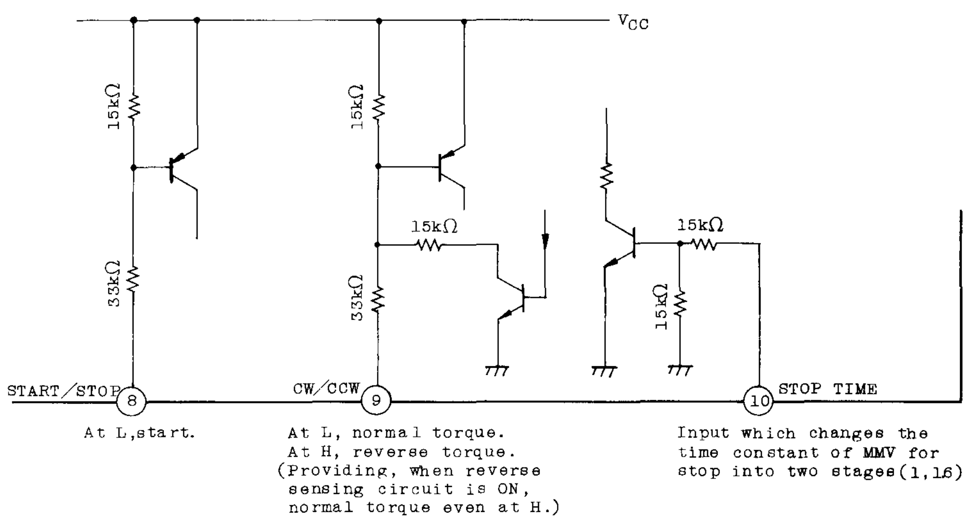
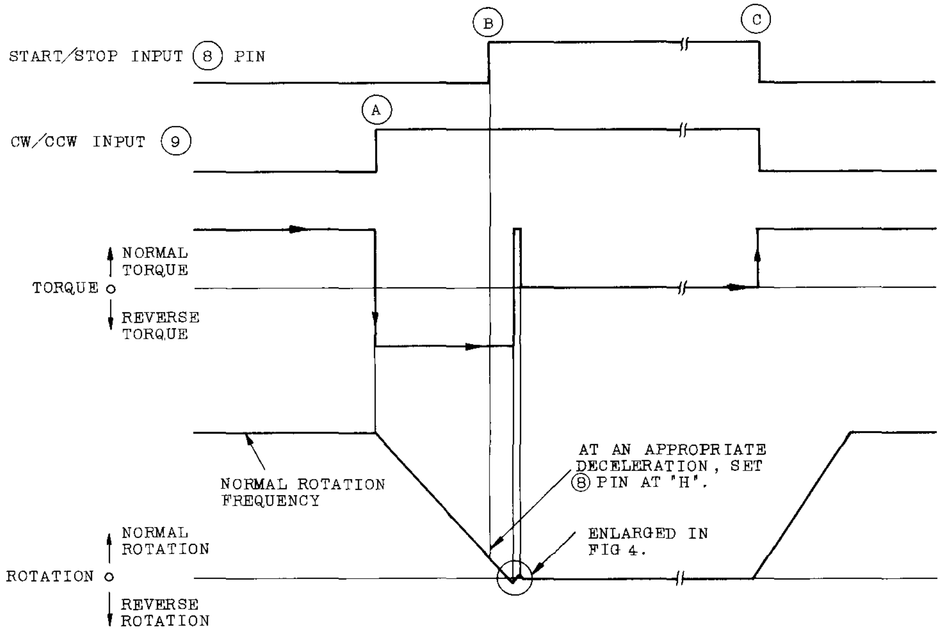


Fig. 3 PROCEDURE FOR STOP/START



Stop Sequence (Procedure for stopping the system in normal rotation)

1. Set CW/CCW input pin (⑨ pin) to "H" to make the clockwise mode with reverse torque state. (Ⓐ point)
2. Detect the reduction of rotation speed due to the reverse torque with FG, etc, and when rotation speed is reduced to 1/3~1/8 normal one, set START/STOP input pin (⑧ pin) to "H". (⑧ point)
3. By this procedure, the motor stops automatically.
   For starting the system, it is enough to set both START/STOP input and CW/CCW input to "L". (Ⓒ point)

Fig. 4 ENLARGED VIEW OF REVERSE SENSING

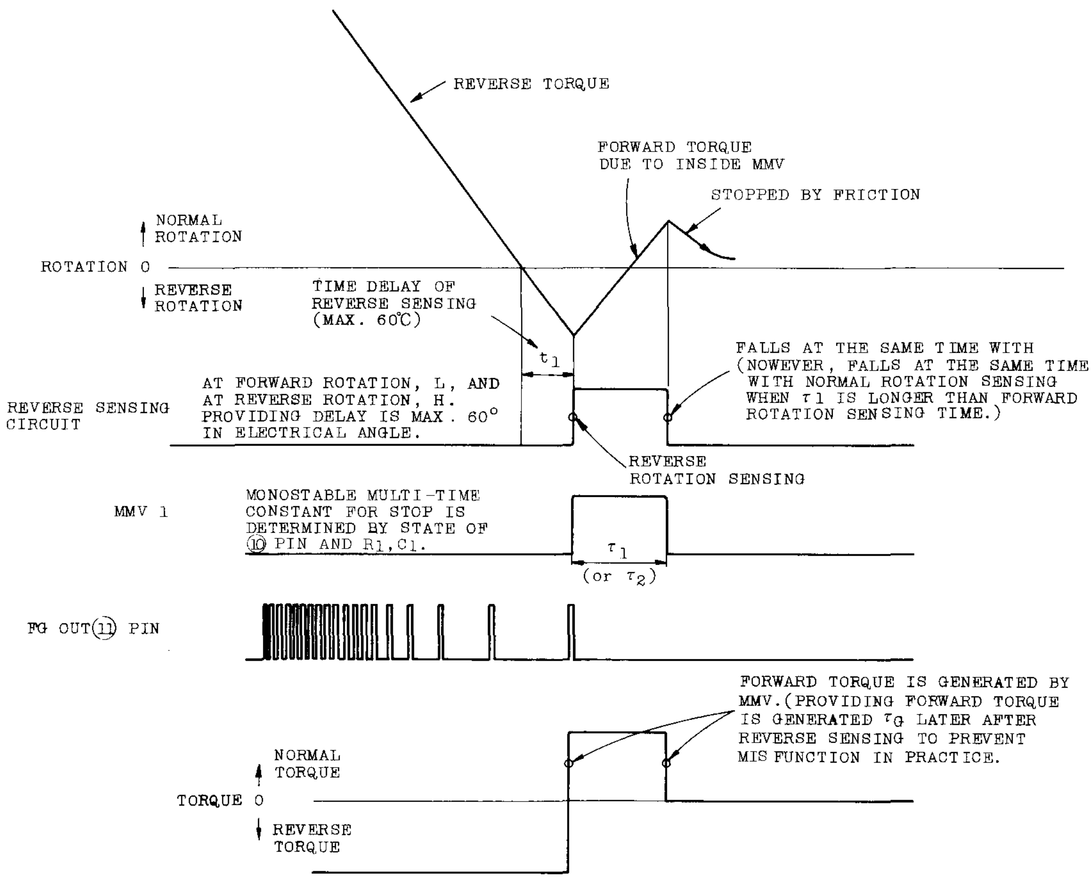
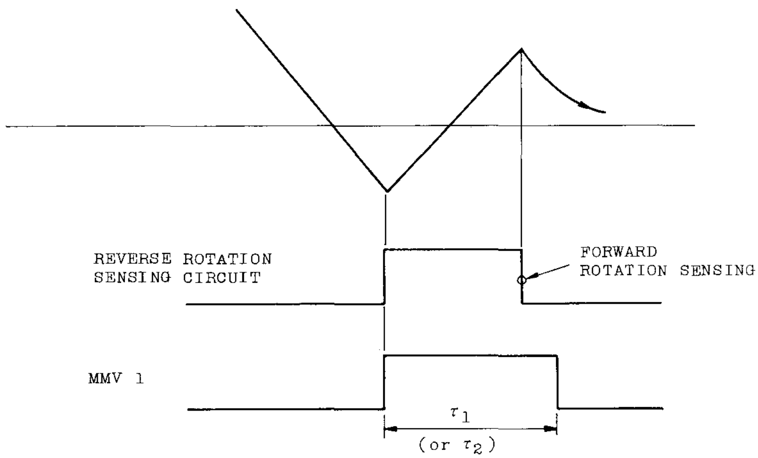


Fig. 5 TIMING IN CASE τ_1 (or τ_3) IS LONGER THAN FORWARD ROTATION SENSING TIME



(3) Position Sensing Input Circuit

The common mode voltage range of ⑭, ⑮, ⑯, ⑰, ⑱ and ⑲ pins in position sensing input circuit is 2V to V_{CC}-0.5V. Therefore, in case of V_{CC}=5V, the range is 2~4.5V.

Hysteresis of 7mV(TYP.) is provided at the input to make the operation accurate.

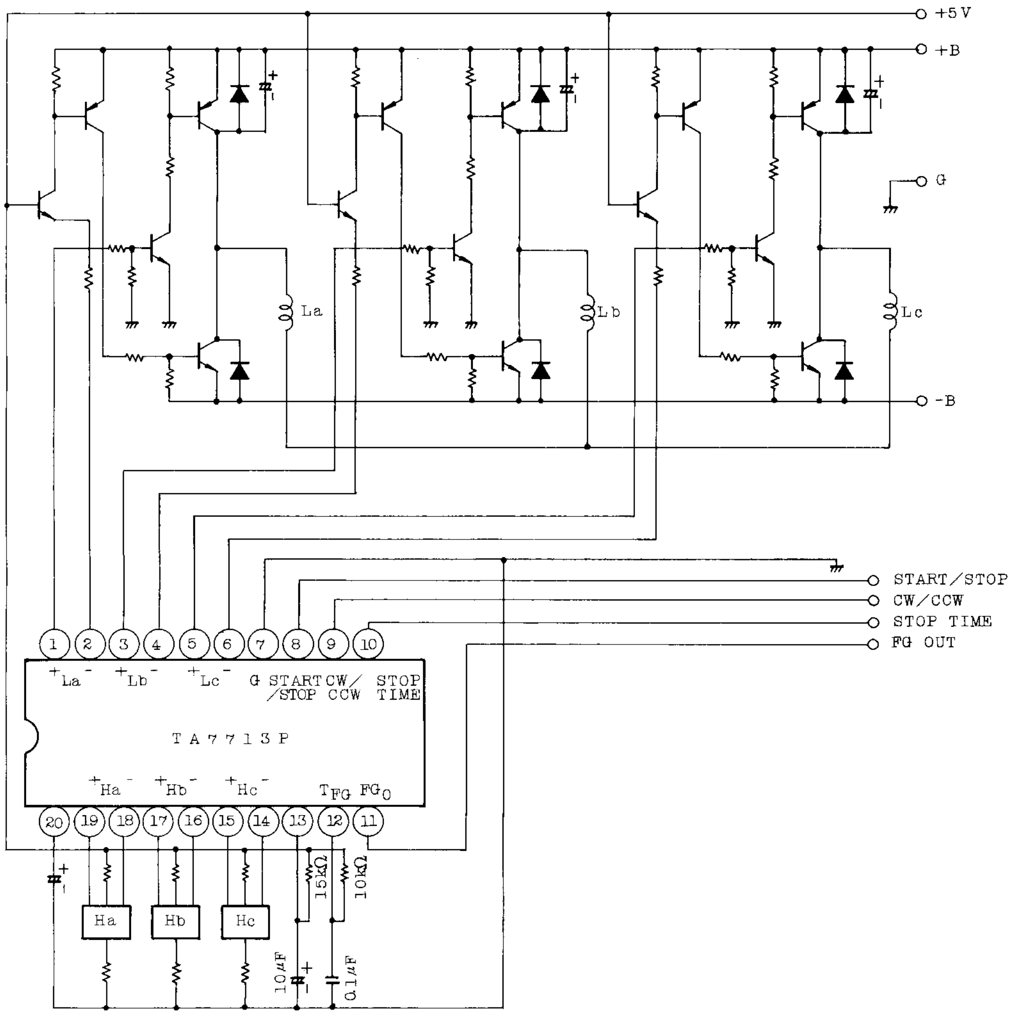
Take care not to allow the hall output exceed the max. voltage 400mV of the position sensing input as shown in maximum rating for caution.

(4) Output Circuit

As shown in the block diagram, in the output circuit, the Darlington emitters of PNP and NPN are of open type on the upper side, and the lower side NPN is the open collector type.

Connect the external transistor in the same manner as that of the application circuit.

BASIC APPLICATION CIRCUIT

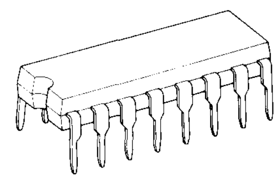


TA7715P

FREQUENCY TO VOLTAGE CONVERTER

The TA7715P is a general purpose F-V converter designed for FDD, VTR, ATR and player F-servo system use.

It contains High Gain Input Amplifier, Hysteresis Amplifier (for wave form shaping), and Sample-and-Hold type F-V conversion amplifier.



DIP16-P-300A

Weight: 1.0g (Typ.)

MAXIMUM RATINGS ($Ta=25^{\circ}C$)

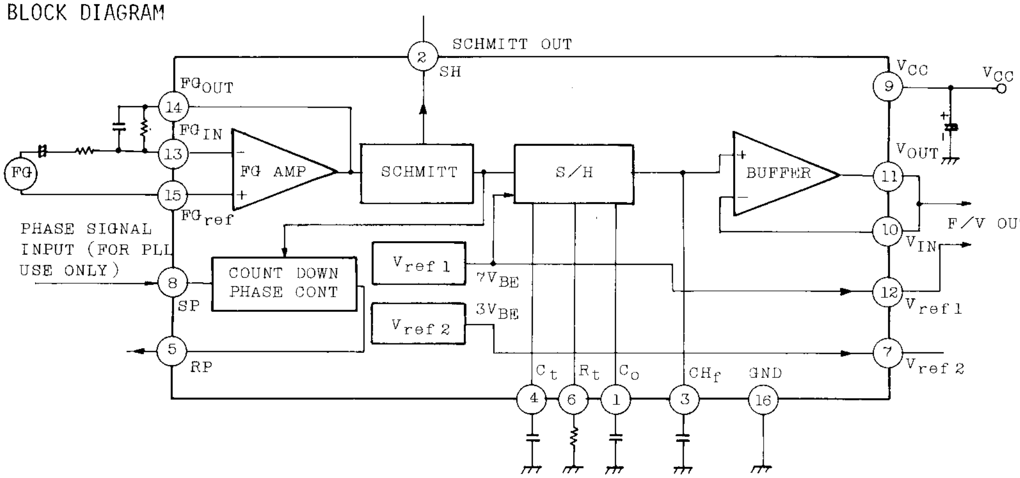
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	15	V
Power Dissipation (Note)	P_D	750	mW
Operating Temperature	T_{opr}	-25 ~ 75	°C
Storage Temperature	T_{stg}	-55 ~ 150	°C

Note : Derated above $Ta=25^{\circ}C$ in the proportion of $6mW/^{\circ}C$.

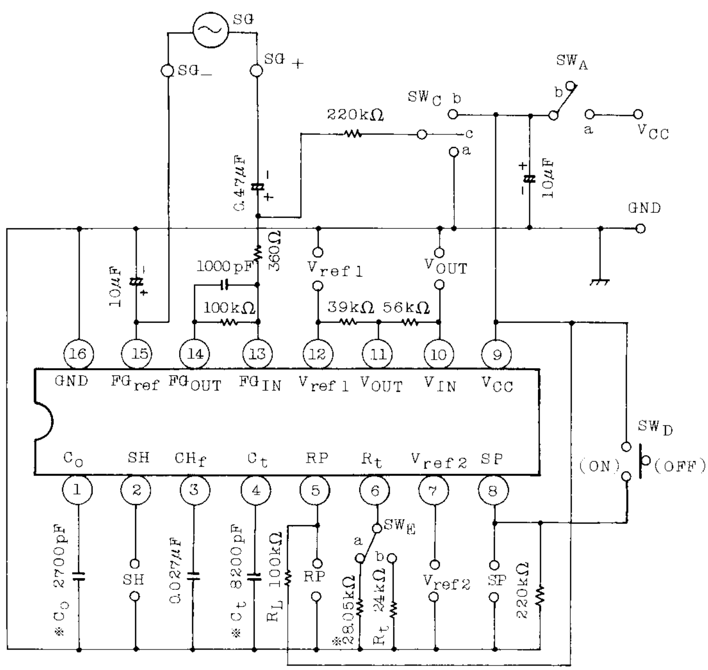
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, $V_{CC}=10V$, $Ta=25^{\circ}C$)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage Range	$V_{CC(opr)}$		$e_i=20mV_{rms}$, f=726Hz	9	10	12	V
Supply Current	I_{CC}			2.5	-	10	mA
Input Sensing Voltage	V_{IN}		f=726Hz	0.35	-	2.5	mV_{rms}
Reference Voltage	V_{ref-1}			4.0	5.0	6.0	V
	V_{ref-2}			1.5	2.0	2.5	
F/V Converter Output Voltage	V_{OUT}		$e_i=20mV_{rms}$, f=726Hz $R_f=27.6k\Omega$	-0.5	0	0.5	V
F/V Converter Output Noise Voltage	V_{NF}		$e_i=20mV_{rms}$, f=726Hz	-	-	5	mV_{rms}
Max. Output Voltage	V_{FH}		$e_i=20mV_{rms}$, f=900±10Hz	2.5	-	-	V
	V_{FL}		$e_i=20mV_{rms}$, f=580±10Hz	-	-	-2.2	
RP Saturation Voltage	$V_{RP(sat)}$		$R_L=100k\Omega$	-	-	0.3	V

BLOCK DIAGRAM



TEST CIRCUIT



※ ±1% ACCURACY IS REQUIRED

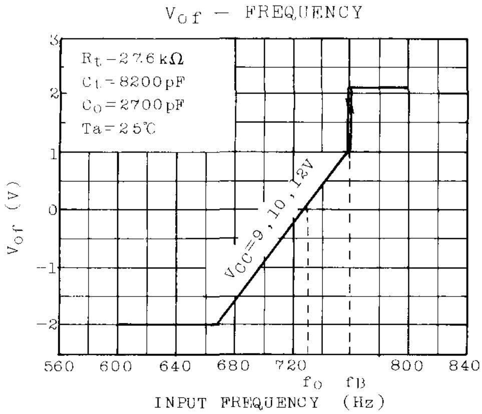
TEST CONDITIONS

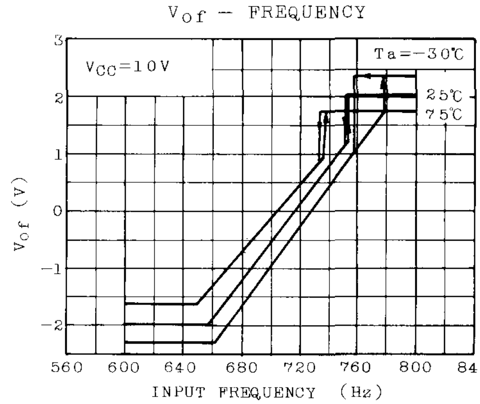
CHARACTERISTIC	SYMBOL	SW CONDITION	MEASURING POINT	NOTE
Operating Voltage Range	$V_{CC(opr)}$	SW_A=a, SW_C=OFF SW_D=OFF, SW_E=a	-	
Supply Current	I_{CC}	"	9 PIN V_{FCM}	
Input Sensing Voltage	V_{IN}	"	SG Terminal DV_M	AC Voltage Measure
Reference Voltage	V_{ref-1}	"	12 PIN V_M	
	V_{ref-2}	"	7 PIN V_M	
F/V Converter Output Voltage	V_{OUT}	"	10 12 PIN DV_M	
F/V Converter Output Noise Voltage	V_{NF}	"		AC Voltage Measure
Max. Output Voltage	V_{FH} V_{FL}	"	10 - 12 PIN DV_M	
Rp Saturation Voltage	$R_{P(sat)}$	"	5 PIN V_M	

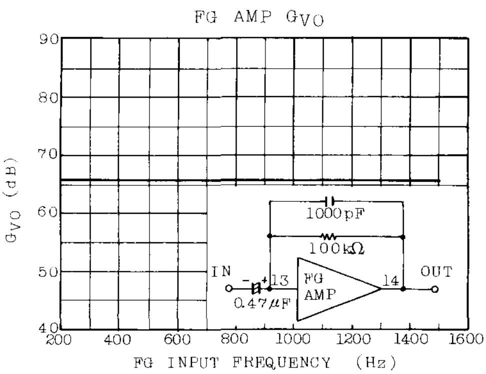
Note : V_{FCM} : Voltage forcing current measuring.

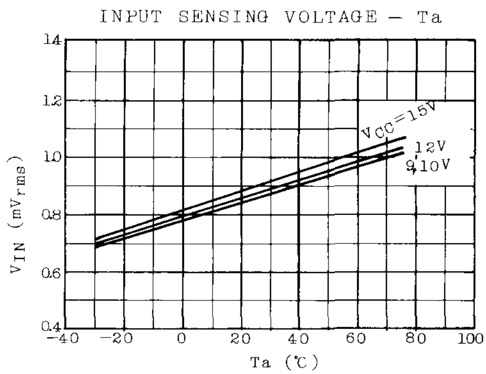
V_M : Voltage measuring.

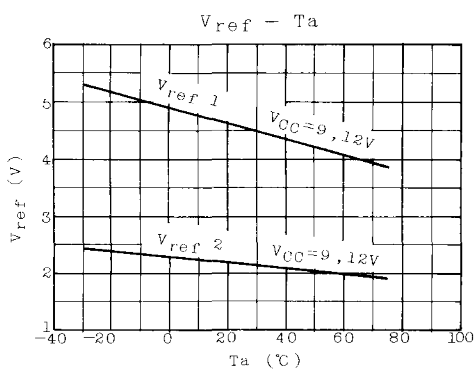
DV_M : Differencial voltage measuring.


Vof – FREQUENCY
Rt=27.6kΩ
Ct=8200pF
Co=2700pF
Ta=25℃
VCC=9,10,12V
Vof (V)
fo
fB
INPUT FREQUENCY (Hz)

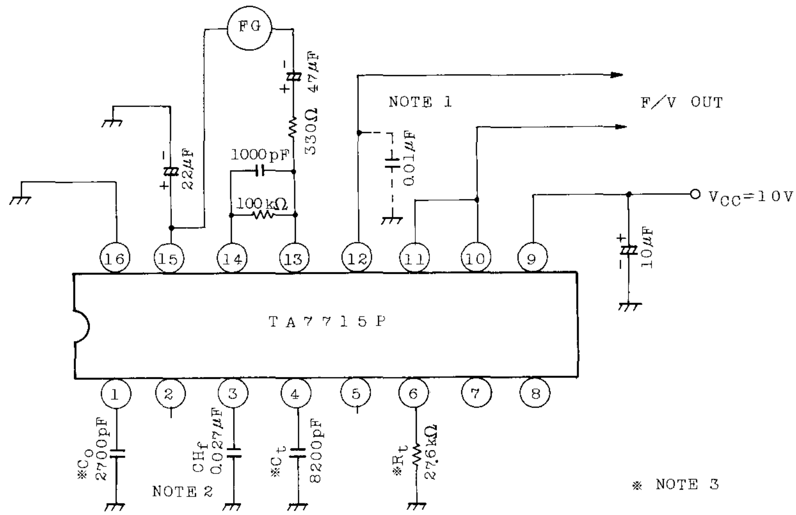

Vof – FREQUENCY
VCC=10V
Ta=–30℃
25℃
75℃
Vof (V)
INPUT FREQUENCY (Hz)


FG AMP GVO
GVO (dB)
1000pF
100kΩ
IN
0.47μF
13
FG
AMP
14
OUT
FG INPUT FREQUENCY (Hz)


INPUT SENSING VOLTAGE – Ta
VCC=15V
12V
9,10V
VIN (mVrms)
Ta (℃)


Vref – Ta
Vref 1
VCC=9,12V
Vref 2
VCC=9,12V
Vref (V)
Ta (℃)

APPLICATION CIRCUIT 1



Note 1 : Connect if required.

Note 2 : CH_f value is depend on Input Frequency and internal Bias Current (Base current).

Recommended value is 0.027μF at Input Frequency range of 300 to 1kHz.

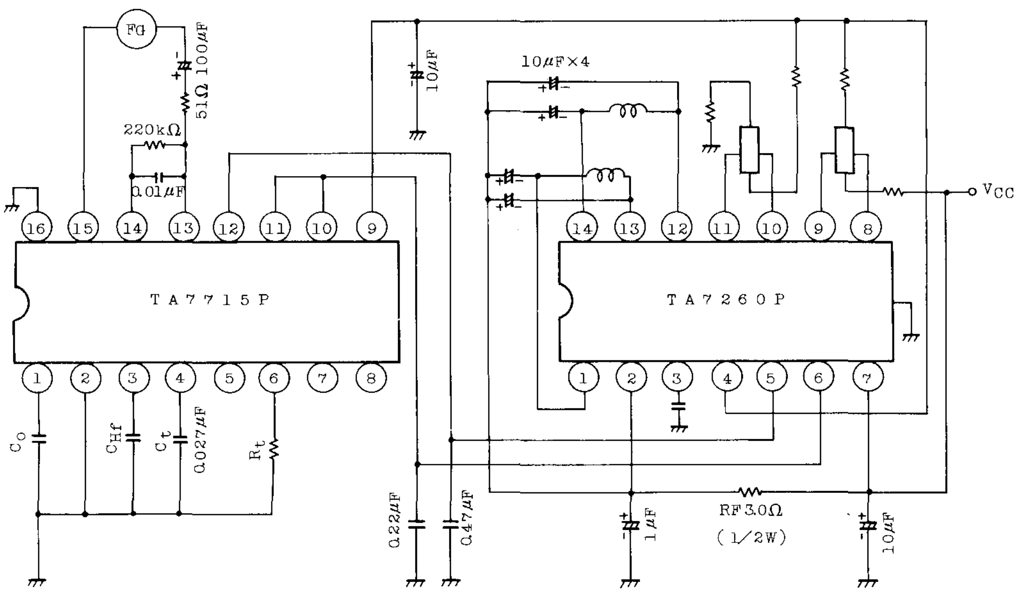
Note 3 : Center Frequency and Jump Up Frequency are caluculated by following equations.

$$f_C = \frac{1}{R_t(5C_t + 3C_o)} \quad \text{(Hz)}$$

$$f_B = 0.187 \frac{(5C_t + 3C_o)}{C_t} f_C \quad \text{(Hz)}$$

Note 4 : Recommended to use low leakage capacitance for CH_f, C_o, C_t.

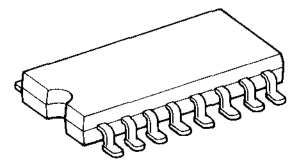
TEST CIRCUIT 2



TA7733F

FUNCTIONAL BRIDGE DRIVER.

FEATURES:
. Wide Operating Supply Voltage Range. $V_{CC(opr)}$=1.8~15V
. Capsealded in Flat Package 16 pin.
. Forward and Reverse Rotation, Short Brake Modes are Available by Means of Rotation Control Signals.
. High Efficiency is Obtained.
. Can be Used as Interface Driver.



SSOP16-P-225

Weight: 0.2g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

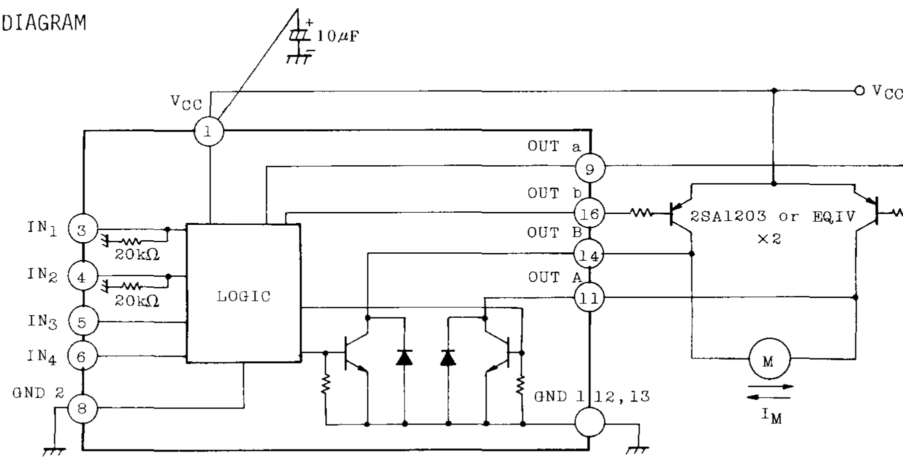
CHARACTERISTIC		SYMBOL	RATING	UNIT
Peak Supply Voltage		V_{CC}	18	V
Output Current		$I_{O(AVE)}$	0.5	A
Power Dissipation	-	P_D	350	mW
	(Note)		550	
Operating Temperature		T_{opr}	-30 ~ 75	°C
Storage Temperature		T_{stg}	-55 ~ 150	°C

Note : This rating is obtained by mounting on 20 × 20 × 0.8mm PCB that occupied above 60% of copper area.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C±1.5°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}			-	13	-	mA
		I_{CC2}			-	7.2	-	mA
		I_{CC3}			-	19.2	-	mA
		I_{CC4}			-	2.4	-	mA
Saturation Voltage		$V_{sat\ 1}$		I_{O1}=500mA, Lower Side	-	0.4	-	V
		$V_{sat\ 2}$		I_{O2}=25mA, Upper Side	-	0.5	-	V
Output TR Leakage Current		I_L		V_C=15V	-	-	50	μA
Input Voltage	"H" Level	$V_{IN3,4}$"H"			1.2	-	V_{CC}	V
	"L" Level	$V_{IN3,4}$"L"			-	-	0.3	V
Input Current	"L" Level	$I_{3,4}$,"L"		Input "L" (SOURSE Current)	-	-	20	μA
Input Voltage	"H" Level	$V_{IN5,6}$"H"			1.0	-	V_{CC}	V
	"L" Level	$V_{IN5,6}$"L"			-	-	0.3	V
Input Current				Input "H" (Sink Current)	-	-	30	μA
Diode Forward Voltage					-	1	-	V

BLOCK DIAGRAM



FUNCTION

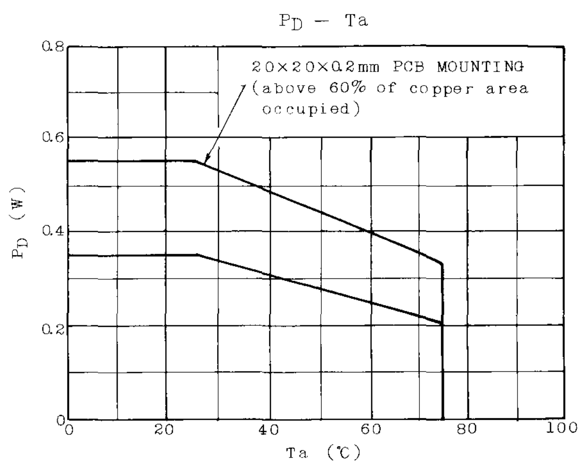
(1) BRIDGE DRIVER

CONTROL	INPUT MODE				OUTPUT				OPERATING MODE	NOTE
	IN1	IN2	IN3	IN4	OUT(A)	OUT(B)	OUT(a)	OUT(b)		
2 INPUT CONTROL	H	L	H	H	ON (-500mA)	—	ON (-25mA)	—	Forward Rotation	
	L	H	H	H	—	ON (-500mA)	—	ON (-25mA)	Reverse Rotation	
	H	H	H	H	ON (-500mA)	ON (-500mA)	—	—	Brake	
	L	L	H	H	—	—	—	—	Stop	
1 INPUT CONTROL	H	L	L	H	ON (-500mA)	—	ON (-25mA)	—	Forward Rotation	
	L	L	L	H	—	ON (-500mA)	—	ON (-25mA)	Reverse Rotation	
	H/L	H	L	H	ON (-500mA)	ON (-500mA)	—	--	Brake	
INHIBIT				L	—	—	—	—	Stop	

(2) INTERFACE DRIVER APPLICATION

If IN3 and IN4 connect to "HIGH", Out(A) and Out(B) can be used as a interface driver output for each inputs.

(Connect Out(a) and Out(b) to GND)



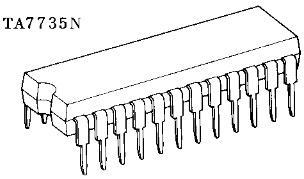
TA7735F/N

SENSOR-LESS DC MOTOR DRIVER.

TA7735N/F are Sensor-less DC Motor Driver IC designed especially for Portable use VCR Head and FDD Spindle Motor drives.
It consist of 3 phase unipolar output drivers, ring counter for system starter, CW/CCW control circuit and switching regulator.

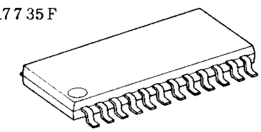
. 3-Phase Unipolar Voltage Drive Type Motor Driver IC.
. Output Current Up to 1.2A.
. Excellent High Efficiency with Built-in Switching Regulator.
. Surface Mount Availability with TA7735F.
. Wide Range of Operating Supply Voltage
  : $V_{CC\ opr}$=4~12V

TA7735N



SDIP24-P-300

TA7735F



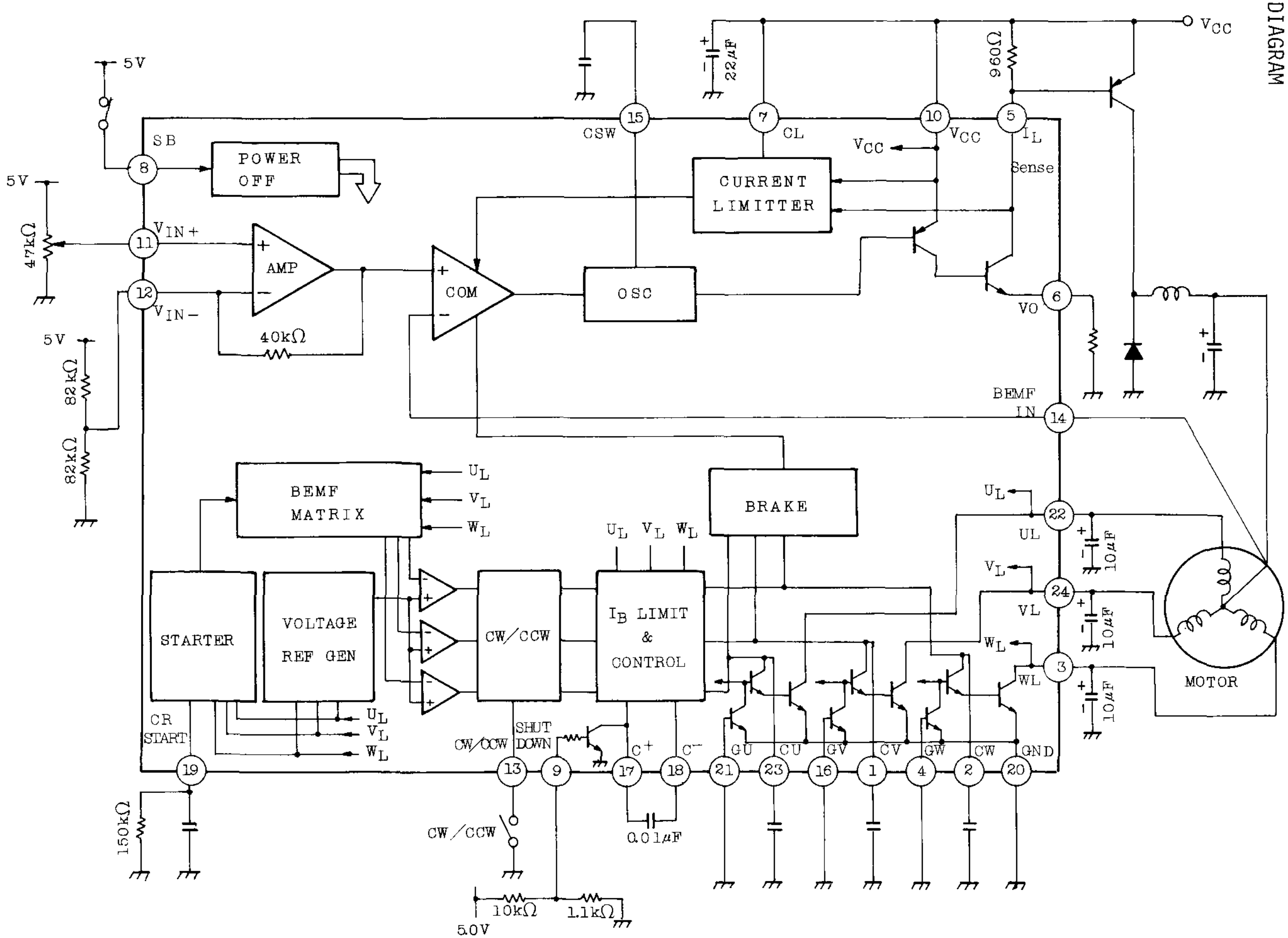
SSOP24-P-300

Weight:
SDIP24-P-300: 1.2g (Typ.)
SSOP24-P-300: 0.3g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Output Terminal Break-Down Voltage		U_L, V_L, W_L	30	V
Supply Voltage		V_{CC1} V_{CC2}	18	V
Operating Supply Voltage		V_{CC1} V_{CC2}	12	V
Output Current		I_O	1.2	A
Power Dissipation	TA7735F	P_D	0.5	W
	TA7735N		1.2	
Operating Temperature		Topr	-20~75	°C
Storage Temperature		Tstg	-55~150	°C

BLOCK DIAGRAM

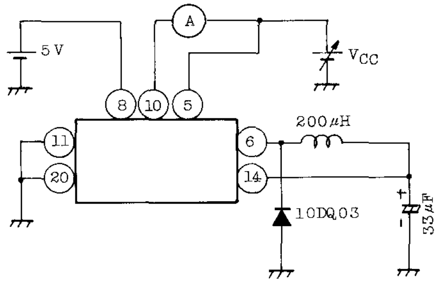


ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C)

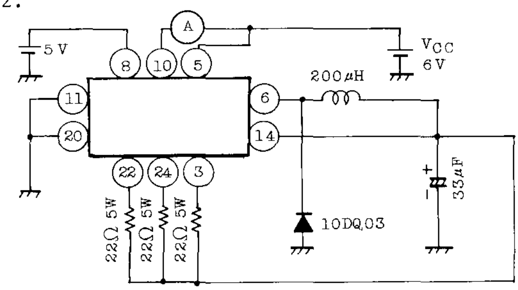
CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{CC1}	1	V_{CC}=6V, Output OFF	2.0	3.7	6.0	mA
	I_{CC2}		V_{CC}=12V, Output OFF	3.0	5.5	10.0	
	I_{CC3}	2	V_{CC}=6V, R_L=22Ω	-	15	-	
Output Saturation Voltage	V_{SAT1}	3	V_{CC}=6V, V_{CL}=6V R_L=10Ω, V_{13}=1V	-	0.4	0.7	V
	V_{SAT2}		V_{CC}=6V, I_O=800mA V_{13}=1V	-	0.6	-	
Output Saturation Difference Voltage	ΔV_{SAT}		V_{CC}=6V, V_{CL}=6V R_L=10Ω, V_{13}=1V	-	50	100	mV
Output Leakage Current	I_L	4	V_{CC}=18V	-	-	200	μA
Switching Regulator: Output Transistor Saturation Voltage	V_{SAT-S}	5	I_O=500mA, R_{SC}=0Ω	-	1.0	1.4	V
Switching Regulator: Output Transistor Leakage Current	I_{L-S}	6		-	-	30	μA
Switching Regulator: Switching Frequency	f_{OSC}	7	V_8=5V, V_{CC}=6V C=820pF	80	100	120	kHz
CW/CCW Control Operating Voltage: "H" Level	V_{TH-H}	3	Pin ⑬	0.8	-	-	V
CW/CCW Control Operating Voltage: "L" Level	V_{TH-L}			-	-	0.4	
Control Amp Input Current	I_B	8	Pin ⑪	-	5	10	μA
Ring OSC Frequency	f_{RNG}	11	R=150kΩ, C=3.3μF	0.5	1.8	3.0	Hz
Output Voltage	G_{V-1}	9	V_{11}=2.4V, R_L=33Ω	2.15	2.40	2.65	V
	G_{V-2}	9	V_{11}=3.7V, R_L=33Ω	3.60	4.00	4.40	
	G_{V-3}	10	V_{11}=2.0V, R_L=33Ω	1.05	1.50	1.95	

MEASURING CIRCUIT

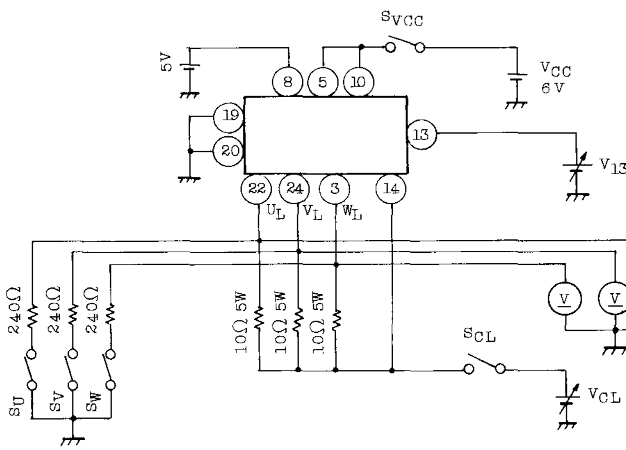
1.



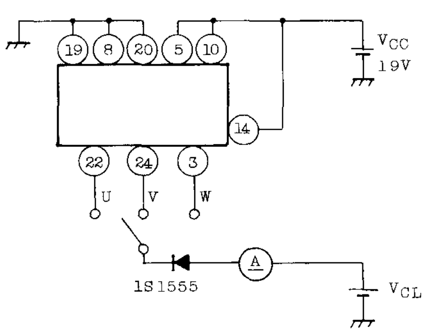
2.



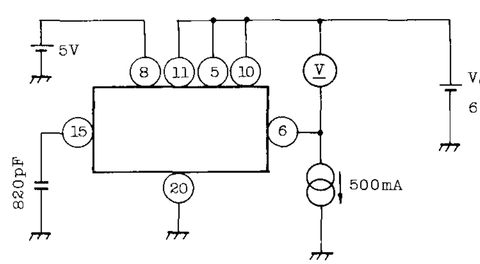
3.



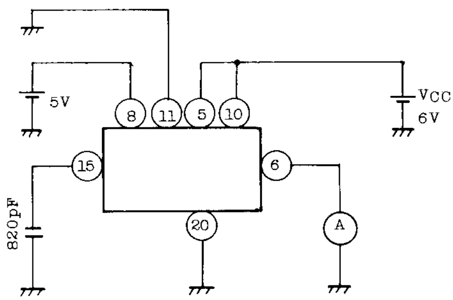
4.



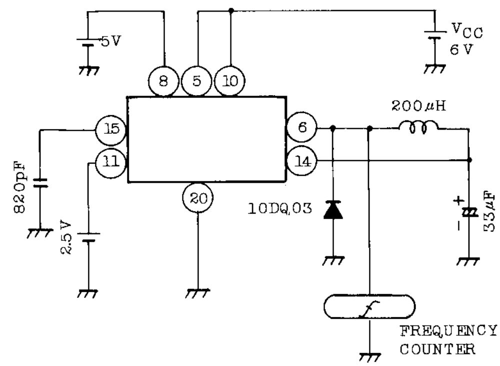
5.



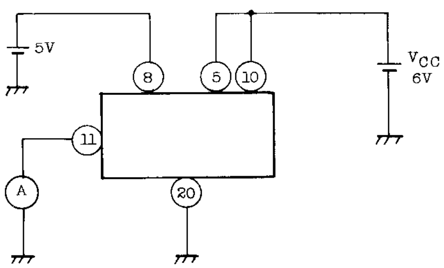
6.


5V
8
11
5
10
VCC
6V
15
6
820pF
20
A

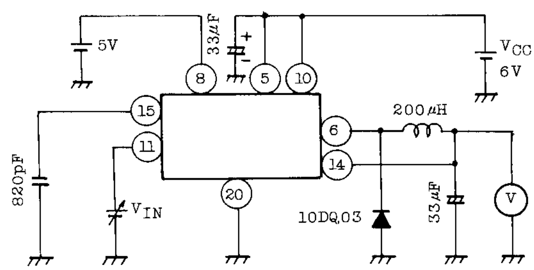
7.


5V
8
5
10
VCC
6V
15
11
6
14
200μH
820pF
2.5V
20
10DQ03
33μF
FREQUENCY
COUNTER

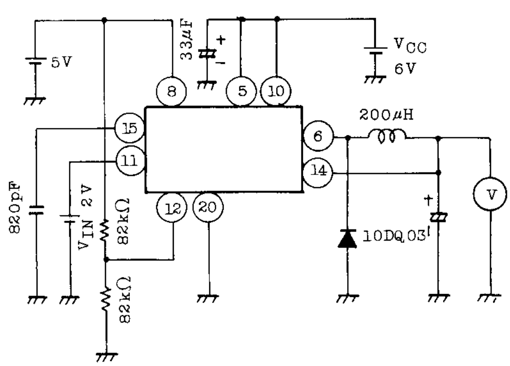
8.


5V
8
5
10
VCC
6V
11
A
20

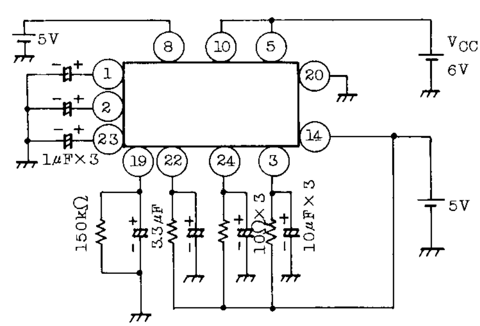
9.


5V
33μF
8
5
10
VCC
6V
15
11
6
14
200μH
820pF
VIN
20
10DQ03
33μF
V

10.


5V
33μF
8
5
10
VCC
6V
15
11
6
14
200μH
12
20
820pF
VIN 2V
82kΩ
82kΩ
10DQ03
V

11.


5V
8
10
5
VCC
6V
1
2
23
20
14
1μF×3
19
22
24
3
150kΩ
3.3μF
10Ω×3
10μF×3
5V

FUNCTION

(A) V_{13}=1.0V

Initial → MODE1 → MODE2 → MODE3 → MODE4 → MODE5 → MODE6

	S_W	S_U	S_V	S_W	S_U	S_V	S_W
W_L	L	L	H	H	H	H	L
V_L	H	H	L	L	H	H	H
U_L	H	H	H	H	L	L	H

(B) V_{13}=GND

Initial → MODE1 → MODE2 → MODE3 → MODE4 → MODE5 → MODE6

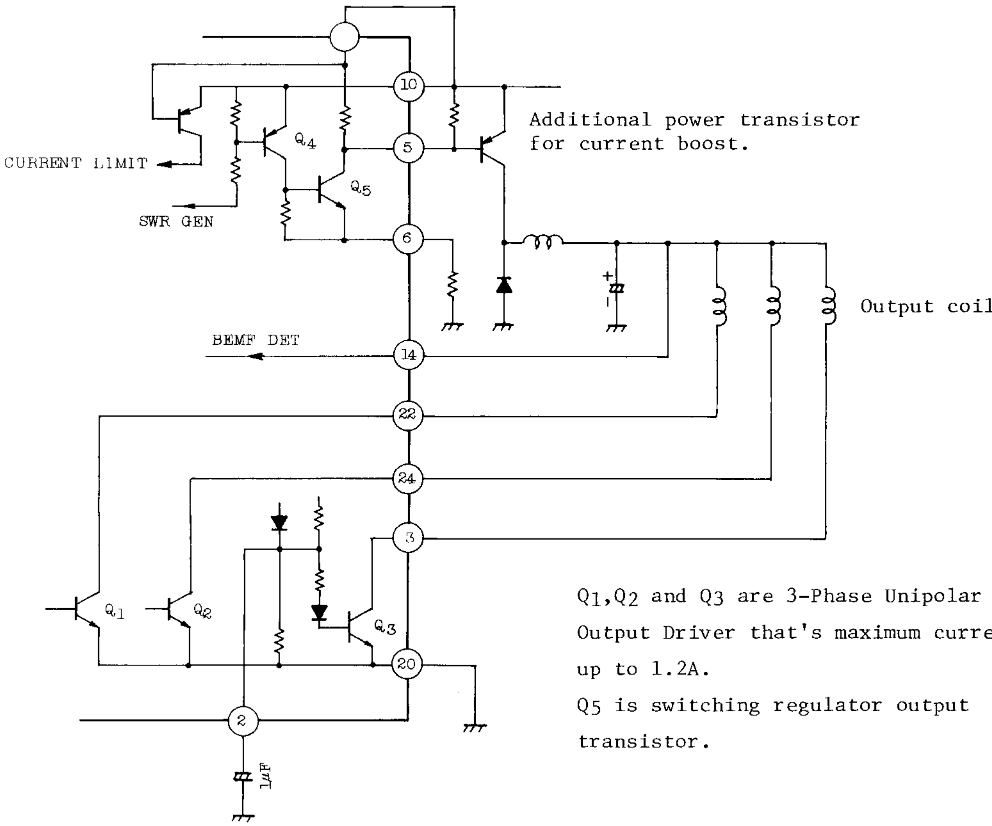
	S_W	S_V	S_U	S_W	S_V	S_U	S_W
W_L	L	L	H	H	H	H	L
V_L	H	H	H	H	L	L	H
U_L	H	H	L	L	H	H	H

TEST CONDITIONS

- Use measuring circuit 3 and V_{CL}=1.5V.
- All switches must be operated momentaly shorted to GND ("L" Level).
- Initializing is obtained with SW "ON" and S_{CL} ON.
- Power switch SV_{CC} and S_{CL} must be held "ON" state until the end of measuring.

INTERNAL CIRCUIT

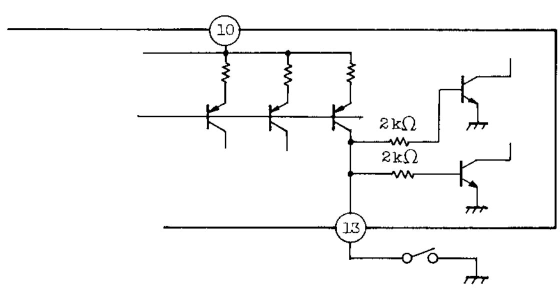
(1) Output Driver/Switching Regulator



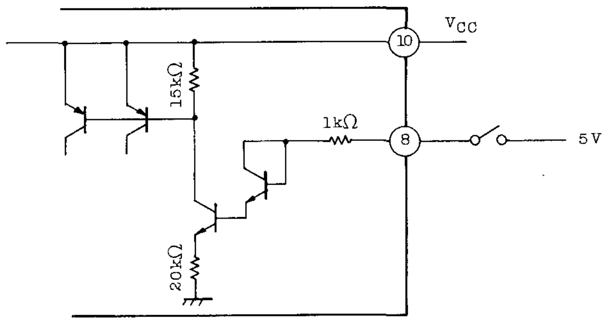
Q_1,Q_2 and Q_3 are 3-Phase Unipolar Output Driver that's maximum current up to 1.2A.

Q_5 is switching regulator output transistor.

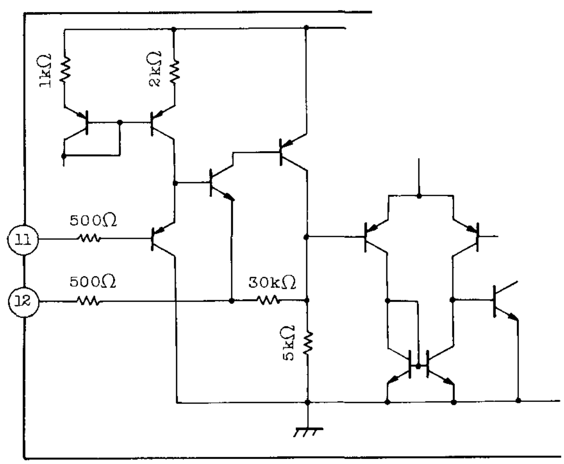
(2) CW/CCW Control Input



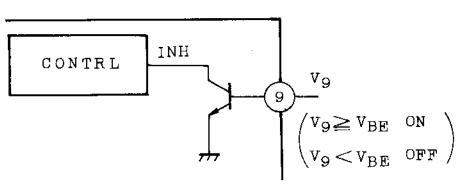
(3) Stand-By Control Input



(4) Control Amplifier



(5) Shut Down Terminal

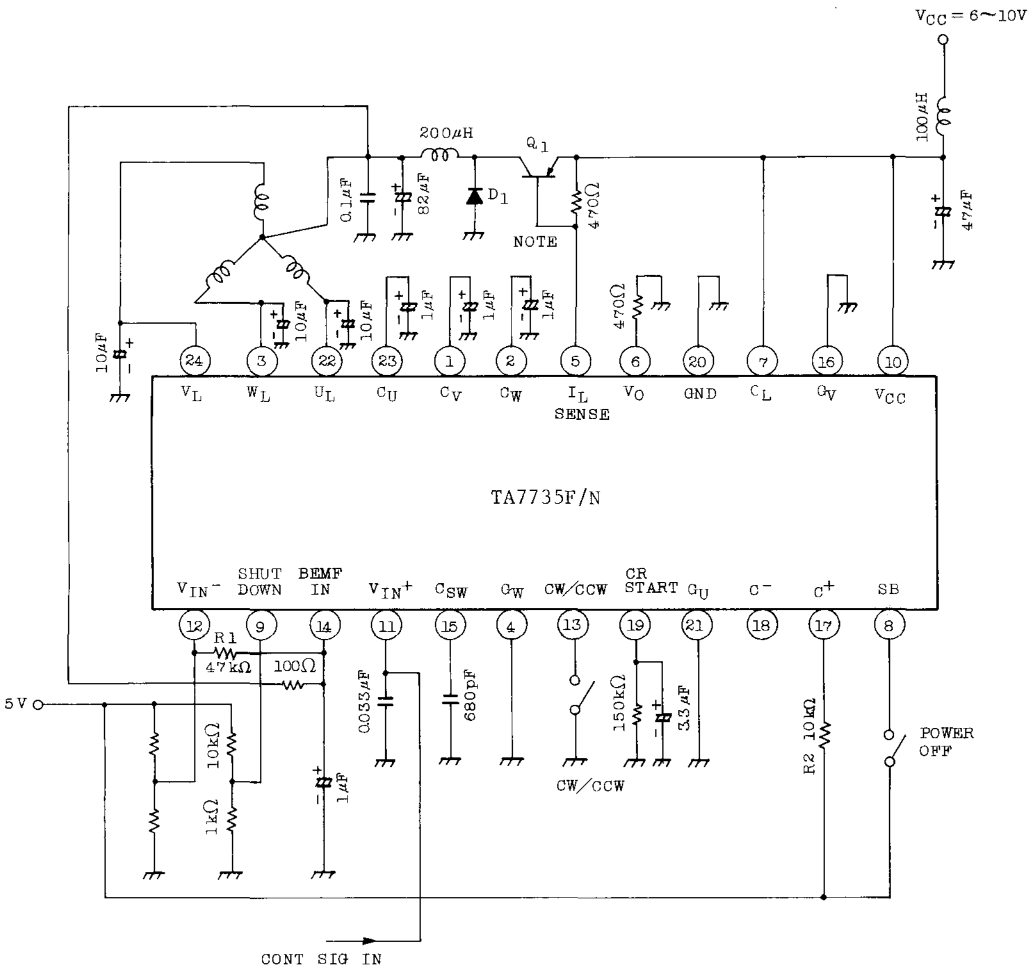


Pin(9)is shut down input for system reset.

Thermal and over voltage shut down are available by using this terminal.

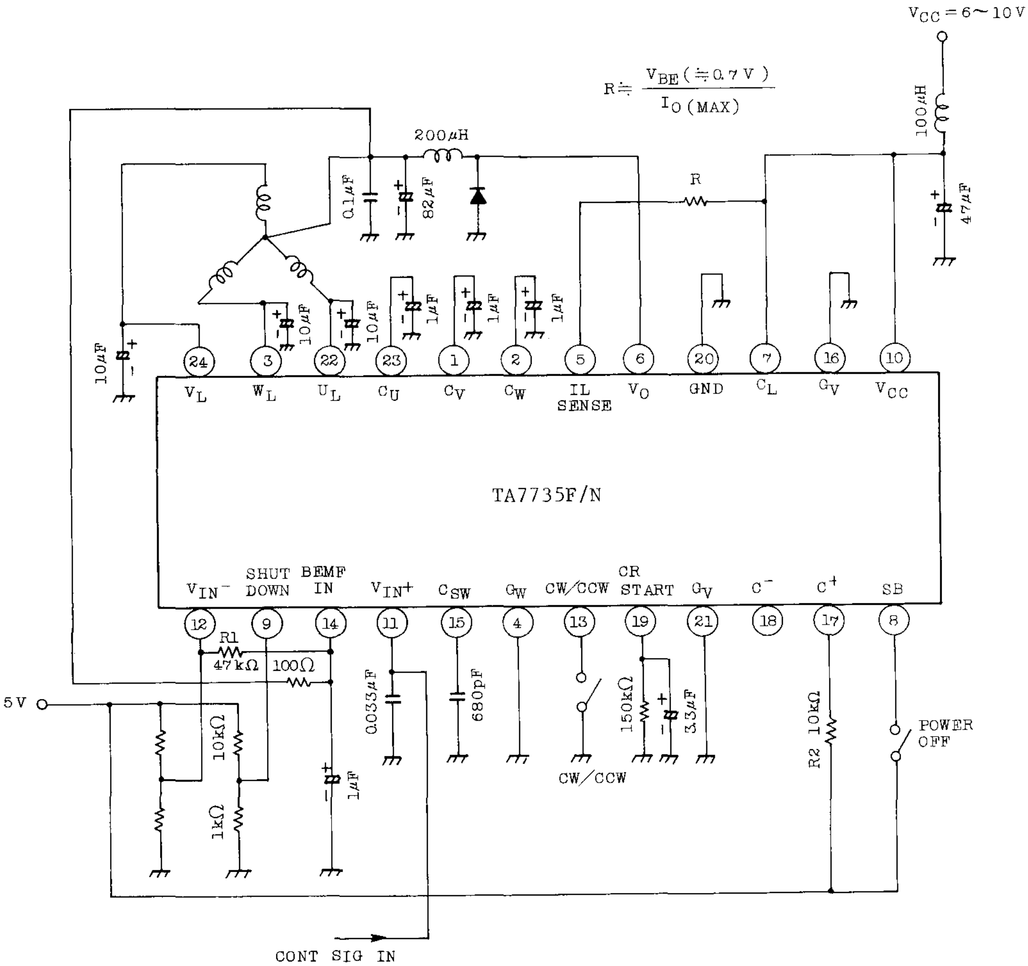
APPLICATION CIRCUIT 1.

(Output Current Boost Application with Feed Back (R_1))



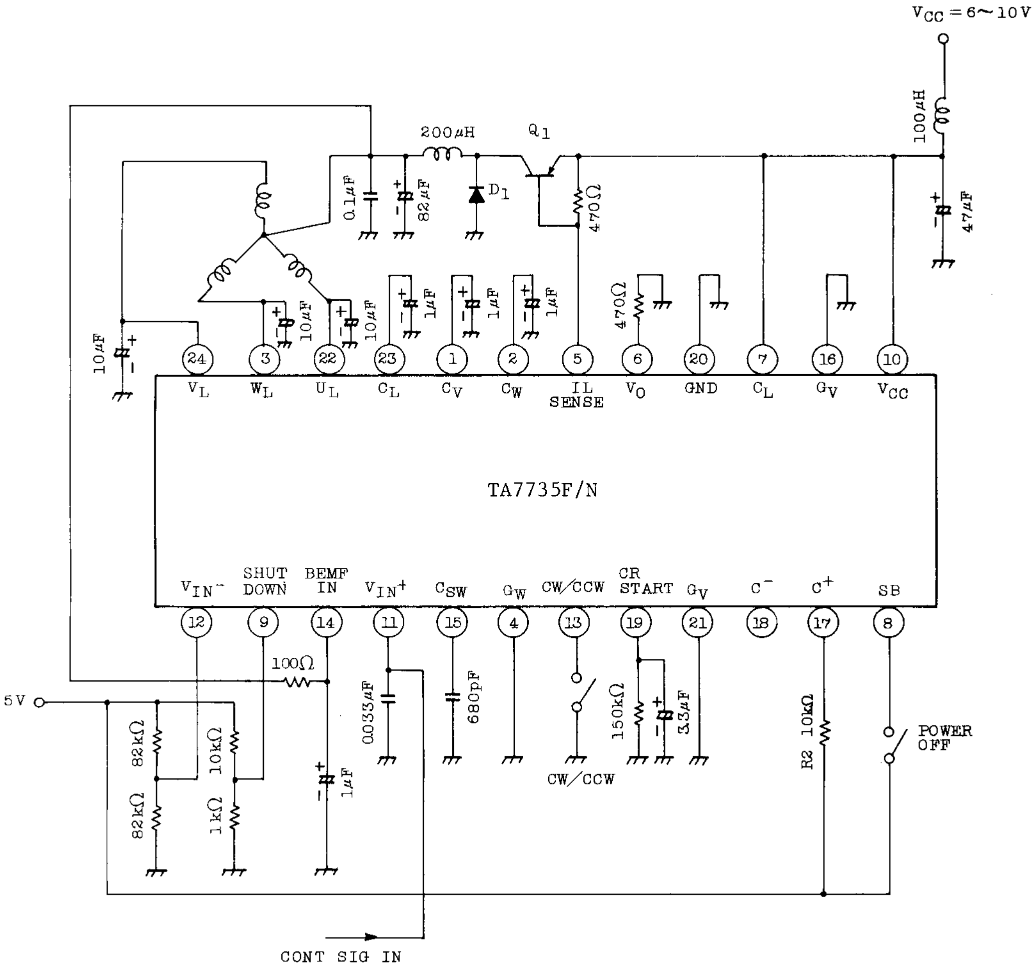
Note : Switching characteristics are required with D_1 and Q_1 for higher efficiency.

APPLICATION CIRCUIT 2.



APPLICATION CIRCUIT 3.

(Output Current Boost Application with No-Local Feed Back)



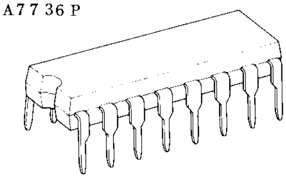
Note: ·Switching characteristics are required with D_1 and Q_1 for higher efficiency.
·This application has no local feed back loop by R_1 (Shown in application circuit 1).

TA7736F/P

DC MOTOR DRIVER IC.

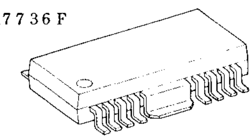
The TA7736P is a 3-phase Bi-directional motor driver IC.
It designed for use VCR, tape deck, floppy disk and record player motor drivers.
It contains output power drivers, position sensing circuits, control amplifier and CW/CCW control circuit.

TA7736P



DIP16-P-300A

TA7736F



HSOP16-P-300

Weight:

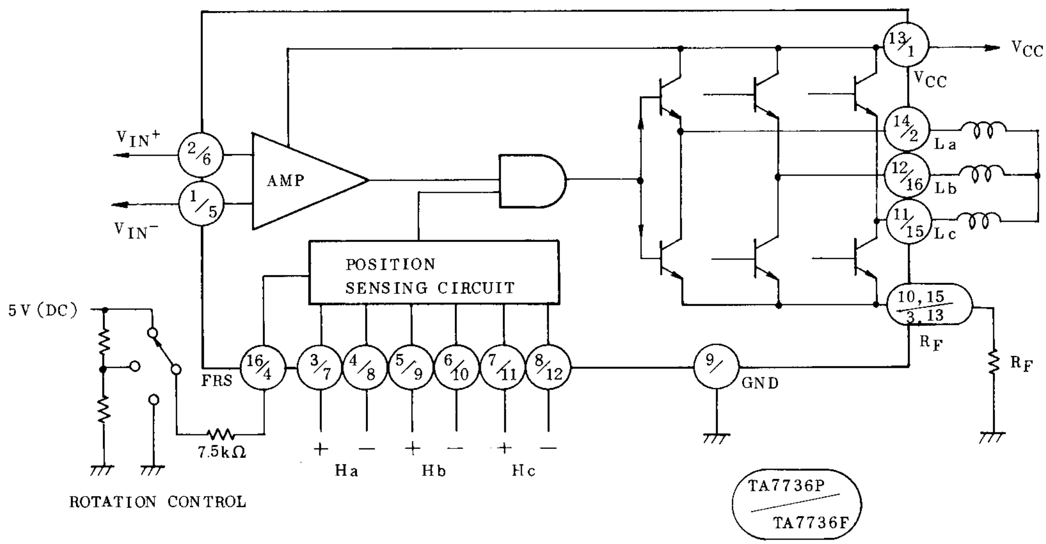
DIP16-P-300A: 1.0g (Typ.)
HSOP16-P-300: 0.5g (Typ.)

. 3-Phase Bi-Directional Driver and Output Current Up to 1.0A.
. Few External Parts Required.
. Wide Operating Supply Voltage Range
  : $V_{CC(opr)}$(Min.)=7V
. Forward and Reverse Rotation is Controlled Simply by Means of a CW/CCW Control Signal Fed Into 16 PIN.
. High Sensitivity of Position Sensing Amplifier. (V_H=10mV(Typ.), Recommend to Use TOSHIBA Ga-As Hall Sensor "THS" Series.)
. Surge Protect Diode Connected for All Input Terminals.
  (Position Sensing, Control, CW/CCW Control Inputs.)

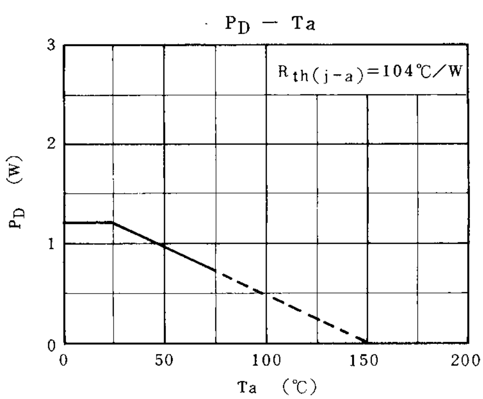
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	26	V
Output Current		$I_{O(AVE)}$	1.0	A
Power Dissipation	TA7736P	P_D	1.2	W
	TA7736F		0.9	
Operating Temperature		Topr	-30~75	°C
Storage Temperature		Tstg	-55~150	°C

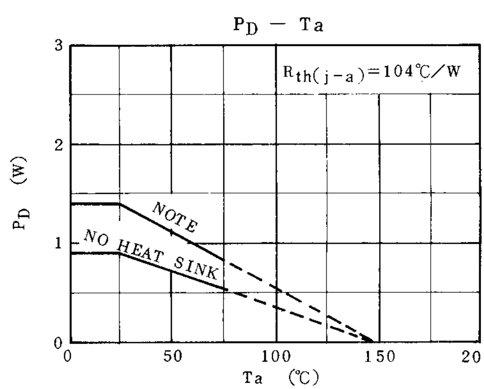
BLOCK DIAGRAM



TA7736P



TA7736F

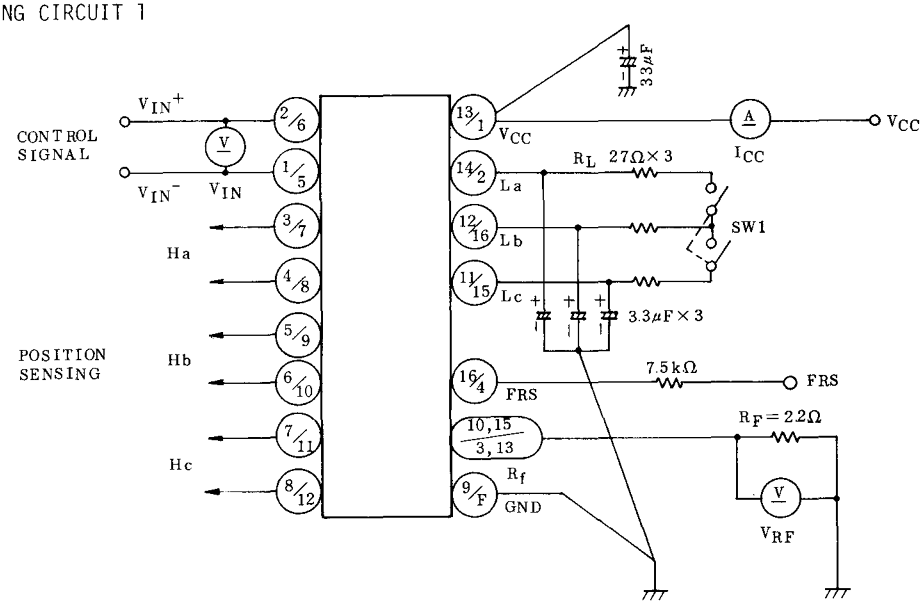


Note 60 × 30 × 1.6mm PCB mounting occupied copper area in excess of 50%.

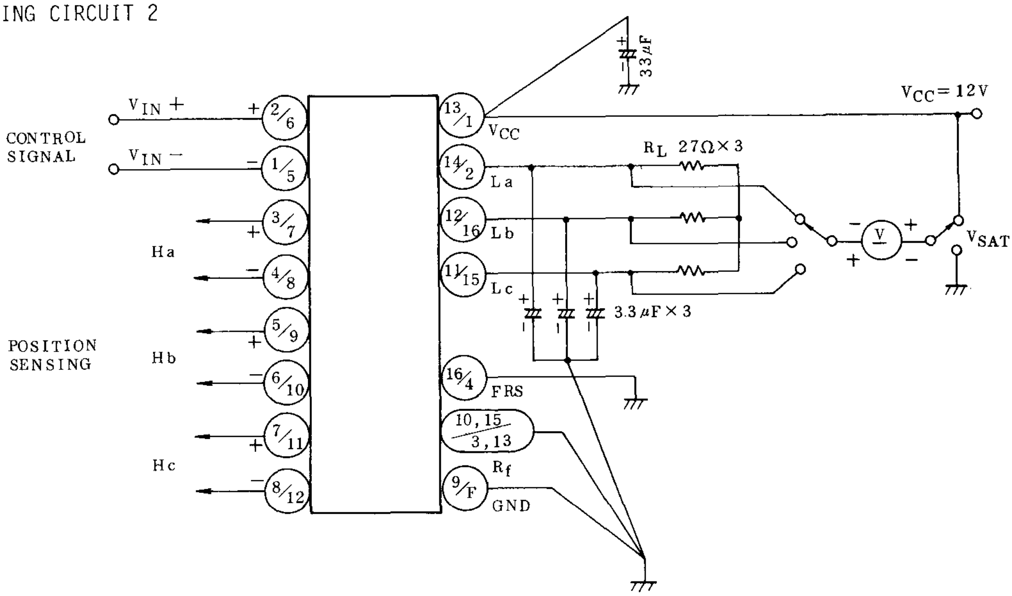
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=12V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC1}	–	FRS=Open	2	4	7	mA
		I_{CC2}		FRS=5V	2	5	9	
		I_{CC3}		V_{CC}=22V, FRS=GND	2	5	9	
Input Offset Voltage		V_{IO}	–		–	40	–	mV
Residual Output Voltage		V_{OR}	–	$V_{IN}^{+}=V_{IN}^{-}$=7V	–	0	10	mV
Voltage Gain		G_V	–	R_{NF}=2.2Ω	–	15	–	times
Saturation Voltage	Upper	V_{SAT1}	–	I_L=400mA	–	1.0	1.5	V
	Lower	V_{SAT2}			–	0.4	1.0	
Cut-off Current	Upper	I_{OC1}	–	V_C=20V	–	–	20	μA
	Lower	I_{OC2}			–	–	20	
Position Sensing Input Sensitivity		V_H	–		–	10	–	mV
Maximum Position Sensing Input Voltage		$V_{H\ MAX}$	–		–	–	400	mV
Input Operating Voltage	Position	CMR-H	–		2.0	–	V_{CC}-2.5	V
	Control	CMR-C	–		2.0	–	V_{CC}-2.5	
Rotation Control Input Voltage	CW	V_F	–		–	0	0.4	V
	STOP	V_S			2.2	2.7	3.2	
	CCW	V_R	–		4.8	5.0	5.8	

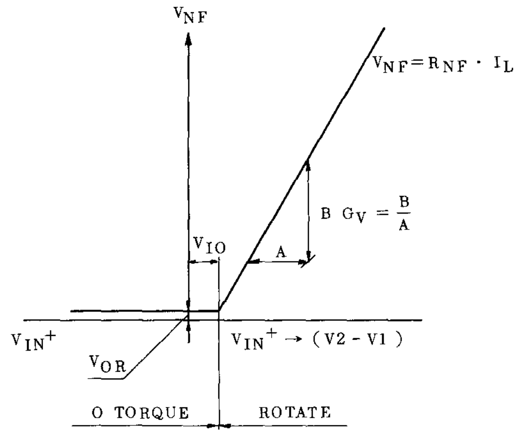
MEASURING CIRCUIT 1



MEASURING CIRCUIT 2



INPUT vs OUTPUT

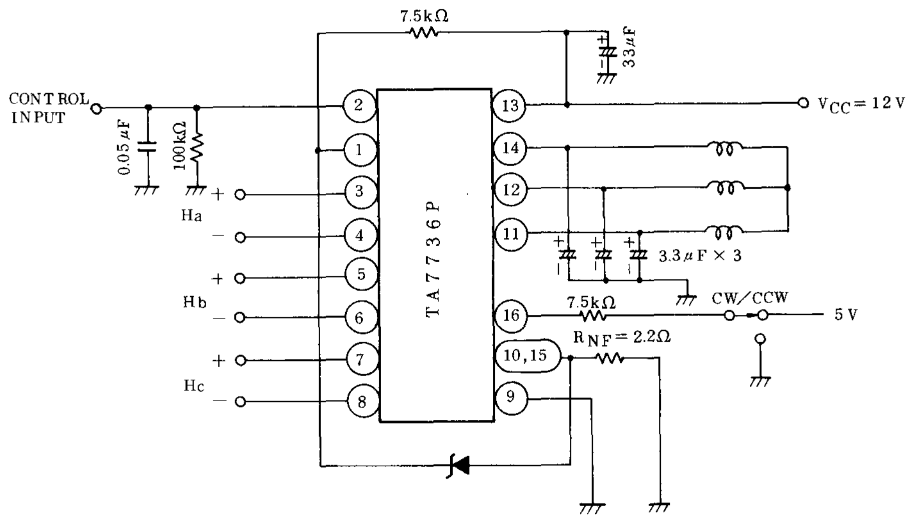


FUNCTION

FRS (16 PIN)	POSITION SENSING INPUT			COIL OUTPUT		
	Ha	Hb	Hc	La	Lb	Lc
L	1	0	1	H	L	M
	1	0	0	H	M	L
	1	1	0	M	H	L
	0	1	0	L	H	M
	0	1	1	L	M	H
	0	0	1	M	L	H
H	1	0	1	L	H	M
	1	0	0	L	M	H
	1	1	0	M	L	H
	0	1	0	H	L	M
	0	1	1	H	M	L
	0	0	1	M	H	L
M	1	0	1	High Impedance		
	1	0	0			
	1	1	0			
	0	1	0			
	0	1	1			
	0	0	1			

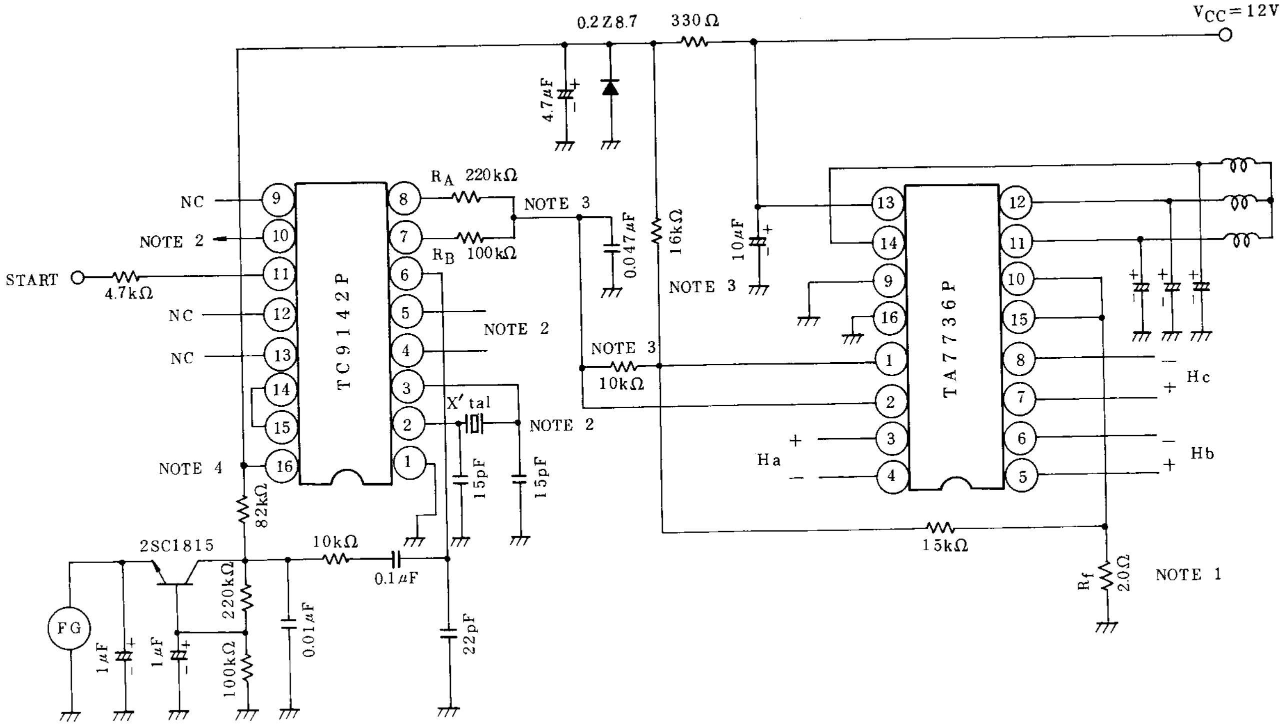
APPLICATION CIRCUIT 1

(BASIC APPLICATION CIRCUIT)



APPLICATION CIRCUIT 2

(TC9142P + TA7736P $3\frac{1}{2}$ PLL FDD)



Note 1. Rf is a feed back Resistor that's voltage drop is equal to Input Voltage (V2-V1) in this application with feed back by Zener Diode.

Note 2. Required X'tal frequency is calculated by following

fx=(no·a/60)·128·20 N=42.6 no·a·N

(at PIN 10 "High" state)

fx=(no·a/60)·128·27 N=57.6 no·a·N

(at PIN 10 "Low" state)

Where no=Required Rotation Speed (rpm)

a=Number of FG pulse (pulse/rotation)

N=Count Down Ratio (4.32 or 128)

PIN 4	PIN 5	N
H	H	32
L	H	128
H	L	4

Note 3. Recommended value of R_A and R_B is 50kΩ to 300kΩ

The combination ratio of F/V and P/V output is designed by changing these value. For example, if you want more F/V conversion gain compare to P/V's one for fast system initial start up. Use a higher value of R_B compare to R_A.

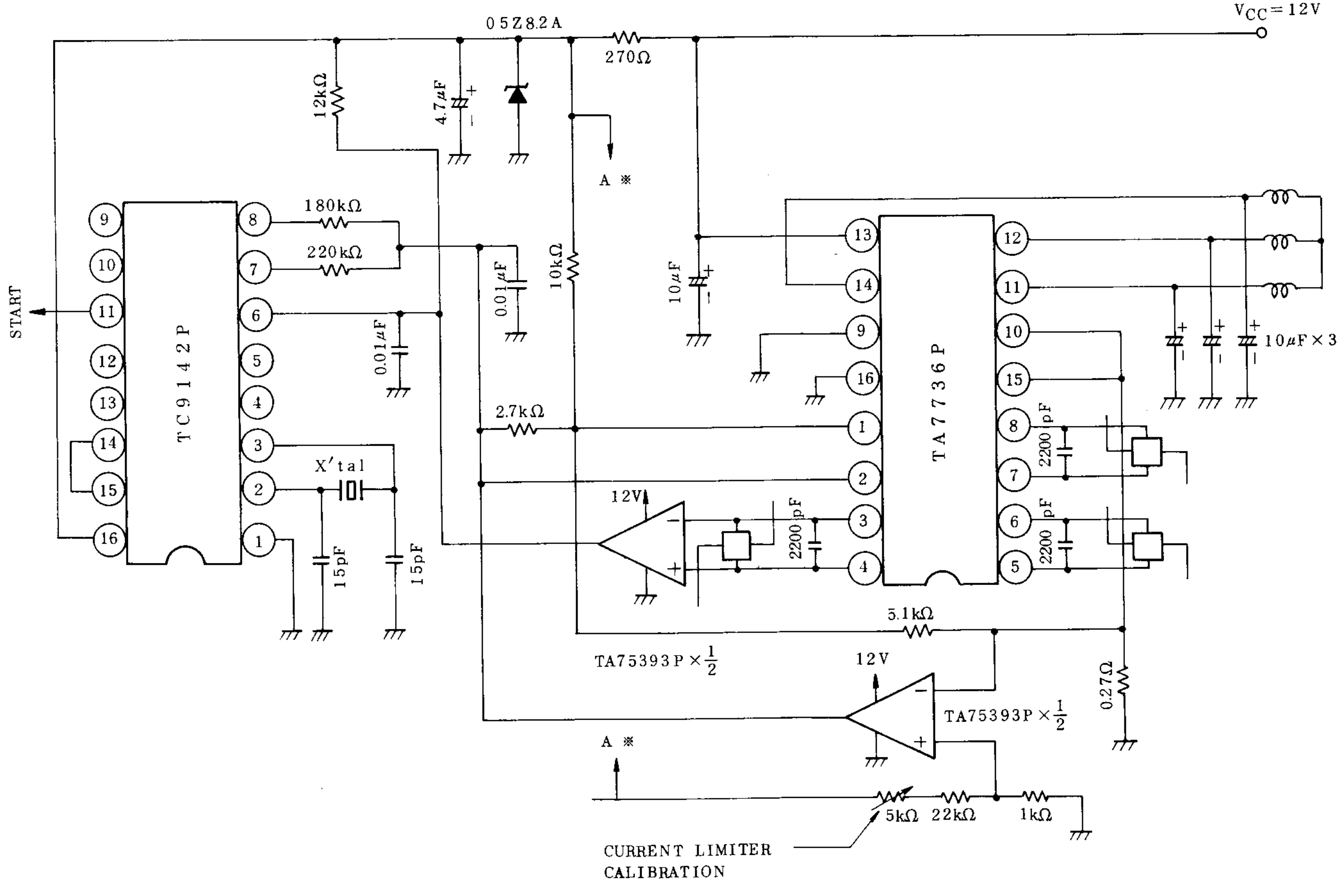
Note 4. TC9142P's FG Amplifier gain is 30dB (Typ.) and required input signal is over 30mVrms.

If the FG doesn't output over this value.

Required a Front Amplifier.

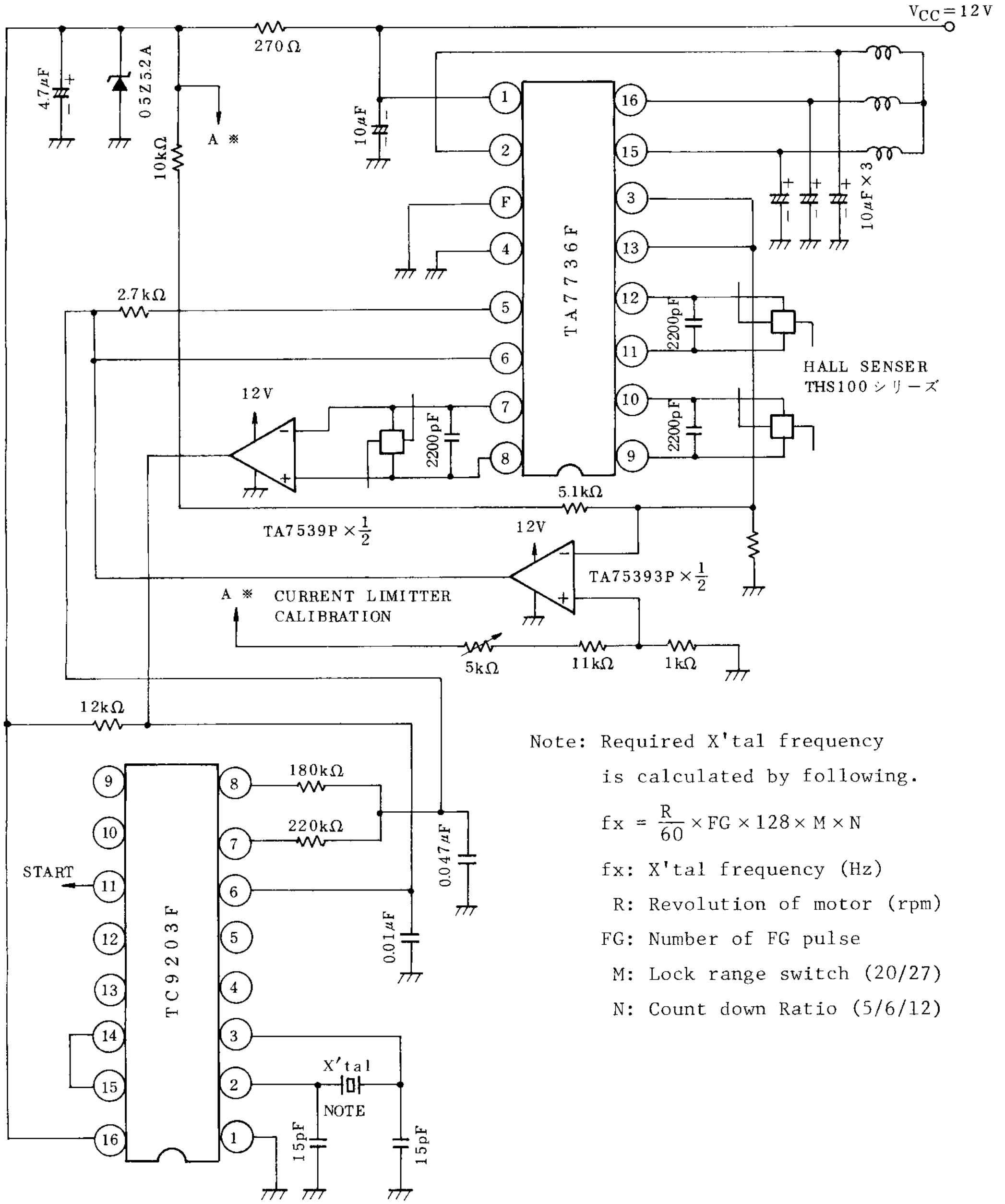
APPLICATION CIRCUIT 3

(TC9142P + TA7736P $3\frac{1}{2}$ PLL WDD)



APPLICATION CIRCUIT 4

(TC9203F + TA7736F 3.5 PLL HDD)



Note: Required X'tal frequency is calculated by following.

$$fx = \frac{R}{60} \times FG \times 128 \times M \times N$$

fx: X'tal frequency (Hz)

R: Revolution of motor (rpm)

FG: Number of FG pulse

M: Lock range switch (20/27)

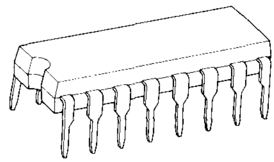
N: Count down Ratio (5/6/12)

TA7745F/P

DC MOTOR DRIVER

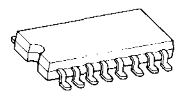
- 3 Phase Power Driver.
- Voltage Control System.
- High Efficiency is Obtaind.
- Capsealded in Flat Package 16 Pin.
- Operating Voltage Range : $V_{CC}=4 \sim 15V$, $V_S=2 \sim 15V$
- High Sensitivity of Position Sensing Inputs and Have a Hysterisis : $V_H=20mV$ (Typ.)
- Output Current : $I_O=1.0A$ (Max.)
- Build in Thermal Shut Down Circuit.
- Forward and Reverse Rotation and Stop Modes are Available by Means of Rotation Control Terminal.

TA7745P



DIP16-P-300A

TA7745F



SSOP16-P-225

MAXIMUM RATINGS (Ta=25°C)

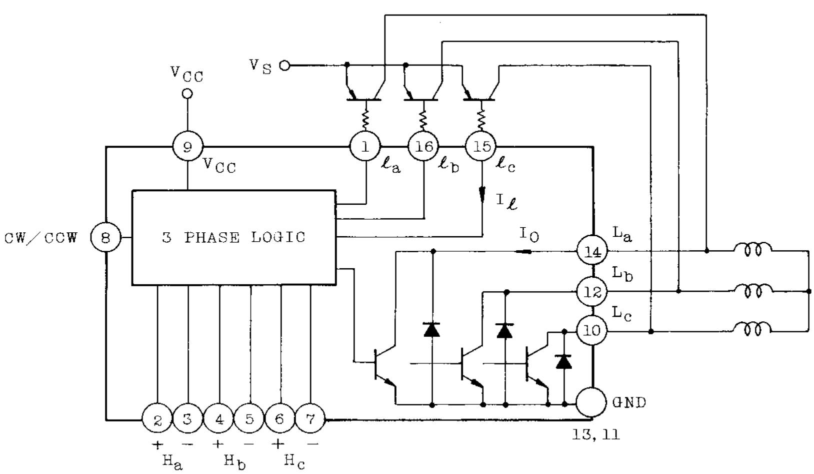
CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	18	V
		V_S	18	V
Output Current	1	I_O	1.0	A
	2	I_ℓ	20.0	mA
Power Dissipation		P_D	350(F)	mW
			Note 550(F)	
			1200(P)	
Operating Temperature		Topr	$-30 \sim 75$	°C
Storage Temperature		Tstg	$-55 \sim 150$	°C

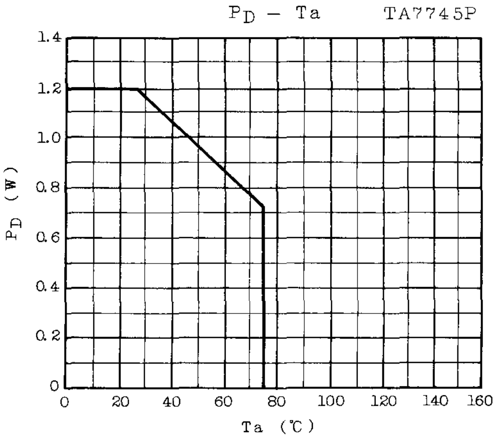
Note : This rating is obtained by mounting on $20 \times 20 \times 0.8$mm PCB that occupied above 60% of copper area.

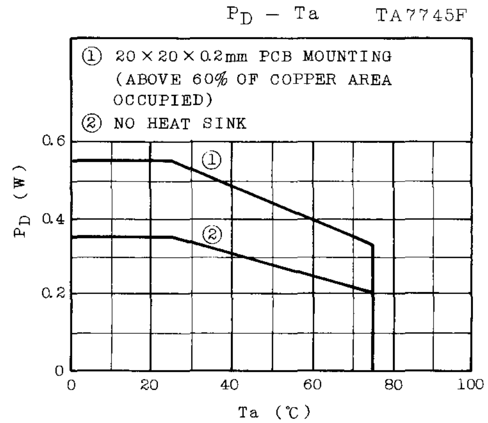
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}		V_{CC}=5V, Output "OPEN"	0.5	1	3.0	mA
		I_{CC2}		V_{CC}=9V, Output "OPEN"	0.6	1.3	3.5	
		I_{CC3}		V_{CC}=12V, Output "OPEN"	0.7	1.5	5.0	
Saturation Voltage	La, Lb, Lc Side	$V_{S\ L-1}$		I_O=0.1A	-	0.12	0.3	V
		$V_{S\ L-2}$		I_O=0.5A	-	0.5	1.0	
	ℓa, ℓb, ℓc, Side	$V_{S\ U}$		$I_ℓ$=1.0mA	-	-	0.2	
Position Sensing Input	Sensitivity	V_H			-	20	-	mV
	Operating DC Level	CMR-H			1	-	V_{CC} -1.5	V
Diode Forward Voltage		V_F		I_F=1A	-	2.0	-	V
Rotation Control Input Voltage	Forward	V_{FWR}		Source Current Mode	3.9	-	V_{CC}	V
	Stop	V_{STP}		No Current Flow	1.8	-	2.8	
	Reverse	V_{RVS}		Sink Current Mode	0	-	2.1	
Saturation Voltage Differencial		ΔV_S		I_O=200mA	-	-	50	mV
Leakage Current		I_L		V=18V	-	-	50	μA

BLOCK DIAGRAM

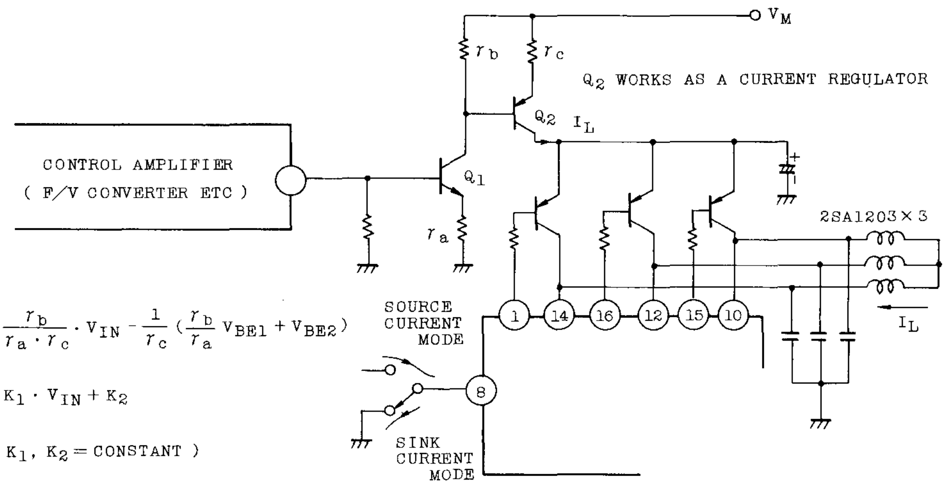






APPLICATION CIRCUIT 1

(3-PHASE Bi-Pola DRIVE)



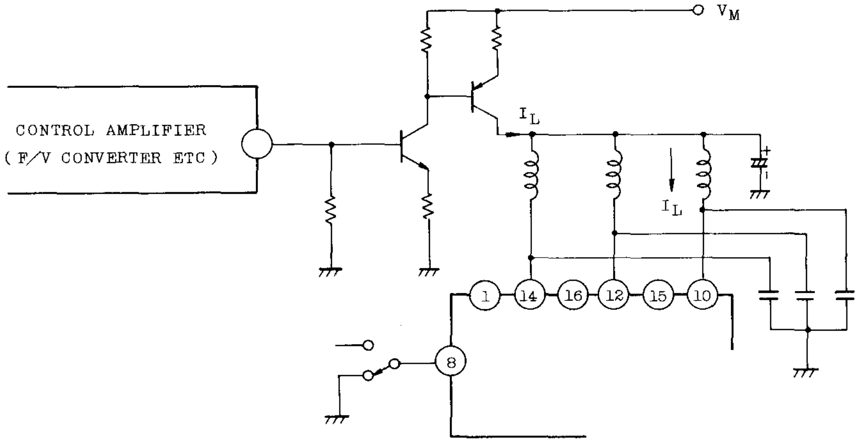
$$I_L \fallingdotseq \frac{r_b}{r_a \cdot r_c} \cdot V_{IN} - \frac{1}{r_c}\left(\frac{r_b}{r_a} V_{BE1} + V_{BE2}\right)$$

$$\fallingdotseq K_1 \cdot V_{IN} + K_2$$

(K_1, K_2 = CONSTANT)

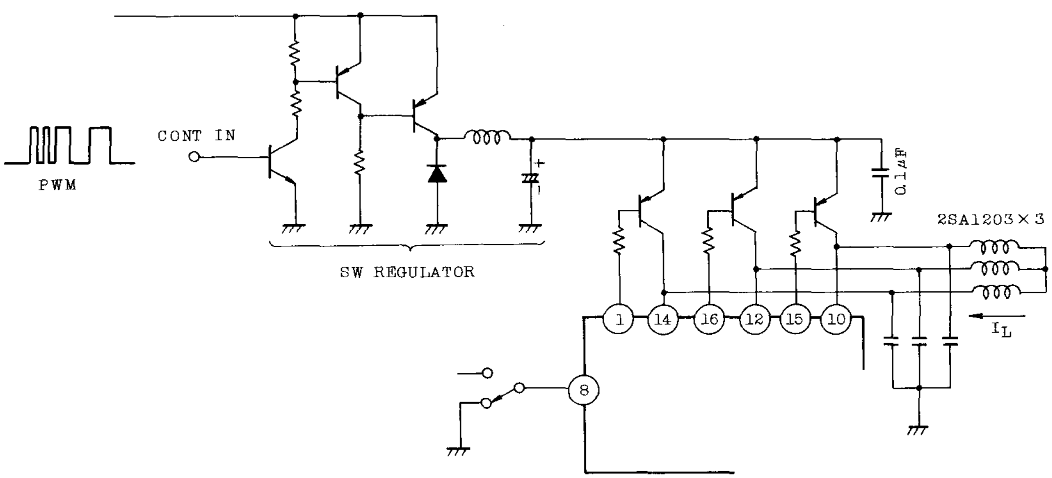
APPLICATION CIRCUIT 2

(3-PHASE UNI-Pola DRIVE)



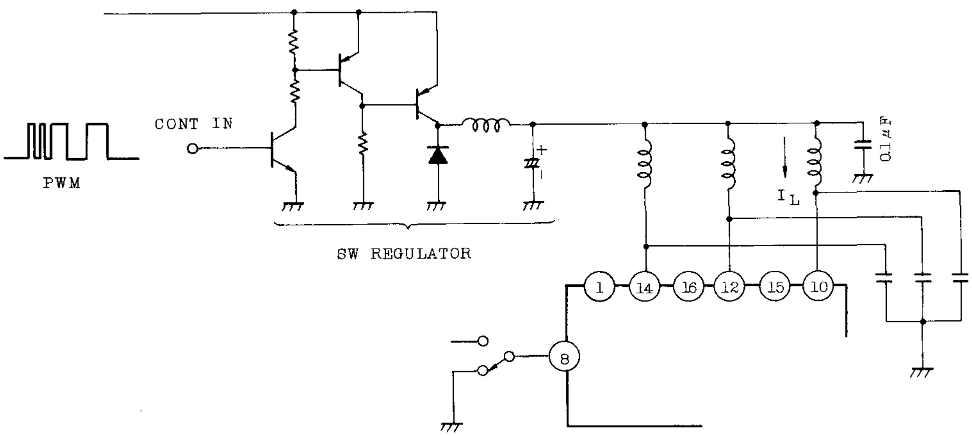
APPLICATION CIRCUIT 3

(HIGH EFFICIENCY DRIVE (UNI-Pola))



APPLICATION CIRCUIT 4

(HIGH EFFICIENCY DRIVE (Bi-Pola))

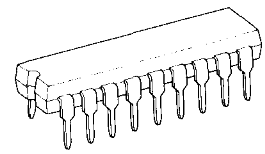


TA7759P

DC MOTOR CONTROLLER

TA7759P is a MOTOR CONTROLLER IC designed especially for FDD and WDD Spindle Motor Control.
It consists of Position Sensing Circuit, One Shot Multi Vibrator type F/V Conversion Amplifier and Output Pre-driver.

- 4 Phase Half Wave Type
- No Frequency Generator Required
- Wide Range of Operating Supply Voltage
  : V_{CC} opr=6 ~ 18V



Weight: 1.4g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	25	V
Output Current	I_O	10	mA
Regulator Output Current	I_{CC2}	10	mA
Position Sensing Input Voltage	V_H	* 400	mV
Power Dissipation	P_D	1.2	W
Operating Temperature	T_{opr}	-30~85	°C
Storage Temperature	T_{stg}	-55~150	°C

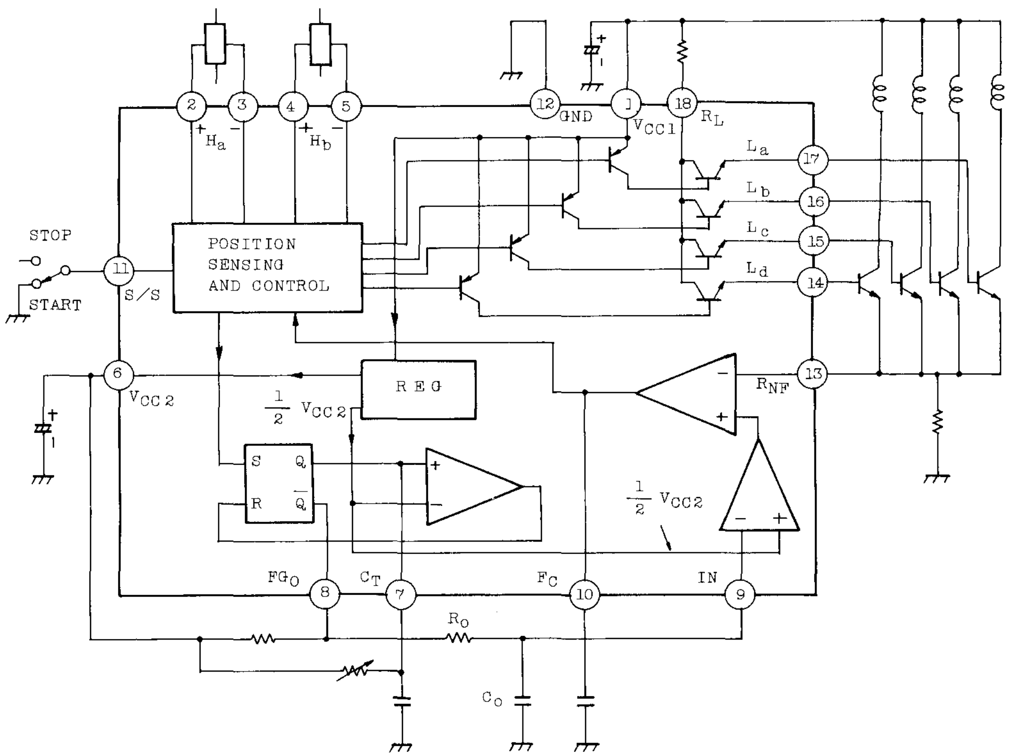
* Tj=25°C

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=12V, Rf=0.5Ω, Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current			I_{CC1}		Output open	–	3.9	5.5	mA
			I_{CC2}		V_{CC}=24V, Output open	–	5.0	–	mA
Saturation Voltage			V_{SAT1}		I_O=10mA (14),(15),(16),(17) Pin	–	1.0	1.6	V
			V_{SAT2}		I_O=1mA (14),(15),(16),(17) Pin	–	0.6	–	V
Leakage Current			I_L		V_{CE}=24V (14),(15),(16),(17) Pin	–	–	100	μA
Position Sensing Input	Common Mode Range		CMR			2.0	–	V_{CC}−2.0	V
	Input Sensitivity		V_H			–	5	–	mV
Regulator	Output Voltage		V_{CC2}		(6) Pin open	4.5	5.1	5.7	V
	Line Regulation		Reg In		I_{CC2}=0~4mA Tj=25°C	–	30	100	mV
	Temperature Coefficient		T_{CVO}		Ta=−30~85°C	–	−3.5	–	mV/°C
START/STOP Input (Pin (11))	Operating Voltage	"H"	V_{IN} "H"			1.0	–	V_{CC}+0.3	V
		"L"	V_{IN} "L"			−0.3	–	0.4	V
	Input Current		I_{IN} S/S		V_{IN}=1V	–	17	40	μA
Voltage Gain			GV		Pin (9) to Pin (13)	–	14	–	dB

BLOCK DIAGRAM



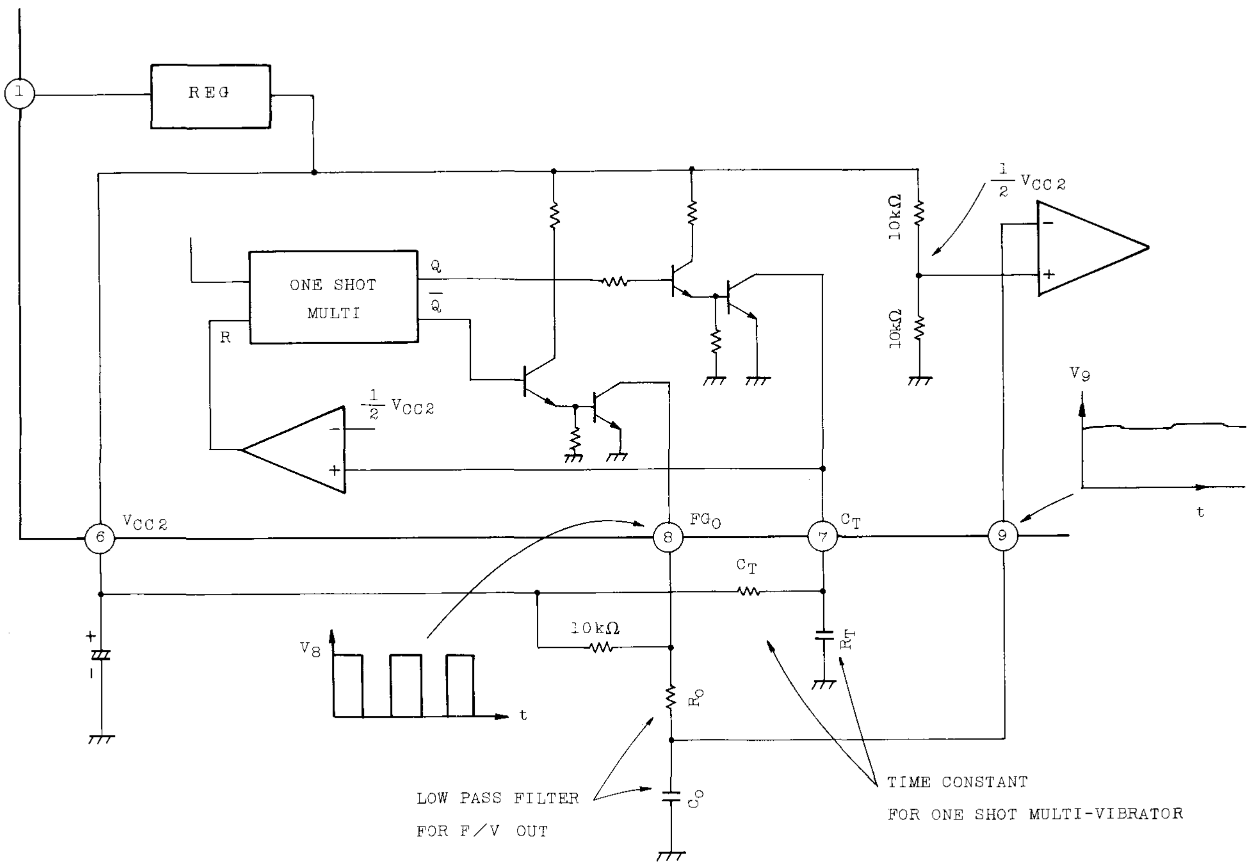


Fig. ONE SHOT MULTI-VIBRATOR SECTION

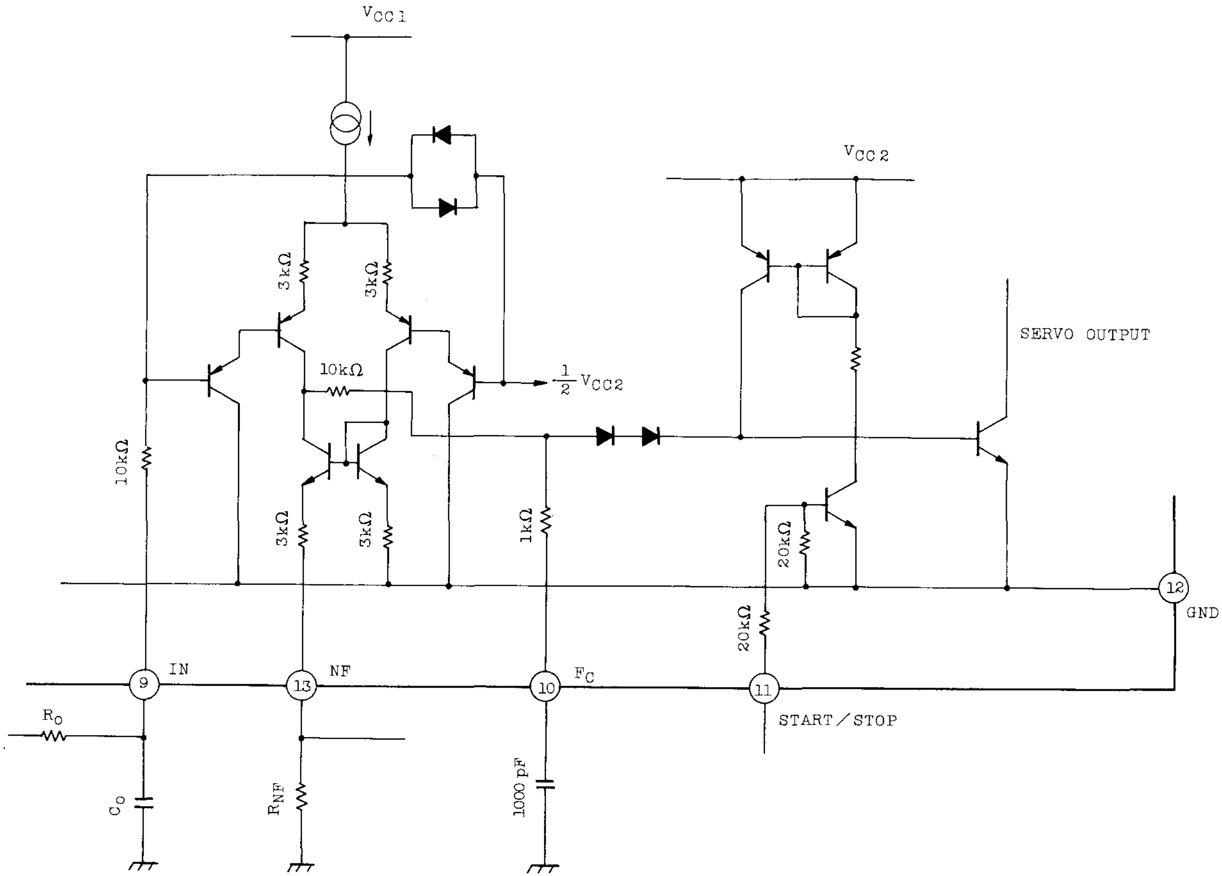


Fig. CONTROL SECTION

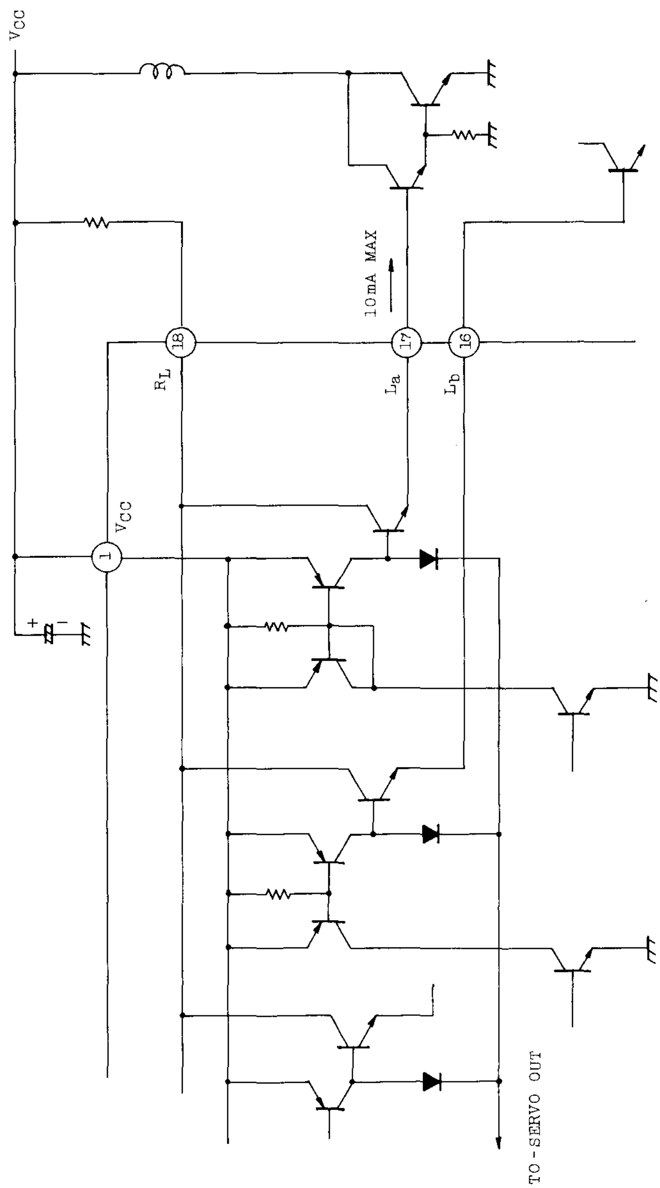
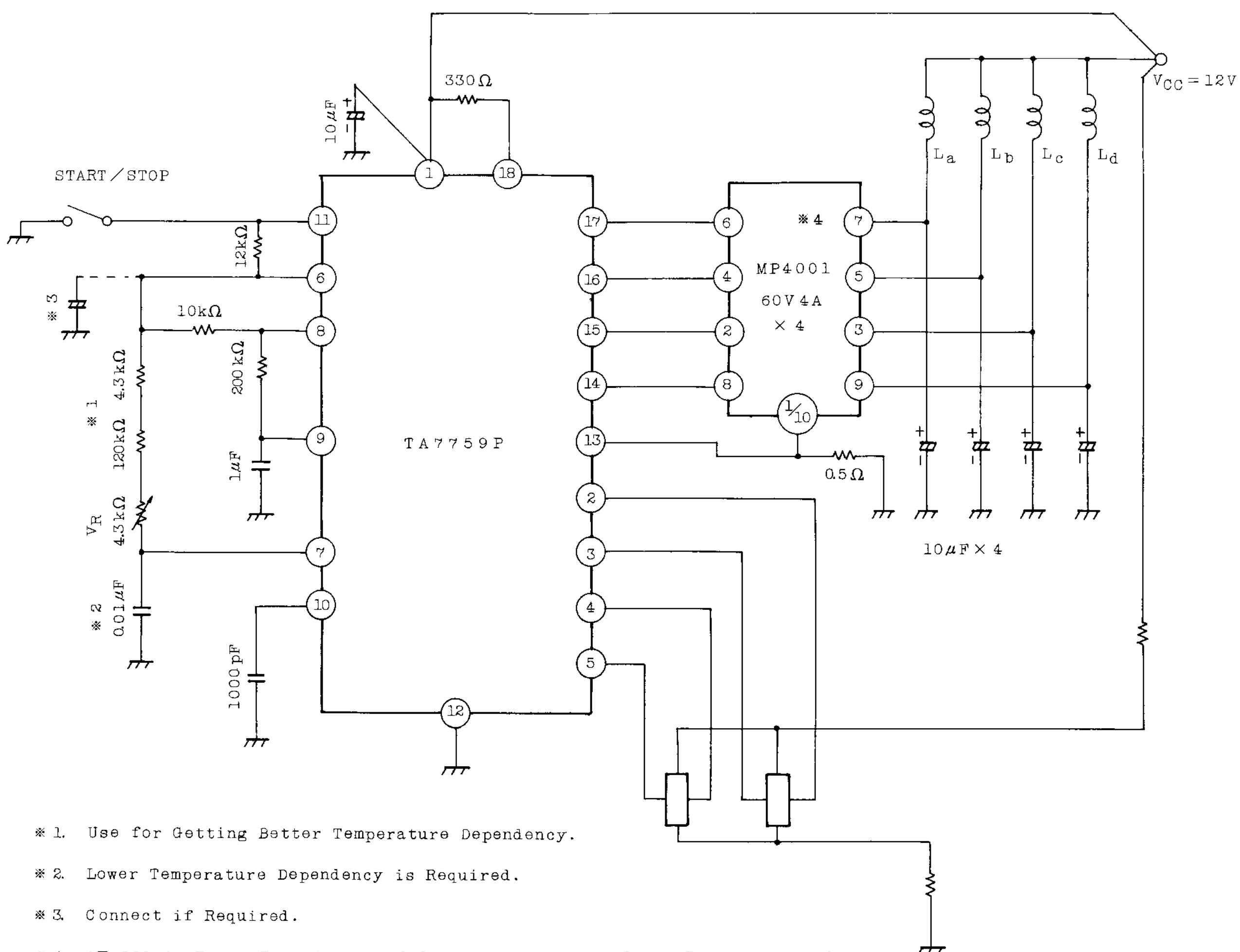


Fig. OUTPUT SECTION

APPLICATION CIRCUIT ($5\frac{1}{4}$ WDD)



※ 1. Use for Getting Better Temperature Dependency.

※ 2. Lower Temperature Dependency is Required.

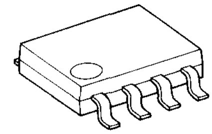
※ 3. Connect if Required.

※ 4. MP4001 is Power Transistor Module that contains 4 Power Transistors of 60V 4A Voltage and Current Ratings.

TA7768F

TA7768F is designed for small motor speed control, and is suitable for DC motor speed control in a portable equipment, such as cassette recorder, radio cassette, etc.

. Small Flat Package
. Low Voltage Operating
  Operating Supply Voltage Range : V_{CC}=1.0~5.0V



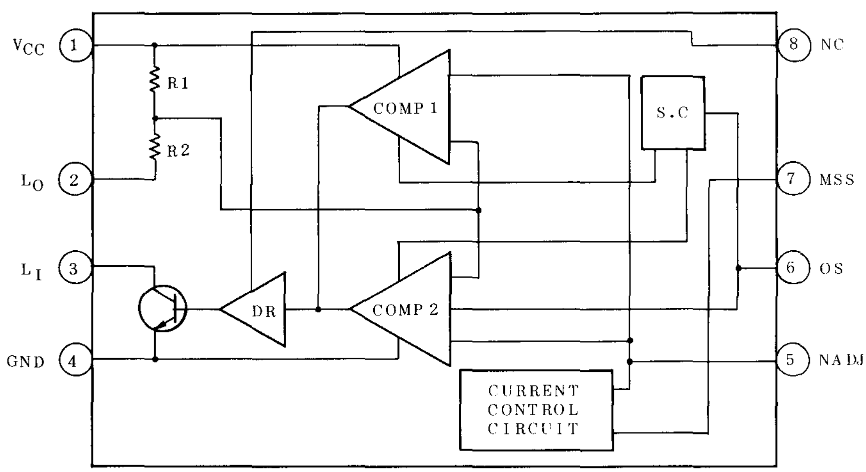
SOP8-P-225

Weight : 0.1g(Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{CC}	6	V
Output Current	$I_{O\ MAX}$	750	mA
Power Dissipation	P_D	240	mW
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~150	°C

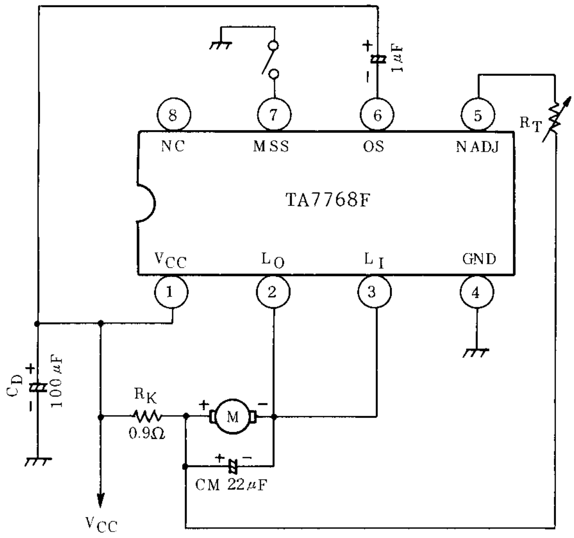
BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS ($Ta=25°C$, $V_{CC}=3.0V$)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Power Supply Current	I_{CC}	-	Output Open	1.5	3.0	4.5	mA
Starting Current	I_{MS}	-		500	-	-	mA
Output Saturation Voltage	V_{CE}	-	$I_O=200mA$	-	-	0.2	V
Rotating Fluctuation	Δ_N	-	$V_{CC}=2.1\sim3.0$	-	-	±0.8	%
Reference Current	Iref	-		24.8	33.0	43.5	μA
Reference Current Fluctuation 1	ΔI_{ref1}	-	$V_{CC}=2.1\sim3.6V$	-	-	1.5	%
Reference Current Fluctuation 2	ΔI_{ref2}	-	$I_O=50\sim300mA$	-	2.5	-	%
Reference Current Fluctuation 3	ΔI_{ref3}	-	$Ta=-25\sim75°C$	-	2.5	-	%

APPLICATION CIRCUIT



$R_K=0.25\cdot R_m$

$$R_T = \frac{Ea}{5\cdot I_{ref}}$$

Note:

R_m=D/C Resistance of motor

Ea=Counter-electromotive force

APPLICATION

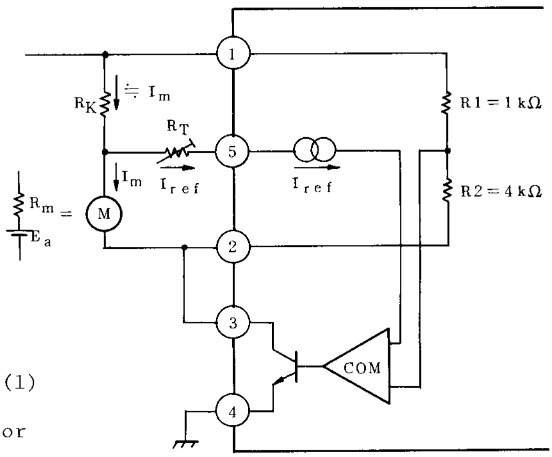


Fig. 1

Equivalent circuit of Motor is discribed by serial connection with equivalent DC resistance R_m (usually Motor coil DC resistance) and voltage source Ea (counter-electromotive force) which is propotional to motor rolation, as shown in Fig.1.

When V1-2, the voltage between ① and ② pins of TA7768F is set,

$$V_{1-2} \quad R_K \cdot I_m + R_m \cdot I_m + E_a \text{ .... } (1)$$

Input balancing condition of the comparator

$$R_K \cdot I_m + R_T \cdot I_{ref} = V_{1-2} \cdot \frac{R1}{R1+R2} \text{ ...}(2)$$

From (1) and (2)

$$k \cdot (R_K \cdot I_m + R_m \cdot I_m + E_a) = R_K \cdot I_m + R_T \cdot I_{ref}$$

$$k = \frac{R1}{R1+R2} = \frac{1}{1+4} = 0.2$$

$$k(R_K+R_m) = R_K \text{ .... } (3)$$

$$R_T \cdot I_{ref} = k \cdot E_a$$

$$E_a = 5 \cdot R_T \cdot I_{ref} \text{ .... } (4)$$

For TA7768F application, R_K should be firstly fixed considering Motor DC resistance R_m by using the formula (3).

Then counter-electromotive force Ea at necessary rotation is calcurated by Ea-rotation characteristics. And R_T is finally given throught the formula (4).

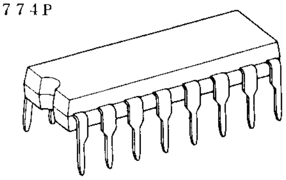
TA7774F/P

STEPPING MOTOR DRIVER IC

TA7774P/F is 2-phase Bipolar stepping motor driver IC designed especially for 3.5 or 5.25 inches FDD head actuator drives.
It consists of TTL compatible input circuit, dual bridge driver outputs with flyback diodes, changing circuit of motor coil drive voltage (Power saving circuit) and stand-by circuit.

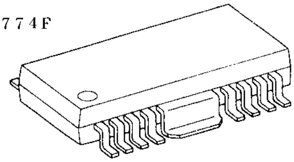
. One Chip 2-Phase Bipolar Stepping Motor Driver.
. Power Saving and Stand-by Operation are available.
  I stand-by (I_{CC3}) $\leq$115μA
. Build-in Punch Through Current Restriction Circuit for System Reliability and Noise Suppression.
. TTL Compatible Inputs
. Surface Mount is available with F Type.
. Output Current up to 0.4A (peak)

TA7774P



DIP16-P-300A

TA7774F



HSOP16-P-300

Weight:

DIP16-P-300A: 1.11g (Typ.)
HSOP16-P-300: 0.50g (Typ.)

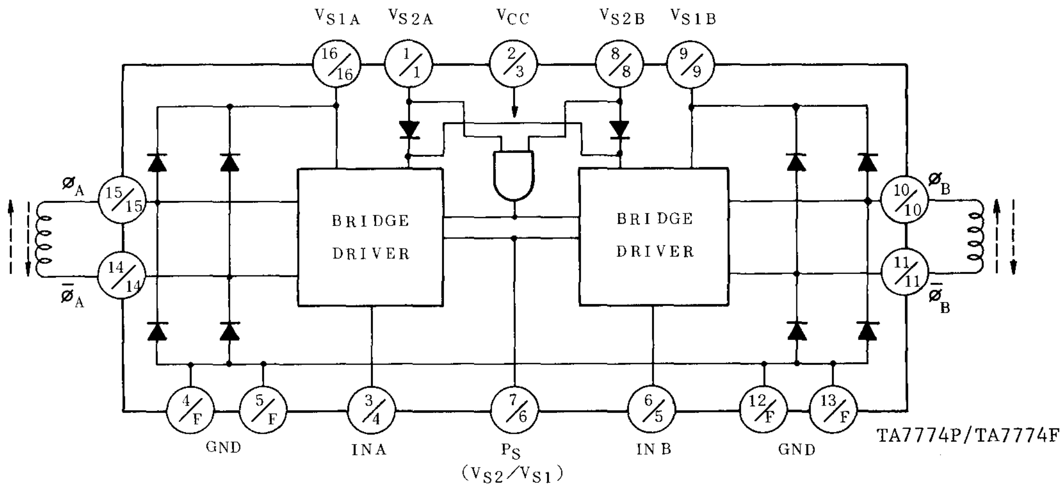
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	7.0	V
		V_{S1}	17.0	
		V_{S2}	~V_{CC}	
Output Current		I_{O} peak	±400	mA
		I_{O} seek	±350	
		I_{O} hold	±100	
Input Voltage		V_{IN}	~V_{CC}	V
Power Dissipation	TA7774P	P_D	1.4	W
			2.7(Note 1)	
	TA7774F		1.4(Note 2)	
Operating Temperature		T_{opr}	-30~75	°C
Storage Temperature		T_{stg}	-55~150	°C

Note 1. This value is obtained by 50 × 50 × 0.8mm PCB mounting occupied copper area in excess of 60%.

Note 2. This value is obtained by 60 × 30 × 1.6mm PCB mounting occupied copper area in excess of 50%.

BLOCK DIAGRAM



Note: Pin 2,7,12,13 of TA7774F are all NC
and Heat Fin is connected to GND.

LOGIC

INPUT		OUTPUT		
PS	IN	ϕ	$\bar{\phi}$	STATE
L	L	L	H	Enable V_{S1}
L	H	H	L	Enable V_{S1}
H	L	L	H	Enable V_{S2}
H	H	H	L	Enable V_{S2}

V_{S2a}	V_{S2b}	STATE
L	*	Power Off (stand-by)
*	L	Power Off (stand-by)
H	H	Operation

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, Ta=25°C, V_{CC}=5V, V_{S1}=12V, V_{S2}=5V)

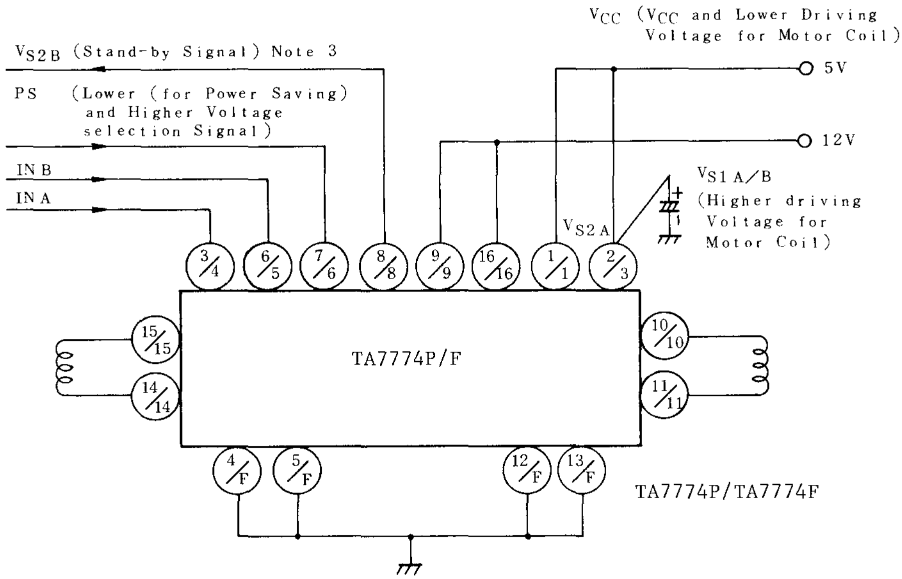
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Supply Current	I_{CC1}	1	PS:H, V_{S2}:H		–	9	14	mA
	I_{CC2}		PS:L, V_{S2}:H		–	8.5	13	
	I_{CC3}		V_{S2}:L		70	90	115	μA
Input Operating Voltage	V_{IN} H		Tj=25°C, V_{S2}:H	3 , 6 PIN	2.0	–	V_{CC}	V
	V_{IN} L				GND	–	0.8	
	V_{PS} H			7 PIN	2.0	–	V_{CC}	
	V_{PS} L				GND	–	0.8	
	V_{VS2} H			8 PIN	2.0	–	V_{CC}	
	V_{VS2} L				GND	–	0.4	
Input Current	I_{IN}	1	Tj=25°C, V_{S2}:H V_{IN}/PS:Sink Current	3 , 6 PIN	–	2.6	30	μA
	I_{PS}			7 PIN	–	2.6	30	
Output Saturation Voltage	V_{SAT1H1}	2	PS:L, V_{S2}:H	I_{OUT}=100mA	–	0.9	–	V
	V_{SAT1H2}			I_{OUT}=400mA	–	1.2	1.5	
	V_{SAT2H1}	3	PS:L, V_{S2}:H	I_{OUT}=20mA	–	1.6	–	
	V_{SAT2H2}			I_{OUT}=100mA	–	1.8	2.1	
	V_{SATL1}		V_{S2}:H	I_{OUT}=20mA	–	0.03	–	
	V_{SATL2}	2		I_{OUT}=100mA	–	0.15	–	
	V_{SATL3}			I_{OUT}=400mA	–	0.35	0.6	
Diode Forward Voltage	V_F U	4	I_F=350mA		–	1.5	–	V
	V_F L				–	1.0	–	
Delay Time	t_{pLH}		IN–φ		–	7	–	μs
	t_{pHL}				–	2	–	
Operating Voltage	$V_{CC(opr)}$				4.5	5.0	7.0	V

Recommendable Operating Voltage $V_{S1(opr.)}$ 12V±10%

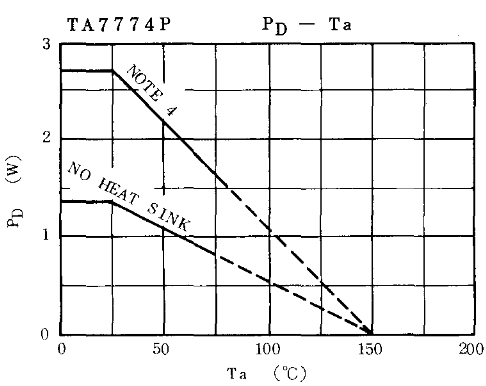
$V_{S2(opr.)}$ 5V±10%

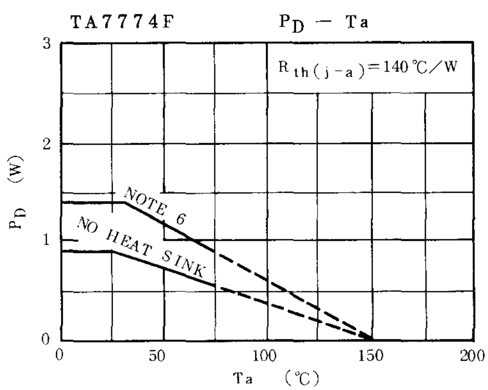
Operating Voltage Restriction $V_{S1} \geqq V_{S2}$

BASIC APPLICATION CIRCUIT



Note 3. Stand-by state is also available by V_{CC} power off with this application.

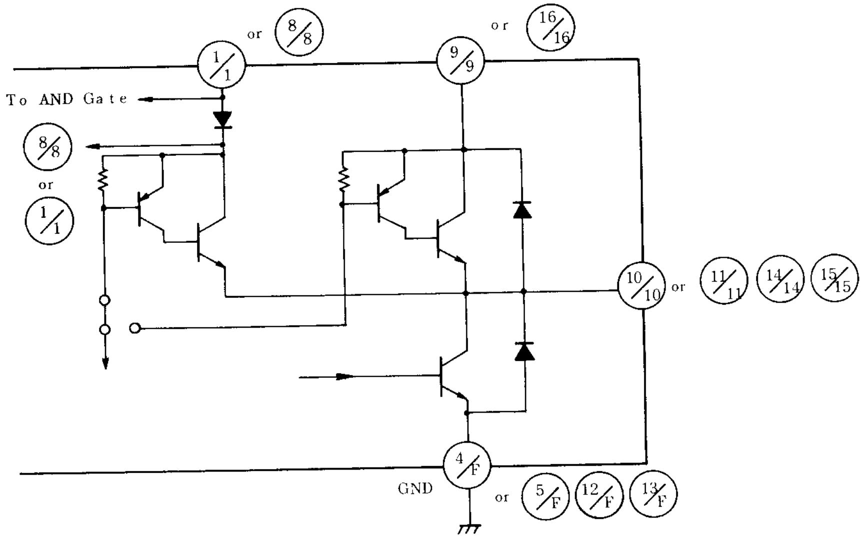




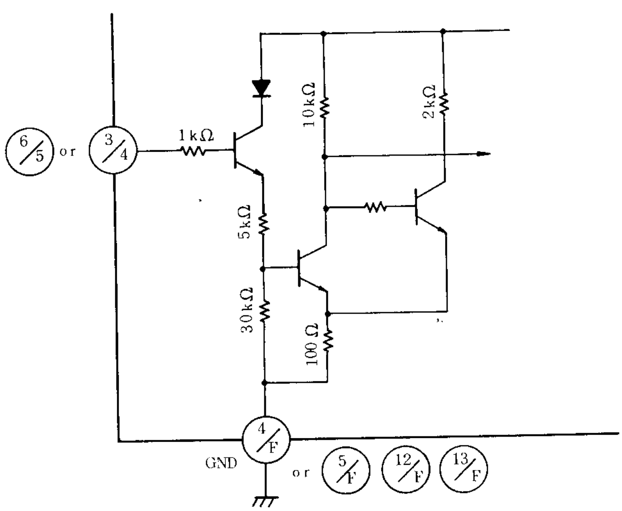
Note 4. 50 × 50 × 0.8mm PCB mounting occupied copper area in excess of 60%.

Note 5. 60 × 30 × 1.6mm PCB mounting occupied copper area in excess of 50%.

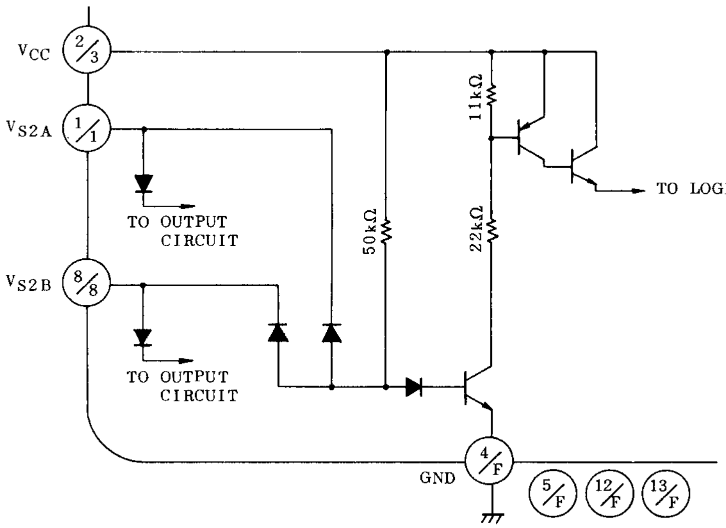
OUTPUT CIRCUIT



INPUT CIRCUIT IN A, IN B

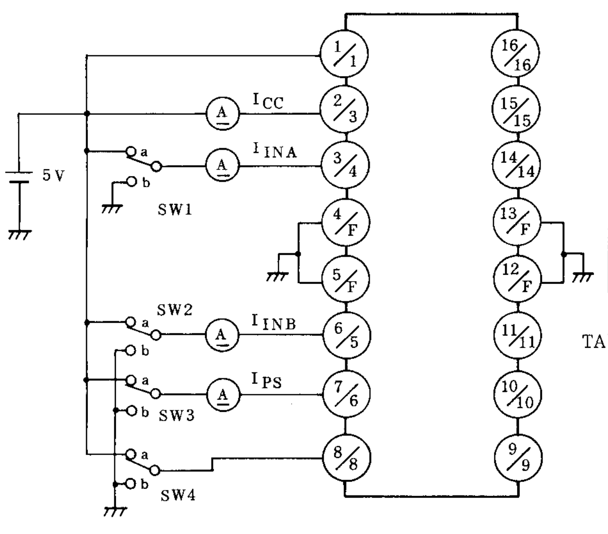


INPUT CIRCUIT V_{S2A} or V_{S2B}



MEASURING CIRCUIT 1

I_{CC1}, I_{CC2}, I_{CC3}, $I_{IN\ A}$, $I_{IN\ B}$, I_{PS}

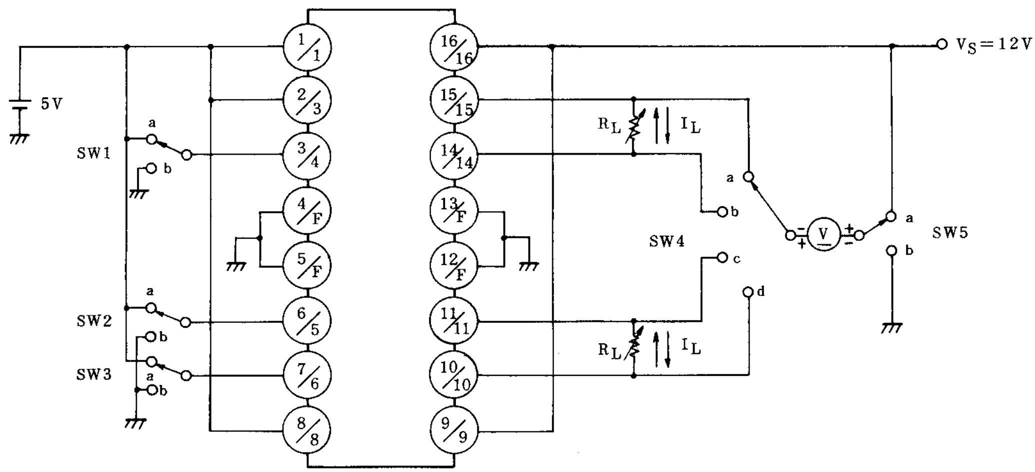


ITEM	SW1	SW2	SW3	SW4
I_{CC1}	b	b	a	a
I_{CC2}	b	b	b	a
I_{CC3}	b	b	–	b
I_{INA}	a	–	–	a
I_{INB}	–	a	–	a
I_{PS}	–	–	a	a

TA7774P/TA7774F

MEASURING CIRCUIT 2

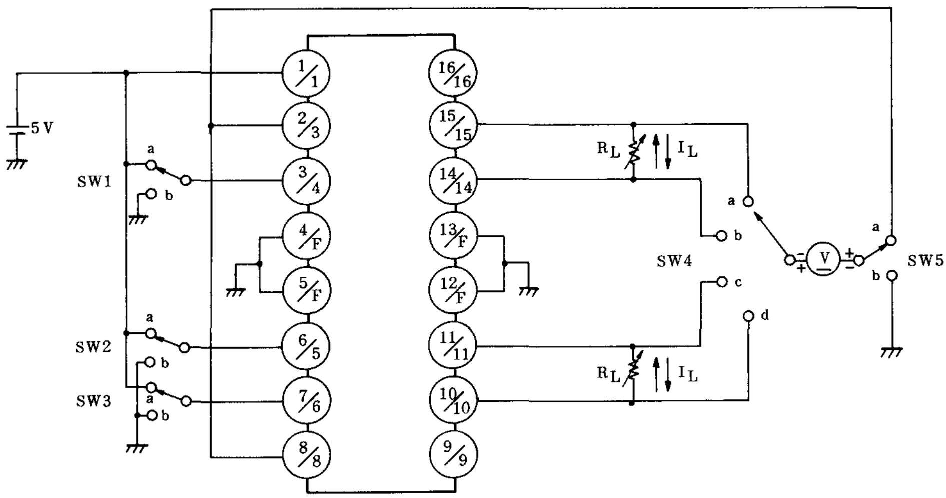
V_{SAT1H1}, V_{SAT1H2}, V_{SATL2}, V_{SATL3}



ITEM	SW1	SW2	SW3	SW4	SW5	I_L (mA)
V_{SAT1H1}	a	–	b	a	a	100
	b	–		b		
	–	a		d		
	–	b		c		
V_{SAT1H2}	a	–	b	a	a	400
	b	–		b		
	–	a		d		
	–	b		c		
V_{SAT2H1}	a	–	–	b	b	100
	b	–		a		
	–	a		c		
	–	b		d		
V_{SAT2H2}	a	–	b	b	b	400
	b	–		a		
	–	a		c		
	–	b		d		

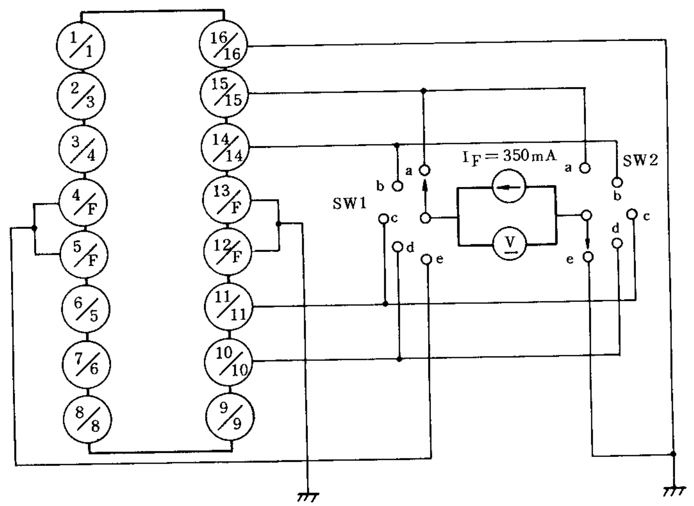
MEASURING CIRCUIT 3

V_{SAT2H1}, V_{SAT2H2}, V_{SATL1}



ITEM	SW1	SW2	SW3	SW4	SW5	I_L (mA)
V_{SAT2H1}	a	–	a	a	a	20
	b	–		b		
	–	a		c		
	–	b		d		
V_{SAT2H2}	a	–	a	a	a	100
	b	–		b		
	–	a		c		
	–	b		d		
V_{SATL1}	a	–	a	b	b	20
	b	–		a		
	–	a		c		
	–	b		d		

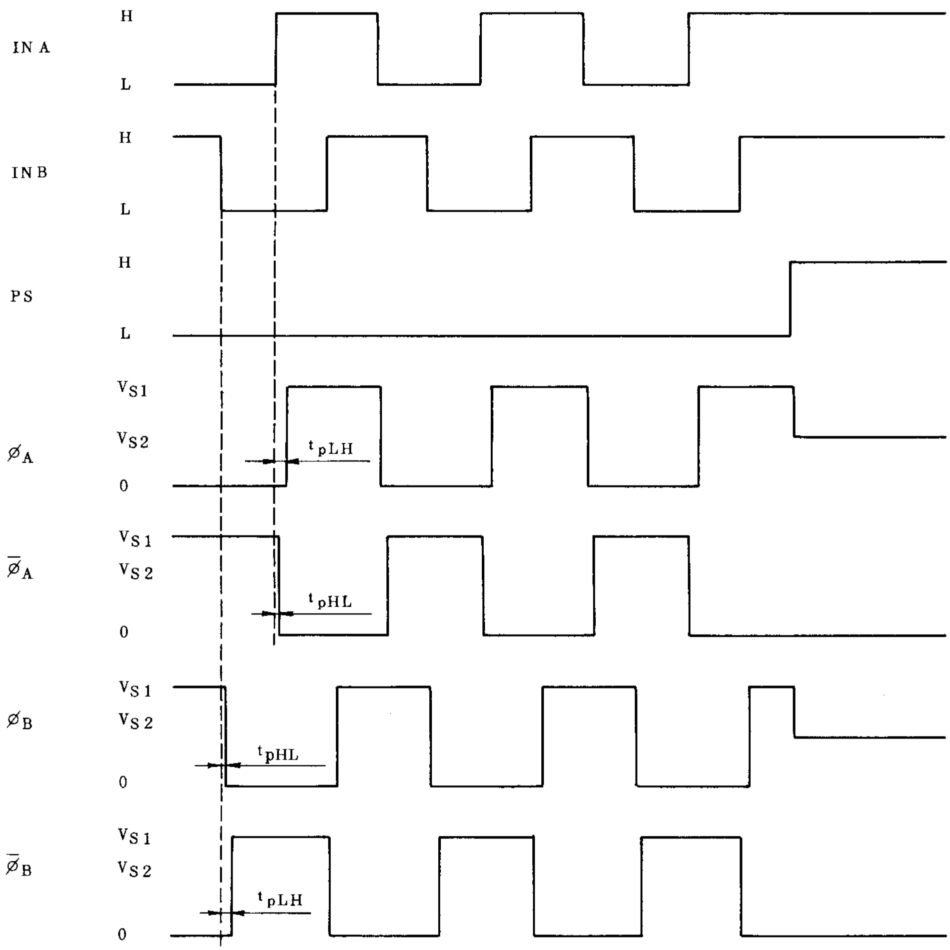
MEASURING CIRCUIT 4 V_{FU}, V_{FL}



MEASURING METHOD

ITEM	SW1	SW2
V_{FU}	a	e
	b	
	c	
	d	
V_{FL}	e	a
		b
		c
		d

TIMING CHART



t_{pLH} : 7μs (Typ.)

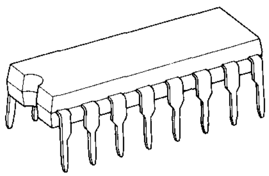
t_{pHL} : 2μs (Typ.)

TA8102P

POWER DRIVE IN FOR DC PLAYER

TA8102P is a power driver IC designed for controlling the focus actuator coil of pickup, tracking actuator coil, disk motor and feed motor in CD player.
This is the most suitable for the power driver of the general-purpose motor.

- Two operation amplifiers with bootstap terminals are incorporated.
- BTL Application also available.
  (BTL Application is realized with single 5V power supply)
- High output current : I_O(peak)=1A
- High input impedance is realized by built-in buffer amplifier.
- Built-in thermal shut down.



DIP16-P-300A

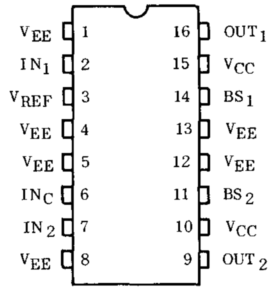
Weight : 1.11g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{CC}	15	V
Output Current	I_O(peak)	1	A
Power Dissipation	P_D	1.4*	W
Operating Temperature	Topr	-25~75	°C
Storage Temperature	Tstg	-55~150	°C

* Derated above Ta=25°C in the proportion of 2mW/°C.

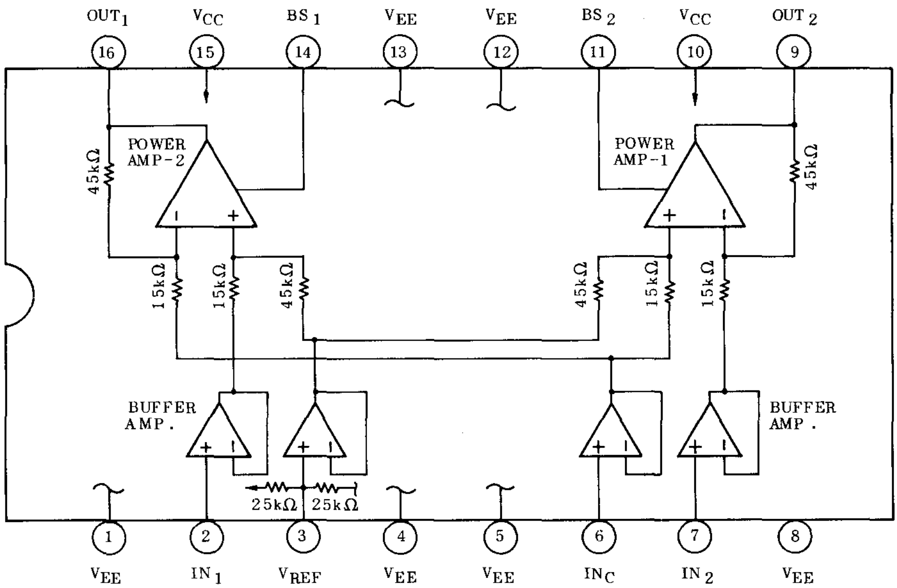
PIN CONNECTION (TOPVIEW)



Note. Output protection circuit is not incorporated.

Care should be taken not to short between
Output-V_{CC}
Output-GND
Output-Output

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=5V, V_{EE}=5V, 2ch Amp. operation, without bootstrap, R_L=∞, Rg=0Ω, Ta=25°C)

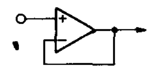
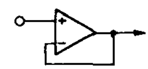
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operation Power Supply Voltage		$V_{CC}-V_{EE}$			4.5	–	12	V
Quiescent Current		I_{CCQ}		$IN_1=IN_2=IN_C$=2.1V	5	11	18	mA
Input Offset Current		$\lvert I_{IO} \rvert$		IN1, IN2	–	100	300	nA
Input Bias Current		I_I		IN_1, IN2	–	500	1500	nA
Output Offset Voltage		$\lvert V_{IO} \rvert$		$IN_1=IN_2=IN_C$=2.1V $R_{in}C$=20kΩ	–	–	60	mV
Output Voltage		V_{OH}		DC 350mA Load	2.8	–	–	V
		V_{OL}			–	–	-3.8	
Gain		GV		R_L=5Ω, V_{IN}=100mV_{rms} f=1kHz	8.5	9.5	10.5	dB
Frequency Band Range		f_C		R_L=5Ω, V_{IN}=100mV_{rms} G=-3dB	50	–	–	kHz
Total Harmonics Distortion		THD		R_L=5Ω, f=1kHz V_{OUT}=5Vp-p	–	-50	–	dB
Slew Rate		SR		R_L=5Ω, V_{OUT}=2Vp-p	–	0.5	–	V/μs
Output Noise Voltage		V_{NO}		Rg=10kΩ	–	0.1	–	mV_{rms}
Cross Talk		C.T		R_L=5Ω, Rg=10kΩ f=1kHz, V_O=0dBm CH1 ↔ CH2	–	60	–	dB
Ripple Rejection Ratio	V_{CC} Side	RR_C		R_L=5Ω, Rg=10kΩ	–	65	–	dB
	V_{EE} Side	RR_E		f_R=100Hz, -20dBm	–	65	–	
Thermal Shut Down Operating Temperature		ON		Tj	–	140	–	°C
		OFF			–	130	–	

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=5V, BTL operation, With bootstrap, R_L=∞, Rg=0Ω, R_{INC}=0Ω, Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operation Power Supply Voltage	V_{CC}			4.5	–	12	V
Quiescent Current	I_{CCQ}		IN_1=IN_2=IN_C=2.1V	5	11	18	mA
Input Offset Current	$\|I_{IO}\|$		IN_1, IN_2	–	100	300	nA
Input Bias Current	I_I		IN_1, IN_2	–	500	1500	nA
Output Offset Voltage	$\|V_{IO}\|$		IN_1=IN_2=IN_C=2.1V Rg=10kΩ, R_{INC}=20kΩ	–	–	60	mV
Output Voltage	V_{OH}		DC 350mA Load	4.0	–	–	V
	V_{OL}		DC 350mA Load	–	–	1.2	V
	V_O		R_L=8Ω, f=1kHz	–	8.5	–	Vp-p
Gain	GV		R_L=5Ω, V_{IN}=100mV_{rms} f=1kHz	14.5	15.5	16.5	dB
Frequency Range	f_C		R_L=5Ω, V_{IN}=100mV_{rms} G=–3dB	50	–	–	kHz
Total Harmonic Distortion	THD		R_L=5Ω, f=1kHz V_{OUT}=5Vp-p	–	–50	–	dB
Slew Rate	SR		R_L=5Ω, V_{OUT}=2Vp-p	–	0.5	–	V/μs
Output Noise Voltage	VNO		Rg=10kΩ	–	0.1	–	mV_{rms}
Ripple Rejection Ratio	RR		R_L=5Ω, Rg=100kΩ f_R=100hZ, –20dBm	–	60	–	dB

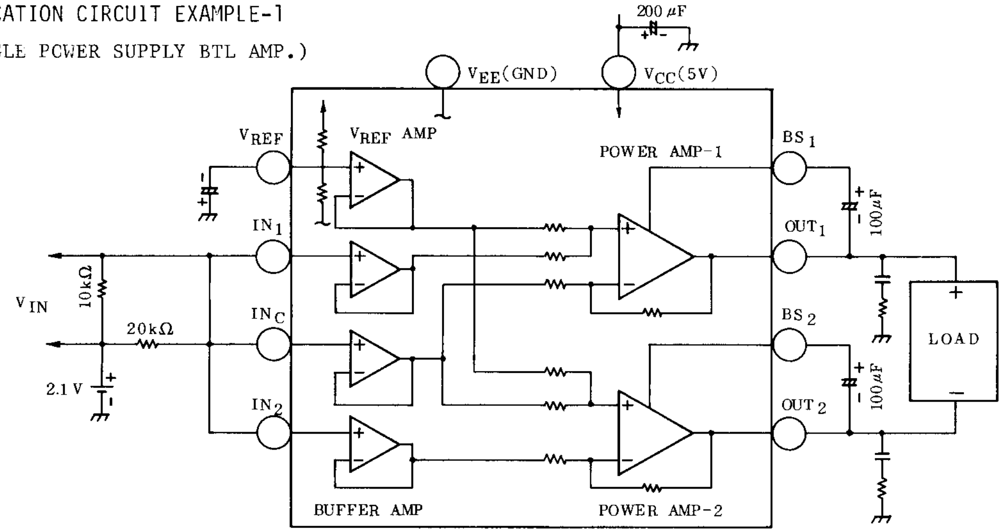
FUNCTION DESCRIPTION OF EACH TERMINAL

PIN No.	SYMBOL	I/O	FUNCTION	REMARKS
1	V_{EE}	-	Negative power supply terminal.	Connect to pins 4,5,8,12 and 13
2	IN_1	I	Power amp.-1 Control signal input terminal.	 Buffer amp.
3	V_{REF}	-	Reference voltage source terminal.	
4 5	V_{EE}	-	Negative power supply voltage terminal.	Connect to pins 1 and 8.
6	IN_C	I	Power amp.-1 and 2 common control signal input terminal.	
7	IN_2	I	Power amp.-2 control signal input terminal.	 Buffer amp.
8	V_{EE}	-	Negative power supply voltage terminal.	Connect to pins 1, 4 and 5.
9	OUT2	O	Power amp.-2 output terminal. Error signal amp. output of IN_2 and IN_C.	
10	V_{CC}	-	Positive power supply voltage terminal.	Connect to 15 pin
11	BS2	-	Bootstrap terminal -2.	
12 13	V_{EE}	-	Negative power supply voltage terminal.	
14	BS1	-	Bootstrap terminal -1.	
15	V_{CC}	-	Positive power supply voltage terminal.	Connect to 10 pin
16	OUT_1	O	Power amp.-1 output terminal. Error signal amp. output of IN_2 and IN_C.	

Note: Outside IC, connect to { V_{CC} terminal (10,15 pins)
V_{EE} terminal (1,4,5,8,12,13 pins)

APPLICATION CIRCUIT EXAMPLE-1

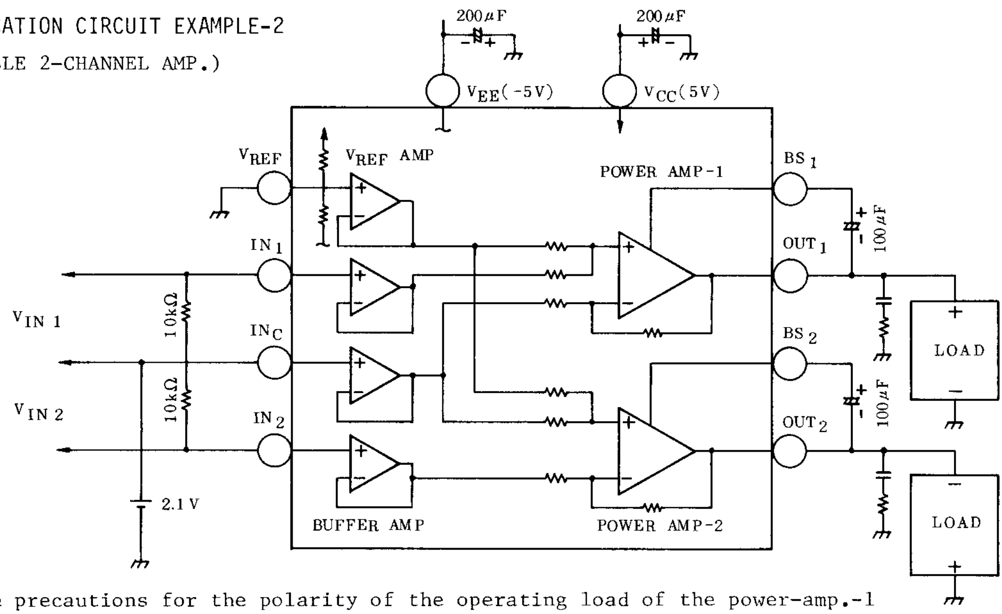
(SINGLE POWER SUPPLY BTL AMP.)



. Therough connecting resistance to V_{REF} terminal, reference electric potential can be freely set.
. Gain is G_V=15.5dB fixed.

APPLICATION CIRCUIT EXAMPLE-2

(DOUBLE 2-CHANNEL AMP.)

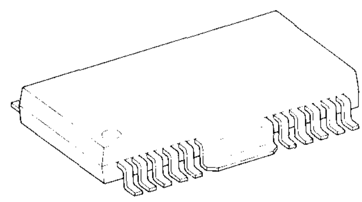


. Take precautions for the polarity of the operating load of the power-amp.-1 as a non-inverting amplifier and of the power-amp.-2 as a inverting amplifier.
. Gain is fixed at G_V=9.5dB.

TA8212F

◦ QUAD POWER OPERATIONAL AMPLIFIER

TA8212F is Quad Power Operational Amplifier designed especially for Tracking and Focus Actuator drives and Spindle and Carriage Motor controls for CD Players and also applicable to any other Motor Drive and Power Drive Applications.



HSOP20-P-450

Weight: 0.79g (Typ.)

◦ Features

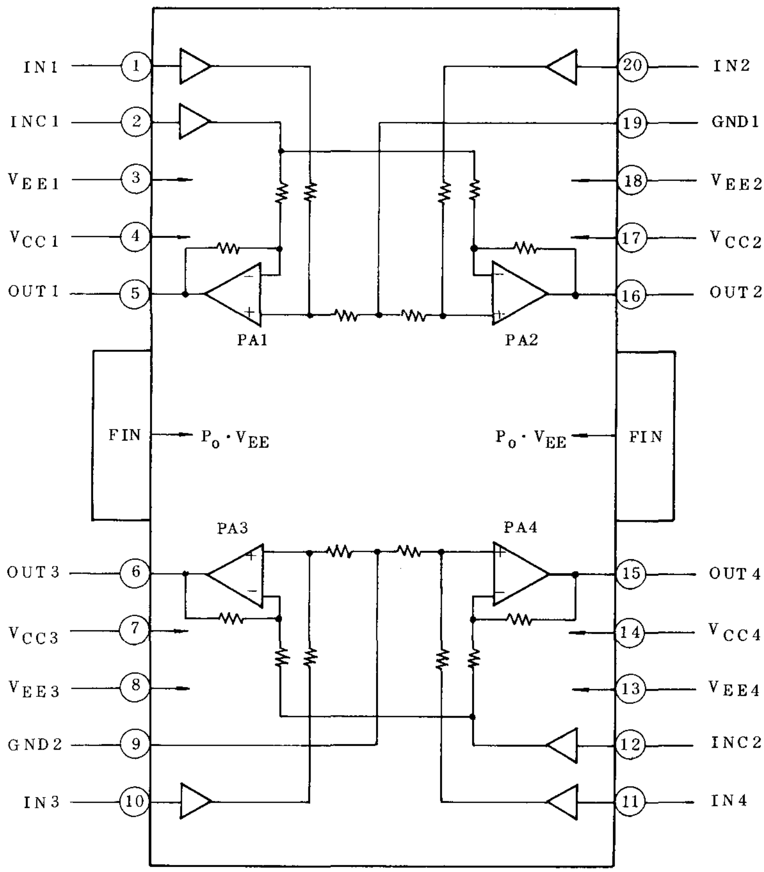
- Thermal Shut Down Circuit insided.
- Buffer Amplifiers for High Input Impedance Feature.
- PFP20 Surface Mountable Power Package Sealded.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	$V_{CC}-V_{EE}$	14.5	V
Output Current	I_O(PEAK)	700	mA
Power Dissipation	P_D	1.0	W
		2.0 (Note)	
Operating Temperature	T_{opr}	-25~75	°C
Storage Temperature	T_{stg}	-55~150	°C

Note: PCB (50 × 50 × 1.6mm, occupied copper area in excess of 60%) Mounting Condition.

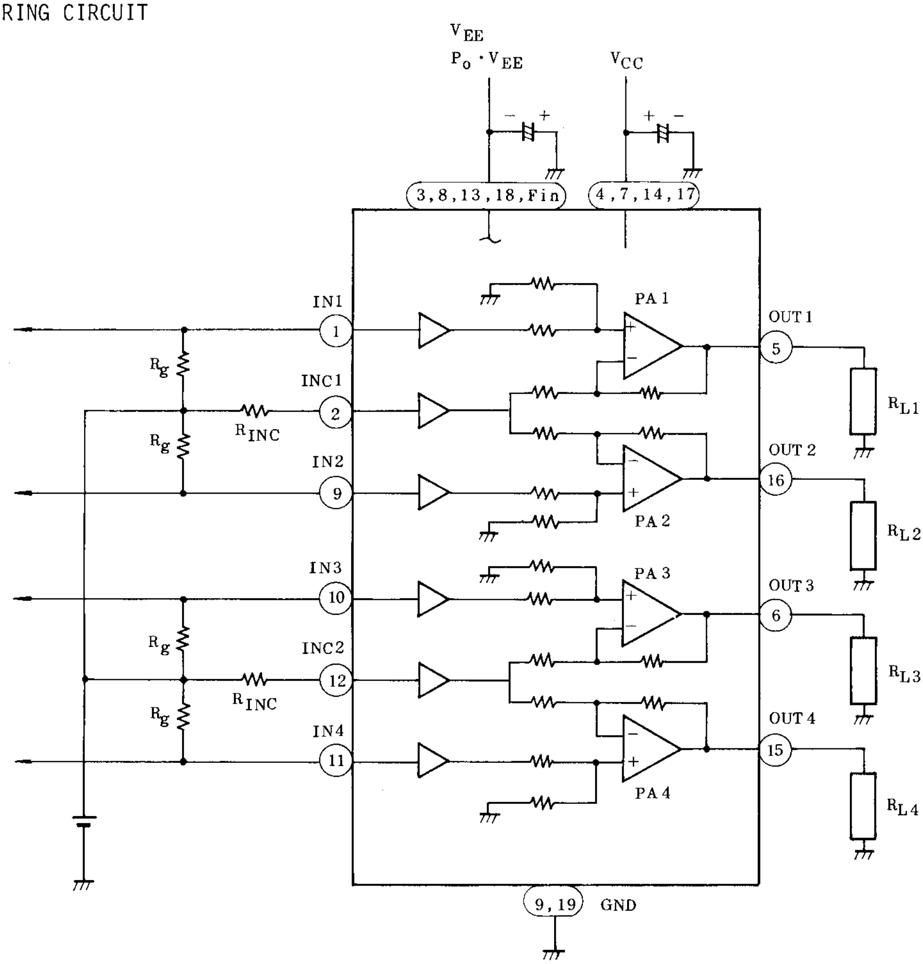
BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS (Unless otherwise noted, V_{CC}=5V, V_{EE}=-5V, R_L=5Ω, Ta=25°C)

CHARACTERISTIC	SYMBOL	MEASURING CIRCUIT	MEASURING CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage	V_{CC}-V_{EE}	-		8	10	12	V
Quiescent Current	I_{CCQ}	-	IN=INC=2V, R_L=∞	5	17	29	mA
Input Offset Current	$\|I_{IO}\|$	-		-	100	300	nA
Input Bias Current	I_I	-		-	0.5	-	μA
Output Offset Voltage	$\|V_{IO}\|$	-	Rg=10kΩ, R_{INC}=10kΩ	-	-	60	mV
Output Current	V_{OH}	-		2.7	3.3	-	
	V_{OL}			-	-3.3	-2.8	
Closed Loop Gain	G_V	-	V_{IN}=100mV_{rms}, f=1kHz	8.5	9.5	10.5	dB
Frequency Range	f_C	-	V_{IN}=100mV_{rms}, G=-3dB	50	-	-	kHz
Total Harmonics Distortion	THD	-	f=1kHz, V_{OUT}=5Vp-p	-	-50	-	dB
Slew Rate	SR	-	V_{OUT}=2Vp-p	-	0.5	-	V/μs
Output Noise Voltage	V_{NO}	-	Rg=10kΩ	-	0.1	-	mV_{rms}
Cross Talk	C.T	-	Rg=10kΩ, f=1kHz V_o=0dBm, between each channel	-	-60	-	dB
Ripple Rejection Ratio	RR	-	Rg=10kΩ f_R=100Hz, -20dBm	-	-65	-	dB
Thermal Shutdown Circuit Operating Temperature	Tj(ON)	-		150	-	-	°C

MEASURING CIRCUIT



TERMINAL DESCRIPTIONS

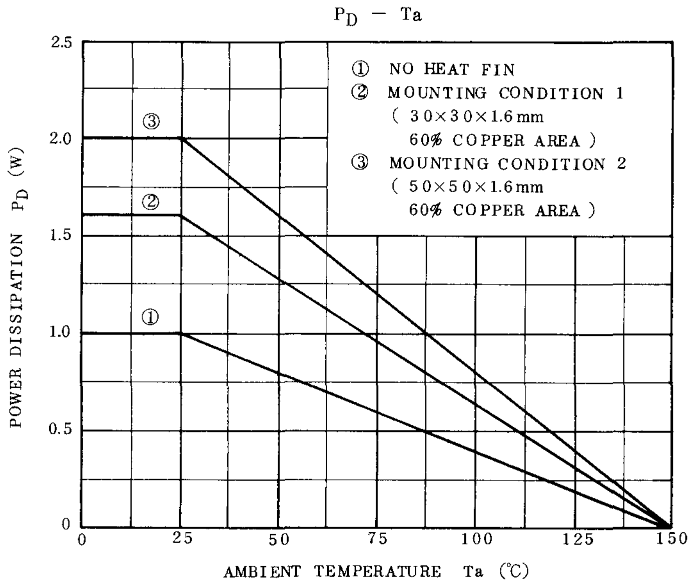
PIN NO.	SYMBOL	I/O	FEATURES	NOTE
1	IN 1	I	Power Amp 1 Input Terminal	
2	INC 1	I	Power Amp 1 and 2 Common Input	
3	V_{EE1}	-	Negative Supply Voltage	Note 1
4	V_{CC1}	-	Positive Supply Voltage	Note 2
5	OUT 1	O	Power Amp 1 Output	
6	OUT 3	O	Power Amp 3 Output	
7	V_{CC3}	-	Positive Supply Voltage	Note 2
8	V_{EE3}	-	Negative Supply Voltage	Note 1
9	GND 2	-	GND	Note 3
10	IN 3	I	Power Amp 3 Input	
11	IN 4	I	Power Amp 4 Input	
12	INC 2	I	Power Amp 3 and 4 Common Input	
13	V_{EE4}	-	Negative Supply Voltage	Note 1
14	V_{CC4}	-	Positive Supply Voltag	Note 2
15	OUT 4	O	Powet Amp 4 Output	
16	OUT 2	O	Power Amp 2 Output	
17	V_{CC2}	-	Positive Power Supply	Note 2
18	V_{EE2}	-	Negative Power Supply	Note 1
19	GND 1	-	GND	Note 3
20	IN 2	I	Power Amp 2 Input	
FIN	Po.V_{EE}	-	Heat FIN and connect to all V_{EE} terminals with low impedance	Note 1

Note 1: FIN, 3, 8, 13, 18 PINs are required to connect each other.

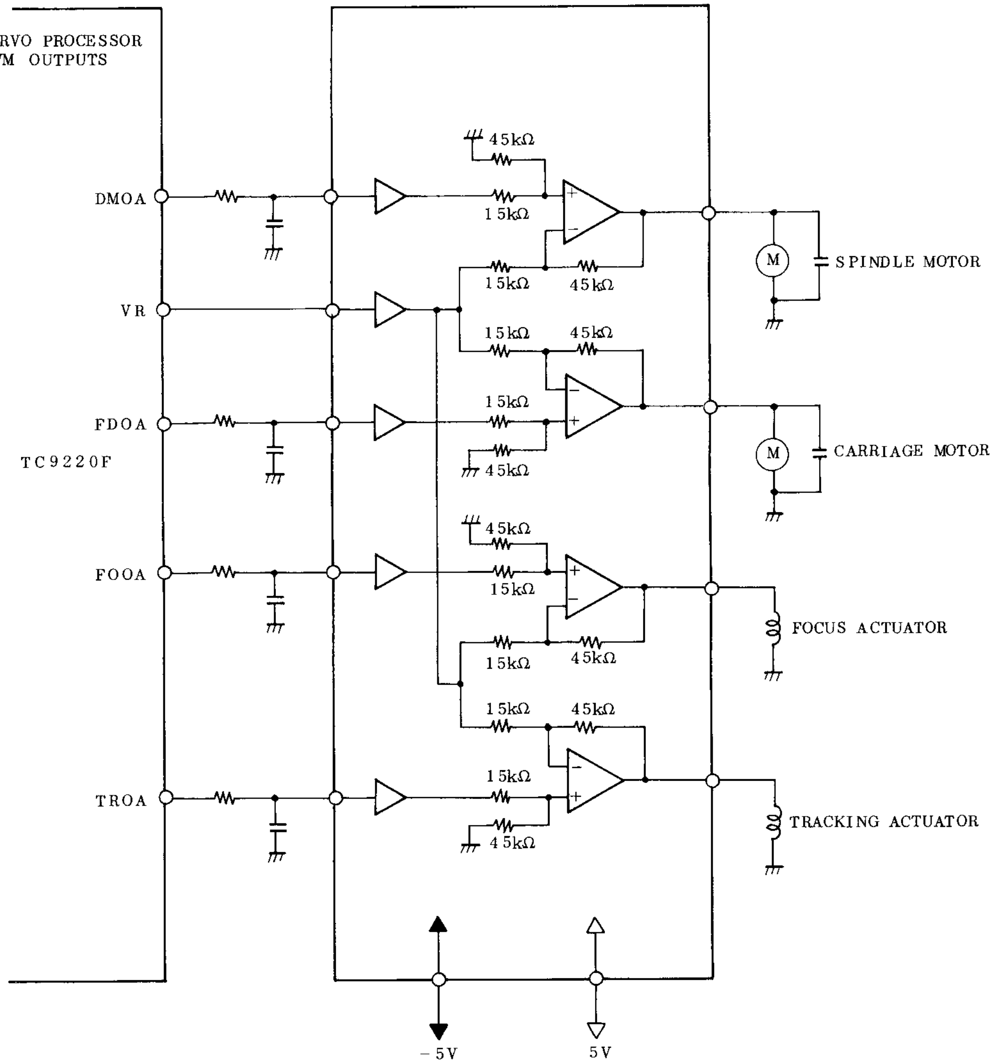
Note 2: 4, 7, 14, 17 PINs are required to connect each other.

Note 3: 9 and 19 PINs are required to connect.

ALLOWABLE POWER DISSIPATION



APPLICATION CIRCUIT

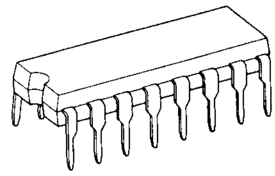


Closed Loop Gain of Gv is fixed approximating 9.5dB by internal circuit.

TA8400P

DUAL BRIDGE DRIVER

TA8400P is Dual Bridge Driver designed especially for VCR cassette and tape loading motor drives.



DIP16-P-300A

Weight: 1.11g (Typ.)

- 4 Modes Available (CW/CCW/STOP/BRAKE)
- Output Current Up to 0.4A (AVE) and 1.0A (PEAK)
- Wide Range of Operating Voltage
  - V_{CC} opr=4.5~18V
  - V_S opr=0~22V
  - V_{ref} opr=0~22V
- Built-in Thermal Shutdown, Over Current Protector and Punch-Through Current Restriction Circuit.
- Hysteresis for All Inputs.

MAXIMUM RATINGS (Ta=25°C)

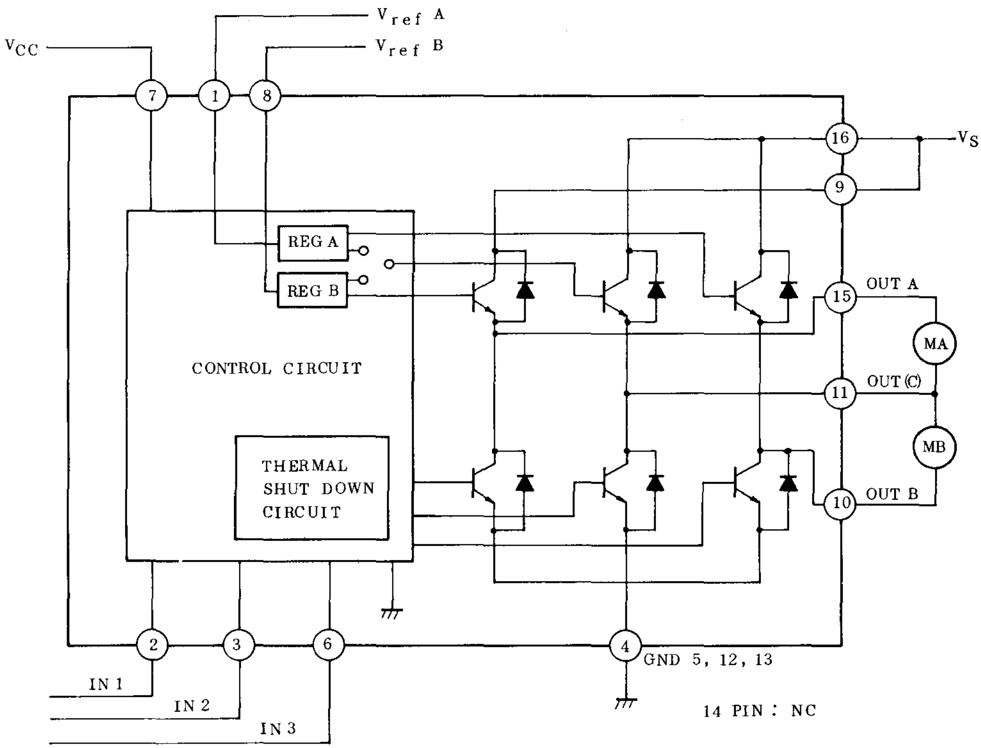
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	25	V
Motor Drive Voltage	V_S	25	V
Reference Voltage	V_{ref}	25	V
Output Current	$I_{O(PEAK)}$	Note 1.0	A
	$I_{O(AVE)}$	0.4	A
Power Dissipation	P_D	1.4	W
Operating Temperature	T_{opr}	-30~75	°C
Storage Temperature	T_{stg}	-55~150	°C

Note: Duty 1/10, 100 msec

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C, V_{CC}=12V, V_S=12V)

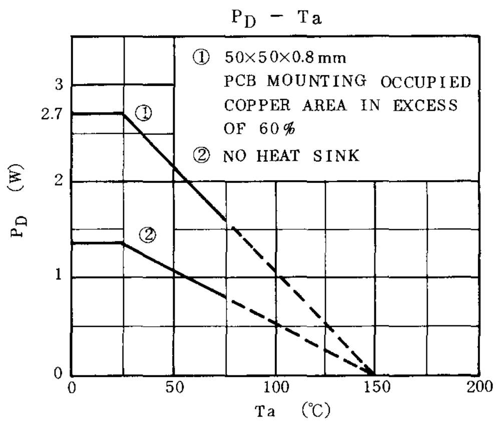
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}	–	Output off, CW/CCW Mode	–	25	38	mA
		I_{CC2}	–	Output off, Brake Mode	–	25	38	
		I_{CC3}	–	Output off, Stop Mode	–	10	20	
Input Operating Voltage	"H"	V_{IN-H}	–	Tj=25°C, 2, 3, 6 pin	3.5	–	5.5	V
	"L"	V_{IN-L}	–	Tj=25°C, 2, 3, 6 pin	0	–	1.2	
Input Current		I_{IN}	–	V_{IN}=GND, Source Mode	6	12	60	μA
Input Hysteresis Voltage		V_{HYS}	–		–	0.7	–	V
Saturation Voltage	Upper	V_{SAT-1U}	–	$V_{ref}=V_S$, I_O=0.4A	–	1.0	1.5	V
	Lower	V_{SAT-1L}	–	$V_{ref}=V_S$, I_O=0.4A	–	0.3	–	
	Upper	V_{SAT-2U}	–	$V_{ref}=V_S$, I_O=1.0A, ON LOAD: 20 msec	–	2.0	2.5	
	Lower	V_{SAT-2L}	–	$V_{ref}=V_S$, I_O=1.0A, NO LOAD: 20 msec	–	0.8	1.3	
Output Voltage		V_{O-1}	–	V_{ref}=8V, I_O=0.4A Output Measure	8.2	8.8	9.3	V
		V_{O-2}	–	V_{ref}=8V, I_O=1A Output Measure	8.1	8.6	9.2	
Leakage Current	Upper	I_{L-U}	–	V_S=25V	–	–	200	μA
	Lower	I_{L-L}	–	V_S=25V	–	–	200	
Diode Forward Voltage	Upper	V_{F-U}	–	I_F=1.0A	–	3.6	–	V
	Lower	V_{F-L}	–	I_F=1.0A	–	0.9	–	
Reference Current		I_{ref}	–	V_{ref}=8V, Source Mode	–	0.45	0.7	mA
Thermal Shut Down Operating Temperature		T_{SD}	–	Tj	110	130	150	°C

BLOCK DIAGRAM

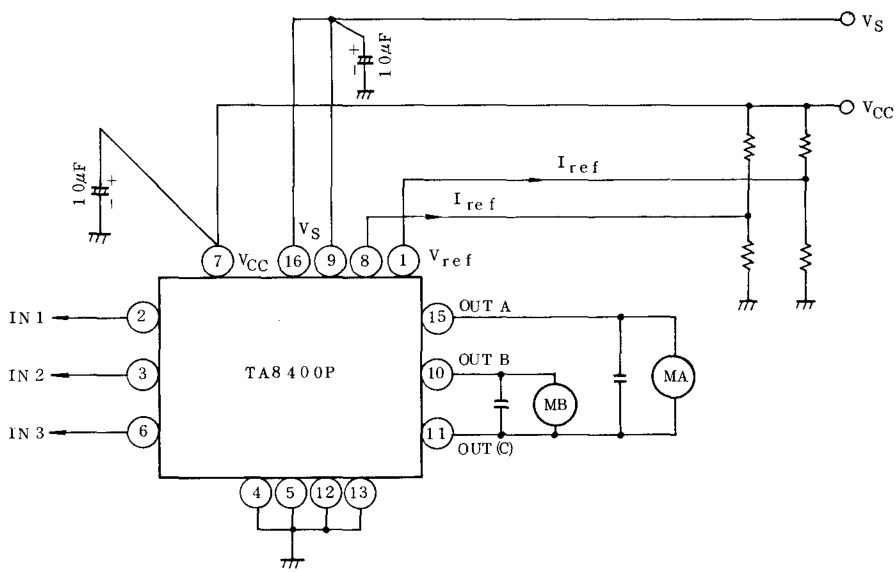


INPUT		Note	OUTPUT			MODE	
IN 1	IN 2	IN 3	OUT(C)	OUT A	OUT B	MA	MB
0	0	1/0	∞	∞	∞	STOP	STOP
1	0	0	H	L	∞	CW/CCW	STOP
1	0	1	L	H	∞	CCW/CW	STOP
0	1	0	H	∞	L	STOP	CW/CCW
0	1	1	L	∞	H	STOP	CCW/CW
1	1	1/0	L	L	L	BRAKE	BRAKE

∞ : HIGH IMPEDANCE
Note: Inputs are all low active type.



APPLICATION CIRCUIT

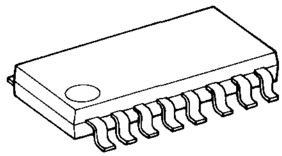


16 pin is required to connect to 9 pin.

TA8401F

FUNCTIONAL BRIDGE DRIVER

- Wide operating Supply Voltage Range : $V_{CC(opr)}$=3~15V
- Capsuled in Flat Package 16 pin.
- Forward and Reverse Rotation, Short Breke Modes are available by means of Rotation Control Signals.
- High Efficiency is obtained.
- Can be used as Interface Driver.



SSOP16-P-225A

Weight: 0.2g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

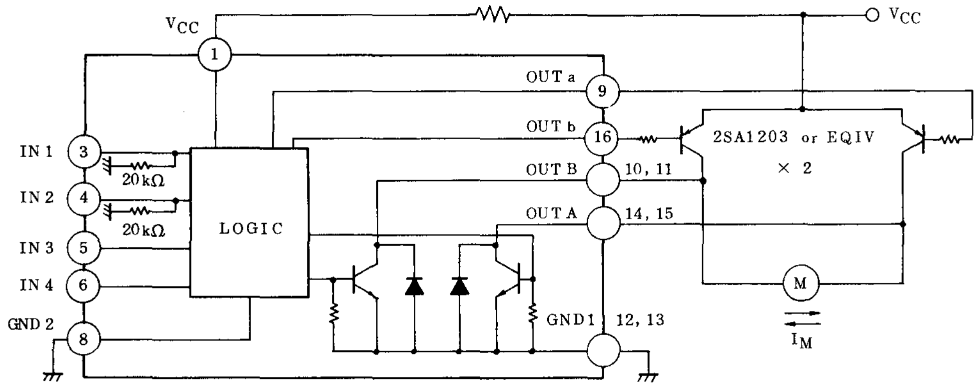
CHARACTERISTIC		SYMBOL	RATING	UNIT
Peak Supply Voltage		V_{CC}	18	V
Output Current		$I_{O(AVE)}$	0.5	A
Power Dissipation	-	P_D	350	mW
	(Note)		550	
Operating Temperature		T_{opr}	-30~75	°C
Storage Temperature		T_{stg}	-55~150	°C

Note: This rating is obtained by mounting on 20×20×0.8mm PCB that occupied above 60% of copper area.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25±1.5°C, V_{CC}=5V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}		Output OFF CW/CCW MODE	-	13	20	mA
		I_{CC2}		Output OFF STOP MODE	-	11	15	
		I_{CC3}		Output OFF BRAKE MODE	-	17	26	
		I_{CC4}		Output OFF INHIBIT (INPUT 4="L")	-	2.4	7	
Saturation Voltage		$V_{sat\ 1}$		I_{O1}=500mA, Lower Side	-	0.3	0.5	V
		$V_{sat\ 2}$		I_{O2}=25mA, Upper Side	-	0.3	0.55	
Output TR Leakage Current		I_L		V_C=15V	-	-	50	μA
Input Voltage	"H" Level	$V_{IN3,4}$"H"			2.0	-	V_{CC}	V
	"L" Level	$V_{IN3,4}$"L"			-	-	0.8	
Input Current		$I_{3,4}$		Input "L", V_{IN}=GND (Source Current)	-	-	20	μA
Input Voltage	"H" Level	$V_{IN5,6}$"H"			1.0	-	V_{CC}	V
	"L" Level	$V_{IN5,6}$"L"			-	-	0.3	
Input Current		$I_{5,6}$		Input "H" (Sink Current) V_{IN}=1V	-	-	30	μA
Diode Forward Voltage		V_F		I_F=500mA	-	1.3	-	V

BLOCK DIAGRAM



FUNCTION

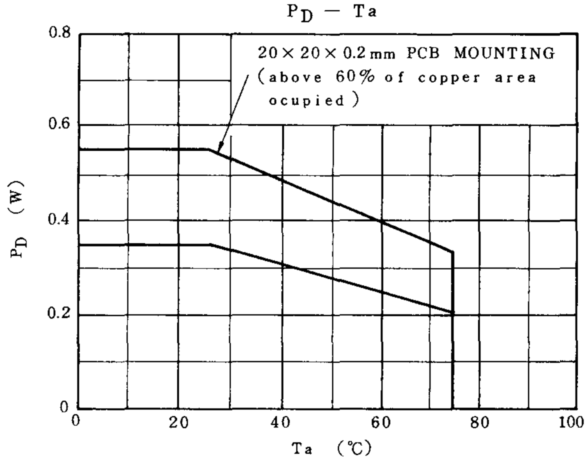
(1) BRIDGE DRIVER

CONTROL	INPUT MODE				OUTPUT				OPERATING MODE	NOTE
	IN1	IN2	IN3	IN4	OUT Ⓐ	OUT Ⓑ	OUT ⓐ	OUT ⓑ		
2 INPUT CONTROL	H	L	H	H	ON (−500mA)	—	ON (−25mA)	—	Forward Rotation	
	L	H	H	H	—	ON (−500mA)	—	ON (−25mA)	Reverse Rotation	
	H	H	H	H	ON (−500mA)	ON (−500mA)	—	—	Brake	
	L	L	H	H	—	—	—	—	Stop	
1 INPUT CONTROL	H	L	L	H	ON (−500mA)	—	ON (−25mA)	—	Forward Rotation	
	L	L	L	H	—	ON (−500mA)	—	ON (−25mA)	Reverse Rotation	
	H/L	H	L	H	ON (−500mA)	ON (−500mA)	—	—	Brake	H/L: Don't care
INHIBIT	H/L	H/L	H/L	L	—	—	—	—	Stop	H/L: Don't care

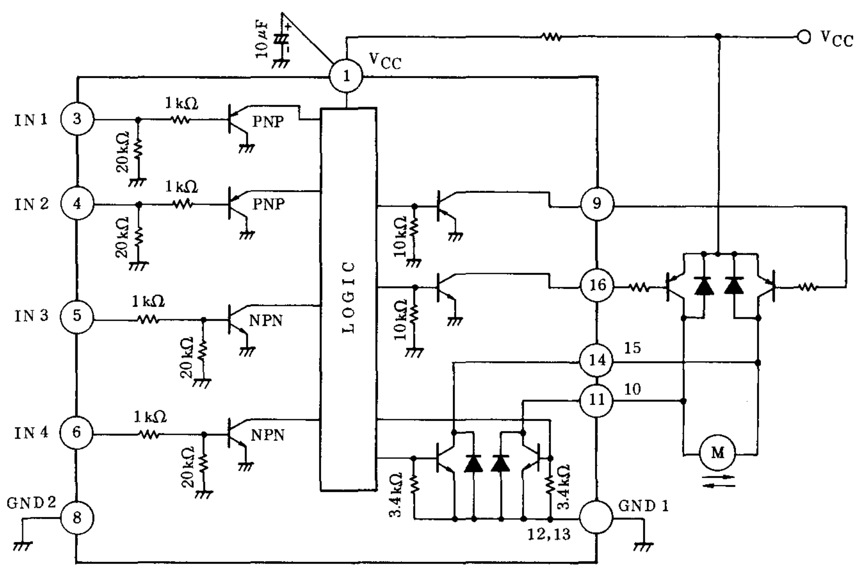
(2) INTERFACE DRIVER APPLICATION

If IN3 and IN4 connect to "HIGH" Out Ⓐ and Out Ⓑ can be used as a interface driver output for each inputs.

(Connect Out ⓐ and Out ⓑ to GND)



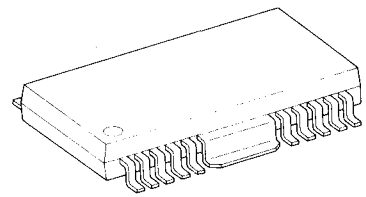
APPLICATION CIRCUIT



TA8402F

3 PHASE HALL MOTOR DRIVER.

TA8402F is output current detect voltage drive type 3 phase unipolar hall motor driver.
Bipolar drive also available with additional transistors.


HSOP20-P-450

Weight: 0.8g (Typ.)

. 3 Phase Unipolar Hall Motor Driver and Also Available Bipolar Drivers with Additional Transistors.
. Built-in Control Amplifier.
. Built-in Regulator for Hall Sensors.
. Output Current Up to 1.0A Max.(AVE).
. Wide Range of Operating Voltage
  : V_{CC} opr=4.0~15V, V_S opr=0~15V
. Built-in Thermal Shut Down Circuit.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage (Control)		V_{CC}	18	V
Supply Voltage (Motor)		V_S	18	V
Output Current	La, Lb, Lc	I_O	1.0	A
	ℓa, ℓb, ℓc	I_ℓ	30	mA
	Regulator (for Hall Sensor)	I_H	15	mA
Power Dissipation		P_D	1.0 3.2 Note 1	W
Operating Temperature		Topr	-30~75	°C
Storage Temperature		Tstg	-55~150	°C

Note 1. This rating is obtained by 50 × 50 × 1mm Fe board mounting.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C, V_{CC}=5V)

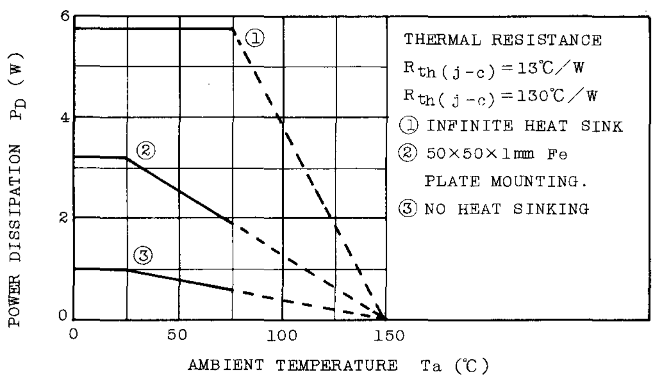
CHARACTERISTIC			SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current			I_{CC1}		Stop Mode, Output Open, No Hall Bias	-	1	3	mA
			I_{CC2}		FWD/REV Mode, Output Open, Hall Bias 1.5V	-	12.5	20	mA
Output Saturation Voltage			V_{SAT1}		I_O=0.1A	-	0.1	0.2	V
			V_{SAT2}		I_O=1.0A	-	0.8	1.4	
			V_{SAT3}		I_O=0.5A	-	0.4	-	
Saturation Voltage Differencial			ΔV_{SAT}		I_O=0.1A	-	10	50	mV
Regulator (⑩ PIN)	Output Voltage		V_{OH}		I_H=3mA	2.90	3.05	3.20	V
	Load Regulation		$R_{eg}(V_{OH})$		I_H=3~15mA	-	2	10	mV/mA
	Temperature Coefficient		T_{CVH}		Ta=0~75°C	-	6	-	mV/°C
Position Sensing Input	Hysteresis		V_{HYS}			-	2	-	mV
	Offset		$V_{H(OFF)}$			-5	0	5	mV
	Operating Voltage Range		CMR(VH)			0.2	-	3	V
Rotation Control Input (⑰ PIN)	FWD	Operating Voltage	V_{FWD}			3.9	-	V_{CC}	V
		Input Current	I_{FWD}		V_{FWD}=5V, Sink Mode	-	1.5	2.0	mA
	STOP	Operating Voltage	V_{STP}			2.1	2.5	2.8	V
	REV	Operating Voltage	V_{REV}			0	-	0.9	V
		Input Current	I_{REV}		V_{REV}=0, Source Mode	-	0.4	0.6	mA
ET Amp (⑧ PIN)	Operating Voltage Range		CMR(ET)			1.5	2.5	3.5	V
	Gain		G_{ET}		⑦⑧ PIN→⑥ PIN, V_7=1.5V, V_8=2.5V	-	0	-	dB
CS Input (⑤ PIN)	Gain		G_{CS}		⑤ PIN→⑥ PIN V_{CS}=0~15mV	30	33	36	dB
	Limitting Voltage		$V_{CS(lim)}$			0.40	0.55	0.70	V
	Limitting Voltage Temperature Coefficient		$T_{C}(V_{lim})$			-	0.6	-	mV/°C
Diode Forward Drop			V_F		I_F=0.7A	-	1.3	-	V
Thermal Shut Down Operating Temperature			T_{TSD}			150	160	-	°C

TRUTH TABLE

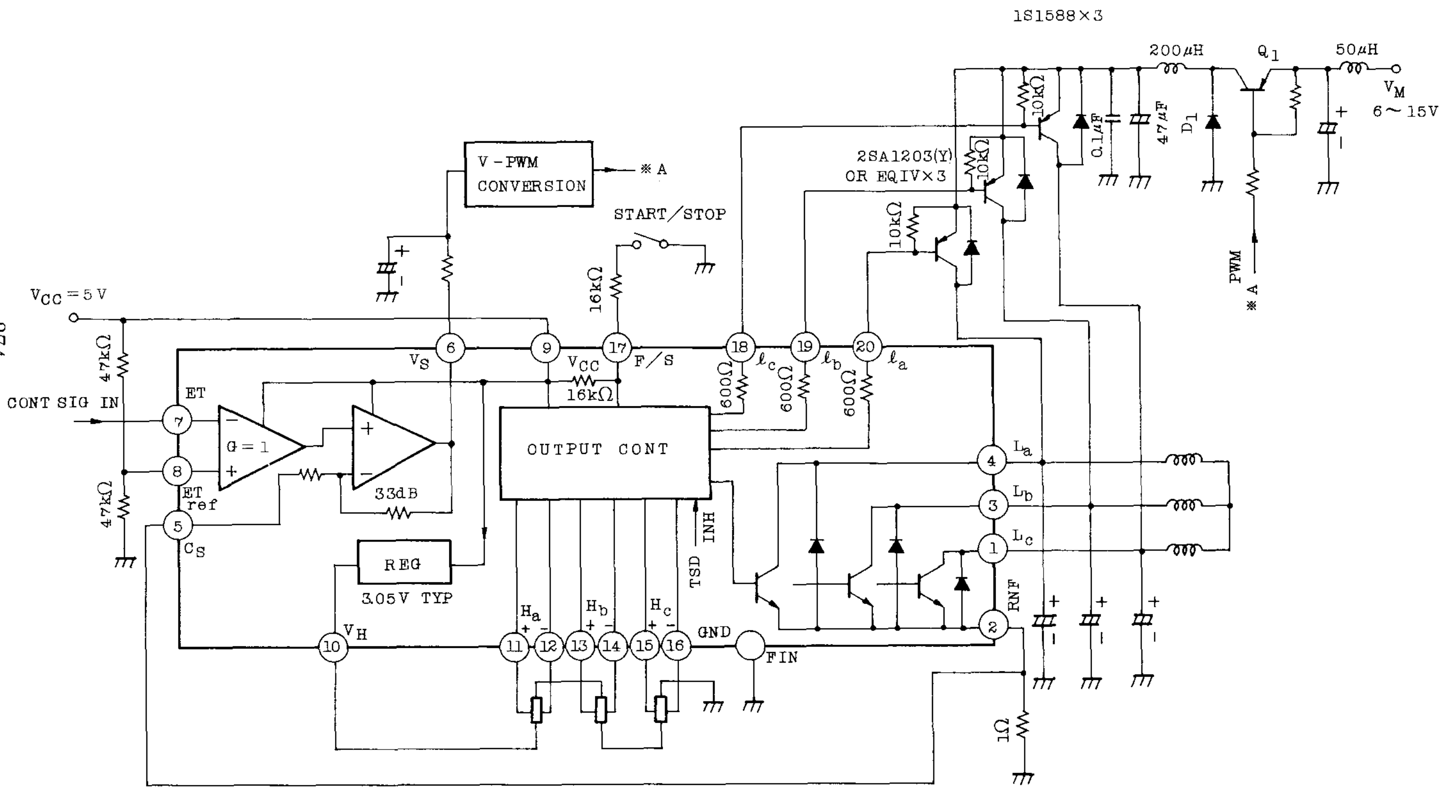
FWD/REV INPUT (17 PIN)	POSITION SENSING INPUT			OUTPUT					
	Ha	Hb	Hc	La (4 PIN)	Lb (3 PIN)	Lc (1 PIN)	ℓa (20 PIN)	ℓb (19 PIN)	ℓc (18 PIN)
REV	H	L	H	OFF	ON	OFF	OFF	OFF	ON
$V_{17}=0$	H	L	L	OFF	ON	OFF	ON	OFF	OFF
	H	H	L	OFF	OFF	ON	ON	OFF	OFF
	L	H	L	OFF	OFF	ON	OFF	ON	OFF
	L	H	H	ON	OFF	OFF	OFF	ON	OFF
(Note 2)	L	L	H	ON	OFF	OFF	OFF	OFF	ON
FWD	H	L	H	OFF	OFF	ON	OFF	ON	OFF
$V_{17}=5V$	H	L	L	ON	OFF	OFF	OFF	ON	OFF
	H	H	L	ON	OFF	OFF	OFF	OFF	ON
	L	H	L	OFF	ON	OFF	OFF	OFF	ON
	L	H	H	OFF	ON	OFF	ON	OFF	OFF
(Note 3)	L	L	H	OFF	OFF	ON	ON	OFF	OFF
STOP	H	L	H	OFF					
$V_{17}=2.5V$	H	L	L						
	H	H	L						
	L	H	L						
	L	H	H						
(Note 4)	L	L	H						

Note 2. This condition is obtained with 17 PIN grounded.
Note 3. This condition is obtained with 17 PIN open.
Note 4. This condition is obtained with 17 PIN ground through 16kΩ resistor.

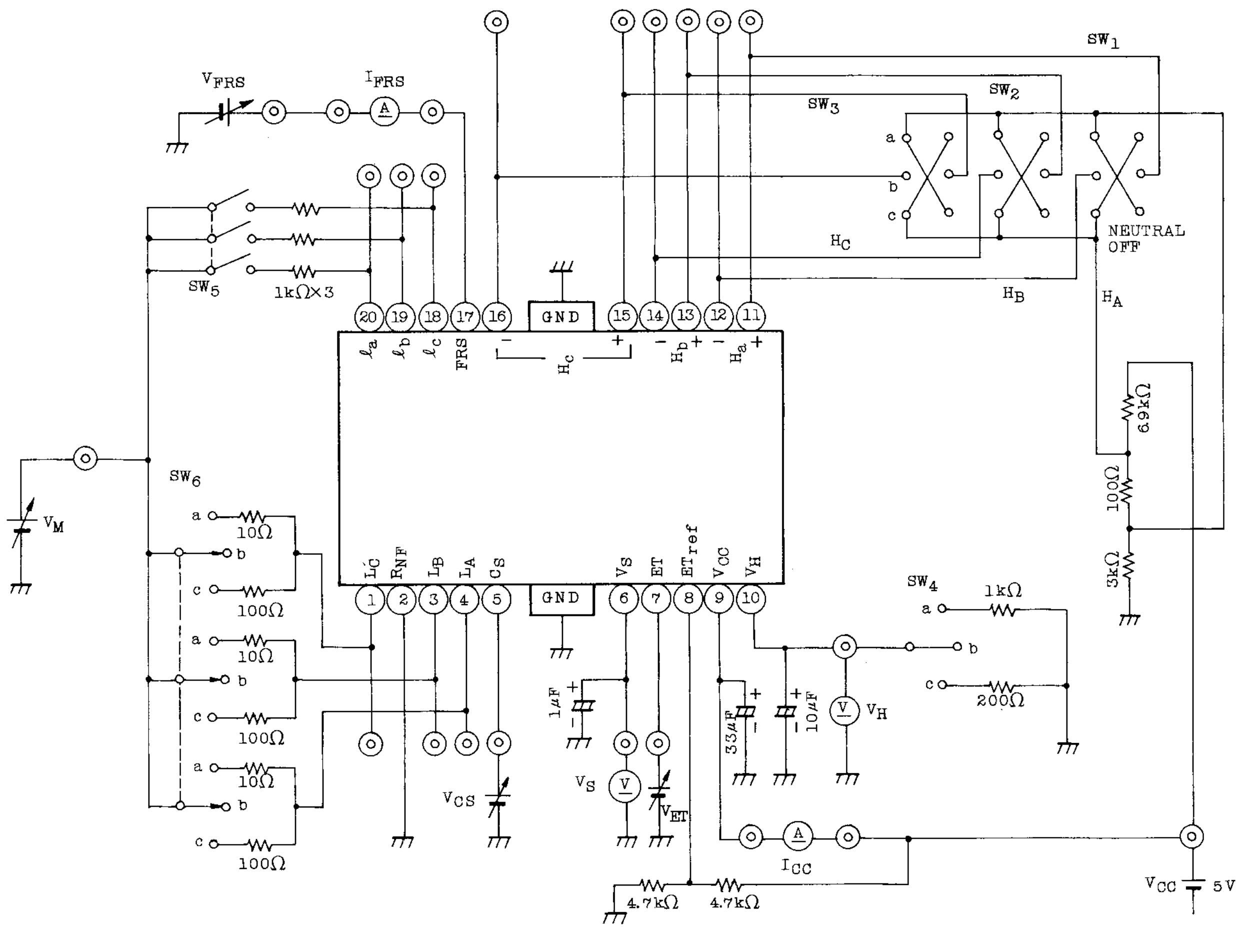
P_D – Ta



BLOCK DIAGRAM AND BASIC APPLICATION CIRCUIT



MEASURING CIRCUIT

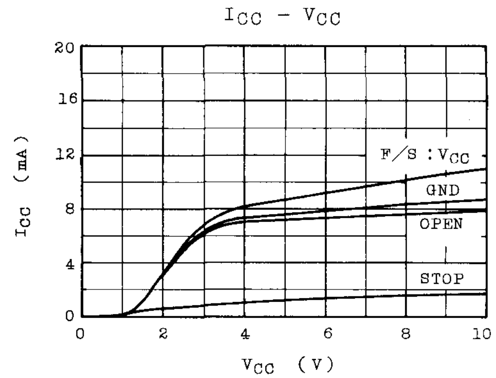


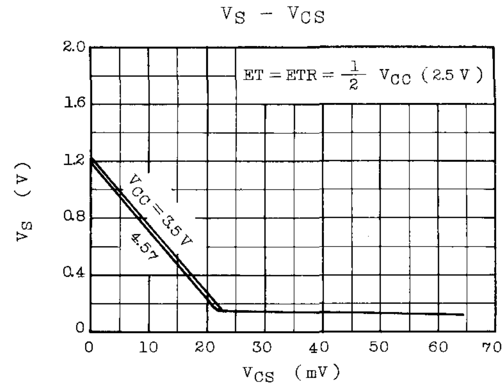
MEASURING METHOD

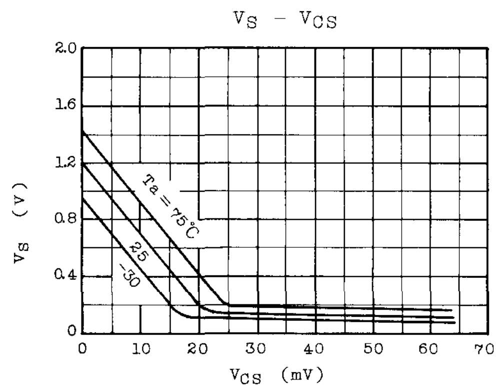
CHARAC-TERISTIC	SWITCH 1	2	3	4	5	6	MEASURING METHOD	METER
I_{CC1}	b	b	b	b	OFF	b	V_{FRS}=2.5V	I_{CC}
I_{CC2}	a	a	a			b	All position sensing inputs are all shorted and V_{FRS}=5V	I_{CC}
V_{SAT1}	Refer to truth table					c	. I_O calibration is required with V_M.	Measure each output to ground voltage
V_{SAT2}						a	. Measure each output to GND voltage.	
ΔV_{SAT}						c	. ΔV_{SAT} is the maximum differential voltage between the highest V_{SAT} value and lowest one.	
V_{OH}	b	b	b	a		b	I_H=3mA	V_H
Rg							Reg is load regulation of V_{OH} under the condition of I_H=3~15mA	
V_{FWD} V_{STP} V_{REV}	Refer to truth table			b	ON	c	V_{FWD}, V_{STP}, V_{REV} are threshold voltages when output change own states.	V_{FRS}
I_{FWD} I_{REV}							I_{FWD}, I_{REV} are operating input current.	I_{FRS}
G_{ET}	b	b	b	b	OFF	b	G_{ET} is a gain of ET Amp. measure V_S differential under the condition of V_{ET}=2.2~2.3V.	V_S
G_{CS}							G_{CS} is a gain of CS Amp. Measure V_S differential under the condition of V_{CS}=0~15mV.	V_S

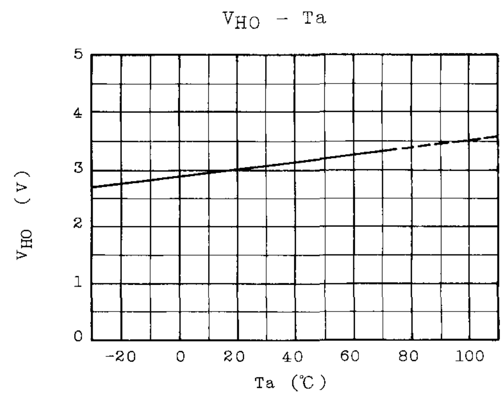
. Diode Forward Drop

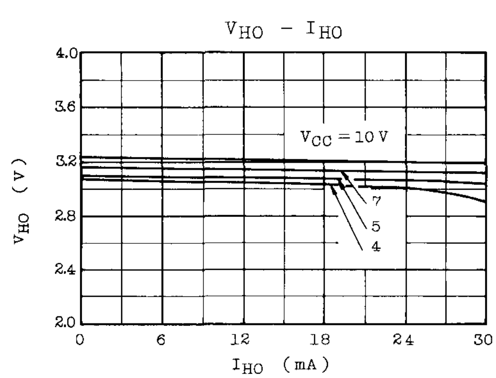
Measure voltage drops between GND and each output under specified condition (I_F=0.7A).

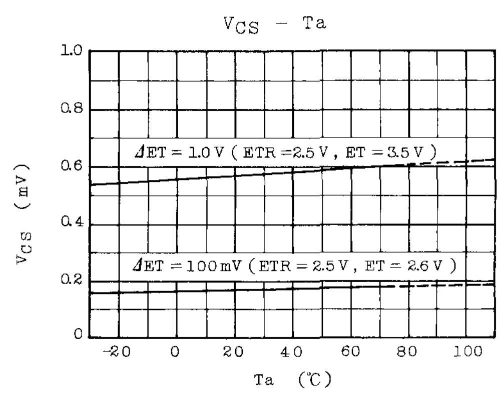

ICC - VCC
F/S : VCC
GND
OPEN
STOP
ICC (mA)
VCC (V)

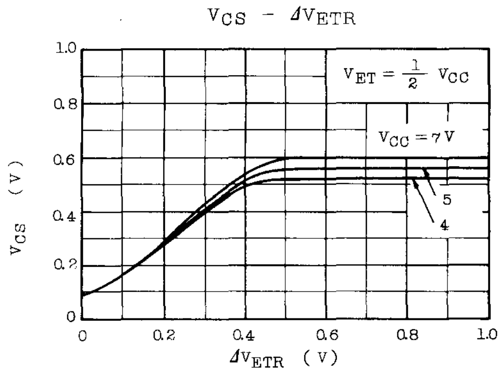

VS - VCS
ET = ETR = 1/2 VCC (2.5 V)
VCC = 3.5 V
4.57
VS (V)
VCS (mV)

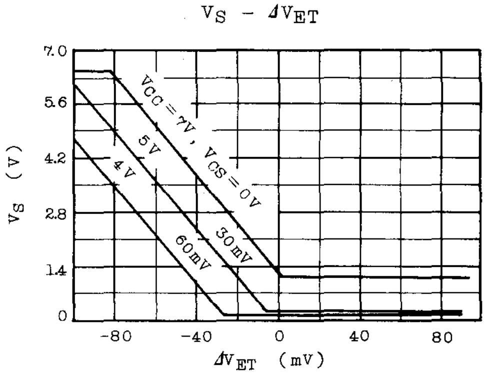

VS - VCS
Ta = 75°C
25
−30
VS (V)
VCS (mV)

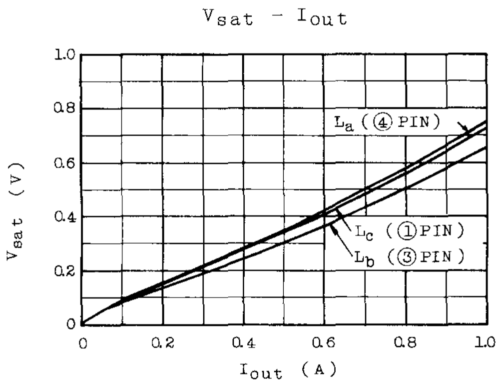

VHO - Ta
VHO (V)
Ta (℃)


VHO - IHO
VCC = 10 V
7
5
4
VHO (V)
IHO (mA)


VCS - Ta
ΔET = 1.0 V (ETR = 2.5 V, ET = 3.5 V)
ΔET = 100 mV (ETR = 2.5 V, ET = 2.6 V)
VCS (mV)
Ta (℃)


VCS - ΔVETR
VET = 1/2 VCC
VCC = 7 V
5
4
VCS (V)
ΔVETR (V)
1.0
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1.0


VS - ΔVET
VCC = 7V, VCS = 0V
5V
4V
30mV
60mV
VS (V)
ΔVET (mV)
7.0
5.6
4.2
2.8
1.4
0
-80
-40
0
40
80

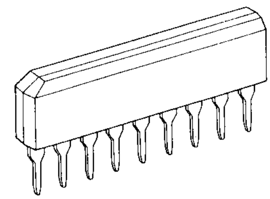

Vsat - Iout
La (④ PIN)
Lc (① PIN)
Lb (③ PIN)
Vsat (V)
Iout (A)
1.0
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1.0

TA8405S

DUAL BRIDGE DRIVER

TA8405S is Dual Bridge Driver designed especially for VCR cassette and tape loading motor drives.

- 4 Modes Available (CW/CCW/STOP/BRAKE)
- Output Current Up to 0.4A (AVE) and 1.0A (PEAK)
- Wide Range of Operating Voltage
  $V_{CC\ opr} = 4.5\sim22V$
  $V_{S\ opr} = 0\sim22V$
- Built-in Thermal Shutdown, Over Current Protector and Punch-Through Current Restriction Circuit.
- Hysteresis for All Inputs.



Weight: 0.92g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

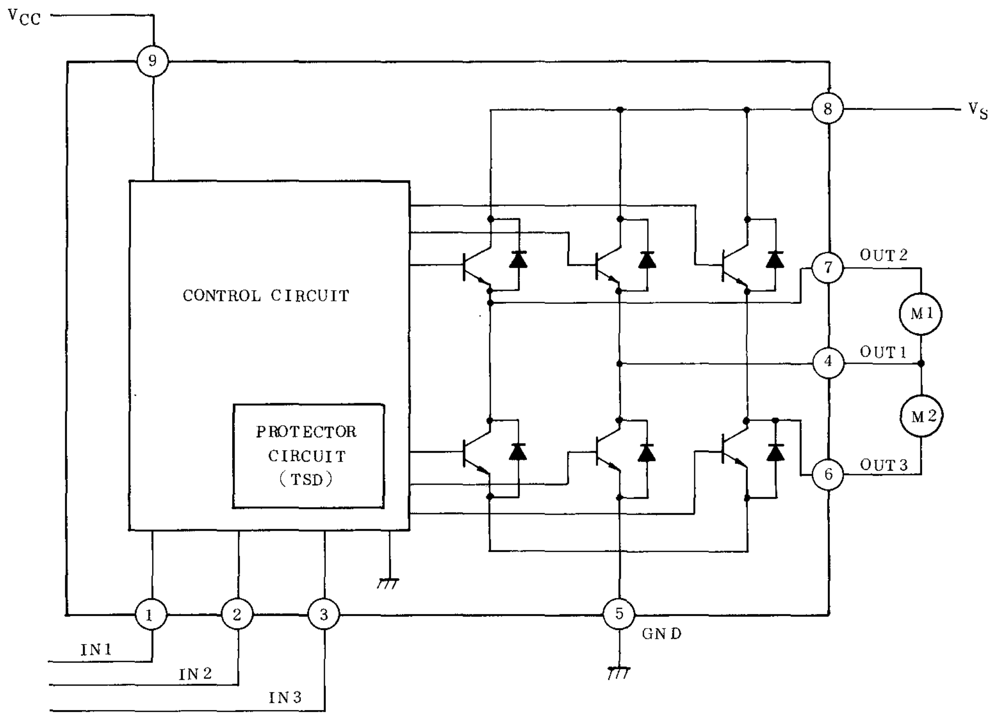
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	25	V
Motor Drive Voltage	V_S	25	V
Output Current	$I_{O(PEAK)}$	1.0 Note 1	A
	$I_{O(AVE)}$	0.4	A
Power Dissipation	P_D	0.75	W
Operating Temperature	T_{opr}	-30~75	°C
Storage Temperature	T_{stg}	-55~150	°C

Note 1: Duty 1/10, 100 msec.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C, V_{CC}=12V, V_S=12V)

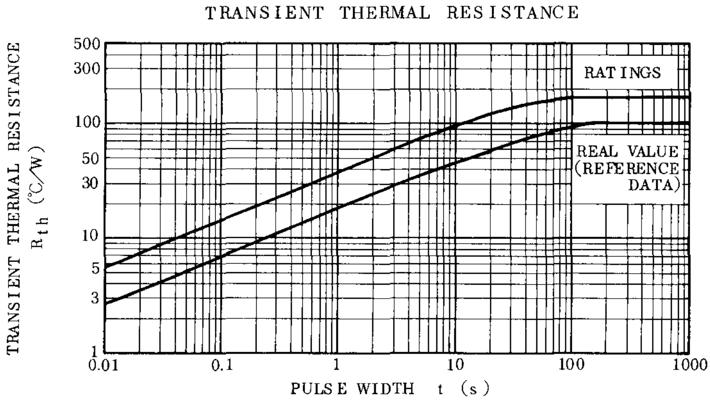
CHRACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}	1	Output off, CW/CCW Mode	-	7	15	mA
		I_{CC2}	1	Output off, Brake Mode	-	15	38	
		I_{CC3}	1	Output off, Stop Mode	-	7	15	
Input Operating Voltage	"H"	V_{IN-H}	2		3.5	-	5.5	V
	"L"	V_{IN-L}	2		0	-	1.2	
Input Current		I_{IN}	2	V_{IN}=GND, Source Mode	-	4	60	μA
Input Hysteresis Voltage		V_{HYS}	2		-	1.5	-	V
Saturation Voltage	Upper	V_{SAT-1U}	3	I_O=0.4A	-	1.0	1.4	V
	Lower	V_{SAT-1L}	3	I_O=0.4A	-	0.3	1.2	
	Upper	V_{SAT-2U}	3	I_O=1.0A,ON LOAD: 20msec	-	1.3	2.3	
	Lower	V_{SAT-2L}	3	I_O=1.0A,ON LOAD: 20msec	-	1.0	1.5	
Leakage Current	Upper	I_{L-U}	5	V_S=25V	-	-	50	μA
	Lower	I_{L-L}	5	V_S=25V	-	-	50	
Diode Forward Voltage	Upper	V_{F-U}	4	I_F=1.0A	-	2.1	-	V
	Lower	V_{F-L}	4	I_F=1.0A	-	1.6	-	
Thermal Shut Down Operating Temperature		T_{SD}	-	Tj	-	130	-	°C

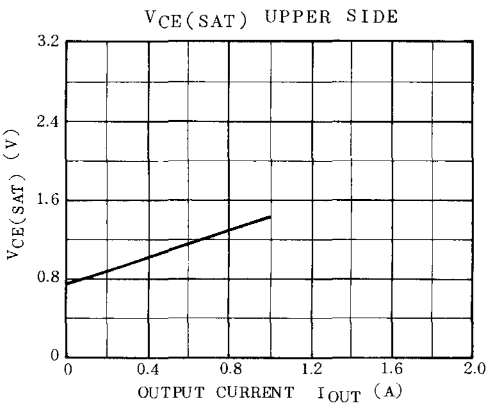
BLOCK DIAGRAM

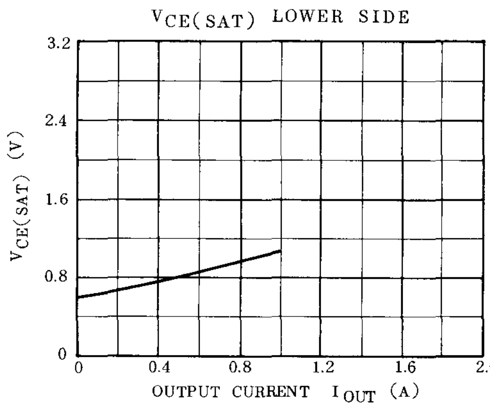


INPUT *			OUTPUT			MODE	
IN 1	IN 2	IN 3	OUT 1	OUT 2	OUT 3	M1	M2
0	0	1/0	∞ **	∞	∞	STOP	STOP
1	0	0	H	L	∞	CW/CCW	STOP
1	0	1	L	H	∞	CCW/CW	STOP
0	1	0	H	∞	L	STOP	CW/CCW
0	1	1	L	∞	H	STOP	CCW/CW
1	1	1/0	L	L	L	BRAKE	BRAKE

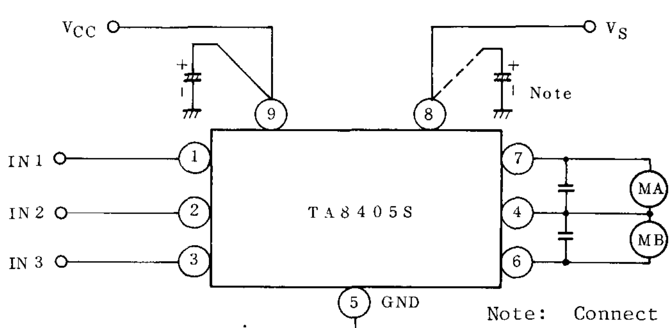
*: Inputs are all low active type.
**: ∞: High impedance





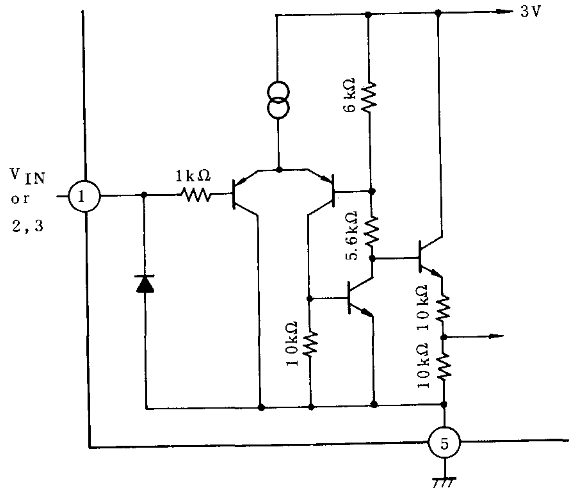


APPLICATION CIRCUIT

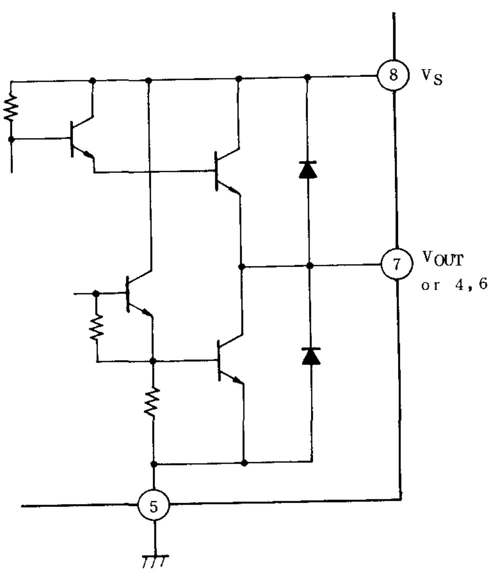


Note: Connect if required

(1) INPUT CIRCUIT

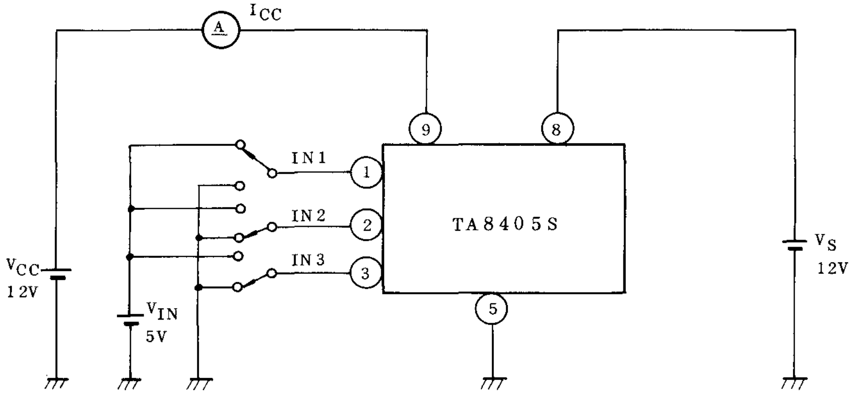


(2) OUTPUT CIRCUIT



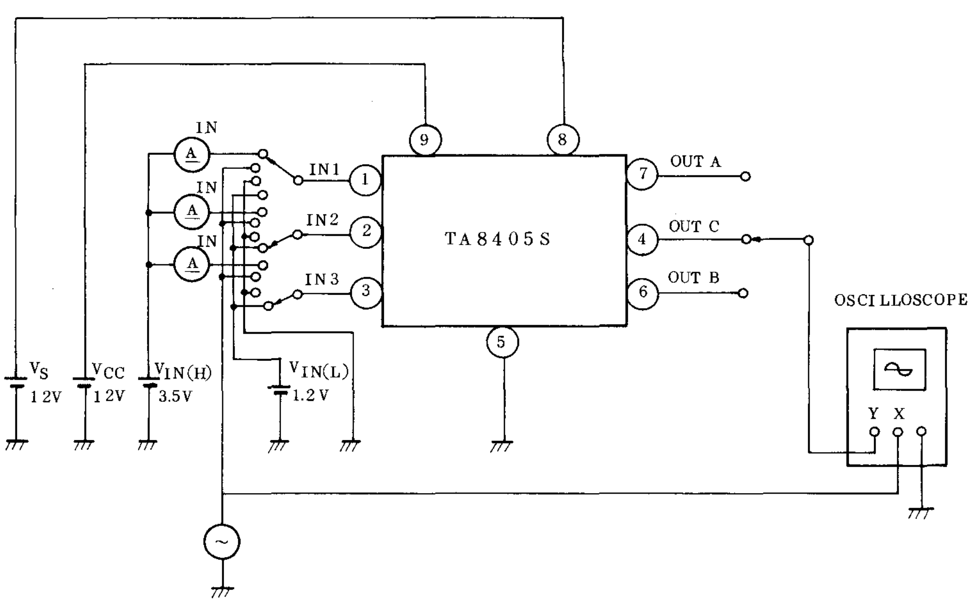
TEST CIRCUIT 1

$I_{CC}1, 2, 3$



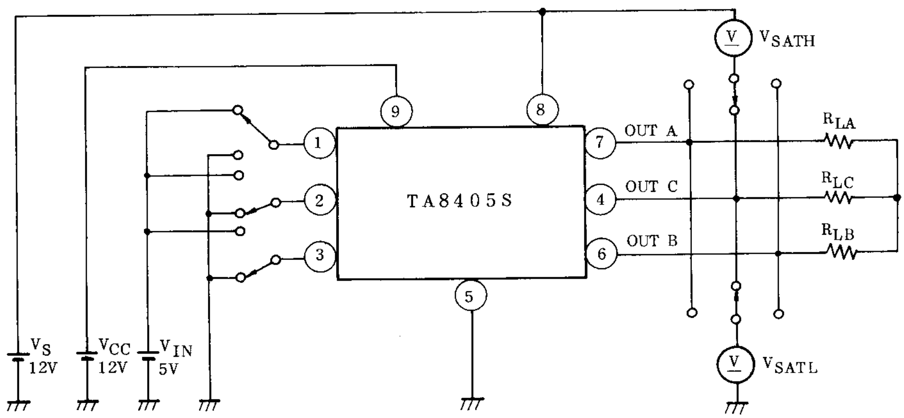
TEST CIRCUIT 2

$V_{IN}1, 2$, I_{IN}, ΔV_T



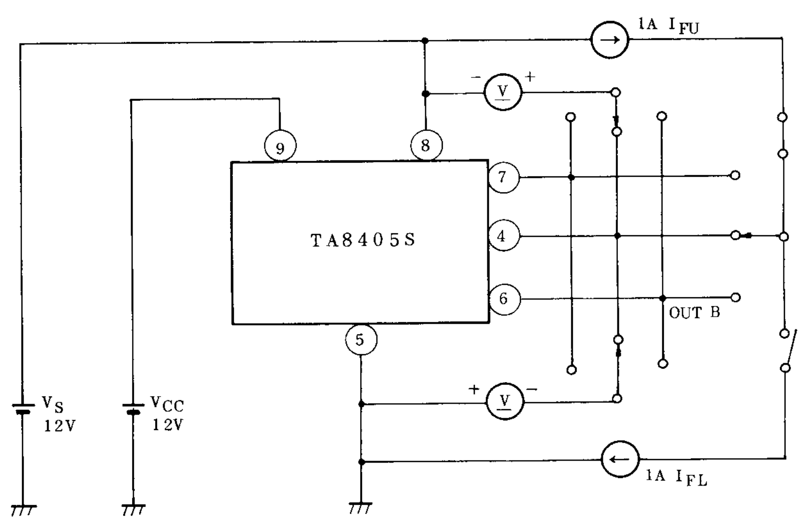
TEST CIRCUIT 3

V_{SAT} U-1, L-1, U-2, L-2



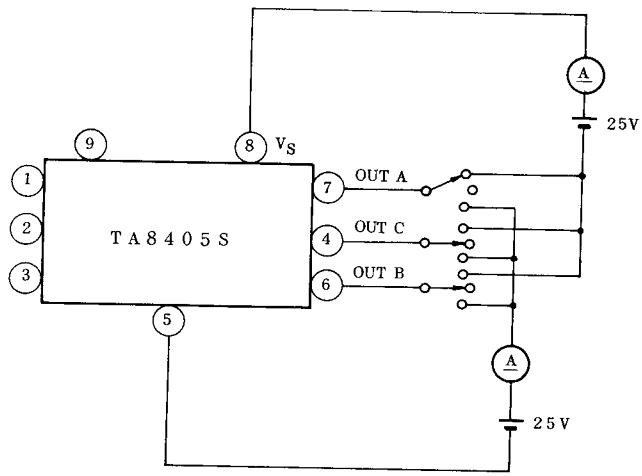
TEST CIRCUIT 4

V_F U, L



TEST CIRCUIT 5

$I_{L\ U,L}$

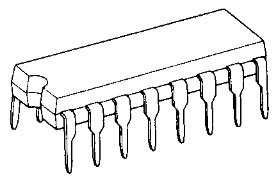


TA8406F/P

DUAL POWER OPERATIONAL AMPLIFIER

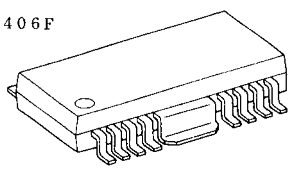
TA8406P/F are dual power operational amplifier. It is intended for use especially DC MOTOR positioning system applications such as Arm Driver (for Audiodisk Players), head or voice coil motor drivers (for Floppy and Winchester Disk Drivers) and any other power driver applications.

TA8406P



DIP16-P-300A

TA8406F



HSOP16-P-300

FEATURES

- Built-in Over Current Protector
- Few External Parts are Required.
- Output Current Up to 0.5A(AVE) and 1.0A(PEAK)
- Excellent Crosstalk Characteristics

Weight:

DIP16-P-300A: 1.11g (Typ.)
HSOP16-P-300: 0.50g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}, V_{EE}	±18	V
Output Current		I_O(AVE)	0.5	A
Power Dissipation	TA8406P	P_D	1.4	W
			2.7 Note1	
	TA8406F		1.4 Note2	
Operating Temperature		Topr	-30~75	°C
Storage Temperature		Tstg	-55~150	°C

Note 1. This value is obtained by 50 × 50×0.8mm PCB mounting occupied in excess of 60% of copper area.

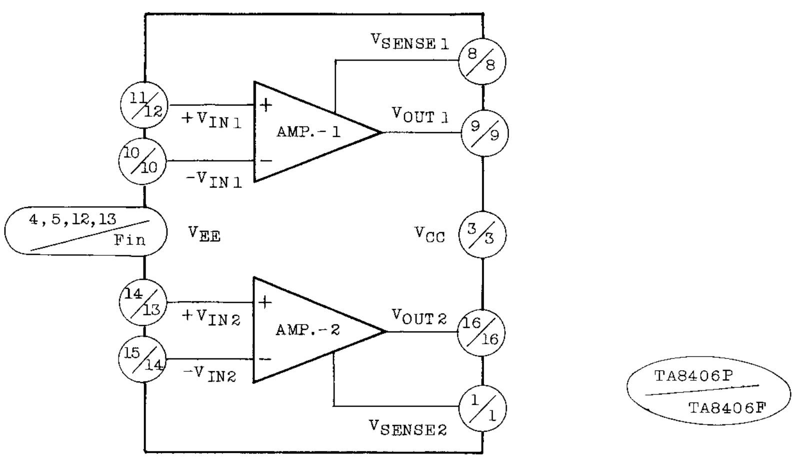
Note 2. This value is obtained by 60 × 30 × 1.6mm PCB mounting occupied in excess of 50% of copper area.

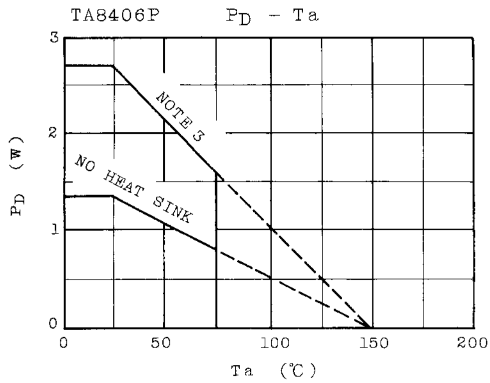
ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=15V, V_{EE}=-15V, Ta=25°C)

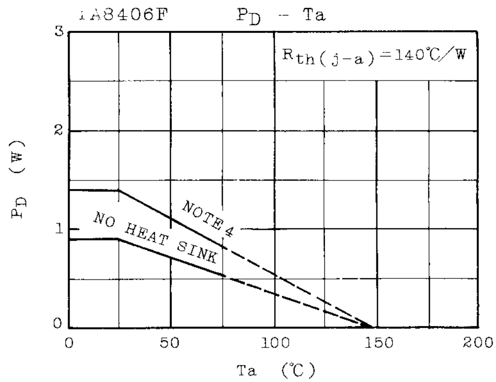
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC}			-	10	20	mA
Input Off Set Current		I_{IO}			-	10	200	nA
Input Bias Current		I_I			-	100	700	nA
Input Off Set Voltage		V_{IO}			-	2	6	mV
Output Voltage Swing	Upper	V_{OH}	-	R_L=33Ω	12.0	13.0	-	V
	Lower	V_{OL}			-12.0	-13.0	-	
Open Loop Gain		B_{VO}			-	100	-	dB
Input Common Mode Voltage Range		CMR			±12	±14	-	
Common Mode Rejection Ratio		CMRR			70	90	-	dB
Supply Voltage Rejection Ratio		SVRR			-	50	150	μV/V
Slew Rate		SL		G_V=0, R_L=33Ω, R=10Ω, C=0.1μF	-	0.15	-	V/μsec
Short Circuit Current		I_{SC}		R_{SC}=2.2Ω	-	0.35	-	A
Cross Talk		CT		R_L=33Ω, Vout=1Vp-p	-	60	-	dB

BLOCK DIAGRAM



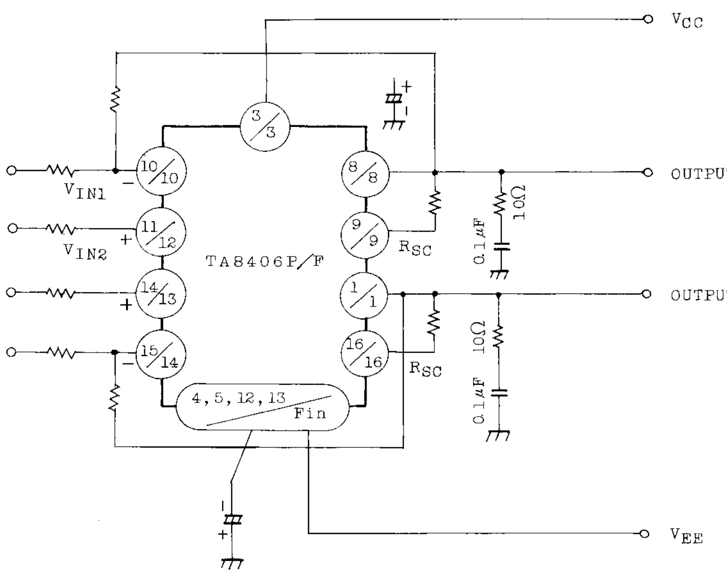


Note 3. 50 × 50 × 0.8mm PCB mounting occupied copper area in excess of 60%.

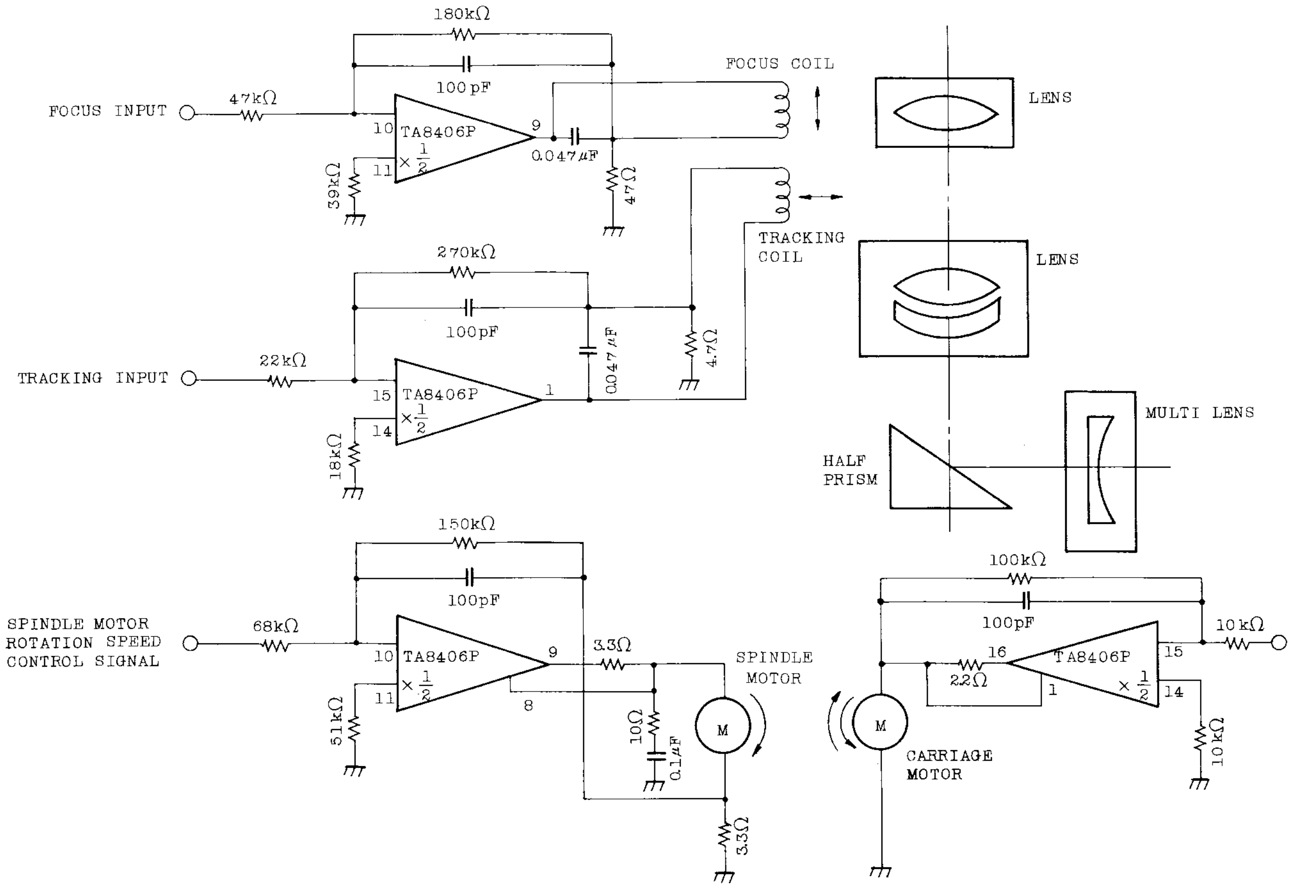


Note 4. 60 × 30 × 1.6mm PCB mounting occupied copper area in excess of 50%.

APPLICATION CIRCUIT 1



APPLICATION CIRCUIT 2 (Compact Disk Player Motor System)

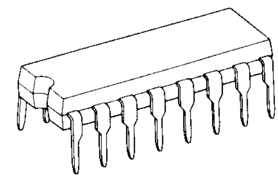


TA8407F/P

DUAL POWER OPERATIONAL AMPLIFIER

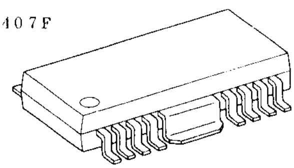
TA8407P/F are dual power operational amplifier.
It is intended for use especially DC MOTOR positioning system applications, such as Arm Driver (for Audiodisk Players), head or voice coil motor drivers(for Floppy and Winchester Disk Drivers) and any other power driver applications.

TA8407P



DIP16-P-300A

TA8407F



HSOP16-P-300

Weight:

DIP16-P-300A: 1.11g (Typ.)
HSOP16-P-300: 0.50g (Typ.)

FEATURES

. Built-in Over Current Protector
. Few External Parts are Required
. Output Current Up to 1.2A Max. (AVE)
. Excellent Crosstalk Characteristics

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}, V_{EE}	±18	V
Output Current (Note 1)		I_O(AVE)	1.2	A
Power Dissipation	TA8407P	P_D	1.4	W
			2.7 Note 1	
	TA8407F		1.4 Note 2	
Operating Temperature		Topr	-30~75	°C
Storage Temperature		Tstg	-55~150	°C

Note 1. This value is obtained by 50 × 50 × 0.8mm PCB mounting occupied in excess of 60% of copper area.

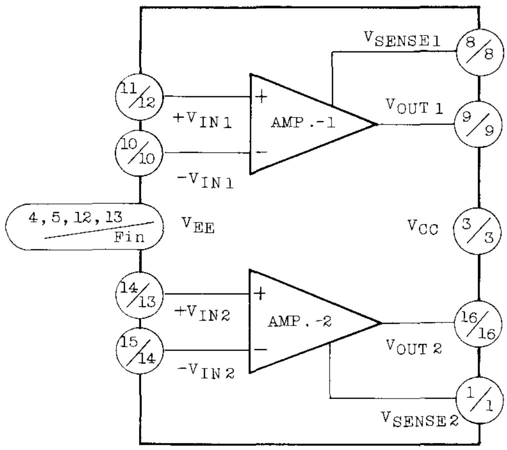
Note 2. This value is obtained by 60 × 30 × 1.6mm PCB mounting occupied in excess of 50% of copper area.

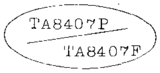
ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=15V, V_{EE}=-15V, Ta=25°C)

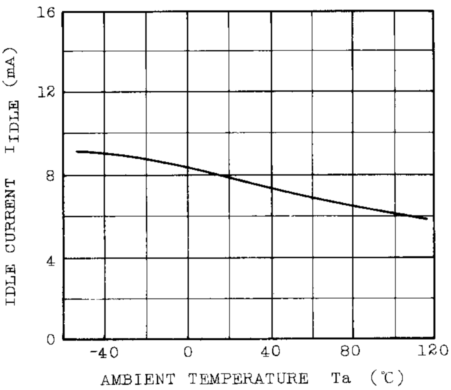
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC}			-	20	35	mA
Input Off Set Current		I_{IO}			-	2	100	nA
Input Bias Current		I_I			-	50	300	nA
Input Off Set Voltage		V_{IO}			-	1.0	7.0	mV
Output Voltage Swing	Upper	V_{OH}		V_{CC}=±15V, I_O=0.3A	11.5	12.1	-	V
	Lower	V_{OL}			-11.5	-12.3	-	
	Upper	V_{OH}		V_{CC}=±6V, I_O=1A	2.2	3.3	-	V
	Lower	V_{OL}			-2.2	-3.7	-	
Open Loop Gain		GVO			-	90	-	dB
Input Common Mode Voltage Range		CMR			-	±14	-	V
Common Mode Rejection Ratio		CMRR			-	95	-	dB
Supply Voltage Rejection Ratio		SVRR			-	45	150	μV/V
Slew Rate		SL			-	0.4	-	V/μsec
Short Circuit Current		I_{SC}		R_{SC}=0.68Ω	0.8	1.0	-	A
Cross Talk		CT			-	60	-	dB

BLOCK DIAGRAM

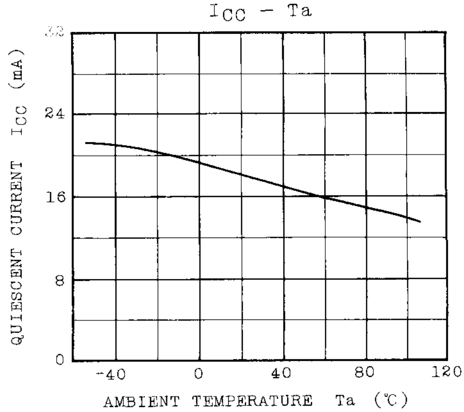




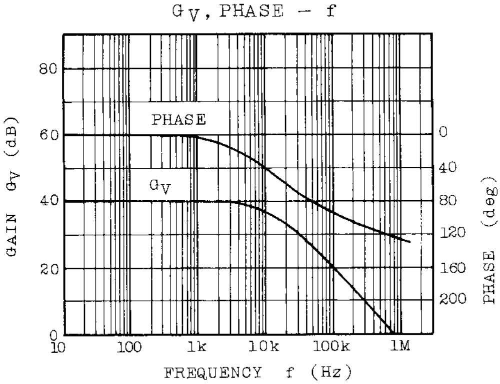
I_{IDLE} – Ta



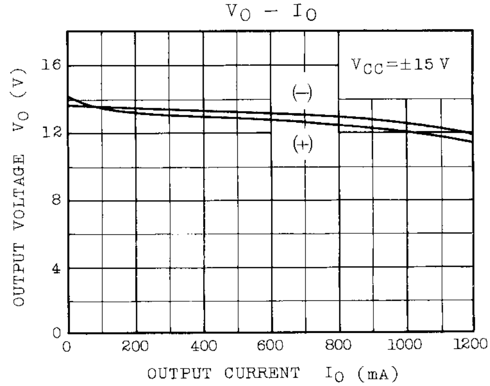
I_{CC} – Ta



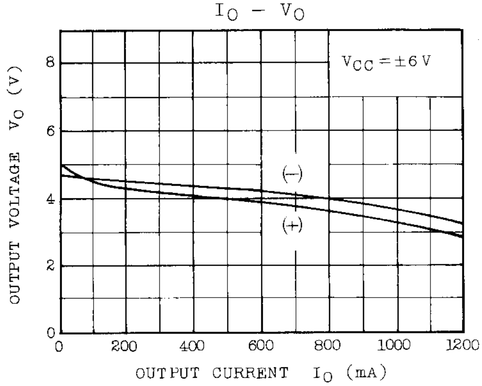
G_V, PHASE – f



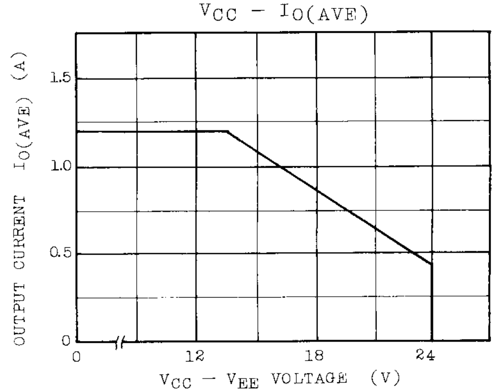
V_O – I_O

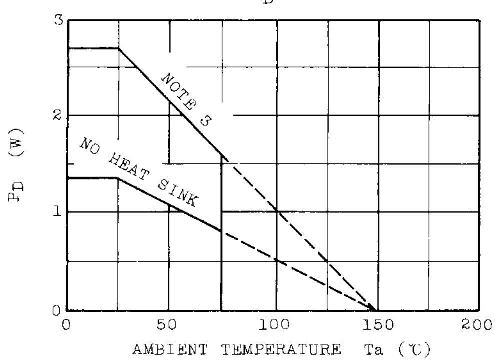


I_O – V_O

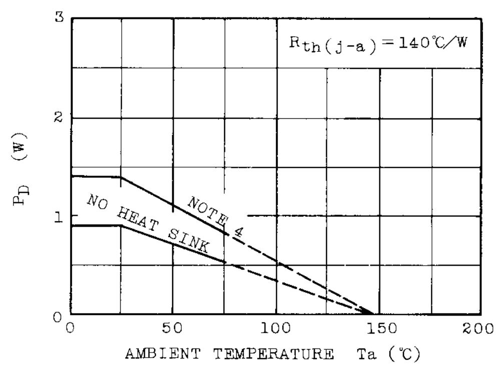


V_{CC} – $I_{O(AVE)}$



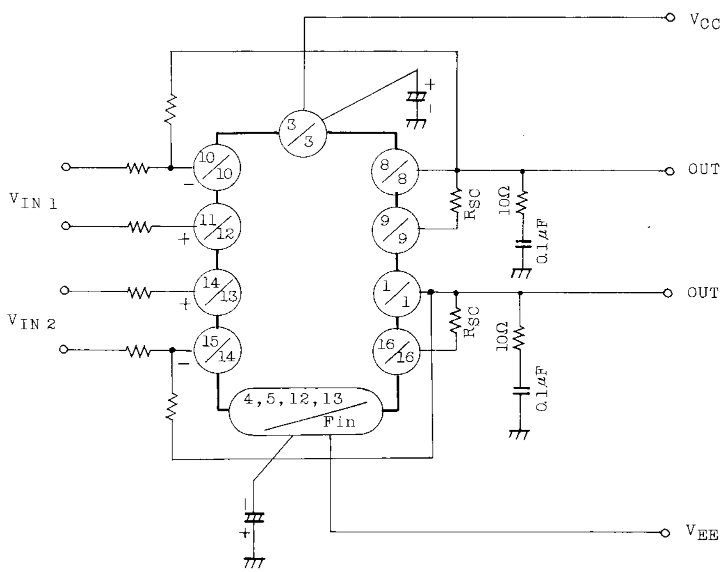


Note 3. 50 × 50 × 0.8mm PCB mounting occupied copper area in excess of 60%.



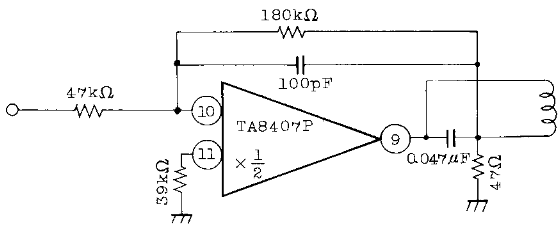
Note 4. 60 × 30 × 1.6mm PCB mounting occupied copper area in excess of 50%.

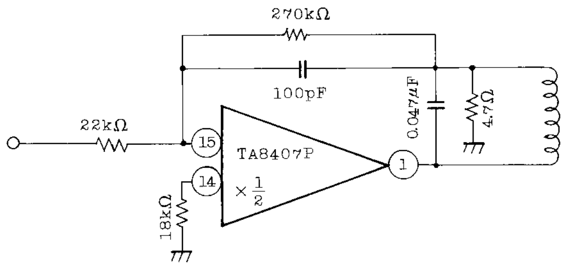
APPLICATION CIRCUIT 1



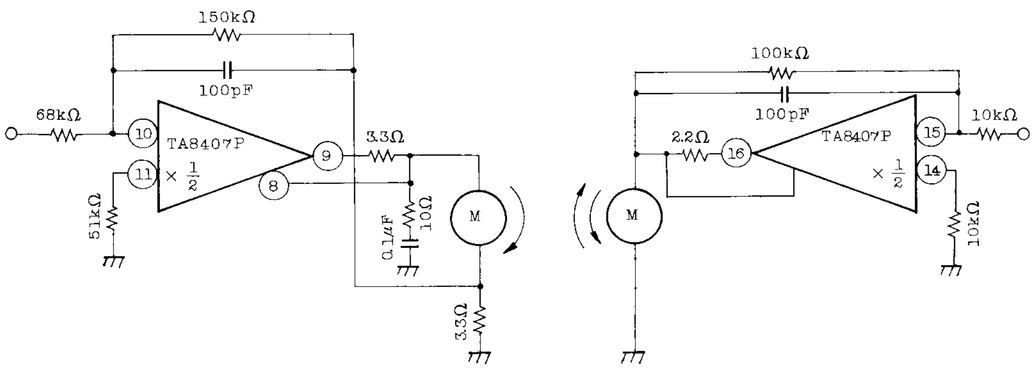
NOTE 1. $I_{SC} \fallingdotseq \frac{0.7\ (V)}{R_{SC}\ (\Omega)}$ (A)

APPLICATION CIRCUIT 2. (Actuator)





APPLICATION CIRCUIT 3. (Speed and Carriage Control)



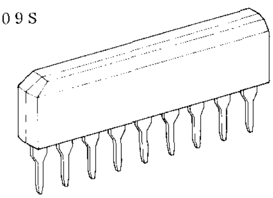
TA8409F/S

BRIDGE DRIVER

TA8409S/F are Bridge Driver with output voltage control.

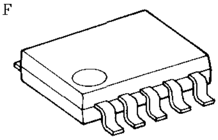
. Modes available (CW/CCW/STOP/BRAKE)
. Output current up to 0.4A(AVE) and 1.0A(PEAK)
. Wide range of operating voltage
  V_{CC} opr=4.5~20V
  V_S opr=0~20V
  V_{ref} opr=0~20V
. Built-in thermal shutdwon and over current protector
. Standby mode available (STOP MODE)
. Hysteresis for all inputs

TA8409S



SIP9-P-A

TA8409F



SSOP10-P-225

Weight:
SIP9-P-A : 0.92g (Typ.)
SSOP10-P-225: 0.09g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

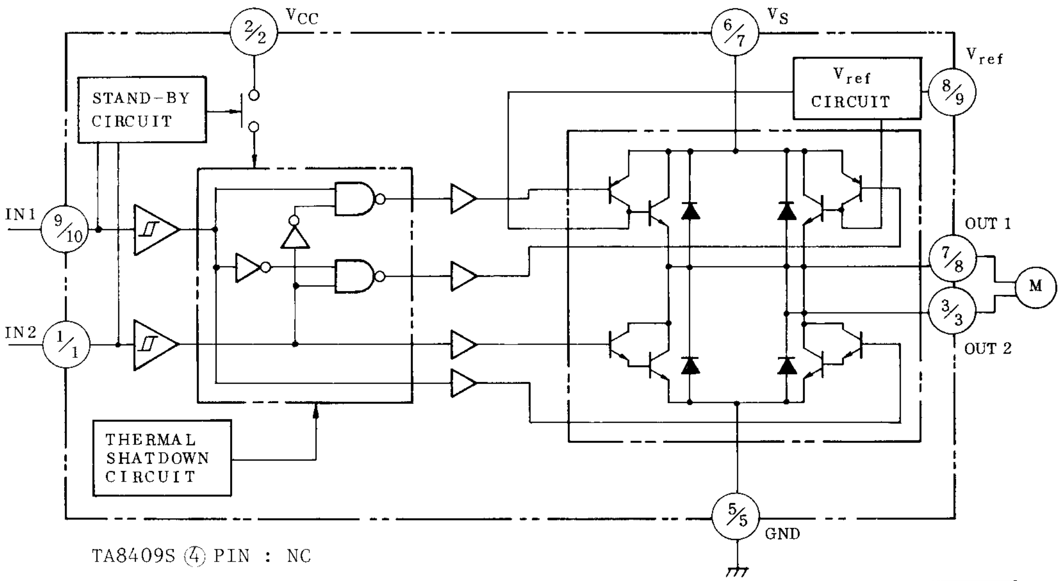
CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	25	V
		V_S	25	
Reference Voltage		V_{ref}	25	V
Output Current	PEAK	$I_{O(PEAK)}$	1.0	A
	AVE	$I_{O(AVE)}$	0.4	
Power Dissipation	TA8409F	P_D	0.735 (Note)	W
	TA8409S		0.75	
Operating Temperature		T_{opr}	-30~75	°C
Storage Temperature		T_{stg}	-55~150	°C

Note: This rating is obtained by mounting on 50 × 50 × 0.8mm PCB that occupied above 30% of copper area.

ELECTRICAL CHARACTERISTICS ($Ta=25°C$, $V_{CC}=12V$, $V_S=18V$)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}	1	Output OFF, CW/CCW Mode	-	10.0	15.0	mA
		I_{CC2}	1	Output OFF, STOP Mode	-	0	50	μA
		I_{CC3}	1	Output OFF, BRAEK Mode	-	6.5	10.0	mA
Input Operating Voltage	1 (High)	V_{IN1}	2	Tj=25°C IN1,2	3.5	-	5.5	V
	2 (Low)	V_{IN2}	2	Tj=25°C IN1,2	GND	-	0.8	
Input Current		I_{IN}	2	Sink Mode, $V_{IN}=3.5V$	-	3	10	μA
Input Hysteresis Voltage		ΔV_T	2		-	0.7	-	V
Saturation Voltage	Upper Side	$V_{SAT\ U-1}$	3	$V_{ref}=V_S$, $V_{OUT}-V_S$ Measure $I_O=0.2A$, CW/CCW Mode	-	0.9	1.2	V
	Lower Side	$V_{SAT\ L-1}$	3	$V_{ref}=V_S$, V_{OUT}-GND Measure $I_O=0.2A$, CW/CCW Mode	-	0.8	1.2	
	Upper Side	$V_{SAT\ U-2}$	3	$V_{ref}=V_S$, $V_{OUT}-V_S$ Measure $I_O=0.4A$, CW/CCW Mode	-	1.0	1.35	
	Lower Side	$V_{SAT\ L-2}$	3	$V_{ref}=V_S$, V_{OUT}-GND Measure $I_O=0.4A$, CW/CCW Mode	-	0.9	1.35	
Output Voltage		$V_{SAT\ U-1}'$	3	$V_{ref}=10V$, V_{OUT}-GND Measure $I_O=0.2A$	10.4	11.2	12.2	V
		$V_{SAT\ U-2}'$	3	$V_{ref}=10V$, V_{OUT}-GND Measure $I_O=0.4A$	-	10.9	-	
Leakage Current	Upper Side	$I_{L\ U}$	4	$V_L=25V$	-	-	50	μA
	Lower Side	$I_{L\ L}$	4	$V_L=25V$	-	-	50	
Diode Forward Voltage	Upper Side	$V_{F\ U-1}$	5	$I_F=0.4A$	-	1.5	-	V
	Lower Side	$V_{F\ L-1}$	5	$I_F=0.4A$	-	0.9	-	
Reference Current		Iref	2	Vref=10V, Source Mode	-	20	40	μA

BLOCK DIAGRAM



TA8409S ④ PIN : NC

TA8409F ④ , ⑥ PIN : NC

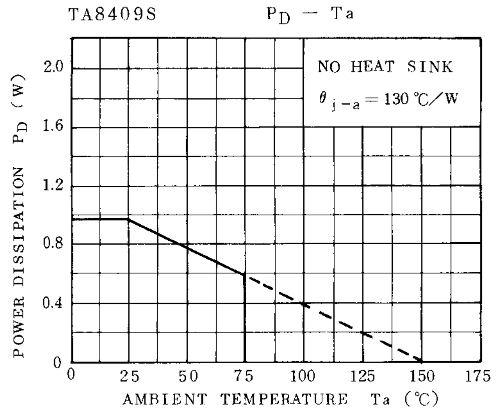
TA8409S/TA8409F

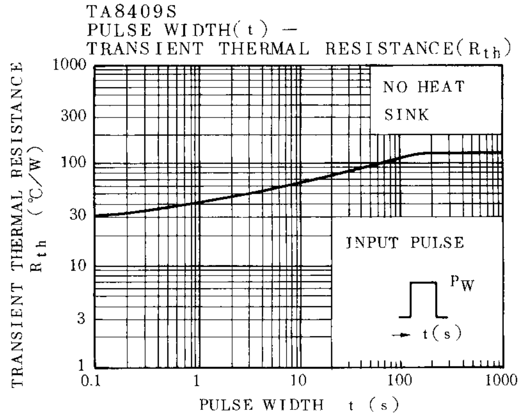
FUNCTION

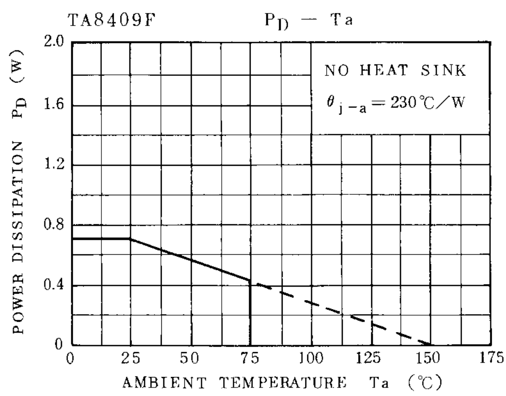
INPUT (Note)		OUTPUT		MODE
IN1	IN2	OUT1	OUT2	MOTOR
0	0	∞	∞	STOP
1	0	H	L	CW/CCW
0	1	L	H	CCW/CW
1	1	L	L	BRAEK

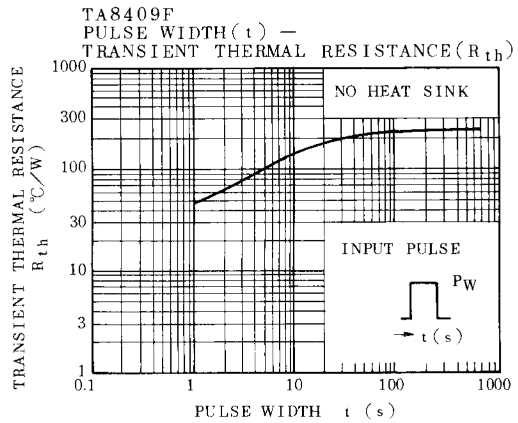
∞ : High Impedance

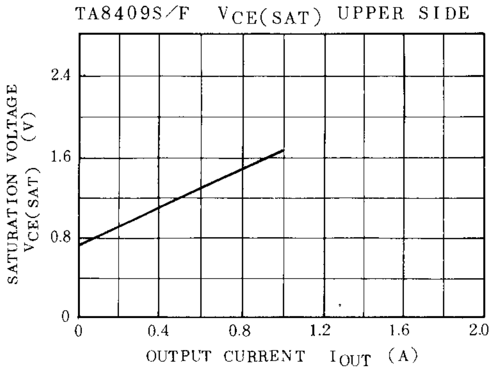
(Note) Inputs are all high active type.

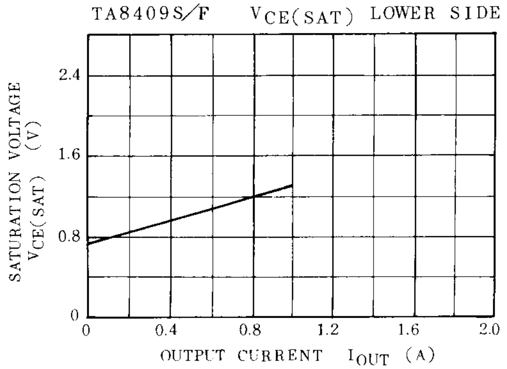

TA8409S
P_D — Ta
NO HEAT SINK
θ_{j-a} = 130℃/W
POWER DISSIPATION P_D (W)
2.0
1.6
1.2
0.8
0.4
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)


TA8409S
PULSE WIDTH(t) —
TRANSIENT THERMAL RESISTANCE(R_{th})
NO HEAT SINK
INPUT PULSE
P_W
t(s)
TRANSIENT THERMAL RESISTANCE R_{th} (℃/W)
1000
300
100
30
10
3
1
0.1
1
10
100
1000
PULSE WIDTH t (s)

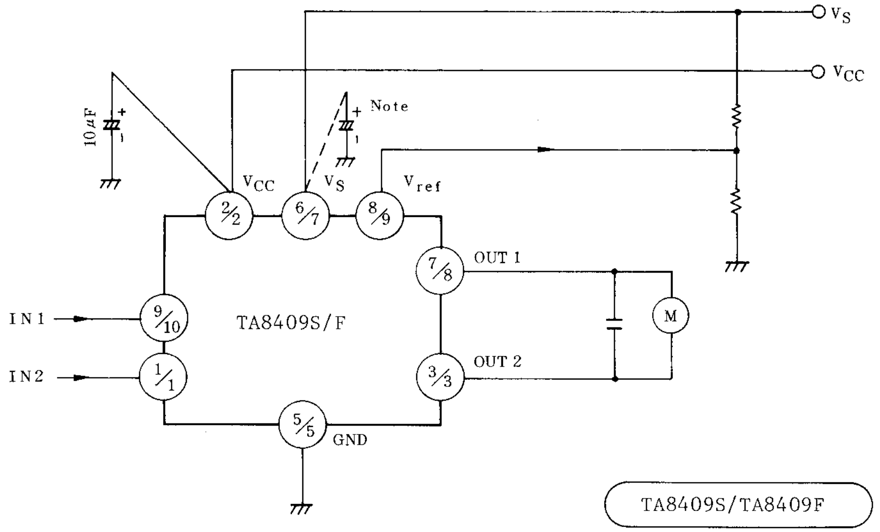

TA8409F
P_D — Ta
NO HEAT SINK
θ_{j-a} = 230℃/W
POWER DISSIPATION P_D (W)
2.0
1.6
1.2
0.8
0.4
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)


TA8409F
PULSE WIDTH(t) —
TRANSIENT THERMAL RESISTANCE(R_{th})
NO HEAT SINK
INPUT PULSE
P_W
t(s)
TRANSIENT THERMAL RESISTANCE R_{th} (℃/W)
1000
300
100
30
10
3
1
0.1
1
10
100
1000
PULSE WIDTH t (s)


TA8409S/F $V_{CE(SAT)}$ UPPER SIDE
SATURATION VOLTAGE $V_{CE(SAT)}$ (V)
2.4
1.6
0.8
0
0
0.4
0.8
1.2
1.6
2.0
OUTPUT CURRENT I_{OUT} (A)


TA8409S/F $V_{CE(SAT)}$ LOWER SIDE
SATURATION VOLTAGE $V_{CE(SAT)}$ (V)
2.4
1.6
0.8
0
0
0.4
0.8
1.2
1.6
2.0
OUTPUT CURRENT I_{OUT} (A)

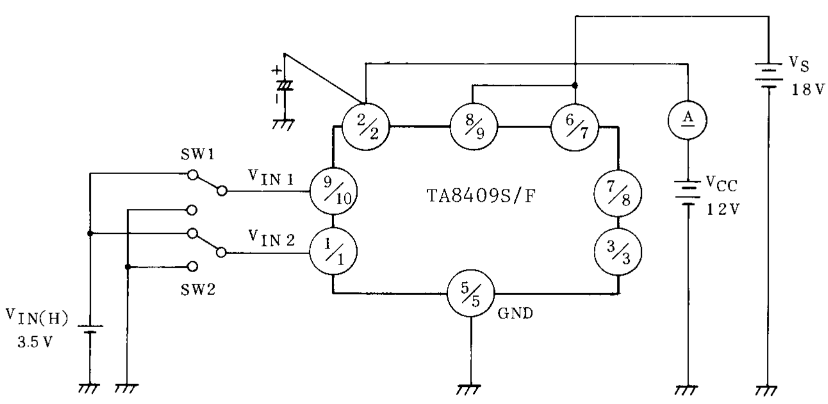
APPLICATION CIRCUIT



(Note) Connect if required.

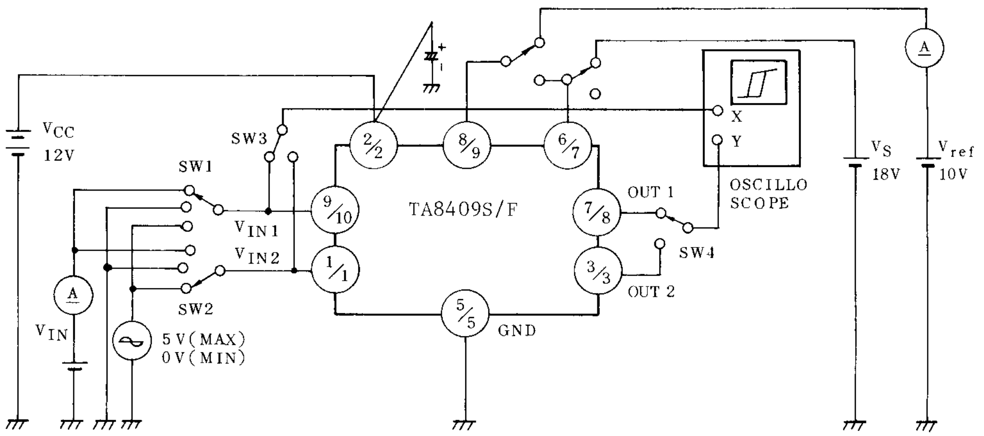
TEST CIRCUIT 1

I_{CC1}, I_{CC2}, I_{CC3}



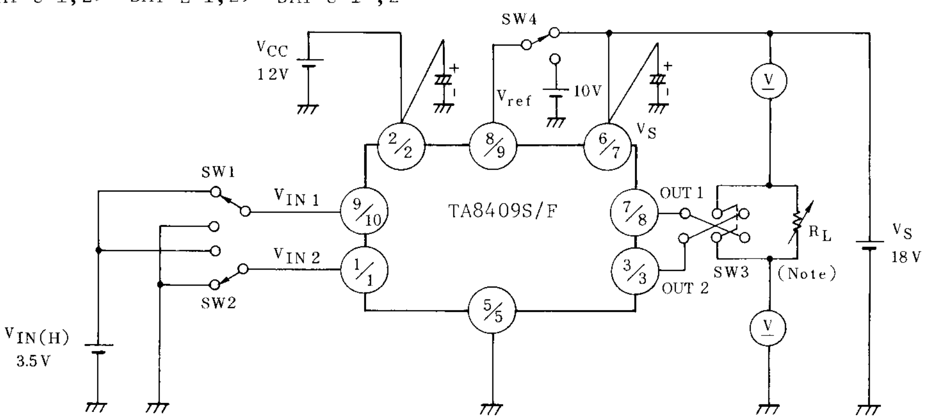
TEST CIRCUIT 2

V_{IN1}, V_{IN2}, I_{IN}, ΔV_T, I_{ref}



TEST CIRCUIT 3

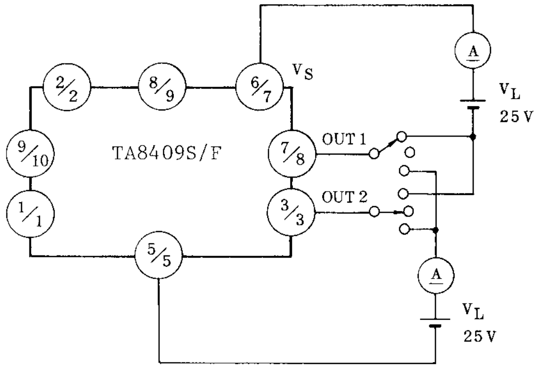
V_{SAT} U-1,2, V_{SAT} L-1,2, V_{SAT} U-1',2'



(Note) Calibrate I_{OUT} to 0.2/0.4A by R_L.

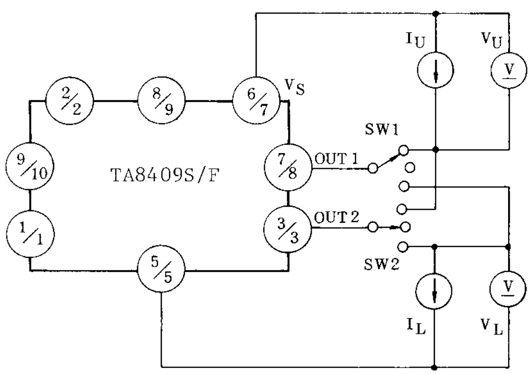
TEST CIRCUIT 4

I_L U,L



TEST CIRCUIT 5

V_F U-1,2, V_F L-1,2



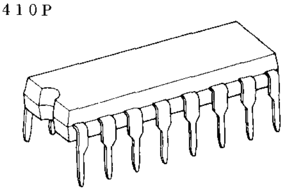
TA8410AK/F/K/P

DUAL POWER OPERATIONAL AMPLIFIER

TA8410 series are a dual power operational amplifier. It is intended for use especially DC MOTOR positioning system applications such as Arm Driver (for Audiodisk Players), head or voice coil motor drivers (for Floppy and Hard Disk Drivers) and any other power driver applications.

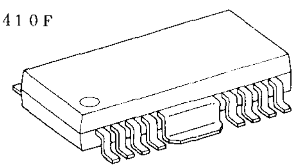
- Built-in Over Current Protector
- Few External Parts Required
- Output Current Up to 0.6A (AVE)
- Package TA8410P DIP 16
  TA8410F PFP 16
  TA8410K/AK S-SIP 10

TA8410P



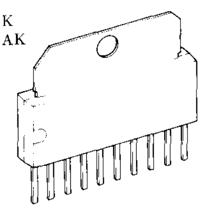
DIP16-P-300A

TA8410F



HSOP16-P-300

TA8410K
TA8410AK



HSIP10-P

Weight:

DIP16-P-300A: 1.0g (Typ.)
HSOP16-P-300: 0.5g (Typ.)
HSIP10-P : 3.0g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage	TA8410P TA8410F TA8410K	V_{CC} V_{EE}	±9	V
	TA8410AK		±15	
Output Current		$I_{O(AVE)}$	0.6	A
Power Dissipation	TA8410P	P_D	1.4, 2.7 (Note 1)	W
	TA8410F		1.4 (Note 2)	
	TA8410K TA8410AK		12.5 (Note 3)	
Storage Temperature		T_{stg}	-55~150	°C
Operating Temperature		T_{opr}	-30~75	°C

(Note 1) 50 × 50 × 0.8mm PCB mounting occupied copper area in excess of 60%.

(Note 2) 60 × 30 × 1.6mm PCB mounting occupied copper area in excess of 50%.

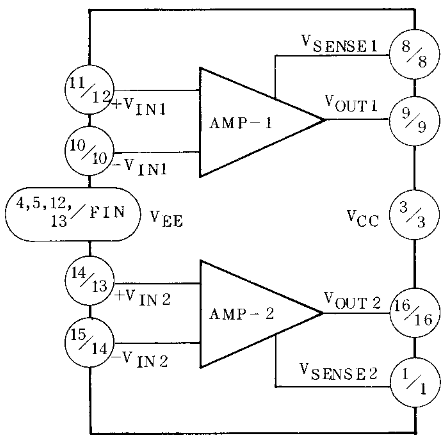
(Note 3) Tc=25°C

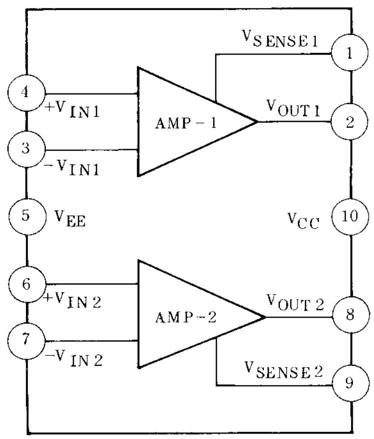
ELECTRICAL CHARACTERISTICS

Unless otherwise specified, Ta=25°C, (TA8410P/F/K, V_{CC}=9V, V_{EE}=-9V)
(TA8410AK, V_{CC}=15V, V_{EE}=-15V)

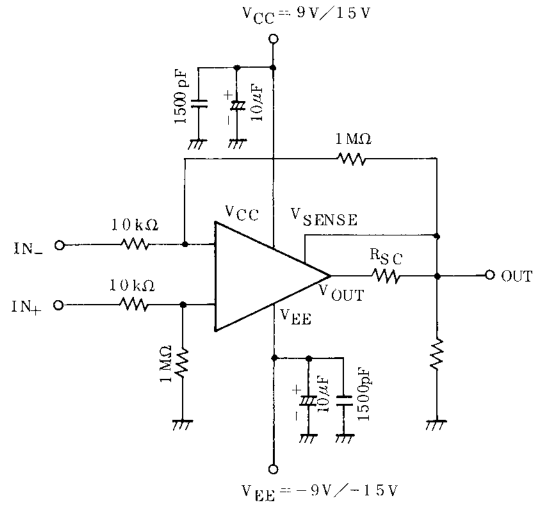
CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current			I_{CC}	-		-	7	18	mA
Input Off Set Current			I_{IO}	-		-	0	100	nA
Input Bias Current			I_I	-		-	100	700	nA
Input Off Set Voltage			V_{IO}	-		-	0	6	mV
Output Voltage Swing	TA8410P TA8410F TA8410K	Upper	V_{OH-1}	-	$R_L=\infty$	7.4	7.6	-	V
			V_{OH-2}		I_O=0.6A	5.5	6.2	-	
		Lower	V_{OL-1}		$R_L=\infty$	7.4	7.7	-	
			V_{OL-2}		I_O=0.6A	5.6	6.2	-	
	TA8410AK	Upper	V_{OH-1}	-	$R_L=\infty$	13.0	13.6	-	
			V_{OH-2}		I_O=0.6A	11.0	11.6	-	
		Lower	V_{OL-1}		$R_L=\infty$	13.0	13.6	-	
			V_{OL-2}		I_O=0.6A	11.0	11.7	-	
Open Loop Gain			G_{VO}	-		-	100	-	dB
Input Common Mode Voltage Range	TA8410P TA8410F TA8410K		CMR	-	G_V=40dB	±8.0	±8.3	-	V
	TA8410AK		CMR	-	G_V=40dB	±14.0	±14.3	-	
Common Mode Rejection Ratio			CMRR	-		70	82	-	dB
Supply Voltage Rejection Ratio			SVRR	-		76	90	-	dB
Unity Gain Cross Frequency			fT	-	Open Loop	-	1.0	-	MHz
Slew Rate			SL	-	R_L=33Ω	-	0.5	-	V/μs
Short Circuit Current			I_{SC}	-	R_{SC}=1.0Ω	-	0.6	-	A
Cross Talk			CT	-	R_L=33Ω, V_{OUT}=1Vp-p	-	60	-	dB

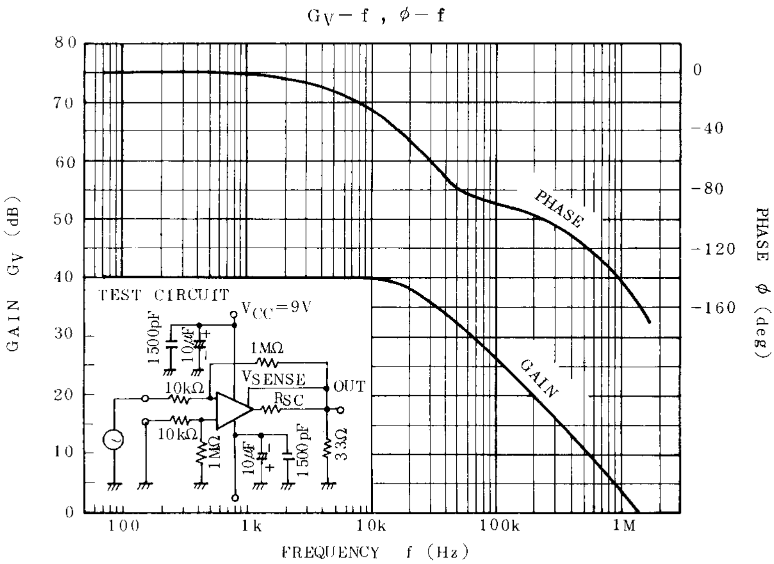
BLOCK DIAGRAM, PIN CONNECTIONS

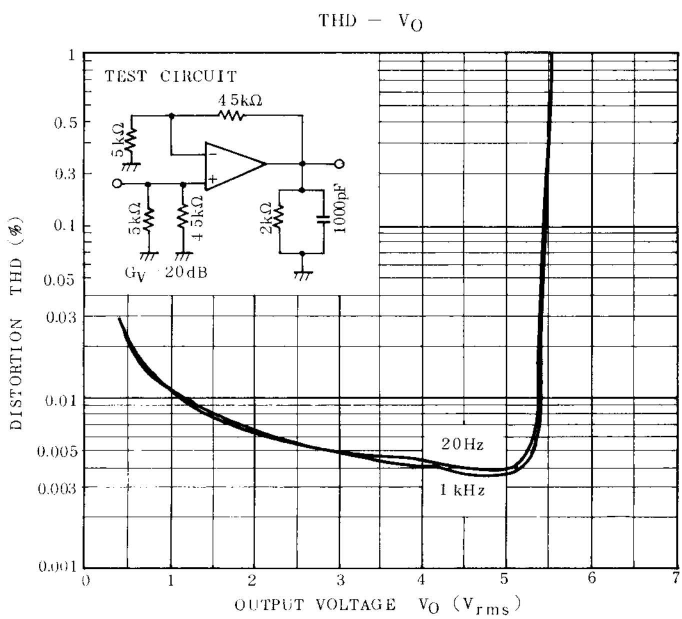


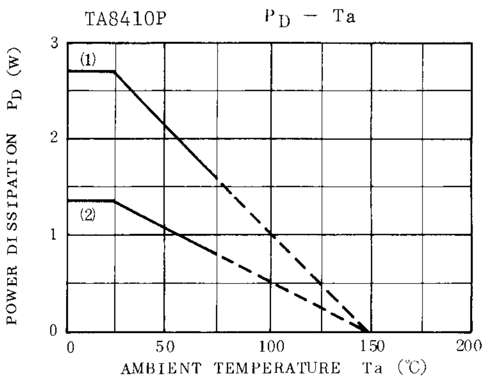


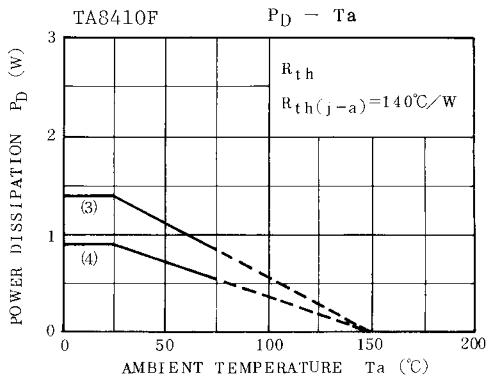
TEST CIRCUIT




GV − f , φ − f
GAIN GV (dB)
PHASE φ (deg)
FREQUENCY f (Hz)
PHASE
GAIN
TEST CIRCUIT
VCC=9V
1500pF
10μF
1MΩ
VSENSE
OUT
10kΩ
RSC
10kΩ
1MΩ
10μF
1500pF
3.3Ω


THD − VO
DISTORTION THD (%)
OUTPUT VOLTAGE VO (Vrms)
TEST CIRCUIT
45kΩ
5kΩ
5kΩ
45kΩ
2kΩ
1000pF
GV 20dB
20Hz
1 kHz



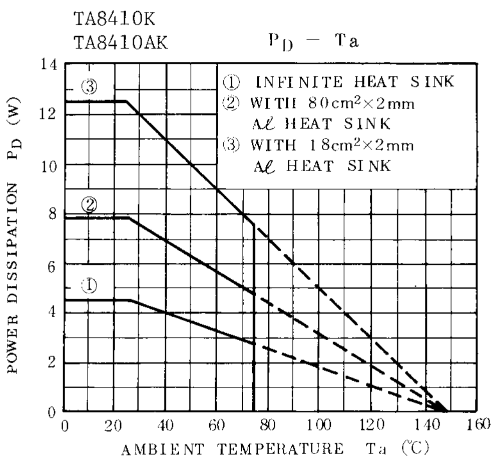


(1) 50 × 50 × 0.8mm PCB mounting occupid copper area in excess of 60%.

(2) No heat sink

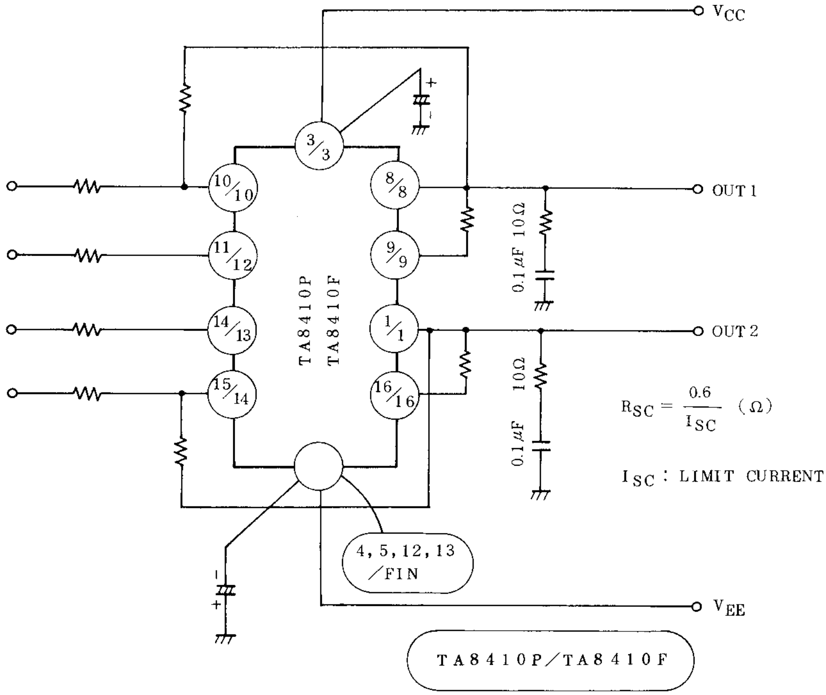
(3) 60 × 30 × 1.6mm PCB mounting occupid copper area in excess of 50%.

(4) No heat sink

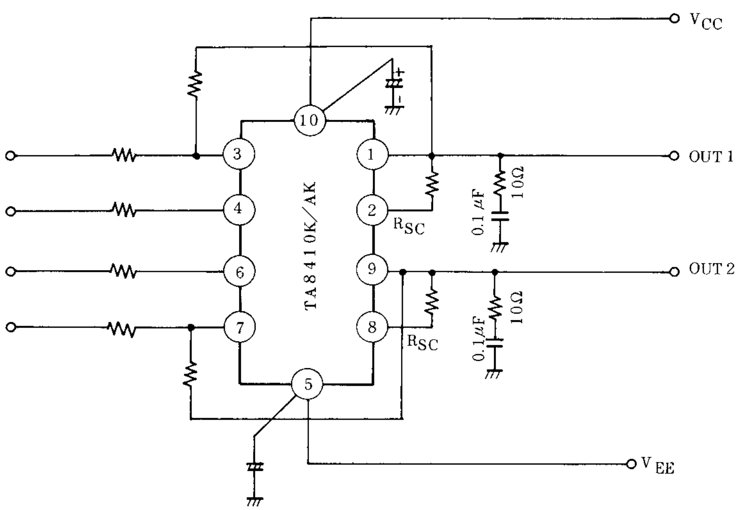


APPLICATION CIRCUIT 1

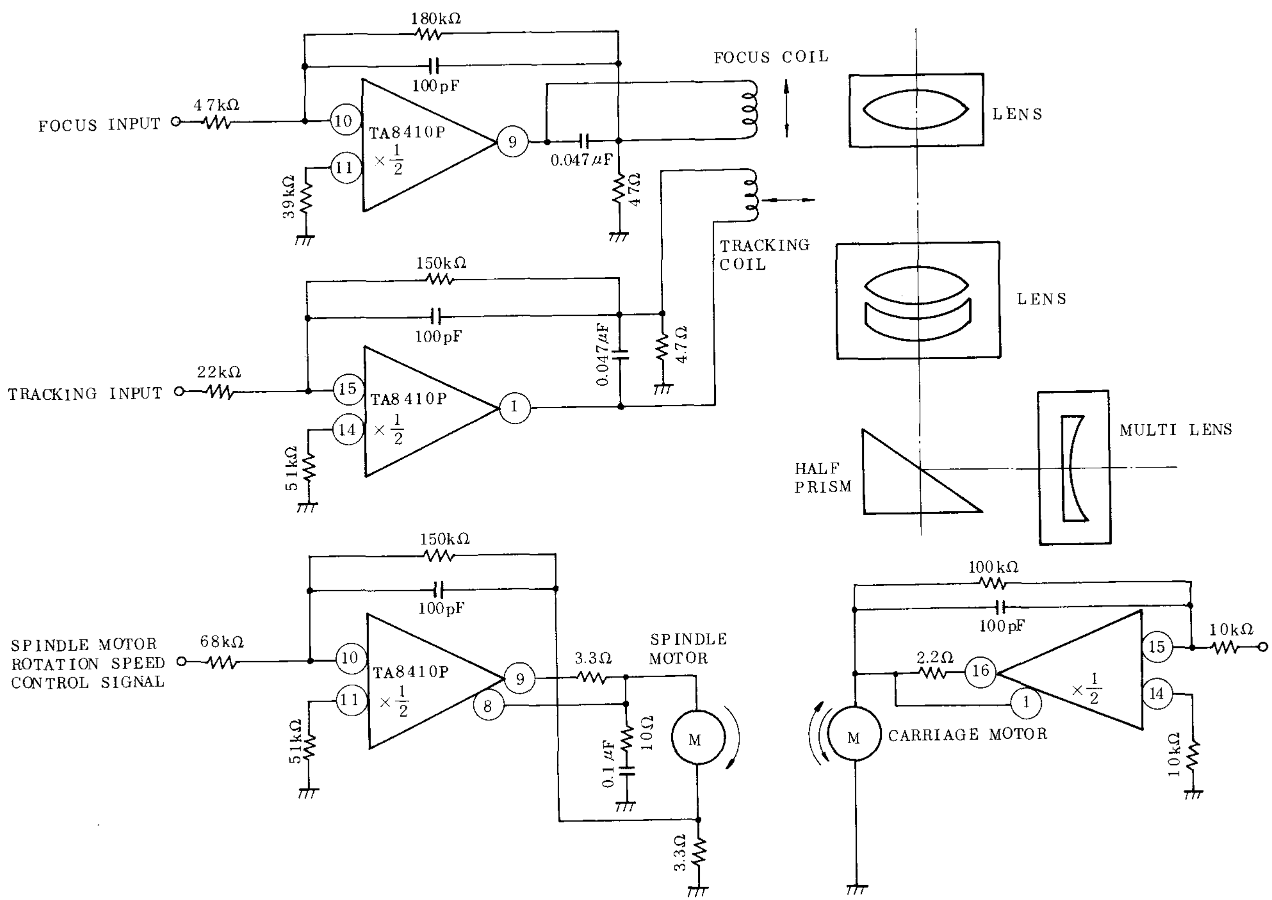
TA8410P
TA8410F



TA8410K
TA8410AK



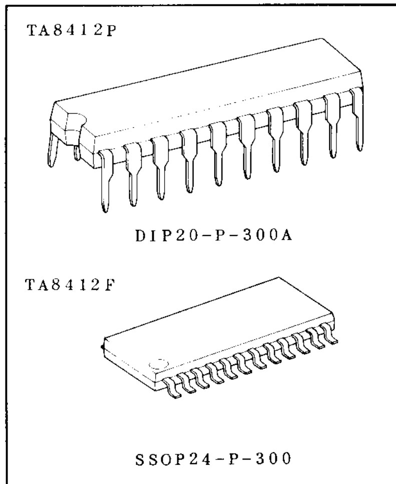
APPLICATION 2 (Drive circuit for CD player motors)



TA8412F/P

3-PHASE BI-DIRECTIONAL HALL MOTOR CONTROL IC

- FG is not required. (System for obtaining rotation signal through position sensing)
- Start/stop, CW/CCW and brake function is provided.
- Gain of position sensing circuit is high, and hysteresis is provided.
- Rotation signal output is provided. (Frequency signal of three times the position sensing output (hall element output) can be obtained.)
- External transistor type.



MAXIMUM RATINGS (Ta=25°C)

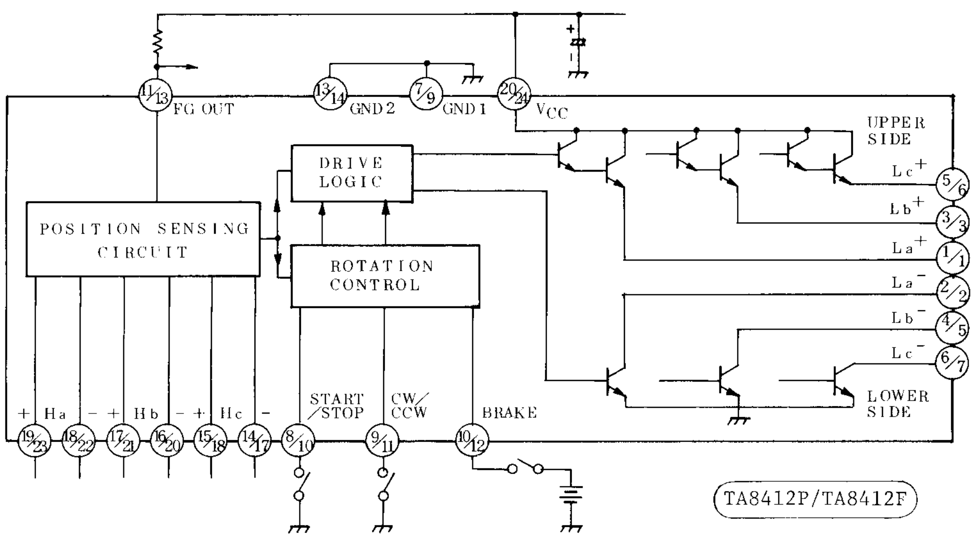
CHARACTERISTIC		SYMBOL	RATING	UNIT
Power Supply Voltage		V_{CC}	18	V
Output Current		I_O	±100	mA
Position Sensing Circuit Input Voltage (Tj=25°C)		V_H	±400	mV
Power Dissipation	TA8412P	P_D *	1.2	W
	TA8412F		0.5	
Operating Temperature		T_{opr}	-30~75	°C
Storage Temperature		T_{stg}	-55~150	°C

* No Heat-Sint.

Weight

DIP20-P-300A: 2.25g (Typ.)
SSOP24-P-300: 0.31g (Typ.)

BLOCK DIAGRAM

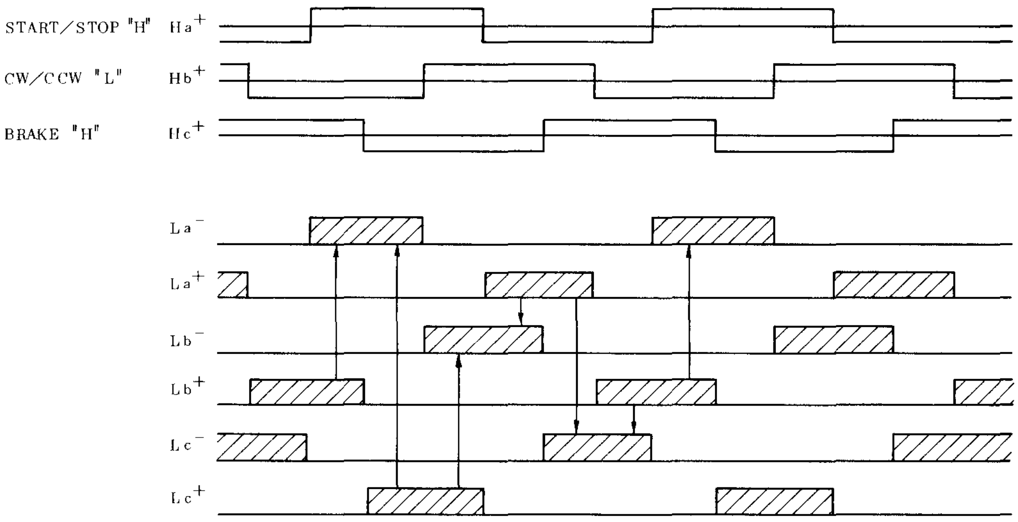


ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=5V, Ta=25°C)

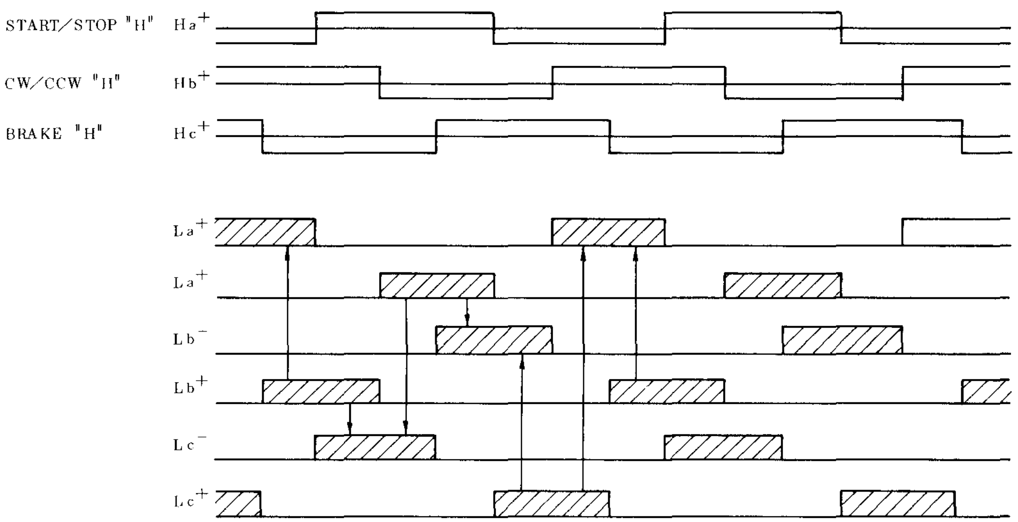
CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operation Power Supply Voltage			$V_{CC\ opr}$	-		4.0	-	18	V
Power Supply Current			I_{CC1}	1	Stop state	-	4	-	mA
			I_{CC2}		Output open	-	4	-	
Saturation Voltage	Upper Side		$V_{SAT\ U-1}$	1	I_O=10mA	-	0.7	-	V
			$V_{SAT\ U-2}$		I_O=100mA	-	1.0	-	
	Lower Side		$V_{SAT\ L-1}$		I_O=10mA	-	0.4	-	
			$V_{SAT\ L-2}$		I_O=100mA	-	0.5	1.0	
Leak Current	Upper Side		$I_{L\ U}$	2	V=18V	-	-	100	μA
	Lower Side		$I_{L\ L}$			-	-	100	
Position Sensing Input	Common Mode Voltage Range		CMR H	-		2.0	-	V_{CC}-0.5	V
	Input Sensitivity		V_H			20	-	-	mV
	Input Hysteresis		V_{H-Hys}			2	7	15	
START Input (Low Act)	Operation Input Voltage	"H"	$V_{IN\ R(H)}$	2		V_{CC}-0.9	-	V_{CC}	V
		"L"	$V_{IN\ R(L)}$			-	-	1.0	
	Input Current	"L"	$I_{IN\ R}$		$V_{IN\ R}$=1.0V	-	70	200	μA
CW/CCW Input (Low Act)	Operation Input Voltage	"H"	$V_{IN\ C(H)}$	2		V_{CC}-0.9	-	V_{CC}	V
		"L"	$V_{IN\ C(L)}$			-	-	1.0	
	Input Current	"L"	$I_{IN\ C}$		$V_{IN\ C}$=1.0V	-	70	200	μA
BRAKE Input (High Act)	Operation Input Voltage	"H"	$V_{IN\ B(H)}$	2		4.0	-	V_{CC}	V
		"L"	$V_{IN\ B(L)}$			-	-	1.0	
	Input Current	"H"	$I_{IN\ B}$		$V_{IN\ N}$=4V	-	100	250	μA
FG Output	Output Voltage	"H"	V_{FGH}	3	I_{FG}=1.0mA	V_{CC}-1.0	-	-	V
	Output Voltage	"L"	V_{FGL}			-	-	0.5	

TIMING CHART

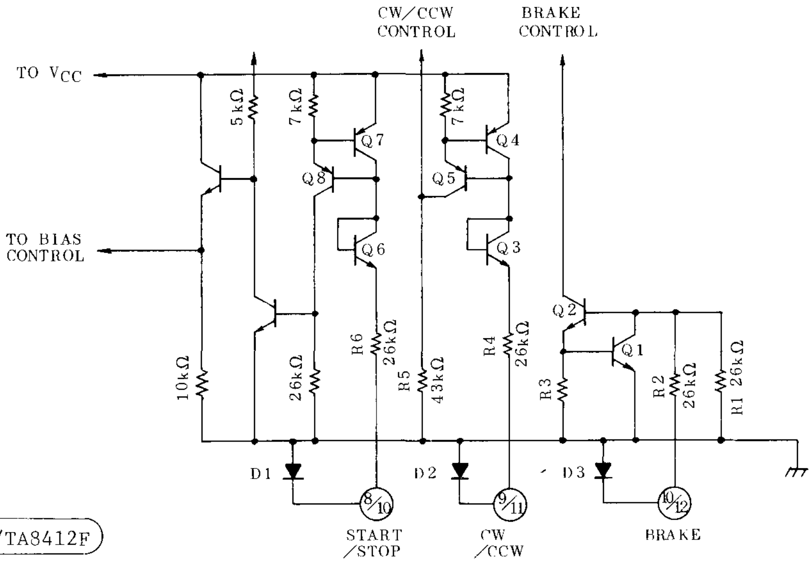
FORWARD ROTATION (Position sensing signal advances Ha→Hb→Hc.)



REVERSE ROTATION (Position sensing signal advances Ha→Hc→Hb.)



(1) Control Input Circuit



FUNCTION

START/STOP	CW/CCW	BRAKE	OUTPUT
H	L	H	Forward Torque Mode
H	H	H	Reverse Torque Mode
H	H or L	L	Brake Mode, La^{+}~Lc^{+};ON
L	H or L	H or L	Stop Mode, All Output;OFF

D1~D3 are input protect diodes.

Input current of START/STOP and CW/CCW are calculated by following equations.

$$I_{IN\ C} = \frac{V_{CC}-V(9/11)-V_{BEQ3}-V_{BEQ4}-V_{BEQ5}}{R4} \doteqdot \frac{V_{CC}-V(9/11)-2.1}{26 \times 10^{3}}$$

(9/11 pin)

$$I_{IN\ R} = \frac{V_{CC}-V8-V_{BEQ6}-V_{BEQ7}-V_{BEQ8}}{R6} \doteqdot \frac{V_{CC}-V8-2.1}{26 \times 10^{3}}$$

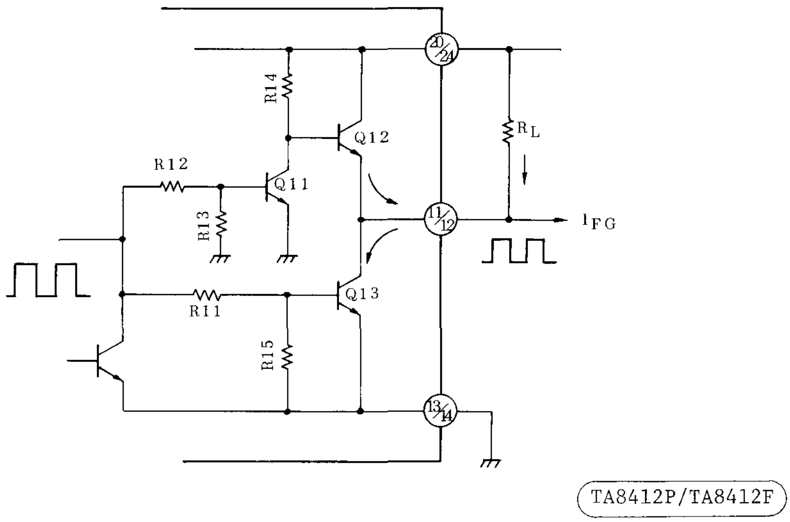
(8 pin)

And also input current of BRAKE (10/12pin) is calculated by following equation.

$$I_{IN\ B} = \frac{V(10/12)-V_{BEQ2}-V_{BEQ3}}{R2} \doteqdot \frac{V(10/12)-1.4}{26 \times 10^{3}}$$

(10/12 pin)

(2) FG Output Circuit



3 pulses a rotation of FG pulse are generated by the circuit.

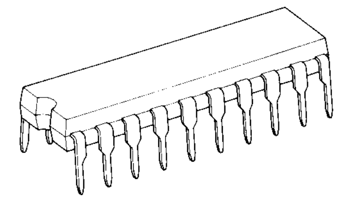
FG output transistors of Q12 and Q13 work push-pull.

Specified output voltage generates if load resistor connect to FG output to V_{CC}.

TA8413P

3-PHASE BI-DIRECTIONAL HALL MOTOR CONTROL IC

- FG is not required. (System for obtaining rotation signal through position sensing)
- Start/stop, CW/CCW and brake function is provided.
- Gain of position sensing circuit is high, and hysteresis is provided.
- Rotation signal output is provided. (Frequency signal of three times the position sensing output (hall element output) can be obtained.)
- External transistor type.



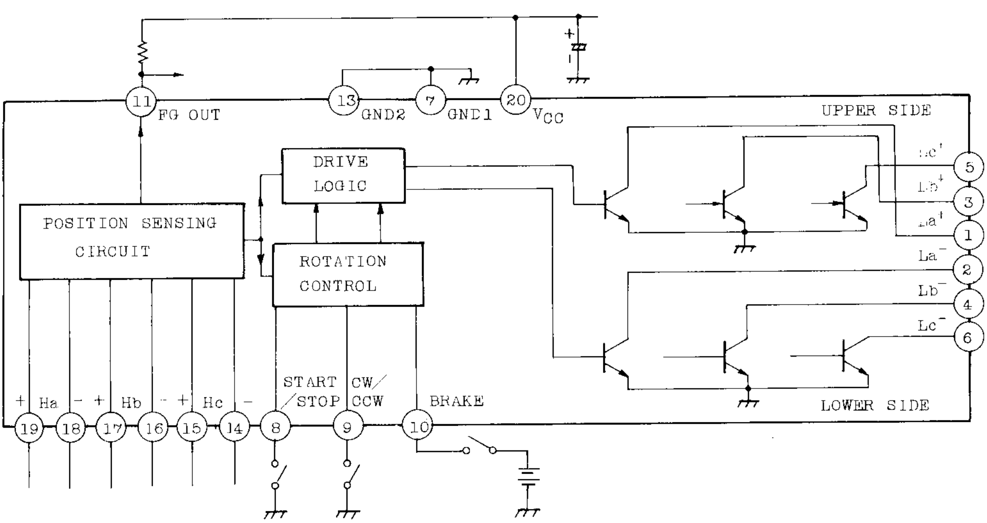
DIP20-P-300A

Weight: 2.25g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{CC}	18	V
Output Current	I_O	+100	mA
Position Sensing Circuit Input Voltage (Tj=25°C)	V_H	±400	mV
Power Dissipation (Ta=25°C)	P_D	1.2	W
Operating Temperature	T_{opr}	-30~75	°C
Storage Temperature	T_{stg}	-55~150	°C

BLOCK DIAGRAM

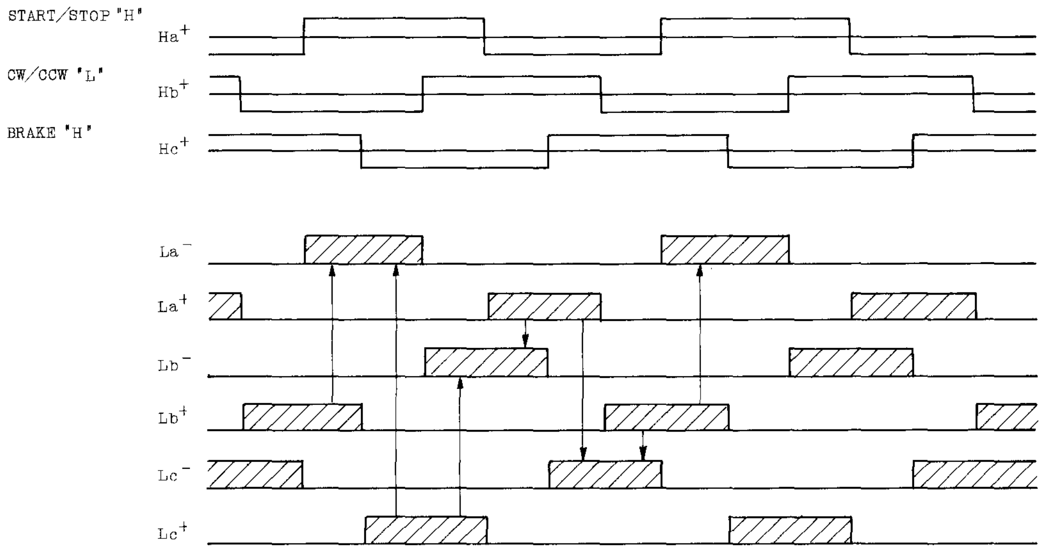


ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=5V, Ta=25°C)

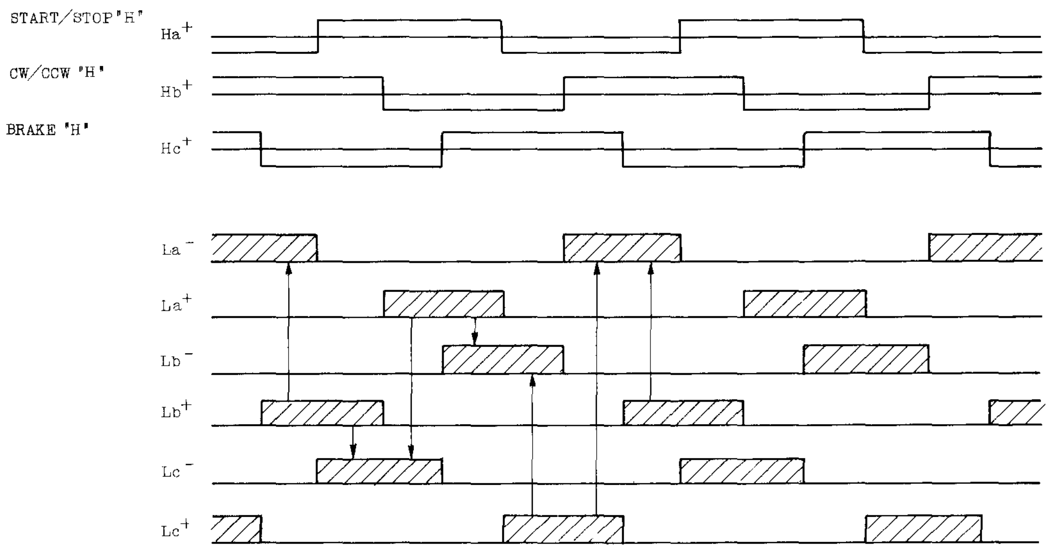
CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operation Power Supply Voltage			$V_{CC\ opr}$	-		4.0	-	18	V
Power Supply Current			I_{CC1}	1	Stop state	-	4	-	mA
			I_{CC2}		Output open	-	4	-	
Saturation Voltage	Upper Side		$V_{SAT\ U-1}$	2	I_O=10mA	-	0.4	-	V
			$V_{SAT\ U-2}$		I_O=100mA	-	0.5	-	
	Lower Side		$V_{SAT\ L-1}$		I_O=10mA	-	0.4	-	
			$V_{SAT\ L-2}$		I_O=100mA	-	0.5	1.0	
Leak Current	Upper Side		$I_{L\ U}$	2	V=18V	-	-	100	μA
	Lower Side		$I_{L\ L}$		V=18V	-	-	100	
Position Sensing Input	Common Mode Voltage Range		CMR H	-		2.0	-	V_{CC}-0.5	V
	Input Sensitivity		V_H			20	-	-	mV
	Input Hysteresis		V_{H-Hys}			2	7	15	
START Input (Low Act)	Operation Input Voltage	"H"	$V_{IN\ R(H)}$	2		V_{CC}-0.9	-	V_{CC}	V
		"L"	$V_{IN\ R(L)}$	2		-	-	1.0	
	Input Current	"L"	$I_{IN\ R}$	2	$V_{IN\ R}$=1.0V	-	70	200	μA
CW/CCW Input (Low Act)	Operation Input Voltage	"H"	$V_{IN\ C(H)}$	2		V_{CC}-0.9	-	V_{CC}	V
		"L"	$V_{IN\ C(L)}$	2		-	-	1.0	
	Input Current	"L"	$I_{IN\ C}$	2	$V_{IN\ C}$=1.0V	-	70	200	μA
BRAKE Input (High Act)	Operation Input Voltage	"H"	$V_{IN\ B(H)}$	2		4.0	-	V_{CC}	V
		"L"	$V_{IN\ B(L)}$	2		-	-	1.0	
	Input Current	"H"	$I_{IN\ B}$	2	$V_{IN\ N}$=4V	-	100	250	μA
FG Output	Output Voltage	"H"	V_{FGH}	3	I_{FG}=1mA	V_{CC}-1.0	-	-	V
	Output Voltage	"L"	V_{FGL}	3	I_{FG}=1mA	-	-	0.5	

TIMING CHART

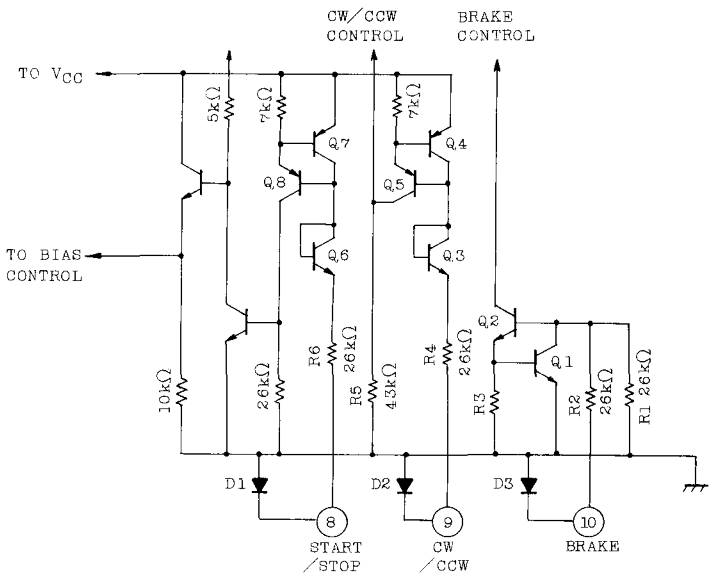
FORWARD ROTATION (Position sensing signal advances Ha→Hb→Hc.)



REVERSE ROTATION (Position sensing signal advances Ha→Hc→Hb.)



(1) Control Input Circuit



START/STOP and CW/CCW inputs are Low Active and BRAKE input is High Active type.

D_1~D_3 are input protect diodes.

Input current of START /STOP and CW/CCW are calculated by following equations.

$$I_{IN\ C} = \frac{V_{CC}-V_9-V_{BEQ3}-V_{BEQ4}-V_{BEQ5}}{R4} \doteqdot \frac{V_{CC}-V_9-2.1}{26\times10^3}$$

((9)pin)

$$I_{IN\ R} = \frac{V_{CC}-V_8-V_{BEQ6}-V_{BEQ7}-V_{BEQ8}}{R6} \doteqdot \frac{V_{CC}-V_8-2.1}{26\times10^3}$$

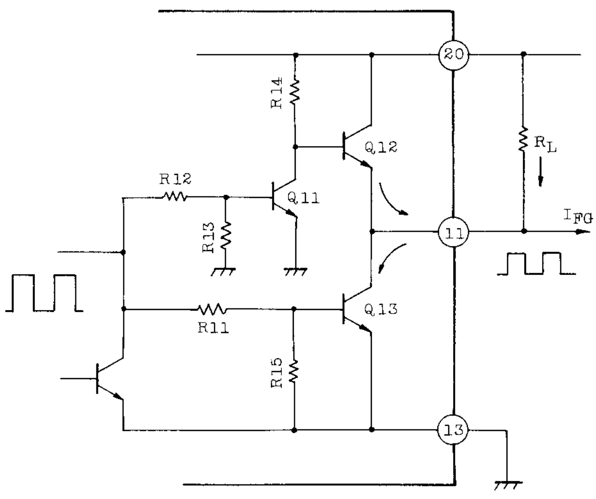
((8)pin)

And also input current of BRAKE ((10) pin) is calculated by following equation.

$$I_{IN\ B} = \frac{V_{10}-V_{BEQ2}-V_{BEQ3}}{R2} \doteqdot \frac{V_{10}-1.4}{26\times10^3}$$

((10) pin)

(2) FG Output Circuit



3 pulses a rotation of FG pulse are generated by the circuit.

FG output transistors of Q_{12} and Q_{13} work push-pull.

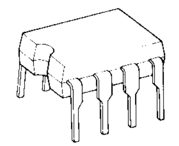
Specified output voltage generates if load resistor connect to FG output to V_{CC}.

TA8414F/P

DC FAN MOTOR DRIVER

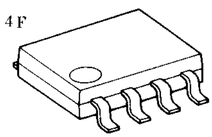
- Build-in Lock Sensing Circuit (Over Heat Protector for Drive Coil)
- Build-in Automatic Self Rotation Recovery Circuit after release of Motor Locking.
- Operating Voltage : $V_{CC\ opr}$=4~28V
- Output Current : $I_{O\ MAX(AVE)}$=100mA

TA8414P



DIP8 P-300A

TA8414F



SOP8-P-225

Weight:

DIP8-P-300A: 0.52g (Typ.)
SOP8-P-225 : 0.08g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	33	V
Output Current		$I_{O(AVE)}$	100	mA
Hall Input Voltage		V_H(Note 1)	1000	mV
Power Dissipation	TA8414P	P_D	500	mW
	TA8414F		240	
			500(Note2)	
Operating Temperature		Topr	-30~85	°C
Storage Temperature		Tstg	-55~150	°C

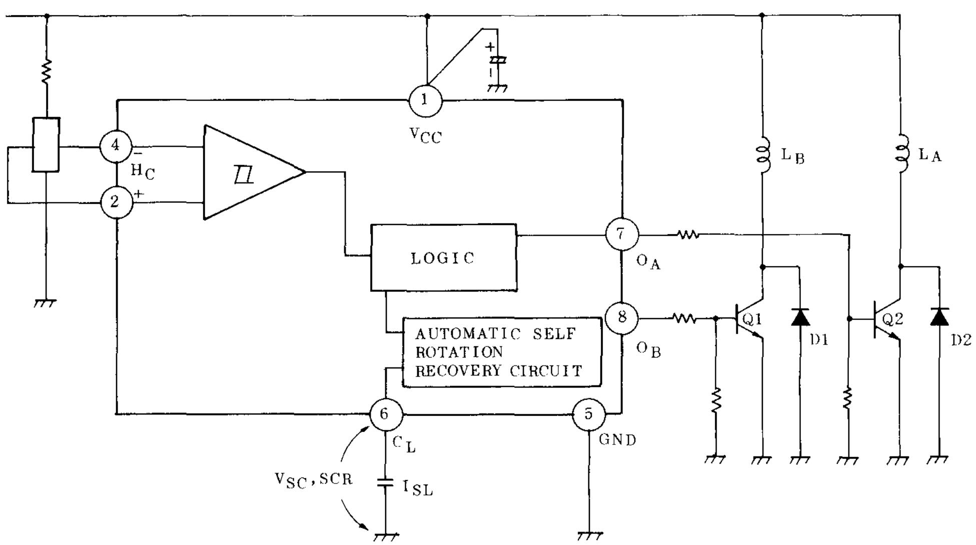
Note 1. Tj=25°C

Note 2. This value is obtained by 20×20×0.8mm PCB mounting occupied in excess of 60% of copper area.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Tj=25°C, V_{CC}=12V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC}	-	V_{CC}=5V	1.3	2.4	3.4	mA
				V_{CC}=12V	1.5	2.6	3.7	
				V_{CC}=27V	1.9	3.0	4.3	
Saturation Voltage		V_{sat}	-	I_O=20mA	-	0.9	1.5	V
				I_O=70mA	-	1.0	1.8	
Automatic Self Rotation Recovery Circuit (PIN ⑥)	Charge Current	I_{SL}	-		4	7	11	μA
	Limitting Voltage	V_{SC}	-		-	1.3	-	V
	Recovery Voltage	V_{SCR}	-		-	2.8	-	
	Duty Ratio	DR	-	t_{off}/t_{on}	3	5	7	
Hall Input (PIN ④, ②)	Offset Voltage	V_{OFF}	-	f=200Hz, I_O=20mA	-	0	7	mV
	Hysteresis Voltage	V_H		V_{IN}=200mV	5	15	30	
	Common Mode Range (Lower)	CMRL		V_{CC}=4~28V	-	0.3	0.5	V
	Common Mode Range (Upper)	CMRU		Tj=25~150°C	V_{CC}-2.5	-	-	

BLOCK DIAGRAM



Operation of Automatic Self Recovery Circuit

If Motor Rotation is disturbed by external force or obstacles.
Over Current, which have a possibility of Drive Coil Burning is generated by decreasing of Back Electro Motive Force (BEMF).
Therefore, Over Heat Protection of Drive Coil is requied to Fan Motor Drive System.
Generally, Series Connection of Temperature Dependance Elements (Posistor) to Output Drive Coil or to use drive IC incorporates protection circuit are required to get coil burning protection.
Posistor is so expensive, therefore, IC's incorporate this function are coming into wider use to Fan Motor Drive in recent years.
Generally, Re-switch operation after the turn on of protection circuit is required for system start up again because the circuit is constructed by flip-flop circuits.
But there's no use re-switch operation with TA8414P/F because of build-in automatic self recovery circuit.
Fig. 1 shows ⑥ pin voltage and the operation of this functions are follows.

1. Normal Rotation States

   Internally generated charging current of ISL (7μA TYP.) charge-ups external capacitance of CL connected to PIN ⑥.
   But FG pulse, generates among in rotation states and the frequency is proportional to rotation speed, discharges CL charge periodically.
   Therefore, Voltage of PIN ⑥ is becoming sawteeth waveform and will not to reach V_{SC} of limitting voltage (1.3V TYP.).

2. Motor Lock States

   If a Motor is locked by external force or obstacles, FG pulse generation is stopped. As a result, the voltage of PIN ⑥ increase.
   Torque generation is stopped after when the voltage of PIN ⑥ reaches to V_{SC}.
   Further more, voltage of PIN ⑥ is increased by charging current of I_{SL} and then reaches to V_{SCR} of self recovery voltage (2.8V TYP.)
   And then, Rotation Torque is generated momentary and voltage of PIN ⑥ is decreased to V_{SC} level during this time interval by discharging of CL.
   During the period of Motor lock, the voltage of PIN ⑥ goes between V_{SCR} and V_{SC} and generates momentary torque periodically at the points of V_{SC}.

3. After Release of Motor Lock

Momentary torque will able to rotate the motor and will generate FG pulse momentary if the motor lock is released.

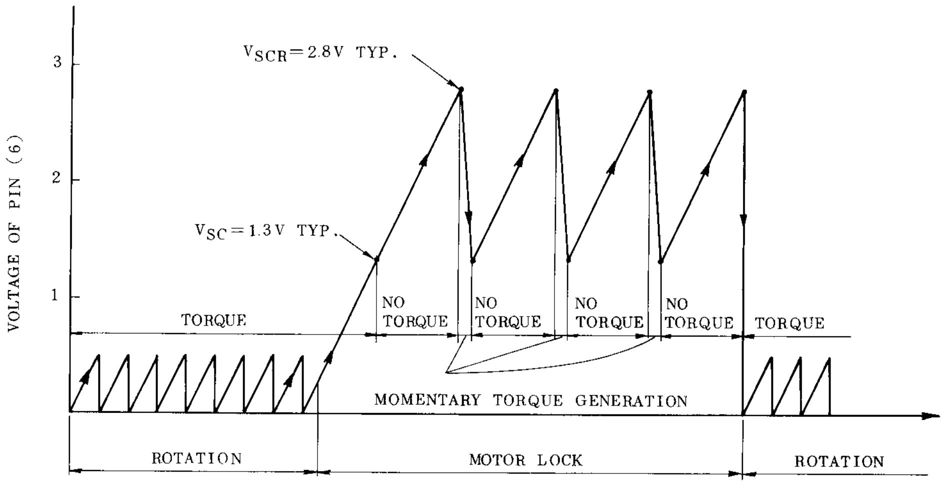


Fig. 1 Operation of Automatic Self Recovery Circuit

OUTPUT CIRCUIT

Fig. 2 shows Output Circuit

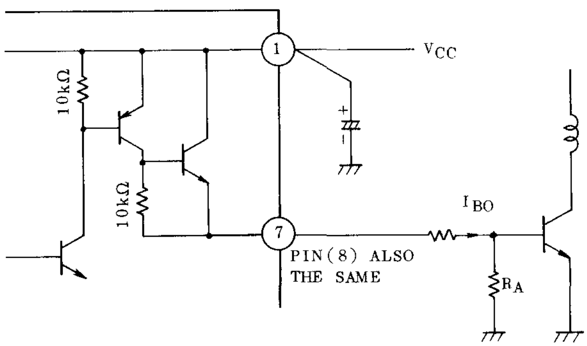


Fig. 2 Output Circuit

INPUT CIRCUIT

Hall sensor Input circuit is shown in Fig.3. High Sensitivity and PNP differential amplifier with build-in hysteresis circuit have wide common Range and high noise elimination characteristics.

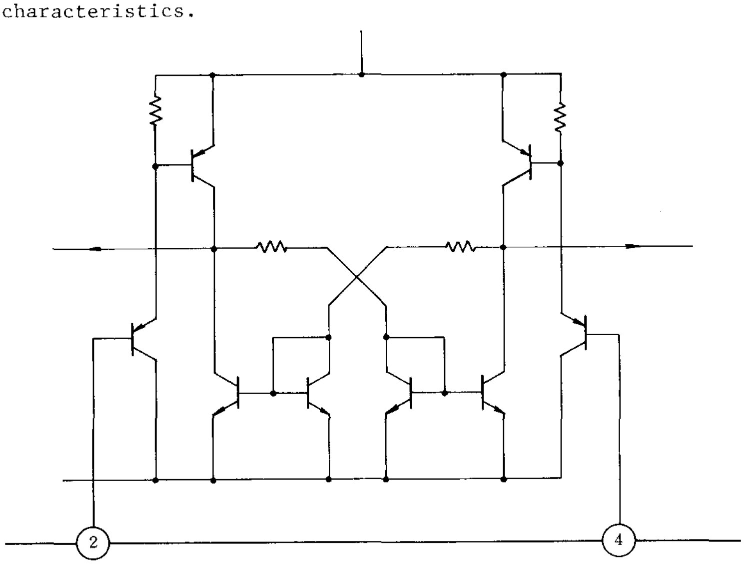
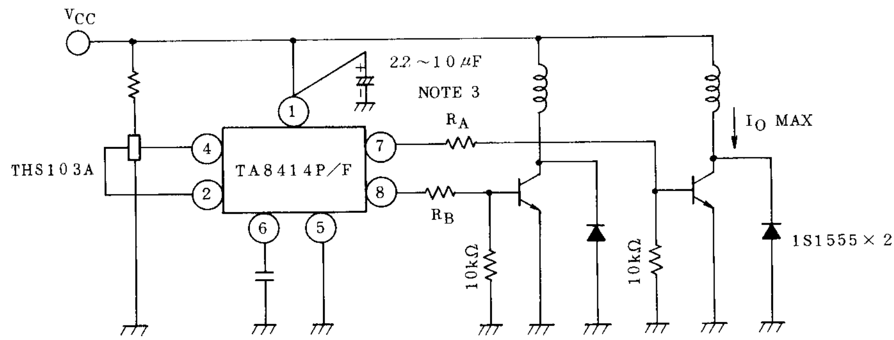


Fig. 3 Input Circuit

APPLICATION CIRCUIT 1   2 Phase Unipolar Fan Motor Drive Circuit



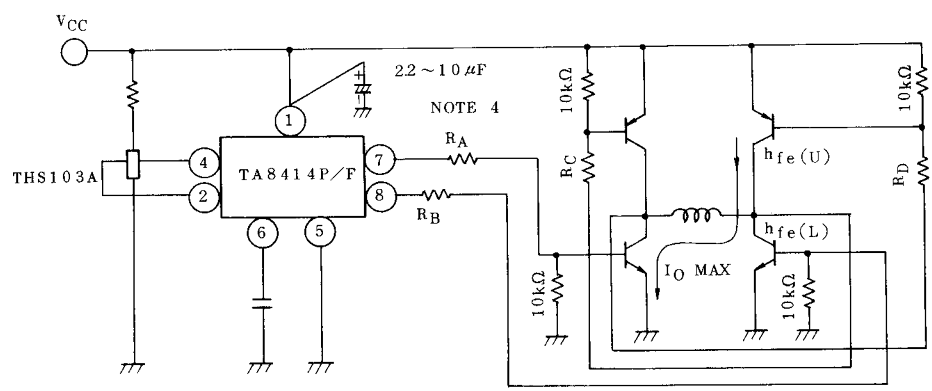
Note 3. R_A and R_B are determined by Output Current and hfe of Power Transistor as follows.

$$\frac{V_{CC}-1.7}{R_A\ (\text{or } R_B)} \geqq F_{OD}\cdot\frac{I_{O\ MAX}}{hfe}$$

F_{OD} : Over Drive

Factor ≧ 2

APPLICATION CIRCUIT 2   1 Phase Bipolar Fan Motor Drive Circuit



Note 4. R_A, R_B, R_C and R_D are determined by Output Current and h_{fe} of Power Transistors as follows.

・R_A and R_B are the same way to Application Circuit 1

$$\cdot\frac{V_{CC}-V_{BE}-V_{CE(SAT)}}{R_D\ (\text{or } R_C)} \geqq F_{OD}\cdot\frac{I_{O\ MAX}}{h_{fe}(u)}$$

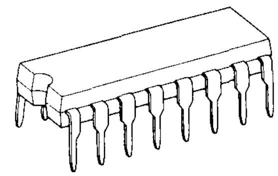
$$\frac{V_{CC}-1.0}{R_D\ (\text{or } R_C)} \geqq F_{OD}\cdot\frac{I_{O\ MAX}}{h_{fe}(u)}$$

TOSHIBA Surface Mountable Transistor Series are recommended to these applications.

TA8415P

STEPPING MOTOR CONTROLLER/DRIVER

TA8415P is general purpose unipolar stepping motor controller/driver, applicable to 3/4 phase motors and 1, 1-2, 2 phase excitation drive by initial setting of control terminals.



DIP16-P-300A

Weight: 1.11g (Typ.)

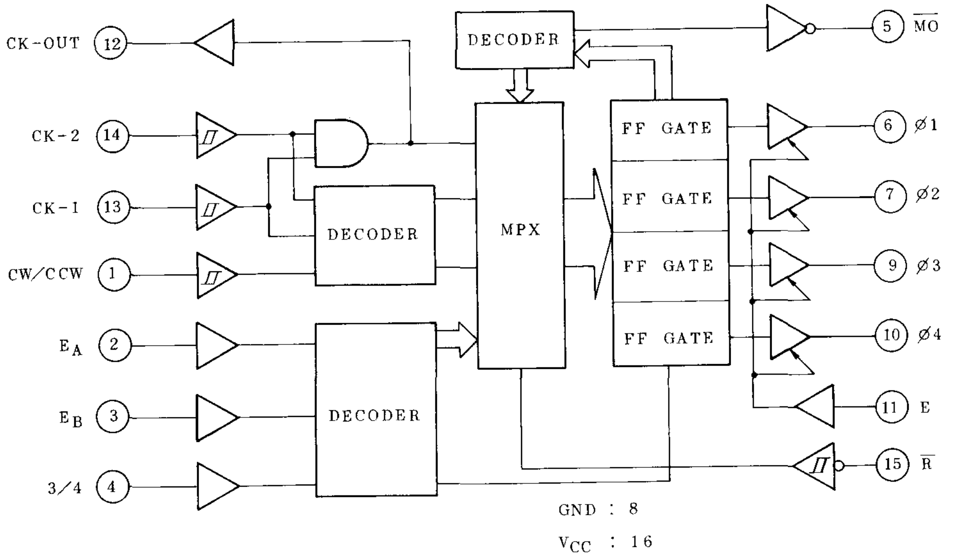
. 1 chip stepping motor controller/driver.
. 3 or 4 phase and 1, 1-2, 2 phase excitation drive are available.
. CW/CCW rotation and 1 clock or 2 clock drive are available.
. Hysteresis is provided with clock, CW/CCW, reset inputs for noise protection.
. Output enable, initial detect are available.
. Output current up to 0.4A.

MAXIMUM RATINGS (Ta=25°C Unless otherwise noted)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	-0.3~7.0	V
Output Sustaining Voltage	$V_{CE(SUS)\phi}$	-0.3~28	V
Output Current (ϕn)	$I_{OUT\phi}$	400	mA
Output Current (MO, CK-OUT)	I_{OUT} MO CK-OUT	10	mA
Input Voltage	V_{IN}	-0.3~V_{CC}+0.3	V
Input Current	I_{IN}	±1	mA
Power Dissipation	P_D	(Note) 1.2	W
Operating Temperature	Topr	-30~85	°C
Storage Temperature	Tstg	-55~150	°C

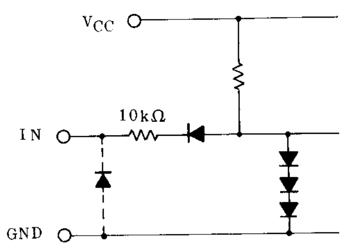
Note No heat sink.

BLOCK DIAGRAM

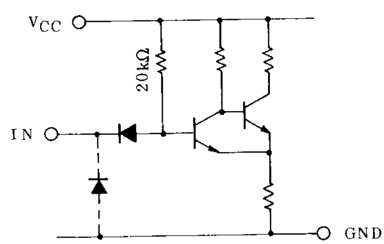


SCHEMATIC OF INPUTS AND OUTPUTS

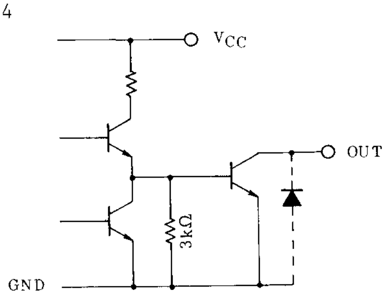
E_A, E_B, 3/4, E



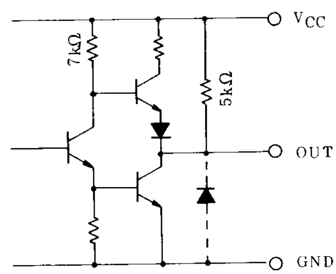
CK-1, CK-2, CW/CCW, $\overline{R}$



ϕ1~ϕ4



$\overline{MO}$, CK-OUT



PIN NAMES AND FUNCTIONS

PIN No.	SYMBOL	NAME	FUNCTION	
1	CW/CCW	Clock Wise/Counter Clock Wise	Direction Control Input	Function Table A
2	EA	Excitation A	Phase Excitation Mode Input	Function Table B
3	EB	Excitation B		
4	3/4	3 Phases/4 Phases	Phase Control Input	
5	$\overline{Mo}$	Monitor Out	Initial Status Output $\overline{Mo}$="L" at Initial State	
6	ϕ1	ϕ1 Out	ϕ1 Output	
7	ϕ2	ϕ2 Out	ϕ2 Output	
8	GND	GND	GND	
9	ϕ3	ϕ3 Out	ϕ3 Output	
10	ϕ4	ϕ4 Out	ϕ4 Output	
11	E	Output Enable	Outputs are Enable at E="H"	
12	CK-OUT	Clock-Out	Clock Output	
13	CK1	Clock In-1	Clock Input 1	Function Table A
14	CK2	Clock In-2	Clock Input 2	
15	$\overline{R}$	Reset	Reset Input	
16	V_{CC}	V_{CC}	V_{CC}	

FUNCTION TABLE A

CK1	CK2	CW/CCW	FUNCTION
↑	H	L	CW
⎍	L	L	Inhibit
H	↑	L	CCW
L	⎍	L	Inhibit
↑	H	H	CCW
⎍	L	H	Inhibit
H	↑	H	CW
L	⎍	H	Inhibit

FUNCTION TABLE B

EA	EB	3/4	FUNCTION	
L	L	L	4 Phases	1 Phase Excitation
H	L	L		2 Phase Excitation
L	H	L		1-2 Phase Excitation
H	H	L	Test Mode ϕ1~ϕ4 ON	
L	L	H	3 Phases	1 Phase Excitation
H	L	H		2 Phase Excitation
L	H	H		1-2 Phase Excitation
H	H	H	Test Mode ϕ1~ϕ4 ON	

Note) Conversion of Phase Excitation Mode must be made after the Reset Mode is established.

RECOMMENDED OPERATING CONDITIONS (Ta=-30~85°C)

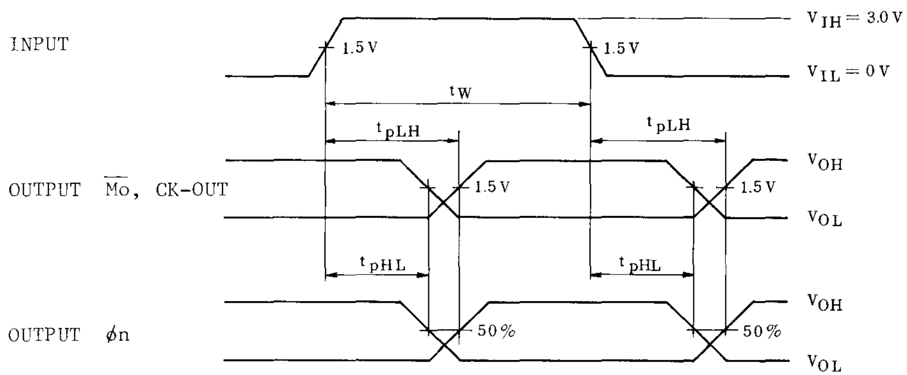
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage		V_{CC}	-		4.5	5.0	5.5	V
Output Sustaining Voltage		$V_{CE(SUS)}$	-		0	-	26	V
"L" Level Output Current ϕn		$I_{OUT\phi}$	-		-	-	400	mA
				Test Mode	-	-	250	
Output Current Mo, CK-OUT	"H" Level	I_{OH}	-		-	-	-0.4	mA
	"L" Level	I_{OL}	-		-	-	8	
Input Voltage		V_{IN}	-		0	-	V_{CC}	V
Clock Frequency		f_{CK}	-		0	-	100	kHz
Power Dissipation		P_D	-		-	-	1.0	W

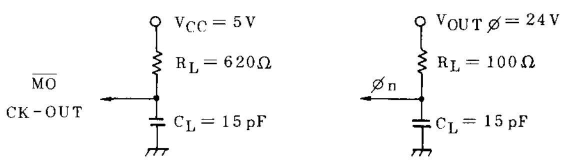
ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage	"H" Level	V_{IH}	-		2.0	-	-	V
	"L" Level	V_{IL}	-		-	-	0.8	
	"H" Level	$I_{OH\phi}$	-	V_{CC}=5.5V, V_{OUT}=26V	-	-	100	μA
Output Voltage $\overline{\text{Mo}}$, CK-OUT	"H" Level	V_{OH}	-	V_{CC}=4.5V, I_{OH}=-0.4mA	2.4	-	-	V
				V_{CC}=5.5V, I_{OH}=-10μA	4.0	-	-	
"L" Level Output Voltage	$\overline{\text{Mo}}$, CK-OUT	V_{OL}	-	V_{CC}=4.5V, I_{OL}=8mA	-	-	0.4	V
	ϕn	$V_{OUT\phi}$	-	V_{CC}=4.5V, I_{OUT}=400mA	-	-	1.1	
				V_{CC}=4.5V, I_{OUT}=200mA	-	-	0.6	
Input Current	"H" Level	I_{IH}	-	V_{CC}=5.5V, V_{IH}=5.5V	-	-	10	μA
	"L" Level	I_{IL}	-	V_{CC}=5.5V, V_{IL}=0.4V	-	-	-0.4	mA
Hysteresis		ΔV_T	-		-	150	-	mV
Supply Current		I_{CC}	-		-	-	100	mA

SWITCHING CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation Delay Time Low-to-High-Level	CK-ϕn	t_{pLH}	-	V_{CC}=5.0V	-	2.0	-	μs
	CK-CK-OUT			R_L-CK-OUT, $\overline{Mo}$=620Ω	-	1.0	-	
	CK-$\overline{Mo}$			R_L-ϕ1~ϕ4=100Ω	-	2.8	-	
	E-ϕn			C_L-All Outputs=15pF	-	1.0	-	
	$\overline{R}$-ϕn			$V_{OUT\phi}$=24V	-	2.0	-	
Propagation Delay Time High-to-Low-Level	CK-ϕn	t_{pHL}			-	1.4	-	μs
	CK-CK-OUT				-	0.7	-	
	CK-$\overline{Mo}$				-	2.1	-	
	E-ϕn				-	1.2	-	
	$\overline{R}$-ϕn				-	1.0	-	
	$\overline{R}$-$\overline{Mo}$				-	2.0	-	
Maximum Clock Frequency		f_{max}			-	250	-	kHz
Set Up Time CK, CW/CCW		t_{set-up}			-	0.1	-	μs
Hold Time CK, CW/CCW		t_{hold}			-	0.1	-	μs
Minimum Clock Pulse Width		$t_{w(CK)}$			-	1.0	-	μs
Minimum Reset Pulse Width		$t_{w(\overline{R})}$			-	1.0	-	μs

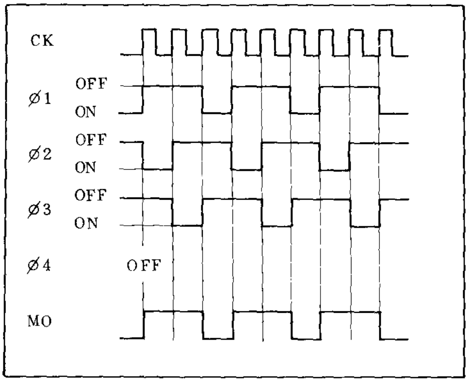




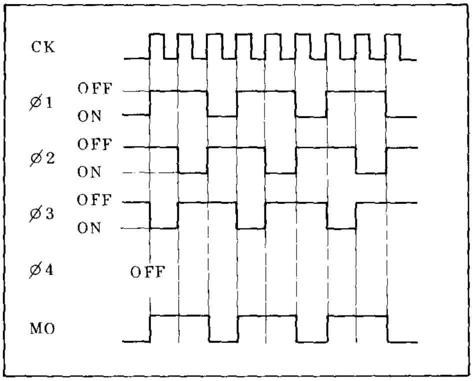
LOAD CIRCUIT

3 PHASES METHOD

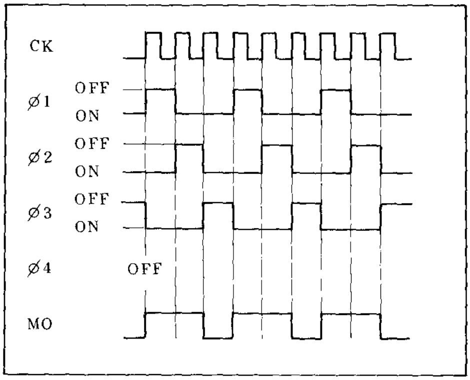
1 PHASE EXCITATION CW



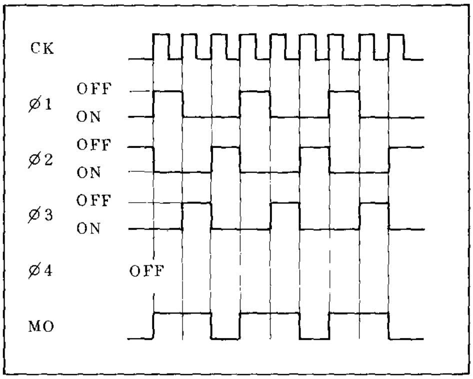
1 PHASE EXCITATION CCW



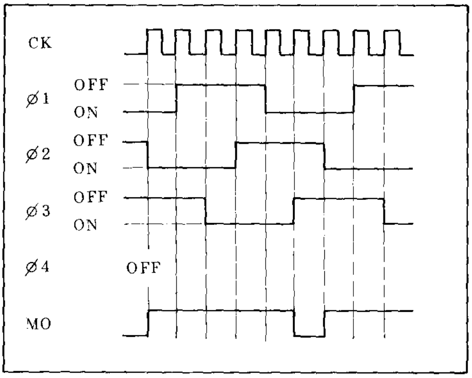
2 PHASE EXCITATION CW



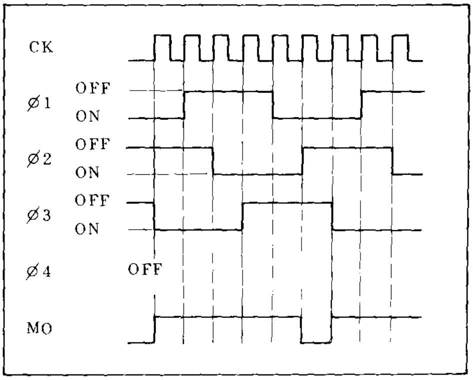
2 PHASE EXCITATION CCW



1-2 PHASE EXCITATION CW

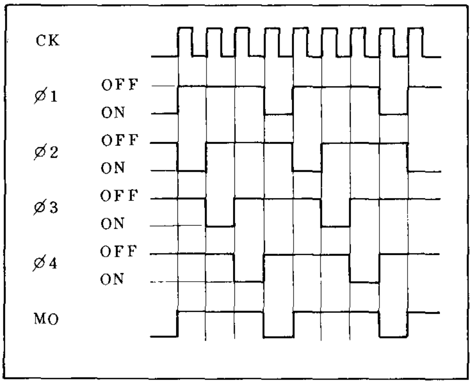


1-2 PHASE EXCITATION CCW

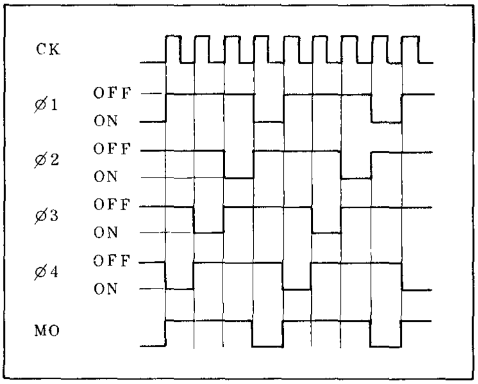


4 PHASES METHOD

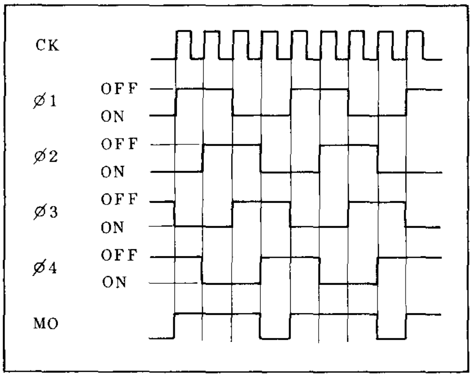
1 PHASE EXCITATION CW



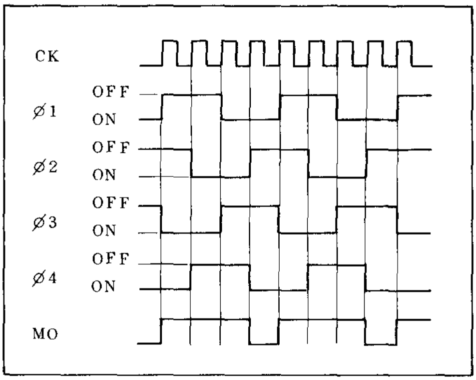
1 PHASE EXCITATION CCW



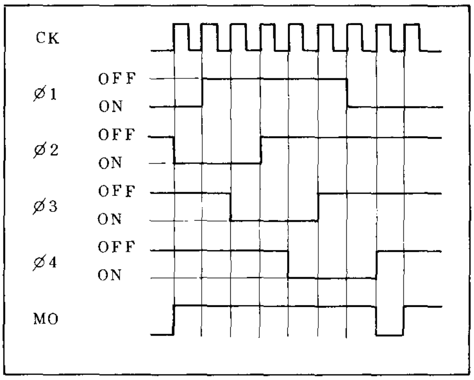
2 PHASE EXCITATION CW



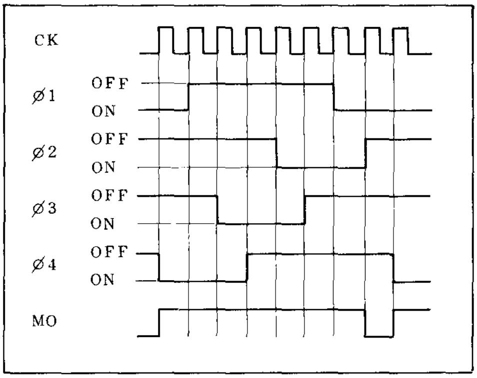
2 PHASE EXCITATION CCW



1-2 PHASE EXCITATION CW

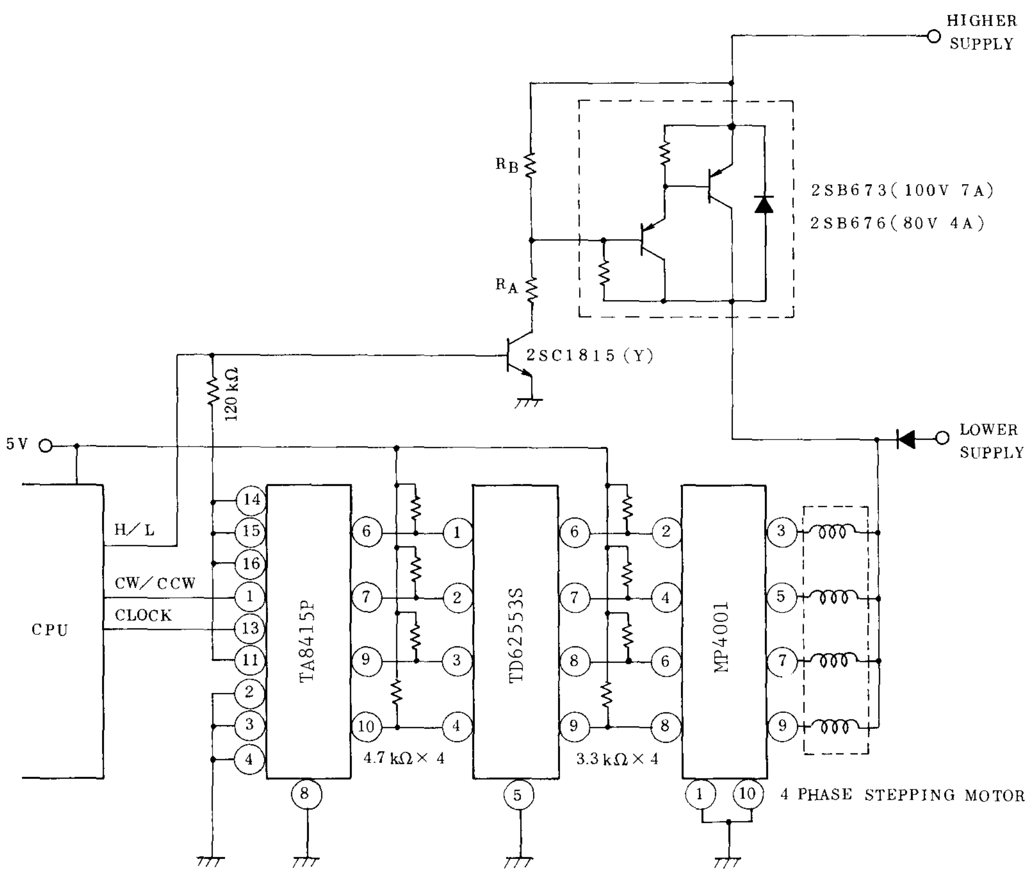


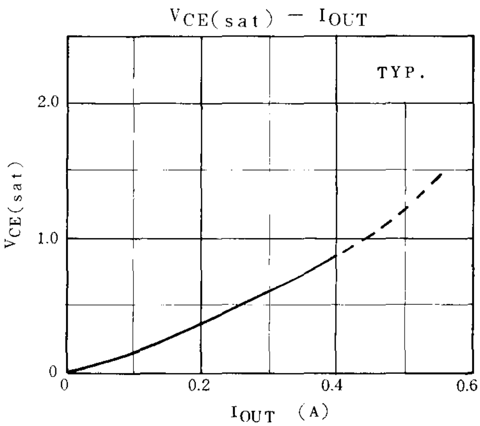
1-2 PHASE EXCITATION CCW

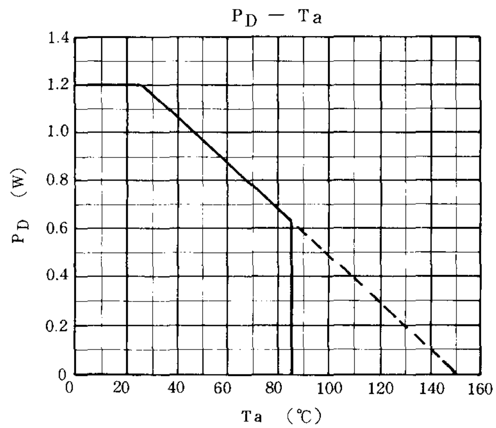


APPLICATION CIRCUIT 1

(TA8415P+TD62553S+MP4001 High Efficiency Stepping Motor Driver Circuit)

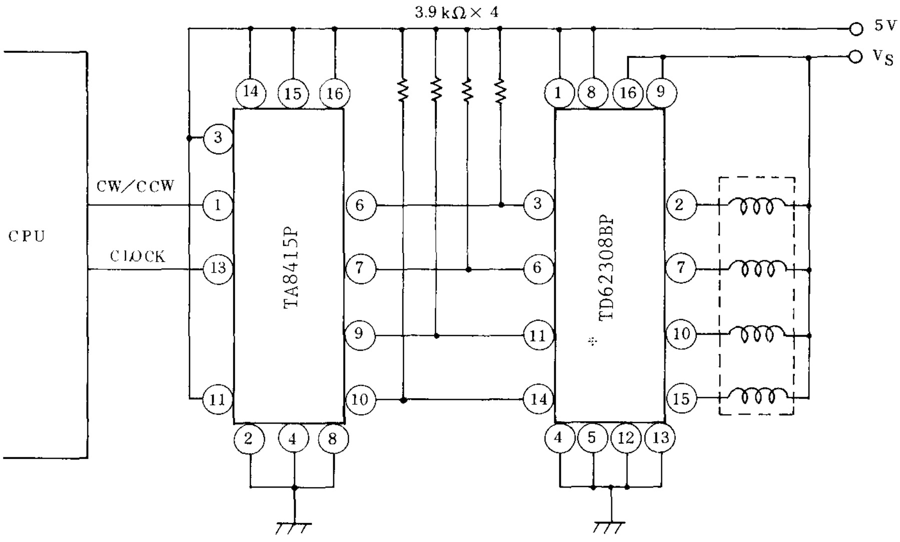






APPLICATION CIRCUIT 2

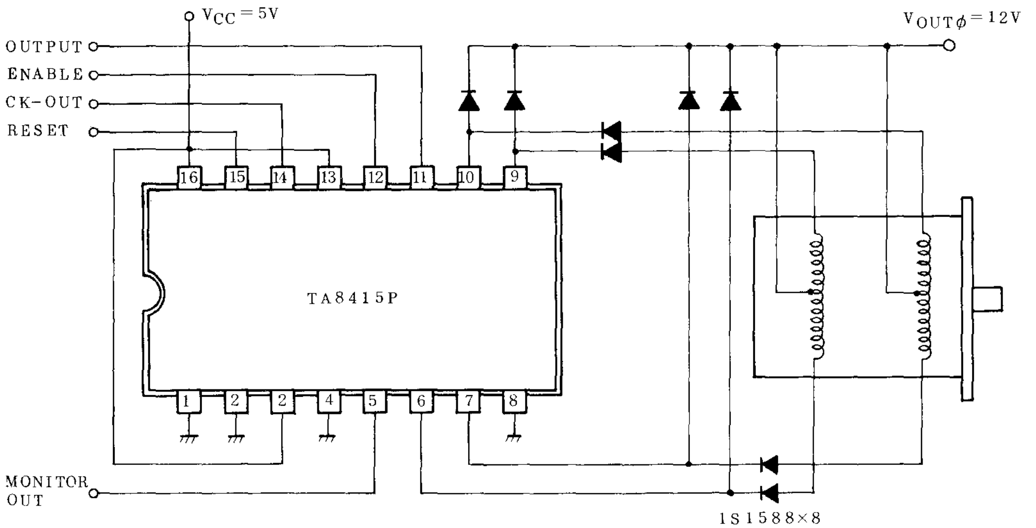
(TA8415P+TD62308BP 4 Phase Stepping Motor Driver Circuit)



* TD62308BP is 4ch transistor array that current capability is up to 1.5A.

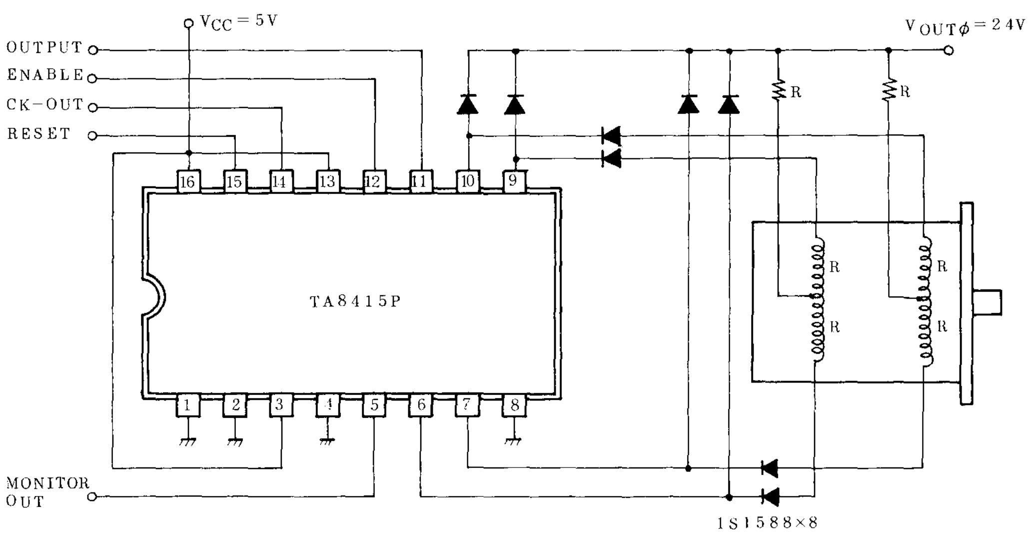
APPLICATION CIRCUIT 3

4 phase motor 1-2 phase excitation drive I.



APPLICATION CIRCUIT 4

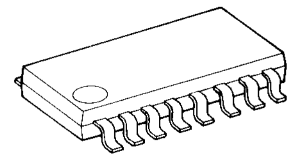
4 phase motor 1-2 phase excitation drive II.



TA8416F

LOW VOLTAGE USE 3 PHASE HALL MOTOR DRIVER

TA8416F is low voltage use 3 phase Hall Motor Driver IC with stand-by function designed especially for portable VCR, Head Phone Stereo and other battery operated electrical equipment motor drive applications.



SSOP16-P-225A

Weight: 0.14g (Typ.)

. 3 phase bipolar/unipolar Hall Motor Driver
. Low voltage use
. Voltage drive type
. Stand-by function for longer battery life
. MFP16 Flat package sealed
. 2 Hall Sensor drive available
. Operating supply voltage : V_{CC}=1.8~7.2V
  V_S=0.2~7.2V
. Output current : $I_{O\ MAX}$ = 0.7A (AVE)
  = 1.3A (PEAK)
. Built-in thermal shut down circuit

MAXIMUM RATINGS (Ta=25°C)

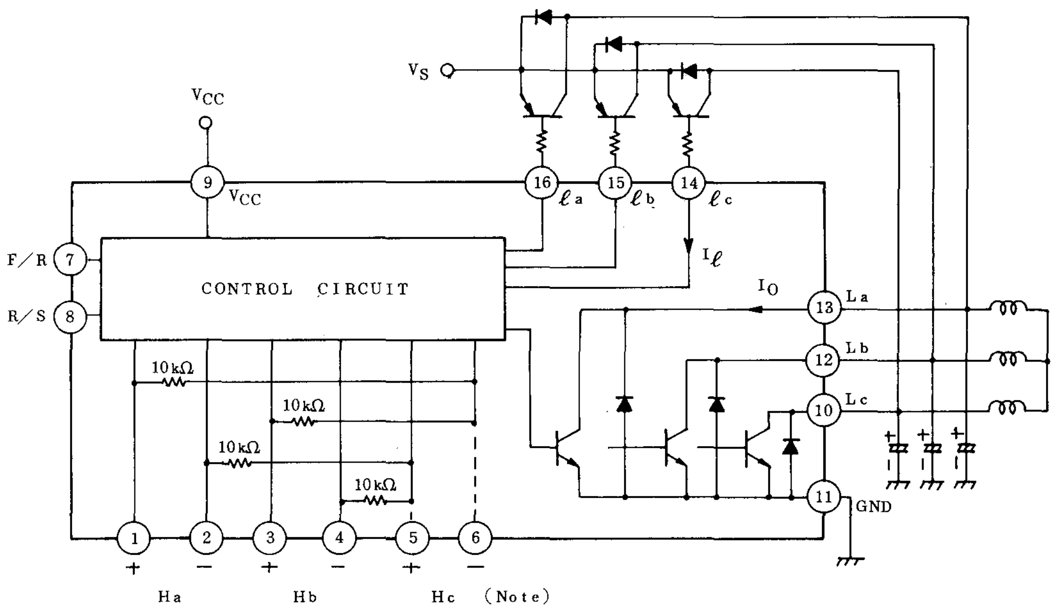
CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	8	V
		V_S	8	
Output Current	-1	I_O	0.7	A
	-2	I_ℓ	20.0	mA
Power Dissipation		P_D	350	mW
			550 (Note)	
Operating Temperature		Topr	-30~80	°C
Storage Temperature		Tstg	-55~150	°C

Note: This rating is obtained by mounting on 20×20×0.8mm PCB that occupied above 60% of copper area.

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current			I_{CC1}	–	V_{CC}=3V, Output "OPEN"	–	2.7	4.0	mA
			I_{CC2}		V_{CC}=6V, Output "OPEN"	–	3.0	5.0	
			I_{CC3}		Stand-by Mode Output "OPEN" V_{CC}=3V	–	0	100	μA
Saturation Voltage	La, Lb, Lc Side		V_{SL-1}	–	I_O=0.1A	–	0.2	–	V
			V_{SL-2}	–	I_O=0.6A	–	0.6	1.0	
	ℓa, ℓb, ℓc Side		V_{SU}	–	$I_ℓ$=10mA	–	0.1	0.2	
Position Sensing Input	Sensitivity		V_H	–		–	20	–	mV
	Operating DC Level		CMR	–		0	–	V_{CC}–1.2	V
Diode Forward Voltage			V_F	–	I_F=0.7A	–	1.2	–	V
Rotation Control Input Voltage	Operating Voltage	Forward	V_{FRD}	–		1.0	–	–	V
		Reverse	V_{RVS}	–		–	–	0.4	
	Operating Current		$I_{IN(FR)}$	–	$V_{F/R}$=3V	–	100	200	μA
Start/Stand-by Control Input Voltage	Operating Voltage	Run	V_{RUN}	–		1.0	–	–	V
		Stand-by	V_{ST}	–		–	–	0.5	
	Operating Current		$I_{IN(RS)}$	–	$V_{F/R}$=3V	–	100	200	μA
Saturation Voltage Differential			ΔV_S	–	I_O=200mA, La, Lb, Lc	–	20	–	mV
Leakage Current			I_L	–	V=8V	–	0	100	μA
Thermal Shut-down Circuit Operating Temperature			T_{SD}	–	Junction Temperature	140	–	–	°C

BLOCK DIAGRAM



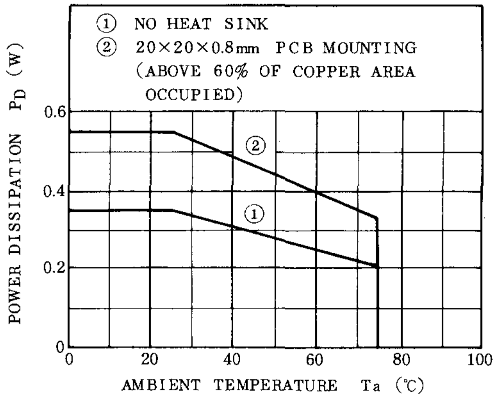
(Note) Refer to terminal description 3.

FUNCTION

ROTATION CONTROL		POSITION SENSING INPUT			UPPER SIDE OUTPUT			LOWER SIDE OUTPUT		
⑦	⑧	Ha	Hb	Hc	ℓa	ℓb	ℓc	La	Lb	Lc
H	H	H	L	H	1	0	0	0	1	0
		H	L	L	1	0	0	0	0	1
		H	H	L	0	1	0	0	0	1
		L	H	L	0	1	0	1	0	0
		L	H	H	0	0	1	1	0	0
		L	L	H	0	0	1	0	1	0
L	H	H	L	H	0	1	0	1	0	0
		H	L	L	0	0	1	1	0	0
		H	H	L	0	0	1	0	1	0
		L	H	L	1	0	0	0	1	0
		L	H	H	1	0	0	0	0	1
		L	L	H	0	1	0	0	0	1
-	L	H	L	H	High Impedance			High Impedance		
		H	L	L						
		H	H	L						
		L	H	L						
		L	H	H						
		L	L	H						

H : $V_H^+ > V_H^-$ 1 : ON
L : $V_H^+ < V_H^-$ 0 : OFF

P_D — Ta



TERMINAL DESCRIPTION

1. Rotation Direction Control Input (FR Input, ⑦ Pin)

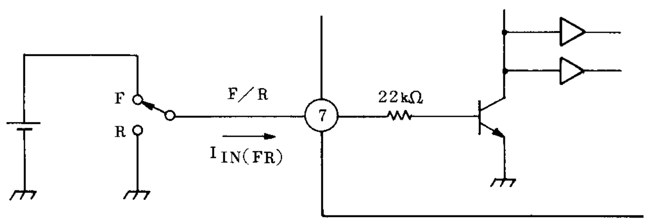
Motor rotation direction is controlled by this terminal. More than 1V of control voltage becomes motor forward rotation and less than 0.4V of this voltage becomes motor reverse rotation.

22kΩ of input resistance is equipped in series of this terminal. Therefore input current is calculated by following equation.

$$I_{IN(FR)} = \frac{V7-V_{BE}}{22\times10^3} = \frac{3-0.7}{22\times10^3} \doteqdot 100\mu A$$

(V7=3V)

And the open mode of the termianl, there's no input current flow.

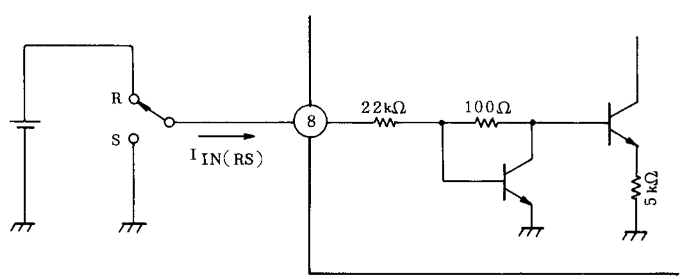


2. Start/Stand-by Control Input (RS Input, ⑧ Pin)

Start (Run) and stand-by modes are controlled by this terminal.

Operating voltage are more than 1V (Start or Run) and less than 0.5V (Stand-by).

Supply current becomes less than 100μA in Stand-by mode.



3. Hall Sensor Inputs ($Ha^{+,-}$, $Hb^{+,-}$, $Hc^{+,-}$, ①, ②, ③, ④, ⑤, ⑥ Pin)

Hall Sensor Inputs for position sensing

2 Hall Sensor Drive is also available by 4 pcs of 10kΩ matrix resistors connect to $Ha^{+,-}$ and $Hb^{+,-}$ terminals.

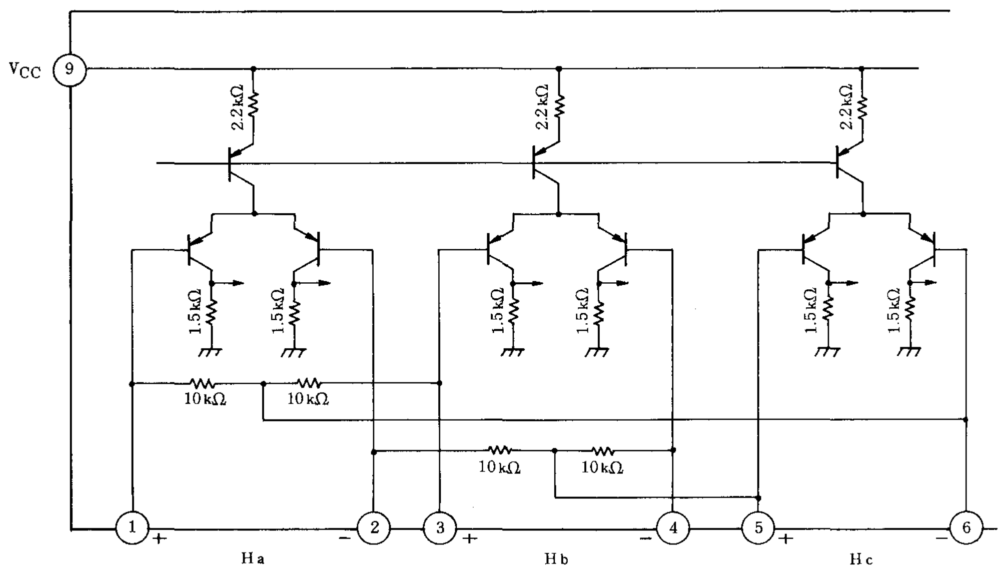
But, in case of lower speed application, poorprecision senser positioning and good torque ripple and W/F characteristics required.

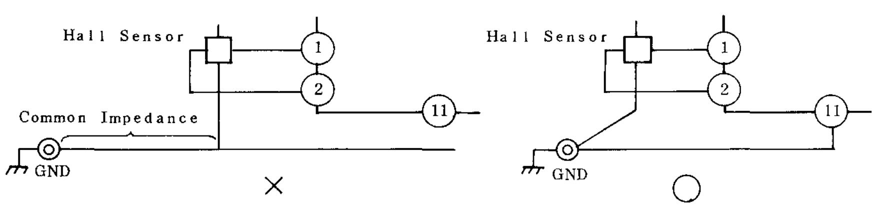
We recommend to use 3 Hall Sensors for stable operations. Input sensitivity is 20mV (TYP), but actual value is 2~3mV.

We recommend to input more than 20mV to get good W/F characteristics.

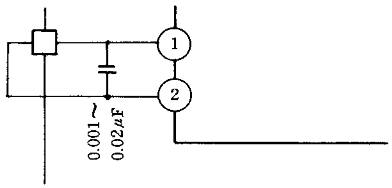
Wide DC operating range of 0~V_{CC}-1.2V is accomplished by PNP input circuit and also built in hysteresis restricts mis-function caused by external noise.

But care should be taken not to have a common impedance between Hall Sensor GND lines and the power GND line for stable operations.





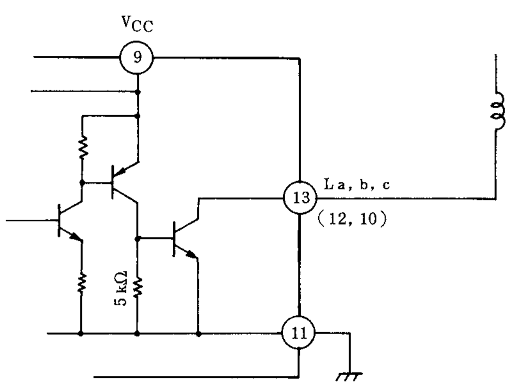
To decrease noise problems, we recommend to connect noise suppression capacitance (0.0001~0.02μF) between each Hall Input Terminal.



4. Output Terminals (La, Lb, Lc, ⑩, ⑫, ⑬ Pin)

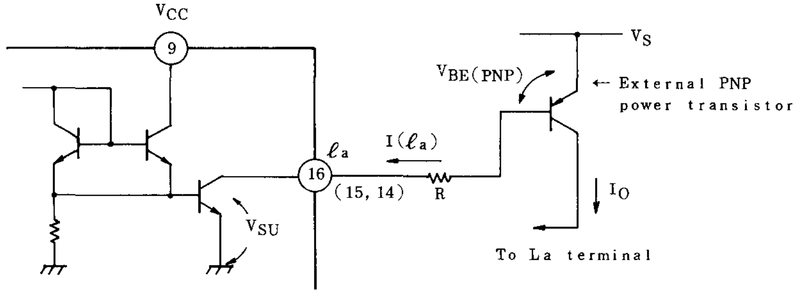
This IC is designed for use 3 phase unipolar drive applications, but Bipolar drives also available with additional 3 transistors.

Care should be taken with back electro motive force generated by coil not to over the specified voltage.



5. Pre-Drive Stage (ℓa, ℓb, ℓc, ⑯, ⑮, ⑭ Pin)

Open collector type Pre-drive stage required current are calculated by following requation.



$I(\ell a) = K_O \cdot \frac{I_O}{h_{fe}}$

$K_O \geqq 2$

h_{fe} : hfe of PNP transistor

I_O : Output current

$I(\ell a) = \frac{V_S - V_{BE(PNP)} - V_{SU}}{R}$

Summing that, $V_{BE(PNP)}=0.7V$, $V_{SU}=0.2V$

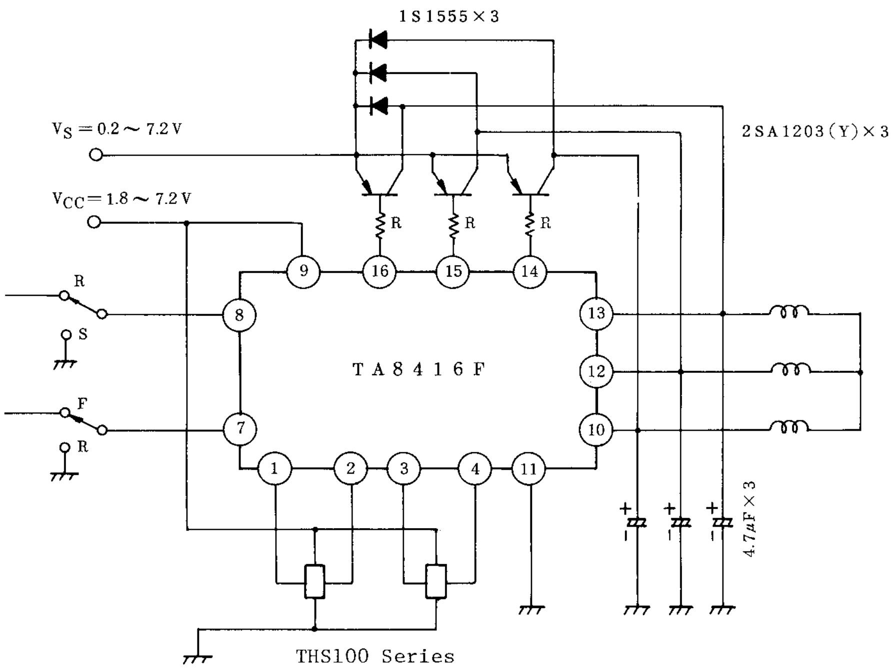
$R = \frac{h_{fe}(V_S-0.9)}{K_O \cdot I_O}$

For Example, $V_S=3V$, $h_{fe}=100$, $I_O=0.7A$, $K_O=2$

R=150Ω

APPLICATION CIRCUIT

1. 3-Phase Full Wave Application

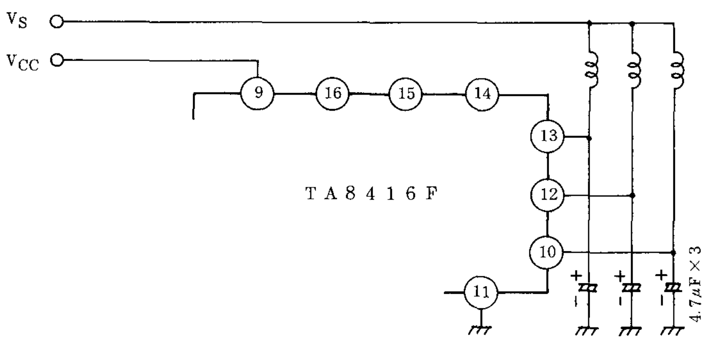


(Note) . V_S and V_{CC} terminals connecting application also available.

. We recommend to use TOSHIBA Ga-As type Hall Sensor THS100 series.

. Output capacitans (4.7μF ×3) are for noise suppression use.
It is required to increase the value if the vibration noise is so loud.

2. 3-Phase Half Wave Application



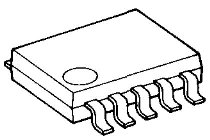
(Note) . Other circuit and configurations are all the same to APPLICATION CIRCUIT 1.

. Care should be taken with BEMF value generated by coils that not increase specified value of output transistor withstand voltage.

TA8420AF/21AF

1 CHIP DC FAN MOTOR DRIVER

- Built-in lock sensing circuit (Over heat protector for driver coil).
- Built-in automatic self rotation recovery circuit after release of motor locking.
- Operating voltage : $V_{CC\ opr}$=4~15V
- Output current : $I_{O\ MAX(AVE)}$=1.0A
- Thermal shutdown circuit incorporated.
- Suitable for super micro fan motor.
- Surface mountable MFP 10 package sealeded.
- Less external component.
- TA8420AF has FG(Frequency generator) out for rotation speed sense and TA8421AF has RD (Rotation detect) out for rotate or stop sense.



SSOP10-P-225

Weight : 0.1g(Typ.)

MAXIMUM RATINGS (Ta=25°C)

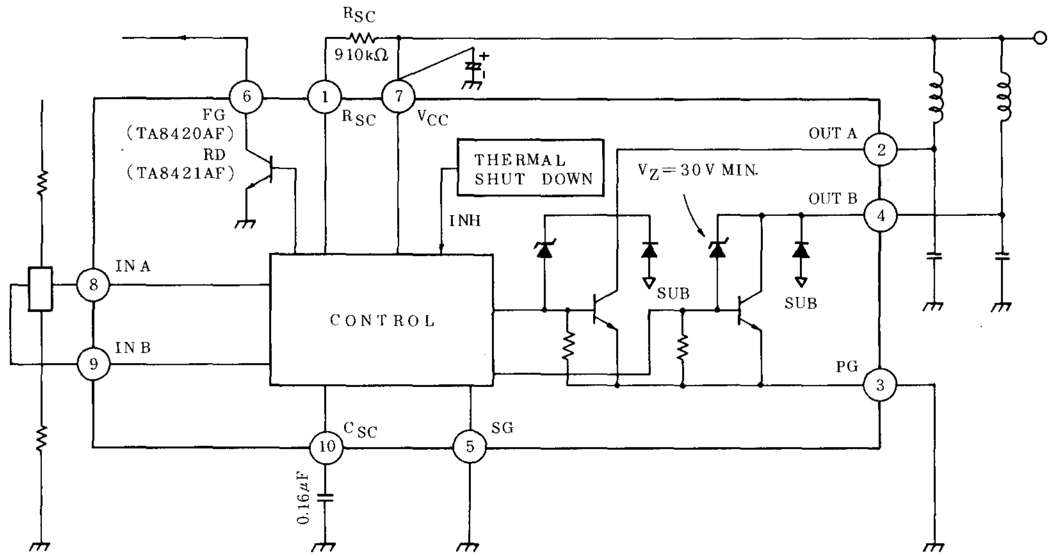
CHARACTERISTIC		SYMBOL	RATING	UNIT
Output Terminal Breakdown Voltage ②, ④, ⑥PIN		V_{CER}	30	V
Operating Supply Voltage		$V_{CC\ opr}$	15	V
Output Current	AVE	$I_{O(AVE)}$	1.0	A
	PEAK	$I_{O(PEAK)}$	2.0 (Note 1)	
FG Output Current (TA8420AF)		I_{FG}	20	mA
RD Output Current (TA8421AF)		I_{RD}		
Hall Input Voltage		V_{HM}	300 (Note 2)	mV
Power Dissipation		P_D	735 (Note 3)	mW
Operating Temperature		T_{opr}	-30~85	°C
Storage Temperature		T_{stg}	-55~150	°C

Note 1. t=0.1sec

Note 2. Tj=-25~150°C

Note 3. This value is obtained by 50X50X1.6mm PCB mounting occupied in excess of 30% of copper area.

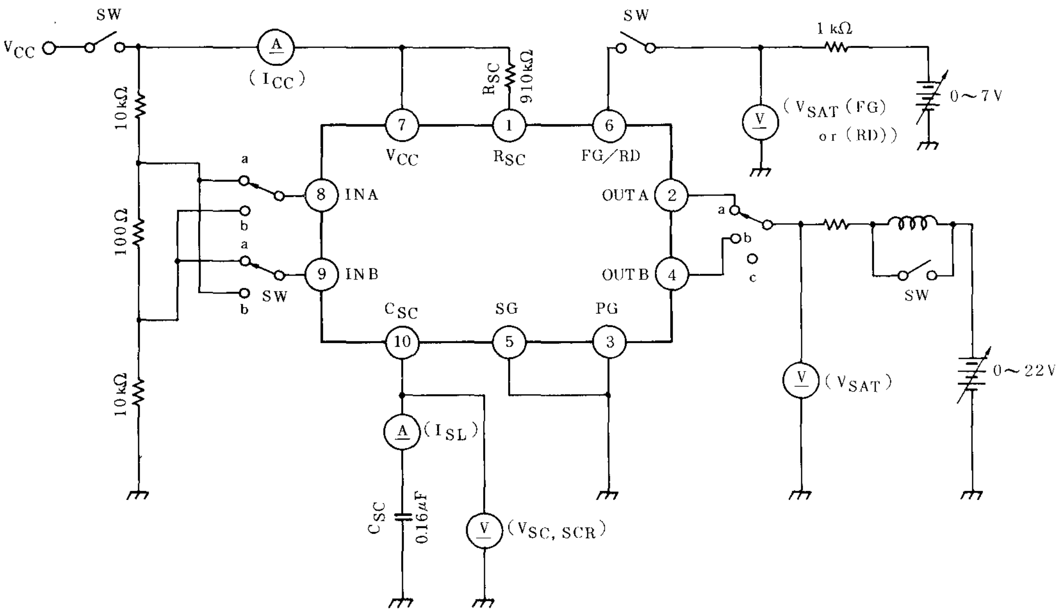
BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS (T_a=25°C, V_{CC}=12V, R_{SC}=910kΩ, C_{SC}=0.16μF)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC}		V_{CC}=5V, OUT A "ON"	3.0	5.2	7.5	mA
				V_{CC}=12V, OUT A "ON"	3.5	5.7	8.0	
Output Saturation Voltage		V_{SAT}		I_O=0.2A, Tj=25°C	–	0.75	1.0	V
				I_O=0.5A, Tj=25°C	–	0.85	1.3	
				I_O=1.0A, Tj=25°C	–	1.0	2.0	
				I_O=2.0A, Tj=25°C	–	1.8	2.6	
Automatic Self Rotation Recovery Circuit	Charge Current	I_{SL}			–	0.25	–	μA
	Limitting Voltage	V_{SC}			–	1.3	–	V
	Recovery Voltage	V_{SCR}			–	2.9	–	
	On Time	t_{on}			150	200	700	ms
	Duty Ratio	DR		t_{off}/t_{on} Tj=−25~150°C	3	5	9	
Hall Input	Sensi-tivity	V_H		Including off set	–	–	7	mV
	Operating DC Level (Lower)	CMRL		Tj=−25~150°C	–	–	2.5	V
	Operating DC Level (Upper)	CMRH		Tj=−25~150°C	V_{CC}−0.8	–	–	
FG Output Saturation Voltage (TA8420AF)		$V_{SAT(FG)}$		I_{FG}=5mA	–	0.3	0.5	V
RD Output Saturation Voltage (TA8421AF)		$V_{SAT(RD)}$		I_{RD}=5mA				
Thermal Shutdown Operating Temperature		T_{SD}			150	–	–	°C

TEST CIRCUIT



FUNCTION

MODE	IN		OUT	
	A (⑧)	B (⑨)	A (②)	B (④)
1	H	L	ON	OFF
2	L	H	OFF	ON

OPERATION OF AUTOMATIC SELF RECOVERY CIRCUIT

If Motor Rotation is disturbed by external force or obstacles.
Over Current, which have a possibility of Drive Coil Burning, is generated by decreasing of Back Electro Motive Force (BEMF).
Therefore, Over Heat Protection of Drive Coil is required for Fan Motor Driver System.
Generally, Series Connection of Temperature Dependance Elements (Posistor) to Output Drive Coil or to use drive IC incorporates protection circuit are required to get coil burning protection.
Posistor is so expensive, therefore, IC's incorporate this function are coming into wider use for Fan Motor Drive in recent years.
Generally, re-switch operation after the turn on of protection circuit is required for system start up again because the circuit is constructed by flip-flop circuits.
But there's no use re-switch operation with TA8420AF, TA8421AF because of built-in automatic self recovery circuit.
Fig.1 shows ⑩ pin voltage and the operation of this functions are as follows.

1. Normal Rotation States
   Internally generated charging current of ISL (0.25μA TYP.) charge-ups external capacitance of C_{SC} connected to PIN ⑩ .
   But FG pulse, generates among in rotation states and the frequency is proportional to rotation speed, discharges CL charge periodically.
   Therefore, voltage of PIN ⑩ is becoming sawteeth waveform and will not to reach V_{SC} of limitting voltage (1.3V TYP.).

2. Motor Lock States
   If a Motor is locked by external force or obstacles, internal FG pulse generation is stopped. As a result, the voltage of PIN ⑩ increase.
   Torque generation is stopped after when the voltage of PIN ⑩ reaches to V_{SC}
   Further more, voltage of PIN ⑩ is increased by charging current of I_{SL} toward the V_{SCR} of self recovery voltage (2.9V TYP.).
   And then the PIN ⑩ voltage reaches to V_{SCR}.
   Automatic self recovery circuit operates and generates a momentary torque (t_{on}=200ms TYP.). But Motor can not start own rotation if the Motor is still locked by external force or obstacles.
   In this period, voltage wave form of PIN ⑩ is becoming sawteeth that peak is V_{SCR} and Botom is Minimum DC level of approximately 0.7V.

3. After Release of Motor Lock

PIN ⑩ voltage can not reaches V_{SC} level after release of Motor lock because of discharging operation of C_{SC}.

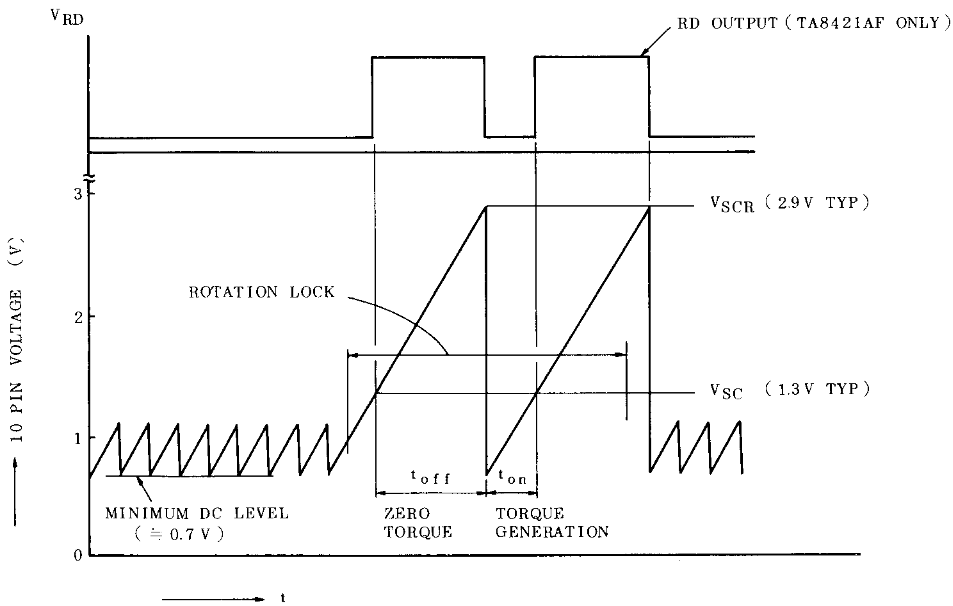


Fig. 1 Automatic Self Rotation Recovery Circuit Operation

○ FG output (TA8420AF) and RD output (TA8421AF)

FG output terminal of PIN ⑩ of TA8420AF outputs a rotation speed proportional FG signals with open collector mode.

This FG signal duty and mode are all the same to output A (PIN②).

RD output terminal of PIN ⑩ of TA8421AF outputs a state signals (Rotate or Stop).

RD output becomes low (Actually $V_{SAT(RD)}$ level of 0.3V TYP.) when the Motor in rotation state and generates t_{off} pulse when the rotation is locked (Refer to Fig. 1).

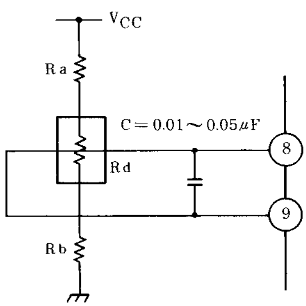
APPLICATION NOTE

○ Hall Input Terminals (PIN⑧, ⑨)

Operating DC Level of Hall Inputs (PIN⑧, ⑨) are 2.5~V_{CC}-0.8V as specified.

If the voltage appeared at Hall Sensor output terminal within this range, there's no requirment of external connecting level shifting resistor.

But Ra, (or Ra and R_B) is required to connect series with Hall sensor if this is not.



R_D : Dynamic Resistance of Hall Sensor.

Fig. 2

$$2.5(V) \leqq V_{CC} \cdot \frac{Rb + \frac{Rd}{2}}{Ra+Rb+Rd} \leqq V_{CC}-0.8(V)$$

- We recommend to connect noise suppression use capacitance between IN A and IN B for stable operation.

○ Recommended Operating Conditions

- TA8420AF, TA8421AF are designed for 5, 12V operating voltage use.
- Please refer to Fig.3 of Recommendation Operating Region.

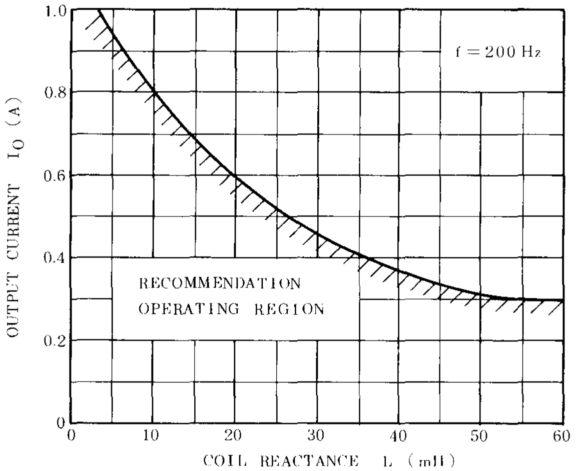


Fig. 3 Recommendation Operating Region

○ Transient Thermal Resistance

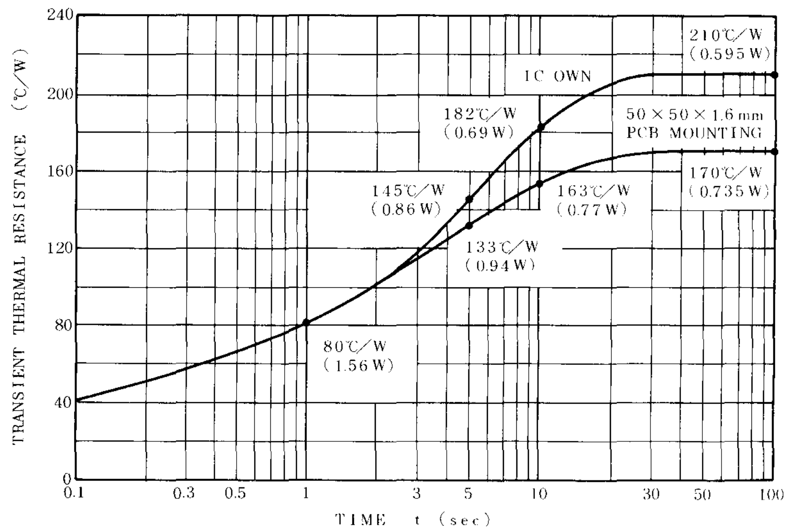
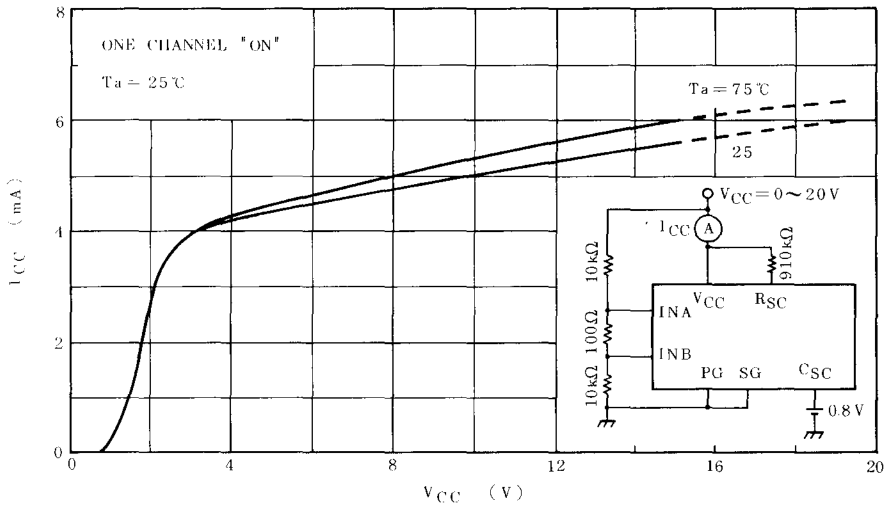
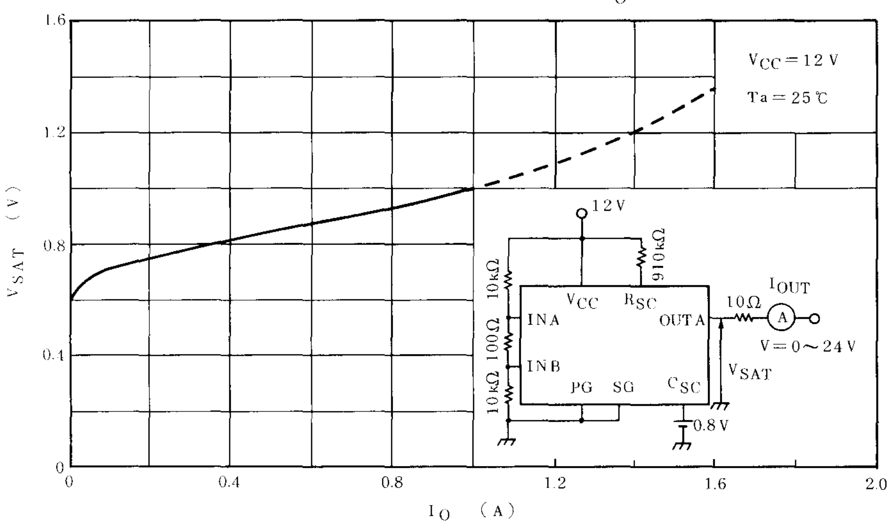


Fig. 4 Transient Thermal Resistance (Single Pulse Condition)

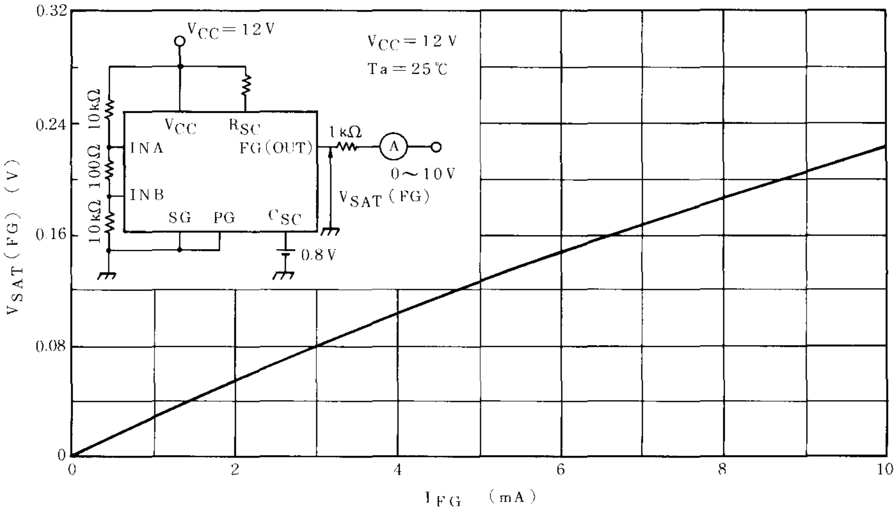
QUIESCENT CURRENT — V_{CC}



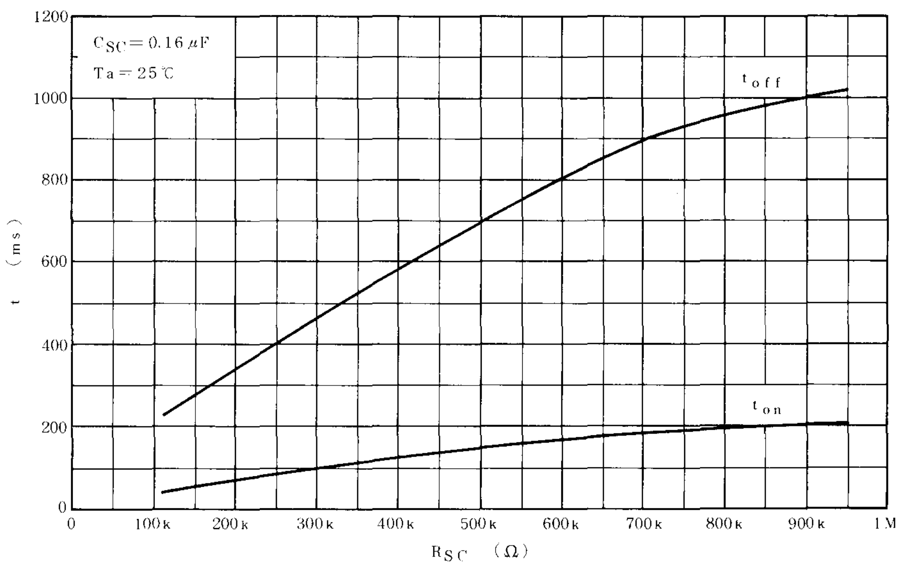
OUTPUT SATURATION — I_O



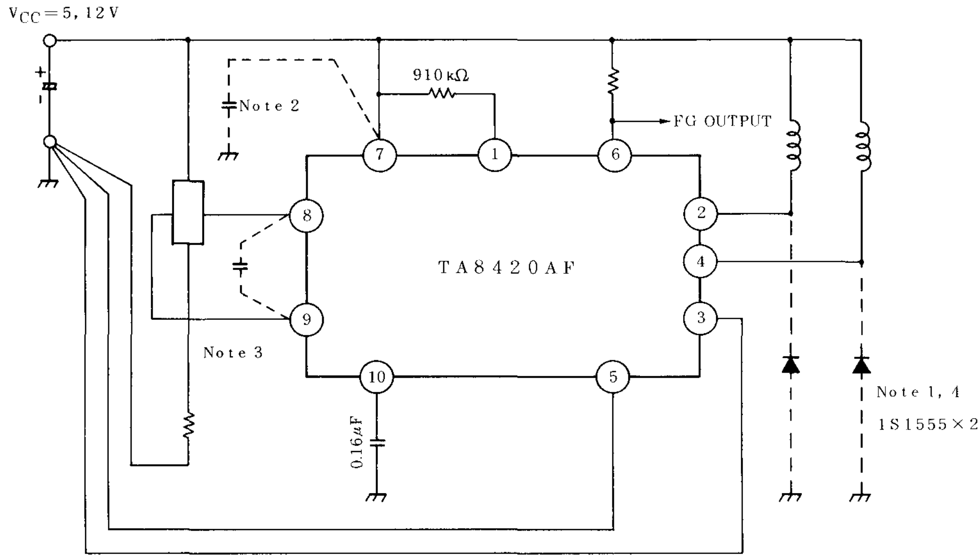
FG, (RD) OUTPUT SATURATION — I_{FG}, (I_{RD})



LOCK DETECT CIRCUIT OPERATING TIME — R_{SC}



APPLICATION CIRCUIT



Note 1. There's no requirement of this diodes in mormal applications
But if the V_{CC} is more than 14V or use large value of coil reactance, we recommend to connect this diodes.

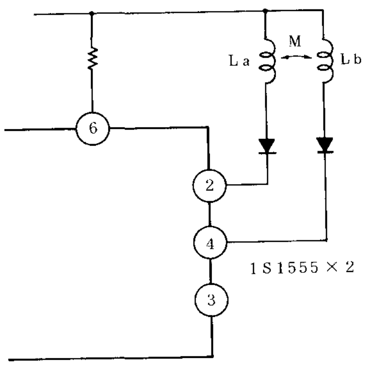
Note 2. There's no requirement of this capacitance in normal applications.
But connection 0.47~10μF of this capacitance increases a stability of operation.

Note 3. This capacitance is for noise suppression use.
Connect if required.

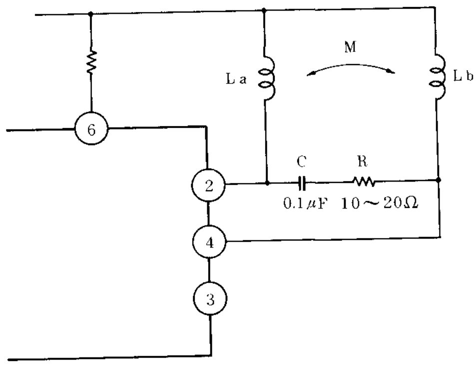
Note 4. We recommend to connect capacitance between each output and GND (or out(A)) and(B)), to suppress R_{FI} and noise problems.

Note 5. In case of large mutual inductive value between La dn Ib.
Diodes (or CR) are required to restrict parasitic oscillation caused by negative electro-motive force generated by inductive mutual effect between La and Lb.

(a)



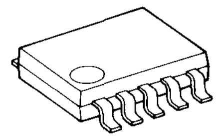
(b)



TA8422F

(TENTATIVE)

- LOW VOLTAGE, LOW NOISE 2 PHASE UNIPOLAR HALL MOTOR DRIVER



SSOP10-P-225

Weight: 0.09g (Typ.)

TA8422F is low voltage and low noise use Hall Motor Driver IC designed especially for Fan and Head Phone Stereo Motors.

Features

- Speed Control is available with external Resistor.
- Low Voltage use: V_{CC} opr=1.2~8.0V(Ta=-30~75°C)
- Low Noise Drive
- Higher Output Current: I_O MAX(AVE) =500mA
  I_O MAX(PEAK)=700mA
- Few external parts required
- Thermal Shut Down Circuit provided.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	8	V
Output Break Down Voltage	V_O	10	V
Output Current	I_O(AVE)	0.5	A
	I_O(PEAK)	0.7 (NOTE 1)	
Power Dissipation	P_D	735 (NOTE 2)	mW
Operating Temperature	T_{opr}	-30~75	°C
Storage Temperature	T_{stg}	-55~150	°C

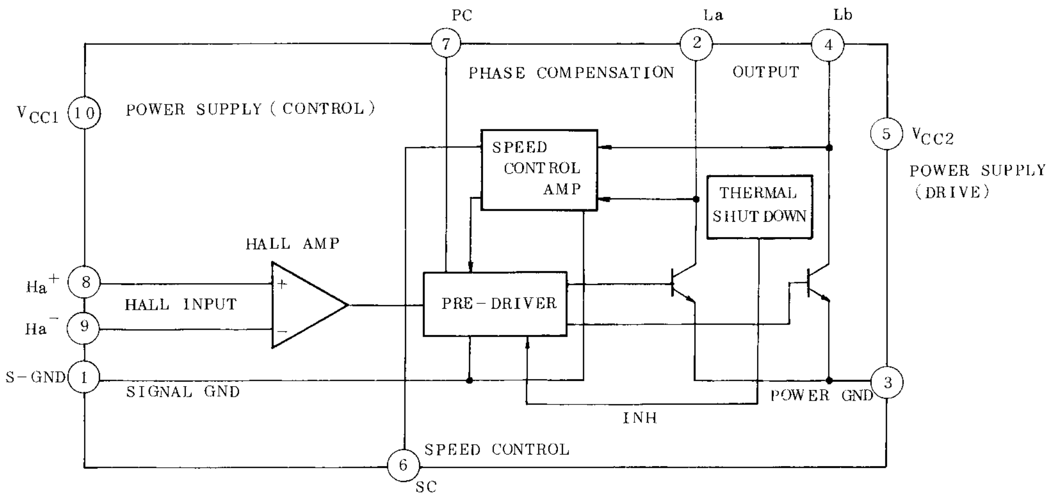
NOTE 1: t=1sec

NOTE 2: This value is obtained by 50 × 50 × 1.6mm GLASS-EPOXY PCB Mounting occupied in excess of 30% of copper area.

ELECTRICAL CHARACTERISTICS (Unless otherwise noted $V_{CC1}=V_{CC2}=3,0V$, Ta=25°C)

CHARACTERISTIC		SYMBOL	MEASURING CIRCUIT	MEASURING CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	Control Side	$I_{CC1}-1$	-	$V_{CC1}=3V$	-	1.0	2.0	mA
		$I_{CC1}-2$		$V_{CC1}=6V$	-	1.5	3.0	
	Drive Side	$I_{CC2}-1$		$V_{CC2}=3V$	-	27	45	
		$I_{CC2}-2$		$V_{CC2}=6V$	-	35	50	
Output Saturation Voltage		V_{SAT1}	-	$I_O=100mA$	-	50	100	mV
		V_{SAT2}		$I_O=500mA$	-	220	380	
Thermal Shut Down Circuit Operating Temperature		TSD	-	Tj Measure	140	155	-	°C
Hall Sensor Input Voltage		V_H	-		50	-	100	mVp-p
Sensor Input Common Mode Range		CMR	-		0	-	V_{CC} -1.0	V

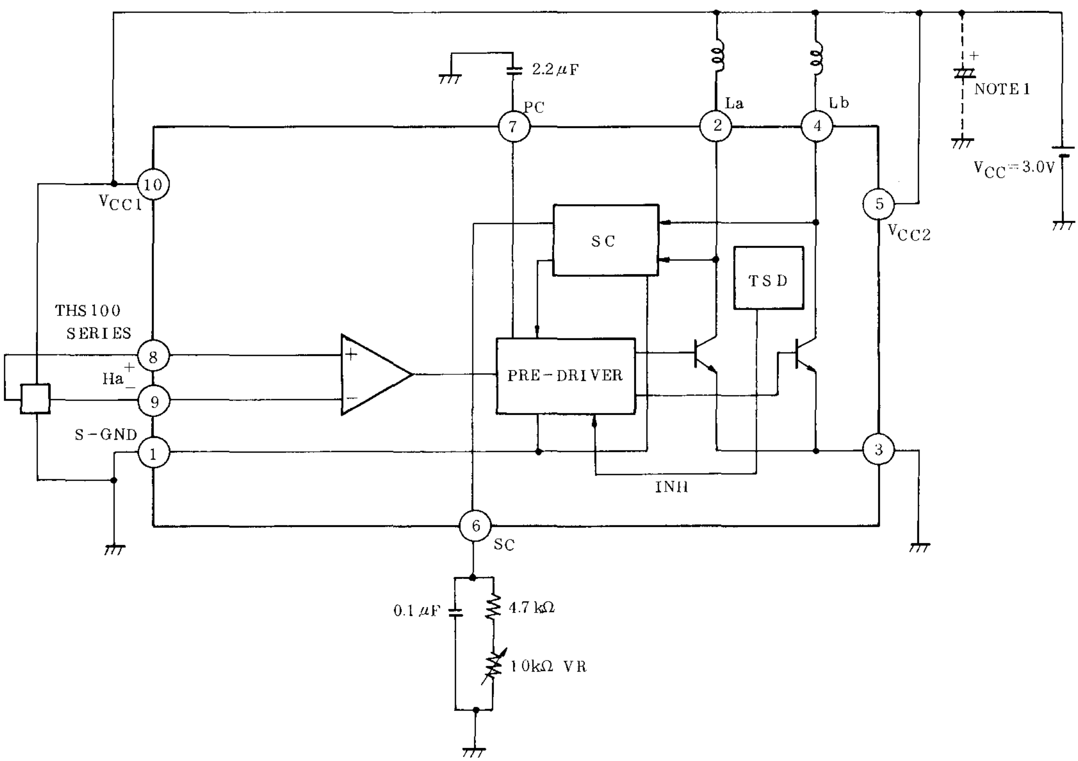
BLOCK DIAGRAM



TERMINAL DESCRIPTIONS

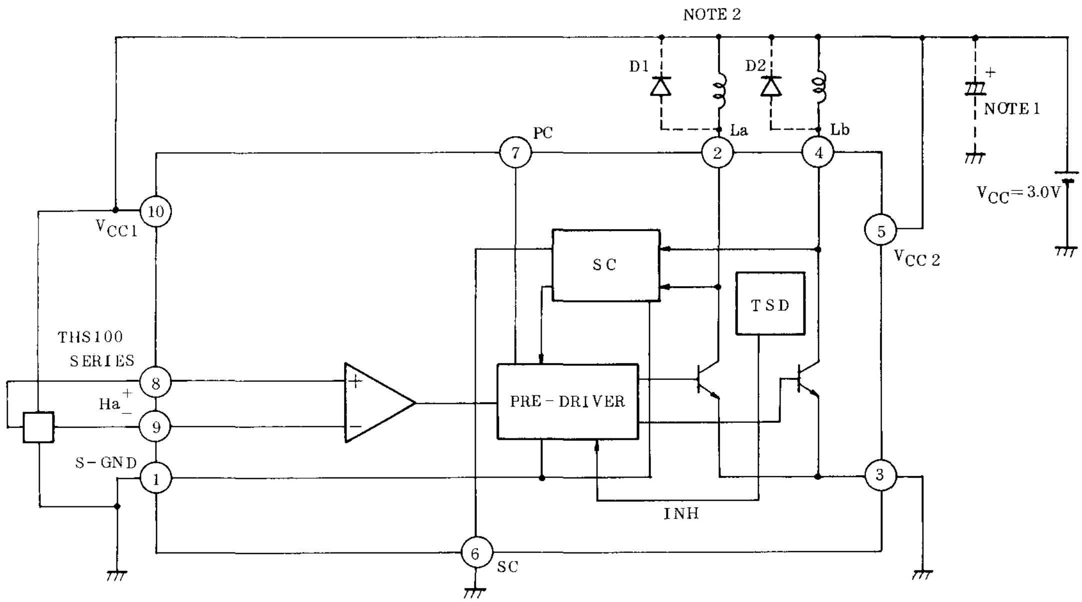
PIN NO.	SYMBOL	FUNCTION
①	S-GND	Signal GND Care should be taken not to have a common impedance with P-GND (③ PIN) line for stable operations.
②, ④	La, Lb	Output La, Output Lb Open Collector type Outputs
③	P-GND	Power GND Care should be taken not to affect any influences to other circuits especially for ① PIN caused by large output current flow through this terminal.
⑤	V_{CC2}	Power Supply(Drive) Connect Bypass Capacitance if required.
⑥	SC	Speed Control Parallel connection of 0.1μF and 5~15kΩ is required for speed control. This time constant controls Motor Speed. Higher value of Resistor sets the Motor Speed low and Lower sets high. Temperature Dependant Resistor compensates temperature characteristics of Motor Speed. Rotation speed vs V_{CC} characteristics is improved by using large value of this capacitance. But this results bad ripple rejection characteristics. So we recommed to select optimum value of the capacitance. Connect this PIN to GND if the Motor required no speed control feature.
⑦	PC	Phase Compensation Connect 0.1μF~2.2μF capacitance for frequency compensation. But if the Motor required no speed control feature there's no requirement (open) of this capacitance.
⑧ ⑨	Ha^+, Ha^-	Sensor Inputs Recommend to input less than 100mVp-p of Hall Sensor Output Voltage to keep low noise characteristics of this IC. We recommend to use TOSHIBA GaAs Hall Sensor THS1000 Series.

APPLICATION CIRCUIT 1 (Speed Control Application)



NOTE 1: Connect if required

APPLICATION CIRCUIT 2 (Free Running Application)



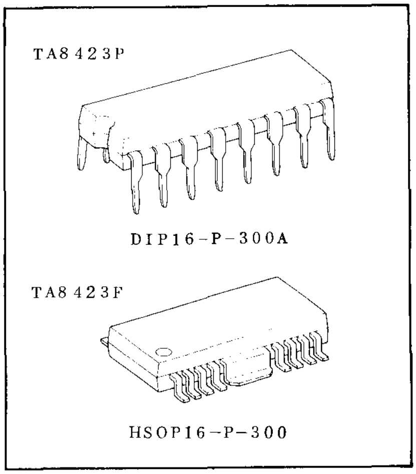
NOTE 1: Connect if required

NOTE 2: D1 and D2 are required to connect if the BEMF generated by Output Coils over the specified Output Break down voltage (Vo=10V).

TA8423F/P

3 PHASE Bi-DIRECTIONAL HALL MOTOR DRIVER

The TA8423P/F are 3 phase Bi-Directional Hall Motor Driver IC designed for VCR (Capstan, head and reel), ADP, Tape Deck, FDD and other Output Driver for 3 phase bipolar Hall motors.



Weight:

DIP16-P-300A: 1.11g (Typ.)
HSOP16-P-300: 0.5g (Typ.)

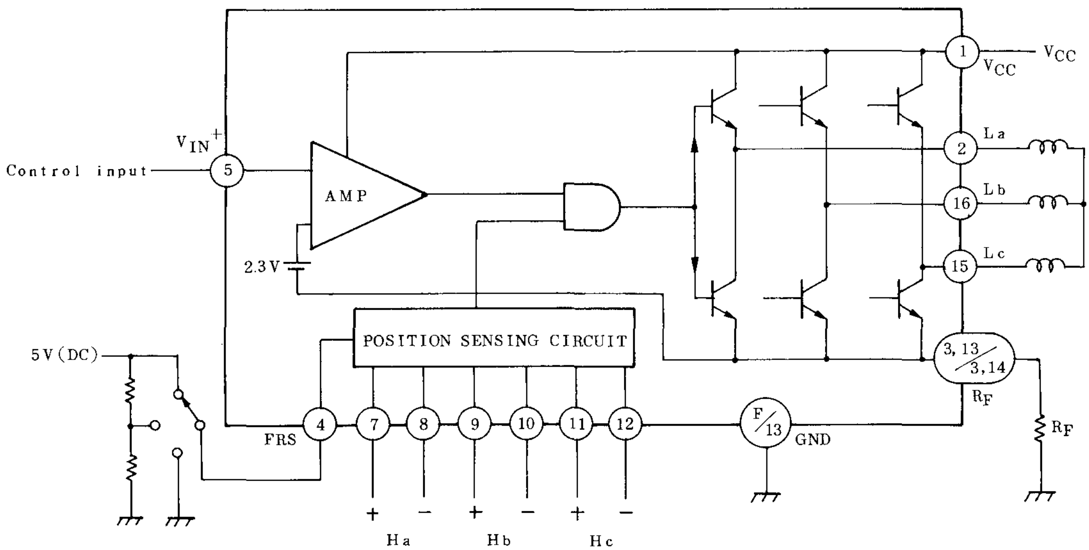
. Few external parts required
. Wide operating supply voltage range
  : $V_{CC(opr)}$=7~17V
. Forward rotation, reverse rotation and stop are controlled by 1 terminal signal control and easy to interface with CPU.
. High sensitivity of the position sensing circuit.
  (Hall sensor input) : V_H=20mV(Typ.)
. Large output current : $I_{O\ MAX}$=1.2A (AVE)
. Protect diodes equipped for all inputs
. Recommend to use TOSHIBA Ga-As Hall sensor "THS100 series"
. Built-in internal reference
. Built-in thermal shut down circuit

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	18	V
Output Current		I_O	1.2	A
Hall Sensor Input Voltage		V_H	400	mV
Power Dissipation	TA8423P	P_D	1.2	W
	TA8423F		0.9	
			8.3(Note)	
Operating Temperature		Topr	-30~75	°C
Storage Temperature		Tstg	-55~150	°C

Note : Tc=25°C

BLOCK DIAGRAM (TA8423F/TA8423P)



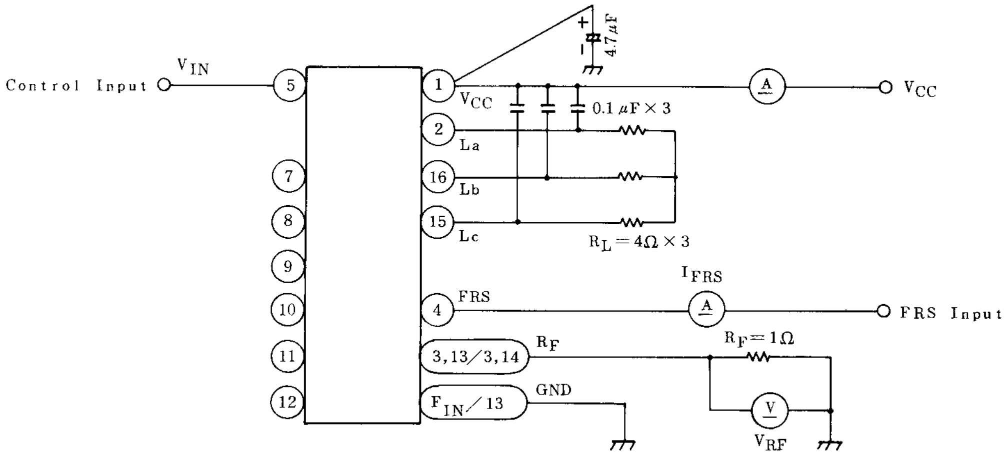
Forward rotation, reverse rotation and stop

Hall Sensor Input

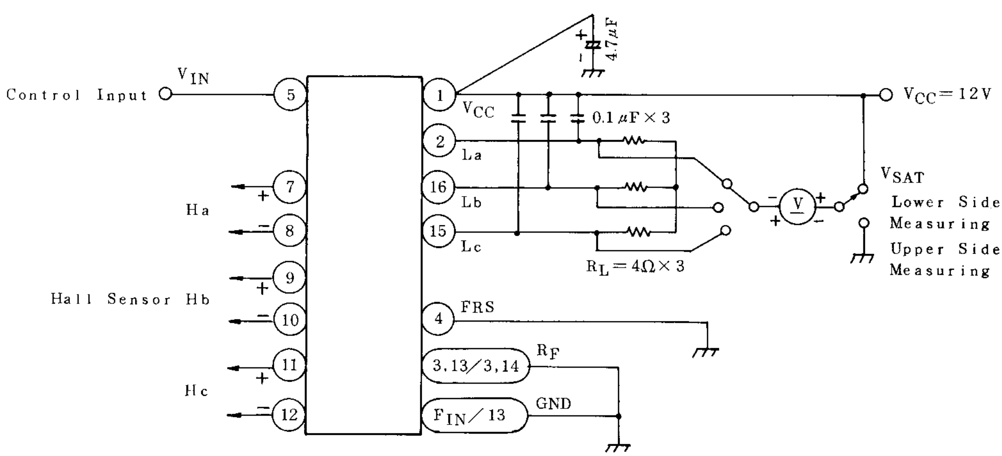
ELECTRICAL CHARACTERISTICS (V_{CC}=12V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}	1	FRS Open	4	8	19	mA
		I_{CC2}		FRS=5V	4.5	9	21	
		I_{CC3}		V_{CC}=18V, FRS=GND	5.5	11	22	
Control Amp.	Reference Voltage	V_{ref}	1		2.2	2.3	2.4	V
	Voltage Gain	G_V			–	1.0	–	
	Input Current	I_{in}		V_{IN}=3.5V	–	2.5	10	μA
	Reference Voltage Ripple Rejection Ratio	R_r			-60	–	–	dB
Cut-off Current	Upper Side	$I_{OL(U)}$	–	V_{CC}=18V	–	–	50	μA
	Lower Side	$I_{OL(L)}$		V_{CC}=18V	–	–	50	
Saturation Voltage	Upper Side	$V_{sat(U)}$	2	I_L=1A	–	1.5	1.9	V
	Lower Side	$V_{sat(L)}$		I_L=1A	–	0.8	1.2	
Gain Difference		ΔG_V	1		–	–	±1	%
Residual Output Voltage		V_{or}	1		–	0	10	mV
Position Sensing Input	Input Sensitivity	V_H			–	20	–	mV
	Common Mode Voltage Range	C_{MRH}	3		2.0	–	V_{CC}-3	V
	Input Offset Voltage	V_{HO}			–	0	5	mV
Rotation Control (Input Operation Voltage)	Forward	V_F	1		-0.3	–	1.3	V
	Stop	V_S			2.4	–	3.0	
	Reverse	V_R			3.9	–	V_{CC}	
Thermal Shut Down Circuit Operating Temperature		TSD	–		150	–	–	°C

TEST CIRCUIT 1

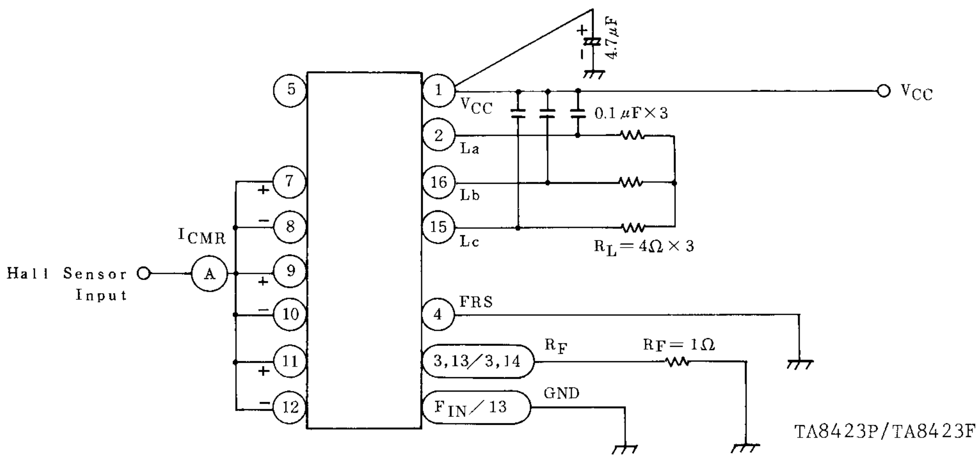


TEST CIRCUIT 2

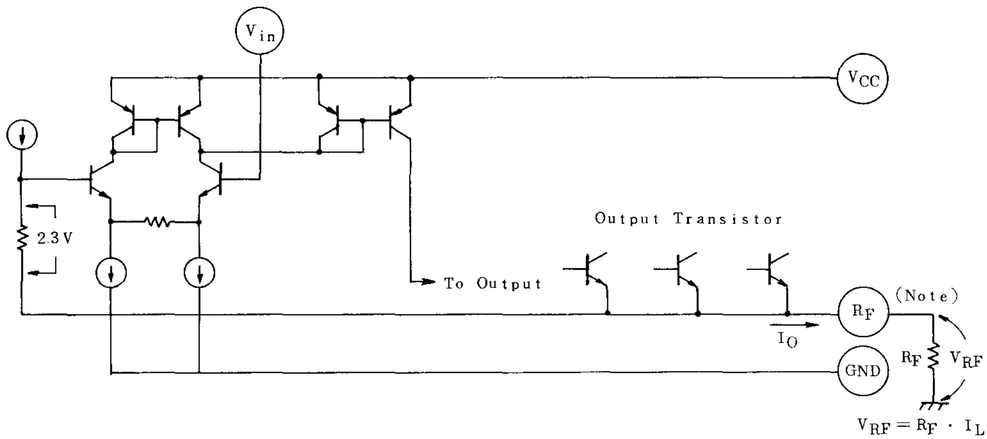


TA8423P/TA8423F

TEST CIRCUIT 3



1. CONTROL INPUT CIRCUIT



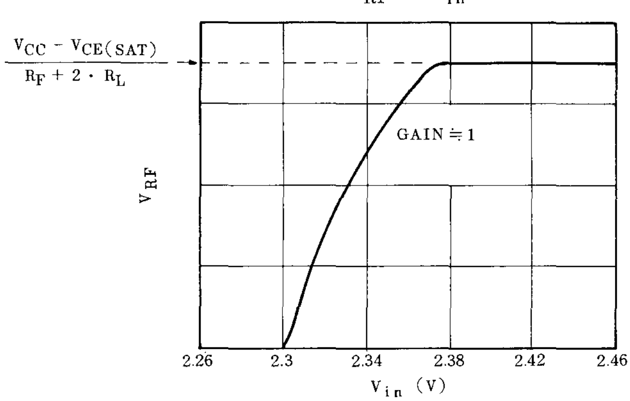
$V_{RF}(=R_F \cdot I_L)$ of feed back voltage is feed backed to negative input of control amp internally.

Voltage gain becomes approximately equal to 1 (0dB) by this internal feed back.

(Note) 2 terminals (3), (13) Pins for F version and (3), (14) Pins for P version) are provided for RF terminal to decrease the interference caused by internal common impedance.
Both Pins are required to connect for stable operation.

INPUT — OUTPUT CHARACTERISTIC

V_{RF} — V_{in}



R_L: Output Coil Resistance
$V_{CE(SAT)}$: Output Saturation Voltage (Upper and Lower Side Total).

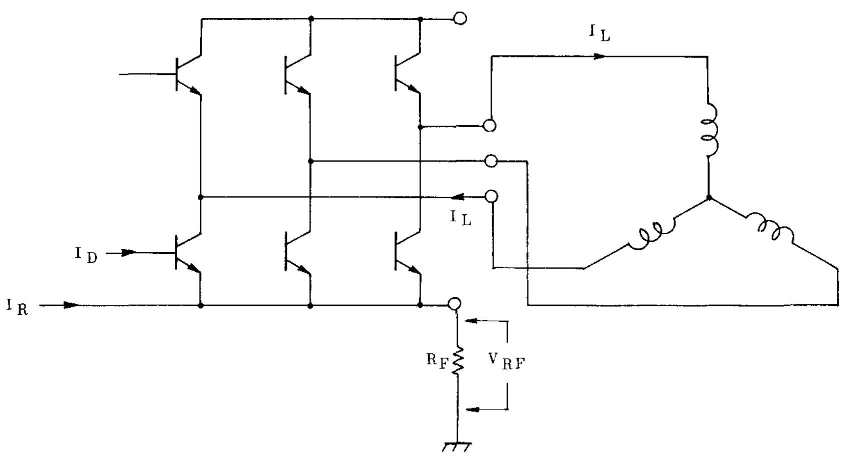
V_{RF} is feed back voltage generated by R_F and output current of I_L, drive current of I_D and internal reference circuit current of I_R.
But I_O and I_R are negligible therefore,

$$I_R \ll I_L + I_D$$

$$V_{RF} \doteqdot R_F\ (I_L + I_O + I_R)$$

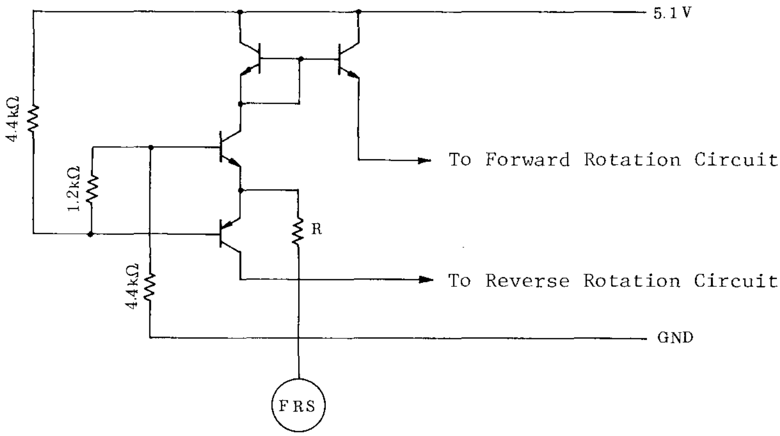
$$I_L \gg I_D,\ I_R$$

$$V_{RF} \doteqdot I_L \cdot R_F$$



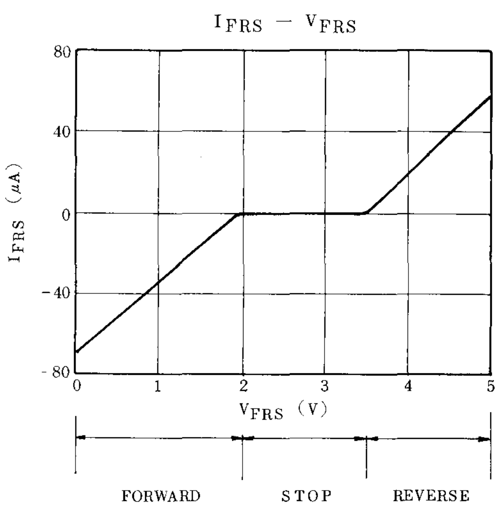
0 Torque state is obtained when less than 2.3V of control voltage fed into input terminal.
0 Torque state also obtained by select a stop mode by controlling FRS input (④Pin).
Less supply current is obtained with this condition.

2. FRS CIRCUIT



Forward, Reverse and Stop Modes are selectable by controlling this terminal. Specified voltages are less than 1.3V (Forward), 2.4~3.0V or Open (Stop) and 3.9V~V_{CC} (Reverse).

V_{FRS} - I_{FRS} characteristic is shown below.



FUNCTION

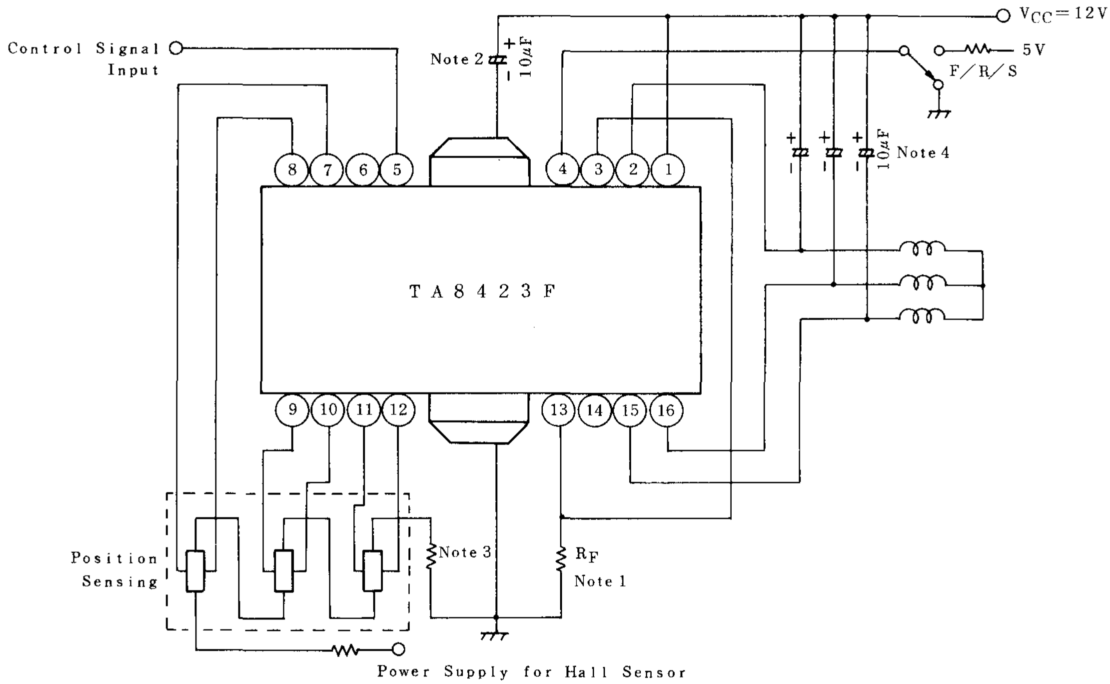
FRS Input (4 Pin)	Position Sensing Input			Output		
	Ha	Hb	Hc	La	Lb	Lc
L (V_4<1.3V)	1	0	1	H	L	M
	1	0	0	H	M	L
	1	1	0	M	H	L
	0	1	0	L	H	M
	0	1	1	L	M	H
	0	0	1	M	L	H
H (3.9V<V_4<V_{CC})	1	0	1	L	H	M
	1	0	0	L	M	H
	1	1	0	M	L	H
	0	1	0	H	L	M
	0	1	1	H	M	L
	0	0	1	M	H	L
M 2.4V<V_4<3.0V or Open	1	0	1	High Impedance (Stop)		
	1	0	0			
	1	1	0			
	0	1	0			
	0	1	1			
	0	0	1			

Note: "1" of the Hall Sensor input means that voltage above +20mV is applied to the positive side of each Hall Sensor from the negative side and "0" means that voltage above +20mV is applied to the negative side from the positive side.

In this case, needless to say, DC potential must be within the specified common mode voltage range of Hall Sensor input.

Further, "H", "M" and "L" of output mean V_{CC}-V_{SAT1}=1/2 V_{CC} and V_{SAT2}, respectively.

APPLICATION CIRCUIT

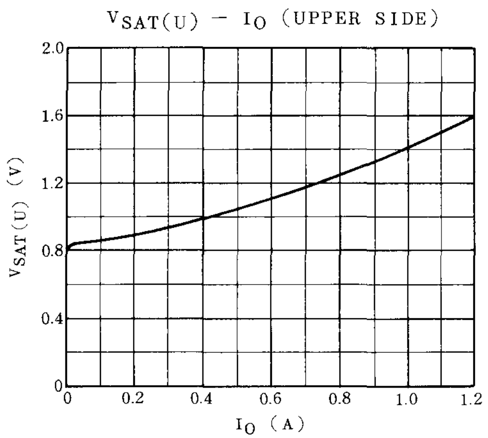


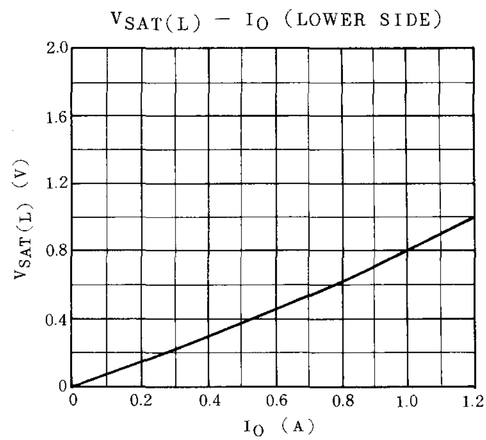
Note 1. Recommendable value of R_F is 0.3 to 5Ω. It depends on required initial torque, gain, coil impedance and control voltage of Pin 5.

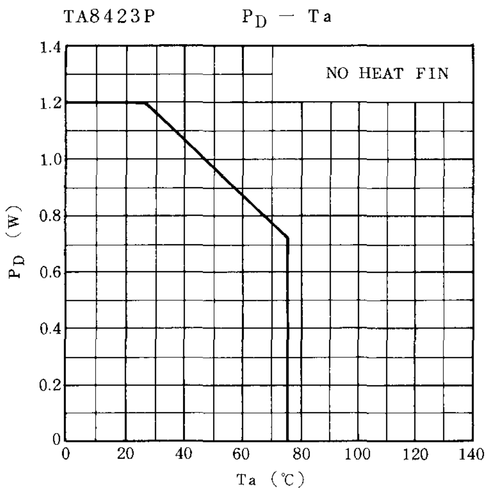
Note 2. To connect directly to IC Pin (Fin for F version and (13) Pin for P version) and GND to eliminate the influence of common impedance.
It is required to increase the value of this capacitance for stable operations in case of poor wiring or patterning of PCB.

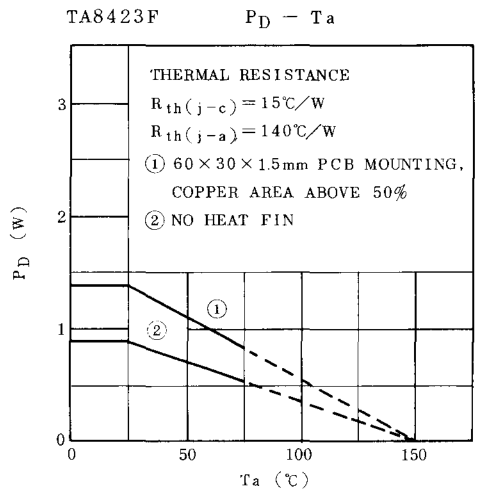
Note 3. Special care should be taken not to have a common impedance with GND line, RF GND line and Hall Sensor GND line.

Note 4. Please select to optimum value for eliminate a vibration noise and parasitic oscillation. And also to change the connection (for example, each output to V_{CC} or to R_F) for getting better characteristics.


VSAT(U) − IO (UPPER SIDE)
VSAT(U) (V)
2.0
1.6
1.2
0.8
0.4
0
0
0.2
0.4
0.6
0.8
1.0
1.2
IO (A)


VSAT(L) − IO (LOWER SIDE)
VSAT(L) (V)
2.0
1.6
1.2
0.8
0.4
0
0
0.2
0.4
0.6
0.8
1.0
1.2
IO (A)


TA8423P
PD − Ta
NO HEAT FIN
PD (W)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
140
Ta (℃)

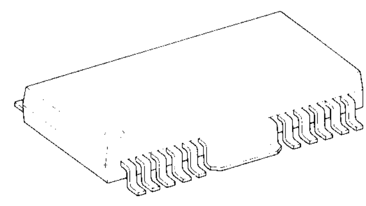

TA8423F
PD − Ta
THERMAL RESISTANCE
Rth(j−c) = 15℃/W
Rth(j−a) = 140℃/W
① 60 × 30 × 1.5mm PCB MOUNTING,
COPPER AREA ABOVE 50%
② NO HEAT FIN
①
②
PD (W)
3
2
1
0
0
50
100
150
Ta (℃)

TA8424F

TENTATIVE

3 PHASE HALL MOTOR DRIVER IC

TA8424F is non switching type 3 Phase Hall Motor Driver IC consisted of FG Amplifier, Regulator for Hall Sensors, control Amplifier and 3 Phase Output Drivers.



HSOP20-P-450

Weight: 0.8g (Typ.)

- Low Noise (Quasi Sinusoidal Drive), Current Control Motor Driver.
- Low Output Impedance with B Class Push-Pull Driver.
- Output Current Up to 1.2A.
- Operating Voltage Range : $V_{CC\ opr}$=7~17V
- Built-in Thermal Shutdown Circuit, FG Amplifier and Regulator.
- 2 Brake Modes Available (Short Brake and Dumping Brake).
- Regulator for built-in Hall Sensors.

MAXIMUM RATINGS (Ta=25°C)

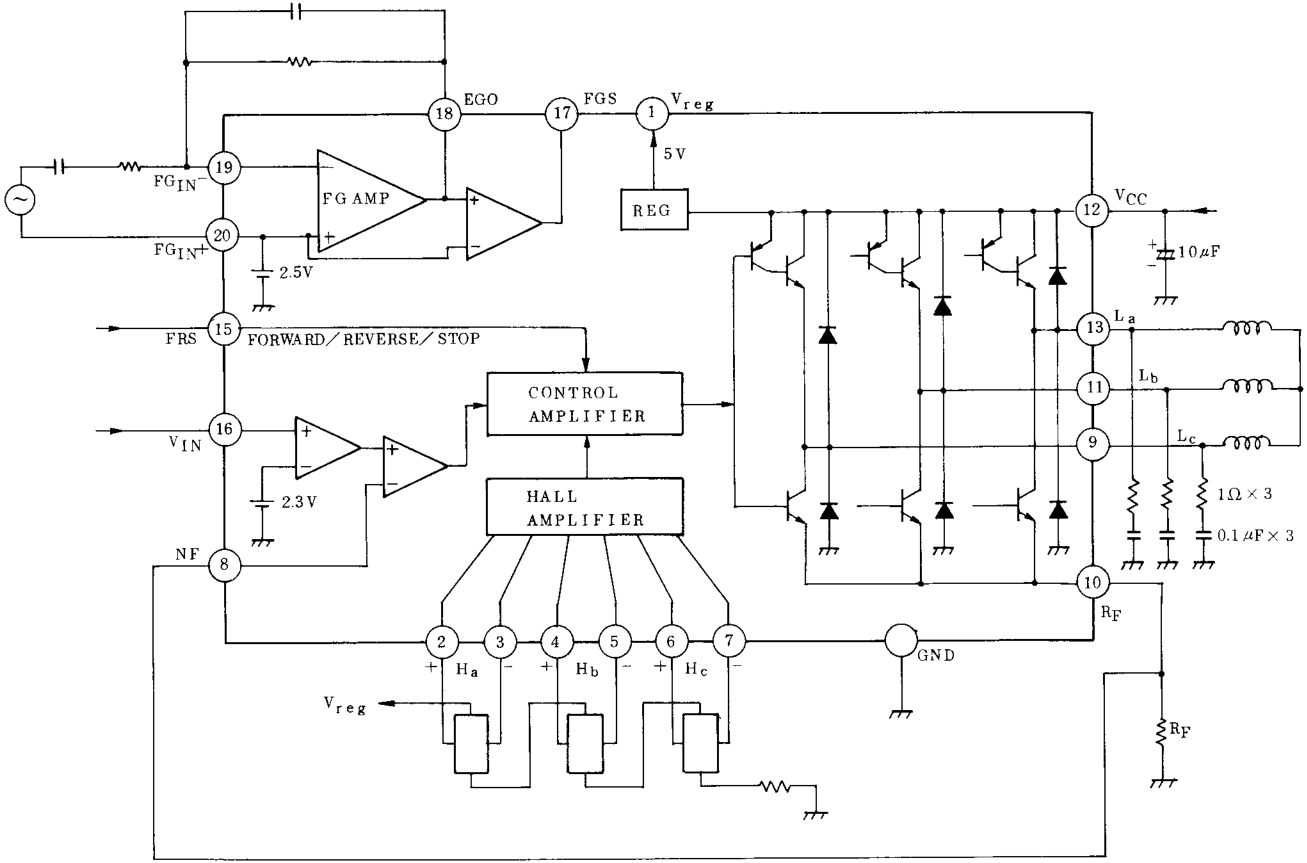
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	18	V
Output Current (Average)	I_O	1.2	A
FG Output Current	I_{FGO}	12	mA
	I_{FGS}	14	
Regulator Output Current	I_{REG}	30	mA
Power Dissipation	P_D	1.0 (Note 1)	W
		3.2 (Note 2)	
		5.8 (Note 3)	
Operating Temperature	T_{opr}	-30~75	°C
Storage Temperature	T_{stg}	-55~150	°C

Note 1 : No Heat Fin

Note 2 : 50 × 50 × 1mm Fe board, Mounting

Note 3 : Tc=75°C

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS (V_{CC}=12V, Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current			I_{CC1}		FRS=2.5V	-	12.5	25	mA
			I_{CC2}		FRS=GND	-	14	25	
			I_{CC3}		FRS=5V	-	14	25	
Rotation Control Circuit	Control Gain (V_C→Out)		G_{VCO}		V_{CC}=12V V_H=50mVp-p	7.5	13	18	dB
	Input Current (V_C)		I_{CIN}		V_{IN}=GND (Sink Current)	-	0.2	5	μA
	Internal Reference-1		$V_{ref\ 1}$			2.15	2.30	2.45	V
Position Sensing Circuit	Common Mode Range		CMRH			1.5	-	5	V
	Input Current		I_H		V_{IN}=2.5V	-	0.2	3	μA
	Voltage Gain (Each Hall Input to OUT)		G_{VHO}		V_{IN}=5V V_{CC}=12V	40	47	51	dB
Output Driver	Upper Side Saturation		$V_{SAT(U)}$		I_O=1.0A	-	1.2	1.9	V
	Lower Side Saturation		$V_{SAT(L)}$		I_O=1.0A	-	0.7	1.5	
	Quiescent Voltage		V_{OS}		V_{IN}=1.0V	5.0	5.5	7.0	
	Quiescent Voltage Difference		V_{OOF}		Each Output to Output	-	25	50	mV
FG Amp	Open Loop Gain		G_{VFG}		f_{FG}=1kHz	-	70	-	dB
	Band Width		f_{FG}			DC	-	50	kHz
	Output Voltage Swing		V_{FGO}		I_{FGO}=5mA	1.0	2.1	4	V
	FGS Saturation		$V_{SAT(FGS)}$		I_{FGS}=4mA	-	0.15	0.25	
	Internal Reference-2		$V_{ref\ 2}$			2.1	2.5	2.9	V
	Hysteresis Voltage		V_{HYS}			-	100	250	mV
Rotation Direction Control	FWD	Operating Voltage	V_{FWD}			4.0	-	V_{CC}	V
	STOP	Operating Voltage	V_{STOP}			1.9	-	3.1	V
	REVERSE	Operating Voltage	V_{REV}			0	-	1.3	V
Regulator Output Voltage			V_{REG}		I_F=10mA	4.7	5.1	5.5	V
Thermal Shutdown Operating Temperature			T_{SD}			150	-	-	°C

Operating Mode

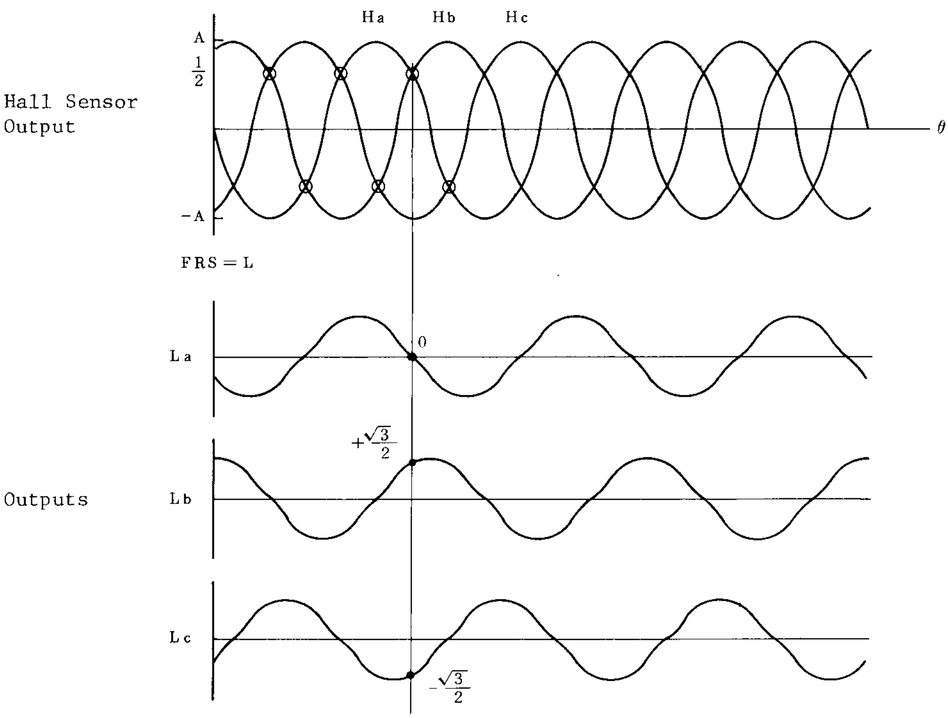
MODE	FRS	VC	OUTPUT
Forward	L	$V_{IN} > 2.3V$	La=Ha-Hb Lb=Hb-Hc Lc=Hc-Ha
Reverse	H	$V_{IN} > 2.3V$	La=-(Ha-Hb) Lb=-(Hb-Hc) Lc=-(Hc-Ha)
Stand-By	M	-	Center (Note)
Brake	-	$V_{IN} < 2.3V$	Center (Note)

Note Low Impedance

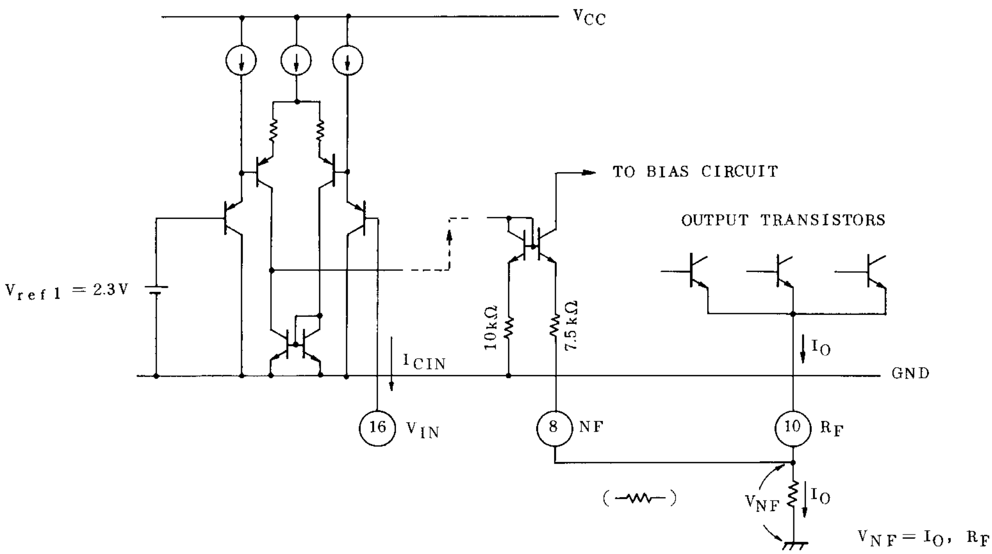
Ha=Asinθ

Hb=Asin(θ-120°)

Hc=Asin(θ-240°)



(1) Control Gain (G_{VCO})

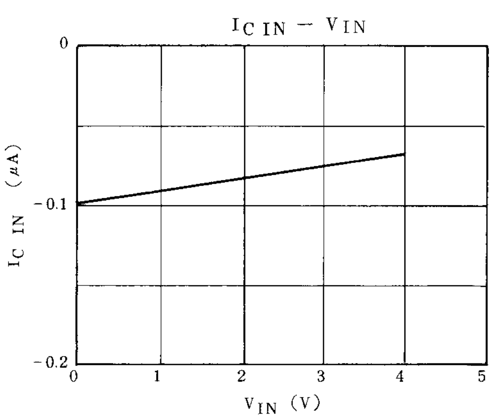


Negative Feedback is looped by R_F and connected its line to ⑧ pin.

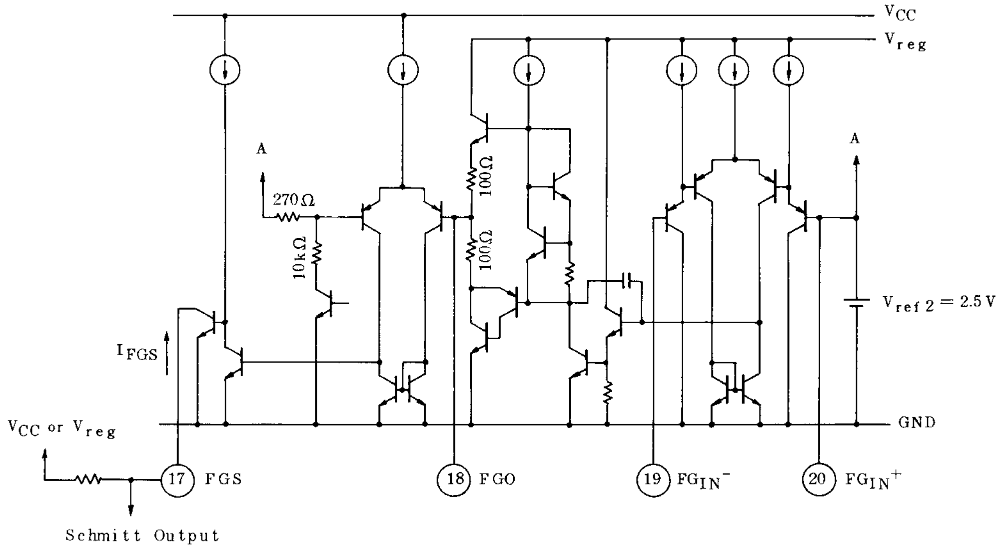
Feedback Voltage V_{NF} is generated by R_F and Output Current I_O.

It is possible to decrease the feedback by connecting a resistor between ⑩ pin and ⑧ pin.

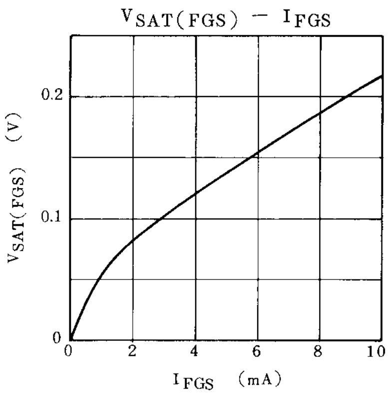
Input current of V_C($I_{C\ IN}$) vs V_C characteristic is shown below.



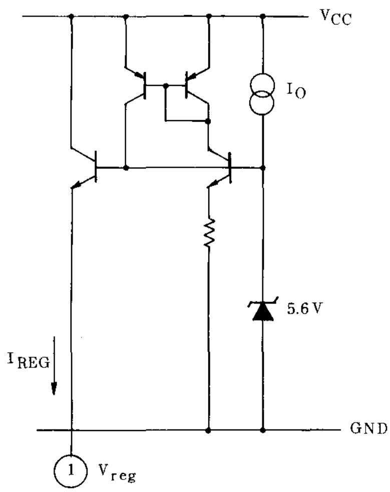
(2) FG Amplifier and Hysteresis Amplifier



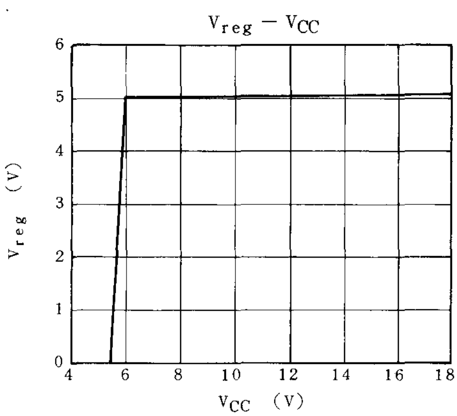
2.5V of Internal Reference is equipped with FG Amplifier. FG signal is fed into FG_{IN}^{+} and FG_{IN}^{-} inputs with differencial mode and outputs to FGO ((18) pin). Amplified FG signal is wave shaped by Hysteresis Amplifier in following stage and outputs a wave shaped signal to FGS ((17) pin).



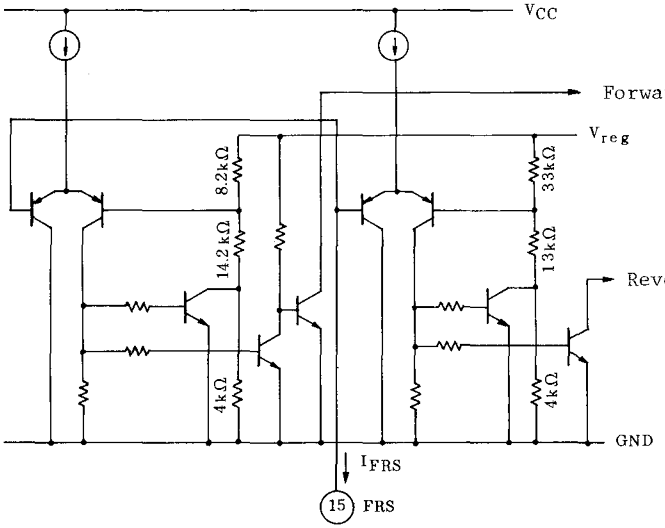
(3) Regulator



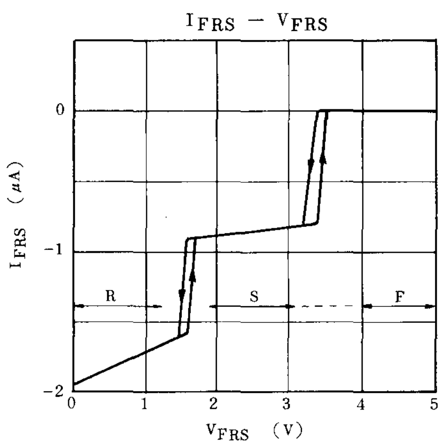
Internal regulator outputs 5V and this current capability is up to 30mA.
V_{CC} vs V_{reg} characteristic is shown below.

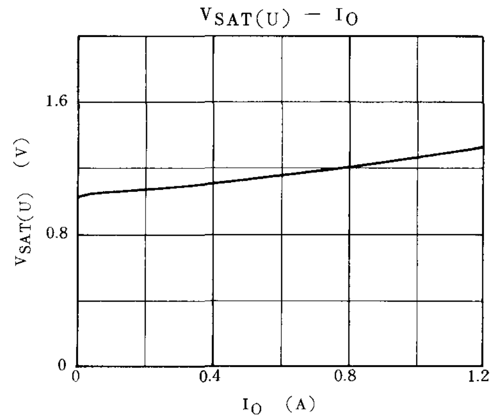


(4) FRS Input (Rotation Direction and Stop Control)

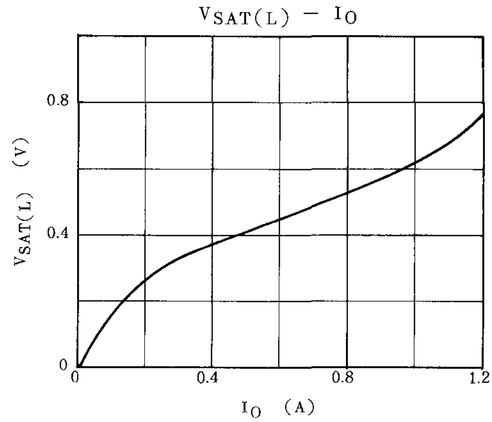


FRS input is a control terminal of Motor Rotation Direction and Stop.
Inputs V_{FRS} Voltage of less than 1.3V sets the Motor direction reverse, 1.9~3.1 sets stop and 4V V_{CC} sets the Motor forward direction.
V_{FRS} vs I_{FRS} characteristic is shown below.

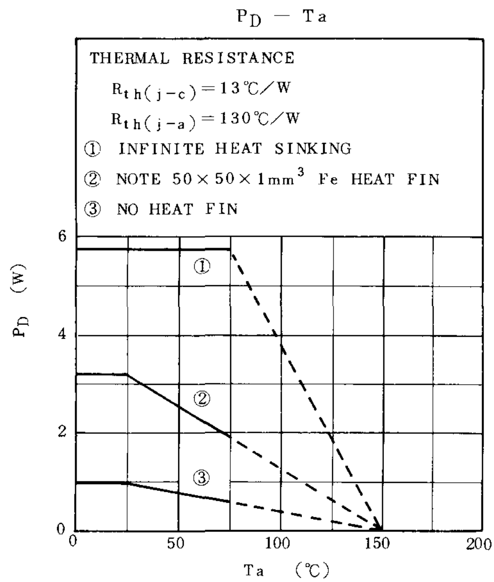




$V_{SAT(U)}$ − I_O
1.6
0.8
0
$V_{SAT(U)}$ (V)
0
0.4
0.8
1.2
I_O (A)

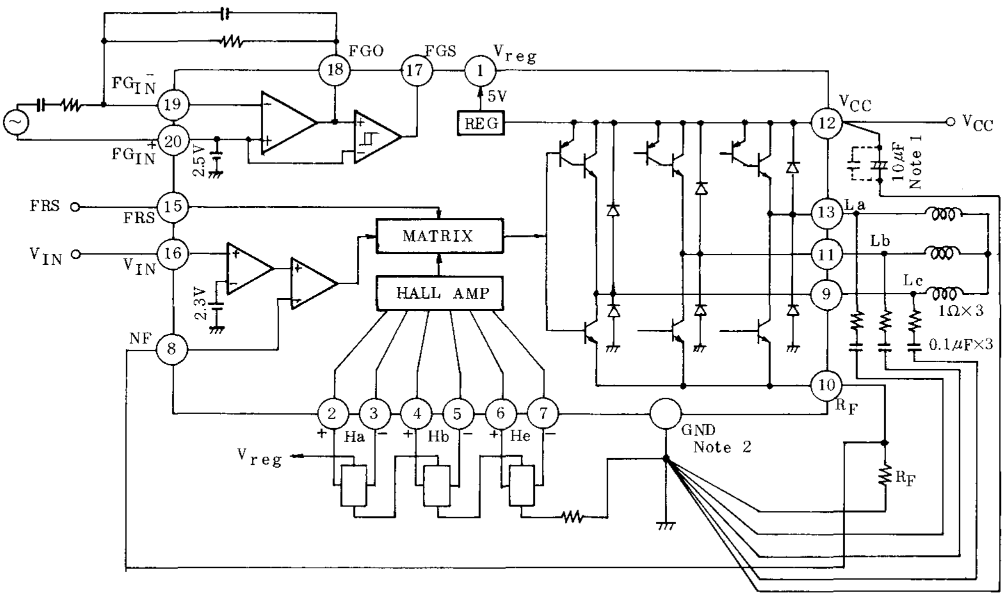


$V_{SAT(L)}$ − I_O
0.8
0.4
0
$V_{SAT(L)}$ (V)
0
0.4
0.8
1.2
I_O (A)



P_D − Ta
THERMAL RESISTANCE
$R_{th(j-c)}$ = 13℃/W
$R_{th(j-a)}$ = 130℃/W
① INFINITE HEAT SINKING
② NOTE 50×50×1mm³ Fe HEAT FIN
③ NO HEAT FIN
6
4
2
0
P_D (W)
①
②
③
0
50
100
150
200
Ta (℃)

APPLICATION CIRCUIT



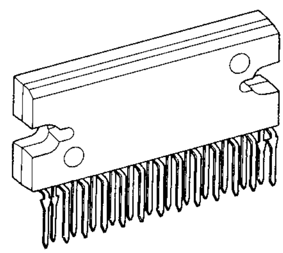
Note 1. Connect if required (0.1~1μF)

Note 2. Care should be taken not to have common impedance between R_F GND Line and other small signal lines for stable operations (especially for Hall Sensor GND line).

TA8425H

PWM CHOPPER TYPE BIPOLAR STEPPING MOTOR DRIVER.

TA8425H is PWM chopper type sinusoidal micro step bipolar stepping motor driver. Sinusoidal micro step operation is accomplished only a clock signal inputting by means of built-in hard ware.



HZIP25-P

Weight: HZIP25-P: 9.9g

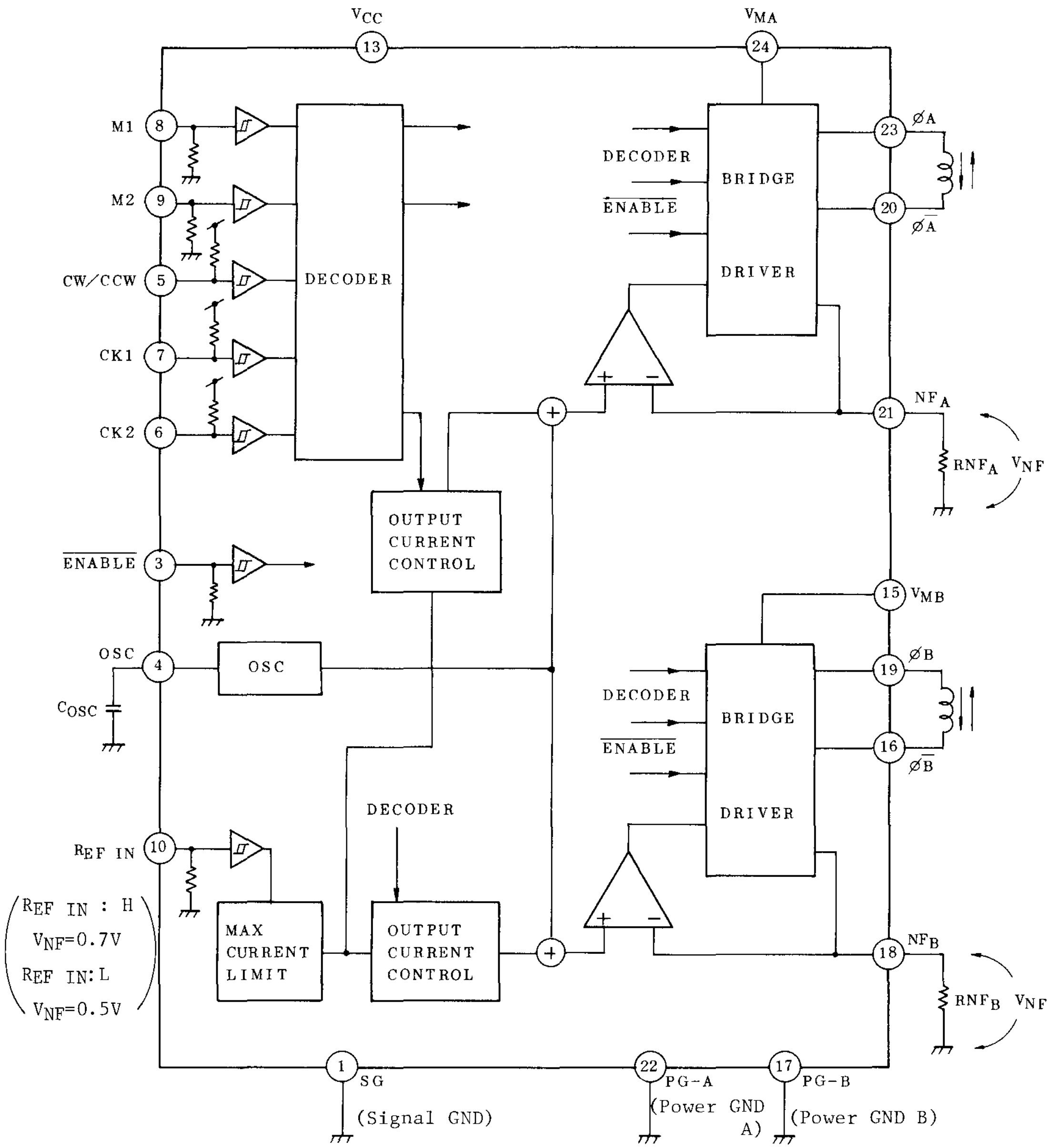
. 1 chip bipolar sinusoidal micro step stepping motor driver.
. Output current up to 1.5A(AVE) and 2.5A(PEAK).
. PWM chopper type.
. Structured by high voltage Bi-CMOS process technology.
. Forward and reverse rotation are available.
. 2, 1-2, W1-2, 2W1-2 phase 1 or 2 clock drive are selectable.
. Package: CPP-25
. 40kΩ(Typ.) of pull up resistors are provided with CK1,CK2, $\overline{\text{ENABLE}}$ terminals.
. 40kΩ(Typ.) of pull down resistors are provided with M1,M2, REF IN terminals.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	5.5	V
	V_M	40	
Output Current	I_O (PEAK)	2.5	A
	I_O (AVE)	1.5	
Input Voltage	V_{IN}	~V_{CC}	V
Power Dissipation	P_D	*5	W
		**43	
Operating Temperature	Topr	-40~85	°C
Storage Temperature	Tstg	-55~150	°C
Feed Back Voltage	V_I	1.0	V

* No heat sink
** Tc=85°C

BLOCK DIAGRAM



Pull Up/Pull Down Resistance : 40kΩ(Typ.)
(2), (11), (12), (14), (25) Pin : No Conection.

FUNCTION TABLE

INPUT				MODE
CK1	CK2	CW/CCW	$\overline{ENABLE}$	
↑	H	L	L	CW
⊓	L	L	L	INHIBIT
H	↑	L	L	CCW
L	⊓	L	L	INHIBIT
↑	H	H	L	CCW
⊓	L	H	L	INHIBIT
H	↑	H	L	CW
L	⊓	H	L	INHIBIT
X	X	X	H	Z

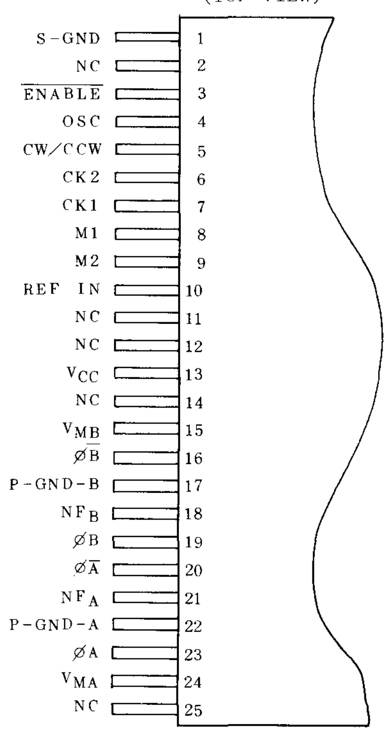
INPUT		MODE (EXCITATION)
M1	M2	
L	L	2 Phase
H	L	1-2 Phase
L	H	W1-2 Phase
H	H	2W1-2 Phase

Z : High impedance

X : Don't Care

PIN CONNECTION

(TOP VIEW)



Note. NC: No connection

RECOMMENDED OPERATING CONDITIONS (Ta=-40~85°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{CC}		4.5	5.0	5.5	V
Output Voltage	V_M		21.6	24	26.4	V
Output Current	I_{OUT}		-	1.5	-	A
Input Voltage	V_{IN}		-	-	V_{CC}	V
Clock Frequency	f_{CLOCK}		-	-	5	kHz
OSC Frequency	f_{OSC}		20	-	40	kHz

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M=24V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage	High	$V_{IN\ H}$	1	M1,M2,CW/CCW, REF IN $\overline{ENABLE}$, CK1, CK2	3.5	-	V_{CC}	V
	Low	$V_{IN\ L}$			GND	-	1.5	
Input Hysteresis Voltage		V_H			-	600	-	mV
Input Current		$I_{IN-1(H)}$	1	M1,M2,REF IN, $\overline{ENABLE}$ V_{IN}=5.0V	-	125	250	μA
		$I_{IN-2(H)}$		CW/CCW,CK1,CK2, V_{IN}=5.0V	-	0	10	
	SOURCE TYPE	$I_{IN-1(L)}$		REF IN, V_{IN}=0V	-	40	70	
		$I_{IN-2(L)}$		CW/CCW,CK1,CK2, V_{IN}=0V	-	125	250	
		$I_{IN-3(L)}$		$\overline{ENABLE}$, V_{IN}=0V	-	100	160	
		$I_{IN-4(L)}$		M1,M2, V_{IN}=0V	-	20	50	
Quiescent Current	V_{CC}	I_{CC1}	2	Output Open (2,1-2 Phase excitation)	-	40	55	mA
	V_{CC}	I_{CC2}		Output Open (W1-2,2W1-2 Phase excitation)	-	38	53	
Comparator Reference Voltage	High	$V_{NF}(H)$	-	REF IN H Output Open (Note)	0.56	0.7	0.82	V
	Low	$V_{NF}(L)$	-	REF IN L Output Open (Note)	0.34	0.45	0.66	
Output Differencial		ΔV_O	-	B/A C_{OSC}=0.0033μF, R_{NF}=0.7Ω	-10	-	10	%
V_{NF} (H) - V_{NF} (L)		ΔV_{NF}		$V_{NF}(L)/V_{NF}(H)$ C_{OSC}=0.0033μF, R_{NF}=0.7Ω	61	67	81	%

Note. 2 Phase excitation, R_{NF}=0.7Ω, C_{OSC}=0.0033μF

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M=24V)

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NF Terminal Current	I_{NF}	-	SOURCE TYPE	-	170	-	μA
OSC Frequency	f_{OSC}	-	C_{OSC}=0.0033μF	25	44	62	kHz
Minimum OSC Frequency	$f_{OSC(MAX)}$	-		100	-	-	kHz
Maximum OSC Frequency	$f_{OSC(MIN)}$	-		-	-	10	kHz

OUTPUT BLOCK

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Saturation Voltage	Upper Side	V_{SAT} U1	-	I_{OUT}=1.5A	-	2.1	2.8	V
	Lower Side	V_{SAT} L1			-	1.3	2.0	
	Upper Side	V_{SAT} U2	-	I_{OUT}=0.8A	-	1.8	2.2	
	Lower Side	V_{SAT} L2			-	1.1	1.5	
	Upper Side	V_{SAT} U3	-	I_{OUT}=2.5A	-	2.5	-	
	Lower Side	V_{SAT} L3		Pulse width 30ms	-	1.8	-	
Diode Forward Voltage	Upper Side	V_F U	5	I_{OUT}=1.5A	-	3.2	-	V
	Lower Side	V_F L		A/$\overline{B}$ OUT	-	1.5	2.1	
				$\overline{A}$/B OUT	-	1.9	2.5	
	Upper Side	V_{FU2}		I_{OUT}=2.5A, Pulse width 30ms	-	4.0	-	
	Lower Side	V_{FL2}		Output A,$\overline{B}$	-	1.8	-	
				Output $\overline{A}$,B	-	2.5	-	
Output Dark Current (A+B Channels)		I_{M1}	-	$\overline{ENABLE}$: H Level	-	-	50	μA
		I_{M2}	-	$\overline{ENABLE}$: L Level	-	8	15	mA

CHARACTERISTIC				SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
A-B Chopping Current (Note 1)	2W1-2φ	W1-2φ	1-2φ	VECTOR	-	θ=0/8	REF IN: H R_{NF}=0.7Ω C_{osc}=0.0033μF	-	100	-	%
	2W1-2φ	-	-			θ=1/8		-	100	-	
	2W1-2φ	W1-2φ	-			θ=2/8		83	90	96	
	2W1-2φ	-	-			θ=3/8		74	82	90	
	2W1-2φ	W1-2φ	1-2φ			θ=4/8		65	74	82	
	2W1-2φ	-	-			θ=5/8		55	64	72	
	2W1-2φ	W1-2φ	-			θ=6/8		45	52	62	
	2W1-2φ	-	-			θ=7/8		29	39	48	
2 Phase excitation mode VECTOR								-	141	-	

Note 1. Maximum current (θ=0) : 100%

2W1-2φ : 2W1-2 phase excitation mode

W1-2φ : W1-2 phase excitation mode

1-2φ : 1-2 phase excitation mode

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M=24V)

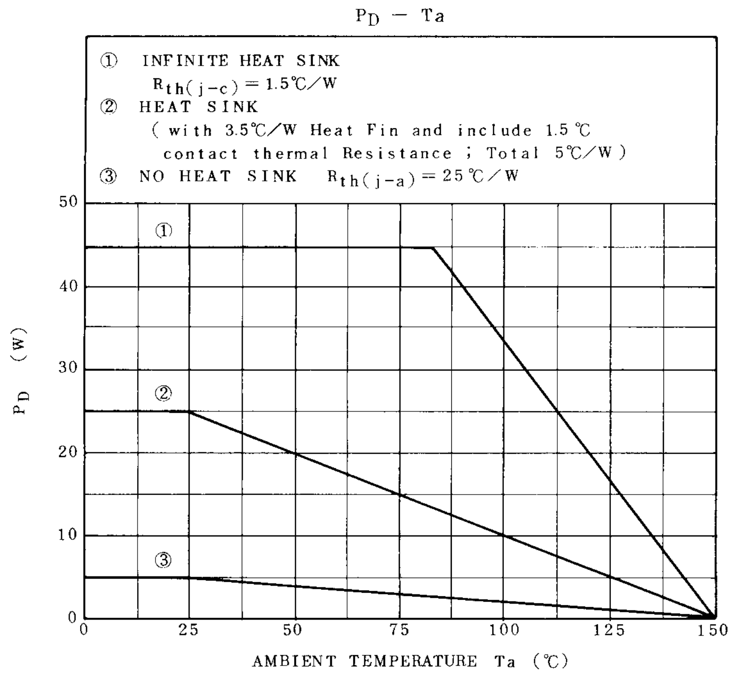
CHARACTERISTIC				SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
A-B Chopping Current (Note 1)	2W1-2ϕ	W1-2ϕ	1-2ϕ	VECTOR	-	θ=0/8	RFE IN: L, R_{NF}=0.7Ω, C_{OSC}=0.0033μF	-	100	-	%
	2W1-2ϕ	-	-			θ=1/8		-	100	-	
	2W1-2ϕ	W1-2ϕ	-			θ=2/8		-	90	-	
	2W1-2ϕ	-	-			θ=3/8		-	83	-	
	2W1-2ϕ	W1-2ϕ	1-2ϕ			θ=4/8		-	77	-	
	2W1-2ϕ	-	-			θ=5/8		-	69	-	
	2W1-2ϕ	W1-2ϕ	-			θ=6/8		-	61	-	
	2W1-2ϕ	-	-			θ=7/8		-	51	-	
2 Phase excitation mode VECTOR								-	141	-	
Feed Back Voltage Step				ΔV_{NF}	-	Δθ=0/8-1/8	REF IN: H, R_{NF}=0.7Ω, C_{OSC}= 0.0033μF	-	0	-	mV
						Δθ=1/8-2/8		-	62	-	
						Δθ=2/8-3/8		-	54	-	
						Δθ=3/8-4/8		-	54	-	
						Δθ=4/8-5/8		-	75	-	
						Δθ=5/8-6/8		-	77	-	
						Δθ=6/8-7/8		-	90	-	
Output Tr Switching Characteristics				t_r	-	R_L=2Ω, V_{NF}=0V, C_L=15pF		-	0.3	-	μs
				t_f				-	2.2	-	
				t_{pLH}	-	CK~Output		-	1.5	-	
				t_{pHL}				-	2.7	-	
				t_{pLH}	-	OSC~Output		-	5.4	-	
				t_{pHL}				-	6.3	-	
Output Leakage Current	Upper Side			I_{OH}	6	V_M=30V		-	-	50	μA
	Lower Side			I_{OL}				-	-	50	

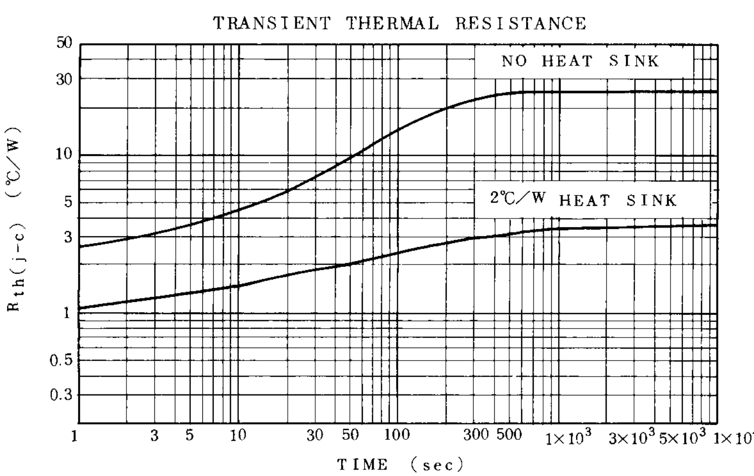
Note 1. Maximum current (θ=0) : 100%

2W1-2ϕ : 2W1-2 phase excitation mode

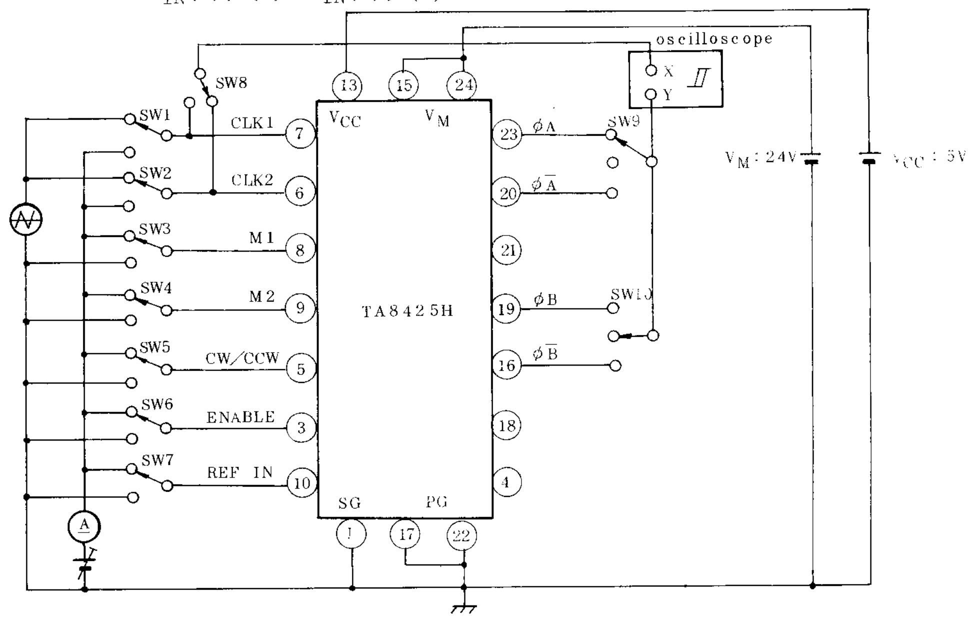
W1-2ϕ : W1-2 phase excitation mode

1-2ϕ : 1-2 phase excitation mode

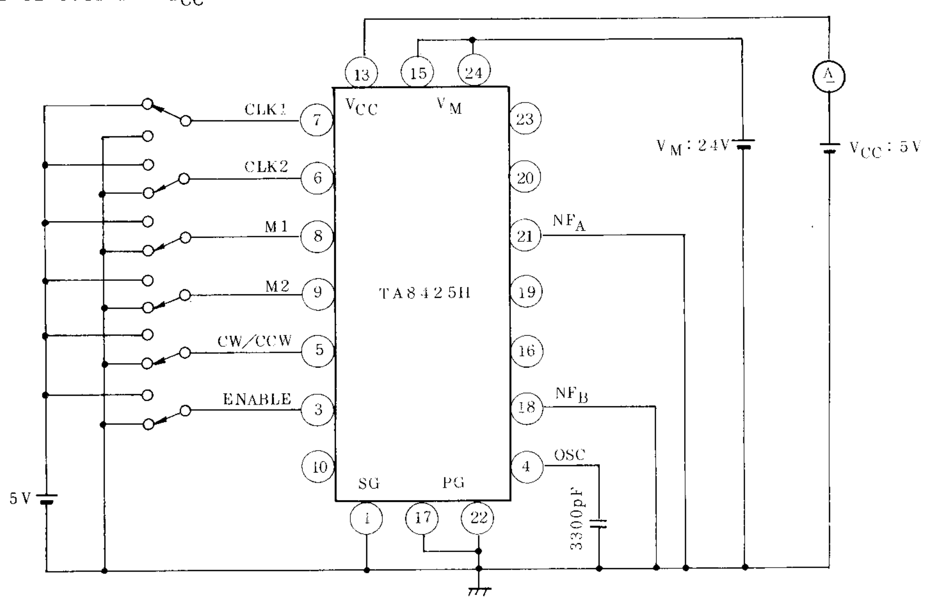

PD — Ta
① INFINITE HEAT SINK
Rth(j-c) = 1.5℃/W
② HEAT SINK
(with 3.5℃/W Heat Fin and include 1.5 ℃
contact thermal Resistance ; Total 5℃/W)
③ NO HEAT SINK Rth(j-a) = 25 ℃/W
PD (W)
50
40
30
20
10
0
0
25
50
75
100
125
150
AMBIENT TEMPERATURE Ta (℃)


TRANSIENT THERMAL RESISTANCE
NO HEAT SINK
2℃/W HEAT SINK
Rth(j-c) (℃/W)
50
30
10
5
3
1
0.5
0.3
1
3
5
10
30
50
100
300
500
1×10³
3×10³
5×10³
1×10⁴
TIME (sec)

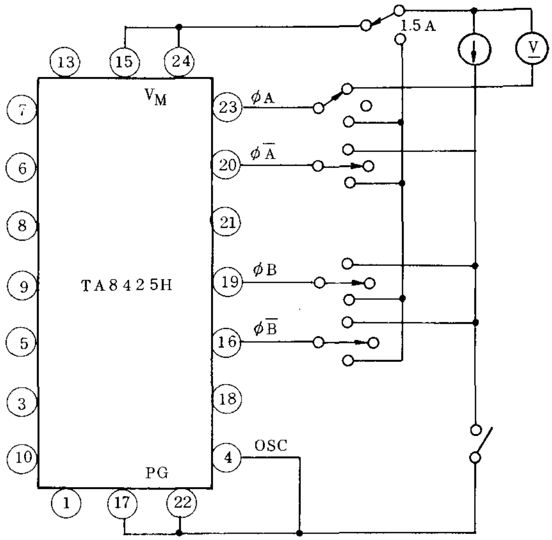
TEST CIRCUIT-1: $V_{IN}(H)$, (L) . $I_{IN}(H)$, (L)



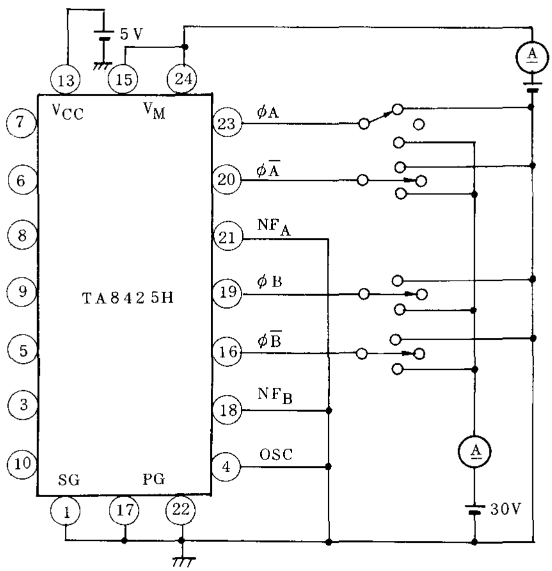
TEST CIRCUIT-2: I_{CC}



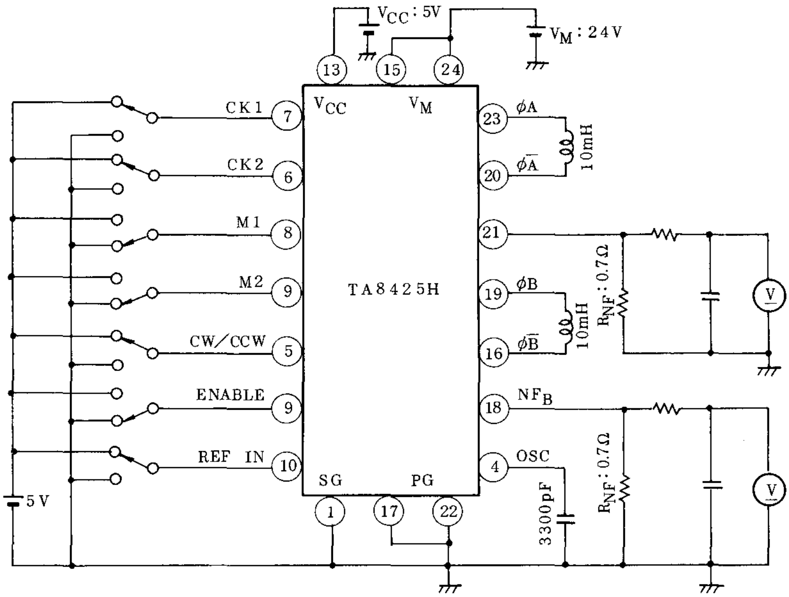
TEST CIRCUIT-4: V_{F-U}, V_{F-L}



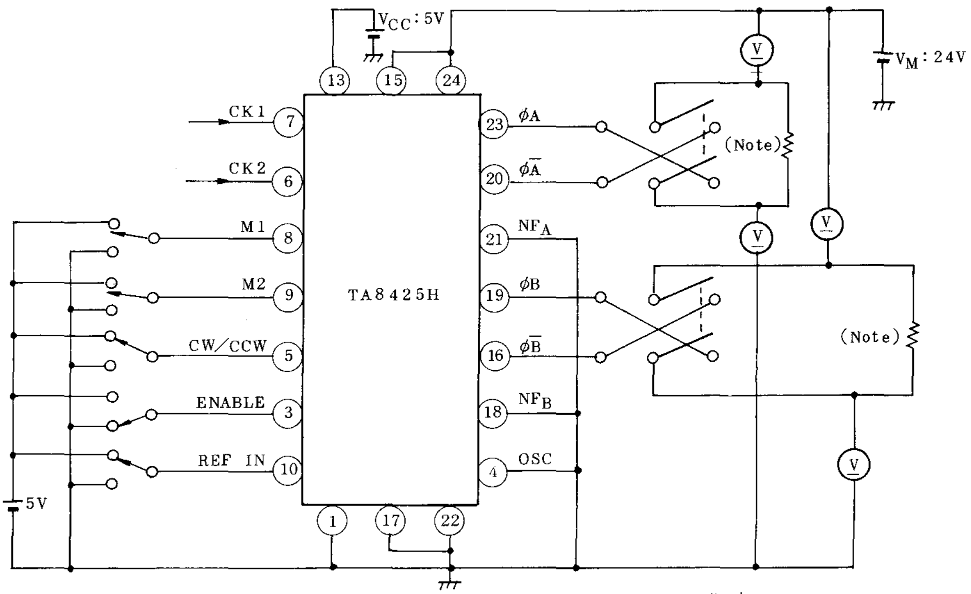
TEST CIRCUIT-6: I_{OH}, I_{OL}



TEST CIRCUIT-3: V_{NF}(H), (L)



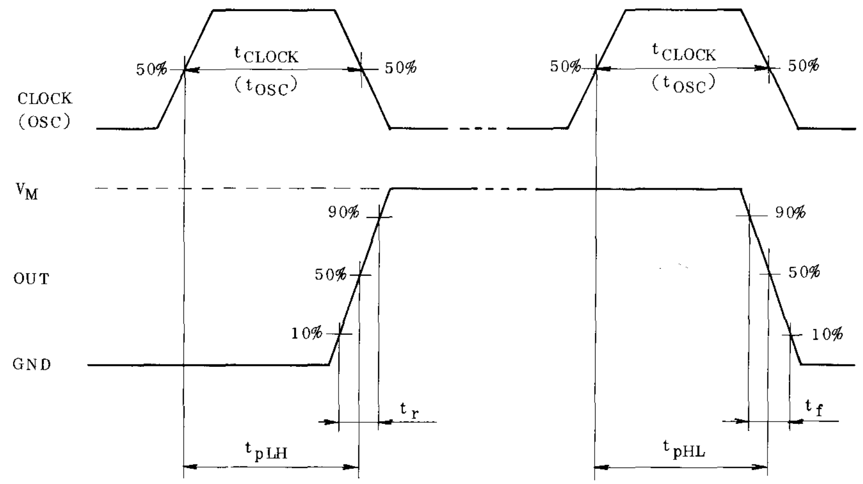
TEST CIRCUIT-4: V_{SAT-U}, V_{SAT-L}



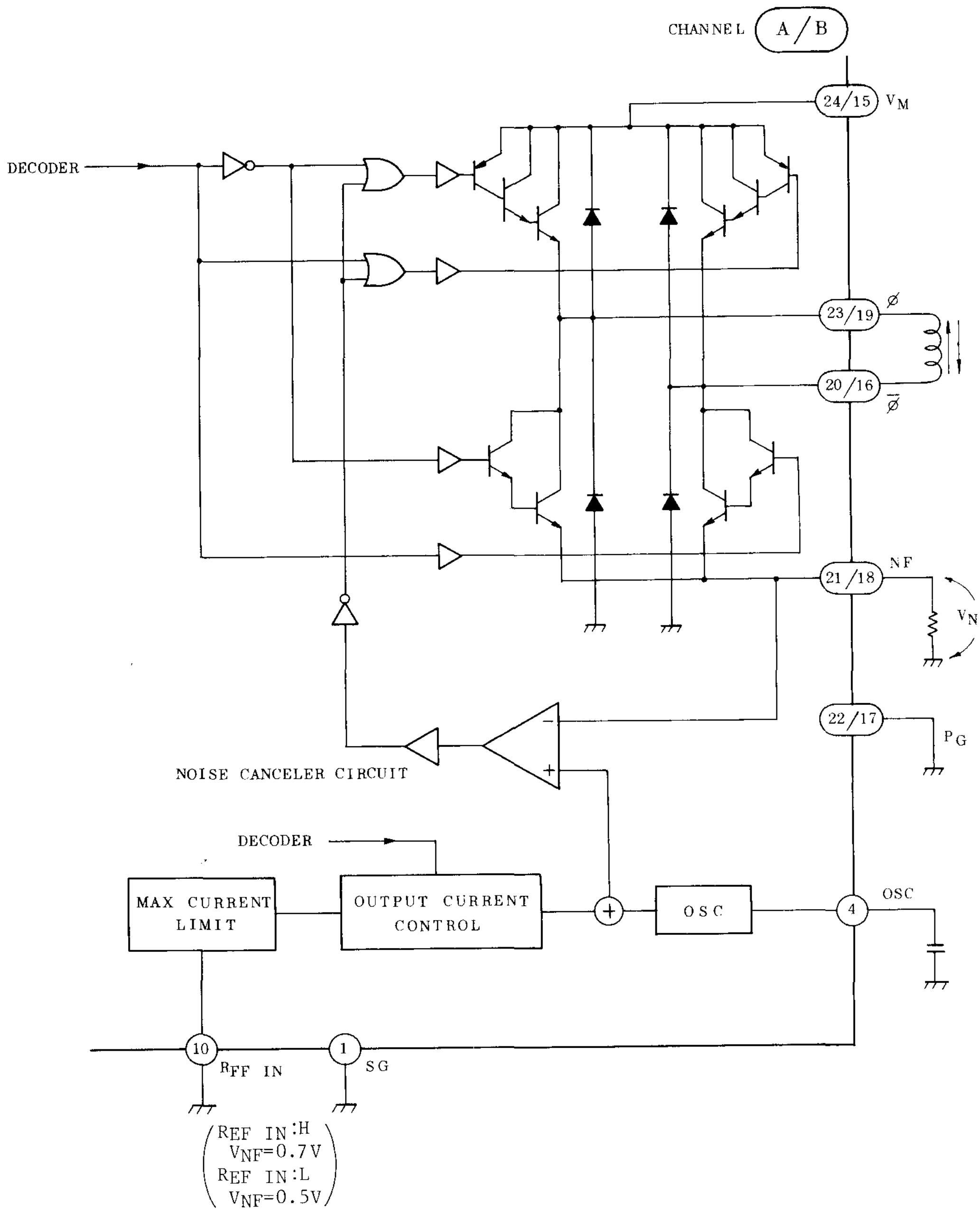
(Note) Adjust a resistance-value so as to get output current: 1.5A/0.8A

CHARACTERISTICS, WAVEFORM

. CK(OSC)-OUT

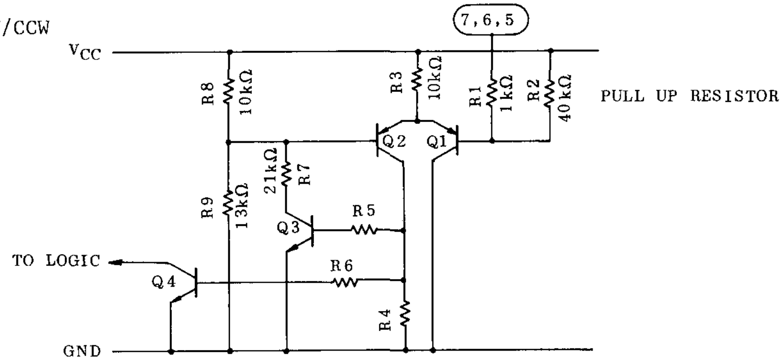


OUTPUT CIRCUIT

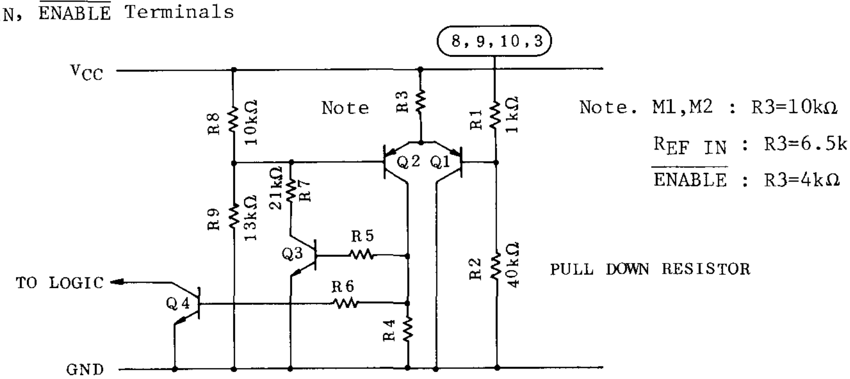


INPUT CIRCUIT

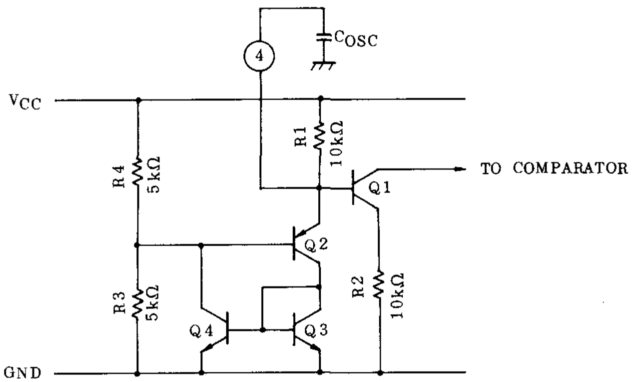
. CK1, CK2, CW/CCW Terminals



. M1,M2, REF IN, $\overline{\text{ENABLE}}$ Terminals



. OSC Terminal



OSC FREQUENCY CALCULATION

Sawtooth OSC circuit consists of Q1 through Q4 and R1 through R4.
Q2 is turned "off" when V_{OSC} is less than the voltage of $2.5V+V_{BE}$ Q2 approximately equal to 3.2V.
V_{OSC} is increased by C_{OSC} charging through R1.
Q3 and Q4 are turned "on" when V_{OSC} becomes 3.2V (Higher level.)
Lower level of V ④ pin is equal to V_{BE} Q2+V_{SAT} Q4 approximately equal to 1.4V.
V_{OSC} is calculated by following equation.

$$V_{OSC} = 5 \cdot (1-e^{-\frac{1}{C_{OSC} \cdot R1} t})$$

Assuming that V_{OSC}=1.4V (t=t1) and =3.2V (t=t2),
C_{OSC} is external capacitance connected to pin ④ and R1 is on-chip 10kΩ resistor.
Therefore, OSC frequency is calculated as follows.

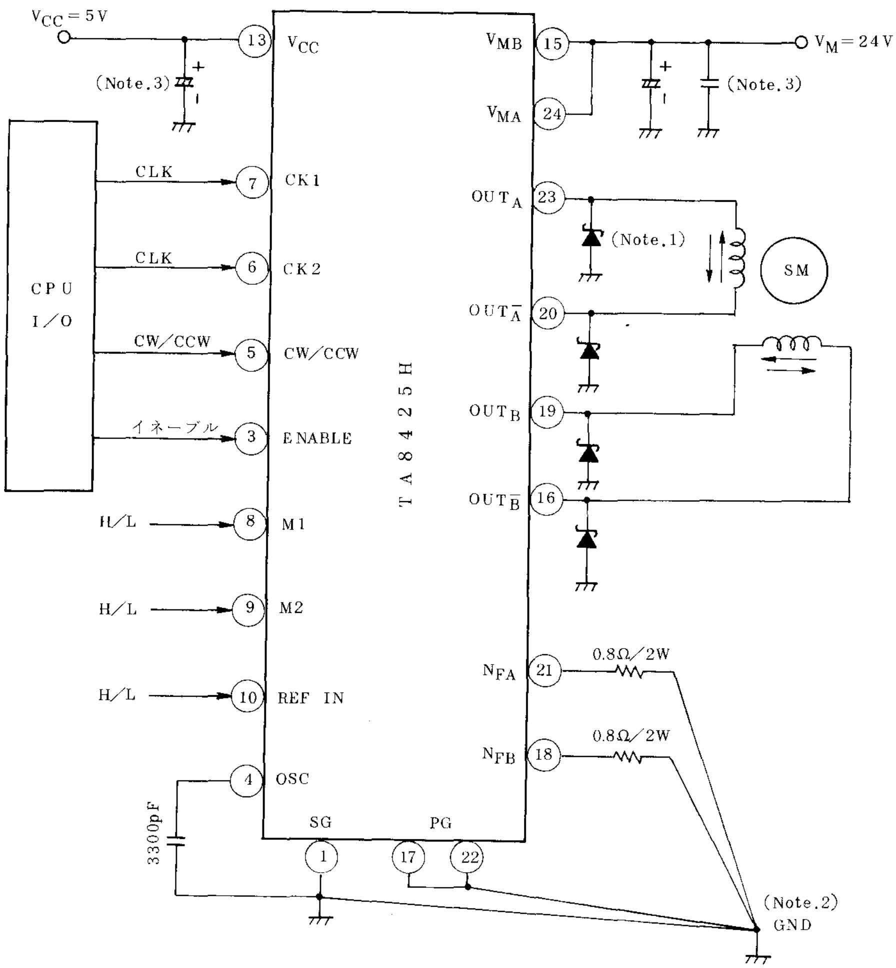
$$t1 = -C_{OSC} \cdot R1 \cdot \ell n\ (1 - \frac{1.4}{5})$$

$$t2 = -C_{OSC} \cdot R1 \cdot \ell n\ (1 - \frac{3.2}{5})$$

$$f_{OSC} = \frac{1}{t2-t1} = \frac{1}{C_{OSC}\ (R1 \cdot \ell n\ (1-\frac{1.4}{5}) - R1 \cdot \ell n\ (1-\frac{3.2}{5}))}$$

$$\fallingdotseq \frac{1}{6.93 \cdot C_{OSC}}\ (kHz)\ (C_{OSC} : \mu F)$$

APPLICATION CIRCUIT



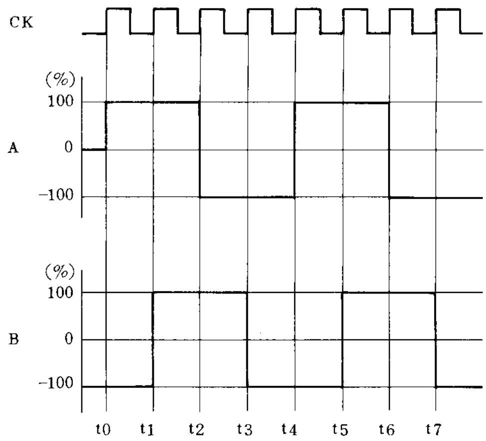
(Note) Schottky diode (3GWJ42) to be connected additionally between each output (pin 16/19/20/23) and GND for preventing Punch-Through Current is recommended.

(Note) GND pattern to be laid out at one point in order to prevent common impedance.

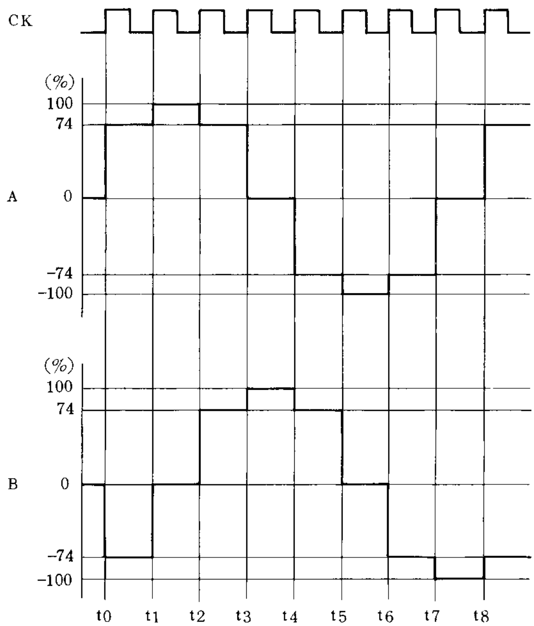
(Note) Capacitor for noise suppression to be connected between the Power Supply (V_{CC}, V_M) and GND to stabilize the operation.

EXCITATION

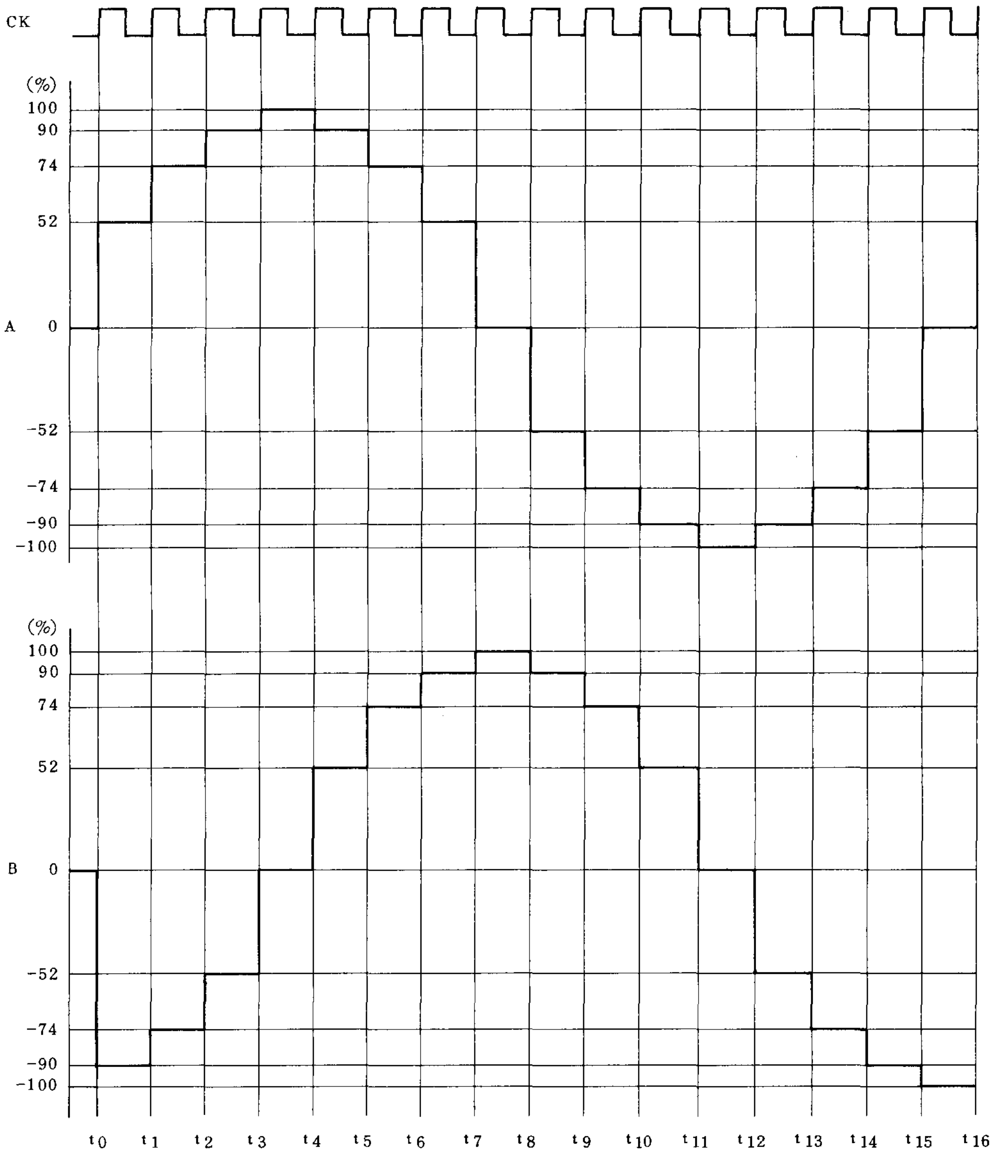
2 Phase Excitation (M1:L, M2:L)



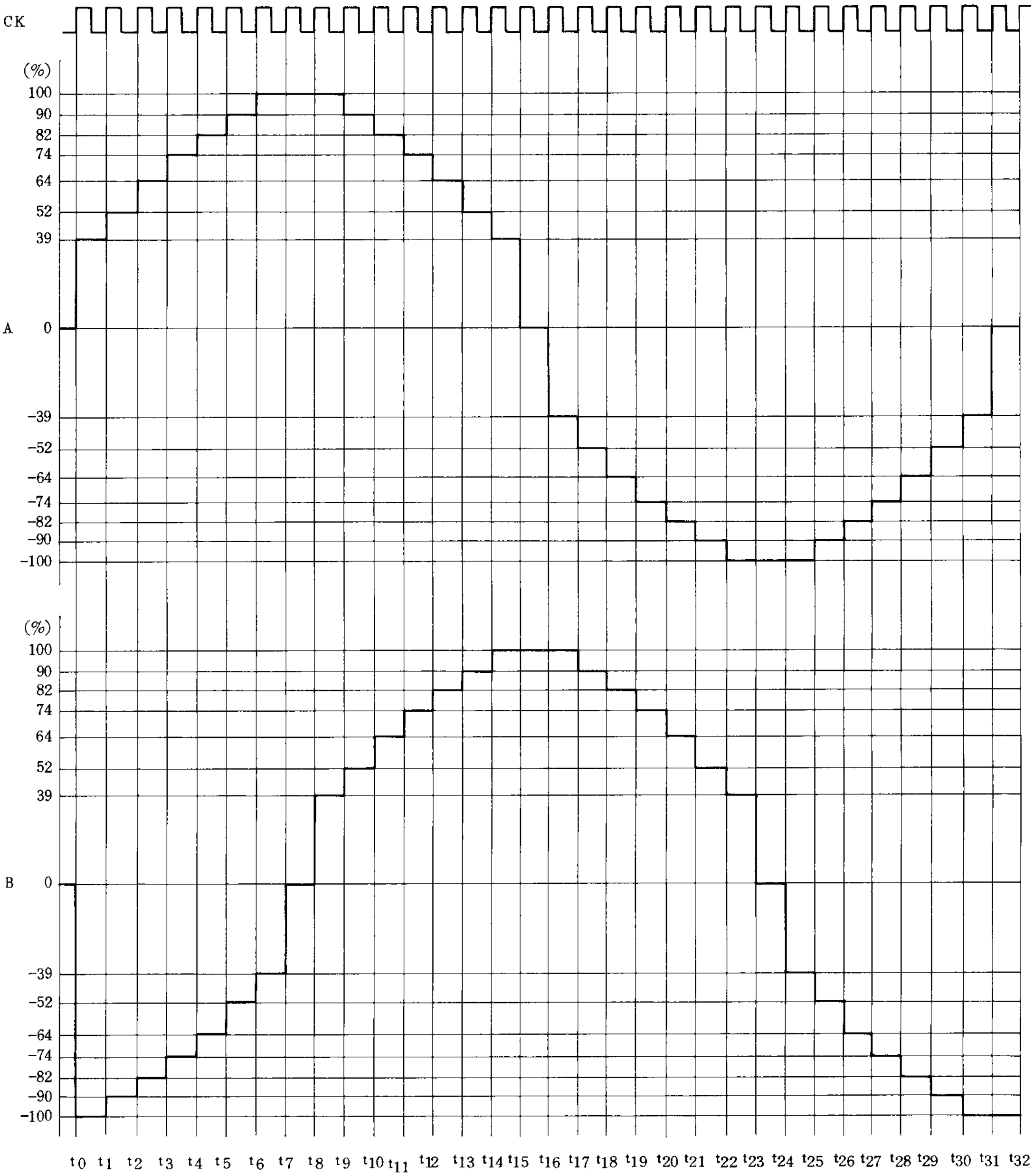
1-2 Phase Excitation (M1:H, M2:L)



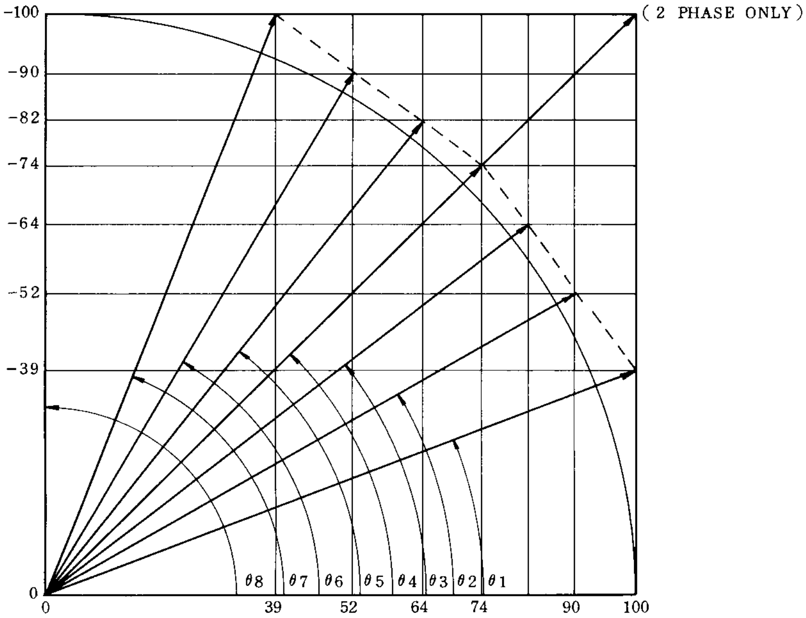
W1-2 Phase Excitation (M1:L, M2:H)



2W1-2 Phase Excitation (M1:H, M2:H)



OUTPUT CURRENT VECTOR ORBIT (NORMALIZE TO 90 DEG FOR EACH ONE STEP)

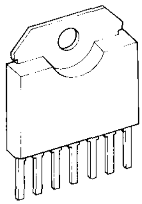


θ	ROTATION ANGLE		VECTOR LENGTH		
	Ideal	Real	Ideal	Real	
θ0	0°	0°	100	100.00	-
θ1	11.25°	21.31°	100	107.34	-
θ2	22.5°	30.02°	100	103.94	-
θ3	33.75°	37.97°	100	104.02	-
θ4	45°	45°	100	104.65	141.42
θ5	56.25°	52.03°	100	104.02	-
θ6	67.5°	59.98°	100	103.94	-
θ7	78.75°	68.69°	100	107.34	-
θ8	90°	90°	100	100.00	-
			1-2, W1-2, 2W1-2 Phase		2 Phase

TA8428K

1.5A FULL BRIDGE DRIVER

TA8428K is Full Bridge Driver IC for Brush Motor Rotation Control that has current capability of up to 1.5A(AVE).
Thermal Shutdown and Short Current Protector are provided.


HSIP7-P

Weight : 1.9g(Typ.)

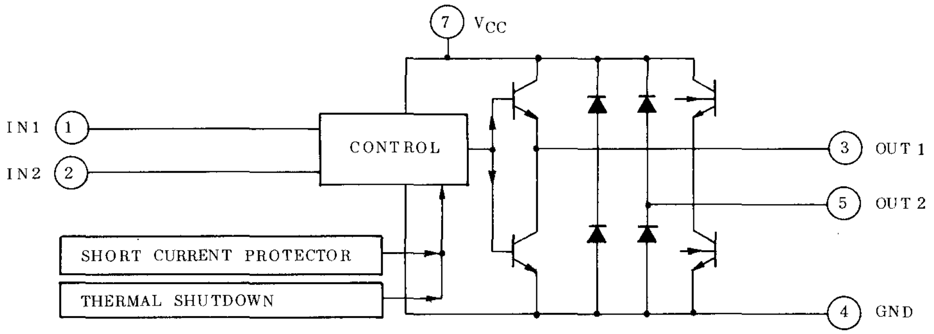
. 1.5A MAX (AVE) Full Bridge Driver
. 4 Modes (Forward/Reverse/Short Brake and Stop) are available with 2 TTL Compatible Inputs Control.
. M-SIP 7 Compact SIP Package sealed.
. Free wheeling diodes are equipped.
. Multi Protection System Driver (Thermal Shutdown and Short Current Protector)
. Operating Voltage : V_{CC}=7.0~27.0V

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	30	V
Output Current	AVE	I_O	1.5	A
	PEAK		3.0 (Note 1)	
Input Voltage		V_{IN}	-0.3~V_{CC}	V
Power Dissipation		P_D	1.25(Note 2)	W
			10.0(Note 3)	
Operating Temperature		Topr	-40~85	°C
Storage Temperature		Tstg	-55~150	°C

Note 1 : t=100msec
Note 2 : No heat sink
Note 3 : Tc=85°C

BLOCK DIAGRAM



FUNCTION TABLE

IN1	IN2	OUT1	OUT2	MODE
H	H	L	L	Brake
L	H	L	H	CW/CCW
H	L	H	L	CCW/CW
L	L	High Impedance		Stop

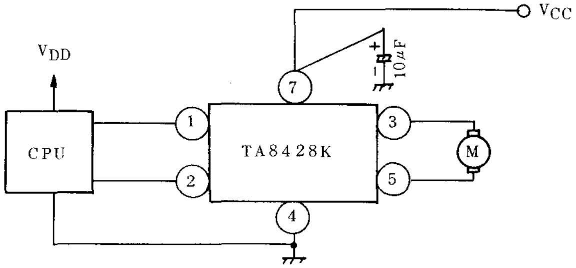
Note. 6 PIN is Non connection.

Note. Heat Fin is connected with GND with low impedance.

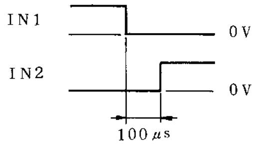
ELECTRICAL CHARACTERISTICS (V_{CC}=24V, Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current	I_{CC1}	-	Stop Mode	-	8	15	mA
	I_{CC2}		Forward/Reverse Mode	-	35	85	
	I_{CC3}		Brake Mode	-	16	30	
Input Voltage	V_{IN-L}	-		-	-	0.8	V
	V_{IN-H}			2.0	-	-	
Input Current	I_{IN-L}	-	V_{IN}=GND	-	-	50	μA
Output Saturation Voltage	V_{SAT}	-	I_O=1.5A Upper and Lower Total	-	2.2	2.9	V
Output Leakage Current	I_L	-	V_{CC}=25V	-	-	50	μA
Diode Forward Voltage	V_{F-U}	-	I_F=1.5A	-	2.6	-	V
	V_{F-L}			-	1.5	-	
Limiting Current	I_{SC}	-		-	3	-	A
Thermal Shutdown Operating Temperature	T_{SD}	-		-	150	-	°C
Propagation Delay Time	t_{pLH}	-		-	1	10	μs
	t_{pHL}			-	1	10	

APPLICATION CIRCUIT



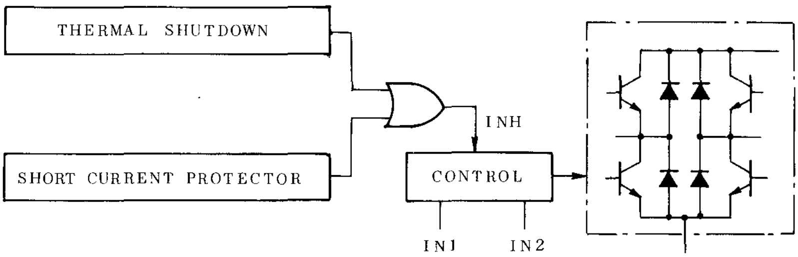
Note. Recommend to take approximately 100μs of input dead time for reliable operations.



TERMINAL DESCRIPTION

PIN NUMBER	NAME	DESCRIPTION
1	IN 1	TTL Compatible Inputs.
2	IN 2	(PNP Type Low Active Comparator Inputs)
3	OUT 1	Output Terminals and Free Wheeling Diodes are connected between
5	OUT 2	each output to GND and V_{CC}.
4	GND	GND Terminal
6	NC	Non connection
7	V_{CC}	Supply Voltage Terminal for Control and Motor Dtive.

TA8428K has 2 built-in protective functions which work independently.
These circuit operations are as follows.

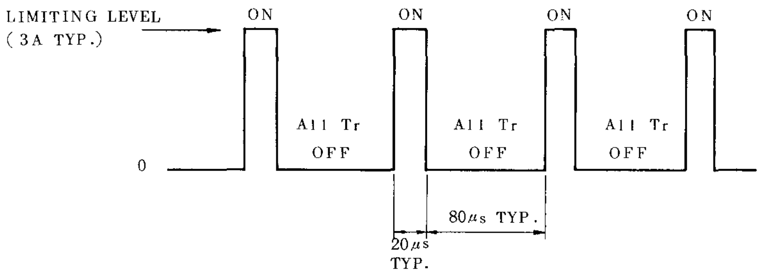


Thermal Shutdown

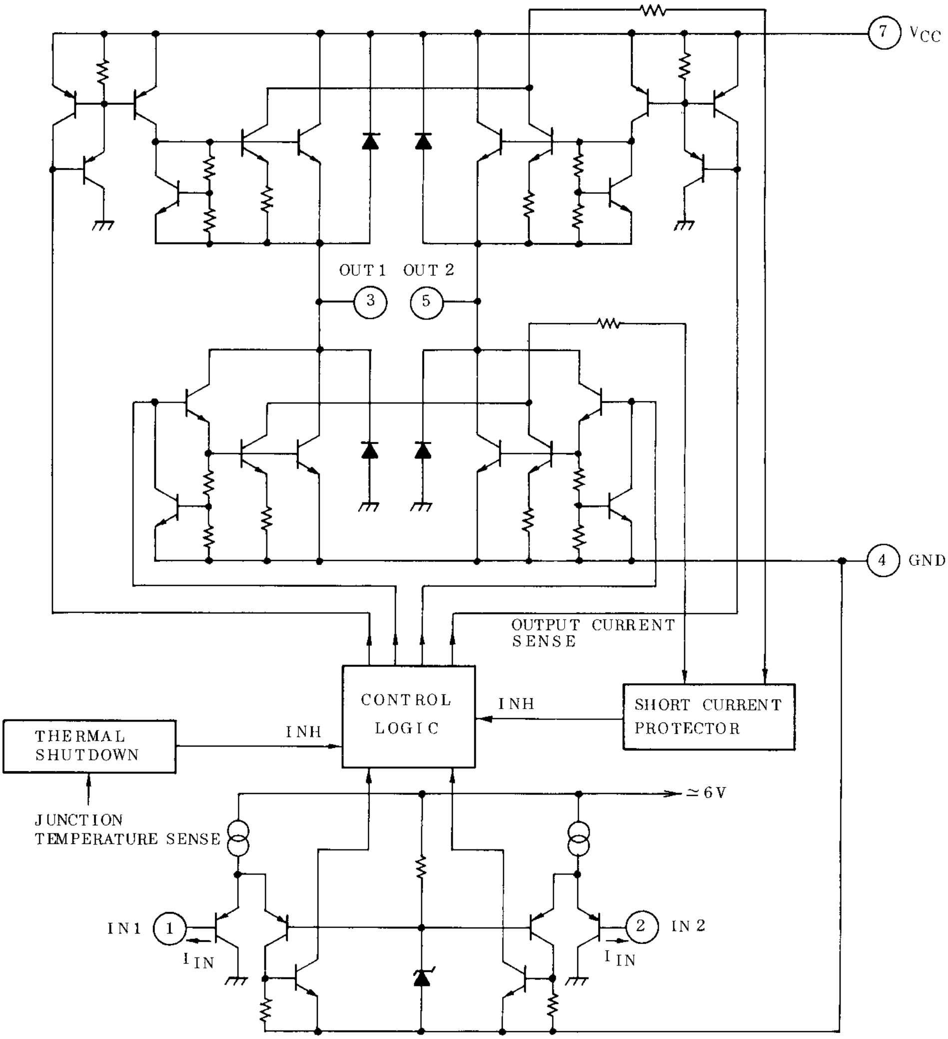
If junction temperature of TA8428K is over the specified temperature (150°C TYP.) by excess power dissipation or abnormal ambient temperature change, thermal Shutdown circuit turn "ON" and output 4 transistors become High impedance.
(All transistors turn "OFF")

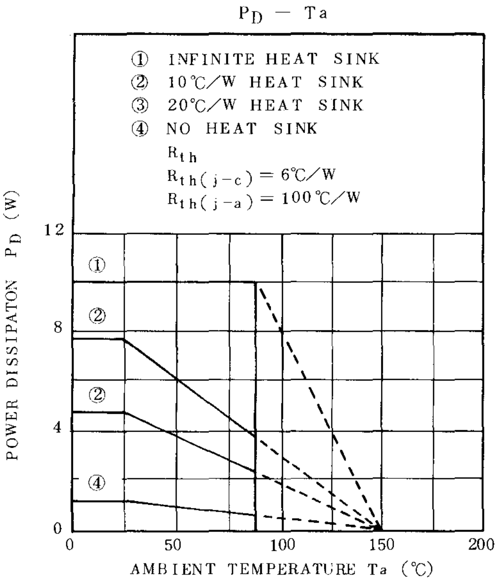
Short Current Protector

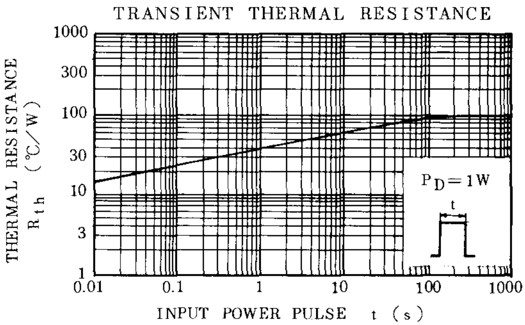
Short current protector circuit senses all output transistor current. If output transistor current is over the specified limiting current value (3A TYP.), short current protector operates and all output transistors periodically turn "OFF" (High Impedance Mode) in a period of approxiamtely 80μs.
This state is continued until the release of over current mode.

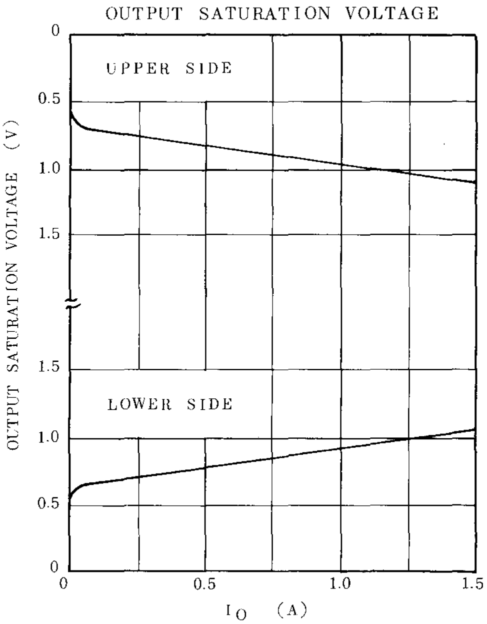


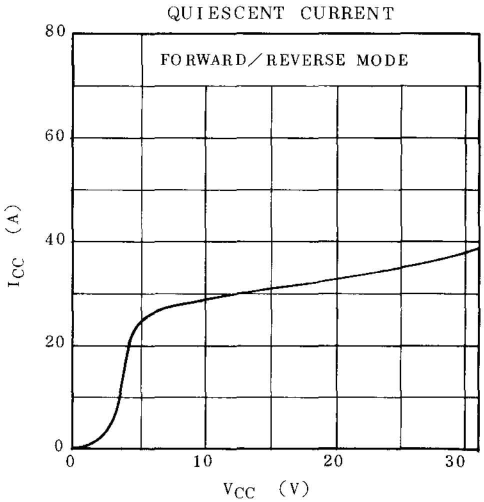
INTERNAL CIRCUIT




PD — Ta
① INFINITE HEAT SINK
② 10℃/W HEAT SINK
③ 20℃/W HEAT SINK
④ NO HEAT SINK
Rth
Rth(j-c) = 6℃/W
Rth(j-a) = 100℃/W
POWER DISSIPATON PD (W)
0
4
8
12
0
50
100
150
200
AMBIENT TEMPERATURE Ta (℃)


TRANSIENT THERMAL RESISTANCE
THERMAL RESISTANCE Rth (℃/W)
1000
300
100
30
10
3
1
PD = 1W
t
0.01
0.1
1
10
100
1000
INPUT POWER PULSE t (s)

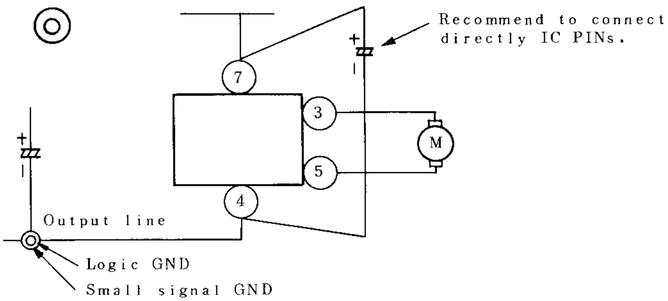

OUTPUT SATURATION VOLTAGE
UPPER SIDE
LOWER SIDE
OUTPUT SATURATION VOLTAGE (V)
0
0.5
1.0
1.5
1.5
1.0
0.5
0
0
0.5
1.0
1.5
IO (A)

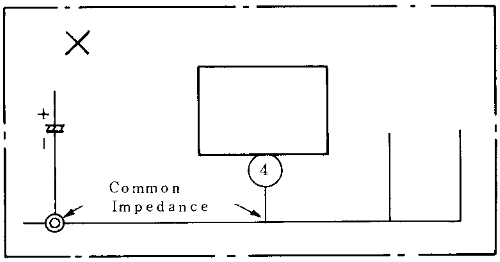

QUIESCENT CURRENT
FORWARD/REVERSE MODE
ICC (A)
80
60
40
20
0
0
10
20
30
VCC (V)

APPLICATION NOTE

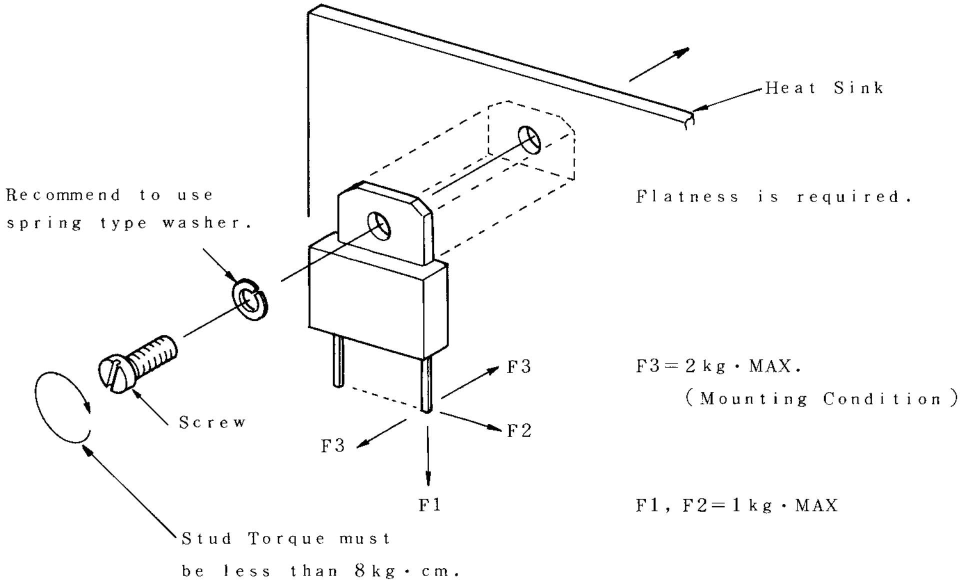
Wiring Requirements

- Care should be taken not to have a common impedance with output current line and logic (or control) signal GND lines for stable operations.
- Recommend to connect additional diodes between GND to Out and Out to V_{CC} terminals to improve braking characteristics and reliability.





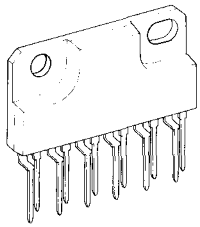
MOUNTING REQUIREMENTS



TA8429H

3.0A FULL BRIDGE DRIVER

TA8429H is Full Bridge Driver IC for Brush Motor Rotation Control that has current capability of up to 3.0A(AVE).
Thermal Shutdown and Short Current Protector are provided.
And also Stand-by function available.



HZIP12-P-B

Weight : 4.04g(Typ.)

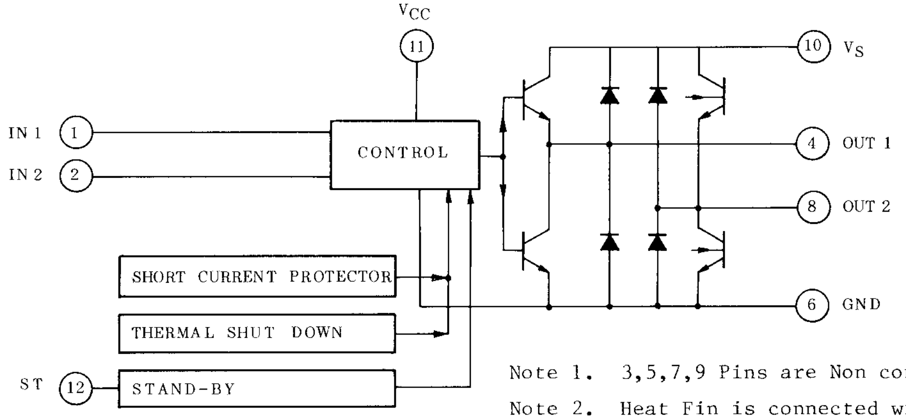
- 3.0A(AVE) Full Bridge Driver with Independent Motor Driving Power Supply Terminal.
- Stand-by Mode available : $I_{ST} \leq 100\mu A$(Max.)
- Thermal Shutdown and Short Circuit Protector Circuit are provided.
- 4 Modes (Forward/Reverse/Short Brake and Stop) are available with 2 Low Active TTL Compatible Inputs Control.
- Free Wheeling Diodes are equipped.
- CPP12 Power Package Sealed.
- Operating Voltage : $V_{CC(opr.)}=7\sim27V$
  $V_{S(opr.)}=0\sim27V$

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	30	V
Output Current	AVE	I_O	3.0	A
	PEAK		4.5 (Note 1)	
Input Voltage		V_{IN}	-0.3 V_{CC}	V
Power Dissipation		P_D	2.25 (Note 2)	W
			20.0 (Note 3)	
Operating Temperature		T_{opr}	-40~85	°C
Storage Temperature		T_{stg}	-55~150	°C

Note 1 : t=100msce
Note 2 : No heat sink
Note 3 : Tc=90°C

BLOCK DIAGRAM

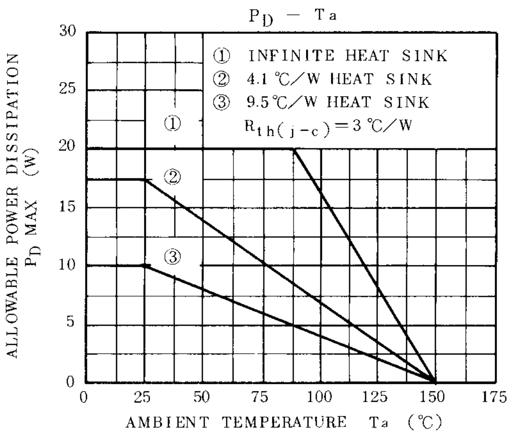


Note 1. 3,5,7,9 Pins are Non connection.

Note 2. Heat Fin is connected with GND with low impedance.

FUNCTION TABLE

INPUT			OUTPUT		
IN 1	IN 2	ST	OUT 1	OUT 2	MODE
H	H	H	L	L	SHORT BRAKE
L	H	H	L	H	CW/CCW
H	L	H	H	L	CCW/CW
L	L	H	High Impedance		STOP
H/L	H/L	L			STAND-BY



ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=24V)

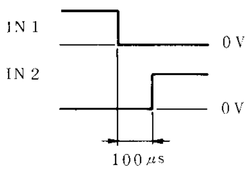
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current-1 (V_{CC} line)		I_{CC1}		Stop Mode	–	6	12	mA
		I_{CC2}		Forward/Reverse Mode	–	20	40	
		I_{CC3}		Brake Mode	–	20	40	
Quiescent Current-2 (V_S line)		I_{S1}		Stop Mode	–	3	8	mA
		I_{S2}		Forward/Reverse Mode	–	16	40	
		I_{S3}		Brake Mode	–	3	8	
Stand-by Current		I_{ST}		V_{CC}, V_S line total	–	–	100	μA
Operating Voltage	"L" Level	V_{IN-L}			–	–	0.8	V
	"H" Level	V_{IN-H}			2.0	–	–	
Input Current		I_{IN-L}		V_{IN}=GND	–	–	12	μA
Output Saturation Voltage (Upper and Lower Side Total)		V_{SAT1}		I_O=1.5A	–	2.1	2.8	V
		V_{SAT2}		I_O=3.0A	–	3.3	4.1	
Output Leakage Current		I_L		V_L=25V	–	–	50	μA
Diode Forward Voltage	Upper	V_{F-U}		I_F=3A	–	5.0	–	V
	Lower	V_{F-L}			–	1.5	–	
Limitting Current		I_{SD}			–	5.0	–	A
Thermal Shutdown Operating Temperature		T_{SD}			–	150	–	°C
Propagation Delay Time		t_{pLH}			–	1	10	μA
		t_{pHL}			–	1	10	

TERMINAL DESCRIPTION

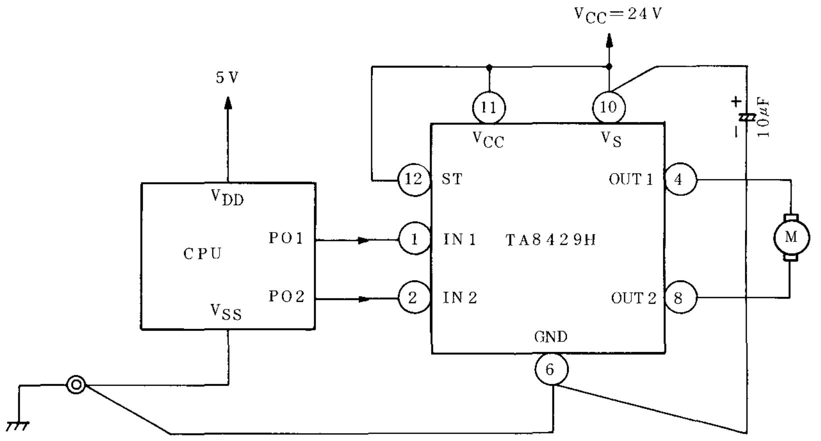
PIN NUMBER	NAME	DESCRIPTION
1	IN1	TTL compatible control inputs.
2	IN2	(PNP type low active comparator inputs)
3	NC	Non connection.
4	OUT1	Output terminals, free wheeling diodes are connected between
8	OUT2	each output with GND and V_S.
5	NC	Non connection.
6	GND	GND terminal.
7	NC	Non connection.
9	NC	Non connection.
10	V_S	Supply voltage terminal for Motor Drive.
11	V_{CC}	Supply voltage terminal for control circuit.
12	ST	Stand-by terminal. Stand-by state is obtained with this terminal connected with GND (or Open).

NOTE

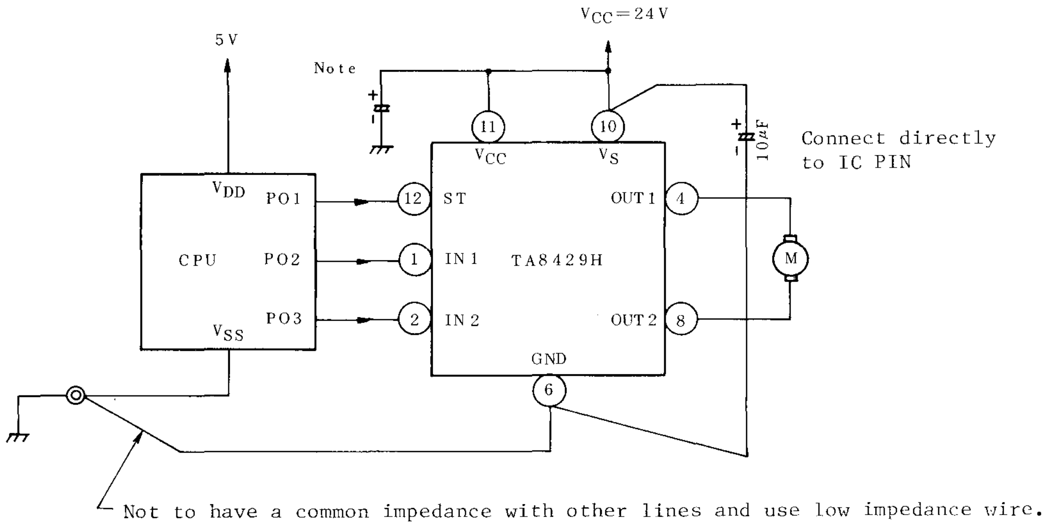
Recommend to take approximately 100μs of input dead time for reliable operations.



APPLICATION CIRCUIT-1 (Single Power Supply Operation)



APPLICATION CIRCUIT-2 (Dual Power Supply (Control and Motor) Operation)



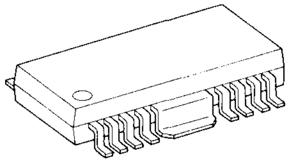
Note. Connect if required.

TA8430AF

STEPPING MOTOR DRIVER

TA8430AF is 2 Phase Bipolar Stepping Motor Driver IC designed especially for low operating voltage use FDD and other portable equipments.

- 2 Phase Bipolar Stepping Motor Driver
- Operating Voltage : $V_{CC\ opr}$=4~6V
- Power Save and Stand-by Mode available
  : $I_{CC\ stand\text{-}by} \leqq 100\mu A$
- Built-in Punch Through Current Restriction Circuit
- 1,2 and 1-2 Phase Excitation Drive available
- C-MOS Compatible Inputs (INA, INB, PS, ST)
- Output Current up to 400mA(AVE) and 600mA(PEAK)
- Sealed in PFP 16 SM Package



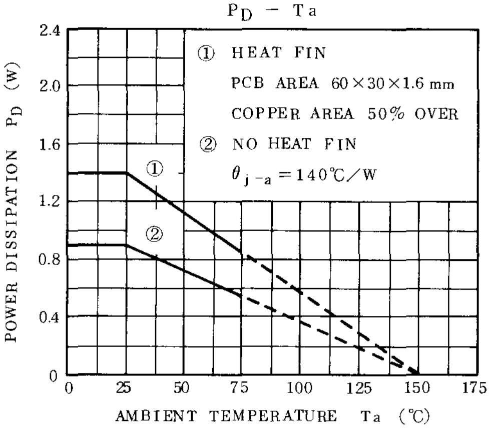
HSOP16-P-300

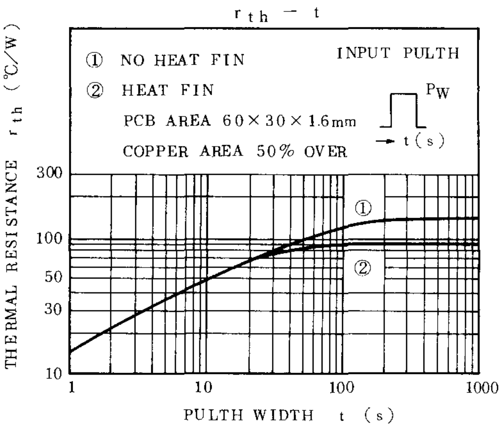
Weight : 0.50g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

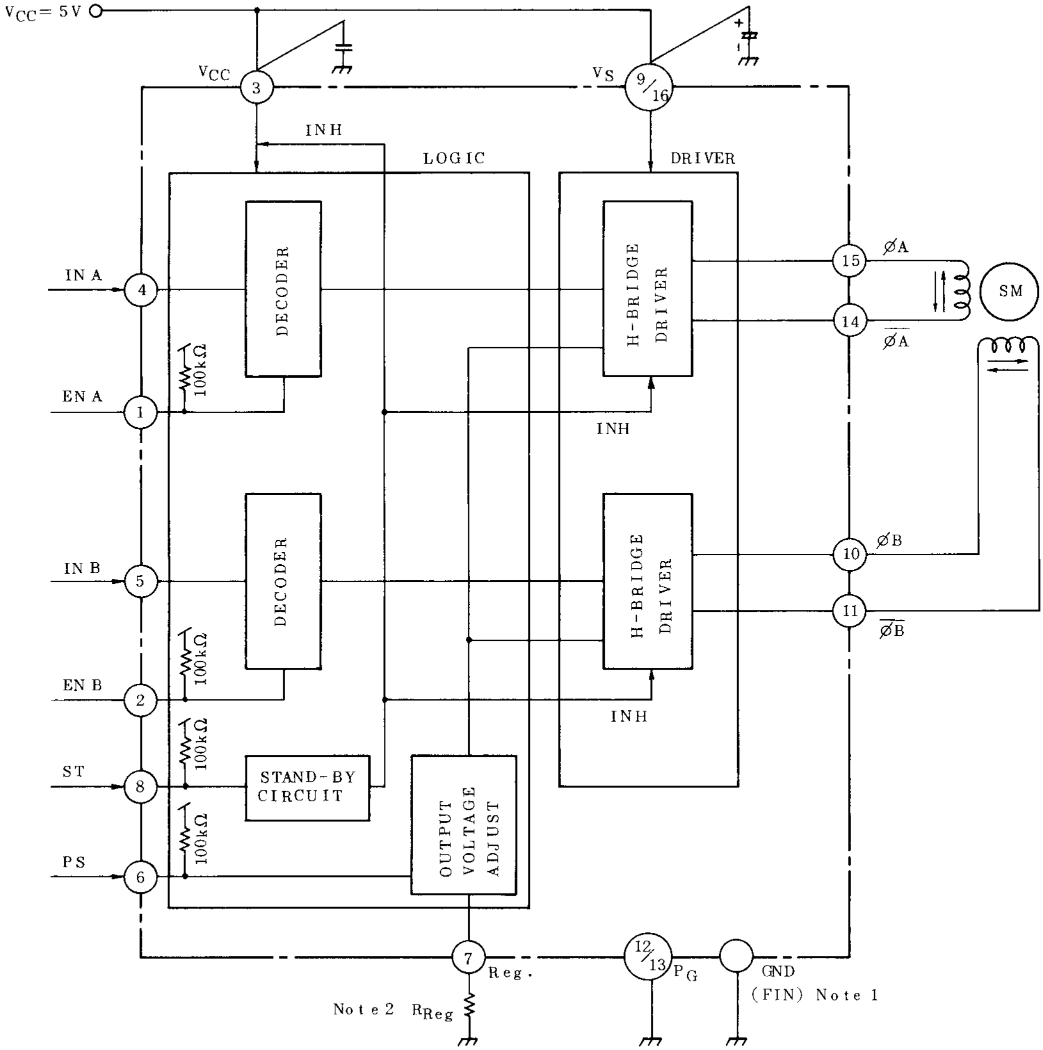
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	8.0	V
	V_S	8.0	
Output Current	$I_{O(MAX.)}$	±600	mA
	$I_{O(AVE.)}$	±400	
Input Voltage	V_{IN}, V_{PS} V_{ST}, V_{EN}	GND-0.4 ~V_{CC}+0.4	V
Power Dissipation (Note)	P_D	1.4	W
Operating Temperature	T_{opr}	-40~85	°C
Storage Temperature	T_{stg}	-55~150	°C

Note : 60X30X1.6mm PCB occupied in excess of 50% of copper area, mounting.


PD − Ta
① HEAT FIN
PCB AREA 60×30×1.6 mm
COPPER AREA 50% OVER
② NO HEAT FIN
θj−a = 140℃/W
①
②
POWER DISSIPATION PD (W)
2.4
2.0
1.6
1.2
0.8
0.4
0
0
25
50
75
100
125
150
175
AMBIENT TEMPERATURE Ta (℃)


rth − t
① NO HEAT FIN
② HEAT FIN
PCB AREA 60×30×1.6mm
COPPER AREA 50% OVER
INPUT PULTH
PW
t (s)
①
②
THERMAL RESISTANCE rth (℃/W)
300
100
50
30
10
1
10
100
1000
PULTH WIDTH t (s)

BLOCK DIAGRAM



Note 1。 GND terminal of 12/13 connect to FIN.

Note 2. Output Voltages, appeared at $\overline{\phi}$A, ϕA, $\overline{\phi}$B and ϕB, are adjusted by R_{reg} when Power Save function is selected.

LOGIC DIAGRAM

INPUT				OUTPUT		
ST	EN	PS	IN	ϕ	$\bar{\phi}$	Upper Side Saturation Voltage
H	H	L	L	L	H	$V_S-V_{SAT\ U}$
H	H	L	H	H	L	$V_S-V_{SAT\ U}$
H	H	H	L	L	H	V_{REG} (Note)
H	H	H	H	H	L	V_{REG} (Note)

(Note) V_{REG} is a voltage appeared at PIN 7 and its value becomes approximately equal to V_{OUT} in powers operation period.

ST	ENA	ENB	ϕA, $\bar{\phi} A$	ϕB, $\bar{\phi} B$	MODE
H	L	H	∞	ENABLE	OPERATION
H	H	L	ENABLE	∞	OPERATION
H	H	H	ENABLE	ENABLE	OPERATION
L	X	X	∞	∞	STAND-BY

X : Don't Care

∞ : High Impedance

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_S=5V, ST=5V, PS=0V, EN=5V)

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Supply Current	I_{CC1}		Output Open		–	14	20	mA
	I_{CC2}		Output Open, PS=5V		–	14	20	
	I_{CC3}		Output Open	ENA=0V, ENB=5V ENA=5V, ENB=0V	–	9	15	
	I_{CC4}		Output Open PS=5V	ENA=0V, ENB=5V ENA=5V, ENB=0V	–	9	15	
	I_{CC5}		V_{ST}=0V		20	65	110	μA
Input Voltage	V_{INH}		Source Type	4 ,5 Pin	3.5	–	V_{CC}	V
	V_{INL}				GND	–	1.7	
	V_{ENH}, V_{PSH} V_{STH}		Pull Up Resistance Built-in (100kΩ) Source Type	1 , 2 6 , 8 Pin	3.5	–	V_{CC}	
	V_{ENL}, V_{PSL} V_{STL}				GND	–	1.7	

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_S=5V, ST=5V, PS=0V, EN=5V)

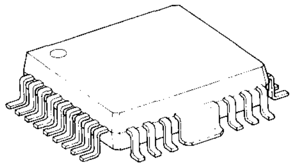
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Input Current		I_{INH}		V_{IN}=3.5V	4 , 5 Pin	–	0	0.1	μA
		I_{INL}		V_{IN}=0V		–	0.25	0.5	
		I_{ENH}, I_{PSH}		V_{EN}=V_{PS}=3.5V	1 , 2 , 6 Pin	–	0	0.1	
		I_{ENL}, I_{PSL}		V_{EN}=V_{PS}=0V		–	0.25	0.5	
		I_{STH}		V_{ST}=3.5V	8 Pin	–	0	0.1	
		I_{STL}		V_{ST}=0V		–	65	110	
Saturation Voltage		$V_{SAT\ U1}$			I_{OUT}=100mA	–	0.8	–	V
		$V_{SAT\ U2}$			I_{OUT}=400mA	–	0.9	1.2	
		$V_{SAT\ L1}$			I_{OUT}=100mA	–	0.1	–	
		$V_{SAT\ L2}$			I_{OUT}=400mA	–	0.2	0.4	
Output Control Upper Voltage		$V_{REG\ 1}$		R_{REG}=39kΩ	I_{OUT}=100mA	–	2.0	–	V
		$V_{REG\ 2}$		V_{PS}=5V	I_{OUT}=400mA	–	1.9	–	
Control Circuit Output Current		I_{REG}				41	56	71	μA
Diode Forward Voltage		V_{FU}		I_F=400mA		–	1.5	2.0	V
		V_{FL}				–	1.0	2.0	
Operating Supply Voltage Range		$V_{CC(opr)}$				4.0	–	6.0	V
Propagation Delay Time	IN-φ	t_{pLH}		R_L=8.2Ω, C_L=15pF		–	4.5	–	μs
	EN-φ					–	3	–	
	PS-φ					–	4.5	–	
	ST-φ					–	10	–	
	IN-φ	t_{pHL}				–	0.1	–	
	EN-φ					–	10	–	
	PS-φ					–	0.2	–	
	ST-φ					–	5	–	

TA8434F

SINGLE CHIP 3-PHASE MOTOR DRIVER FOR FDD SPINDLE MOTOR

The TA8434F is Single Chip Motor Driver IC for FDD Spindle Motor.

- 1 Chip Motor Driver with 3-Phase Semi-Linear Driving.
- Adjustment Free with Digital Servo System.
- 300, 360rpm are Obtaind.
- Output Current : I_O=0.7A MAX. (AVE)
- Operating Voltage : V_{CC}=4.25~15V
- Built-in Theraml Shut-Dwon Circuit.
- Built-in Over Voltage Protection Circuit.
- Power Flat Package Sealed.
- I^2L Structure.
- Built-in Stand-by Circuit.



HQFP30-P-1010

Weight : 0.6g(Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	18	V
Output Current	I_O	0.7	A
Power Dissipation	P_D	1.0	W
		1.5*	
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~150	°C

* With Heat-Sink (60 × 30 × 1.6mm Cu 50%)

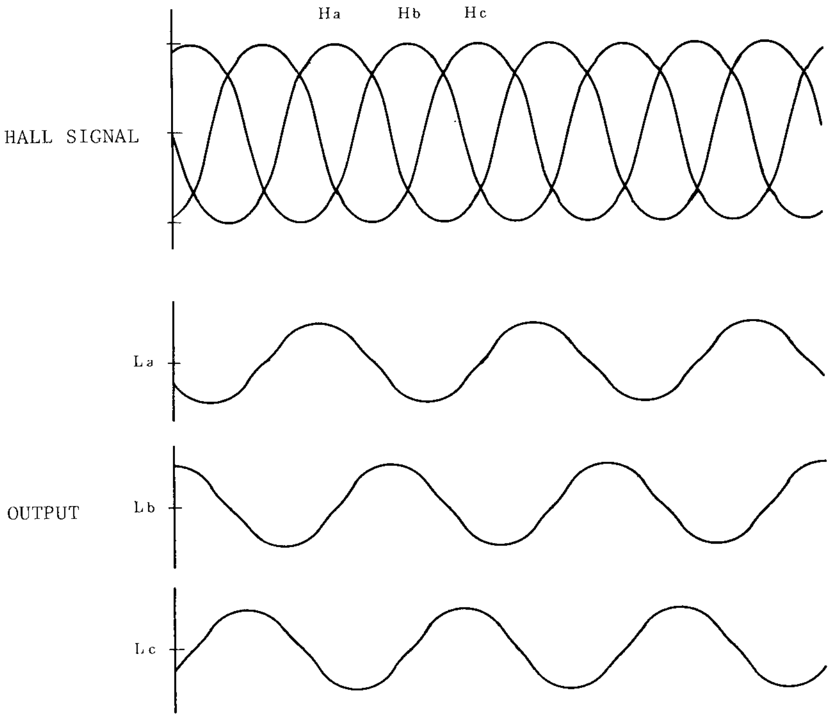
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=5V, Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage			V_{CC}			4.25	-	15	V
Supply Current			I_{CC1}		ST=GND Output Open	-	-	200	μA
			I_{CC2}		ST=GND	-	25	30	mA
Hall Amp.	Gain		G_{HO}		Output Open	-	48	-	dB
	Input Sensitivity		V_H			50	-	300	mV
	Common Mode Voltage Range		CMR			1.0	-	V_{CC}-1	V
FG Amp.	Closed Loop Gain		G_{FGO}			40	46	50	dB
	Reference Voltage		V_{ref}			2.35	2.50	2.65	V
	Input Sensitivity					-	2.50	-	mV
	Input Offset Voltage					-	±2	-	mV
Integrator Amp.	Output Voltage	High	V_{INT-H}			3.5	3.8	4.7	V
		Low	V_{INT-L}			0.5	1.0	1.5	V
	A-Input Current		IA-			-	-	0.3	μA
Speed Changing	Open Loop Gain		G_{INT}		-3dB Point	-	55	-	dB
	Input Switching Voltage		V_{MS-th}		H : 360rpm	3.0	-	V_{CC}	V
					L : 300rpm	0	-	2.0	V
	Input Current		I_{MS}		V_{MS}=GND	-	5	30	μA
OSC Frequency Range			f_{OSC}		Tj=-30~125°C	300	490	600	kHz
PWM Output Voltage		High	$V_{PWM\ H}$		I_{OH}=-100μA (fx/8192)<FG	-	V_{CC}-0.1	-	V
		Hiddle	$V_{PWM\ M}$		OUTPUT-V_{CC}:50kΩ OUTPUT-GND:50kΩ (fx/8192)=FG	-	V_{CC}/2	-	V
		Low	$V_{PWM\ L}$		I_{OL}=100μA (fx/8192)>FG	-	0.1	-	V

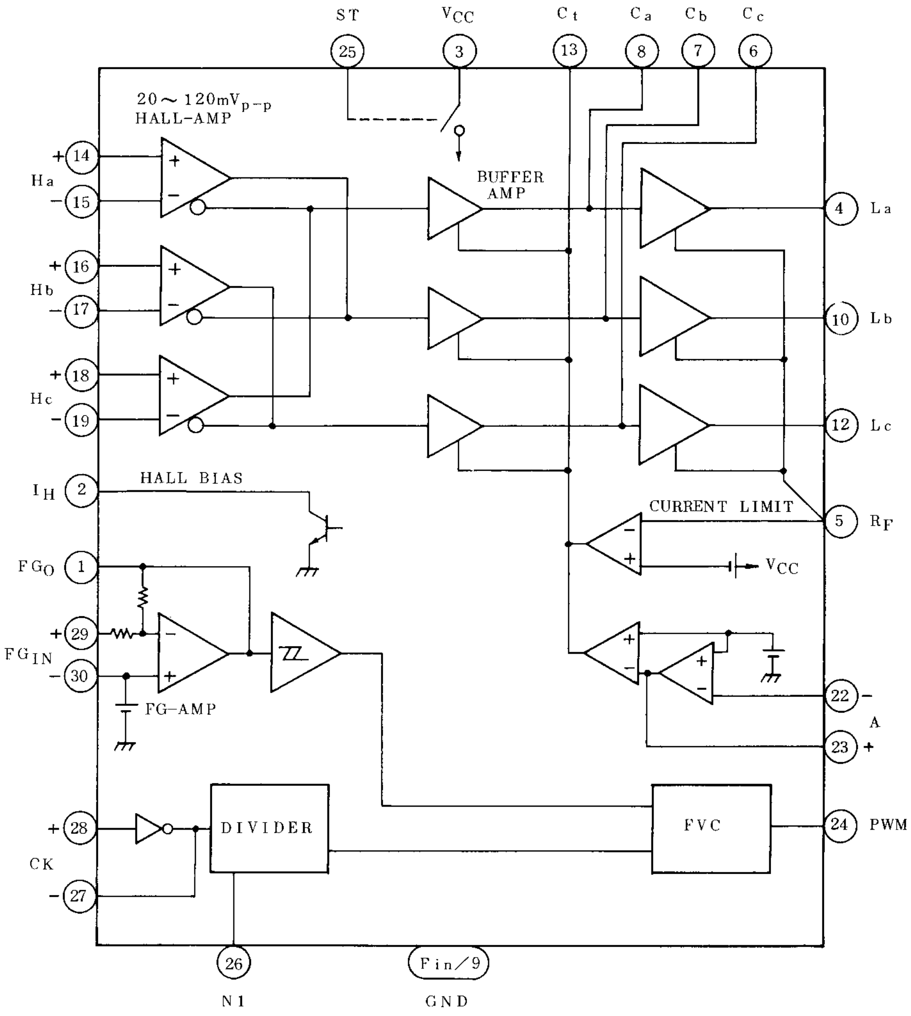
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=5V, Ta=25°C)

<table>
<tr><th colspan="3">CHARACTERISTIC</th><th>SYMBOL</th><th>TEST CIR-CUIT</th><th>TEST CONDITION</th><th>MIN.</th><th>TYP.</th><th>MAX.</th><th>UNIT</th></tr>
<tr><td rowspan="5">Output Stage</td><td colspan="2">Static Voltage</td><td>V_{MID}</td><td></td><td>$G_V(INT)=1$
$V22=(V_{CC}/2)+1V$</td><td>-</td><td>$\frac{V_{CC}-0.7}{2}$</td><td>-</td><td>V</td></tr>
<tr><td colspan="2">Output Refferencial Voltage-1</td><td>V_M-diff1</td><td></td><td>$G_V(INT)=1$
$V22=(V_{CC}/2)+1V$</td><td>-</td><td>10</td><td>55</td><td>mV</td></tr>
<tr><td colspan="2">Output Refferencial Voltage-2</td><td>V_M-diff2</td><td></td><td>$G_V(INT)=1$
$Ha=Hb=Hc=V_{CC}/2$
$V22=(V_{CC}/2)-1V$</td><td>-</td><td>±1</td><td>-</td><td>V</td></tr>
<tr><td rowspan="2">Saturation Voltage</td><td>Upper</td><td>Vsat U</td><td></td><td>I_O=800mA</td><td>-</td><td>0.95</td><td>1.7</td><td rowspan="2">V</td></tr>
<tr><td>Lower</td><td>Vsat L</td><td></td><td>I_O=800mA</td><td>-</td><td>0.4</td><td>0.55</td></tr>
<tr><td rowspan="3">Stand-by Input</td><td colspan="2" rowspan="2">Switching Voltage</td><td rowspan="2">V_{ST-th}</td><td rowspan="2"></td><td>H : Stand-by Mode</td><td>2.4</td><td>-</td><td>V_{CC}</td><td rowspan="2">V</td></tr>
<tr><td>L : Enable Mode</td><td>0</td><td>-</td><td>0.8</td></tr>
<tr><td colspan="2">Input Current</td><td>I_{ST}</td><td></td><td>V_{ST}=GND</td><td>-</td><td>0.2</td><td>1.0</td><td>μA</td></tr>
<tr><td colspan="3">Hall Bias Storation Voltage</td><td>V_{SB-SAT}</td><td></td><td>I_{OL}=10mA</td><td>-</td><td>0.22</td><td>0.5</td><td>V</td></tr>
<tr><td colspan="3">Current Limit Operating Voltage</td><td>V_{SID}</td><td></td><td>Rf Voltage</td><td>260</td><td>300</td><td>350</td><td>mV</td></tr>
<tr><td colspan="3">Thermal Shut Down Operating Temperature</td><td>THD</td><td></td><td></td><td>150</td><td>-</td><td>-</td><td>°C</td></tr>
</table>

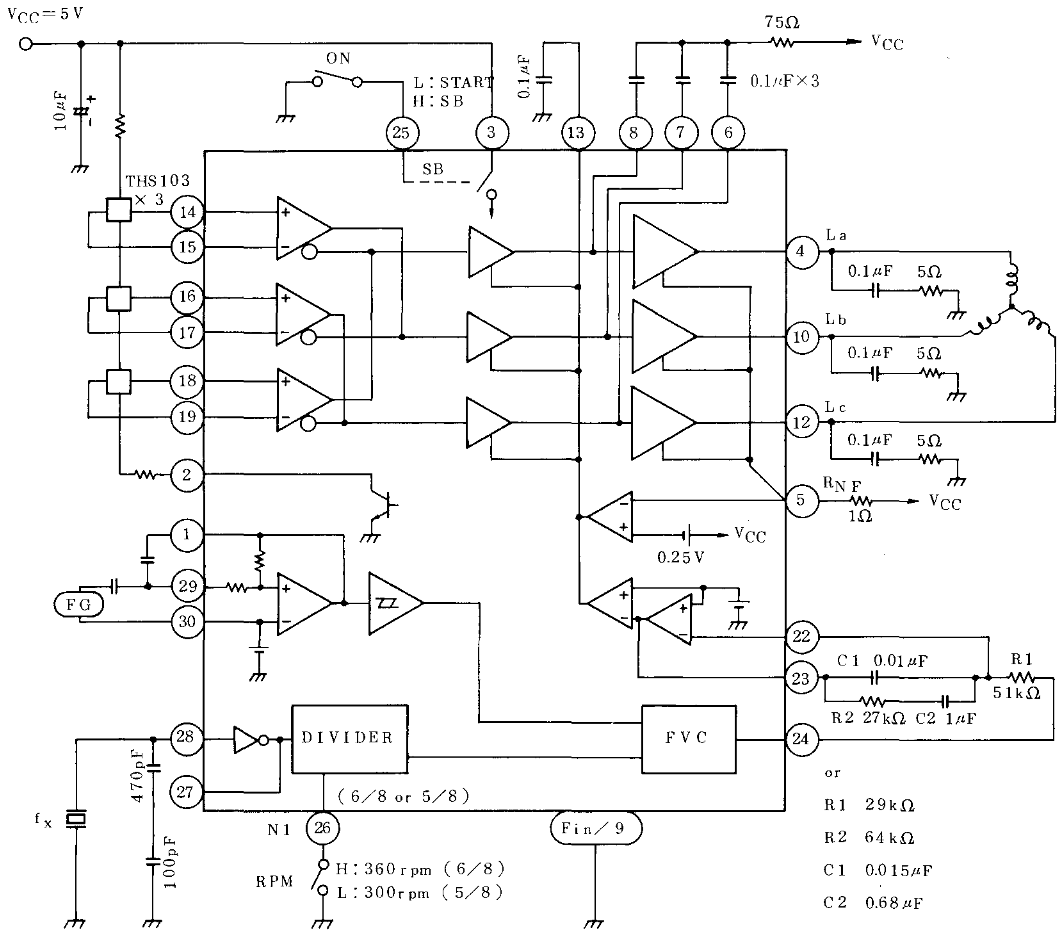
TIMING CHART



BLOCK DIAGRAM



APPLICATION CIRCUIT



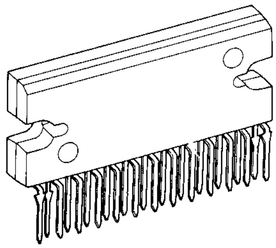
f_x = 8192 × a

a : FG PULSE

TA8435H

PWM CHOPPER TYPE BIPOLAR STEPPING MOTOR DRIVER.

TA8435H is PWM chopper type sinusoidal micro step bipolar stepping motor driver. Sinusoidal micro step operation is accomplished only a clock signal inputting by means of built-in hard ware.



HZIP25-P

Weight: HZIP25-P: 9.86g (Typ.)

- 1 chip bipolar sinusoidal micro step stepping motor driver.
- Output current up to 1.5A(AVE) and 2.5A(PEAK).
- PWM chopper type.
- Structured by high voltage Bi-CMOS process technology.
- Forward and reverse rotation are available.
- 2, 1-2, W1-2, 2W1-2 phase 1 or 2 clock drives are selectable.
- Package: HZIP25-P
- Input Pull-up Resistor equipped with $\overline{RESET}$ and $\overline{ENAELE}$: R=100kΩ(TYP.)
- Output Monitor available with $\overline{MO}$. IO($\overline{MO}$) = ±2mA MAX.
- Reset and Enable are available with $\overline{RESET}$ and $\overline{ENABLE}$.

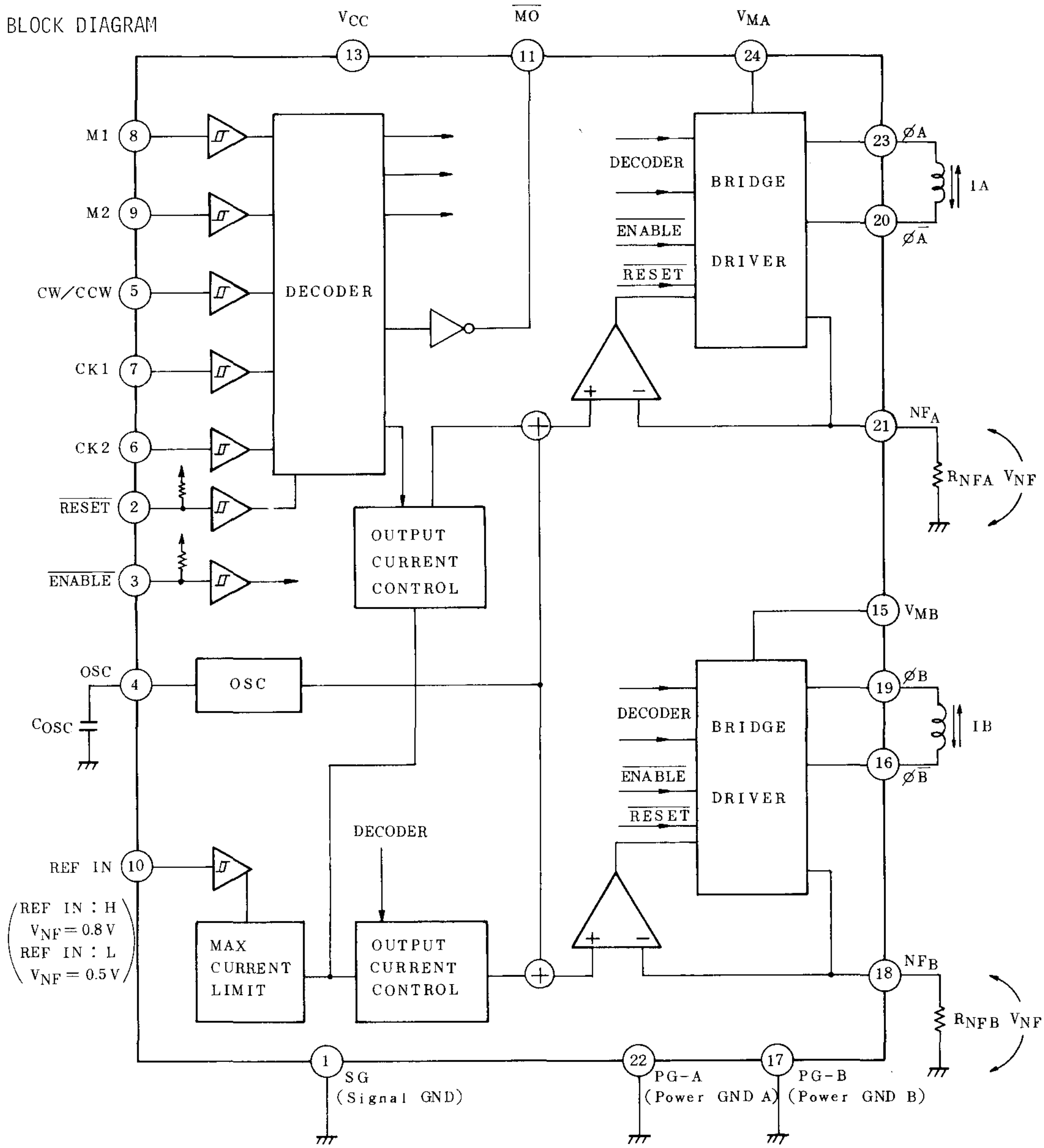
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	5.5	V
	V_M	40	
Output Current	I_O(PEAK)	2.5	A
	I_O(AVE)	1.5	
$\overline{MO}$ Output Current	I_O($\overline{MO}$)	±2	mA
Input Voltage	V_{IN}	~V_{CC}	V
Power Dissipation	P_D	*5	W
		**43	
Operating Temperature	T_{opr}	-40~85	°C
Storage Temperature	T_{stg}	-55~150	°C
Feed Back Voltage	V_I	1.0	V

* No heat sink

** Tc=85°C

BLOCK DIAGRAM



Pull-up Resistance : 100kΩ(TYP.)

⑫ , ⑭ , ㉕ Pin : Non Connection

INPUT					MODE
CK1	CK2	CW/CCW	$\overline{RESET}$	$\overline{ENABLE}$	
↑	H	L	H	L	CW
⊓	L	L	H	L	INHIBIT
H	↑	L	H	L	CCW
L	⊓	L	H	L	INHIBIT
↑	H	H	H	L	CCW
⊓	L	H	H	L	INHIBIT
H	↑	H	H	L	CW
L	⊓	H	H	L	INHIBIT
X	X	X	L	L	INITIAL
X	X	X	X	H	Z

INPUT		MODE
M1	M2	(EXCITATION)
L	L	2 Phase
H	L	1-2 Phase
L	H	W1-2 Phase
H	H	2W1-2 Phase

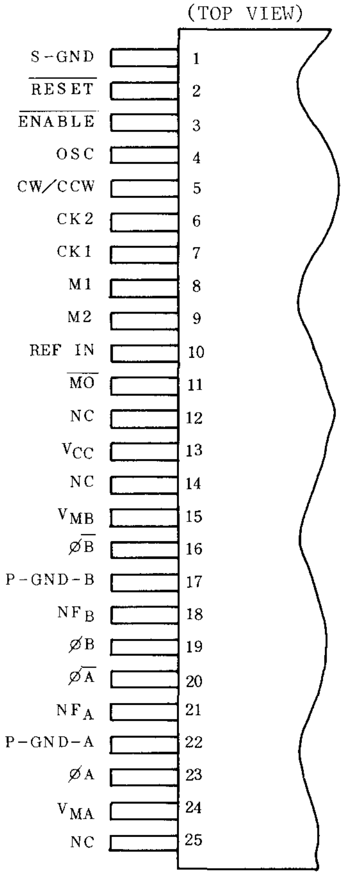
Z : High impedance

X : Don't Care

INITIAL MODE

	$I_{\phi A}$	$I_{\phi B}$
2 Phase	100%	-100%
1-2 Phase	100%	0%
W1-2 Phase	100%	0%
2W1-2 Phase	100%	0%

PIN CONNECTION



Note. NC : Non connection

RECOMMENDED OPERATING CONDITIONS (Ta=-20~75°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{CC}		4.5	5.0	5.5	V
Output Voltage	V_M		21.6	24	26.4	V
Output Current	I_{OUT}		–	–	1.5	A
Input Voltage	V_{IN}		–	–	V_{CC}	V
Clock Frequency	f_{CLOCK}		–	–	5	kHz
OSC Frequency	f_{OSC}		15	–	40	kHz

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M=24V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Input Voltage	High	$V_{IN\ H}$	1	M1, M2, CW/CCW, REF IN		3.5	–	V_{CC} +0.4	V
	Low	$V_{IN\ L}$		$\overline{ENABLE}$, CK1, CK2, $\overline{RESET}$		GND -0.4	–	1.5	
Input Hysteresis Voltage		V_H				–	600	–	mV
Input Current		$I_{IN-1(H)}$	1	M1, M2, REF IN, V_{IN}=5.0V		–	–	100	nA
		$I_{IN-1(L)}$		$\overline{ENABLE}$, $\overline{RESET}$, V_{IN}=0V INTERNAL PULL-UP RESISTOR		10	50	100	μA
		$I_{IN-2(L)}$		SOURCE TYPE, V_{IN}=0V		–	–	100	nA
Quiescent Current	V_{CC}	I_{CC1}	1	Output Open $\overline{RESET}$: H, $\overline{ENABLE}$: L (2,1-2 Phase excitation)		–	10	18	mA
	V_{CC}	I_{CC2}		Output Open (W1-2, 2W1-2 Phase excitation) $\overline{RESET}$:H, $\overline{ENABLE}$:L		–	10	18	
	V_{CC}	I_{CC3}		$\overline{RESET}$: L, $\overline{ENABLE}$: L		–	5	–	
		I_{CC4}		$\overline{RESET}$: H, $\overline{ENABLE}$: L		–	5	–	
Comparator Reference Voltage	High	$V_{NF(H)}$	3	REF IN: H, L=10mH	Note	0.72	0.8	0.88	V
	Low	$V_{NF(L)}$		REF IN: L, L=10mH		0.45	0.5	0.55	
Output Differencial		ΔV_O	–	B/A, C_{OSC}=0.0033μF, R_{NF}=0.8Ω		-10	–	10	%
$V_{NF(H)}$ - $V_{NF(L)}$		ΔV_{NF}	–	$V_{NF(L)}/V_{NF(H)}$, C_{OSC}=0.0033μF, R_{NF}=0.8Ω		56	63	70	%
Output Voltage		$V_{OH(MO)}$	–	I_{OH}=-40μA		4.5	4.9	V_{CC}	V
		$V_{OL(MO)}$		I_{OL}=-40μA		GND	0.1	0.5	

Note. 2 Phase excitation, R_{NF}=0.8Ω, C_{OSC}=0.0033μF

ELECTRICAL CHARACTERISTICS ($Ta=25°C$, $V_{CC}=5V$, $V_M=24V$)

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
NF Terminal Current	I_{NF}	-	SOURCE TYPE	-	170	-	μA
OSC Frequency	f_{OSC}	-	$C_{OSC}=0.0033\mu F$	25	44	62	kHz
Maximum OSC Frequency	$f_{OSC(MAX)}$	-		100	-	-	kHz
Minimum OSC Frequency	$f_{OSC(MIN)}$	-		-	-	10	kHz

OUTPUT BLOCK

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Saturation Voltage	Upper Side	$V_{SAT\ U1}$	4	$I_{OUT}=1.5A$	-	2.1	2.8	V
	Lower Side	$V_{SAT\ L1}$			-	1.3	2.0	
	Upper Side	$V_{SAT\ U2}$		$I_{OUT}=0.8A$	-	1.8	2.2	
	Lower Side	$V_{SAT\ L2}$			-	1.1	1.5	
	Upper Side	$V_{SAT\ U3}$		$I_{OUT}=2.5A$	-	2.5	3.0	
	Lower Side	$V_{SAT\ L3}$		Pulse width 30ms	-	1.8	2.2	
Diode Forward Voltage	Upper Side	$V_{F\ U1}$	5	$I_{OUT}=1.5A$	-	2.0	3.0	V
	Lower Side	$V_{F\ L1}$			-	1.5	2.1	
	Upper Side	$V_{F\ U2}$		$I_{OUT}=2.5A$	-	2.5	3.3	
	Lower Side	$V_{F\ L2}$		Pulse width 30ms	-	1.8	2.5	
Output Dark Current (A+B Channels)		I_{M1}	2	$\overline{ENABLE}$: H Level $\overline{RESET}$: L Level	-	-	50	μA
		I_{M2}		$\overline{ENABLE}$: L Level $\overline{RESET}$: H Level Output Open	-	8	15	mA

CHARACTERISTIC	2W1-2ϕ	W1-2ϕ	1-2ϕ	SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
A-B Chopping Current (Note 1)	2W1-2ϕ	W1-2ϕ	1-2ϕ	VECTOR	-	θ=0/8	REF IN : H $R_{NF}=0.8\Omega$ $C_{OSC}=0.0033\mu F$	-	100	-	%
	2W1-2ϕ	-	-			θ=1/8		-	100	-	
	2W1-2ϕ	W1-2ϕ	-			θ=2/8		86	91	96	
	2W1-2ϕ	-	-			θ=3/8		78	83	88	
	2W1-2ϕ	W1-2ϕ	1-2ϕ			θ=4/8		66.4	71.4	76.4	
	2W1-2ϕ	-	-			θ=5/8		50.5	55.5	60.5	
	2W1-2ϕ	W1-2ϕ	-			θ=6/8		35	40	45	
	2W1-2ϕ	-	-			θ=7/8		15	20	25	
2 Phase excitation mode VECTOR								-	141	-	

Note 1. Maximum current (θ=0) : 100%

2W1-2ϕ : 2W1-2 phase excitation mode
W1-2ϕ : W1-2 phase excitation mode
1-2ϕ : 1-2 phase excitation mode

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M=24V)

CHARACTERISTIC				SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
A-B Chopping Current (Note 1)	2W1-2ϕ	W1-2ϕ	1-2ϕ	VECTOR	-	θ=0/8	REF IN : L, R_{NF}=0.8Ω, C_{OSC}=0.0033μF	-	100	-	%
	2W1-2ϕ	-	-			θ=1/8		-	100	-	
	2W1-2ϕ	W1-2ϕ	-			θ=2/8		86	91	96	
	2W1-2ϕ	-	-			θ=3/8		78	83	88	
	2W1-2ϕ	W1-2ϕ	1-2ϕ			θ=4/8		66.4	71.4	76.4	
	2W1-2ϕ	-	-			θ=5/8		50.5	55.5	60.5	
	2W1-2ϕ	W1-2ϕ	-			θ=6/8		35	40	45	
	2W1-2ϕ	-	-			θ=7/8		15	20	25	
2 Phase excitation mode VECTOR								-	141	-	
Feed Back Voltage Step				ΔV_{NF}	-	Δθ=0/8-1/8	REF IN: H, R_{NF}=0.8Ω, C_{OSC}= 0.0033μF	-	0	-	mV
						Δθ=1/8-2/8		32	72	112	
						Δθ=2/8-3/8		24	64	104	
						Δθ=3/8-4/8		53	93	133	
						Δθ=4/8-5/8		87	127	167	
						Δθ=5/8-6/8		84	124	164	
						Δθ=6/8-7/8		120	160	200	
Output T_r Switching Characteristics				t_r	7	R_L=2Ω, V_{NF}=0V, C_L=15pF		-	0.3	-	μs
				t_f				-	2.2	-	
				t_{pLH}		CK~Output		-	1.5	-	
				t_{pHL}				-	2.7	-	
				t_{pLH}		OSC~Output		-	5.4	-	
				t_{pHL}				-	6.3	-	
				t_{pLH}		$\overline{RESET}$~Output		-	2.0	-	
				t_{pHL}				-	2.5	-	
				t_{pLH}		$\overline{ENABLE}$~Output		-	5.0	-	
				t_{pHL}				-	6.0	-	
Output Leakage Current	Upper Side			I_{OH}	6	V_M=30V		-	-	50	μA
	Lower Side			I_{OL}				-	-	50	

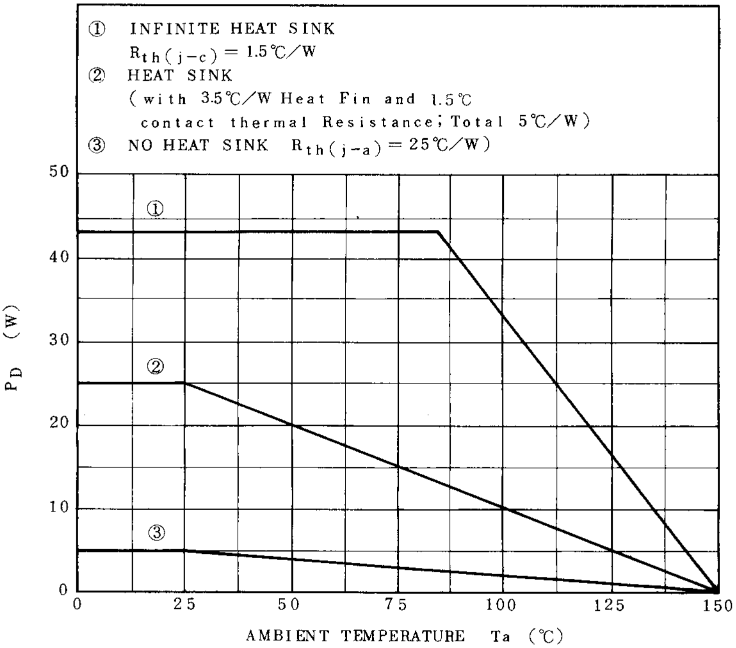
Note 1. Maximum current (θ=0) : 100%

2W1-2ϕ : 2W1-2 phase excitation mode

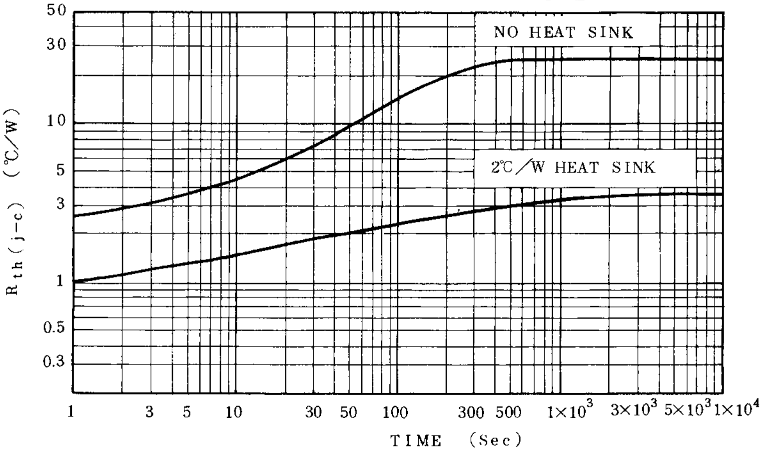
W1-2ϕ : W1-2 phase excitation mode

1-2ϕ : 1-2 phase excitation mode

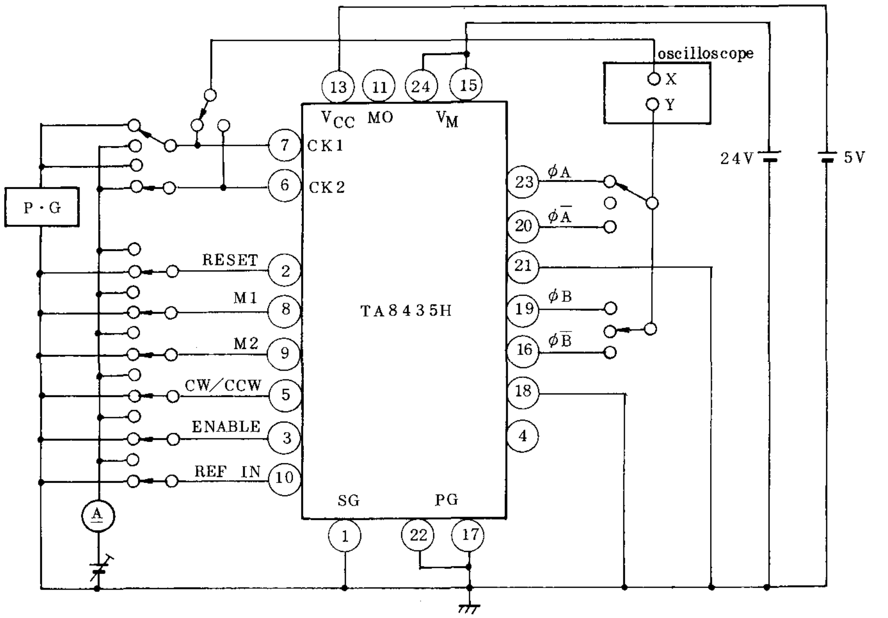
P_D — Ta



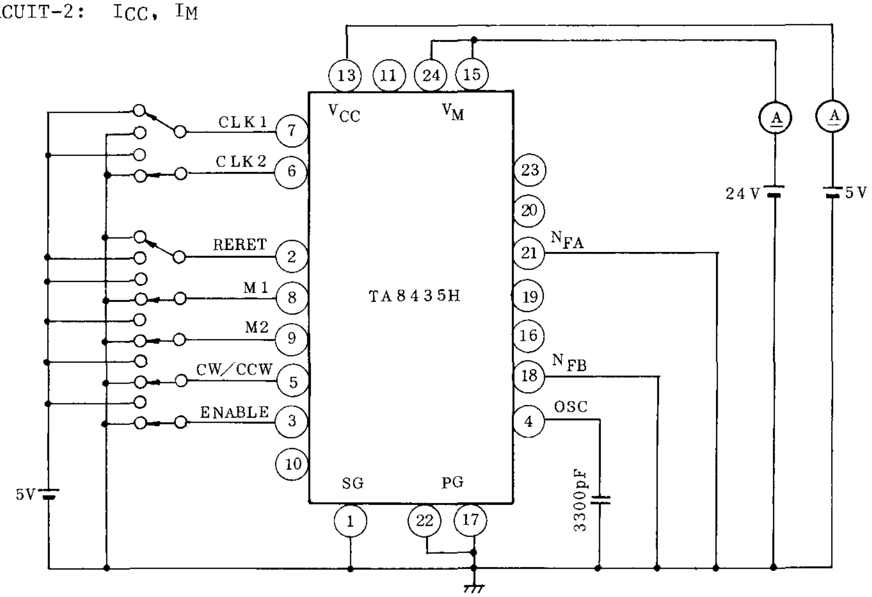
TRANSIENT THERMAL RESISTANCE



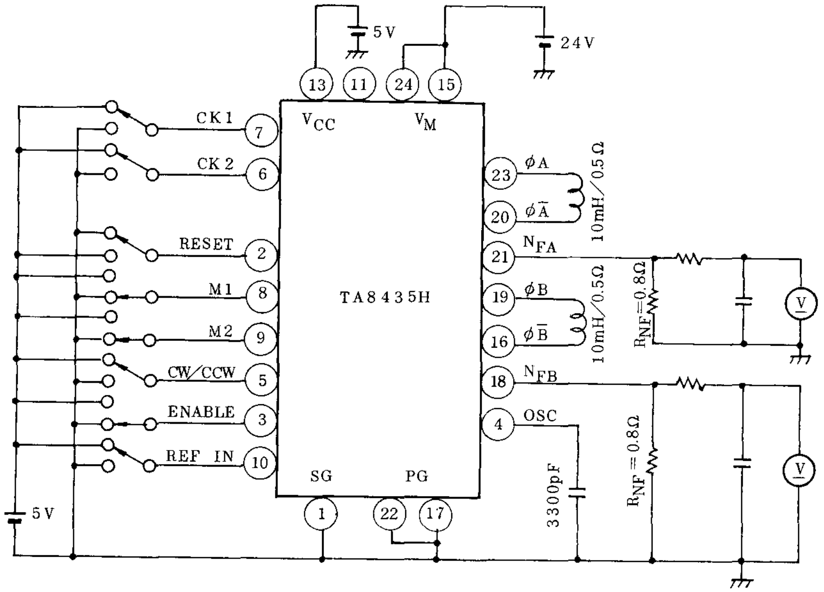
TEST CIRCUIT-1: V_{IN}(H), (L) . I_{IN}(H), (L)



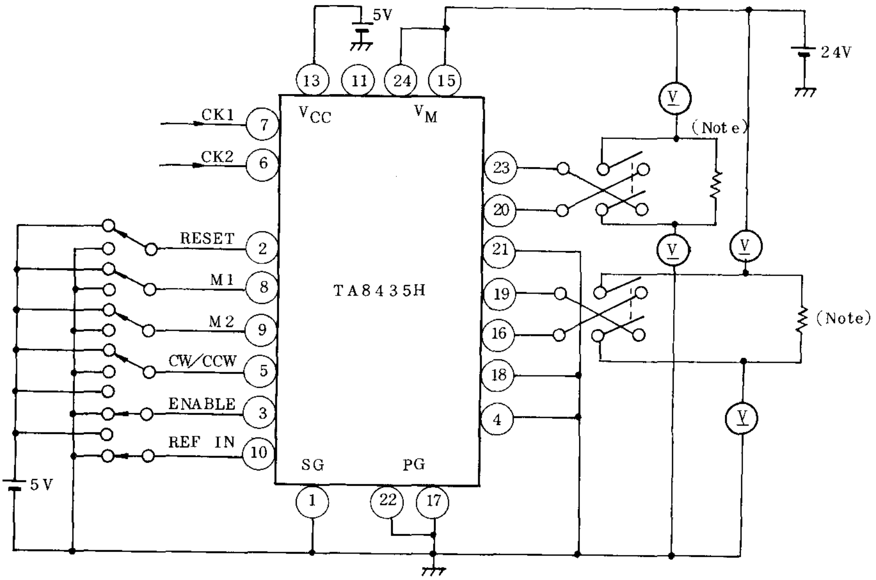
TEST CIRCUIT-2: I_{CC}, I_M



TEST CIRCUIT-3: V_{NF}(H), (L)

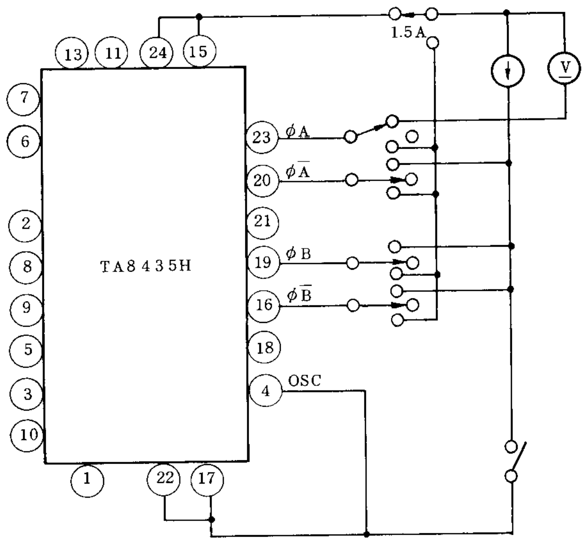


TEST CIRCUIT-4: V_{SAT-U}, V_{SAT-L}

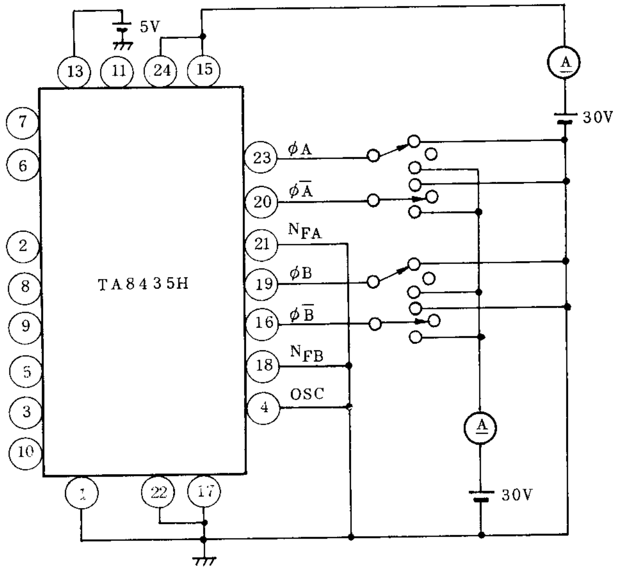


(Note) Adjust a resistance-value so as to get output current: 1.5A/0.8A

TEST CIRCUIT-5: V_{F-U}, V_{F-L}

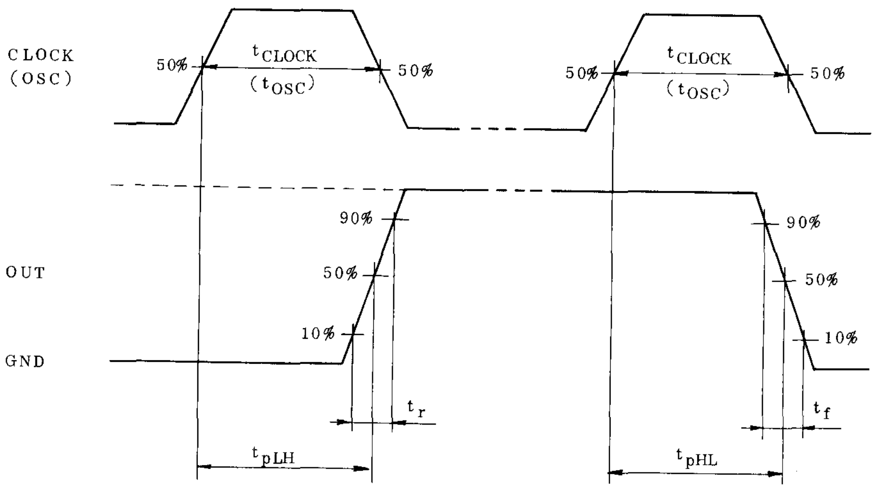


TEST CIRCUIT-6: I_{OH}, I_{OL}

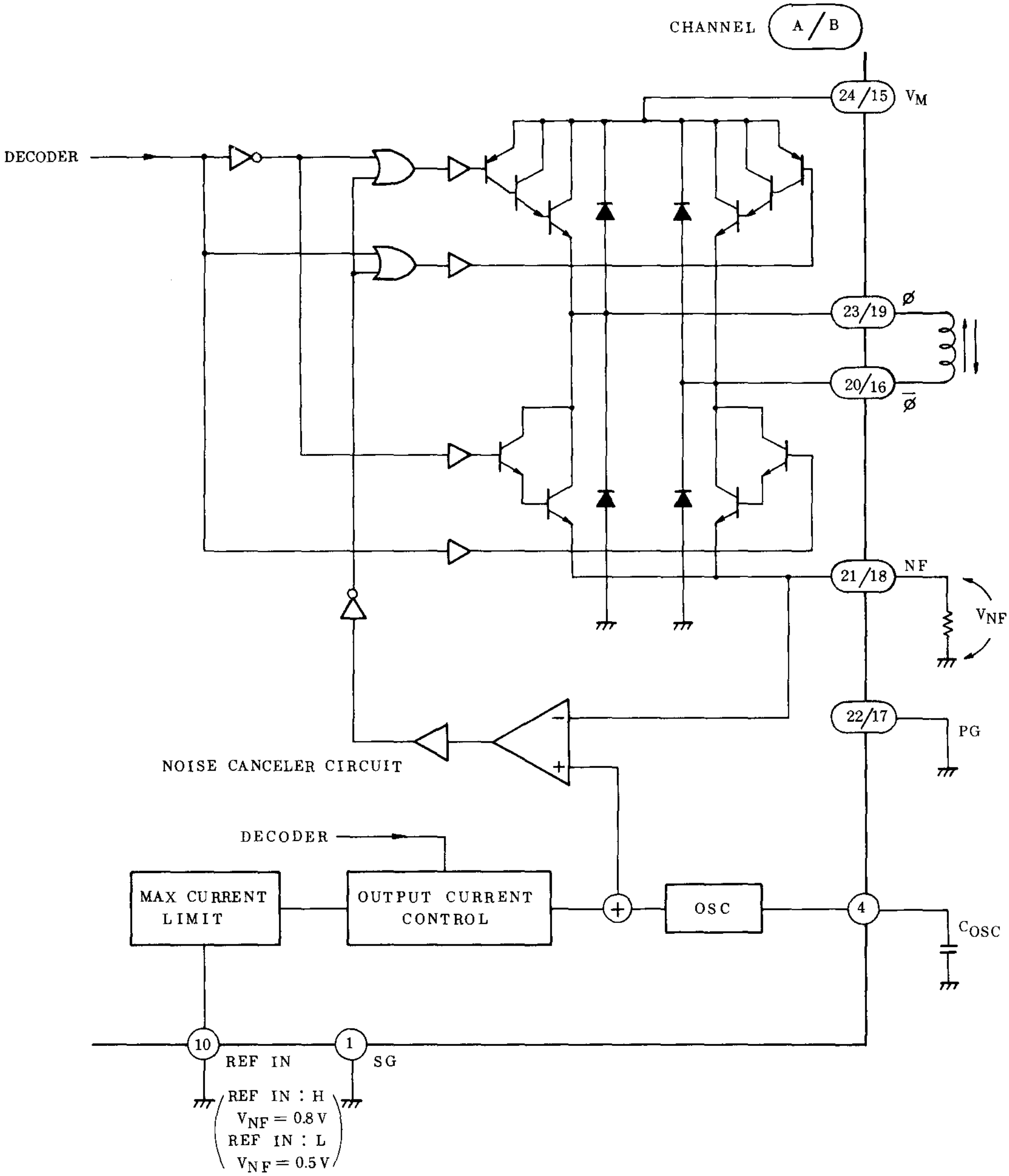


CHARACTERISTICS, WAVEFORM

. CK(OSC)-OUT

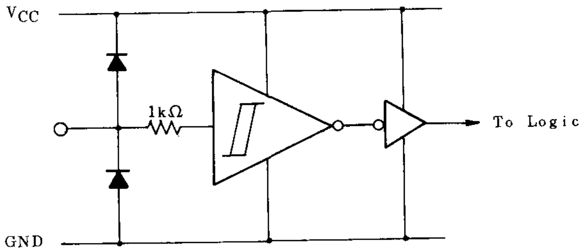


OUTPUT CIRCUIT

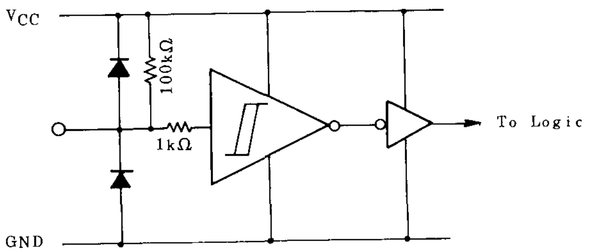


INPUT CIRCUIT

. CK1, CK2, CW/CCW, M1, M2, REF IN : Terminals

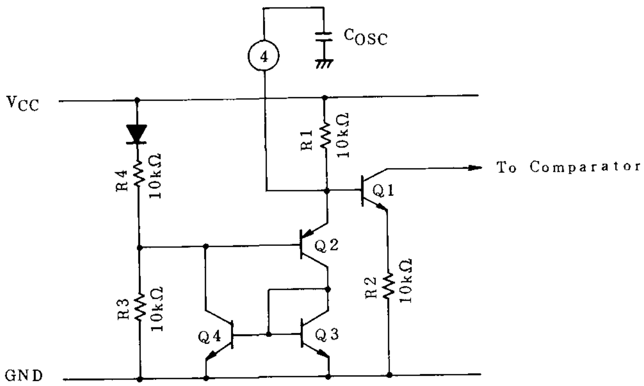


. $\overline{\text{RESET}}$, $\overline{\text{ENABLE}}$: Terminal



. 100kΩ of Pull-up Resister is equipped.

. OSC : Terminal



OSC FREQUENCY CALCULATION

Sawtooth OSC circuit consists of Q1 through Q4 and R1 through R4.
Q2 is turned "off" when V_{OSC} is less than the voltage of 2.5V+V_{BE} Q2 approximately equal to 2.85V.
V_{OSC} is increased by C_{OSC} charging through R1.
Q3 and Q4 are turned "on" when V_{OSC} becomes 2.85V(Higher level).
Lower level of V ④pin is equal to V_{BE} Q2+V_{SAT} Q4 approximately equal to 1.4V.
V_{OSC} is calculated by following equation.

$$V_{OSC} = 5 \cdot (1-e^{-\frac{1}{C_{OSC} \cdot R1} t})$$

Assuming that V_{OSC}=1.4V (t=t1) and =2.85V(t=t2)
C_{OSC} is external capacitance connected to pin ④ and R1 is on-chip 10kΩ resistor.
Therefore, OSC frequency is calculated as follows.

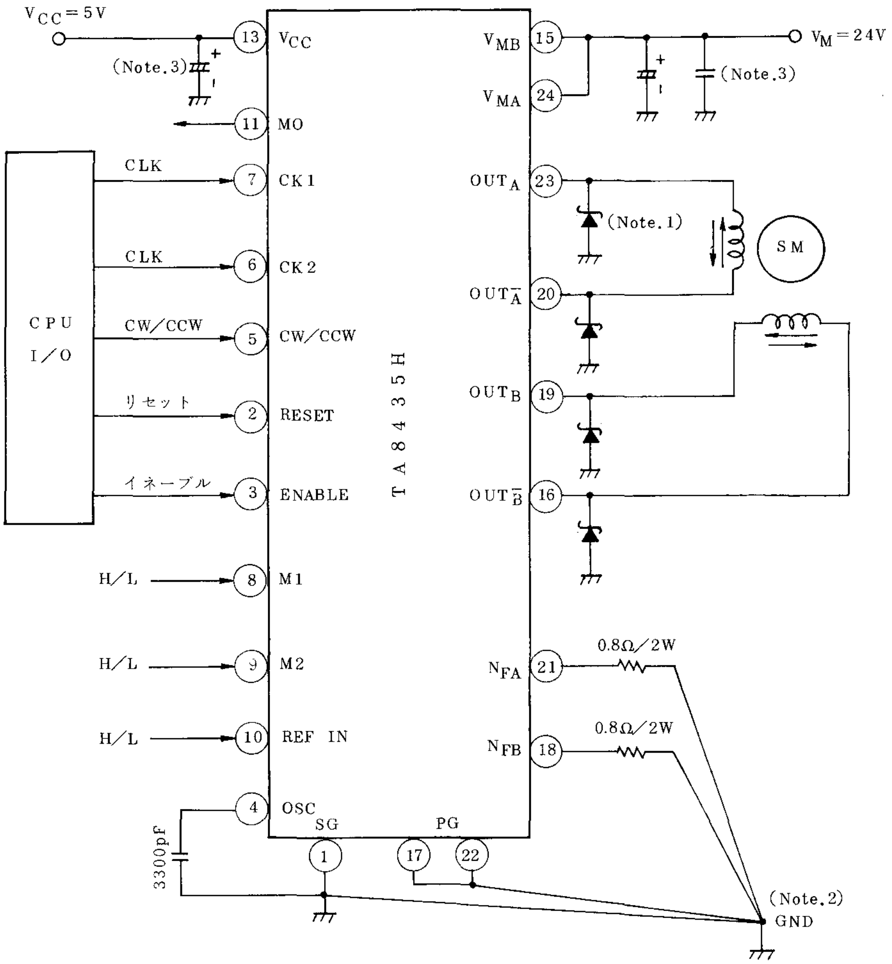
$$t1=-C_{OSC} \cdot R1 \cdot \ell n \left(1 - \frac{1.4}{5}\right)$$

$$t2=-C_{OSC} \cdot R1 \cdot \ell n \left(1 - \frac{2.85}{5}\right)$$

$$f_{OSC} = \frac{1}{t2-t1} = \frac{1}{C_{OSC} \left(R1 \cdot \ell n \left(1 - \frac{1.4}{5}\right) - R1 \cdot \ell n \left(1 - \frac{2.85}{5}\right)\right)}$$

$$\doteqdot \frac{1}{5.15 \cdot C_{OSC}} \text{ (kHz) } (C_{OSC} : \mu F)$$

APPLICATION CIRCUIT



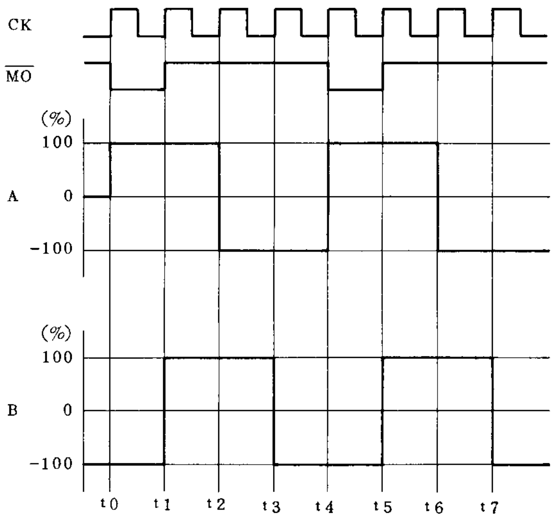
(Note. 1) Schottky diode (3GWJ42) to be connected additionally between each output (pin 16/19/20/23) and GND for preventing Punch-Through Current

(Note. 2) GND pattern to be laid out at one point in order to prevent common impedance.

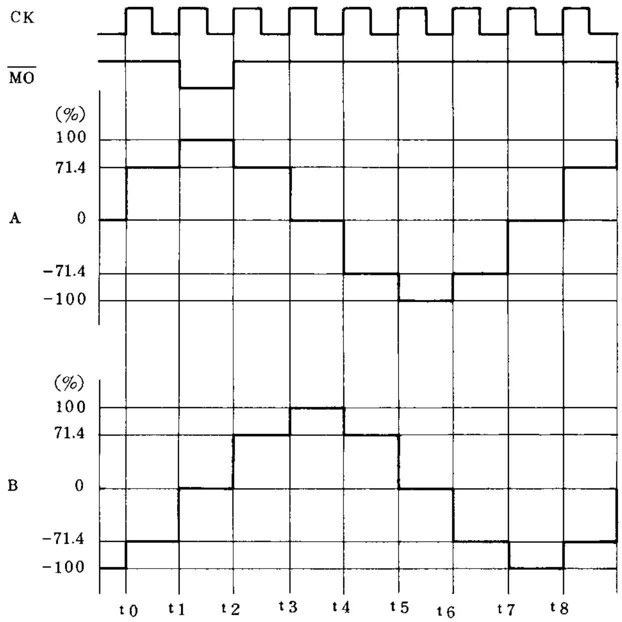
(Note. 3) Capacitor for noise suppression to be connected between the Power Supply (V_{CC}, V_M) and GND to stabilize the operation.

EXCITATION

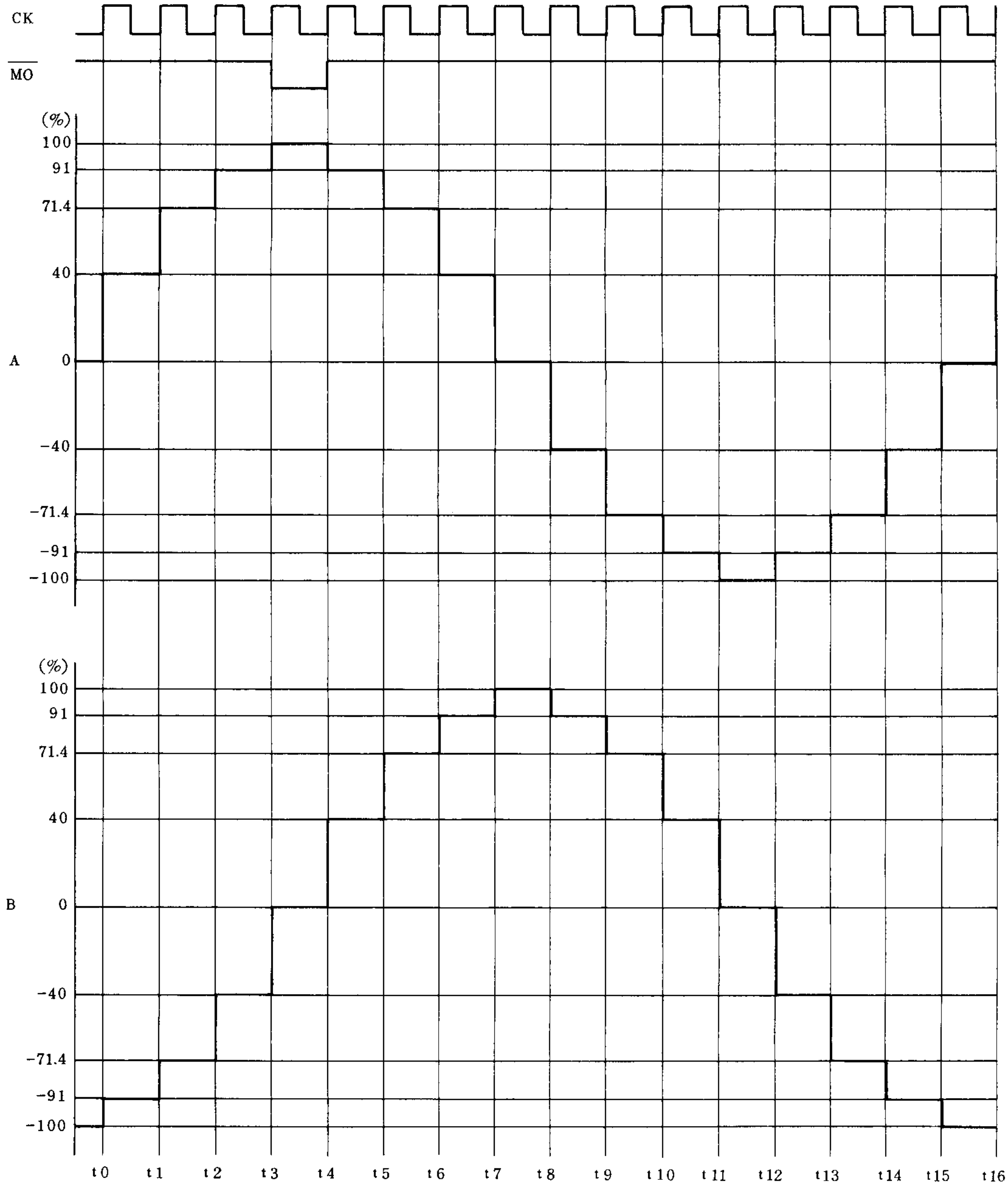
2 Phase Excitation (M1:L, M2:L)



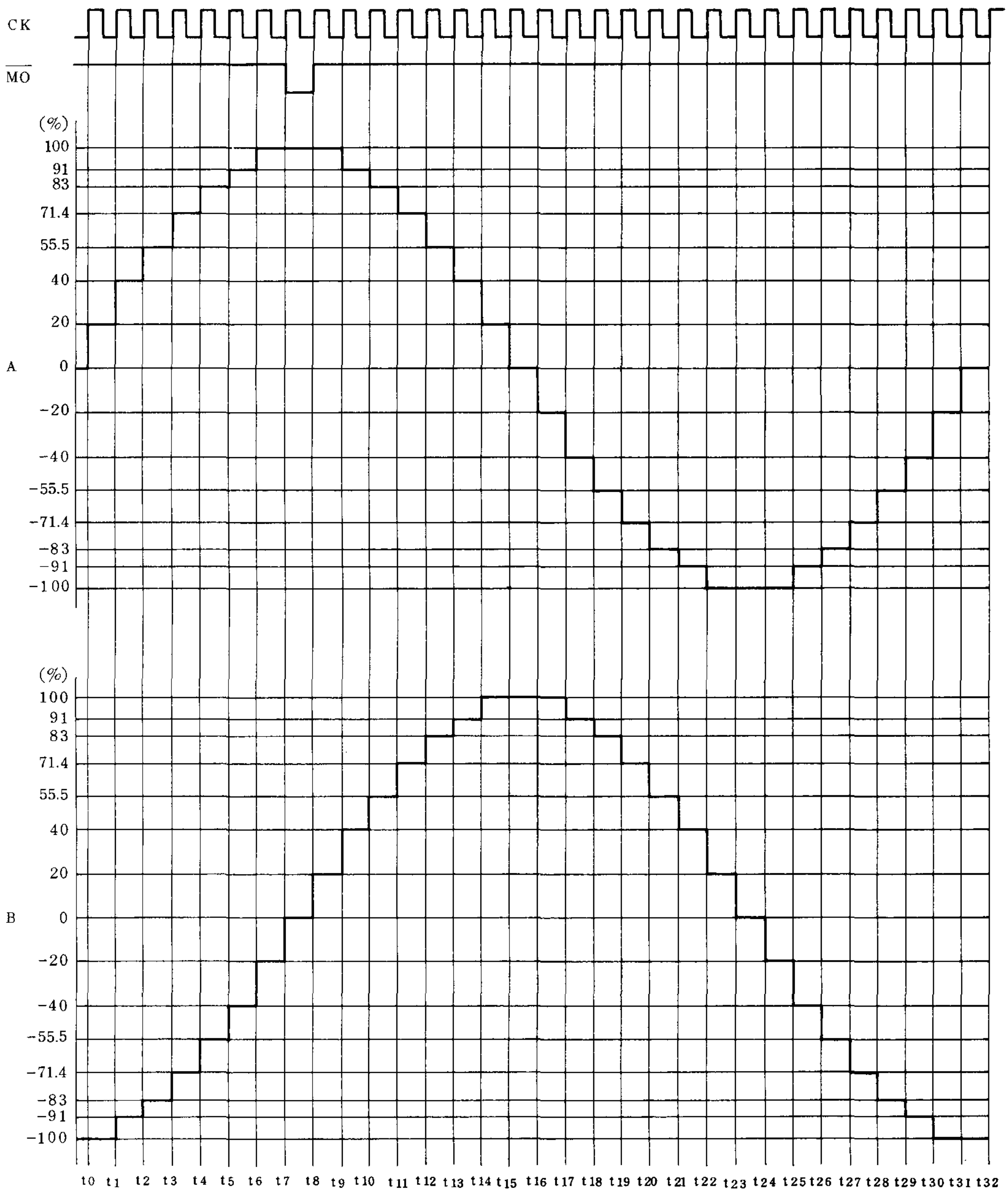
1-2 Phase Excitation (M1:H, M2:L)



W1-2 Phase Excitation (M1:L, M2:H)



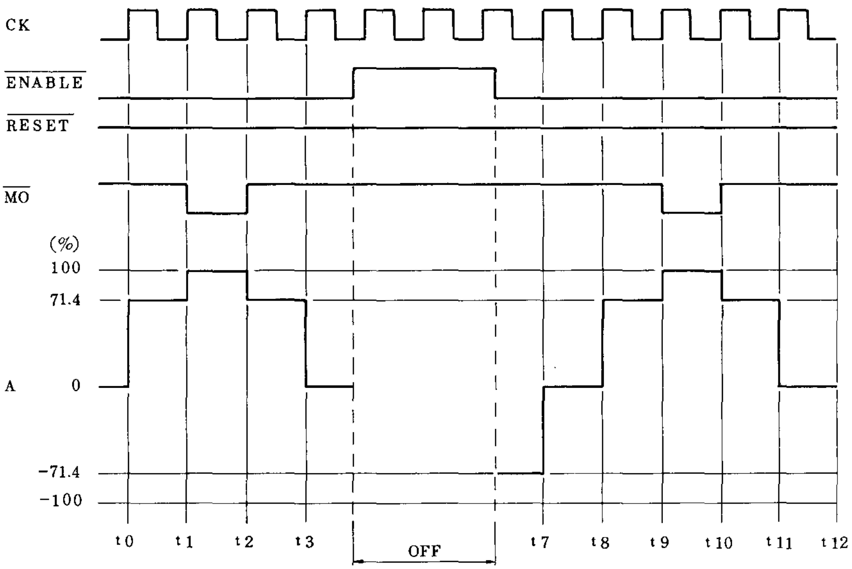
2W1-2 Phase Excitation (M1:H, M2:H)



$\overline{\text{ENABLE}}$ AND $\overline{\text{RESET}}$ FUNCTION AND $\overline{\text{MO}}$ SIGNAL

$\overline{\text{ENABLE}}$ Signal disables only Output Signal.
Internal logic functions are proceeded by CK signal without regard to $\overline{\text{ENABLE}}$ signal.
Therefore, Output Current is initiated from the proceeded timing point of internal logic circuit after release of disable mode.
Fig.1 shows the $\overline{\text{ENABLE}}$ functions, when the system is selected in 1-2 Phase drive mode.

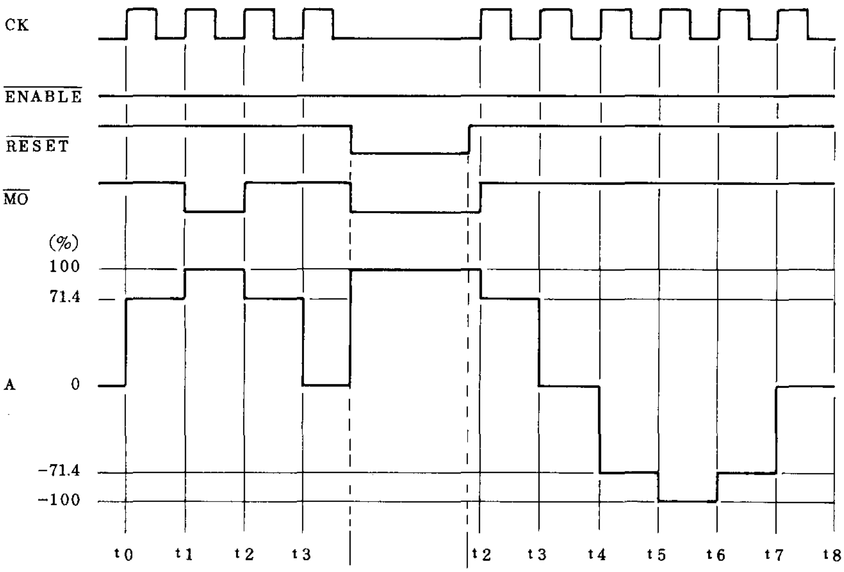
Fig.1 1-2 Phase drive mode (M1:H, M2:L)



Outputs are initiated from the initial point after release of RESET (High) as shown in Fig. 2.

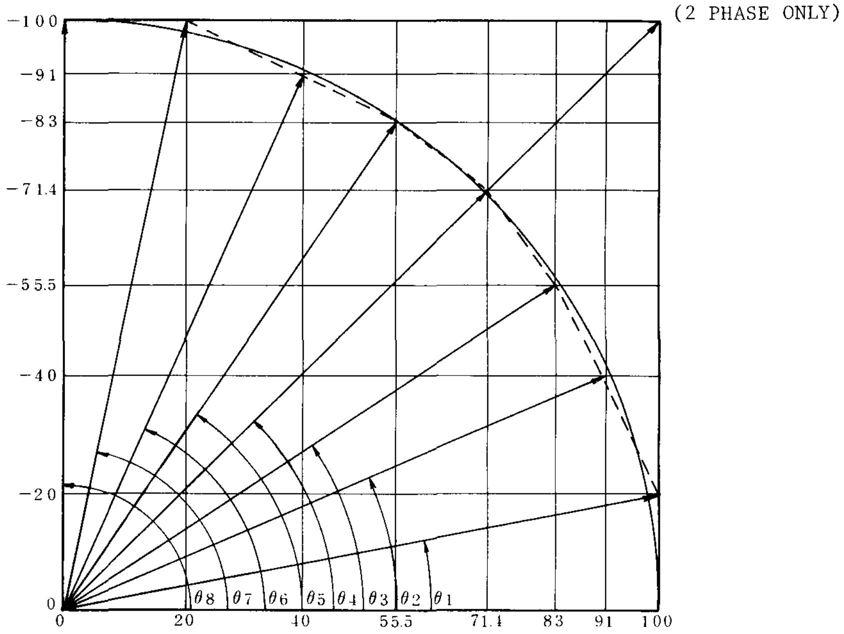
Fig. 2 1-2 Phase drive mode (M1:H, M2:L)

Low level active of $\overline{\text{RESET}}$ initializes internal decoder and $\overline{\text{MO}}$ becomes low.



$\overline{\text{MO}}$ (Monitor Output) Signals can be used as rotation and initial signal for stable rotation checking.

OUTPUT CURRENT VECTOR ORBIT (NORMALIZE TO 90 DEG FOR EACH ONE STEP)



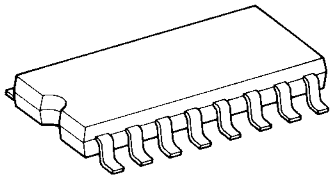
θ	ROTATION ANGLE		VECTOR LENGTH		
	Ideal	Real	Ideal	Real	
θ0	0°	0°	100	100.00	-
θ1	11.25°	11.31°	100	101.98	-
θ2	22.5°	23.73°	100	99.40	-
θ3	33.75°	33.77°	100	99.85	-
θ4	45°	45°	100	100.97	141.42
θ5	56.25°	56.23°	100	99.85	-
θ6	67.5°	66.27°	100	99.40	-
θ7	78.75°	78.69°	100	101.98	-
θ8	90°	90°	100	100.00	-
			1-2, W1-2, 2W1-2 Phase		2 Phase

TA8436AF

TENTATIVE DATA

SMART MOS DUAL H-BRIDGE DRIVER IC

TA8436AF is a monolithic type bridge driver IC, which is composed of 4 MOS FETs output and control circuit for Forward, Reverse and Breaking function by direct connection with MCU.
Breaking characteristics is very speedy and powerful.



SOP16-P-300A

Weight : 0.16g(Typ.)

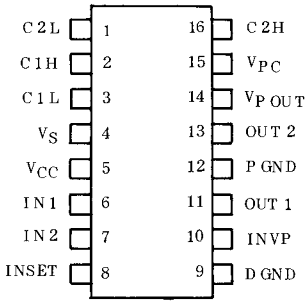
- Direct Interface with MCU
- 4 Mode Functions (Forward, Reverse, Break, Stip)
- Low On-resistance 620Ω (at Forward, Reverse, I_D=1.0A)
- I_D=3.0A Peak
- Low Power Dissipation
- Built-in Charge Pump
- 20 pin Mini Flat Package
- Compatible with MPC1710BM

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage (Load)	V_S	-0.5~8.0	V
Power Supply Voltage (Control)	V_{CC}	-0.5~7.0	V
Power Dissipation	P_D	650	mW
Input Voltage	V_{IN}	-0.5~7.0	V
Operating Temperature	Topr	-30~60	°C
Storage Temperature	Tstg	-55~125	°C
Soldering Temperature for Lead	$T_ℓ$	240	°C

(Note 1) Supply Voltage : -0.5~7.0V, equal to input voltage.

PIN CONNECTION (TOP VIEW)



THERAML CHARACTERISTICS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Thermal Resistance	Rth(j-a)	150	°C/W
	Rth(j-c)	33	

OPERATING CONDITION

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage (Load)	V_S	2.0~6.0	V
Power Supply Voltage (Control)	V_{CC}	4.5~5.5	V
Charge Pump Output Voltage	V_{PC}	11.0~17.0	V
Operating Temperature	T_{opr}	-30~60	°C
Charge Pump External Condenser	C1, 2, 3	10~100	nF

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Power Supply Current (Stand-by)	I_{ST}		V_{CC}=5V, V_{INSET}=0V	-	-	1.0	μA
Power Supply Current (Operating)	I_{CC}		V_{CC}=5V	-	-	1.0	mA
Input Current	$I_{IN(H)}$		V_{CC}=5V, V_{IN}=5V	-	-	1.0	μA
	$I_{IN(L)}$		V_{CC}=5V, V_{IN}=0V	-1.0	-	-	
Input Voltage	$V_{IN(H)}$		V_{CC}=5V	3.0	-	-	V
	$V_{IN(L)}$			-	-	0.8	
Input Resistance INSET, INVP	R_{IN}		V_{IN}=5V	35	-	65	kΩ
Output On Resistance (Source)	R_{ONSO}		I_{OUT}=1A	-	-	0.41	Ω
Output On Resistance (Sink)	R_{ONSI}			-	-	0.21	
Output Current (Ave)	$I_{DS(AVE)}$			-	-	1.0	A
Output Current (Peak)	$I_{DS(PEAK)}$		>T=100ms	-	-	3.0	
Vp OUT Output Voltage	$V_{P\ OUT}$			11.0	-	17.0	V
Charge Pump Output Voltage (Load Stand-by)	$V_{PC\ OFF}$			-	-	17.0	V
Charge Pump Output Voltage (Load Drive)	$V_{PC\ ON}$			11.0	-	-	
Shut Down Circuit Operating Voltage	V_{INS}			2.5	-	4.2	V
Pump Up Time	T_{VPC}			-	-	30.0	ms
Turn On Time	T_{ON}			-	-	3.0	μs
Turn Off Time	T_{OFF}			-	-	2.0	μs
Through Current	I_{STH}			-	-	1	mA
Vp OUT Rising Time	$T_{VP\ OUT}$		C=500pF	-	-	5	ms

BLOCK DIAGRAM

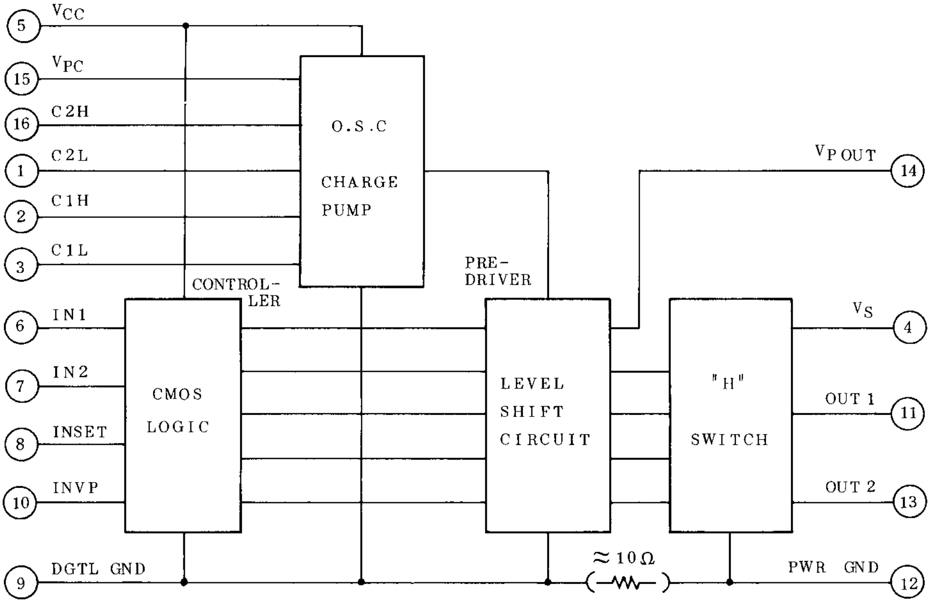


Table 1. Truth Table

INSET	IN1	IN2	INVP	OUT1	OUT2	VP OUT
1	1	1	×	0	0	×
1	1	0	×	1	0	×
1	0	1	×	0	1	×
1	0	0	×	∞	∞	×
0	×	×	×	∞	∞	0
1	×	×	1	×	×	0
1	×	×	0	×	×	1

× : High Impedance

Fig. 1 PUMP UP TIME

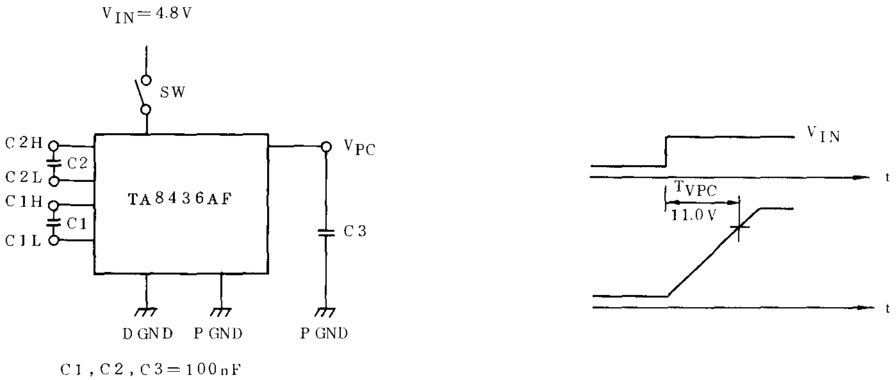


Fig. 2 OUTPUT CHARACTERISTIC

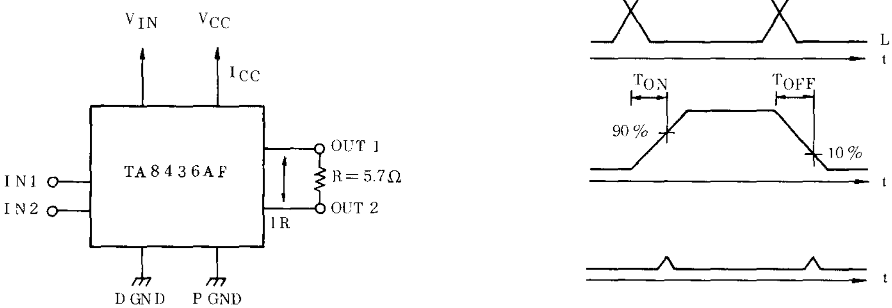
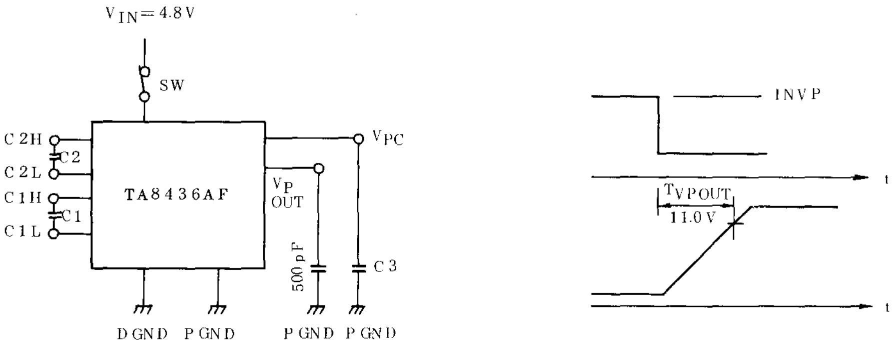
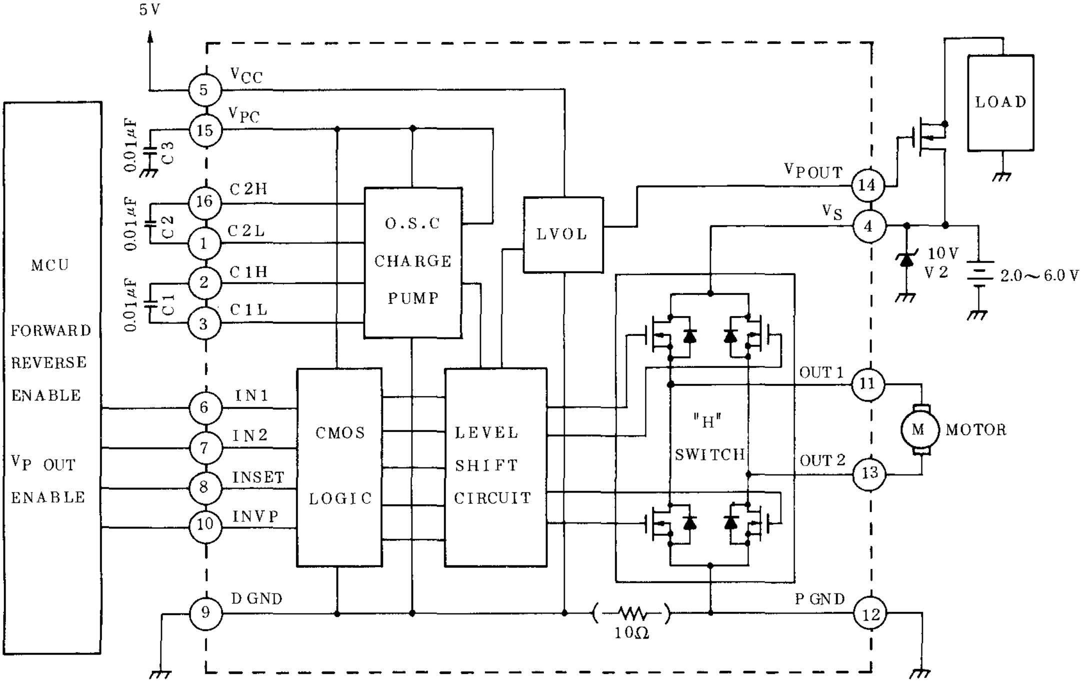


Fig. 3 V_P OUT RISING TIME



APPLICATION CIRCUIT

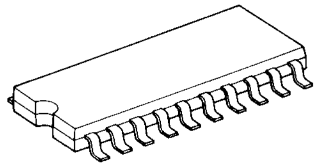


TA8437F

TENTATIVE DATA

SMART MOS DUAL H-BRIDGE DRIVER IC

TA8437F is monolithic type Smart MOS IC 2 ways H-bridge driver IC, which employs 2 units of H-bridge composed of MOS FET output and their control unit.
This IC is suitable for low voltage operating stepping motor application.



SOP20-P-300A

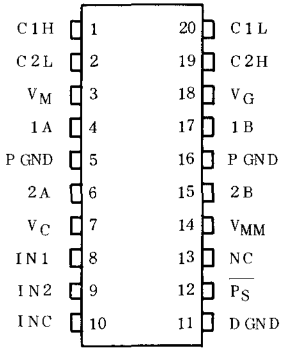
Weight : 0.48g(Typ.)

- Direct Operation by Logic Level Signal from MPU, etc.
- High Efficiency for Control-system (CMOS structure) and Output Stage (MOS FET structure)
- Low On-resistance
- Low Power Dissipation
- Built-in Charge Pump
- Built-in Power Save Function
- 20 pin Mini Flat Package
- Compatible with MPC1711M

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Power Supply Voltage (Motor)	V_M	-0.5	7.0	V
Power Supply Voltage (Control)	V_C	-0.5	6.0	V
Power Dissipation	P_D	-	650	mW
Input Voltage	V_{IN}	-0.5	6.0	V
Operating Temperature Range	Topr	-30	60	°C
Storage Temperature	Tstg	-55	125	°C
Soldering Temperature for Lead	T_ℓ	-	240	°C
Thermal Resistance	Rth(j-c)	-	33	°C/W
	Rth(j-a)	-	200	

PIN CONNECTION (TOP VIEW)



BLOCK DIAGRAM

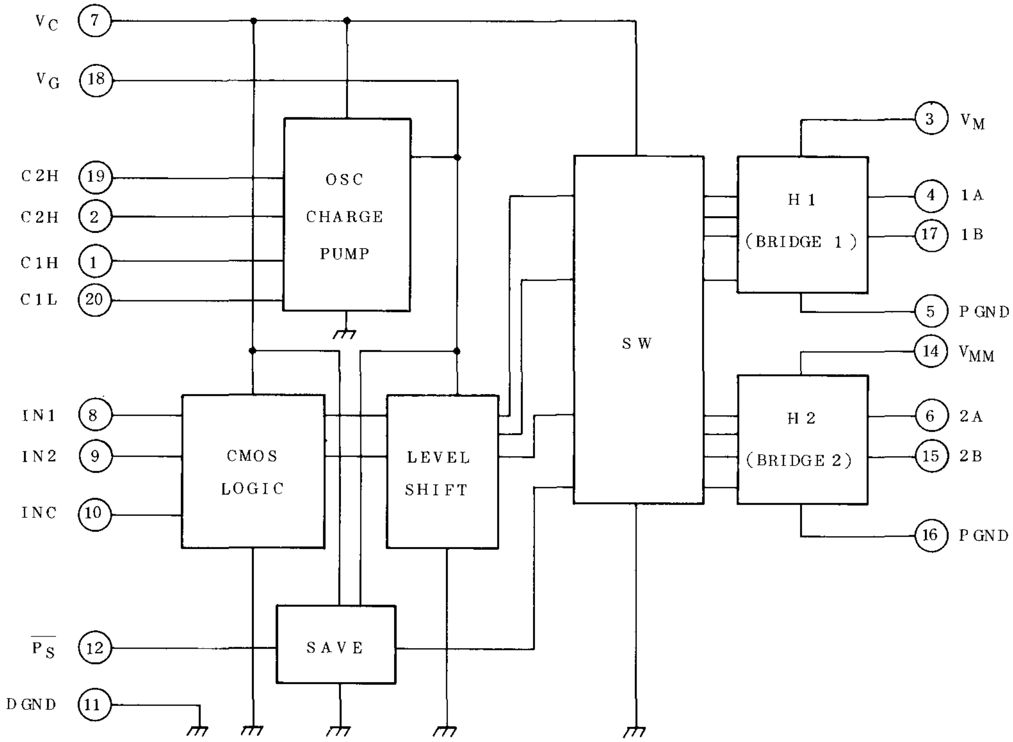


Table 1. Truth Table

$\overline{P_S}$	INC	IN1	IN2	H1	H2
1	1	1	1	F	F
1	1	1	0	F	R
1	1	0	1	R	F
1	1	0	0	R	R
×	0	×	×	∞	∞
0	1	1	1	PSF	PSF
0	1	1	0	PSF	PSR
0	1	0	1	PSR	PSF
0	1	0	0	PSR	PSR

F : Forward
R : Reverse
∞ : High Impedance
PSF : Power Save Forward
PSR : Power Save Reverse
× : Don't Care

ELECTRICAL CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Power Supply Current		I_C		V_L=5.0V, Input: OFF Output: OFF	-	-	1.0	mA
Input Current		$I_{IN(H)}$		V_{IN}=5.0V	-	-	1.0	μA
		$I_{IN(L)}$		V_{IN}=0V	-1.0	-	-	
Input Resistance		R_{IN}		V_{IN}=5.0V	35	-	65	kΩ
Input Voltage		$V_{IN(H)}$			2.5	-	-	V
		$V_{IN(L)}$			-	-	0.8	
Drive Current		I_{DR}			-	-	300	mA
Output On Resistance	Source	R_{ONSO}		I_{OUT}=300mA	-	-	1.7	Ω
	Sink	R_{ONSI}			-	-	1.3	
Charge Rump Output Voltage		V_{PC}			10	-	15	V
Charge Pump Turn On Time		T_{VGON}		Fig.2	-	-	3	ms
Turn On Time		T_{ON}		Fig.3	-	-	5	μs
Turn Off Time		T_{OFF}			-	-	5	
Through Current		I_{STH}			-	-	50	mA

RECOMMENDED OPERATING CONDITION

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Power Supply Voltage	Motor	V_M		2.0	-	6.0	V
	Control	V_C		4.5	-	5.5	
Power Gate Voltage		V_G		10.0	-	15.0	V
Operating Temperature		T		-30	-	60	°C

Fig. 2 TVGON

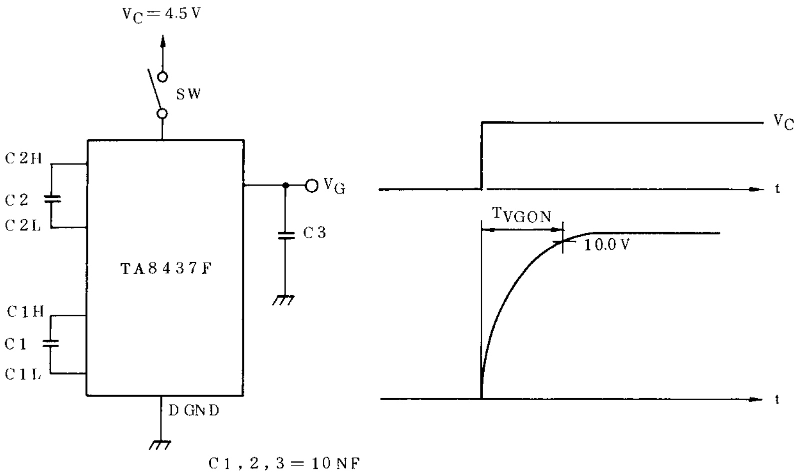
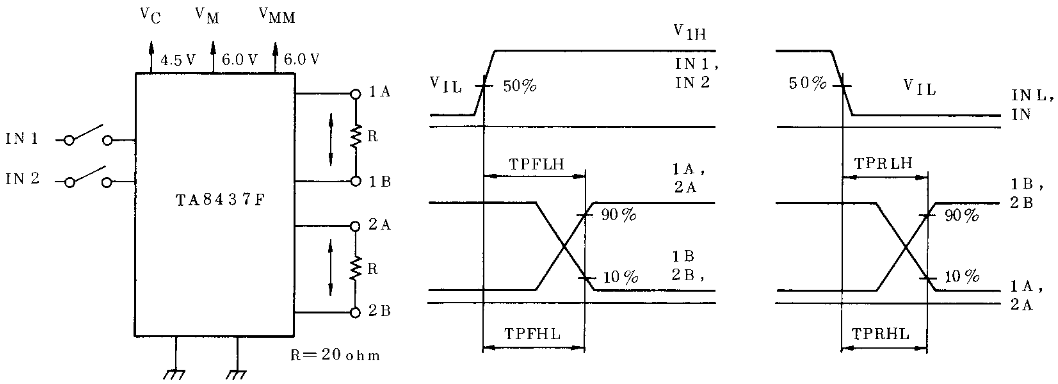
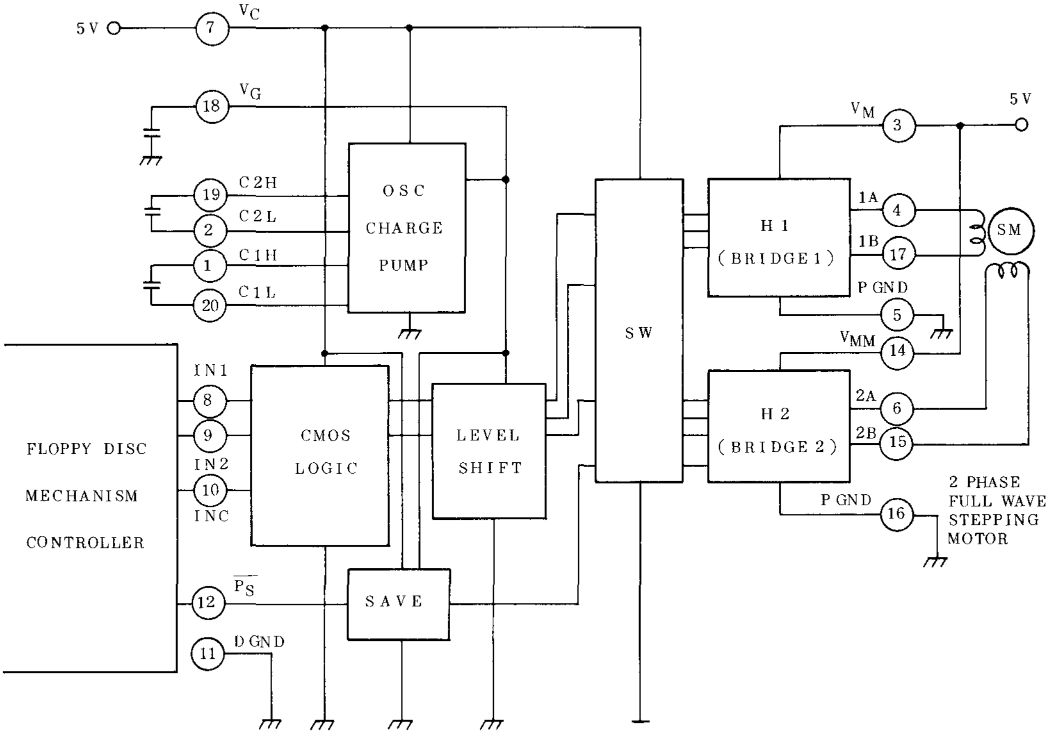


Fig. 3 OUTPUT WAVE



APPLICATION CIRCUIT

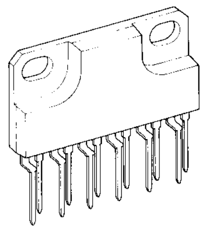


TA8440H

TENTATIVE DATA

DC MOTOR FULL BRIDGE DRIVER

The TA8440H is a full-dridge driver for selecting the forward and reverse running of a motor with brushes and is able to control 4 modes of forward, reverse, stop and braking.
The motor driving unit and the control unit have a separate power supply line, independently and the TA8440H is also usable as a stepping motor driver.



HZIP12-P-B

Weight : 3.97g (Typ.)

- Output Current is as large as 1.5A(AVE) and 3.0A(PEAK).
- 4 modes of forward, reverse, stop, and braking are available and a counter-electromotive force absorbing diode has been built-in.
- Thermal Shutdown Circuit Incorporated.
- Input is Compatible with CMOS.
- Built-in Input Pull-up Resistor. BRAKE=40kΩ(Typ.)
- Built-in Input Pull-down Resistor. IN,ENABLE=40kΩ(Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	7	V
		V_S	50	
Input Voltage		V_{IN}	$-0.3\sim V_{CC}$	V
Output Current	Average	I_O(AVE)	1.5	A
	Peak	I_O(PEAK)	30 (Note 1)	
Power Dissipation		P_D	2.52 (Note 2)	W
			20.0 (Note 3)	
Operating Temperature		Topr	-30~75	°C
Storage Temperature		Tstg	-55~150	°C

(Note 1) t=100[mSEC]

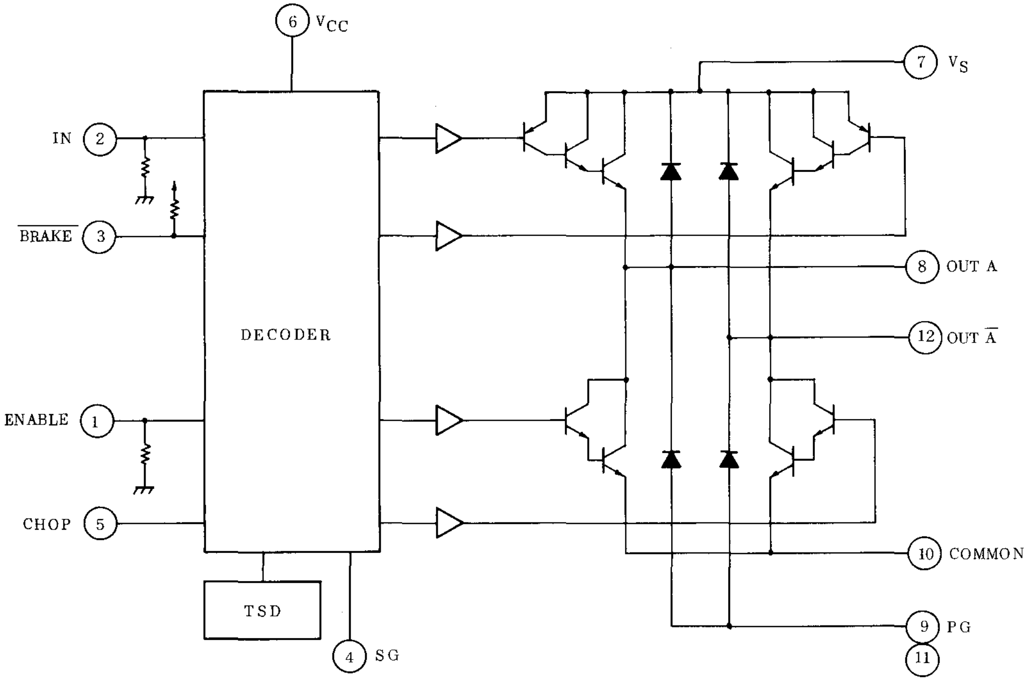
(Note 2) No Heat Sink

(Note 3) Tc=75°C

TRUTH TABLE

INPUT				OUTPUT		MODE
IN	$\overline{\text{BRAKE}}$	ENABLE	CHOP	OUT A	OUT $\overline{\text{A}}$	
H	H	H	L	H	L	CW/CCW
L	H	H	L	L	H	CCW/CW
*	*	L	*	∞	∞	STOP
*	L	H	*	L	L	BRAKE
H	H	H	H	∞	L	SHOP
L	H	H	H	L	∞	CHOP

BLOCK DIAGRAM

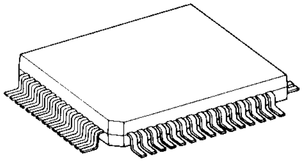


Pull-up, Pull-down Resistor : 40kΩ(Typ.)

TA8443F

PLL-PWM 3-PHASE HALL MOTOR PRE-DRIVER

TA8443F is 3-phase hall motor pre-driver with PLL controller and PWM controller.
8 bit D/A converter system has been employed for each of the speed control system (AFC) and the phase control system (APC).
TA8443F contains two error amplifiers, adjustable oscillator, dead-time control comparator, pulse-steering flip-flop, amd output-control circuit.



QFP60-P-1414F

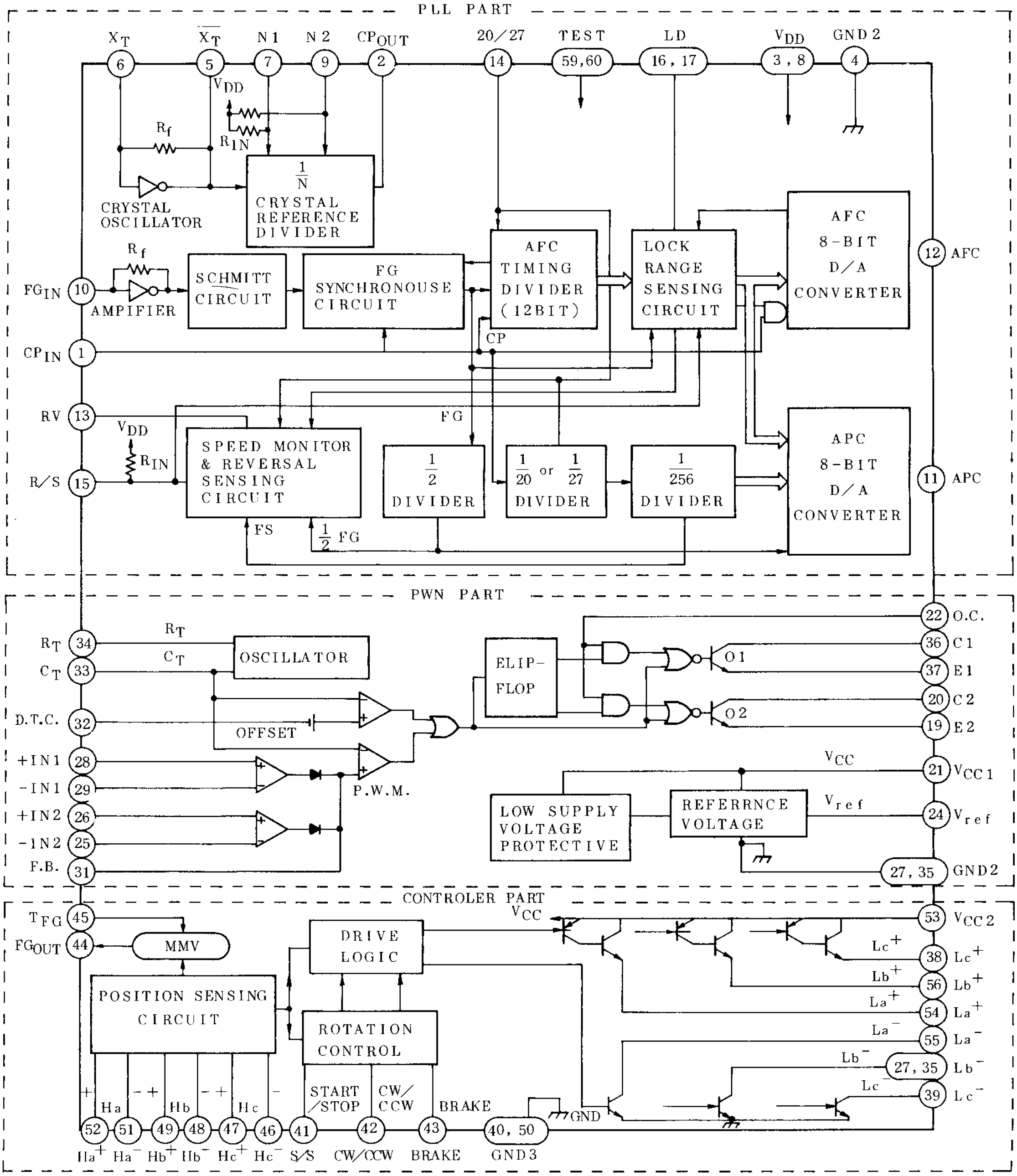
Weight : 0.8g(Typ.)

. This is multi-chip IC with TC9203, TA76494 and TA7712.
. Start/stop, CW/CCW and brake function are provided.
. Package is OFF-60.
. For further detailes, refer ro each technical data.

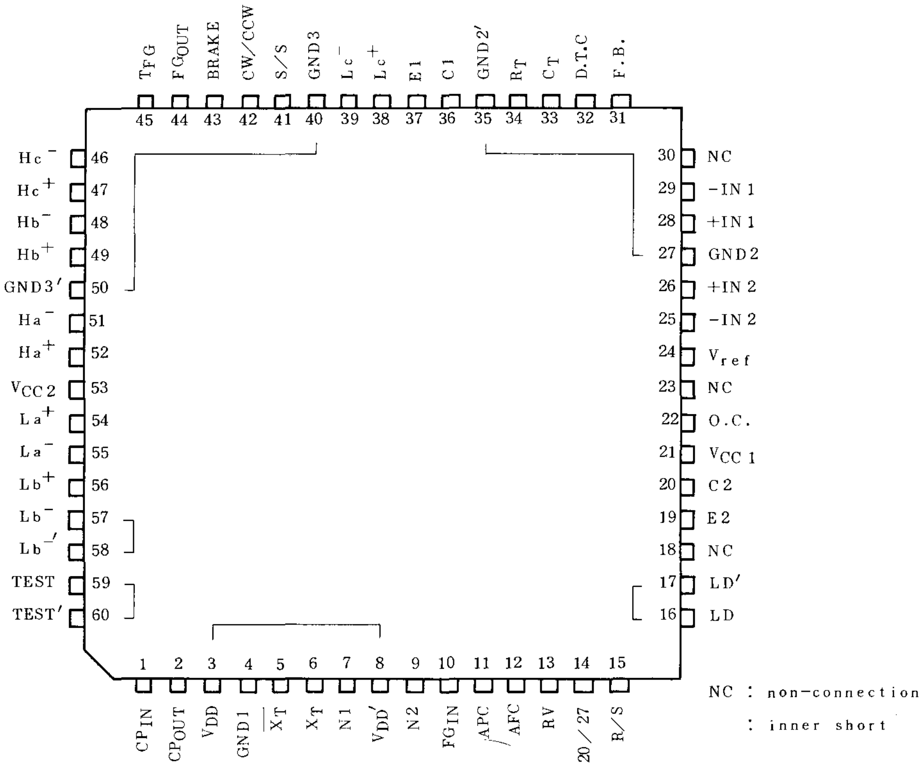
MAXIMUM RATINGS (Ta=25°C)

BLOCK	CHARACTERISTIC	SYMBOL	RATING	UNIT
PULL part (TC9203)	Supply Voltage	V_{DD}	-3.0~7.0	V
	Input Voltage	V_{IN}	$-0.3\sim V_{DD}+0.3$	V
PWM part (TA76494)	Supply Voltage	V_{CC1}	30	V
	Amplifier Input Voltage	V_{ICM}	$V_{CC}+0.3$	V
	Collector Output Voltage	V_{CER}	30	V
	Collector Output Current	I_C	250	mA
Controller part (TA7712)	Power Supply Voltage	V_{CC2}	8.0	V
	Output Current	I_O	±25	mA
	Position Sensing Circuit Input Voltage (Tj=25°C)	V_H	±500	mV
TA8443F	Power Dissipation	P_D	810	mW
	Operating Temperature	T_{opr}	-30~75	°C
	Storage Temperature	T_{stg}	-55~150	°C

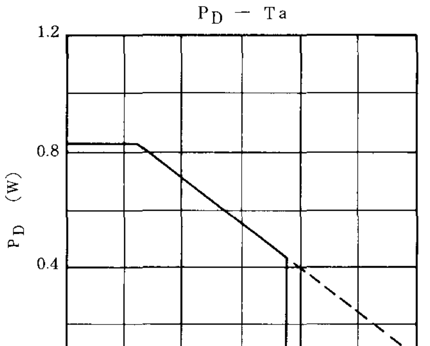
BLOCK DIAGRAM



PIN CONNECTION



POWER DISSIPATION



ELECTRICAL CHARACTERISTICS

PLL PART (Unless otherwise specified, V_{DD}=5V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		V_{DD}	-	*	4.5	5.0	5.5	V
Operating Supply Current		I_{DD}	-	X'tal=8MHz, CP_{IN}=CP_{OUT} *	-	5.0	12.0	mA
Operating Frequency Range	X_T	f_{XT}	-	*	1.0	~	8.0	MHz
	CP_{IN}	f_{CP}	-	Square wave *	0.05	~	4.0	MHz
	FG_{IN}	f_{FG}		V_{IN}=0.5Vp-p, Sine wave *	-	~	10	kHz
Input Operating Voltage	FG_{IN}	V_{IN} FG	-	f_{FG}=10kHz, Sine wave *	0.5	~	V_{DD}-0.5	Vp-p
AFC, APC D/A Converter	Ladder Resistor	R_L	-		30	50	75	kΩ
	Max. Deviation		-	V_{DD}=4.5~5.5V	-	±2.5	±6.5	LSB
	Resolution		-		-	V_{DD}/256	-	V
	Temperature Drift		-		-	±1	-	LSB
Pullup Resistor		R_{IN}	-	N1,N2,20/27,R/S *	10	30	50	kΩ
Input Voltage	"H" Level	V_{IH}	-	N1,N2,20/27,R/S *	$V_{DD}\times0.8$	~	V_{DD}	
	"L" Level	V_{IL}	-	CP_{IN} *	0	~	$V_{DD}\times0.2$	
Input Leak Current		I_{IH}/I_{IL}	-	CP_{IN} *	-	-	±1.0	μA
Output Current	"H" Level	I_{OH}	-	RV,LD, CP_{OUT}; V_{OH}=4V	-0.5	-1.0	-	mA
	"L" Level	I_{OL}	-	RV,LD, CP_{OUT}; V_{OL}=1V	0.5	1.0	-	mA
Amplifier Feedback Resistor	XT	R_f	-		100	200	400	kΩ
	FG_{IN}	R_f	-		300	500	800	kΩ

*: Guaranteed within the range of V_{DD}=4.5~5.5V, Ta=-30~75°C.

PWM PART (V_{CC1}=15V, f=10kHz unless otherwise noted)

· REFERENCE SECTION

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	Vref	Iref=1mA, Ta=25°C	4.75	5	5.25	V
Input Regulation	REG_{IN}	7V ≦ V_{CC1} ≦ Iref=1mA Ta=25°C	–	8	25	mV
Output Regulation	REG_L	1mA ≦ Iref ≦ 10mA, Ta=25°C	–	1	15	mV
Output Voltage Change with Temperature	Vref/T	−30°C ≦ Ta ≦ +75°C Iref=1mA	–	0.01	0.03	%/°C
Short-circuit Output Current Note 2	I_{short}	Vref=0	–	50	–	mA

· OSCILLATOR SECTION

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency	f_{OSC}	C_T=0.01μF, R_T=12k	–	40	–	kHz
Standard Deviation of Frequency Note 3	f_{DIV}	All values of V_{CC}, C_T, R_T, Ta constant	–	3.0	–	%
Frequency Change with Voltage	ΔfV_{IN}	7V ≦ V_{CC1} ≦ 40V, C_T=0.01μF Ta=25°C, R_T=12kΩ	–	0.1	–	%
Frequency Change with Temperature	Δf_{Ta}	0°C ≦ Ta ≦ 70°C, C_T=0.01μF R_T=12kΩ	–	1	2	%

· DEAD-TIME CONTROL SECTION

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Bias Current	I_{IND}	0 ≦ V_I ≦ 5.25V	–	−2	−10	μA
Maximum Duty Cycle, Eqch Output	Dy MAX	V_I=0	45	48	–	%
Input Threshold Voltage	V_{TH-1}	Zero Duty Cycle	–	2.8	3.3	V
	V_{TH-2}	Maximum Duty Cycle	0	–	–	

· PWM COMPARATOR SECTION

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Threshold Voltage	V_{TH}	Zero Duty Cycle	–	4	4.5	V
Input Sink Current	I_I	V(pin 31)=0.7V	0.3	0.7	–	mA

• ERROR-AMPLIFIER SECTION

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Offset Voltage	V_{IO}	V_O PIN31=2.5V	–	2	10	mV
Input Offset Current	I_{IO}	V_O PIN31=2.5V	–	50	250	nA
Input Bias Current	I_{IB}	V_O PIN31=2.5V	–	0.1	1	μA
Common-mode Input Voltage Range	CMR_{IN}	$7V \leq V_{CC1} \leq 40V$	-0.3	–	$V_{CC}-2$	V
Open-loop Voltage Amplification	G_V	V_O PIN31=0.5~3.5V Ta=25°C	70	95	–	dB
Unity-gain Bandwidth	f_O	Ta=25°C	–	350	–	kHz
Common-mode Rejection Ratio	CMR_R	V_{CC1}=40V, Ta=25°C	65	90	–	dB
Output Sink Current	I_O^-	V_O PIN31=0.7V	0.3	0.7	–	mA
Output Source Current	I_O^+	V_O PIN31=3.5V	-2	-10	–	mA

• OUTPUT SECTION

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Off-state Current		I_{CER}	V_{CE}=40V, V_{CC}=40V	–	–	100	A
Emitter Off-state Current		$I_{E(OFF)}$	$V_{CC1}=V_C$=40V, V_E=40V	–	–	-100	A
Collector-Emitter Saturation Voltage	Common-Emitter	$V_{CE(sat)}$	I_C=200mA, V_E=0V	–	0.95	1.3	V
	Emitter Follower	$V_{CE(ON)}$	I_E=-200mA, V_C=15V	–	1.6	2.5	V
Output Voltage Rise Time		t_{r1}	V_{CC1}=15V, R_L=150,Ta=25°C	–	100	200	ns
Output Voltage Fall Time		t_{f1}	$I_C \doteqdot$100mA,Common-Emitter	–	25	100	
Output Voltage Rise Time		t_{r2}	V_{CC1}=15V, R_L=150,Ta=25°C	–	100	200	
Output Voltage Fall Time		t_{f2}	$I_E \doteqdot$100mA,Common-Follower	–	40	100	

• SUPPLY CURRENT

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Standby Supply Current	$I_{CC(SB)}$	V_{CC1}=15V, All other inputs and outputs open	–	8	12.5	mA
Average Supply Current	$I_{CC(BI)}$	V(pin 32)=2V, C_T=0.01μF R_T=12kΩ, V_{CC1}=15V	–	10	–	mA

Note 1 : All typical values except for temperature coefficients are at Ta=25°C.

Note 2 : Duration of the short-circuit should not exceed one second.

Note 3 : Standard deviation is a measure of the statistical distribution about the mean as derived from the formula.

$$\sigma=\sqrt{\frac{\sum_{n=1}^{N}(X_n-X)^2}{N-1}}$$

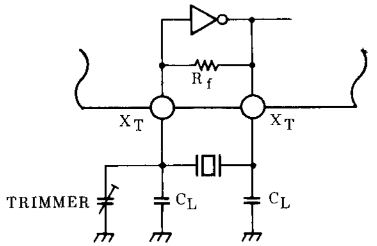
CONTROLLER PART (Unless otherwise specified, V_{CC2}=5V, Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operation Power Supply Voltage			$V_{CC2\ opr}$	–		4.75	5.00	5.25	V
Power Supply Current			I_{CC1}	–	Stop State	–	3.4	6.0	mA
			I_{CC2}		Output Open	–	17.0	26.0	
Saturation Voltage	Upper Side		$V_{SAT\ U-1}$	–	R_L=200Ω	–	1.3	2.0	V
			$V_{SAT\ U-2}$		R_L=2kΩ	–	1.0	1.3	
	Lower Side		$V_{SAT\ L-1}$		R_L=200Ω	–	0.8	1.2	
			$V_{SAT\ L-2}$		R_L=2kΩ	–	0.18	0.4	
Leak Current	Upper Side		$I_{L\ U}$	–		–	–	100	μA
	Lower Side		$I_{L\ L}$			–	–	100	
Position Sensing Input	Common Mode Voltage Range		CMR H	–		2.0	–	4.5	V
	Input Sensitivity		V_H			20	–	–	mV
	Input Hysteresis		$V_{H\text{-}Hye}$			2	7	15	
START Input (RUN)	Operation Input Voltage	"H"	$V_{IN\ R(H)}$	–		4.0	–	–	V
		"L"	$V_{IN\ R(L)}$	–		–	–	1.0	
	Input Current	"L"	$I_{IN\ R}$	–	$V_{IN\ R}$=1.0V	–	–	200	μA
CW/CCW Input (FWD/REV)	Operation Input Voltage	"H"	$V_{IN\ C(H)}$	–		4.0	–	–	V
		"L"	$V_{IN\ C(L)}$	–		–	–	1.0	
	Input Current	"L"	$I_{IN\ C}$	–	$V_{IN\ C}$=1.0V	–	–	200	μA
BRAKE Input (BRAKE)	Operation Input Voltage	"H"	$V_{IN\ B(H)}$	–		4.0	–	–	V
		"L"	$V_{IN\ B(L)}$	–		–	–	1.0	
	Input Current	"L"	$I_{IN\ B}$	–	$V_{IN\ N}$=1.0V	–	–	200	μA
FG Output	Output Current	"H"	I_{FGH}	–		80	–	–	μA
	Output Voltage	"L"	V_{FGL}	–	I_{FG}=0.3mA	–	–	0.4	V
	Pulse Width		τ_{FG}		C=0.1μF R=10kΩ	0.9	1.0	1.1	ms

PLL PART OPERATION

1. Crystal oscillation terminals (XT, $\overline{XT}$)

- The crystal oscillator is used by connecting as shown below.



- C_L of 10~30pF is appropriate.

- Crystal oscillation frequency is calculated by the following equation according to number of FG pulses of a motor to be used.

$$f_X = \frac{R}{60} \times FG' \times 128 \times (20 \text{ or } 27) \times N \quad (Hz)$$

(Note) (20 or 27): 20 at 20/27="H" or Open.
27 at 20/27="L".

f_X: Crystal oscillation frequency, FG': number of FG pulse generated per revolution of motor, R: revolution of motor per minute, N: Ratio of frequency division of the crystal reference frequency divider. (Refer to Item 9.)

- Maximum operating frequency is above 8MHz and crystals up to 8MHz can be used.

2. Reference frequency input/output terminals (CP_{IN}, CP_{OUT})

- Divided output $\frac{f_X}{N}$ from the crystal reference frequency divider is available at CP_{OUT}, which is normally connected CP_{IN}.
- When an external oscillator (CR oscillator, etc.) is connected to CP_{IN}, motor speed can be finally adjusted.

3. FG pulse input terminal (FG_{IN})

- This is the input terminal of FG pulse that shows the motor speed.
  This FG pulse becomes comparision frequency.
- This terminal has built-in Amplifier and Schmitt circuit.
  FG pulses are applied through capacitor coupling and small amplitude is enough for proper operation.

4. Lock range switching terminal (20/27)

- This terminal is for switching rock range of motor, with a pull-up resistor and chattering preventive circuit.

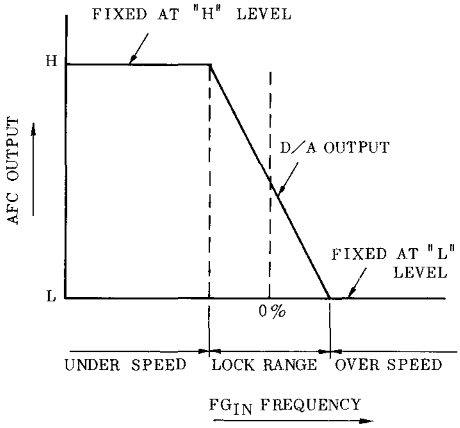
(TRUTH TABLE)

20/27	DIVIDED FREQUENCY	LOCK RANGE
L	1/27	+3.4~-3.9% of reference cycle
H or NC	1/20	+4.6~-5.3% of reference cycle

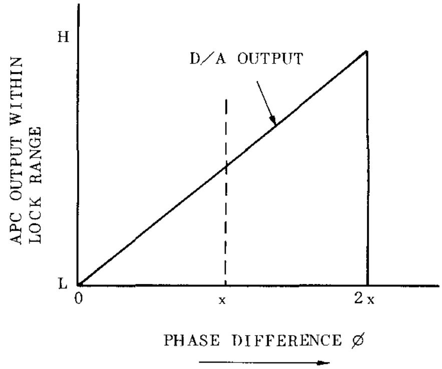
5. APC, AFC output terminal (APC, AFC)

- AFC (speed control output) is a F-V converter for FG frequency, and is consisting of a 8 bit D/A converter.
- APC (phase control output) is a phase comparator (ϕ-V converter) that compares phase difference ϕ between 1/2 FG and reference frequency FS', and is also consisting of a 8 bit D/A converter.
- Both APC and AFC perform the following 3 operations according to FG_{IN} frequency.
  a. When FG_{IN} frequency is within the lock range:
     Both APC and AFC perform the normal operation for FG_{IN}.
  b. When FG_{IN} frequency is below the lock range (under speed):
     APC and AFC outputs are both fixed at "H" level.
  c. When FG_{IN} frequency is above the lock range (over speed):
     APC and AFC outputs are both fixed at "L" level.
- When a motor is in STOP state (P/S=H or NC), both AFC and PAC are fixed "L" level.

AFC Output change status for FG_{IN} frequency

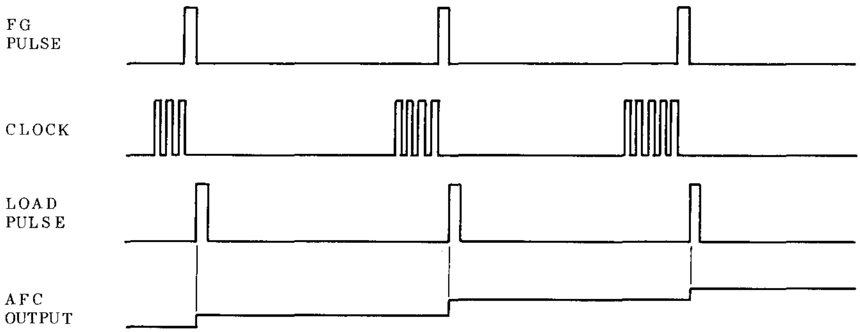


APC Output change status for phase difference ϕ

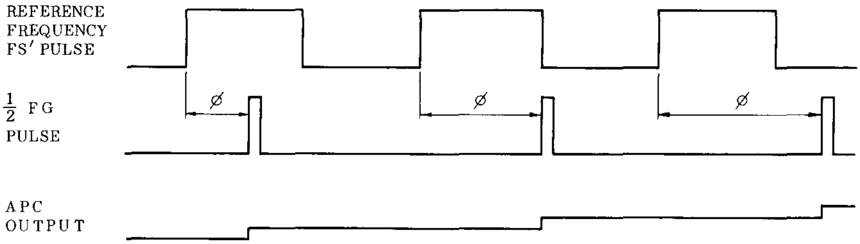


- AFC and APC timing chart within lock range.

a. AFC (SPEED CONTROL SYSTEM)



b. APC (PHASE CONTROL SYSTEM)



6. Lock detecting terminal (LD)

- This terminal is the lock detecting output and is placed at "H" level when FG_{IN} frequency is within the lock range and otherwise, placed at "L" level.

7. RUN/STOP input terminal (R/S)

- RUN/STOP signals of the motor are input to this terminal.
- This terminal has a pull-up resistor and a chattering preventive circuit.
- During RUN (R/S=L), AFC, APC and LD perform the above-mentioned operations for FG_{IN} frequency, and during STOP (R/S=H or NC), AFC, APC and LD are all fixed at "L" level.

8. Reverse signal output terminal (RV)

- At the switching og lock range from 1/20 to 1/27 or the operating from RUN to STOP, reverse signal for braking the motor is output through this terminal.
- Change of RV output status

PREVIOUS STATUS ⇨	RV OUTPUT CHANGE TO "H" LEVEL ⇨	RV OUTPUT CHANGE TO "L" LEVEL
During normal rotation (during lock) at 1/20.	When the lock range is switched from 1/20 to 1/27.	When the motor speed is locked at 1/27, or when FG_{IN} 1/8FS, or when the lock range is switched from 1/27 to 1/20.
During normal rotation (during lock) at 1/20 or 1/27.	When the operation is switched from RUN to STOP.	When FG_{IN} 1/8FS or when the operation is switched from STOP to RUN.

- In other cases than above, RV output is not changed and fixed at "L" level.
- Further, if FG frequency rises up to 1.5 times of normal rotation at 1/20 (2 times of normal rotation at 1/27), RV output is reset.

9. Referecne divided frequency switching terminal (N1, N2)

- Divided frequency 1/N of the crystal reference frequency divider can be switched to 1/5, 1/6 or 1/12 by number of FG pulses or a crystal used.
- This terminal has a built-in pull-up resistor.

(TRUTH TABLE)

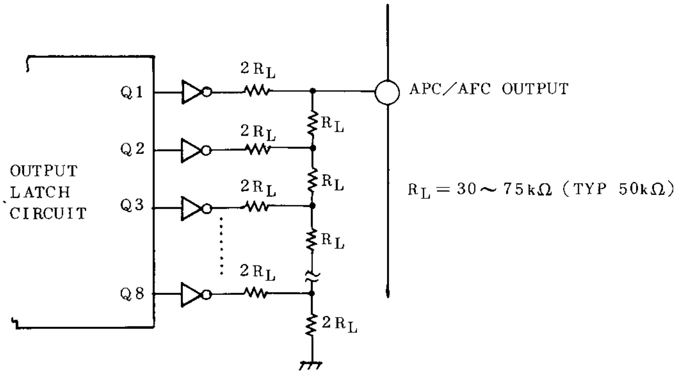
N1	N2	1/N
H	H	1/5
L	H	1/6
H	L	1/12

1/N: CRYSTAL REFERENCE DIVIDED FREQUENCY

(Note) Don't use mode, N1=N2="L", because this mode is test mode.

CAUTION IN APPLICATION

- APC and AFC terminals are for the 8-bit D/A converter outputs, which are directly output from the R-2R ladder type resistor network as shwon in the following diagram. Impedance of these outputs becomes equal to the ladder resistor value R_L. Therefore, input impedance at the receiving side of these terminals shall be designed accordingly.

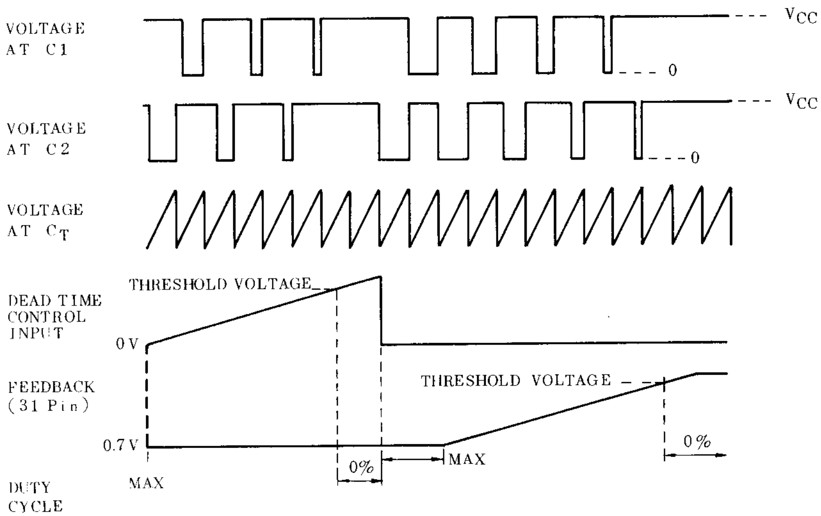


- A filter for an externally mounted differential amplifier on an application circuit shall be selected to meet the response characteristic of a motor to be used.

PWM PART OPERATION

The uncommitted output transistors provide either common-emitter or emitter-follower output capability.
Push-pull or single-ended output operation may be selected through the output-control function.
The architecture of the TA8443F prohibits the possibility of either output being pulsed twice during push-pull operation.

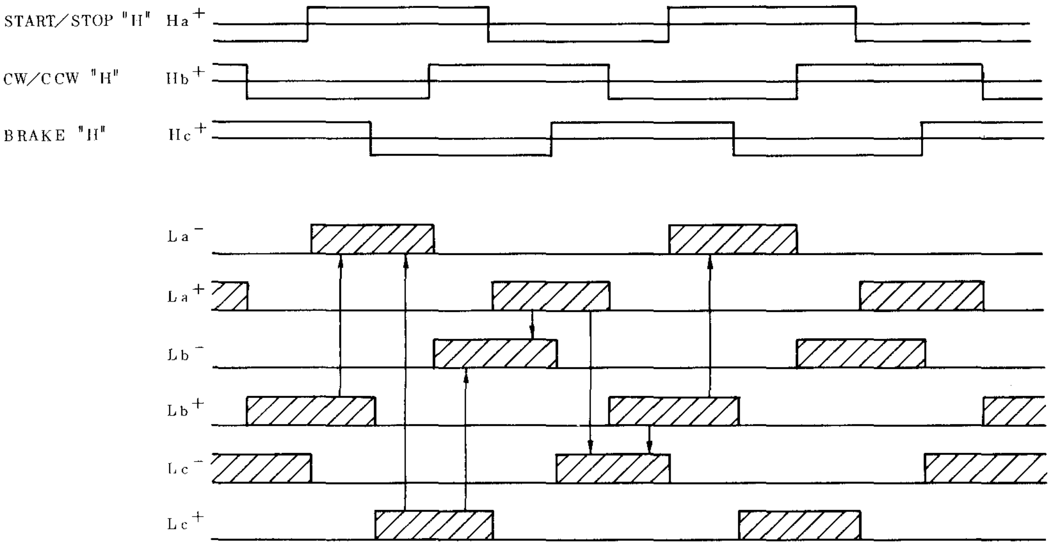
VOLTAGE WAVEFORMS



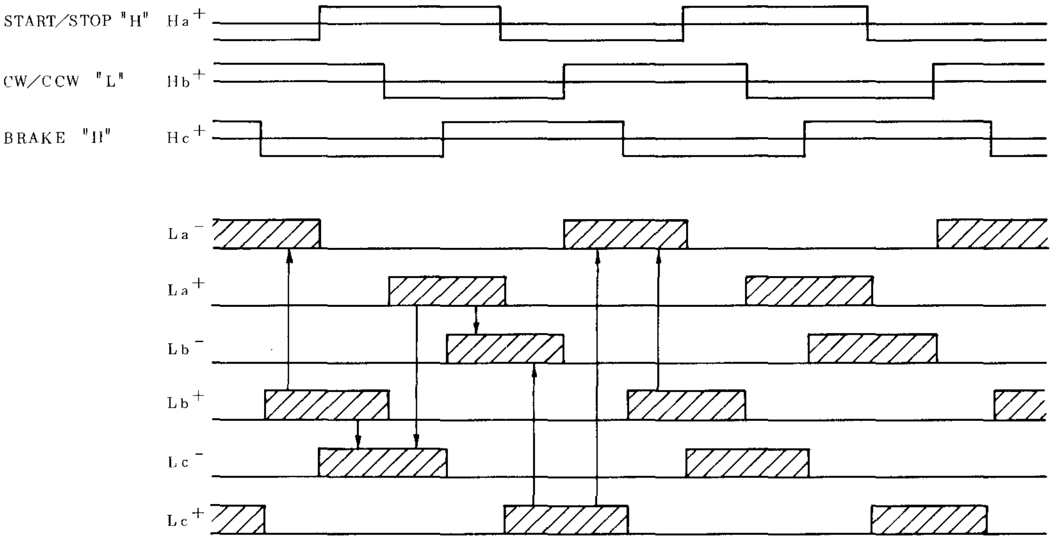
CONTROLLER PART OPERATION

1. TIMING CHART

FORWARD ROTATION (Position sensing signal advances Ha→Hb→Hc.)



REVERSE ROTATION (Position sensing signal advances Ha→Hc→Hb.)



2. APPLICATION OF CONTROLLER PART

Like a video disk player, TA8443P is provided with the stopping function which in a short time, stops the motor having a large inertia, and maked the quick disk-change possible. To make the frequency generator (FG) unnecessary which was formerly required for fetching the rotation signal, the signal from the position sensing input is ORed and is output to FG output pin (44 pin). Therefore, for FG output, three position sensing outputs (Ha, Hb, Hc) are ORed, and the rotation speed signal of the frequency of six times that of one output can be fetched resulting in making it possible to obtain a sufficient controlling characteristic with the F/V (Frequency-Voltage) conversion method of mono-stable type.

(1) Operation of FG Output (44 pin) and T_{FG} (45 pin)

In Fig. 1, Q1 and Q3 are the mono-stable mulit-vibrator to which gate (Q2 base) the signal from each position sensing input of Ha, Hb and Hc is input after ORed and shaped in waveform by FE. The pulse width of MMV made by Q1 and Q2 is determined by R2 and C2 to be connected to TFG (45 pin), and the square wave having the pulse width to be determined by C2 and R2 is output.

Of course, this frequency is proportional to the rotation signal and this frequency is six times the frequency of each position sensing. (6 per 1 electrical rotation) F/V conversion operation is made through connecting FGO output to LPF for integration. However, if R2 is made variable, the conversion gain can be controlled.

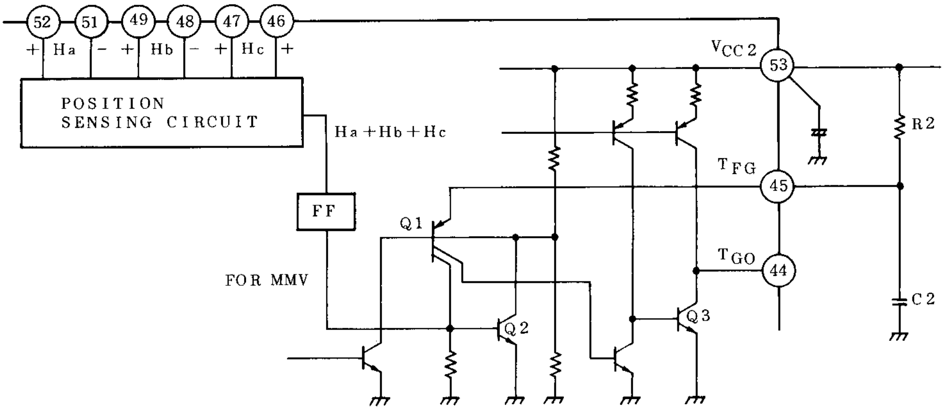


Fig. 1

(2) Each Control Input

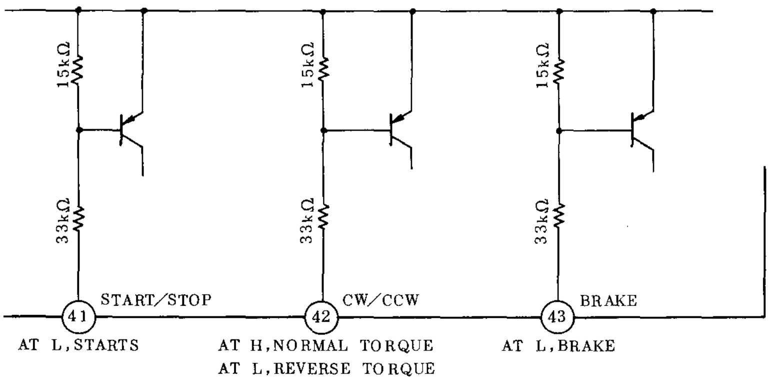


Fig. 2

START/STOP	CW/CCW	BRAKE	OUTPUT
H	H	H	Normal torque mode
H	L	H	Reverse torque mode
H	H/L	L	BRAKE mode
L	H/L	H/L	STOP mode

Note: In STOP mode, (38) , (39) , (54) , (55) , (56) and (57) pins of output are all made OFF. In BRAKE mode, (39) , (55) and (57) pins of output are made ON. (sweep-out mode)

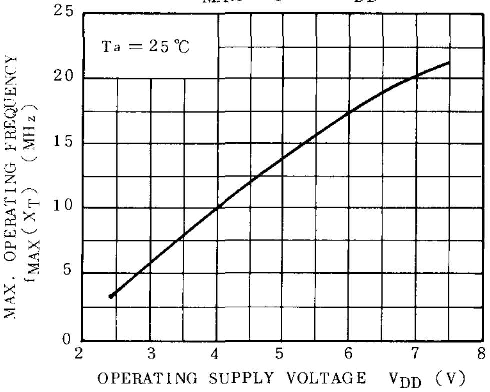
(3) Output Circuit

As shown in the block diagram, in the output circuit, the Darlington emitters of PNP and NPN are provided on the upper side, and the lower side is made as the open collector or NPN.

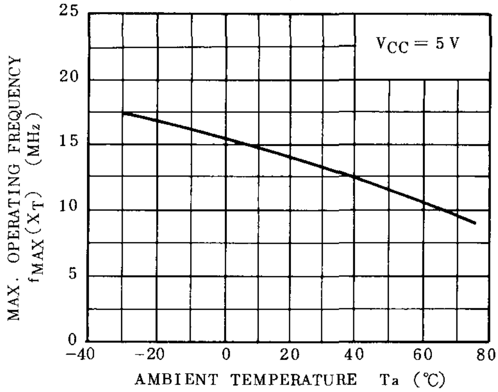
Connect the external transistor in the same manner as that of the application circuit.

CHARACTERISTIC DATA OF PLL PART

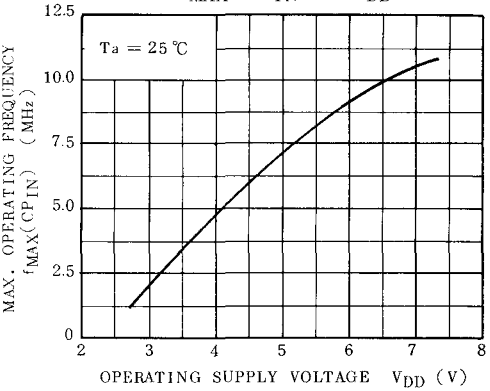
$f_{MAX}(X_T) - V_{DD}$



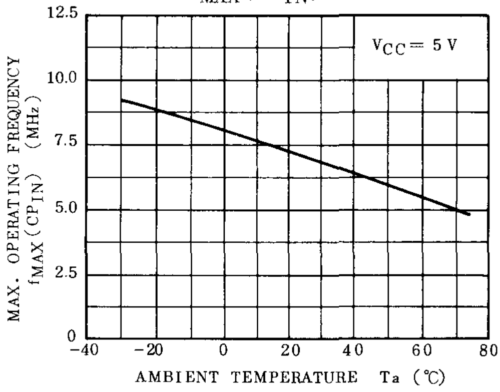
$f_{MAX}(X_T) - Ta$



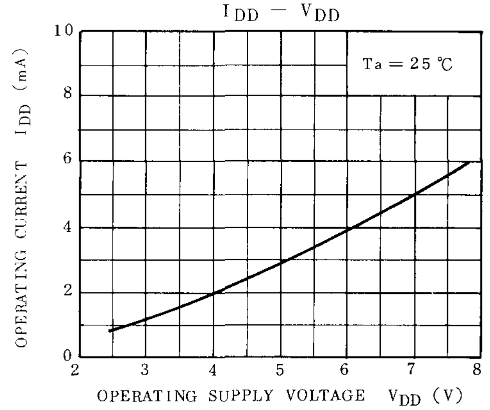
$f_{MAX}(CP_{IN}) - V_{DD}$



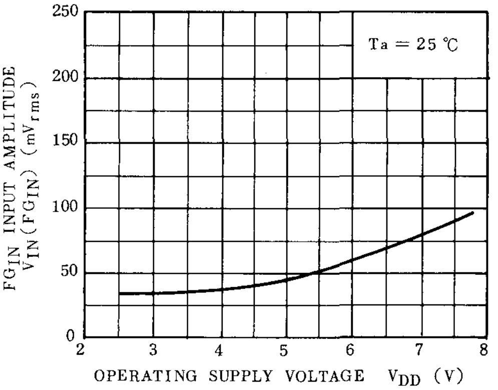
$f_{MAX}(CP_{IN}) - Ta$



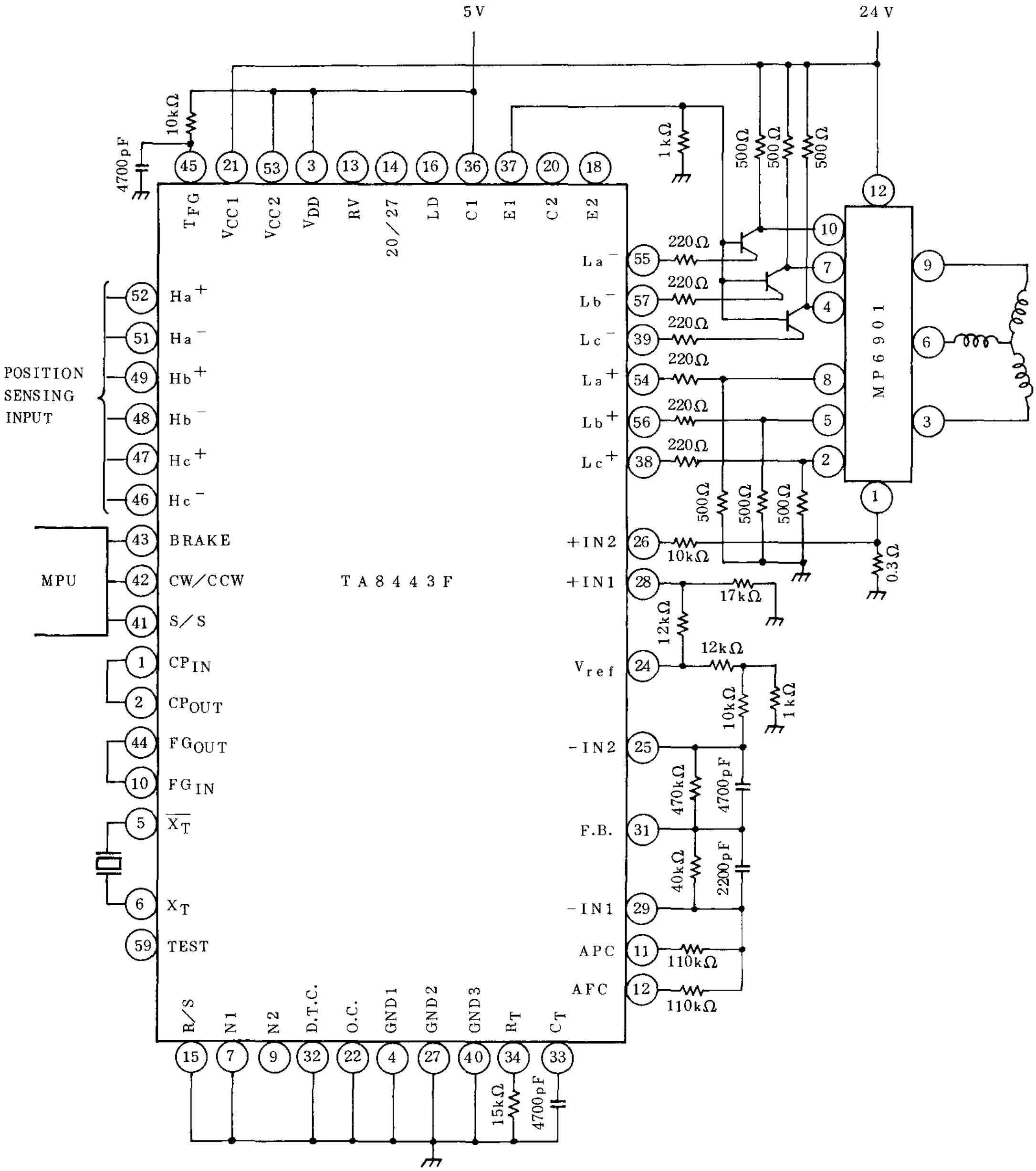
$I_{DD} - V_{DD}$



$V_{IN}(FG_{IN}) - V_{DD}$



APPLICATION CIRCUIT

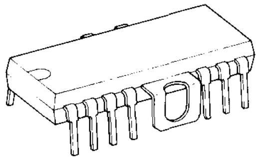


TA8449P

TENTATIVE DATA

QUAD POWER OF. AMP

TA8449P is 0.6A (peak) output current Quad type Power Operational Amplifier, and designed for CD player by 1 chip (Focusing Tracking Actuator, Carrriage and Spindle Motor).
This IC is suitable for large current driver circuit, such as, Motor, Actuator and general purpose Power Operational Amplifier.



HDIP14-P-500A

Weight : 3.0g(Typ.)

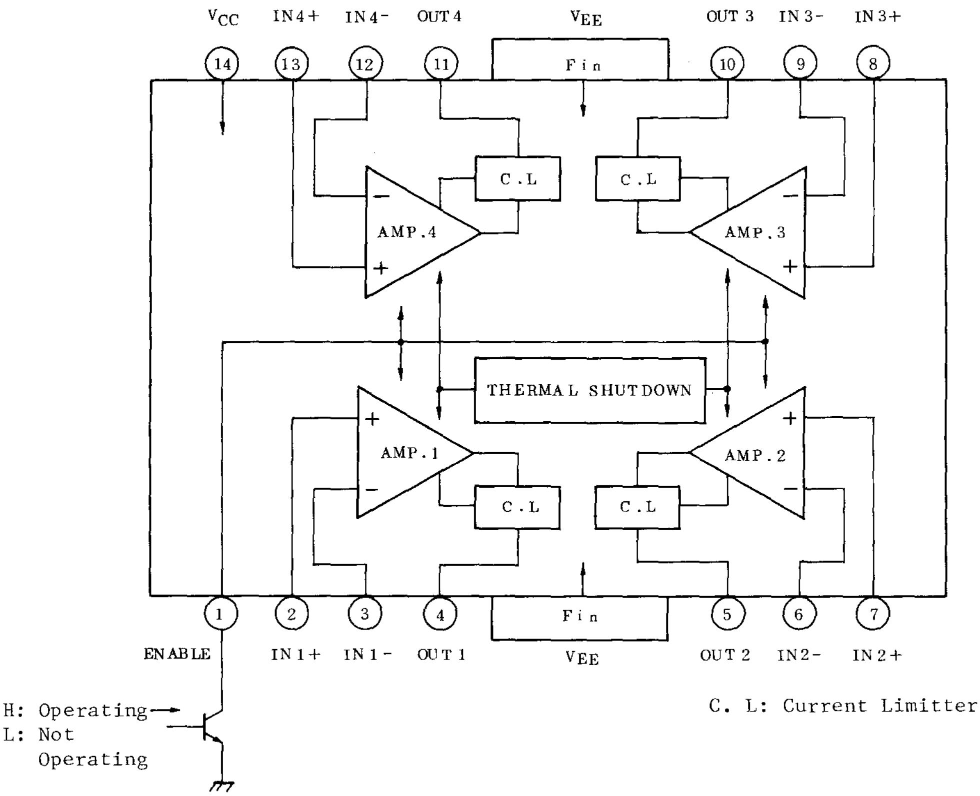
. High Output Current : I_O(MAX)=0.6A/ch
  I_O(AVE)=0.4A/ch
. Built-in Current Limitter : 1.0A(Typ.)
. Built-in Output Enable : GND or V_{EE} : Enable
  : Open or V_{CC}: Disenable
. Thermal Shut Down Circuit

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{CC}	±15	V
	V_{EE}		
Output Current	I_O(peak)	0.6*	V
	I_O(AVE)	0.4	
Power Dissipation	P_D	2.3	W
Operating Temperature	Topr	-30~85	°C
Storage Temperature	Tstg	-55~150	°C

* Single pulse 100ms.

BLOCK DIAGRAM

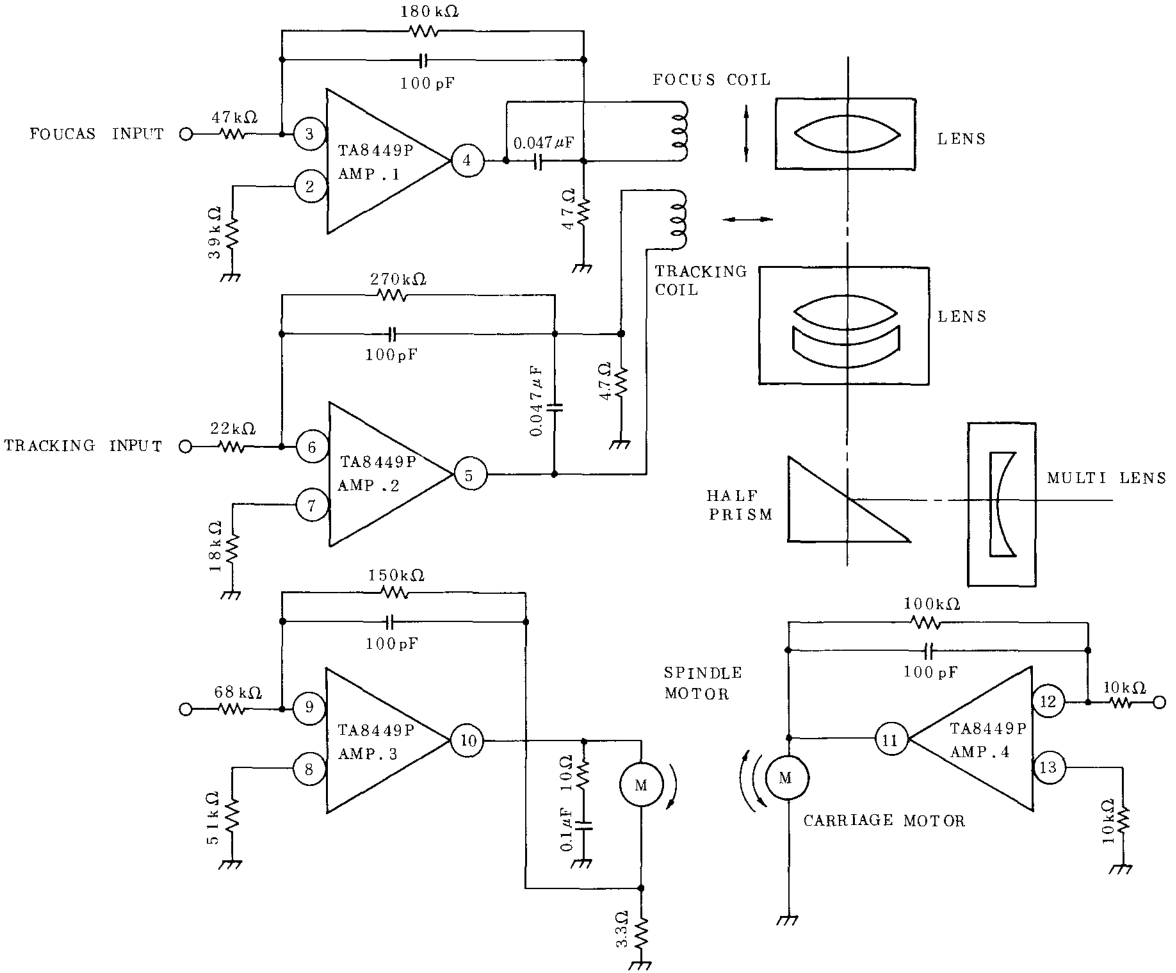


ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, Ta=25°C, V_{CC}=15V, V_{EE}=-15V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Power Supply Voltage		I_{CC1}	-		-	16	35	mA
		I_{CC2}	-	at Disenable	-	0	20	μA
Input Offset Current		I_{IO}	-		-	-	100	nA
Input Bias Current		I_I	-		-	-	300	nA
Input Offset Voltage		V_{IO}	-		-	-	6	mV
Output Maximum Amplitude	Upper	V_{OH}	-	I_O=0.1A	12.0	13.3	-	V
	Lower	V_{OL}			-	-13.5	-12.0	V
	Upper	V_{OH}	-	I_O=0.4A	12.0	13	-	V
	Lower	V_{OL}			-	-13	-12.0	V
Open Loop Gain		G_{VO}	-		-	100	-	dB
Sync. Input Voltage Range		CMR	-		-	±14	-	V
Sync. Voltage		CMRR	-		-	80	-	dB
Supply Voltage		SVRR	-		-	90	-	dB
Band Width		f_T	-		-	1.0	-	MHz
Through Rate		SL	-		-	0.9	-	V/μs
Limiting Current		I_{SC}	-	Tj=25°C	-	1.0	-	A
Crosstalk		CT	-		-	60	-	dB
Enable Operating Current		I_{EN}	-	1 pin=0V	-	1	2	mA
Thermal Shut Down Operating Operating Temperature		T_{SD}	-	T_{SD} ON	150	175	190	°C

APPLICATION CIRCUIT (Actuator for CD Player)



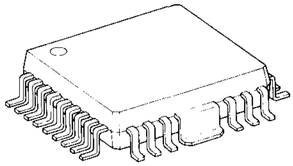
TA8453AF

3 PHASE HALL MOTOR DRIVER WITH PLL CONTROLLER

The TA8453AF is a multi-chip IC with PLL controller and TA7259P.

This is suitable for Polygon Mirror Drive for LBP, and FAX etc.

- 8 bit D/A converter system has been employed for each of the speed control system (AFC) and the phase control system (APC), and realize a free adjustment motor control system.
- Output Current : I_O=1.2A (MAX.)
- Forward rotation, reverse rotation, and stop are controlled by 1 terminal signal control.
- Crystal can be used up to 8MHz, and crystal reference dividing frequency selected from three position 1/5, 1/6 and 1/12.
- Lock range selected from two position of about 3.6% and about 5.0%.
- Operating Supply Voltage : V_{CC}=7~27V



HQFP30-P-1010

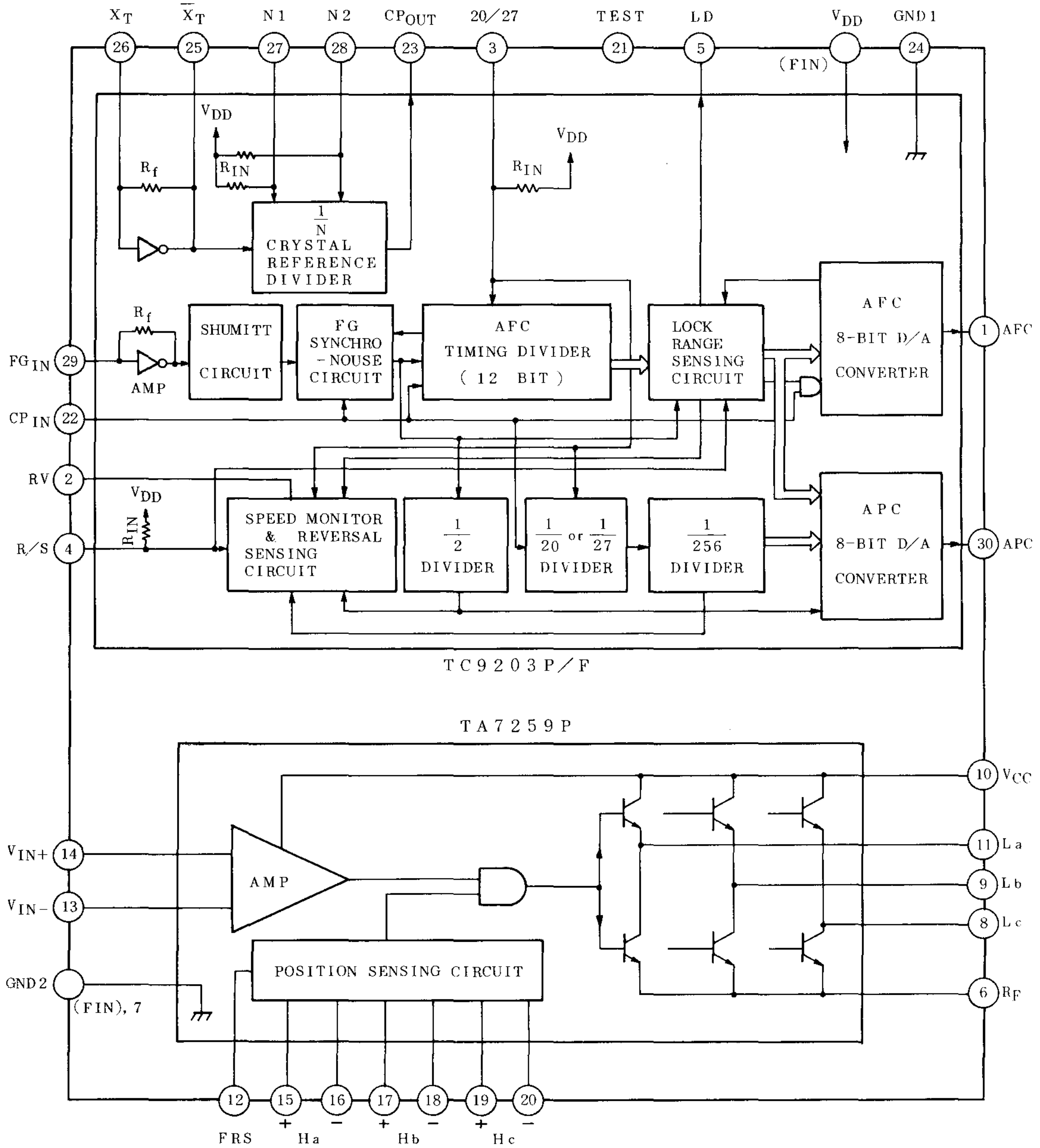
Weight : 0.61g(Typ.)

MAXIMUM RATINGS (Ta=25°C)

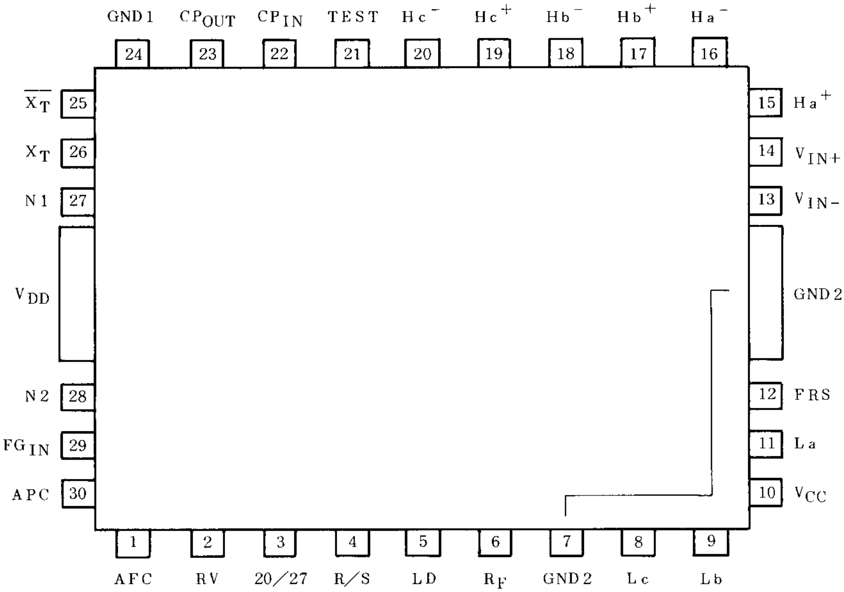
BLOCK	CHARACTERISTIC	SYMBOL	RATING	UNIT
PLL Port (TC9203)	Supply Voltage	V_{DD}	-0.3~7.0	V
	Input Voltage	V_{IN}	-0.3~V_{DD}+0.3	V
Driver Port (TA7259P)	Supply Voltage	V_{CC}	30	V
	Output Current	I_O	1.2	A
TA8453AF	Power Dissipation	P_D	1.0 (Note)	W
	Operating Temperature	T_{opr}	-30~75	°C
	Storage Temperature	T_{stg}	-55~125	°C

(Note) No Heat Sink.

BLOCK DIAGRAM



PIN CONNECTION



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PLL PART

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{DD}=5V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		V_{DD}	-		*	4.5	5.0	5.5	V
Operating Supply Current		I_{DD}	1	X'tal=8MHz CP_{IN}=CP_{OUT}	*	-	5.0	12.0	mA
Operating Frequency Range	XT	XT	2		*	1.0	-	8.0	MHz
	CP_{IN}	f_{CP}	3	Square wave	*	0.05	-	4.0	MHz
	FG_{IN}	f_{FG}	-	V_{IN}=0.5Vp-p Sin wave	*	-	-	10	kHz
Input Operating Voltage	FG_{IN}	$V_{IN\ FG}$	4	f_{FG}=10kHz Sin wave	*	0.5	-	V_{DD}-0.5	Vp-p
AFC, APC D/A Converter	Ladder Resistor	R_L	6			30	50	75	kΩ
	Max. Deviation		-	V_{DD}=4.5~5.5V		-	±2.5	±6.5	LSB
	Resolution		-			-	V_{DD}/256	-	V
	Temperature Drift		-			-	±1	-	LSB
Pullup Resistor		R_{IN}	-	N1,N2,20/27,R/S	*	10	30	50	kΩ
Input Voltage	"H" Level	V_{IH}	-	N1,N2,20/27,R/S	*	V_{DD}X0.8	-	V_{DD}	V
	"L" Level	V_{IL}	-	CP_{IN}	*	0	-	V_{DD}X0.2	V
Input Leak Current		I_{IH}/I_{IL}	-	CP_{IN}	*	-	-	±1.0	μA
Output Current	"H" Level	I_{OH}	-	RV, LD	V_{OH}=4V	-0.5	-1.0	-	mA
	"L" Level	I_{OL}	-	CP_{OUT}	V_{OL}=1V	0.5	1.0	-	mA
Amplifier Feedback Resistor	XT	Rf	5			100	200	500	kΩ
	FG_{IN}					300	500	800	kΩ

* : Guaranted within the range of V_{DD}=4.5V~5.5V, Ta=-30~75°C.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=12V, Ta=25°C)

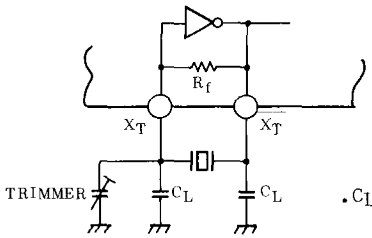
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		I_{CC1}	–	FRS Open	2	4	7	mA
		I_{CC2}		FRS=5V	2	5	9	
		I_{CC3}		V_{CC}=22V FRS=GND	2	5	9	
Input Offset Voltage		V_{IO}	–		–	40	–	mV
Residual Output Voltage		V_{OR}	–	$V_{IN-}=V_{IN+}$=7V	–	0	10	mV
Voltage Gain		G_V	–		–	15.0	–	Times
Saturation Voltage	Upper	V_{SAT1}	–	I_L=400mA	–	1.0	1.5	V
	Lower	V_{SAT2}			–	0.4	1.0	
Cut-off Current	Upper	I_{OC1}	–	V_{CC}=20V	–	–	20	μA
	Lower	I_{OC2}			–	–	20	
Position Sensing Input Sensitivity		V_H	–		–	10	–	mV
Maximum Position Sensing Input Voltage		$V_{H\ MAX}$	–		–	–	400	mV
Input Operating Voltage	Position	CMR-H	–		2.0	–	V_{CC}-2.5	V
	Control	CMR-C	–		2.0	–	V_{CC}-2.5	
Rotation Control Input Voltage	CW	V_F	–		–	0	0.4	V
	STOP	V_S	–		2.5	3.0	3.5	
	CCW	V_R	–		2.5	5.0	5.8	

PLL PART

OPERATION

1. Crystal oscillation terminals (X_T, $\overline{X_T}$)

   . The crystal oscillator is used by connecting as shown below.



.C_L of 10~30pF is appropreate.

Crystal oscillation frequency is calculated by the following equation according to number of FG pulses of a motor to be used.

$$f_X + \frac{R}{60} \quad FG' \times 128 \times (20 \text{ or } 27) \times N \quad (Hz)$$

(Note) (20 or 27) : 20 at 20/27="H" or Open.
27 at 20/27="L".

f_X: Crystal oscillation frequency, FG': number of FG pulse generated per revolution of motor, R: revolution of motor per minute.
N : Ratio of frequency division of the crystal reference frequency divider。
(Refer to Item 9.)

. Maximum operating frequency is above 8MHz and crystals up to 8MHz can be used.

2. Reference frequency input/output terminals (CP_{IN}, CP_{OUT})

   . Divided output $\frac{f_X}{N}$ from the crystal referecne frequency divider is available at CP_{OUT}, which is normally connected CP_{IN}.

   . When an external oscillator (CR oscillator, etc.) is connected to CP_{IN}, motor speed can be finally adjusted.

3. FG pulse input terminal (FG_{IN})

. This is the input terminal of FG pulse that shows the motor speed.
This FG pulse becomes comparision frequency.

. This terminal has built-in Amplifier and Schmitt circuit.
FG pulses are applied through capacitor coupling and small amplitude is enough for proper operation.

4. Lock range switching terminal (20/27)

. This terminal is for switching rock range of motor, with a pull-up resistor and chattering preventive circuit.

(TRUTH TABLE)

20/27	DIVIDED FREQUENCY	LOCK RANGE
L	1/27	+3.4~-3.9% of reference cycle
H or NC	1/20	+4.6~-5.3% of reference cycle

5. APC, AFC output terminal (APC, AFC)

. AFC (speed control output) is a F-V converter for FG frequency, and is consisting of a 8 bit D/A converter.

. APC (phase control output) is a phase comparator (ϕ-V converter) that c-mpares phase difference ϕ between 1/2 FG and reference frequency FS', and is also consisting of a 8 bit D/A converter.

. Both APC and AFC perform the following 3 operations according to FG_{IN} frequency.

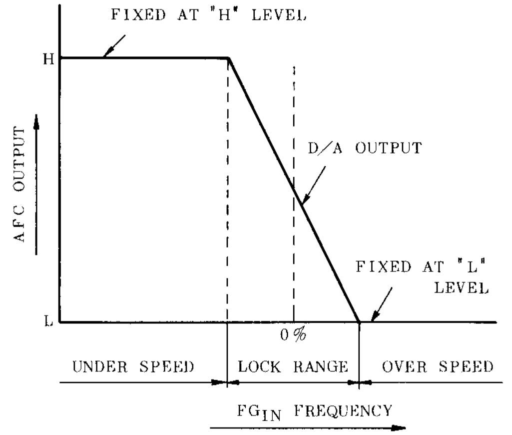
a. When FG_{IN} frequency is within the lock range:
Both APC and AFC perform the normal operation for FG_{IN}.

b. When FG_{IN} frequency is below the lock range (under speed):
APC and AFC outputs are both fixed at "H" level.

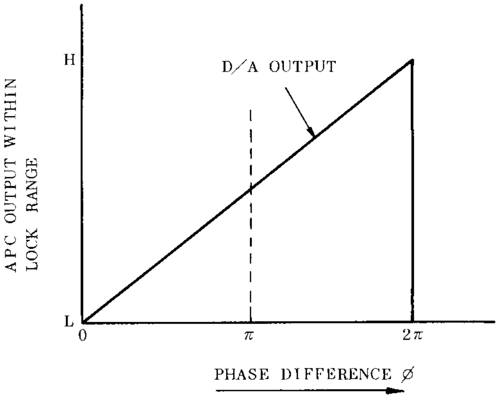
c. When FG_{IN} frequency is above the lock range (over speed):
APC and AFC outputs are both fixed at "L" level.

. When a motor is in STOP state (P/S=H or NC), both AFC and APC are fixed "L" level.

AFC Output change status for FG_{IN} frequency

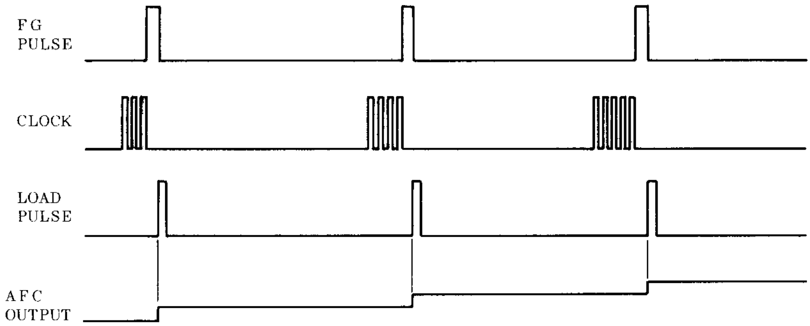


APC Output change status for phase difference ϕ.

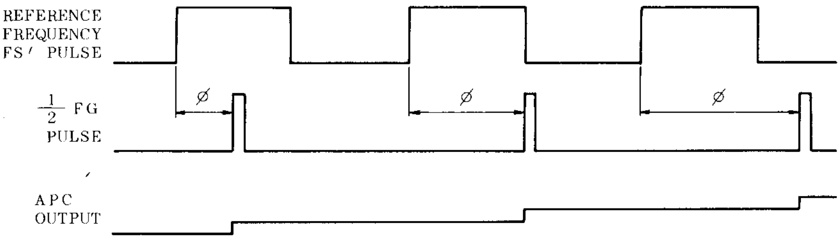


. AFC and APC timing chart within lock range.

a. AFC (SPEED CONTROL SYSTEM)



b. APC (PHASE CONTROL SYSTEM)



6. Lock detecting terminal (LD)

- This terminal is the lock detecting output and is placed at "H" level when FG_{IN} frequency is within the lock range and otherwise, placed at "L" level.

7. RUN/STOP input terminal (R/S)

- RUN/STOP signals of the motor are input to this terminal.
- This terminal has a pull-up resistor and a chattering proventive circuit.
- During RUN (R/S=L), AFC, APC and LD perform the above-mentioned operations for FG_{IN} frequency, and during STOP (R/S=H or NC), AFC, APC and LD are all fixed at "L" level.

8. Reverse signal output terminal (RV)

- At the switching of lock range from 1/20 to 1/27 or the operating from RUN to STOP, reverse signal for braking the motor is output through this terminal.
- Change of RV output status

PREVIOUS STATUS ⇨	RV OUTPUT CHANGE TO "H" LEVEL ⇨	RV OUTPUT CHANGE TO "L" LEVEL
During normal rotation (during lock) at 1/20.	When the lock range is switched from 1/20 to 1/27.	When the motor speed is locked at 1/27, or when FG_{IN} 1/8FS, or when the lock range is switched from 1/27 to 1/20.
During normal rotation (during lock) at 1/20 or 1/27.	When the operation is switched from RUN to STOP.	When FG_{IN} 1/8FS or when the operation is switched from STOP to RUN.

- In other cases than above, RV output is not changed and fixed at "L" level.
- Further, if FG frequency rises up to 1.5 times of normal rotation at 1/20 (2 times of normal rotation at 1/27), RV output is reset.

9. Reference divided frequency switching terminal (N1, N2)

- Divided frequency 1/N of the crystal reference frequency divider can be switched to 1/5, 1/6 or 1/12 by number of FG pulses or a crystal used.
- This terminal has a built-in pull-up resistor.

(TRUTH TABLE)

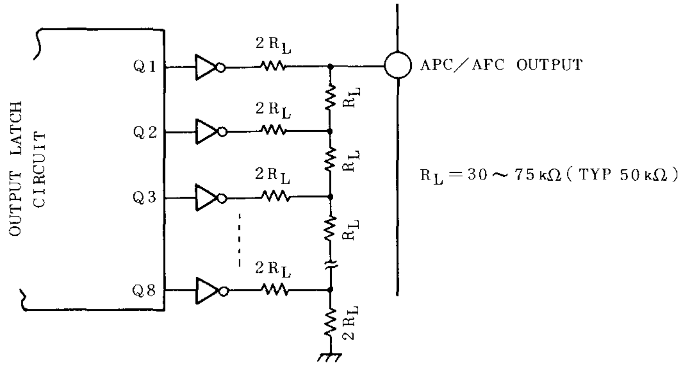
N1	N2	1/N
H	H	1/5
L	H	1/6
H	L	1/12

1/N: CRISTAL REFERENCE DIVIDED FREQUENCY

(Note) Don't use mode, N1=N2="L", because this mode is test mode.

CAUTION IN APPLICATION

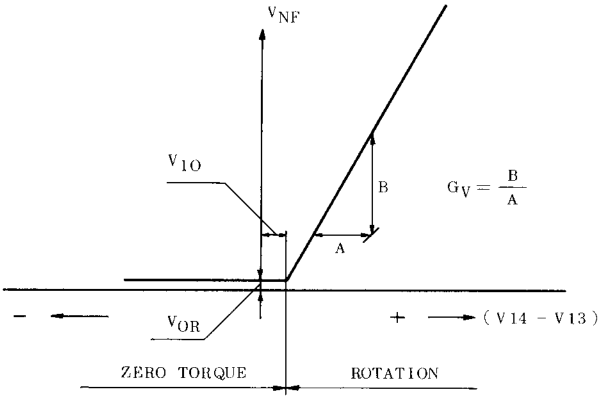
- APC and AFC terminals are for the 8-bit D/A converter outputs, which are directly output from the R-2R ladder type resistor network as shown in the following diagram. Impedance of these outputs becomes equal to the ladder resistor value R_L. Therefore, input impedance at the receiving side of these terminals shall be designed accordingly.



- A filter for an externally mounted differential amplifier on an application circuit shall be selected to meet the response characteristic of a motor to be used.

DRIVER PART

INPUT/OUTPUT CHARACTERISTICS

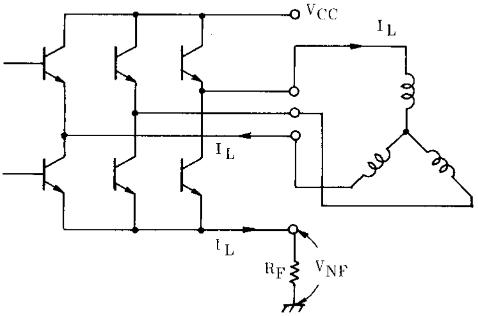


V_{NF} shows voltage drop at R_F.

That is, in the case of star connection, when coil current is I_L'

$V_{NF}=R_F \cdot I_L$

See the following circuit.



Further, if inputs (13 pin, 14 pin) are shorted or V13≧V14, torque at the circuit becomes zero. However, this zero torque state also can be obtained by setting FRS input (12 pin) to specified voltage or by placing the circuit in open state and this is rather advantageous as current consumption is less.

FUNCTION

FRS(CW/CCW/STOP) INPUT	POSITION SENSING INPUT			OUTPUT		
	Ha	Hb	Hc	La	Lb	Lc
L	1	0	1	H	L	M
	1	0	0	H	M	L
	1	1	0	M	H	L
	0	1	0	L	H	M
	0	1	1	L	M	H
	0	0	1	M	L	H
H	1	0	1	L	H	M
	1	0	0	L	M	H
	1	1	0	M	L	H
	0	1	0	H	L	M
	0	1	1	H	M	L
	0	0	1	M	H	L
M	1	0	1	High Impedance		
	1	0	0			
	1	1	0			
	0	1	0			
	0	1	1			
	0	0	1			

Note: "1" of the hole element input means that voltage above +10mV is applied to the positive side of each hall element from the negative side and "0" means that voltage above +10mV is applied to the negative side from the positive side.
In this case, needless to say, DC potential must be within the specified common mode voltage range of hall element input.
Further, "H", "M" and "L" of output mean $V_{CC}-V_{SAT1}$=1/2 V_{CC} and V_{SAT2}, respectively, and "L", "H" and "M" of FRS input mean application of voltage within specified values of V_F, V_R and V_S, respectively.
Further, by applying required voltage for control input ($V_{IN}+$, V_{IN}^-), measure the circuit in operating state.

CONTROL SIGNAL INPUT METHOD

Normally, control voltage which is proportional to (or inversely proportional to) rotation speed (F/V converter etc.) is fed into the front stage of the TA7259P differentially or single polarity. The gain from control input of the TA7259P to output (at R_F terminal) is 5.5 times as indicated in the specification. It is however possible to improve characteristic of W/F, etc. by reducing the gain with NF applied.

It's application example is shown in the diagram below. Further, when NF is applied (Also, when not applied), it is necessary that DC voltages (V13, V14) of control inputs (13 pin, 14 pin) are within the range of values (2.0~V_{CC}-2.5V) shown in the standard.

In addition, when input DC level and F/V converted output (control output) cannot be matched with IC input, a DC level shift diode and attenuator should be inserted in front of IC input. An example is shown in Fig. 1-c.

a) IN CASE OF POSITIVE INPUT

$(N \propto \frac{1}{V_{cont}})$

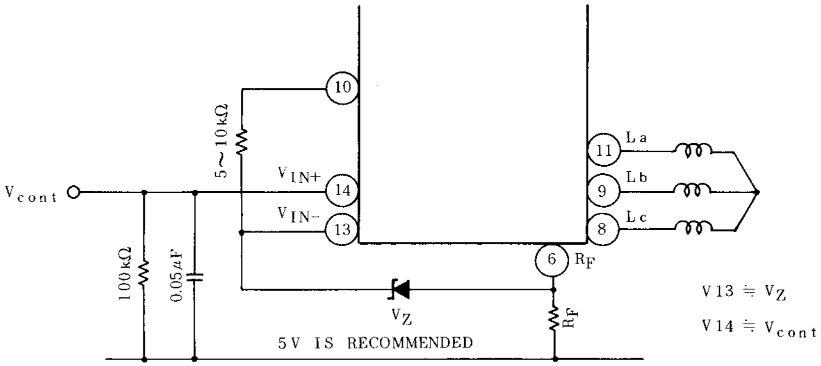
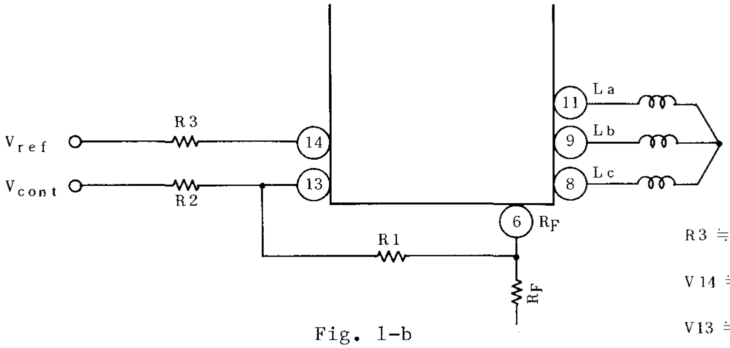


Fig. 1-a

b) IN CASE OF NEGATIVE INPUT

($N \propto V_{cont}$)

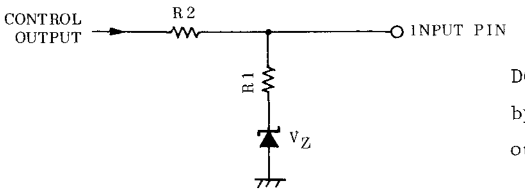


$R3 \fallingdotseq \frac{R1\ R2}{R1 + R2}$

$V14 \fallingdotseq V_{ref}$

$V13 \fallingdotseq V_{cont} \cdot \frac{R1}{R1 + R2}$

Fig. 1-b



DC level of control output is shifted by a zener diode and control signal output is attenuated by R1 and R2.

Fig. 1-c

CAUTIONS IN APPLICATION

IC for motor drive have several high impedance input terminals such as hall element input, control signal input, etc. and to handle a switched high output current. Because of such a reason. Care should be taken not to make a parasitic oscillation path caused by unnecessary feedback.
Further, as load is a coil, it is necessary to pay attention to prevent destruction by impulse at time of ON/OFF, particularly, application of voltage and current in excess of standard values to the output transistor when supply voltage is at high level (V_{CC}=18V or above). It is recommended to use the TA7259P at supply voltage below 18V. If it is used supply voltage above this value, the above-mentioned cautions should be followed.

(1) CAUTIONS FOR RELIABILITY DESIGN

a) Do not into the output transistor inside IC into the high voltage and current operating region.
(Especially, when a motor is locked, V_{CC} is ON/OFF, output is shorted, etc.)

b) It is desirable to design the output ringing absorbing capacitor in capacitance as small as possible (the output transistor may be destructed by charging/ dis-charging current of this capacitor in some cases).
If it becomes a problem, it is recommended to review not only capacitance but also connecting point and connecting method (delta or star connection) in addition to taken an oscillation previenting measure described later further-more, to insert resistor (3Ω to 30Ω) in series to the capacitor.

c) In installing to a printed circuit board, be careful not to apply an abnormal force to the fin of IC and moreover, to solder in several seconds (at 260°C).

d) It is an effective method for assuring reliability to provide a large earthing area on a printed circuit board to promote heat-eadiation from the soldered fin of IC.

(2) CAUTIONS FOR WIRING

It is recommend to design a print pattern with the following methods taken into consideration in order to prevent parasitic oscillation.

a) The output coil current path line should be provided separately from other earth one because the coil current includes switched high current.
In particular, it is recommended to design a line from R_F terminal (6 pin) to the earth so that it's impedance does not become common to other circuits.
(This is especially important.)
If this is not possible or oscillation cannot be eliminated completely, it is adviced to connect a capacitor of 0.001~0.1μF paralelly with R_F.

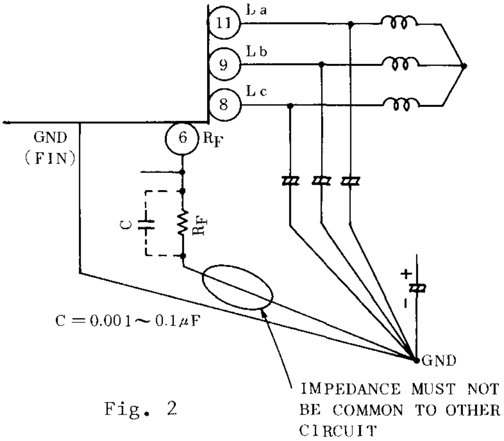


Fig. 2

b) It is also recommended to provide the hall element drive current path independently. (Especially, separately from the output current path)
Further, if plunging input to the position sensing element is expected, it is advised to insert a capacitor of 0.05~1μF between the plus (+) and minus (-) terminals of each position sensing input.
In addition, it should be also consider to insert resistors in series to all hall element inputs.
If plunging input to control input is expected, connect a capacitor of 0.001~0.1μF between control terminal and GND.

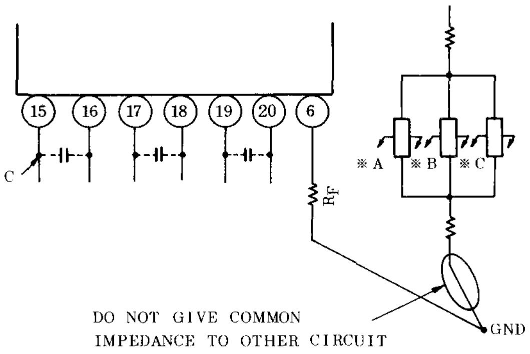


Fig. 3

c) If parasitic oscillation in a high frequency range above 5MHz is observed, commonly connect the capacitors from all coil outputs and connect a capacitor ($C=0.01\sim0.1\mu F$) to R_F terminal (6 pin) from this connecting point (Fig. 4-a). Further, it is also recommended to consider a method to connect capacitos to R_F terminal from respective coil outputs separately from the ringing absorbing capacitor (Fig. 4-b).

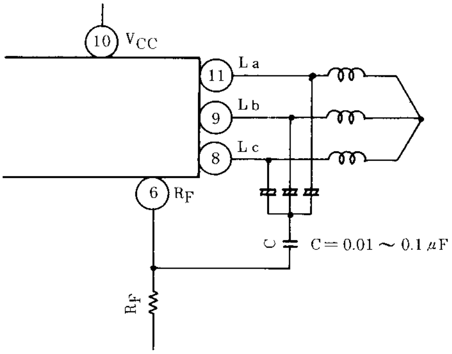


Fig. 4-a

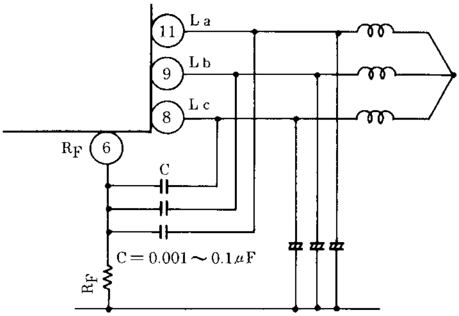


Fig. 4-b

d) It is recommended to connect a path capacitor directly from V_{CC} terminal (10 pin) without giving common impedance to GND. Further, it is also effective to insert C2 ($0.01\sim0.1\mu F$).

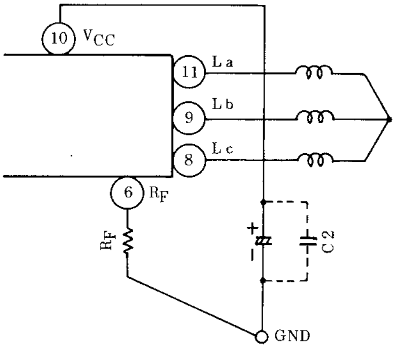


Fig. 5

(3) CONNECTION OF OUTPUT RINGING ABSORBING CAPACITOR

It is advised to connect the output ringing absorbing capacitor to GND from each coil terminal. In addition, it is also advised to consider the following methods from the viewpoint of parasitic oscillation prevention as well as destruction prevention.

a) Change of capacitance
b) Delta connection (Fig. 6-a)
c) Connection to V_{CC} instead of GND (Fig. 6-b). In this case, however, attention should be paid to destruction. If voltage/current locus is outside ASO, it is necessary to connect resistors in series with capacitors.
And propose to connection to R_F terminal.
d) Connect resistors in series with capacitor (Fig. 6-c).
e) Combination of a), b), c) and d).

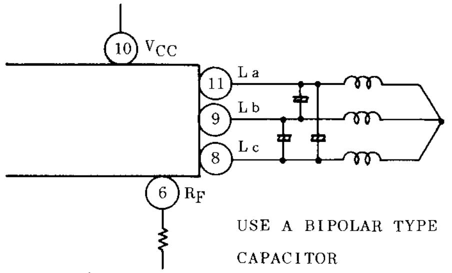


Fig. 6-a

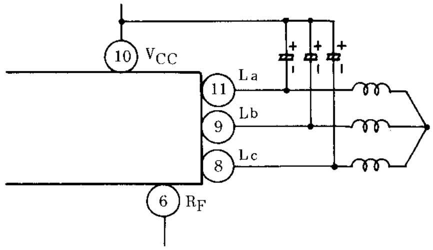


Fig. 6-b

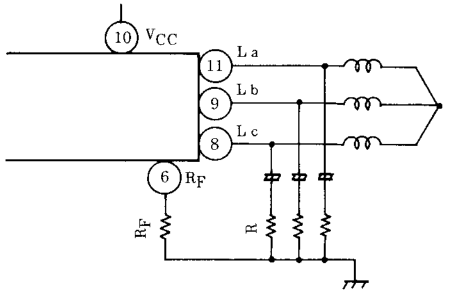
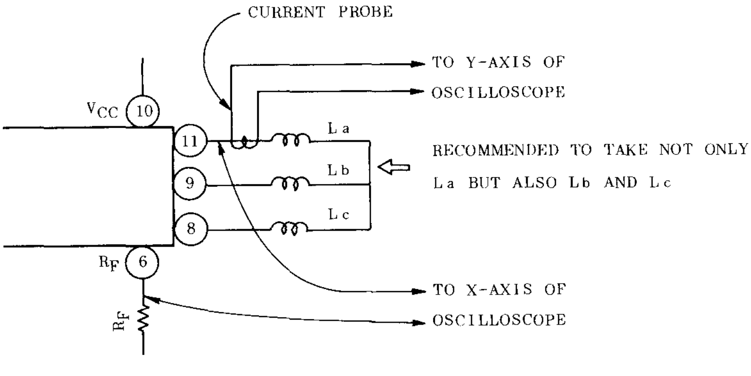


Fig. 6-c

OTHER CAUTIONS

Depending upon capacity and connecting method of the output capacitor, the output transistor inside IC may be destructed in some cases and it is therefore recommended obtain voltage/current locus of the output transistor through the measurement shown below and confirm that the locus is within ASO. (Especially, the measurement at time of SW ON/OFF, CW rotation→CCW rotation→CW rotation is important).



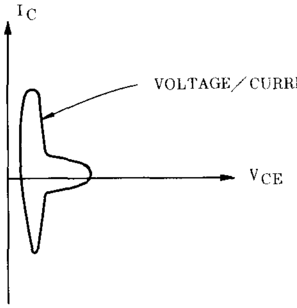
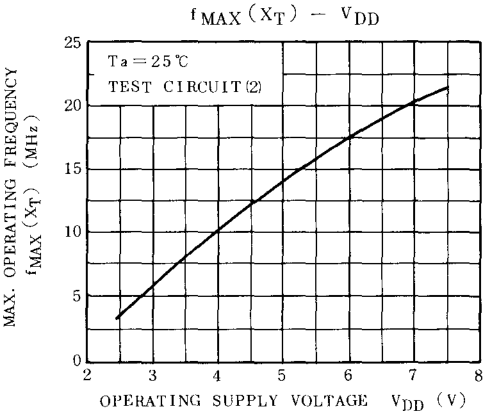
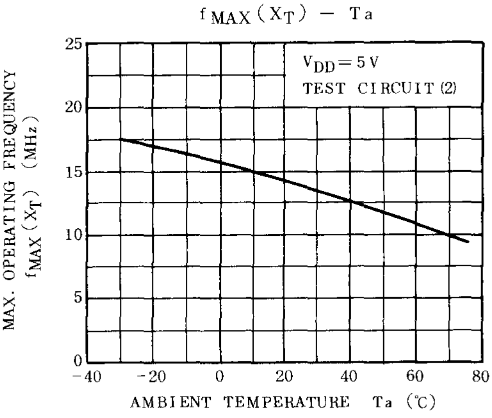
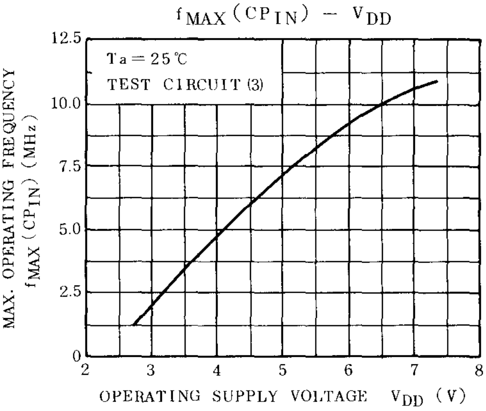


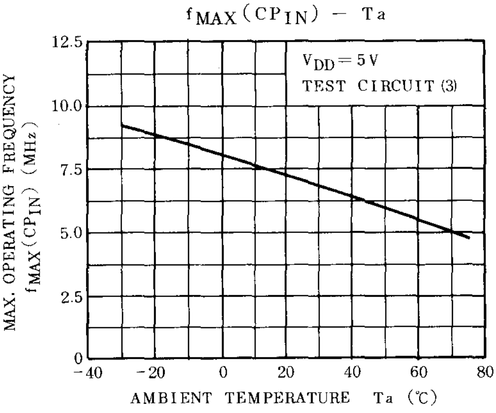
Fig. 7

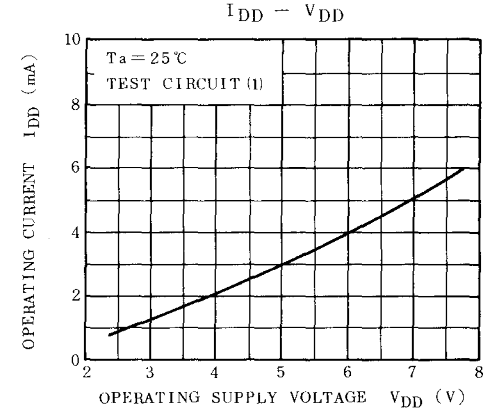
CHARACTERISTIC DATA

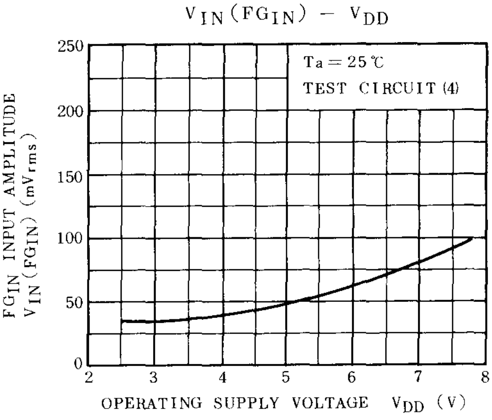




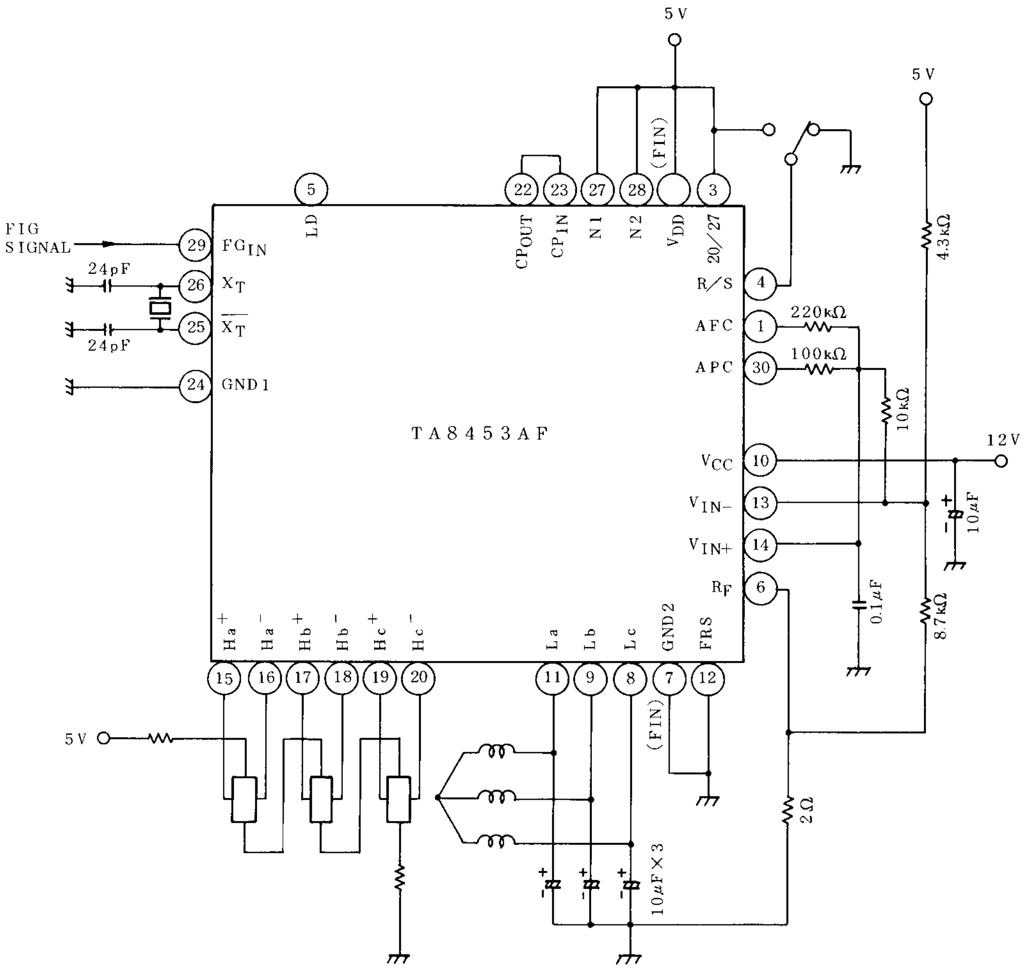








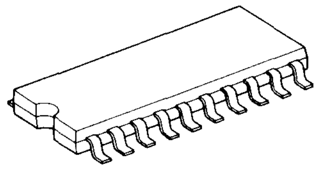
APPLICATION CIRCUIT



TA8459F

SMART MOS DUAL H DRIVER IC

The TA8459F is a dual H driver IC developed for driving various motors and actuators of portable CD players and cameras.



SOP20-P-300A

Weight : 0.48g(Typ.)

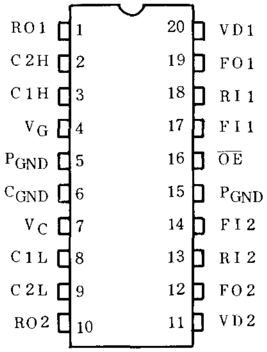
- Direct interface with MPU is possible.
- Connectable directly to the TC9220F, the servo processor for CD player.
- The power stage is dual type with high output current.
  I_O (Average) = 300mA
  I_O (Peak) = 500mA
- Low output on resistance.
  R_{ON} (Standard) = 1.0Ω (I_O=200mA)
- Low current consumption.
- 2 channels are connectable in parallel with each other.
- Built-in charge pump circuit.
- Built-in output stage pass through current preventive circuit.
- High speed operation. ($f_{IN(Max)}$=100kHz)
- 20-pin mini-flat package, enabling compact design.

MAXIMUM RATINGS (Ta=25°C)

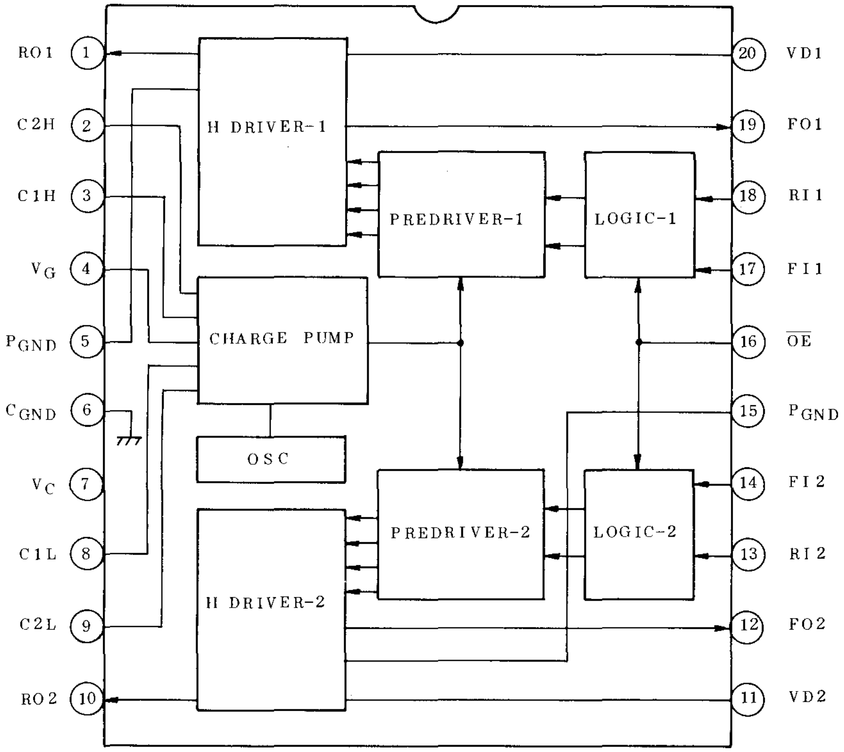
CHARACTERISTIC	SYMBOL	RATING	UNIT
Driver Unit Supply Voltage	V_D	-0.5~7.0	V
Control Unit Supply Voltage	V_{CC}	-0.5~6.0	V
Logic Input Voltage	V_{IN}	-0.5~V_{CC}+0.5	V
Driver Output Current	I_O (Average)	300	mA
	I_O (Peak)	500	
Power Dissipation	P_D	800	mW
Operating Temperature	T_{opr}	-30~75	°C
Storage Temperature	T_{stg}	-50~150	°C

PIN CONNECTION

(TOP VIEW)



BLOCK DIAGRAM



TRUTH TABLE

$\overline{OE}$	DRIVER INPUT		DRIVER OUTPUT	
	FI1/2	RI1/2	FO1/2	RO1/2
L	L	L	L	L
	L	H	L	H
	H	L	H	L
	H	H	HiZ	HiZ
H	–	–	HiZ	HiZ

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Driver Unit Supply Voltage	V_D	0~6.0	V
Control Unit Supply Voltage	V_{CC}	4.0~5.5	
Logic Input Voltage	V_{IN}	0~V_{CC}	V
Logic Input Frequency	f_{IN}	100	kHz
Capacitor for Charge Pump	C1~C3	0.01	μF

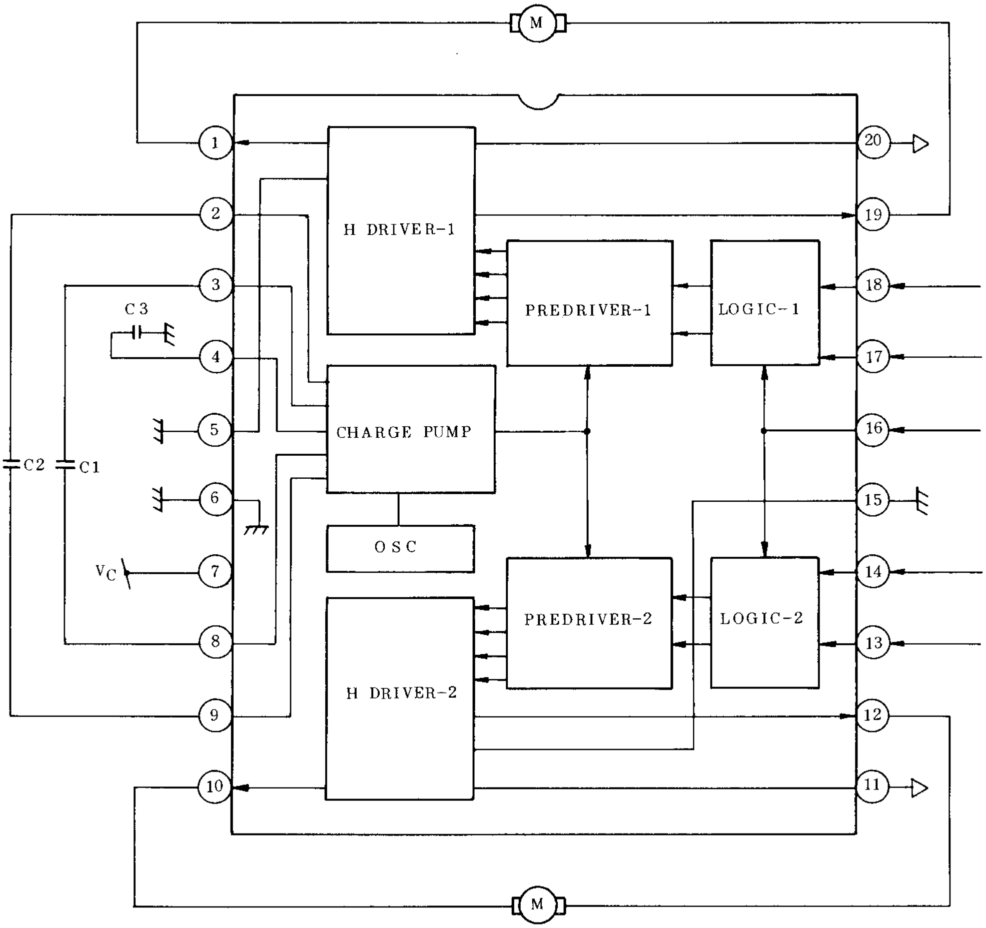
ELECTRICAL CHARACTERISTICS (V_D=V_{CC}=5V, Ta=25°C, unless otherwise specified)

CHARACTERISTIC			SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Driver Unit Supply Current at Not Signal			I_D	-	$\overline{OE}$=H (Fixed)		-	-	1.0	μA
Control Logic Unit supply Current			I_{CC}				-	-	2.0	mA
Predriver Unit Supply Current			I_G				-	-	500	μA
Control Logic Input	Input Voltage	"H" Level	V_{IH}	-	RI1/2, FI1/2, $\overline{OE}$ terminals		3.5	-	-	V
		"L" Level	V_{IL}				-	-	1.5	
	Input Current	"H" Level	I_{IH}	-	V_{IH}=5V	RI1/2, FI1/2 $\overline{OE}$ terminals	-	-	1.0	μA
		"L" Level	I_{IL}		V_{IL}=0V	RI1/2, FI1/2 terminals	-1.0	-	-	
	Pull-up Resistor		R_{UP}	-	$\overline{OE}$ terminals		-	50	-	kΩ
Driver Output Unit	Output ON Resistance		R_{ON}	-	I_O=200mA		-	1.0	1.2	Ω
	Output OFF Leak Current	"H" Level	I_{TLH}	-	V_{IH}=5V	FO1/2, RO1/2 terminals	-	-	1.0	μA
		"L" Level	I_{TLL}		V_{IL}=0V		-1.0	-	-	
	Propagation Delay Time at ON		t_{PON}	-			-	-	2.0	μs
	Propagation Delay Time at OFF		t_{POFF}				-	-	2.0	

FUNCTION OF EACH PIN

PIN No.	SYMBOL	I/O	FUNCTIONAL DESCRIPTION	REMARKS
1	RO1	O	H driver-1 reverse side output terminal.	
2	C2H	-	External capacitor for charge pump connecting terminal 2.	
9	C2L			
3	C1H	-	External capacitor for charge pump connecting terminal 1.	
8	C1L			
4	V_G	-	Charge pump gate voltage terminal.	
5	P_{GND}	-	Power ground terminal.	
6	C_{GND}	-	Control logic unit ground terminal.	
7	V_C	-	Control logic unit supply voltage terminal.	
10	RO2	O	H driver-2 reverse side output terminal.	
11	VD2	-	H driver-2 supply voltage terminal.	
12	FO2	O	H driver-2 forward side output terminal.	
13	RI2	I	H driver-2 reverse side input terminal.	
14	FI2	I	H driver-2 forward side input terminal.	
15	P_{GND}	-	Power ground terminal.	
16	$\overline{OE}$	I	H driver output enable setting terminal. Output is enabled at "L" level.	With a pull-up resistor.
17	FI1	I	H driver-1 forward side input terminal.	
18	RI1	I	H driver-1 reverse side input terminal.	
19	FO1	O	H driver-1 forward side output terminal.	
20	VD1	-	H driver-1 supply voltage terminal.	

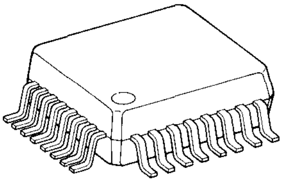
EXAMPLE OR APPLICATION CIRCUIT



TA8460F

DUAL H DRIVER IC WITH SMART MOS PWM Pre-DRIVER

The TA8460F is a dual H driver IC with PWM pre-driver developed for driving various kinds of motors and actuators in portable CD player, camera and FDD.



QFP32-P-0707

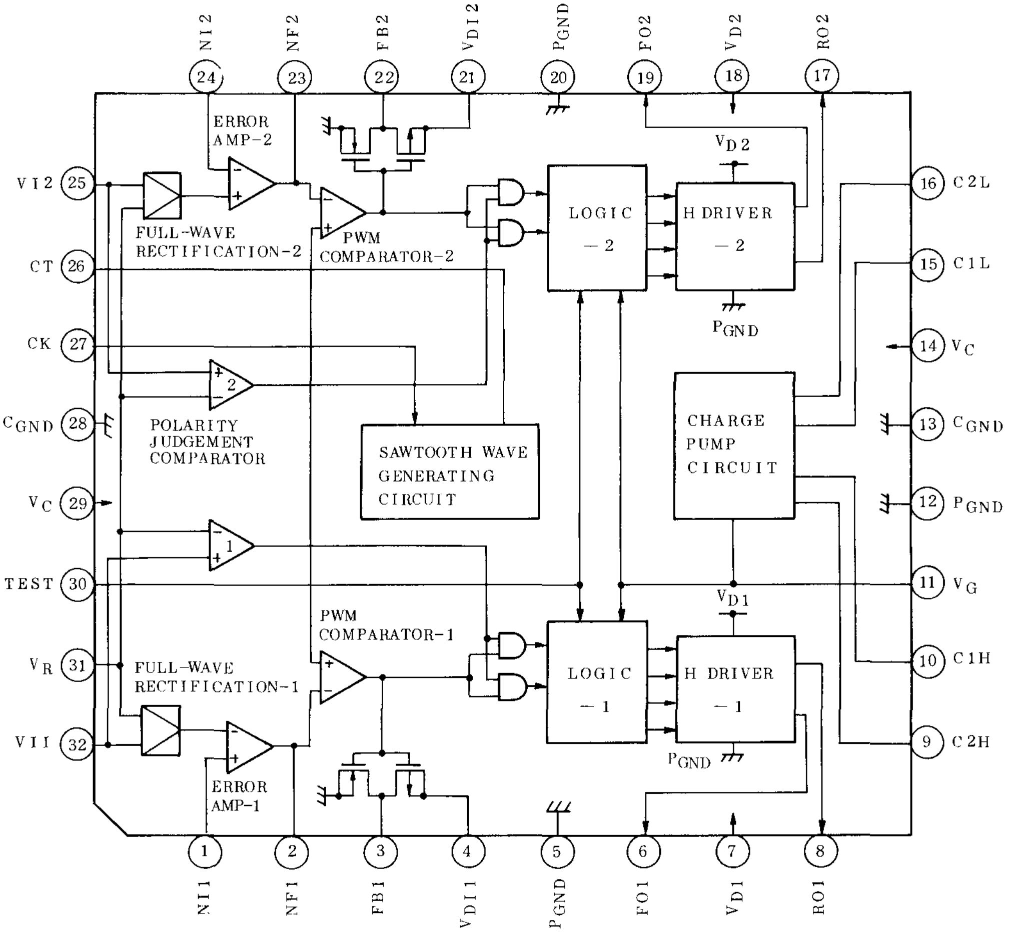
Weight : 0.172g (Typ.)

- Built-in PWM pre-driver.
  High efficiency and low current consumption.
- Built-in AGC circuit for improving driver efficiency.
- Dual output type with high output current.
  I_O (Average) = 300mA
  I_O (Peak) = 500mA
- Low output ON resistance.
  R_{ON}(Typ.)=1.0Ω (I_O=200mA)
- Built-in charge pump circuit.
- Output stage penetrating current preventive circuit.
- 32-pin mini flat package.
  Compact size design is enabled.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drive Unit Supply Voltage	V_D	-0.5~7.0	V
Control Unit Supply Voltage	V_{CC}	-0.5~6.0	V
Logic Input Voltage	V_{IN}	-0.5~V_{CC}+0.5	V
Driver Output Current	I_O(Average)	300	mA
	I_O(Peak)	500	
Power Dissipation	P_D	500	mW
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-50~150	°C

BLOCK DIAGRAM



RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Drive Unit Supply Voltage	V_D	0~6.0	V
Control Unit Supply Voltage	V_{CC}	4.0~5.5	V
Permissive Analog Input Voltage	V_{IA}	0~5.5	V
Reference Input Voltage	V_R	1.6~V_{CC}/2+0.2	V
Logic Input Voltage	V_{IN}	0~V_{CC}	V
Clock Input Frequency	f_{IN}	~100	kHz

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, $V_D = V_{CC} = 5V$, $Ta = 25°C$)

CHARACTERISTIC			SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Driver Unit Supply Current at No Signal			I_D	–	$V_{DI1}=V_{DI2}=V_R$		–	–	1.0	μA
Control Logic Unit Supply Current			I_{CC}				–	–	5.0	mA
Pre-driver Unit Supply Current			I_G				–	–	900	μA
Control Logic Input	Input voltage	H Level	V_{IH}	–	CK, terminal		3.5	–	–	V
		L Level	V_{IL}				–	–	1.5	
	Input current	H Level	I_{IH}	–	$V_{IH}=5V$	CK, terminal	–	–	1.0	μA
		L Level	I_{IL}		$V_{IL}=0V$	CK terminal	-1.0	–	–	
	Pull-up resistance		R_{UP}	–	TEST terminal		–	50	–	kΩ
Analog Input	Input resistance		R_I	–	VI1/2 terminals		35	50	65	kΩ
	Input current		I_R	–	V_R terminal		–	–	1.0	μA
Sawtooth Waveform Generating Circuit	Sawtooth wave amplitude		V_P	–	$C_T=1000pF$ $f_{IN}=88.2kHz$		0.8	1.2	1.6	Vp-p
	Sawtooth wave offset voltage		V_{OF}	–			1.8	2.0	2.3	V
Charge Pump Circuit	V_O output voltage		V_G	–			12	–	15	V
	Oscillation frequency		f_{OSC}	–			170	–	250	kHz
Input/Output	Input blind zone width		$\lvert V_{NS} \rvert$				0	–	30	mV
PWM Conversion Unit	Constant current	Supply side	I_{SUP}	–	C_T terminal		–	120	–	μA
		Sink side	I_{SIN}				–	-900	–	
Driver Output Unit	Output ON resistance		R_{ON}	–	$I_C=200mA$, $V_D=6V$		–	1.0	1.5	Ω
	Output off-leak current	H Level	I_{TLH}	–	$V_{IH}=5V$	F01/2, R01/2 terminals	–	–	1.0	μA
		L Level	I_{TLL}		$V_{IL}=0V$		-1.0	–	–	

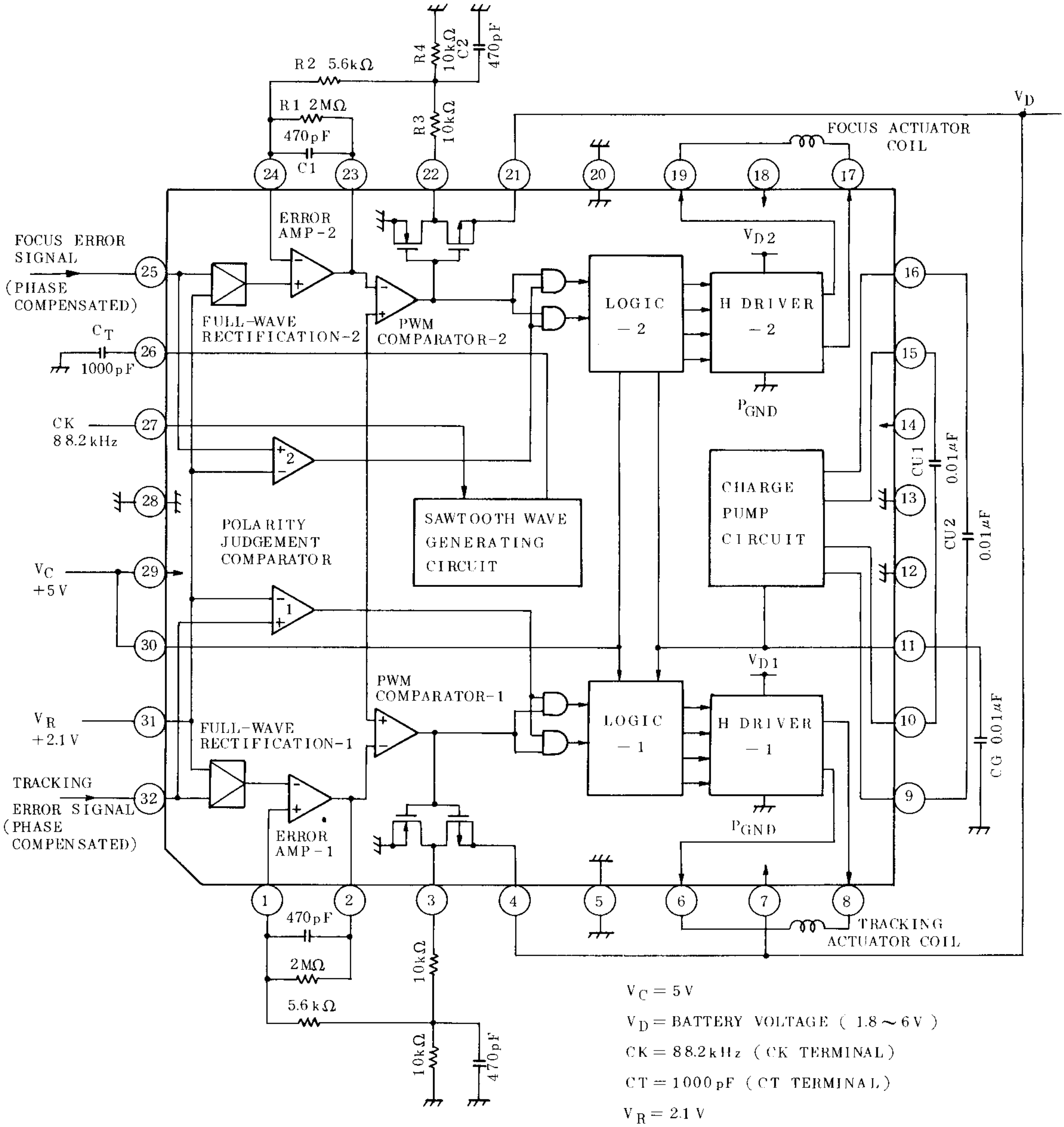
FUNCTION OF EACH PIN

PIN No.	SYMBOL	I/O	FUNCTIONAL DESCRIPTION	REMARKS
1	NI1	I	Error amp 1 negative input terminal.	
2	NF1	O	Error amp 1 output terminal.	Connect to PWM comparator negative input.
3	FB1	O	PWM comparator 1 feedback voltage output terminal.	PWM driver efficiency improving AGC circuit can be composed.
4	V_{DI1}	-	Battery potential drop detection terminal 1.	
5	P_{GND}	-	Power ground terminal.	
6	FO1	O	H driver 1 forward side output terminal.	
7	V_{D1}	-	H driver 1 supply voltage terminal.	
8	RO1	O	H driver 1 reverse side output terminal.	
10	C1H	-	Charge pump external capacitor connecting terminal 1.	
15	C1L			
11	V_G	-	Charge pump gate voltage terminal.	
12	P_{GND}	-	Power ground terminal.	
13	C_{GND}	-	Control logic unit ground terminal.	
14	V_C	-	Control logic unit supply voltage terminal.	
9	C2H	-	Charge pump external capacitor connecting terminal 2.	
16	C2L			
17	RO2	O	H driver 2 reverse side output terminal.	
18	V_{D2}	-	H driver 2 supply voltage terminal.	
19	FO2	O	H driver 2 forward side output terminal.	
20	P_{GND}	-	Power ground terminal.	

PIN No.	SYMBOL	I/O	FUNCTIONAL DESCRIPTION	REMARKS
21	V_{DI2}	–	Battery potential drop detecting terminal 2.	PWM driver efficiency improving AGC circuit can be composed.
22	FB2	O	PWM comparator 2 feedback voltage output terminal.	
23	NF2	O	Error amp 2 output terminal.	Connect to PWM comparator negative input.
24	NI2	I	Error amp 2 negative input terminal.	
25	VI2	–	Analog signal input terminal 2.	
26	CT	–	Sawtooth wave generating constant current terminal.	
27	CK	I	Sawtooth wave generating reference clock input terminal.	
28	CGND	–	Control logic unit ground terminal.	
29	V_C	–	Control logic unit supply voltage terminal.	
30	TEST	I	Test terminal. Normally, keep at "H" level.	
31	V_R	–	Reference voltage terminal.	
32	VI1	I	Analog signal input terminal 1.	

EXAMPLE OF APPLICATION CIRCUITS

(Example-1) CD Player PUH Actuator Coil Control



$V_C = 5V$

$V_D =$ BATTERY VOLTAGE (1.8 ~ 6V)

CK = 88.2kHz (CK TERMINAL)

CT = 1000pF (CT TERMINAL)

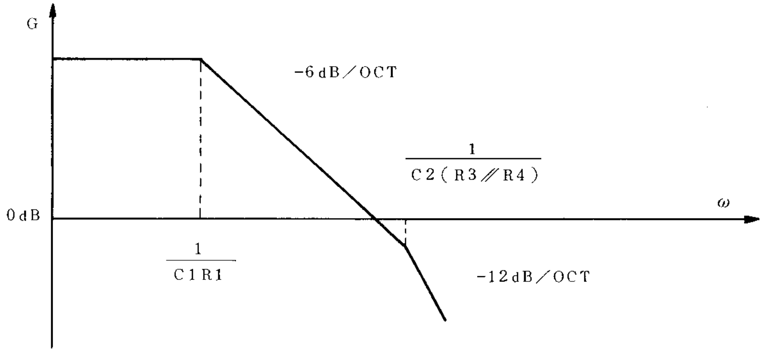
$V_R = 2.1V$

Constants in the application circuit example are decided by (1)~(3):

(1) Gain setting method:

$$\text{Gain (G)} = \frac{R4}{R3 + R4} \times \frac{R1}{R2} \times \frac{V_D}{1.2(V)}$$

(2) Open loop characteristic:



(3) Decision of CT (Sawtooth wave generating charge/discharge): ($C_{u}1=C_{u}2=C_{C}=0.01\mu F$)

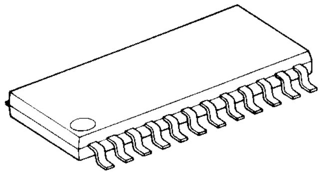
$$C_T = \frac{88.2 \times 10^3}{f_{IN}(kHz)} = 1000pF \qquad (\text{at } f_{IN}=88.2kHz)$$

TA8461F

DUAL POWER OPERATIONAL AMPLIFIER

The TA8461F is a multiple chip IC consisting of 4 saturated voltage discrete transistors and 1 dual operational amplifier.

- Large Output Current : I_{OUT}=1.5A(Max.)
- Sealed in a Small Package : SSOP24



SSOP24-P-300B

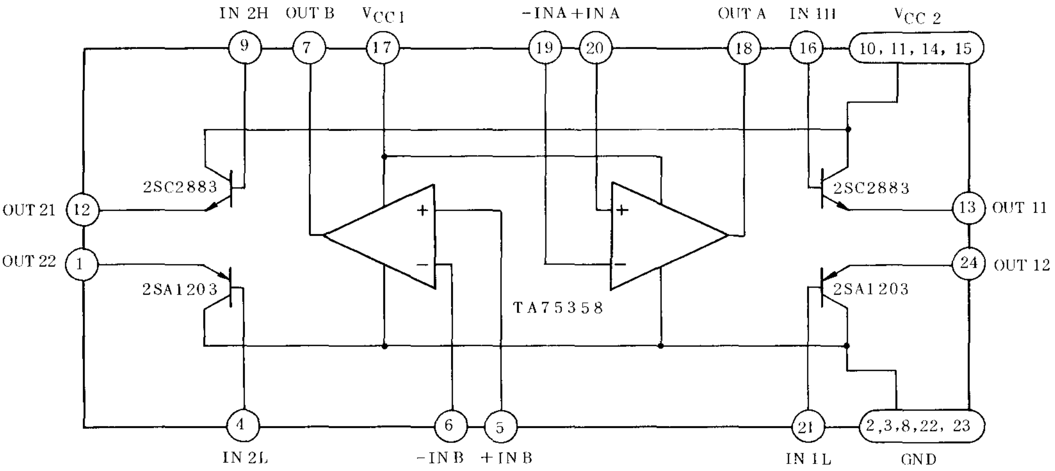
Weight: 0.27g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

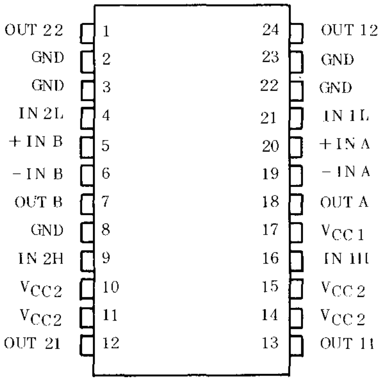
CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	30	V
Output Transistor	Collector-Base Voltage	V_{CBO}	30	V
	Collector-Emitter Voltage	V_{CEO}	30	V
	Emitter-Base Voltage	V_{EBO}	5	V
	Output Current	$I_{OUT(AVE)}$	1.5	A
		$I_{OUT(peak)}$	3.0 (Note)	
	Base Current	I_B	0.3	A
OP. Amp.	Amplifier Differential Input Voltage	DV_{IN}	30	V
	Amplifier Input Voltage	V_{IN}	30	V
Power Dissipation		P_D	1.0	W
Junction Temperature		Tj	125	°C
Operating Temperature		Topr	-40~85	°C
Storage Temperature		Tstg	-55~125	°C

(Note) Pulse measured: Pulse width=10ms(Max.)
Repetition cycle=30%(Max.)

BLOCK DIAGRAM



PIN CONNECTIONS



ELECTRICAL CHARACTERISTICS

OUTPUT TRANSISTOR UNIT (Ta=25°C)

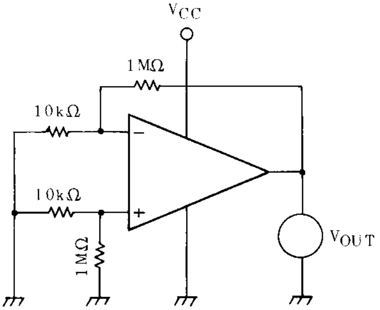
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC Current Amplification Factor	$h_{FE}(1)$		V_{CE}=2V, I_C=0.5A	160	–	600	
	$h_{FE}(2)$		V_{CE}=2V, I_C=1.5A	50	100	–	
Output Saturation Voltage	$V_{CE(sat)}$ (NPN)		I_C=0.5A, I_B=10mA	–	0.2	0.50	V
			I_C=1.5A, I_B=30mA	–	–	2.0	
	$V_{CE(sat)}$ (PNP)		I_C=0.5A, I_B=10mA	–	0.2	0.50	
			I_C=1.5A, I_B=30mA	–	–	2.0	
Transition Frequency	f_T		V_{CE}=2V, I_C=0.5A	–	120	–	MHz
Output Leakage Current	$I_{OL(NPN)}$		V_{CC}=30V	–	0	10	μA
	$I_{OL(PNP)}$		V_{CC}=30V	–	0	10	
Base-Emitter Voltage	$V_{BE(NPN)}$		V_{CE}=2V, I_C=0.5A	–	–	1.0	V
	$V_{BE(PNP)}$		V_{CE}=2V, I_C=0.5A	–	–	1.0	

OPERATIONAL AMPLIFIER UNIT (V_{CC}=5V, Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Offset Voltage	V_{IO}	1	Rg ≦ 10kΩ	–	2	7	mV
Input Offset Current	I_{IO}	2		–	5	50	nA
Input Bias Current	I_I	2		–	45	250	nA
In-Phase Input Voltage	CMV_{IN}	3	V_{CC}=30V	0	–	V_{CC}-1.5	V
Supply Current	I_{CC}	4	R_L=∞, All OP Amps	–	0.7	1.2	mA
Voltage Gain	G_V	5	R_L ≧ 2kΩ	86	100	–	dB
Maximum Output Amplitude Voltage	V_{Op-p}	6	R_L=2kΩ	0	–	V_{CC}-1.5	V
Common Mode Rejection Ratio	CMRR	3		60	85	–	dB
Supply Voltage Rejection Ratio	SVRR	1	Rg ≦ 10kΩ	60	100	–	dB
Source Current	I_{source}	6	IN(–)=0V_{DC}, IN(+)=1V_{DC}	20	40	–	mA
Sink Current	I_{sink}	6	IN(–)=0V_{DC}, IN(+)=1V_{DC}	10	20	–	mA
Cut-off Frequency	f_T	–		–	1.5	–	MHz
Slew Rate	S_R	–		–	0.8	–	V/μsec

TEST CIRCUIT

(1) V_{IO}, SVRR



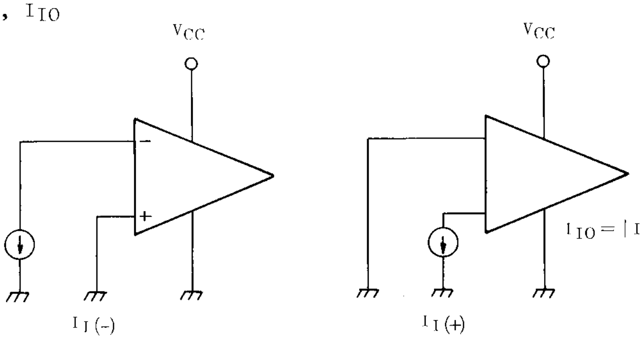
- $V_{IO}=V_{OUT}/100$
- SVRR=20ℓog E (dB)

$$E=\left|\frac{V_{OUT1}-V_{OUT2}}{V_{CC1}-V_{CC2}}\right| \times \frac{1}{100}$$

V_{OUT1} : V_{OUT} (V_{CC1}=5V)

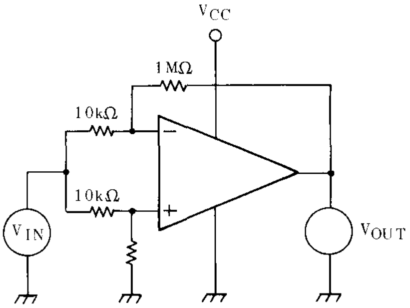
V_{OUT2} : V_{OUT} (V_{CC2}=10V)

(2) I_I, I_{IO}



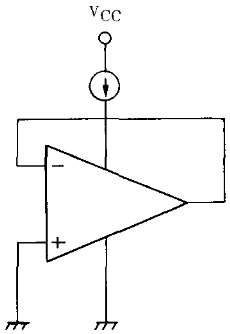
$I_{IO}=|I_I(-)-I_I(+)|$

(3) CMV_{IN}, CMRR



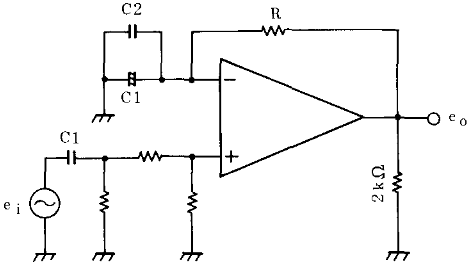
- CMRR=20ℓog G_D/G_C (dB)
  - G_D: Differential Voltage Gain
  - G_C: In-phase Voltage Gain
- CMV_{IN} : V_{IN}=0V, V_{CC}-1.5V

(4) I_{CC}



- I_{CC} : V_{CC}=5V

(5) G_V



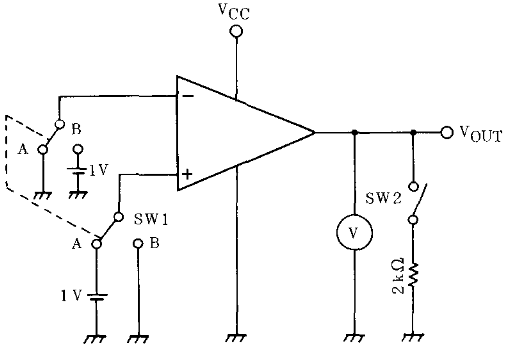
- $G_V = 20 \ell og\ e_o/e_i$ (dB)

  $R \gg 1/W_{C1}$

  C1 : For Preventing DC Short-Circuit.

  C2 : For High Frequency Short-Circuit.
  Use a Mica or Titanium Capacitor.

(6) V_{Op-p}, I_{source}, I_{sink}



- V_{Op-p}

  V_{OH} : SW1 is to A side.

  V_{OL} : SW1 is to B side.

- I_{source}

  SW1 is to A side.

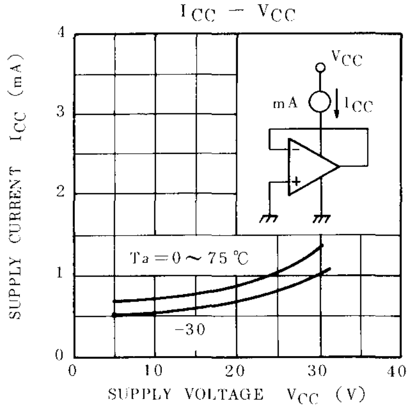
  $V_{OUT} \rightarrow$ 0V Measurement

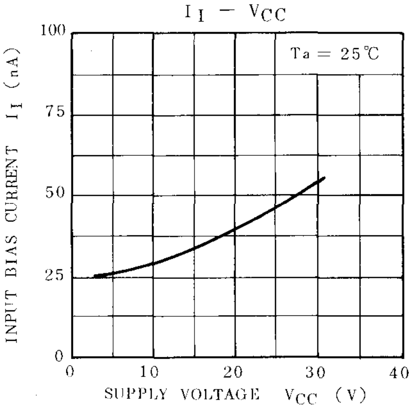
- I_{sink}

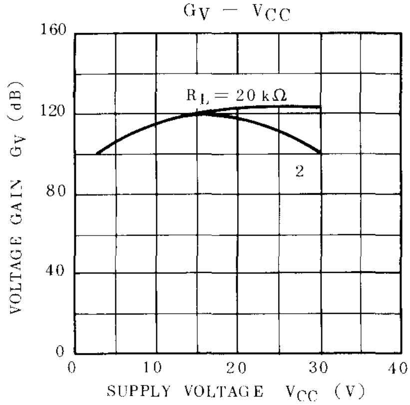
  SW1 is to B side.

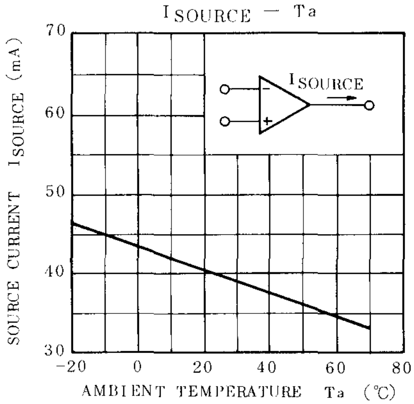
  $V_{OUT} \rightarrow$ 5V Measurement

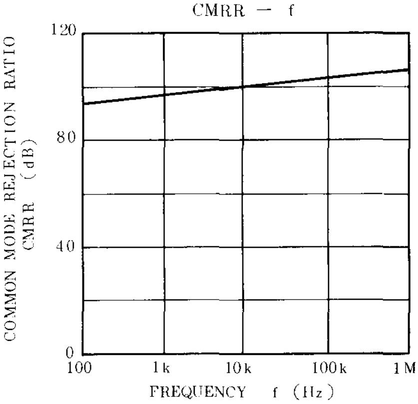
CHARACTERISTIC CURVES (Ta=25°C)

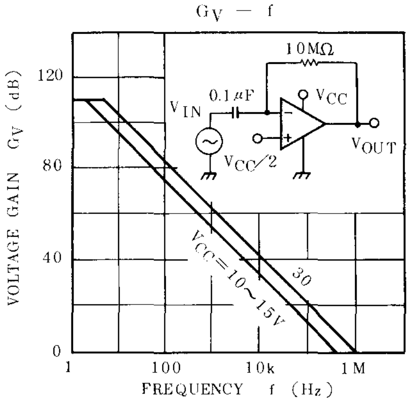


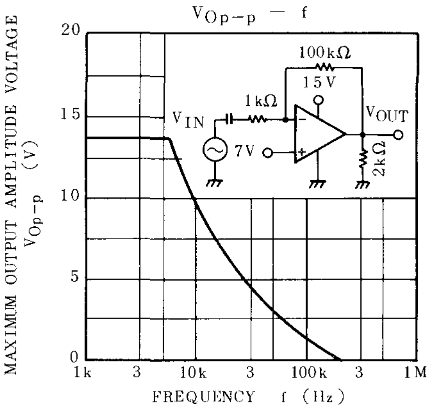




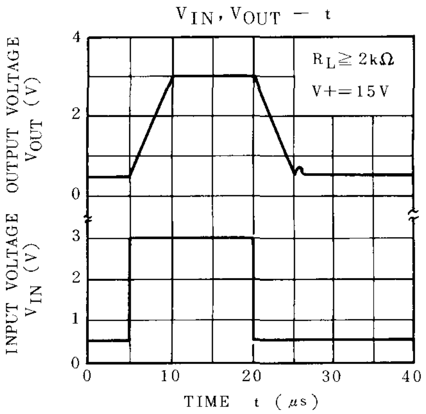




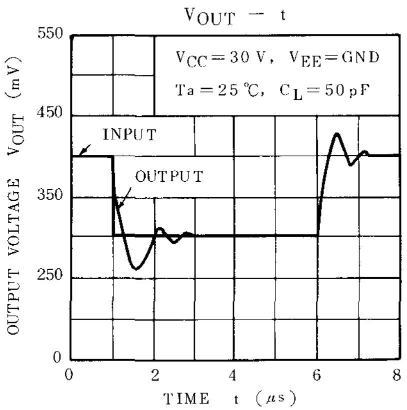




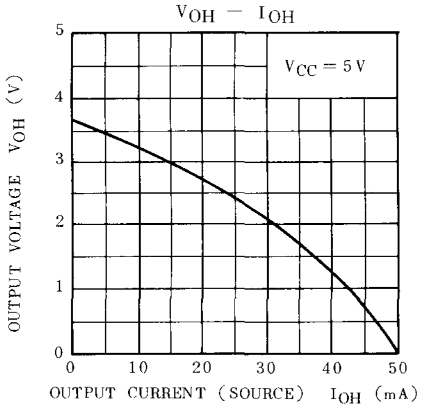
V_{Op-p} — f
MAXIMUM OUTPUT AMPLITUDE VOLTAGE V_{Op-p} (V)
FREQUENCY f (Hz)
100kΩ
15V
1kΩ
V_{IN}
V_{OUT}
7V
2kΩ



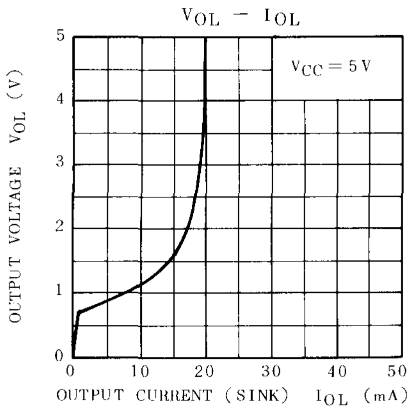
V_{IN}, V_{OUT} — t
OUTPUT VOLTAGE V_{OUT} (V)
INPUT VOLTAGE V_{IN} (V)
$R_L \geq 2k\Omega$
V+=15V
TIME t (μs)



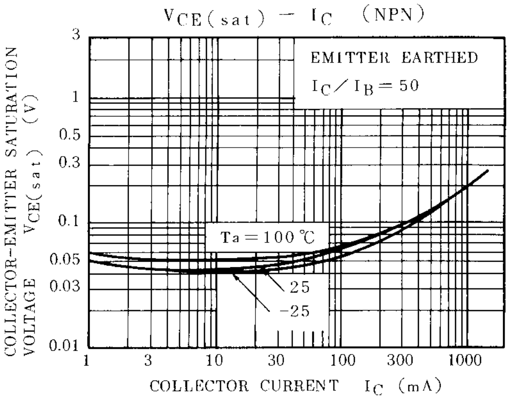
V_{OUT} — t
OUTPUT VOLTAGE V_{OUT} (mV)
V_{CC}=30V, V_{EE}=GND
Ta=25℃, C_L=50pF
INPUT
OUTPUT
TIME t (μs)

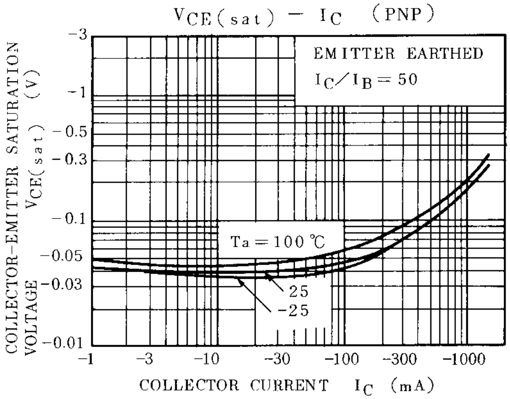


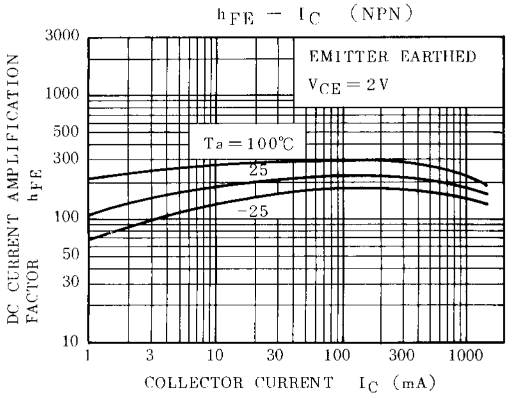
V_{OH} — I_{OH}
OUTPUT VOLTAGE V_{OH} (V)
V_{CC}=5V
OUTPUT CURRENT (SOURCE) I_{OH} (mA)

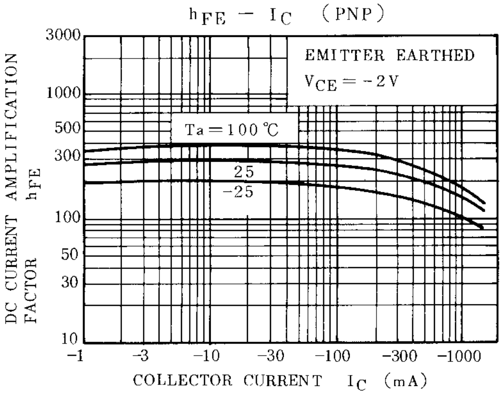


V_{OL} — I_{OL}
OUTPUT VOLTAGE V_{OL} (V)
V_{CC}=5V
OUTPUT CURRENT (SINK) I_{OL} (mA)


VCE(sat) – IC (NPN)
EMITTER EARTHED
IC/IB = 50
Ta = 100°C
25
–25
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
COLLECTOR CURRENT IC (mA)


VCE(sat) – IC (PNP)
EMITTER EARTHED
IC/IB = 50
Ta = 100°C
25
–25
COLLECTOR-EMITTER SATURATION VOLTAGE VCE(sat) (V)
COLLECTOR CURRENT IC (mA)

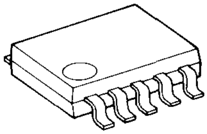

hFE – IC (NPN)
EMITTER EARTHED
VCE = 2V
Ta = 100°C
25
–25
DC CURRENT AMPLIFICATION FACTOR hFE
COLLECTOR CURRENT IC (mA)


hFE – IC (PNP)
EMITTER EARTHED
VCE = –2V
Ta = 100°C
25
–25
DC CURRENT AMPLIFICATION FACTOR hFE
COLLECTOR CURRENT IC (mA)

TA8462F

FAN MOTOT DRIVER IC

The TA8462F is a two-phase half-wave hall motor driver IC.
This IC is best suited for the fan motor driving.
The output current of this IC is 1.5A(peak) and all functions needed for fan motor driving have been incorporated into a 1 chip, enabling it to largely reduce peripheral parts and a space, thus realizing down-sizing.
Further, the TA8462F is provided with the FG output pin (outputs pulses proportional to the motor speed) and the RD output pin (outputs the motor ON/OFF statues).



SSOP10-P-225

Weight : 0.09g(Typ.)

- Built-in Automatic Self Rotation Recovery Circuit After Release of Motor Locking.
- Thermal Shutdown Circuit Incorporated.
- Operating Voltage : 4~15V
- Recommended Operating Voltage : V_{CC}=5V, 12V
- No V_{CC}-GND Reverse Connection Preventive Diode Required.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Output Terminal Breakdown Voltage	V_{CER}	33	V
Output Current (Peak)	$I_{O(peak)}$	1.5 (Note 1)	A
FG Output Current (Peak)	$I_{FG(peak)}$	10 (Note 1)	mA
RD Output Current (Peak)	$I_{RD(peak)}$	10 (Note 1)	mA
Hall Input Voltage	V_{HM}	300 (Note 2)	mV
Power Dissipation	P_D	735 (Note 3)	mW
Operating Temperature	T_{opr}	-30~85	°C
Storage Temperature	T_{stg}	-55~150	°C

(Note 1) t=0.1 sec

(Note 2) Tj=-25~150°C

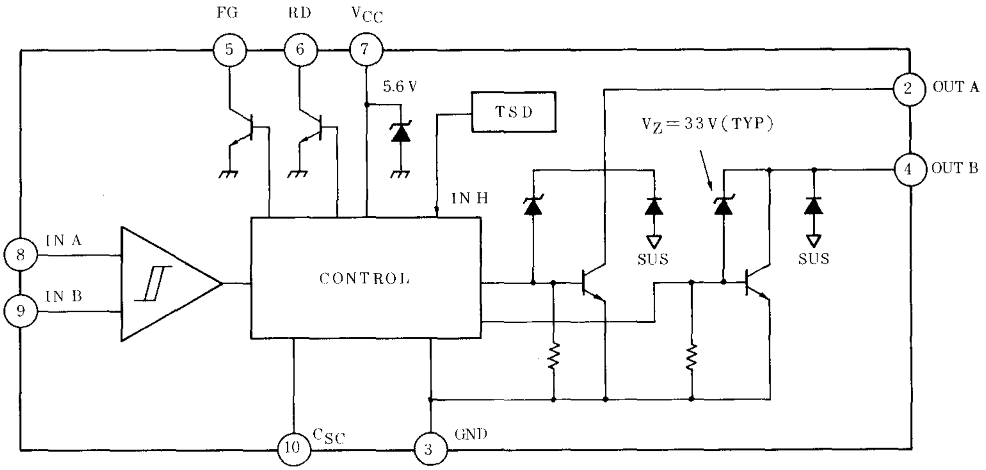
(Note 3) This value is obtained by 50X50X1.6mm PCB mounting occupied in excess of 30% of copper area.

ELECTRICAL CHARACTERISTICS

($Ta=25°C$, $V_{CC}=12V$, $RV_{CC}=200\Omega$, $C_{SC}=1.0\mu F$)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC}		$V_{CC}=5V$, $RV_{CC}=0\Omega$	A:ON	-	8.7	13.0	mA
				Output Open	B:ON	-	7.7	12.0	
				$V_{CC}=12V$, $RV_{CC}=200\Omega$	A:ON	-	28	35	
				Output Open	B:ON	-	28	35	
Output Saturation Voltage		V_{SAT}		$I_O=0.2A$, $Tj=25°C$		-	0.8	1.0	V
				$I_O=1.0A$, $Tj=25°C$		-	1.15	1.6	
Automatic Self Rotation Recovery Circuit	Charge Current	I_c		$C_{SC}=GND$		3.0	6.2	8.0	μA
	Discharge Current	I_d		$C_{SC}=4V$		0.5	1.15	1.6	
	Output OFF Voltage	V_{SCU}		$V_{CC}=5V$		-	3.5	-	V
	Output ON Voltage	V_{SCL}		$V_{CC}=5V$		-	1.5	-	
	Duty	DR		$I_d/I_c=T_{OFF}/T_{ON}$		3	5	8	
	ON Time	T_{ON}				-	0.35	-	sec
	OFF Time	T_{OFF}				-	1.75	-	
Hall Amp.	Sensitivity	V_{HS}		Include Offset/Hysteresis		10	-	-	mV
	Hysteresis	V_{HH}				-	2.5	-	
	Operating DC Potential	CMR				0	~	3	V
Supply Zener Voltage		V_Z				5.4	6.0	6.3	V
FG Output Saturation Voltage		$V_{sat(FG)}$		$I_{FG}=5mA$		-	0.2	0.4	V
RD Output Saturation Voltage		$V_{sat(RD)}$		$I_{RD}=5mA$		-	0.2	0.4	V
Thermal Shutdown Operating Temperature		T_{SD}		Tj		150	-	-	°C

BLOCK DIAGRAM



○ FG and RD Outputs

Both the FG and RD outputs are the open collector outputs.

The FG output is pulse proportional to the number of revolutions (the cycle is the same as OUT B) and the RD output is at the GND level (actually, at $V_{sat(RD)}$ level) when the motor is being driven and the RD output at the potential levl that is to be applied to the RD terminal as hsown in Figure 2 is output when the motor is kept restrained.

○ Automatic Self Rotation Recovery Circuit

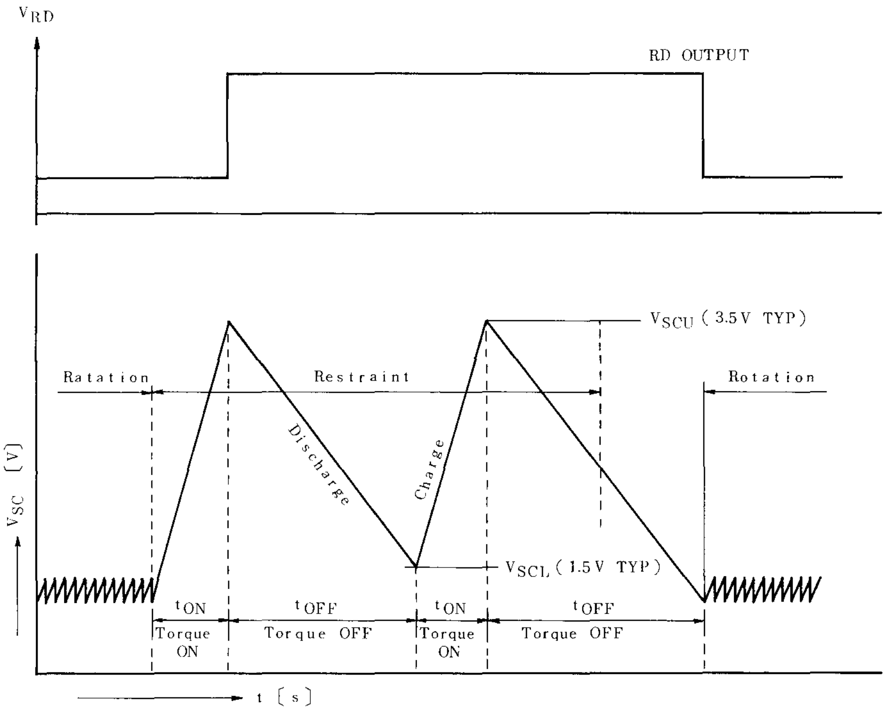


Fig. 1

If the rotation of the fan motor is forced to stop by any physical power, the driving coil may be burnt as inducing voltage caused when the motor is running disappears and large current flows to the driving coil.

Therefore, it becomes necessary to provide the fan motor with a circuit to prevent the driving coil from being burned by detecting the forced stop of the motor rotation from the outside by some method and a circuit to automatically rotate the motor when it is released from the restraint.

The TA8462F is an IC that has cleared the above problems by the burning preventive automatic return circuit.

This operation is shown in Figure 1.

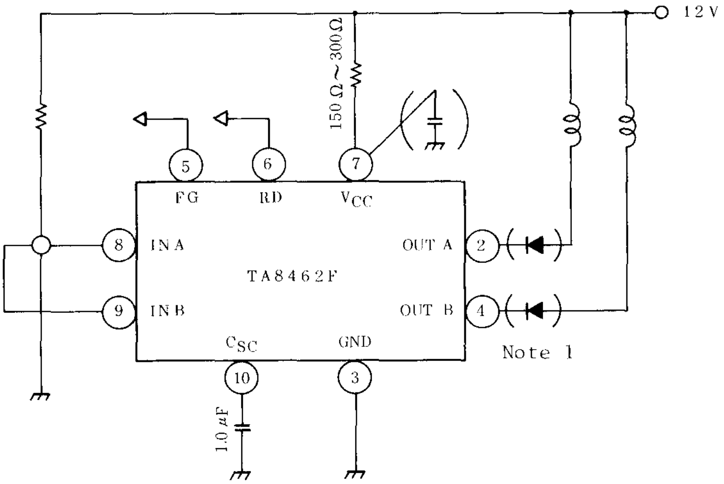
The capacitor C_{SC} connected to the C_{SC} terminal is charged by the charging current I_{SL} (6.3μA TYP) and its potential rises as shown below:

$$V = \frac{1}{C_{SC}} \quad I_{SC}\ dt$$

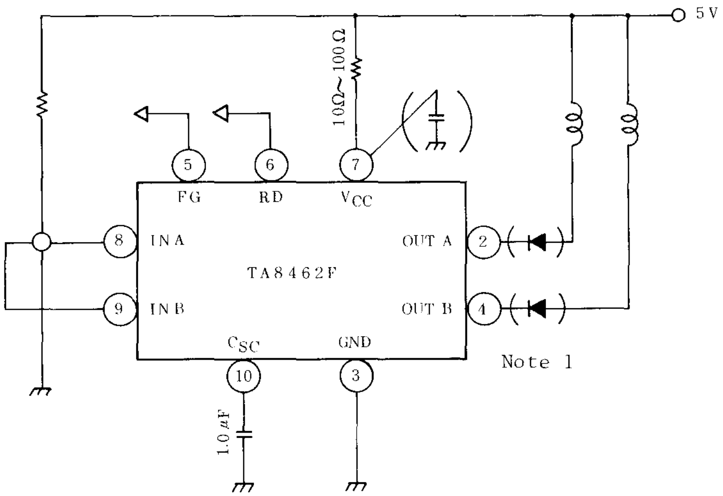
When the motor is rotating, it is charged and discharged repeatedly by trigger pulse but if the motor rotation is physically restrained, C_{SC} discharge by trigger pulse is stopped and the potential further increases. During this period, current flows continuously to the motor. If V_{SC} (OSC potential) reaches V_{SCU} (3.5V TYP), discharge starts slowly and at the same time, the output is turned OFF to cur off current flowing to the motor. When the V_{SC} potential reaches V_{SCL} (1.5V TYP), the output is turned ON to allow current flow to the motor and torque is generated.
As long as the motor rotation is kept restrained, this operation is repeated and the output is turned ON/OFF at a ratio of nearly 1 : 5.
By this operation, the motor is heated and cooled and its temperature rise can be suppressed to a certain level. If the motor is released from the above restraint, the motor is started to run again by the generated torque and is continuously rotated by the generated trigger pulse.

APPLICATION CIRCUIT

• 12Vμse



• 5Vμse



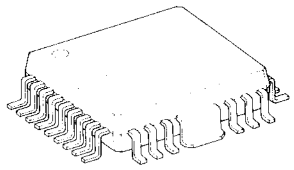
Note 1 : If the mutual induction of a motor is large, it is recommended to insert a diode in the circuit.

TA8463F

SINGLE CHIP 3-PHASE MOTOR DRIVER
FOR FDD SPINDLE MOTOR.

The TA8463F is Single Chip Motor Driver IC for FDD Spindle Motor.

- 1 Chip mtor driver with 3-phase semi-linear driving.
- Adjustment free with digital servo system.
- 300, 360rpm are obtained.
- Built-in index pulse output current.
- Operating supply voltage range : V_{CC}=4.2~7V
- Output current : $I_{O(MAX)}$=0.5A(AVE)
- Built-in thermal shut-down circuit.
- Built-in over current protection circuit.
- Built-in stand-by circuit.



HQFP30-P-1010

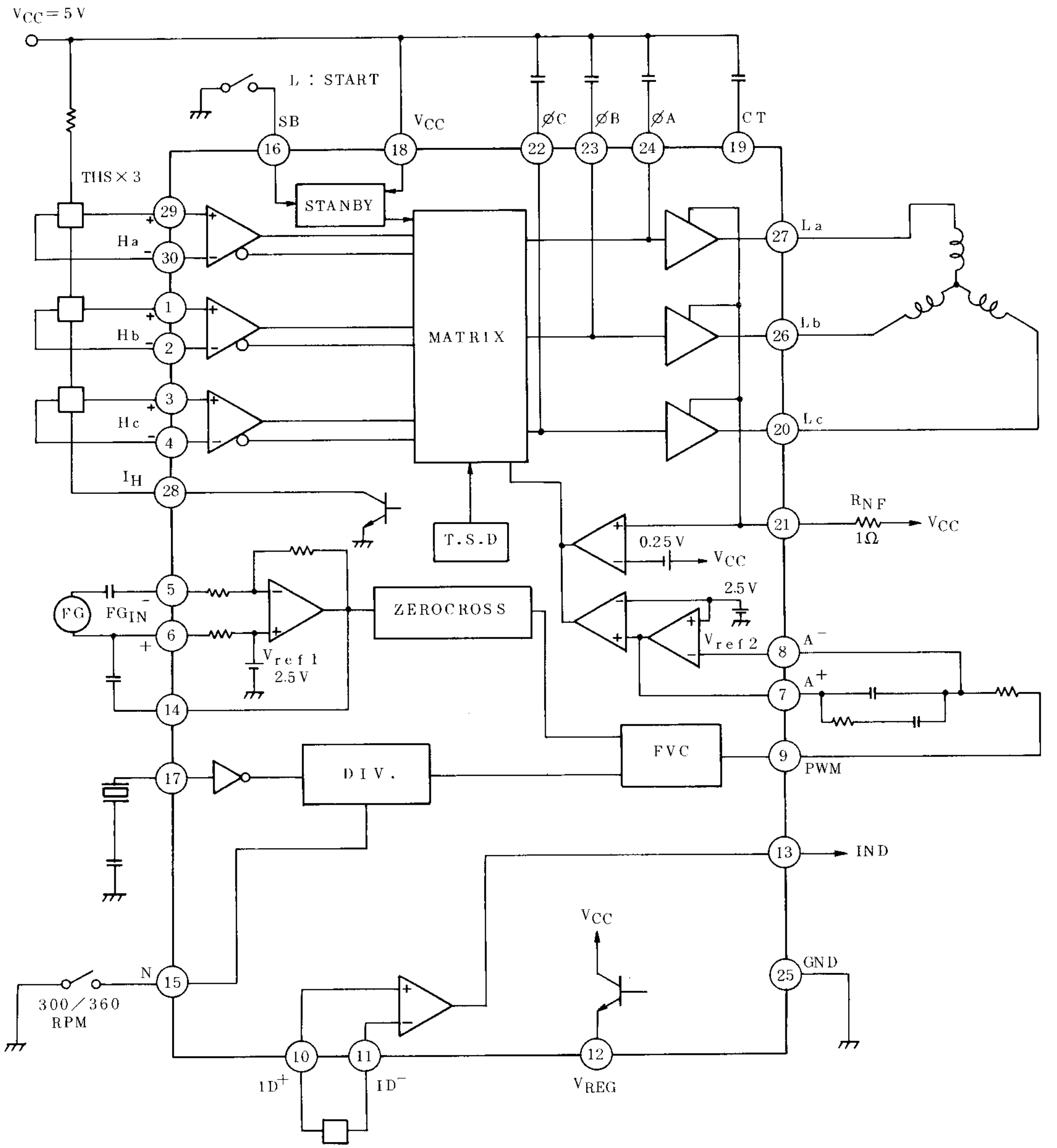
Weight : 0.6g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

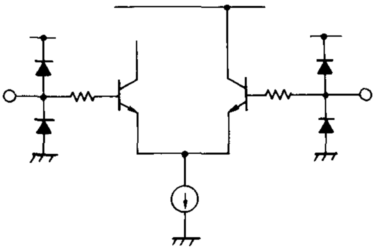
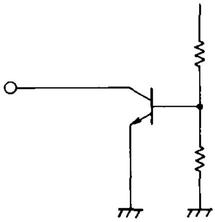
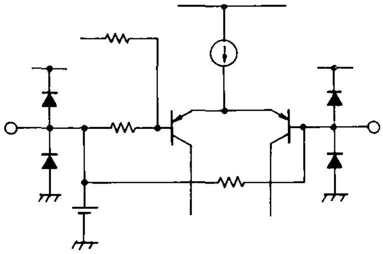
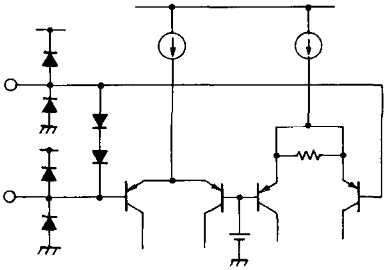
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	8	V
Output Current	I_O	0.6	A
Power Dissipation	P_D	1.0	W
		1.5 (Note)	
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~150	°C

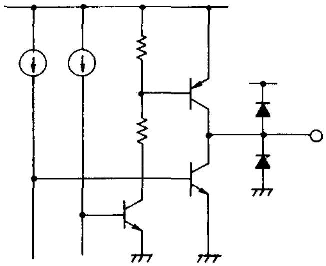
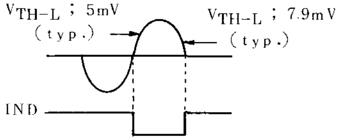
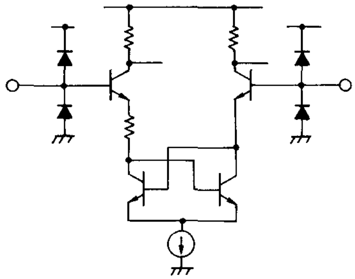
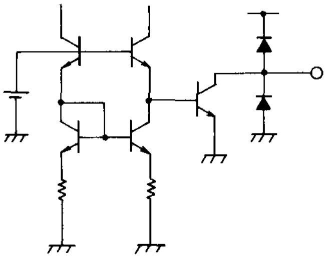
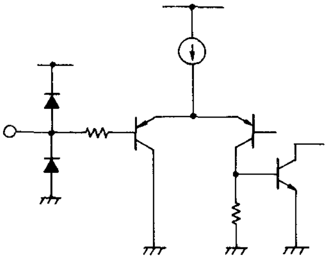
(Note) With Heat-Sink (60X60X1.6mm Cu 50%)

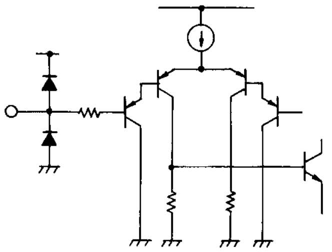
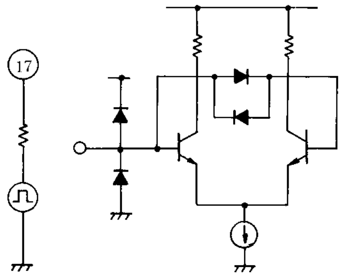
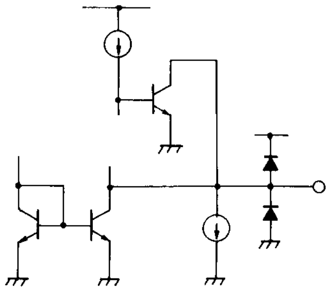
BLOCK DIAGRAM

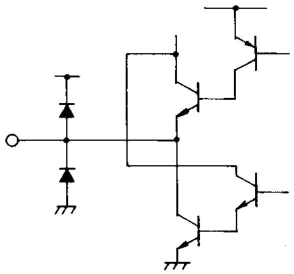
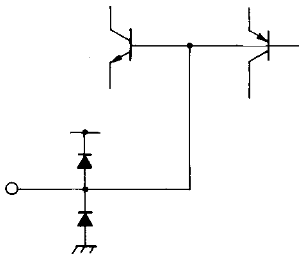


TERMINAL EXPLANATION

No.	SYMBOL	DESCRIPTION	EQUIVALENT CIRCUIT
29 30 1 2 3 4	Ha^+ Ha^- Hb^+ Hb^- Hc^+ Hc^-	. Hall Amp. +/− Input Terminal. The Hall Input Range is ; V_H=50~300 [mVp-p] CMR=1.3~(V_{CC}−0.9) [V]	
28	I_H	. Hall Bias Negative Side Connecting Terminal.	
5 6 14	FG^- FG^+ FGO	. FG Amp. Negative Input Terminal. . FG Amp. Positive Input Terminal. . FG Amp. Ouptut Terminal. High Sensitivity of FG Amp. ; V_{HFG}=2.5mV	
7 8	A^+ A^-	. Error Amp. Output Terminal. . Error Amp. Input Terminal. External Ports Value (C.R) is determined by matching between Motor and IC.	

No.	SYMBOL	DESCRIPTION	EQUIVALENT CIRCUIT
9	PWM	. F/V Converter Output Terminal Reference : No.7 and No.8	
10 11	ID+ ID−	. Index Positive Input Terminal. . Index Negative Input Terminal. 	
13	IND	. Index Amp. Output Terminal. Reference : No.10 and No.11	
15	MS	. Mode Select Terminal. 300rmp ; L 360rpm ; H	

No.	SYMBOL	DESCRIPTION	EQUIVALENT CIRCUIT
16	SB	. Stand-by Terminal. SB ; H ST ; L	
17	OSC	. Oscillation Terminal. External CK Pulse is used, connect Resistor (min. 20kΩ) in series.	
18	V_{CC}	. Supply Voltage Input Terminal.	
19	CT	. Phase Compensation Terminal. Connect Capacitor between 19 pin and GND.	

No.	SYMBOL	DESCRIPTION	EQUIVALENT CIRCUIT
20 26 27	Lc Lb La	. Output Terminals.	
21	R_F	. Power Supply Voltage Input Terminal. By connecting resistors between V_{CC} terminal and (21) pin, Current Limiter is available. $\frac{V_{ISD}}{R_{NF}} = I_{O(max)}$ $V_{ISD}=0.14V$ $I_{O(max)}=0.5A$	
22 23 24	ϕC ϕB ϕA	. Capacitor Connect Terminal for prevention of oscillation.	
25 Fin	GND	. GND	

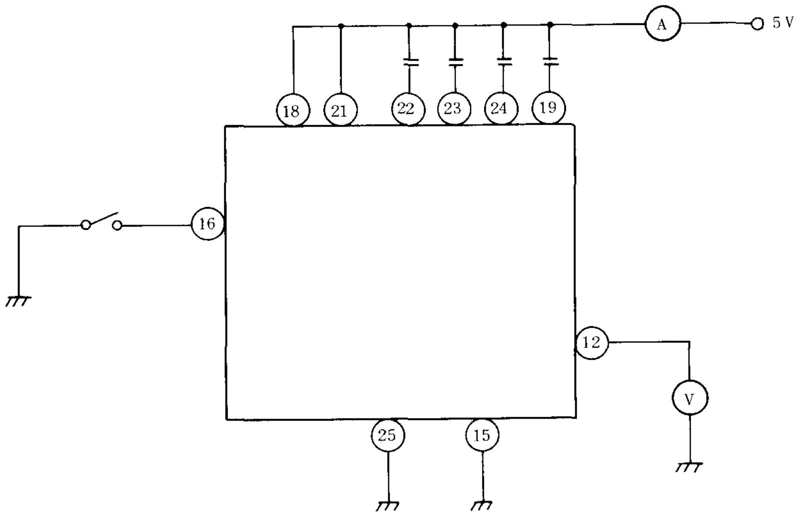
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=5V, Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage			V_{CC}	–		4.2	–	7	V
Supply Current			I_{CC1}	1	Output Open	–	12.5	200	μA
			I_{CC2}	1		–	23.9	36	mA
Hall Amp.	Gain		G_{HO}	–		–	31	–	dB
	Input Sensitivity		V_H	2		50	–	300	mV
	Common Mode Voltage Range		CMR	2		1.3	–	V_{CC}– 0.9	V
FG Amp.	Closed Loop Gain		G_{FGO}	3		40	46	50	dB
	Reference Voltage		V_{ref}	3		2.15	2.6	2.9	V
	Input Sensitivity		V_{HFG}	3		–	2.50	–	mV
	Input Offset Voltage		V_{OFG}	3		–	1	–	mV
Integrator Amp.	Output Voltage	High	V_{INT-H}	4		3.4	3.8	4.7	V
		Low	V_{INT-L}	4		0.4	1.0	1.6	V
	A-Input Current		IA–	4		–	–	0.4	μA
Speed Changing	Open Loop Gain		G_{INT}	–	–3dB Point	–	55	–	dB
	Input Switching Voltage		V_{MS-th}	5	H : 360rpm	3.0	–	V_{CC}	V
					L : 300rpm	0	–	2.0	V
	Input Current		I_{MS}	5	V_{MS}=GND	–	-2.5	0.1	μA
OSC Frequency Range			f_{OSC}	–	Tj=–30~125°C	300	490	600	kHz
PWM Output Voltage		High	$V_{PWM\ H}$	6	I_{OH}=–100μA (f_x/8192)<FG	–	V_{CC}–0.1	–	V
		Hiddle	$V_{PWM\ M}$	6	OUTPUT-V_{CC}:50kΩ OUTPUT–GND:50kΩ (f_x/8192)=FG	–	V_{CC}/2	–	V
		Low	$V_{PWM\ L}$	6	I_{OL}=100μA (f_x/8192)>FG	–	0.1	–	V

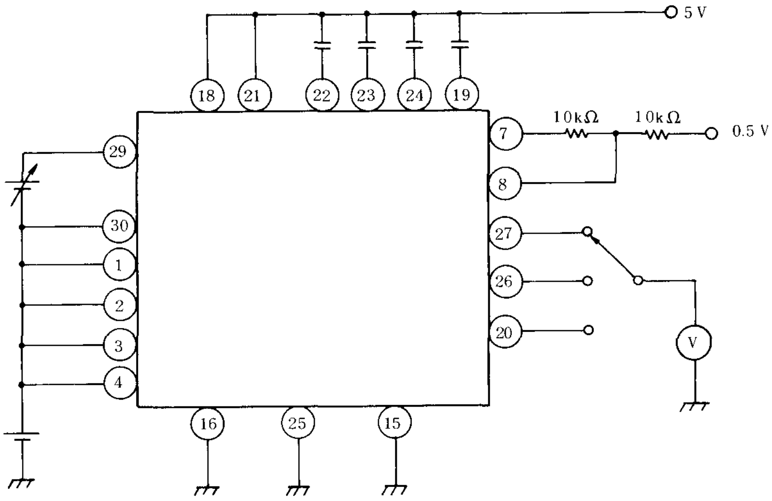
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=5V, Ta=25°C)

CHARACTERISTIC			SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Stage	Static Voltage		V_{MID}		$G_{V(INT)}=1$, $V=\left(\frac{V_{CC}}{2}\right)+1V$	–	2.2	–	V
	Output Refferencial Voltage-1		V_M-diff1		$G_{V(INT)}=1$, $V=\left(\frac{V_{CC}}{2}\right)+1V$	–	10	60	mV
	Output Refferencial Voltage-2		V_M-diff2		$G_{V(INT)}=1$, Ha=Hb=Hc=$V_{CC}/2$, $V=\left(\frac{V_{CC}}{2}\right)-1V$	–	0.4	–	V
	Saturation Voltage	Upper	V_{sat} U		I_O=500mA	–	1.1	1.35	V
		Lower	V_{sat} L		I_O=500mA	–	0.5	0.75	
Stand-by Input	Switching Voltage		V_{ST-th}		H : Stand-by Mode	2.4	–	V_{CC}	V
					L : Enable Mode	0	–	0.8	
	Input Current		I_{ST}		V_{ST}=GND	–	0.05	1.0	μA
Hall Bias Storation Voltage			V_{SB-SAT}		I_{IH}=10mA	–	0.11	0.3	V
					I_{IH}=20mA	–	0.19	0.5	
Current Limit Operating Voltage			V_{SID}		Rf Voltage	–	140	–	mV
Index Stage	Input Current		Iidx	8		–	–	3	μA
	Common Mode Voltage Range		V_{CMR}	8		1.5	–	V_{CC}-0.3	V
	Offset Voltage		V_{TH}	8		–	–	–	V
	Hysteresis Width		V_{hys}	8		–	2.5	–	mV
	Output Voltage	Low	V_{idx} L	8	I_O=1.0mA	–	0.1	0.4	V
		High	V_{idx} H	8	I_O=1.0mA	–	V_{CC}	–	
	Maximum Input		V_{in}	8		–	–	0.3	Vp-p
Index Sensor Bias			V_{REG}	1	R_L=1kΩ	2.1	2.5	2.9	V
Thermal Shut-Dwon Operating Temperature			TSD	–		150	–	–	°C

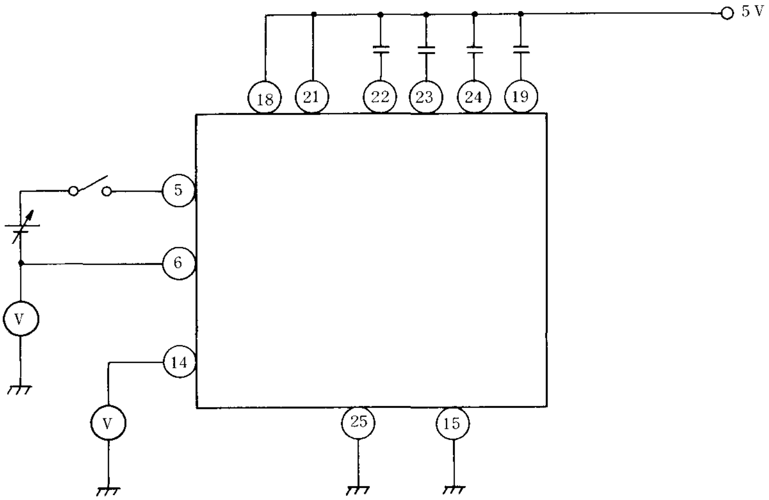
TEST CIRCUIT 1 I_{CC1}, I_{CC2}, V_{REG}



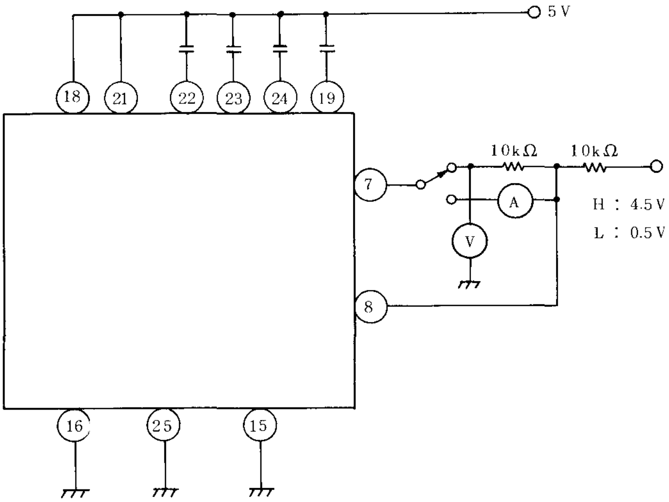
TEST CIRCUIT 2 V_H, CMR



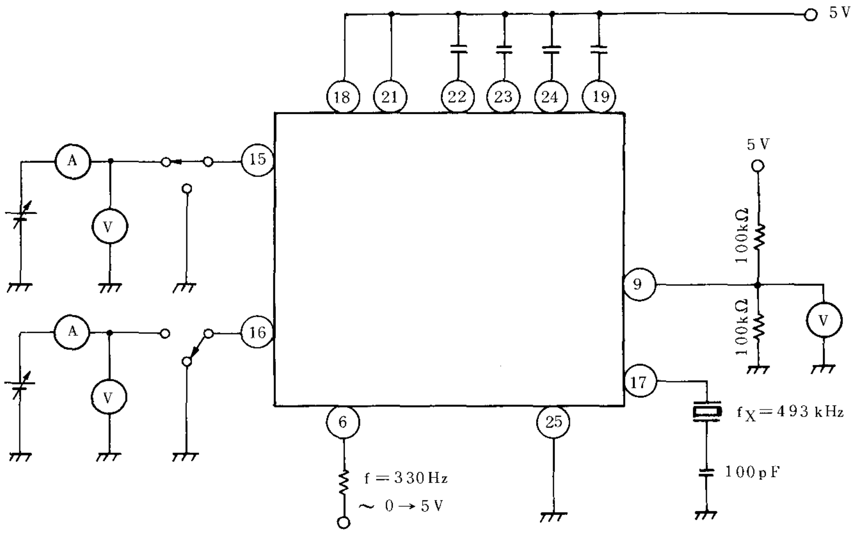
TEST CIRCUIT 3 G_{FGO}, V_{ref}, V_{HFG}, V_{OFG}



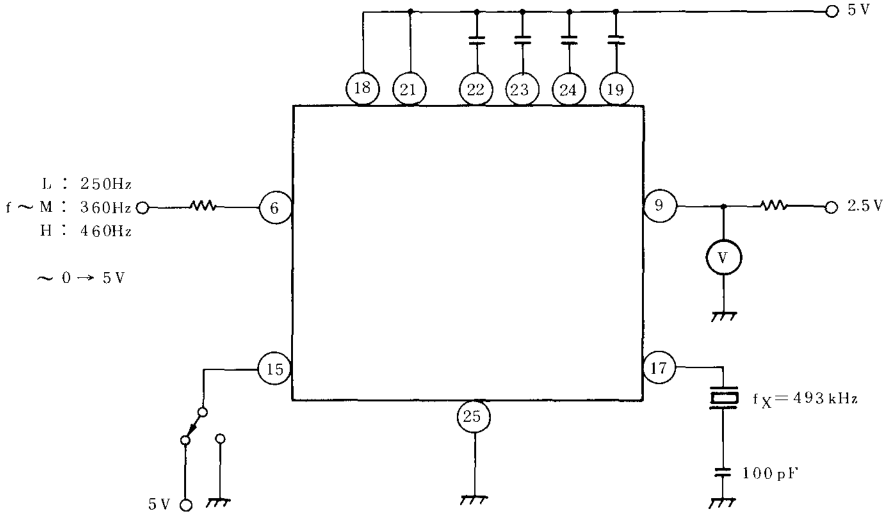
TEST CIRCUIT 4 V_{INT-H}, V_{INT-L}, IA-



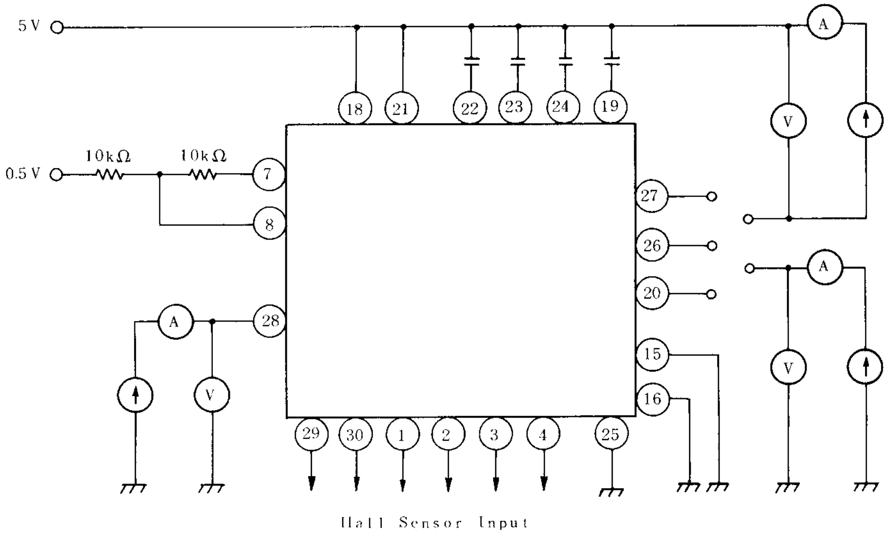
TEST CIRCUIT 5 V_{MS-th}, I_{MS}, V_{ST-th}, I_{ST}



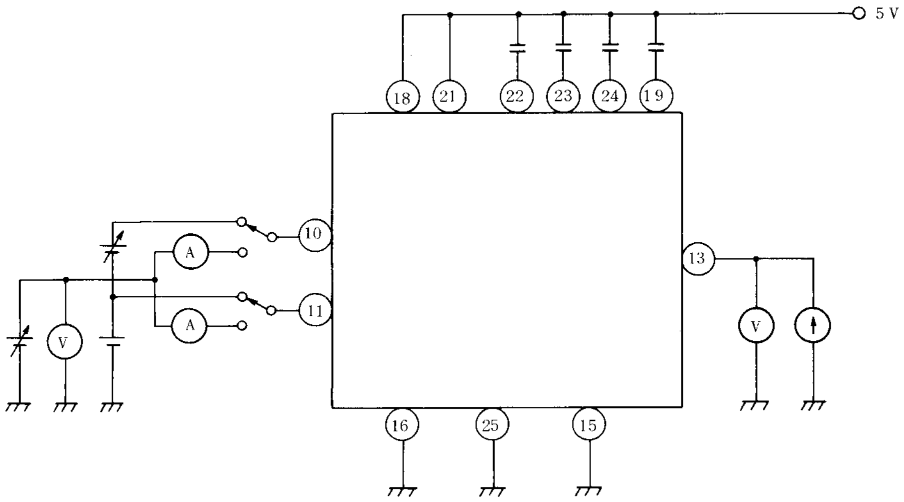
TEST CIRCUIT 6 V_{PWM} H, V_{PWM} M, V_{PWM} L



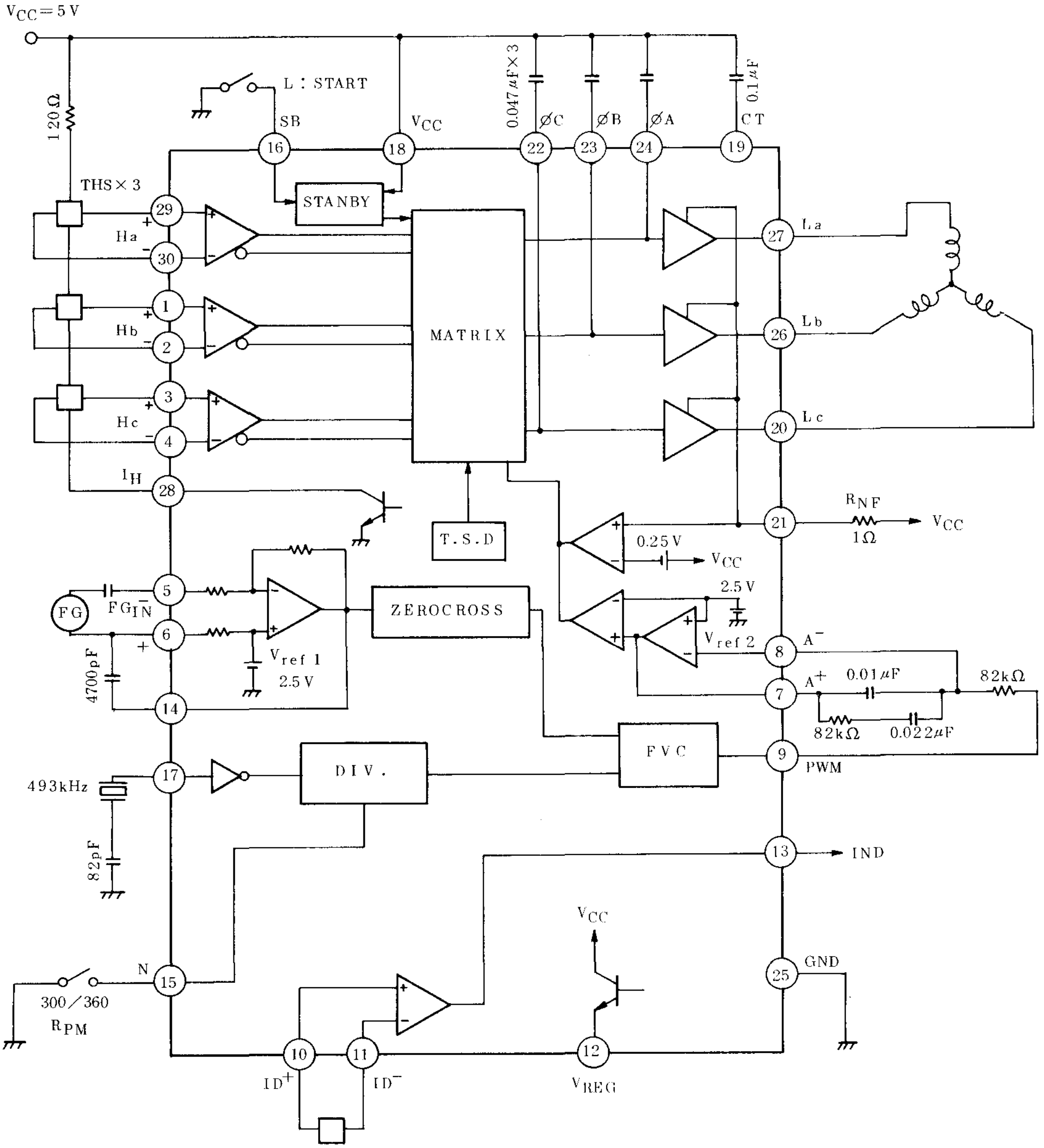
TEST CIRCUIT 7 V_{sat} U, V_{sat} L, V_{SB-SAT}



TEST CIRCUIT 8 Iidx, V_{CMR}, V_{TH}, V_{idxL}, V_{idxH}



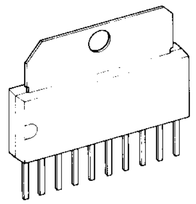
APPLICATION CIRCUIT



TA8464K

DUAL POWER OPERATIONAL AMPLIFIER

The TA8464K is a dual power operational amplifier with the output current 1.2A MAX.
This amplifier is usable for CD player arm driver, brushed motor forward/reverse rotation control driver, and FDD/HDD voice coil motor.
Furthermore, this amplifier is best suited for LDP focus tracking actuator driver because of its high through rate.


HSIP10-P

Weight : 2.47g(Typ.)

- Provided with a Current Limiter.
- High Output Current : I_O MAX(peak)=1.2A
- Internal Phase Compensation Type.
- Less Crosstalk : C_T=55dB(Typ.)
- High Slew Rate : S_L=1.0V/μs(Typ.)

MAXIMUM RATINGS (Ta=25°C)

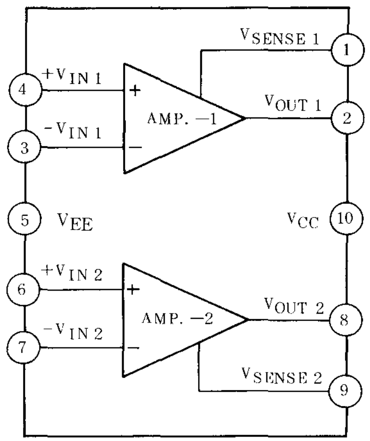
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}, V_{EE}	±18	V
Output Current	I_O(peak)	1.2	A
Power Dissipation	P_D	12.5 (Note 1)	W
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~150	°C

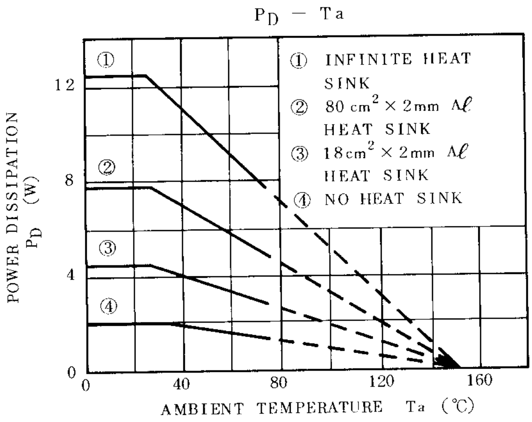
Note 1. Tc=25°C

ELECTRICAL CHARACTERISTICS (V_{CC}=15V, V_{EE}=-15V, Ta=25°C)

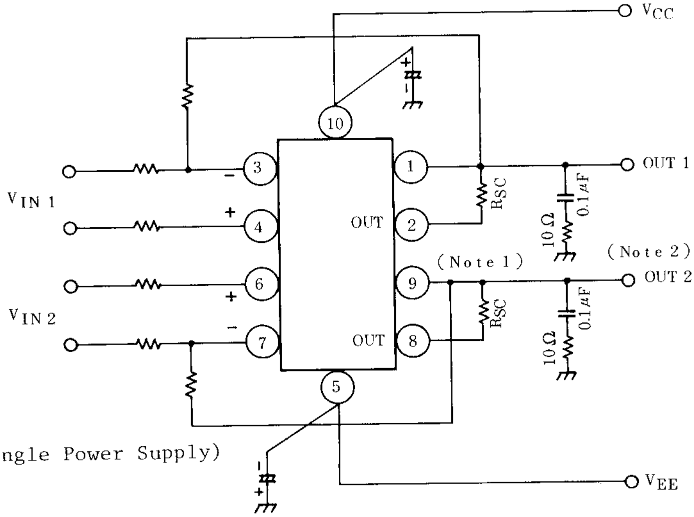
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC}	–		–	17	25	mA
Input Offset Current		I_{IO}	–		–	3	100	nA
Input Bias Current		I_I	–		–	98	300	nA
Input Offset Voltage		V_{IO}	–		–	0	7	mV
Maximum Output Voltage	Upper	V_{OH}	–	V_{CC}=±15V, I_O=300mA	12.2	13.3	–	V
	Lower	V_{OL}			-12.2	-13.3	–	
	Upper	V_{OH}	–	V_{CC}=±6V, I_O=1A	2.0	3.9	–	V
	Lower	V_{OL}			-2.0	-4.0	–	
Open Loop Gain		G_{VO}	–		–	80	–	dB
Input Common Mode Voltage Range		CMR	–		±13	±14	–	V
Common Mode Rejection Ratio		CMRR	–	V_{IN}=-10~10V	90	113	–	dB
Supply Voltage Rejection Ratio		SVRR	–	V_{CC}=-V_{EE}=6~15V±1V	–	65	100	μV/V
Slew Rate		SL	–		–	1.0	–	V/μs
Output Limiting Current		ISC	–	R_{SC}=0.68Ω	0.8	1.0	–	A
Crosstalk		DT	–	V_{IN}=-14~14V	–	55	–	dB
Slew Rate Symmetry		SL'	1	Input: Duty(49:51/51:49) Square wave	–	0.02	1.0	V

BLOCK DIAGRAM





APPLICATION CIRCUIT 1

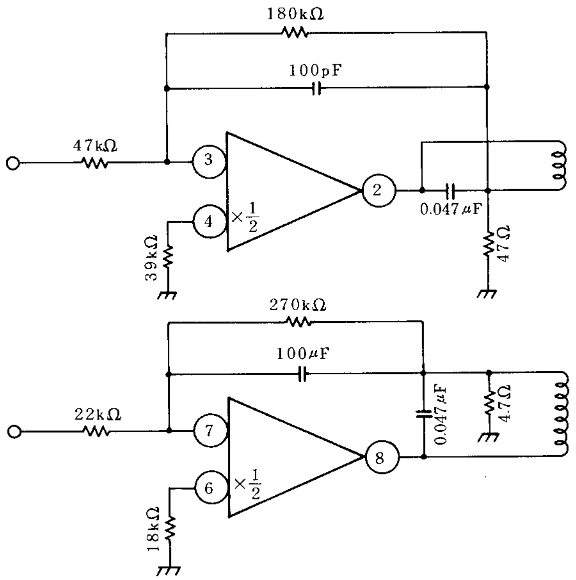


(Usable at a Single Power Supply)

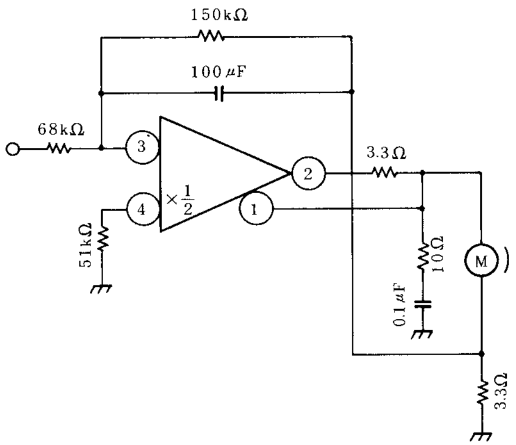
(Note 1) $I_{SC} \fallingdotseq \frac{0.7(V)}{R_{SC}(\Omega)}$ (A)

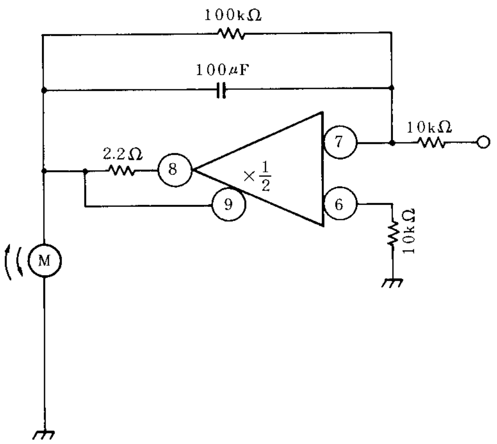
(Note 2) If crosstalk is recognizable remoarkably in applications above 80kHz, change a capacitor to one having a value of about 0.33μF as a compensating circuit. Further, no resistor is needed in this case.

APPLICATION CIRCUIT 2



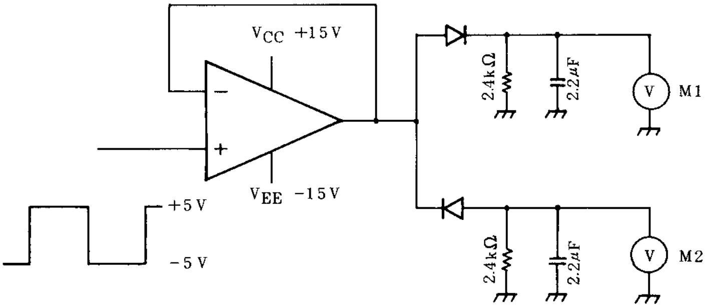
APPLICATION CIRCUIT 3





TEST CIRCUIT 1

Slew Rate, Symmetry SL'



f=38kHz

Duty : 49:51 and 51:49

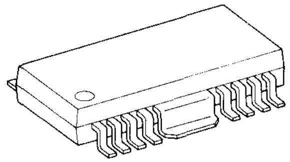
Measured Value M=M1+M2

TA8466F

3 PHASE HALL MOTOR DRIVER

The TA8466F is 3 Phase Hall Motor Driver IC for VCR Deck cylinder motor drive.

- Low Noise by Soft Switching Drive
- Forward Drive
- Small External Condensor Capacity
- Operating Supply Voltage Range : V_{CC}=7~17V
- Hall Sensor Input : V_H=30mVp-p
- Protect Diodes equipped for all inputs
- Built-in Internal Reference
- Built-in Thermal shut down circuit



HSOP16-P-300

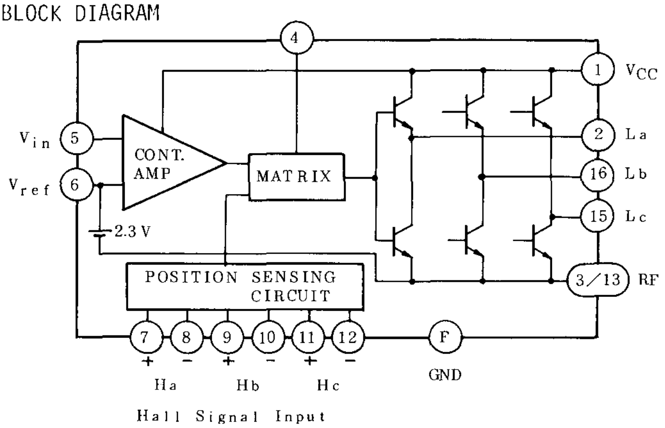
Weight : 0.50g(Typ.)

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	18	V
Output Current	I_O	0.7	A
Power Dissipation	P_D	0.9 (Note 1)	W
		8.3 (Note 2)	
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~150	°C

Note 1 : No Heat Sink Note 2 : Tc=25°C

BLOCK DIAGRAM



(Note)

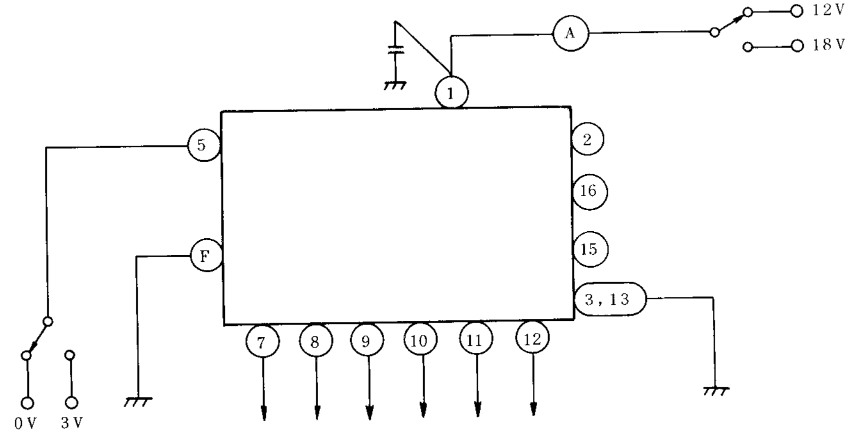
- However pin 4 voltage is same as V_{CC}, pin 4 is to be opened.
- Also pin 6 is to be opened.
- Pin 14 is N.C. pin.

ELECTRICAL CHARACTERISTICS (V_{CC}=12V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC1}	1	Vin=0V	1.5	3.0	4.5	mA
		I_{CC2}		Vin=3V	18	50	95	
		I_{CC3}		V_{CC}=18V, Vin=3V	18	55	110	
Control AMP.	Ref. Voltage	V_{ref}	2		2.2	2.3	2.4	V
	Control Gain	G_V		RF=1Ω	–	1.0	–	
	Input Current	I_{in}		Vin=3.5V	–	2.5	10	μA
	Ref. Voltage Ripple Rejection Ratio	R_r			-53	-64	–	dB
Cut-off Current	Upper Side	$I_{OL(U)}$	3	V_{CC}=18V	–	–	50	μA
	Lower Side	$I_{OL(L)}$		V_{CC}=18V	–	–	50	
Saturation Voltage	Upper Side	$V_{sat(U)}$	4	I_L=0.7A	–	1.2	1.6	V
	Lower Side	$V_{sat(L)}$		I_L=0.7A	–	0.5	0.85	
Gain Difference		ΔG_V	2		–	–	±1	%
Residual Output Voltage		V_{OR}	2	Vin=0V	–	0	12	mV
Hall Amp.	Input Voltage Range	V_H	–		30	–	200	mVp-p
	Common Mode Voltage Range	CMRH			2.0	–	V_{CC}-3	
	Input Offset Voltage	V_{HO}	–		–	0	5	mV
Thermal Shut Down Circuit Operating Temperature		T_{SD}	–		–	155	–	°C

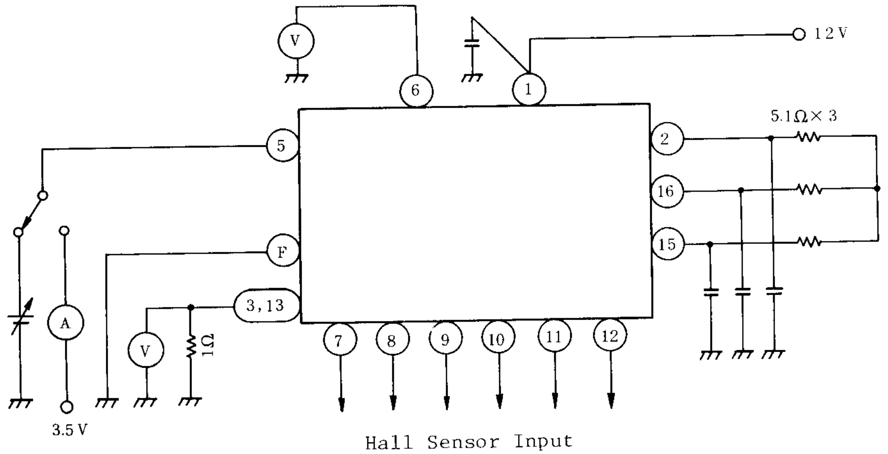
TEST CIRCUIT-1

I_{CC1}, I_{CC2}, I_{CC3}



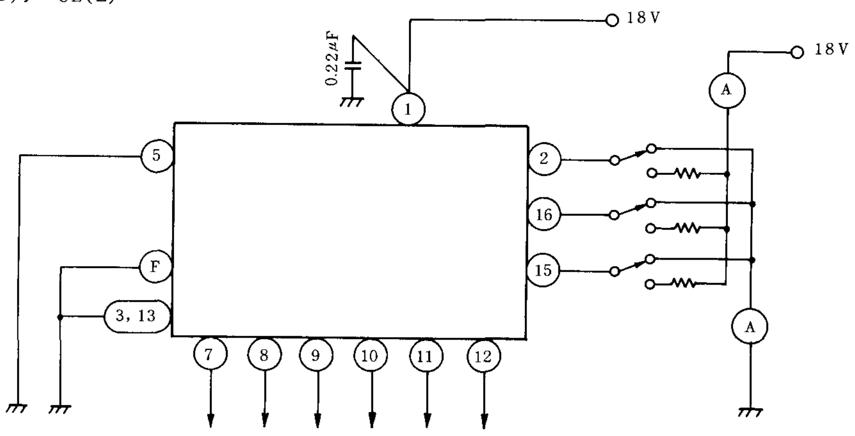
TEST CIRCUIT-2

V_{reg}, G_V, I_{in}, R_r, ΔG_V, V_{or}



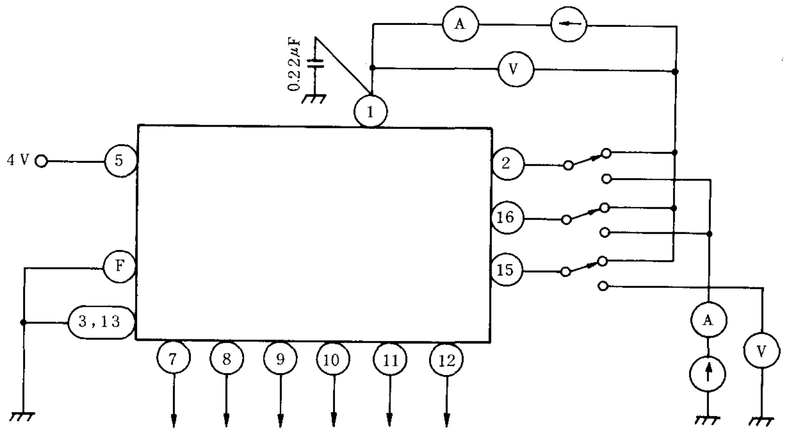
TEST CIRCUIT-3

$I_{OL(U)}$, $I_{OL(L)}$



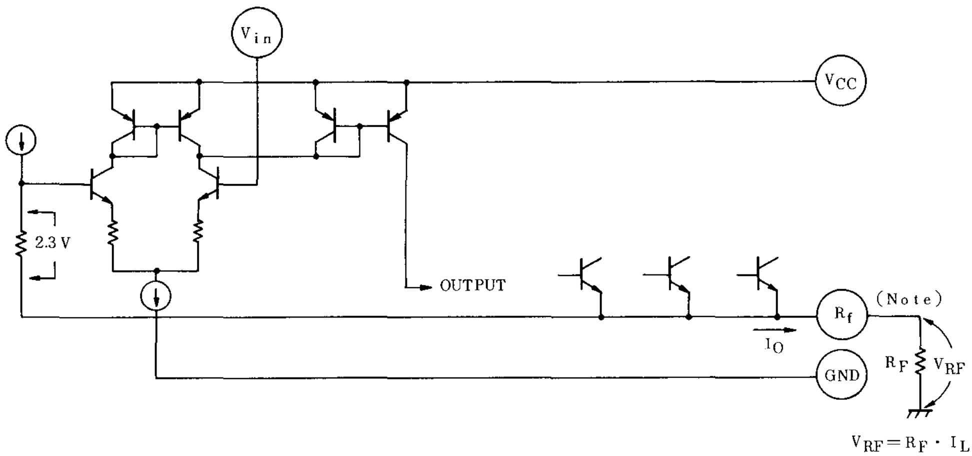
TEST CIRCUIT-4

$V_{sat(U)}$, $V_{sat(L)}$



* Note: V_{CC} shall be impressed while hall sensor signal is applied to input. Otherwise through current will flow.

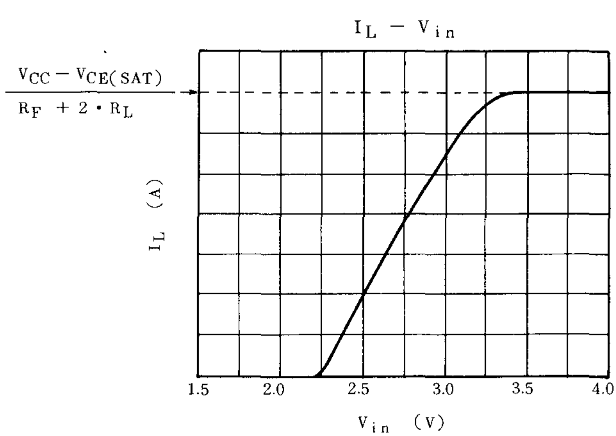
1. CONTROL INPUT CIRCUIT



V_{RF} (=RF · IL) of feed back voltage is feed backed to negative input of control amplifier internally.

(Note)
2 terminals (③, ⑬ pins) are provided for RF terminal to decrease the interference caused by internal common impedance.

INPUT-OUTPUT CHARACTERISTIC

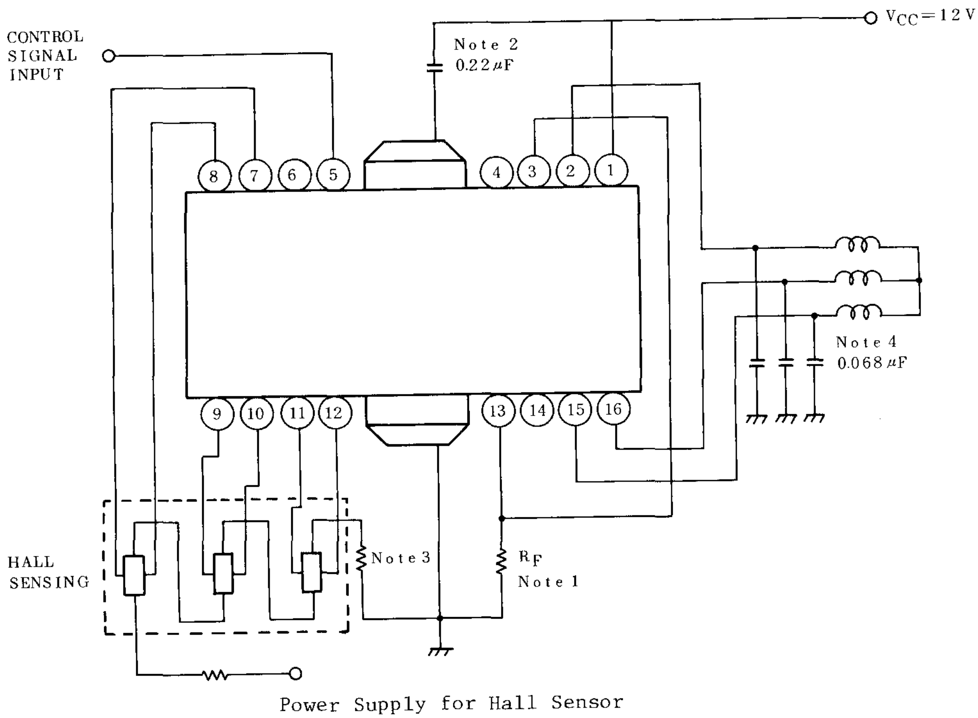


Gain ≑ Double

RL: Output Coil Resistance

$V_{CE(sat)}$: Output Saturation Voltage (Upper and Lower Side Total)

APPLICATION CIRCUIT



Note 1) Recommendable value of RF is 0.3 to 5Ω. It depends on required initial torque, gain, coil impedance and control voltage of Pin 5.

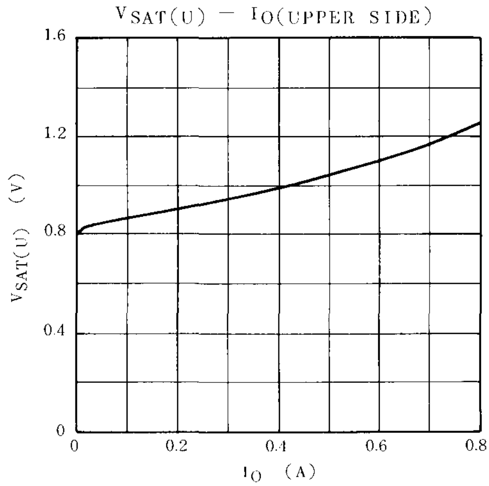
Note 2) To connect directly to IC Pin and GND to eliminate the influence of common impedance. It is required to increase the value of this capacitance for stable operations in case of poor wiring or patterning of PCB.

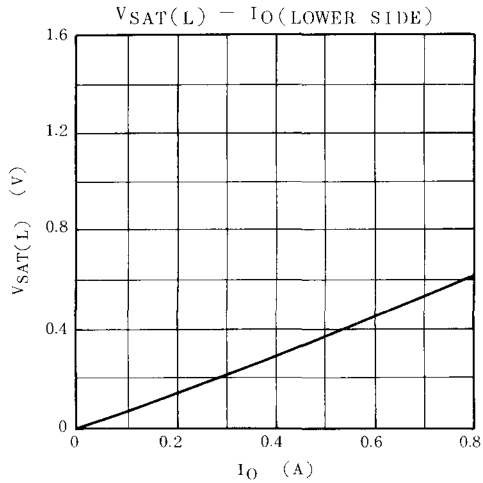
Note 3) Special care should be taken not to have a common impedance with GND line, RF GND and Hall Sensor GND line.

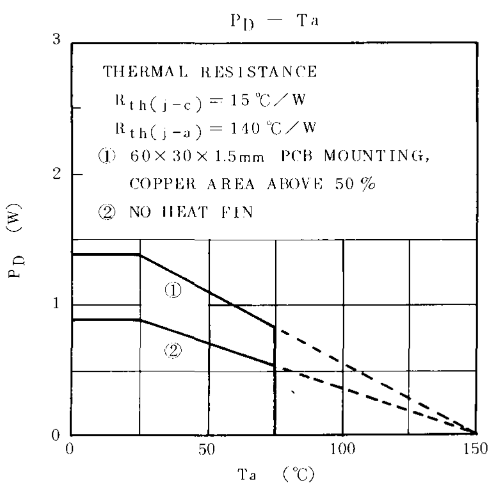
Note 4) Please select to optimum value for eliminate a virbration noise and parasitic oscillation.

Note 5) Hall signal input min 30mVp-p。 The signal smaller than this can cause through current.

OUTPUT AMP. SATURATION VOLTAGE CHARACTERISTICS





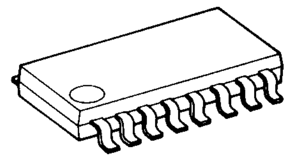


TA8473F

TENTATIVE DATA

FAN MOTOR DRIVER IC

The TA8473F is a fan motor driver IC.
The output current is 0.4A (AVE) and all functions needed for fan motor driving have been incorporated into 1 chip.
This IC is provided with the function to automatically change the motor speed by detecting ambient temperature through the externally mounted thermistor.
Furthermore, the TA8473F is provided with the noise reduction terminal, the FG terminal to output pulses proportional to the motor speed and the RD terminal to detect the motor status.



SSOP16-P-225A

Weight : 0.14g(Typ.)

- Built-in automatic self rotation recovery circuit after release of motor locking.
- Thermal shutdown circuit incorporated.
- Operating voltage : 6~13.8V
- 2 kind of speed of full-speed and half-speed are variable according to ambient temperature.
- Speed change point temperature is externally settable.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Output Terminal Breakdown Voltage		V_{CER}	30	V
Operating Supply Voltage		$V_{CC(opr)}$	13.8	V
Output Current	AVE	$I_{O(ave)}$	0.4	A
	PEAK	$I_{O(peak)}$	1.2 (Note 1)	
RD Output Current		I_{RD}	10	mA
FG Output Current		I_{FG}	10	mA
Hall Input Voltage		V_{HM}	300 (Note 2)	mV
Power Dissipation		P_D	800 (Note 3)	mW
Operating Temperature		Topr	-30~85	°C
Storage Temperature		Tstg	-55~150	°C

(Note 1) t=0.1sec

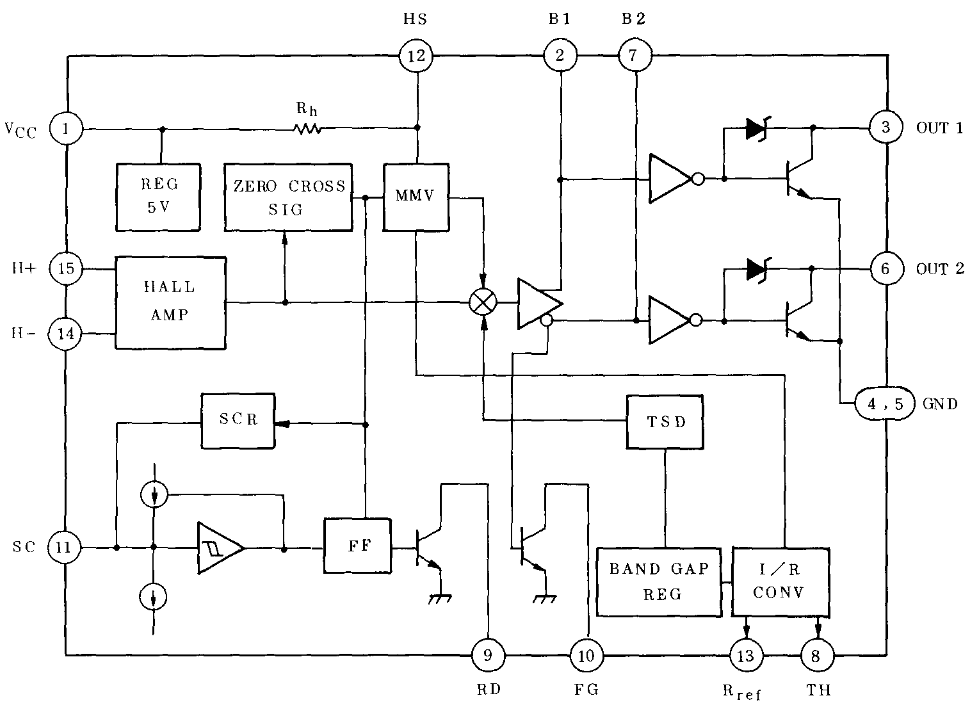
(Note 2) Tj=-25~150°C

(Note 3) This value is obtained by 50×50×1.6mm PCB mounting occupied in excess of 40% of copper area.

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=12V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC}	–	V_{CC}=12V, OUT1"ON"	–	7.0	–	mA
Output Saturation Voltage		V_{SAT1}	–	I_O=0.1A, Tj=25°C	–	0.9	–	V
		V_{SAT2}	–	I_O=0.3A, Tj=25°C	–	1.0	–	
		V_{SAT3}	–	I_O=1.2A, Tj=25°C	–	1.3	–	
Automatic Self Rotation Recovery Circuit	Discharge Current	I_{SL}	–		–	2	–	μA
	Charge Current	I_{SU}	–		–	10	–	
	Discahrge Voltage	V_{SL}	–		–	1.5	–	V
	Charge Voltage	V_{SU}	–		–	4	–	
	Time Constant	T_{SC}	–	C=0.22μF, ON Time		0.25		sec
	Duty	DR	–		–	5	–	
Hall Amp.	Hall Input Voltage	V_{HM}	–		–	±50	±300	mV
	Hysteresis	ΔV_H	–		–	8	–	mV
	Offset Voltage	V_{HO}	–			0		mV
	Operating DC Potential	CMR	–		0	–	V_{CC}-2	V
	Input Bias Current	I_{IN}	–		–	1	–	μA
RD Output Saturation Voltage		$V_{sat(RD)}$	–	I_{RD}=5mA	–	0.15	–	V
FG Output Saturation Votlage		$V_{sat(FG)}$	–	I_{FG}=5mA	–	0.15	–	V
Variable Speed	Terminal Voltage	V_{TH}	–	R_{TH}=10kΩ	–	1	–	V
	Full Speed	$R_{TH(FS)}$	–	R_{ref}=10kΩ	–	6	–	kΩ
	Half Speed	$R_{TH(HS)}$	–	R_{ref}=10kΩ	–	10	–	
Termal Shutdown Operating Temperature		T_{SD}	–		150	–	–	°C

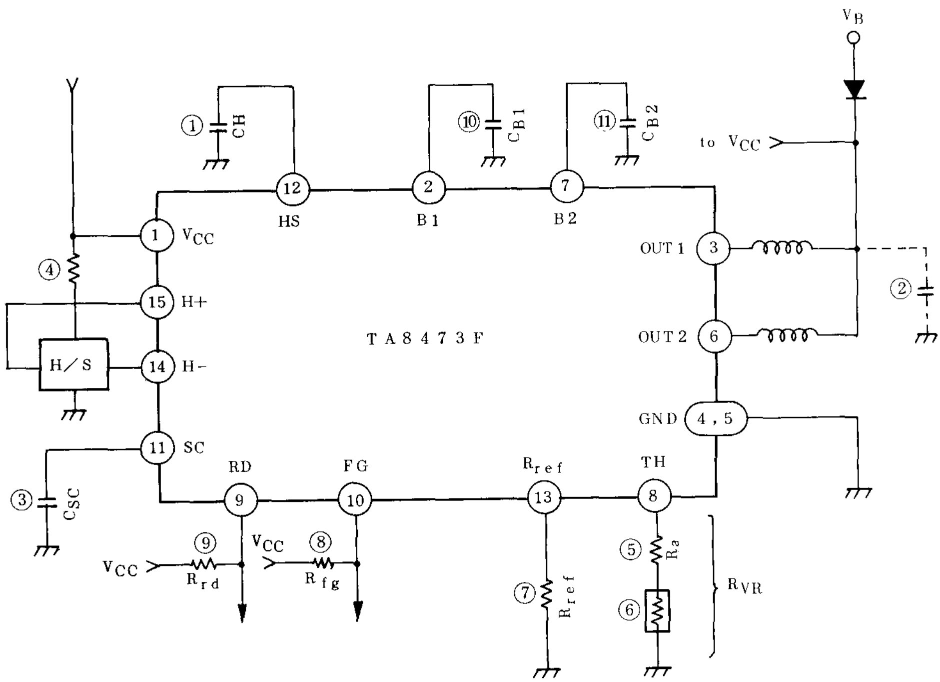
BLOCK DIAGRAM



FUNCTION

MODE	INPUT		OUTPUT	
	H+ (15)	H- (14)	OUT 1 (3)	OUT 2 (6)
Mode 1	H	L	ON	OFF
Mode 2	L	H	OFF	ON

APPLICATION CIRCUIT



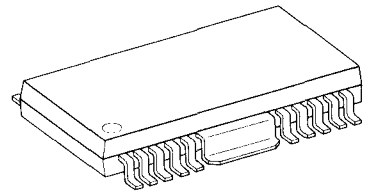
(External Parts)

1	CH	(0.1μF)	The Half-speed is decided by CH and RH
2		T.B.D	Insert this if a noise comes in from the Power Supply.
3	C_{SC}	0.22μF	Capacitor for burning protection circuit.
4		2kΩ	Hall sensor bias resistor.
5	Ra	T.B.D	Resistor for adjusting temperature at which the motor speed changes.
6			Thermistor
7	R_{ref}	(10kΩ)	Reference resistor
8	R_{fg}	10kΩ	Pull-up resistor
9	Rrd	10kΩ	Pull-up resistor
10	C_{B1}	(0.01μF)	Capacitor for noise reduction
11	C_{B1}	(0.01μF)	Capacitor for noise reduction

TA8529F

STEPPING MOTOR DRIVER

TA8529F is Bipolar Stepping Motor Driver IC designed especially for low operating voltage use FDD and other portable equipments.



Weight : 0.79g (Typ.)

- Bipolar Stepping Motor Driver
- Low Saturation Voltage Type
  Saturation Voltage≦0.95 V at I_O=400mA
- 1,2 and 1-2 Phase Excitation Dtive Available
- Stand-by Mode Available
  I_{CC} Stand-by≦15μA
- Built-in Punch Through Current Restriction Circuit
- Output Current Up to 500mA (PEAK)
- Sealed in PFP 20 SM Package

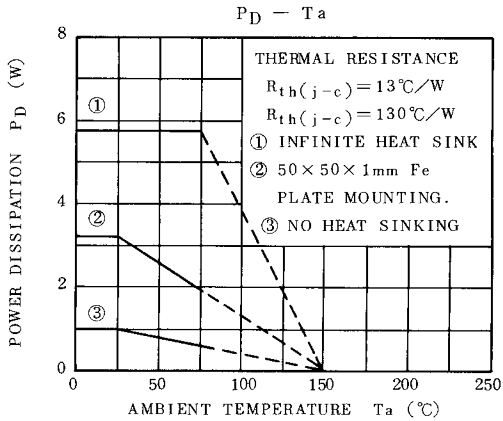
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC1}	7.0	V
	V_{CC2}	17.0	
Output Current	$I_{O(MAX)}$	±500	mA
Input Voltage	V_{IN}	~V_{CC1}	V
Power Dissipation	P_D	1.0	W
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~150	°C

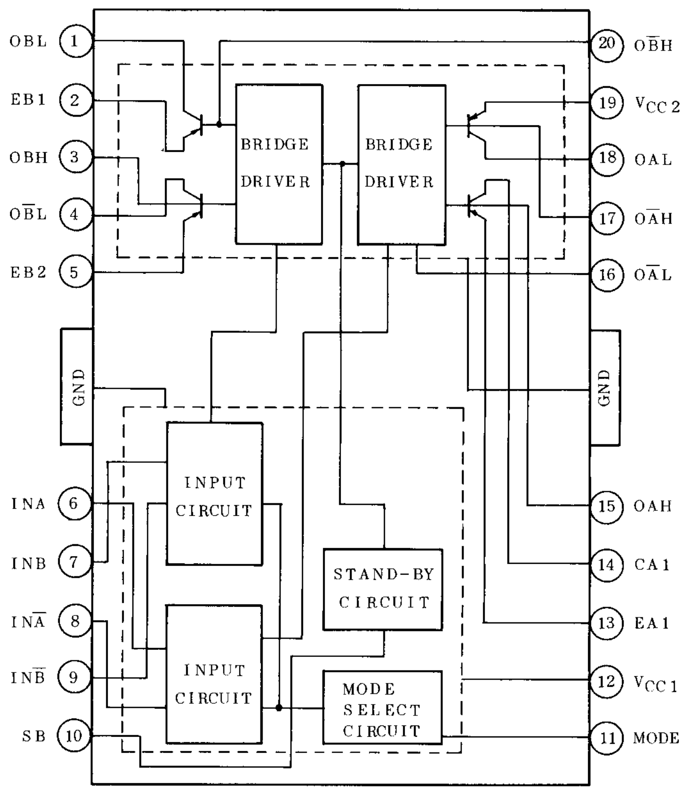
Recommendable Operating Voltage

V_{CC1}=4.5~5.5V

V_{CC2}=4.5~13.2V



BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC1}=5V, V_{CC2}=12V)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{CC1}	–	V_{SB}=5V, Output open	–	–	5	μA
	I_{CC2}			–	–	10	
	I_{CC1}	–	V_{SB}=5V, Output Open ⑥ =5V, ⑦ , ⑧ , ⑨ =0V	–	–	5	μA
	I_{CC2}			–	–	10	
	I_{CC1}	–	V_{SB}=5V, Output open ⑥ , ⑦ =5V, ⑧ , ⑨ =0V	–	–	5	μA
	I_{CC2}			–	–	10	
	I_{CC1}	–	Output open V_{SB}=0V ⑥ =5V, ⑦ , ⑧ , ⑨ =0V	–	25	30	mA
	I_{CC2}			–	20	25	
	I_{CC1}	–	Output open V_{SB}=0V ⑥ , ⑦ =5V, ⑧ , ⑨ =0V	–	35	44	mA
	I_{CC2}			–	35	47	
	I_{CC1}	–	Output open V_{SB}=0V V_{MODE}=0V, ⑥⑦⑧⑨ =0V	–	35	44	mA
	I_{CC2}			–	35	47	
Input Operating Voltage	V_{INH}	–	⑥ , ⑦ , ⑧ , ⑨ PIN	2.0	–	V_{CC1}	V
	V_{INL}			GND	–	0.8	
	V_{SBH}	–	⑩ PIN	3.5	–	V_{CC1}	V
	V_{SBL}			GND	–	2.0	
	V_{MODEH}	–	⑪ PIN	3.5	–	V_{CC1}	V
	V_{MODEL}			GND	–	2.0	
Input Current	I_{INH}	–	V_{IN}=3.5V ⑥ , ⑦ , ⑧ , ⑨ PIN	–	-2	-10	μA
	I_{INL}		V_{IN}=0.4V	–	-200	-300	
	I_{SBH}	–	V_{SB}=3.5V ⑩ PIN	–	-30	-45	μA
	I_{SBL}		V_{SB}=0.4V	–	-150	-220	
Output Saturation Voltage $V_{sat1}=V_{satH1}+V_{satL1}$ $V_{sat2}=V_{satH2}+V_{satL2}$	V_{satH1}	–	I_O=100mA	–	0.1	–	V
	V_{satH2}	–	I_O=400mA	–	0.15	–	
	V_{satL1}	–	I_O=100mA	–	0.1	–	V
	V_{satL2}	–	I_O=400mA	–	0.45	–	
	V_{sat1}	–	I_O=100mA	–	0.2	0.4	V
	V_{sat2}	–	I_O=400mA	–	0.6	0.95	
Diode Forward Voltage	V_F	–	I_F=400mA	–	1.4	1.6	V
Delay Time	t_{pLH}	–	IN-ϕ	–	40	–	μs
	t_{pHL}			–	5	–	

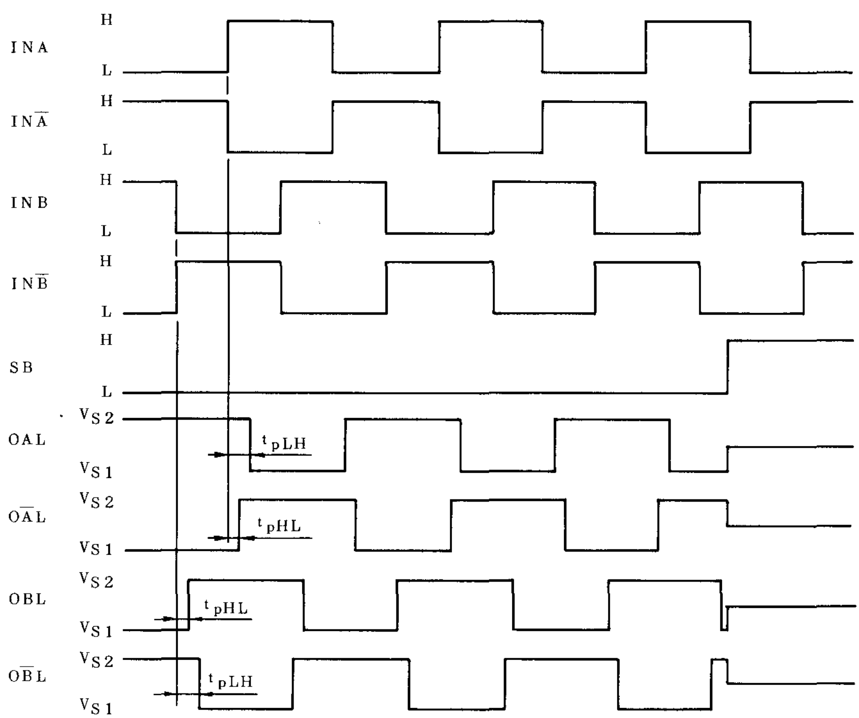
LOGIC DIAGRAM

INPUT				OUTPUT		
SB	MODE	INA(B)	$\overline{\text{INA}}(\overline{\text{B}})$	OA(B)L	$\overline{\text{OA}}(\overline{\text{B}})$L	
L	H	L	L	∞	∞	OPERATION
L	H	H	H	∞	∞	OPERATION
L	H	H	L	L	H	OPERATION
L	H	L	H	H	L	OPERATION
L	L	L	L	H	L	OPERATION
L	L	H	L	L	H	OPERATION
H	X	X	X	∞	∞	STABD-BY

X: Don't Care

∞: High Impedance

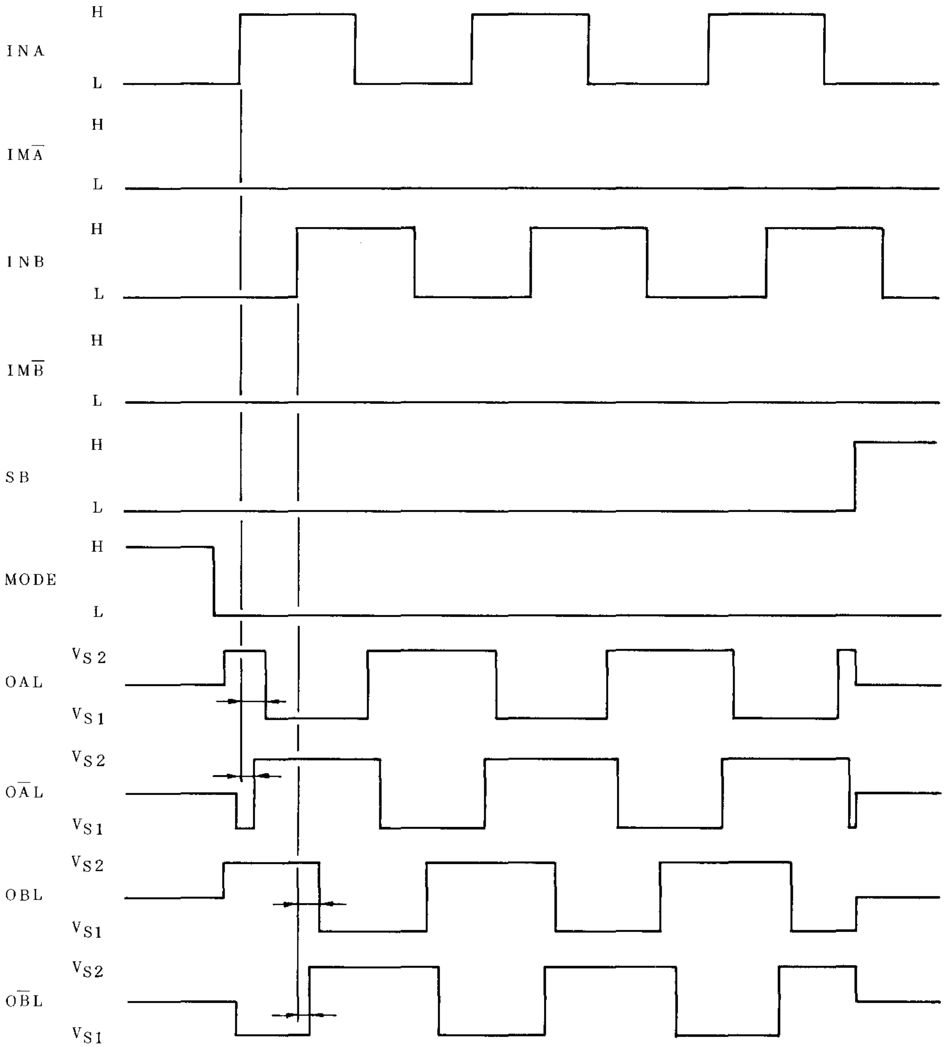
TIMING CHART 1



$V_{S2} = V_{CC2} - V_{sat\,H}$ t_{pLH} : 40 μs

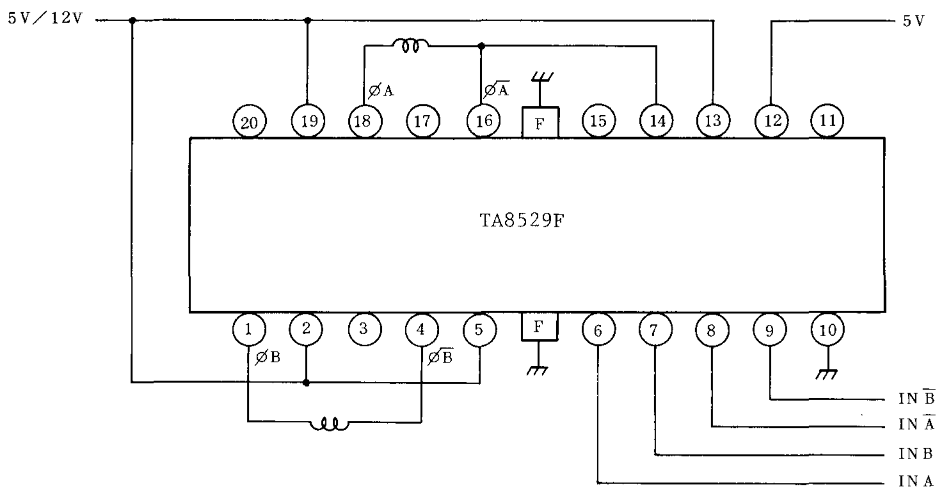
$V_{S1} = V_{sat\,L}$ t_{pHL} : 5 μs

TIMING CHART 2

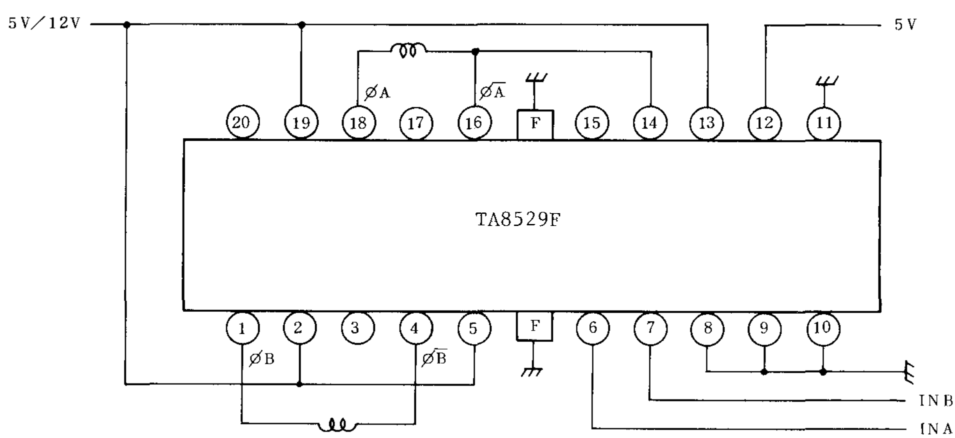


APPLICATION CIRCUIT

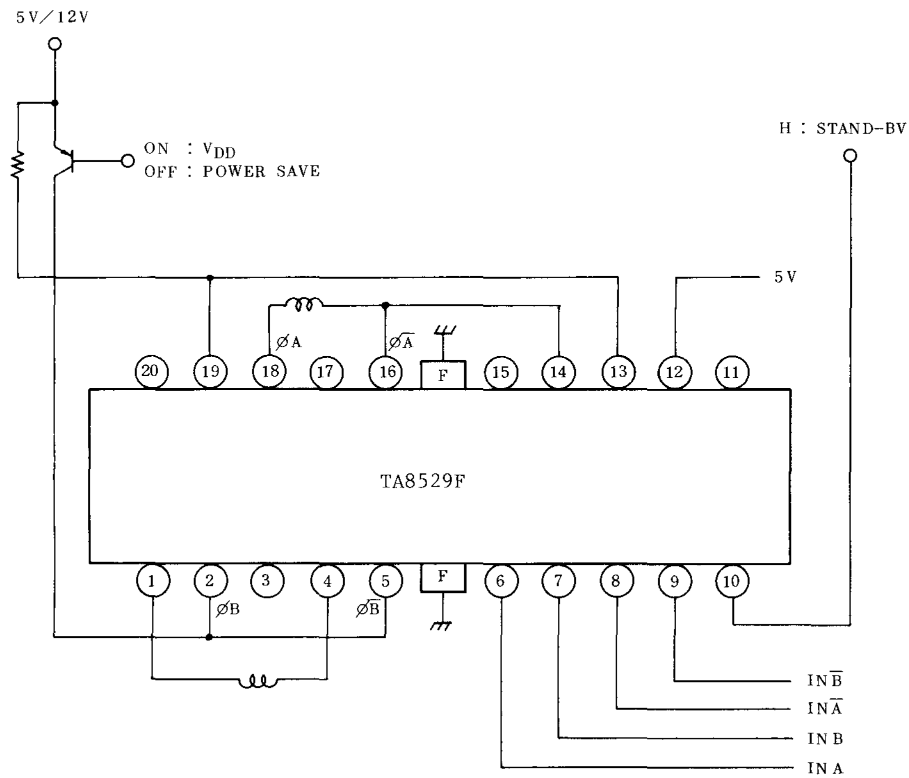
1. 1,2, 1-2 PHASE (INA, INB, IN$\overline{A}$, IN$\overline{B}$)



2. 2 PHASE (INA, INB)



3. POWER SAVE APPLICATION CIRCUIT

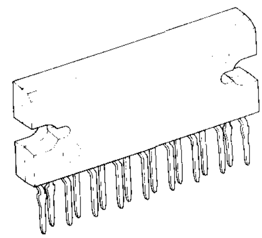


TB6500AH

TENTATIVE DATA

STEPPING MOTOR SYSTEM DRIVER

TB6500AH is Stepping Motor System Driver IC incorporates Dual Bipolar Stepping Motor Drivers, DC Motor Driver and Serial to Parallel Signal Conversion Circuit (12 bit Serial to Parallel Shift Resistor with Latch) which control the 3 Output Drivers states by menas of Input Serial Signal trains.



HZIP25-P

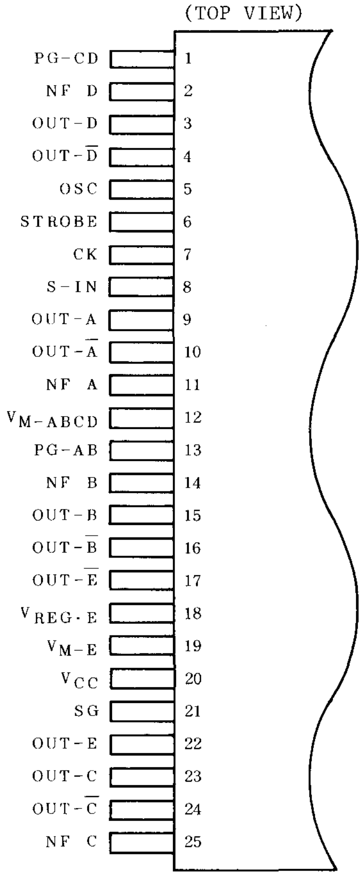
Weight : 9.9g (Typ.)

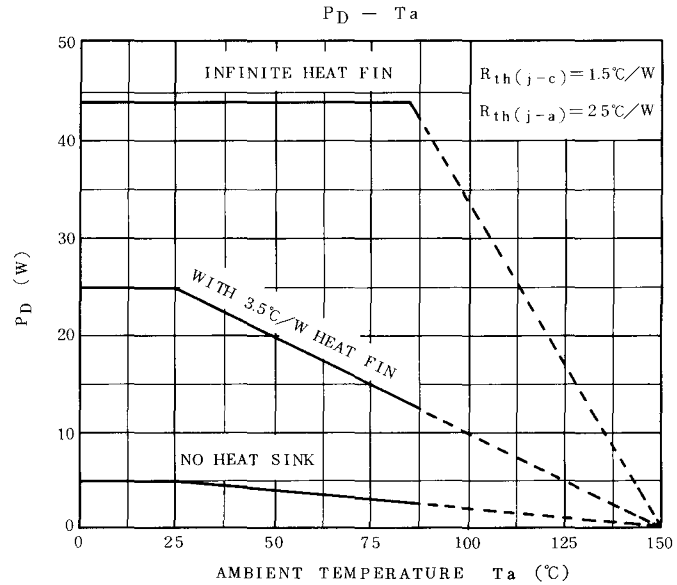
- 2 Bipolar Stepping Motors and 1 Brush DC Motor (or Solenoid) are controlled by input serial signal trains and latch signals.
- Output Current up to 0.8A (for Stepper) and 0.6A (for DC Motor).
- PWM Chopper type Stepping Motor Drivers.
- All C-MOS Compatible Inputs.
- Operating Supply Voltage : V_M=0~27V
  V_{CC}=4.5~5.5V

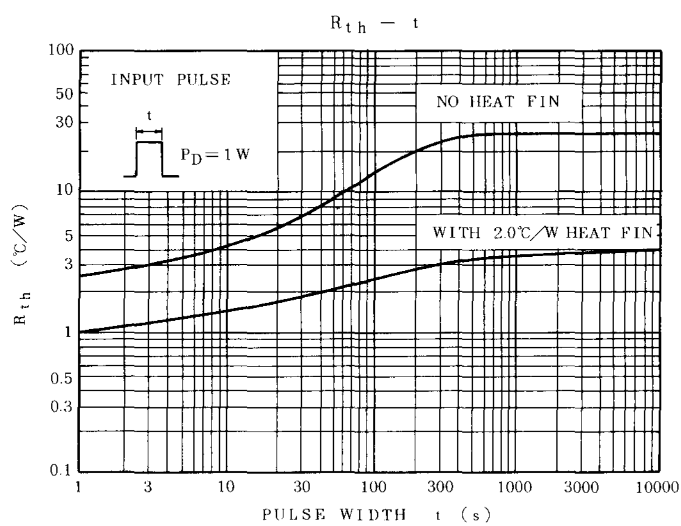
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage (Motor)		V_M	30	V
Supply Voltage (Control)		V_{CC}	5.5	V
Input Voltage		V_{IN}	5.5	V
Output Current		I_{O1}, I_{O2}	0.8	A
		I_{O3}	0.6	
Power Dissipation	Tc=85°C	P_D	43.0	W
			5.0	
Operating Temperature		Topr	-40~85	°C
Storage Temperature		Tstg	-55~150	°C

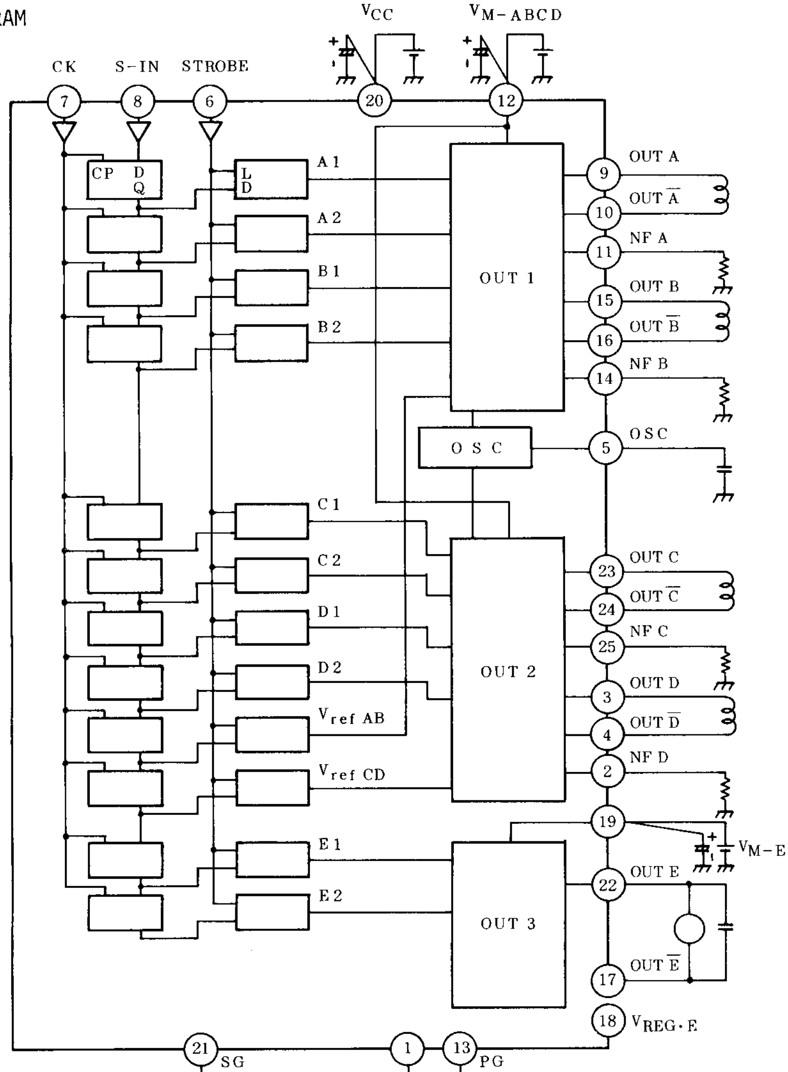
PIN CONNECTION




PD — Ta
INFINITE HEAT FIN
Rth(j-c)=1.5℃/W
Rth(j-a)=25℃/W
WITH 3.5℃/W HEAT FIN
NO HEAT SINK
PD (W)
50
40
30
20
10
0
0
25
50
75
100
125
150
AMBIENT TEMPERATURE Ta (℃)


Rth — t
INPUT PULSE
t
PD=1W
NO HEAT FIN
WITH 2.0℃/W HEAT FIN
Rth (℃/W)
100
50
30
10
5
3
1
0.5
0.3
0.1
1
3
10
30
100
300
1000
3000
10000
PULSE WIDTH t (s)

BLOCK DIAGRAM



Note 1 : Capacitance
Terminal is required to change to optimum value for noise elimination and also required to connect directly to each Power Supply Terminal (V_{CC}, V_M) and the corresponding GND Terminal (See Table) for stable operations.

Note 2 : Heat Fin is connect to GND terminal with Low Impedance.

Table 1

GND	POWER SUPPLY
Pin 21 (SG)	Pin 20 (V_{CC})
Pin 13 (PG)	Pin 12 (V_{MABCD})
Pin 1 (PG)	Pin 19 (V_{M-E})

INPUT SERIAL PULSE TRAIN (8 PIN) AND POWER OUTPUT STATES

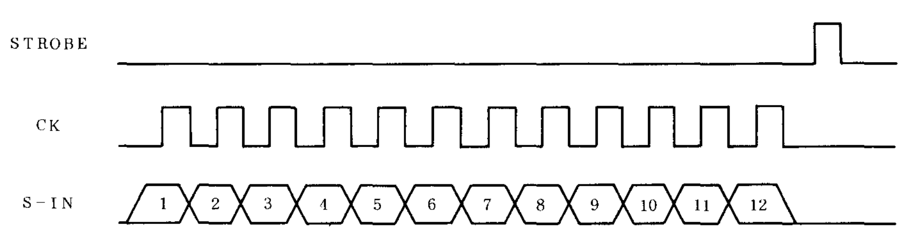
SERIAL INPUT SIGNAL TRAIN			CONTROL	OPERATION
Serial Signal Train (↑)	1	E2	DC Motor Control	(see table 1 below)
	2	E1		
	3	V_{ref} CD	Stepping Motor 2 Chopping Rate Control (V_{ref} CD)	V_{ref}=0.85V Typ.(at "H" Mode) =0.65V Typ.(at "L" Mode)
	4	V_{ref} AB	Stepping Motor 1 Chopping Rate Control (V_{ref} AB)	
	5	D2	Stepping Motor 2 Control (OUT C,D)	(see table 2 below)
	6	D1		
	7	C2		
	8	C1		
	9	B2	Stepping Motor 1 Control (OUT A,B)	
	10	B1		
	11	A2		
	12	A1		

INPUT		OUTPUT		MODE
E1	E2	E	$\overline{E}$	
L	L	∞	∞	STOP
H	L	H	L	CW/CCW
L	H	L	H	CCW/CW
H	H	L	L	BRAKE

INPUT		OUTPUT		MODE
A1	A2	A	$\overline{A}$	
L	L	∞	∞	STOP
H	L	H	L	CW/CCW
L	H	L	H	CCW/CW
H	H	∞	∞	STOP

B1, B2→B, $\overline{B}$ C1, C2→C, $\overline{C}$
D1, D2→D, $\overline{D}$ are all the same.

INPUT SERIAL PULSE TRAIN TIMING CHART



RECOMMENDED OPERATION CONDITION

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage (Control)		V_{CC}		4.5	5.0	5.5	V
Supply Voltage (Motor)		V_M		21.6	24	26.4	V
Input Voltage		V_{IN}		0	–	V_{CC}	V
Output Current	I_{OUT} A,B,C,D	I_{OUT}	Ta=0~70°C, V_{CC}=5V V_M=24V	–	–	0.7	A
	I_{OUT} E			–	–	0.6	
Clock Frequency		f_{CLOCK}		–	–	1.0	MHz
		f_{STROBE}		–	–	1.0	
Clock Pulse Width		t_W CLOCK		500	–	–	ns
		t_W STROBE		500	–	–	
Data Set Up Time		$t_{set\ up}$		250	–	–	ns
Data Hold Time		t_{HOLD}		250	–	–	ns
PWN Oscillation Frequency		f_{PWM}		20	–	100	kHz

ELECTRICAL CHARACTERISTICS

OUTPUT STAGE ($Ta=25°C$, $V_{CC}=5V$, $V_M=24V$)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Operation Power Supply Voltage		$V_M(opr)$	-			0	-	27	V
Saturation Voltage	AB	$V_{CE(SAT)}$ Upper	1	$I_{OUT}=0.7A$	Output-V_M	-	2.2	2.7	V
	CD			$I_{OUT}=0.5A$		-	2.0	2.5	
	AB	$V_{CE(SAT)}$ Lower	1	$I_{OUT}=0.7A$	Output-NF	-	1.5	2.0	
	CD			$I_{OUT}=0.5A$		-	1.3	1.8	
	E	$V_{CE(SAT)}$ Upper	1	$I_{OUT}=0.5A$	Output-V_M	-	2.2	2.7	
				$I_{OUT}=0.3A$		-	2.0	2.5	
	E	$V_{CE(SAT)}$ Lower	1	$I_{OUT}=0.5A$	Output-NF	-	1.5	2.0	
				$I_{OUT}=0.3A$		-	1.2	1.7	
Output Leak Current		I_{OL-H}	2	$V_{CE}=30V$		-	-	50	μA
		I_{OL-L}				-	-	50	
Clamp Diode Forward Voltage	AB	V_{F-U}	3	$I_F=700mA$	Output A-D	-	1.6	2.0	V
	CD	V_{F-L}				-	1.2	1.6	
	E	V_{F-U}	3	$I_F=500mA$	Output E	-	1.5	1.9	
		V_{F-L}				-	1.3	1.7	
Ech Output Voltage		V_{OE}	1	$I_O=0.5A$	$V_{REG.E}=15V$	-	15	-	V
				$I_O=0.3A$		-	15	-	
Reference Voltage		$V_{REG.Eopr}$	1			0	-	22	V
Reference Current		I_{REG}	1			-	50	100	μA

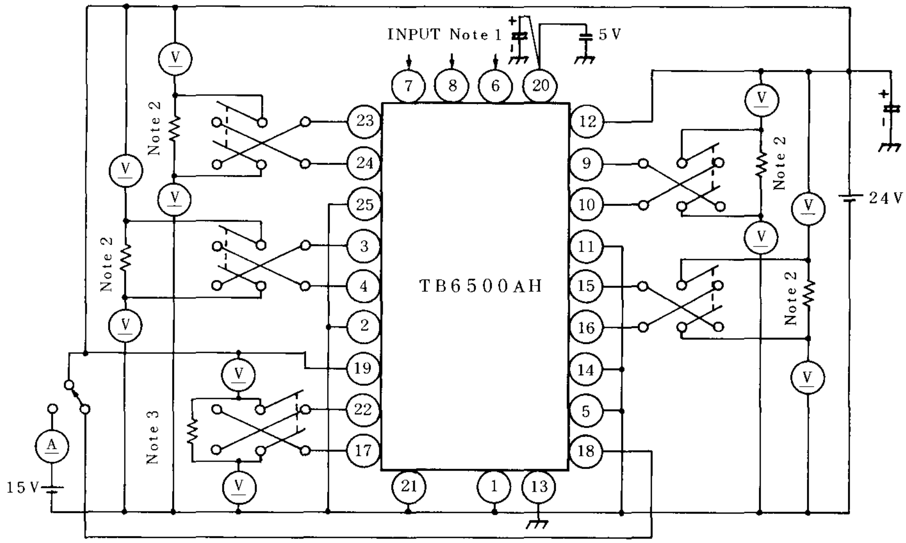
SMALL SIGNAL STAGE (Ta=25°C, V_{CC}=5V, V_M=24V)

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage	$V_{CC(opr)}$	-			4.5	-	5.5	V
Quiescent Current	I_{CC1}	4	CK, STROBE, SIN: Open		-	30	50	mA
	I_{CC2}		CK:1MHz, S-IN:1/2CK Output On Mode		-	30	50	
	I_{CC3}		CK:1MHz, S-IN:1/2CK Output Off Mode		-	30	50	
	I_M ABCD		Output Open Output On Mode		-	30	40	
			Output Open Output Off Mode		-	-	50	μA
	I_M E		CW, CCW, BRAKE Output On, Output Open		-	5	12	mA
			Output Off, Output Open		-	-	50	μA
Input Voltage	$V_{IN(H)}$	5	CK, S-IN, STROBE		3.5	-	V_{CC} +0.4	V
	$V_{IN(L)}$				GND -0.4	-	1.5	
Input Current	$I_{IN(H)}$	5	V_{IN}=5.4V		-3	-	3	μA
	$I_{IN(L)}$		V_{IN}=0.4V		-3	-	3	
Chopping Voltage Level	$V_{ref(H)}$	6	Tj=40~125°C C_{OSC}=3300pF R_{NF}=3.3Ω L=19.5mH	V_{ref} IN=H	0.75	0.85	0.95	V
	$V_{ref(L)}$			V_{ref} IN=L	0.55	0.65	0.75	
V_{ref} Level Differential Voltage	ΔV_{ref}	6	$V_{ref(H)}-V_{ref(L)}$		-	0.2	-	V
Reset Voltage	V_{CCR}	7			3.6	3.88	4.1	V
Min. Reset Pulse	tV_{CCR}				-	-	1	μS
Min. PWM Frequency	f_{PWML}	4			-	-	10	kHz
Max. PWM Frequency	f_{PWMH}				200	-	-	
Thermal Shut Down	$T_{SD(ON)}$	-			120	140	160	°C
	$T_{SD(OFF)}$				110	130	150	
Differential Temperature	ΔT_{SD}		$T_{SD(ON)}-T_{SD(OFF)}$		-	10	-	

AC CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M=24V)

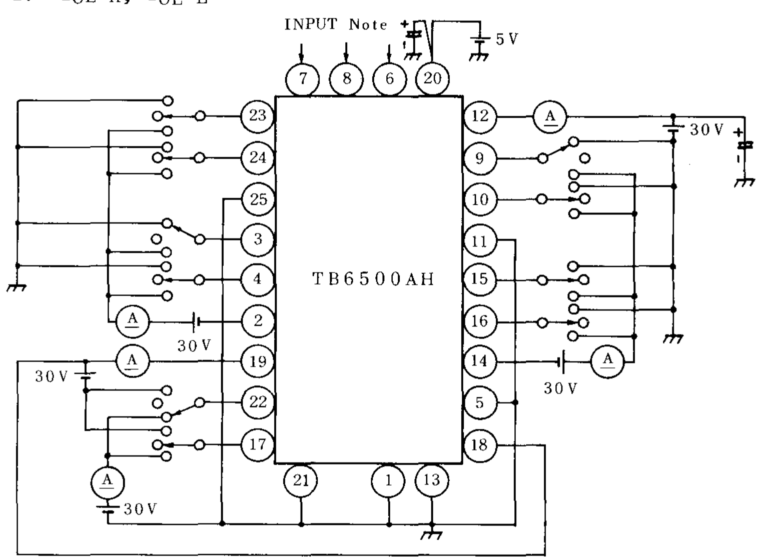
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Clock Frequency	f_{CLOCK}	7			–	–	1.5	MHz
	f_{STROBE}				–	–	1.5	
Min. Clock Pulse Width	t_{CLOCK}	7			340	–	–	ns
	t_{STROBE}				340	–	–	
Data Set Up Time	$t_{suCLK-S.IN}$	7			170	–	–	ns
	$t_{suST-CLK}$				170	–	–	
Data Hold Up Time	$t_{hCLK-S.IN}$				170	–	–	
	$t_{hST-CLK}$				170	–	–	
Output Propagation Time	t_{pLH}	7	CLK-OUT	R_L=40Ω, C_L=15pF	–	2	–	μs
	t_{pHL}				–	2	–	
	t_{pLH}		STROBE-OUT		–	2	–	
	t_{pHL}				–	2	–	
	t_{pON-Z}		V_{CC}.R-OUT		–	2	–	
	t_{pZ-ON}				–	2	–	
Max. Clock Rise Time	t_{rMAX}	7			–	–	1	μs
Max. Clock Fall Time	t_{fMAX}				–	–	1	
Output Rise Time	t_r		R_L=40Ω, C_L=15pF		–	1	–	
Output Fall Time	t_f				–	1	–	
Ech Output Dead Time	t·dead		R_L=100Ω, C_L=15pF		–	250	–	

TEST CIRCUIT 1. $V_{SATU-1,2}$, $V_{SATL-1,2}$



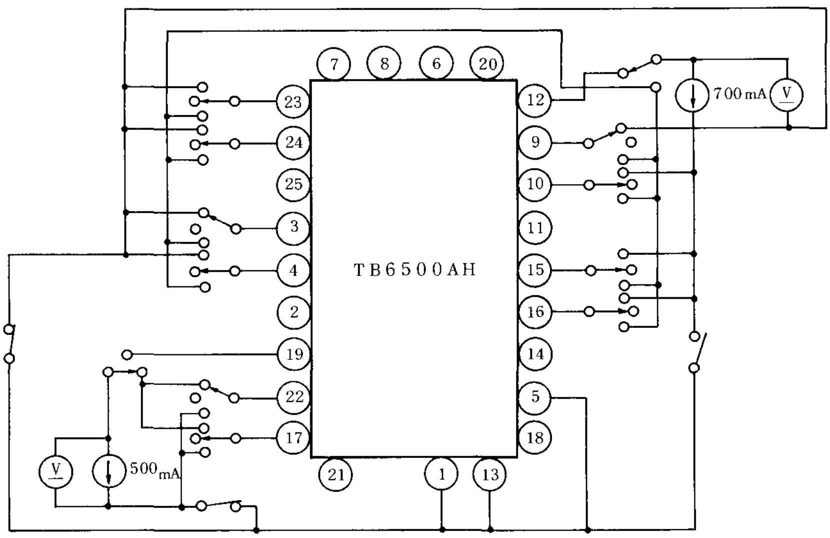
Note 1. Sets Output Transistor active with Input mode select.
Note 2. Calibrate Output Current becomes 0.5A (or 0.7A) with this resistor.
Note 3. Calibrate Output Current becomes 0.3A (or 0.5A) with this resistor.

TEST CIRCUIT 2. I_{OL-H}, I_{OL-L}



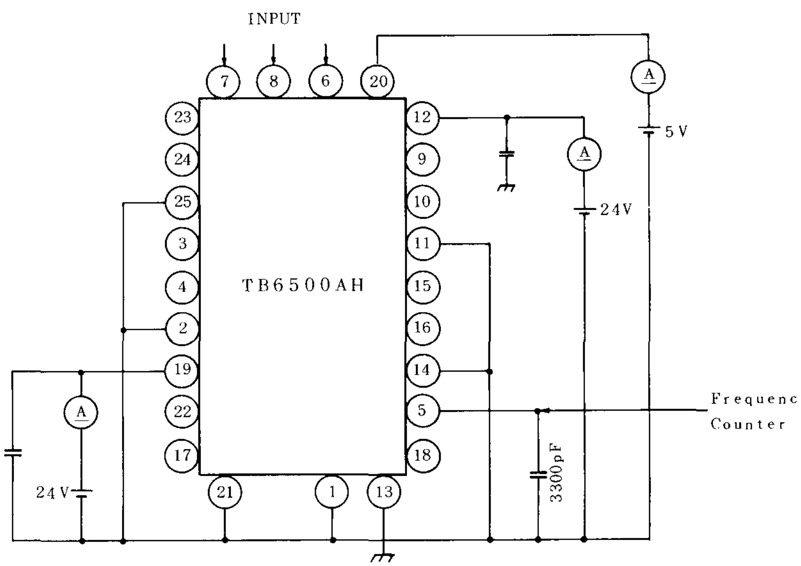
Note. All "L" level S-IN signal, normal CK and Strobe signals are required to measure.

TEST CIRCUIT 3. $V_{F-U1,2}$, $V_{F-L1,2}$

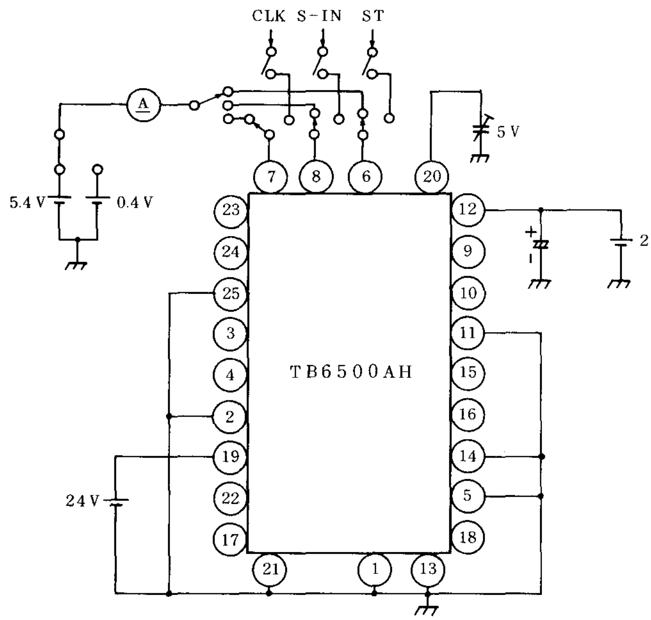


Note. Not to take a GND with any non-connecting Pins.

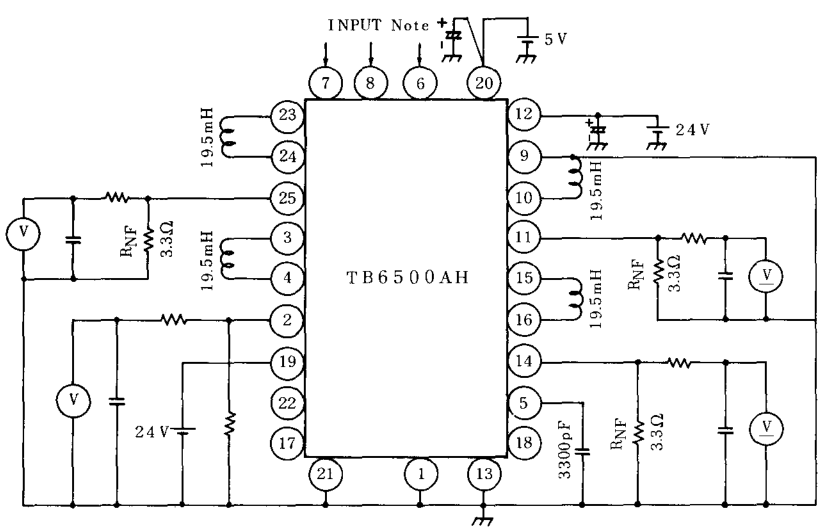
TEST CIRCUIT 4. $I_{CC1,2}$, I_M:ABCD·E, $f_{PWML \cdot H}$



TEST CIRCUIT 5. I_{INH}, I_{INL}, V_{INH}, V_{INL}, V_{CCR}

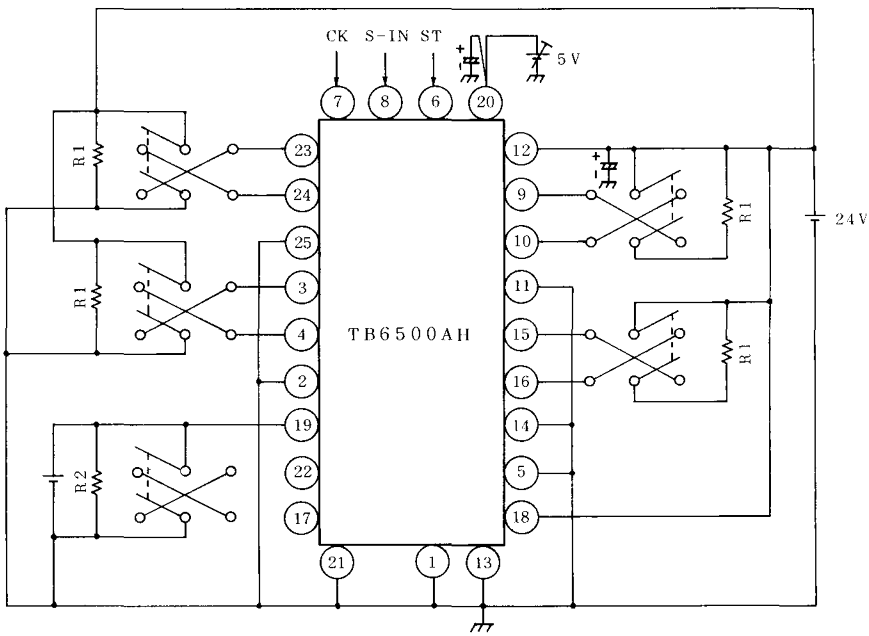


TEST CIRCUIT 6. V_{refH}, V_{refL}, ΔV_{ref}



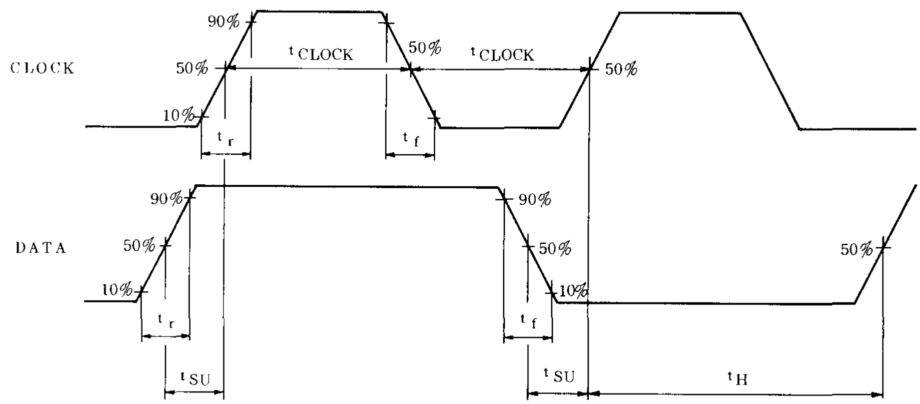
Note. Hold the state (2 phase excitation mode) and measure.

TEST CIRCUIT 7.

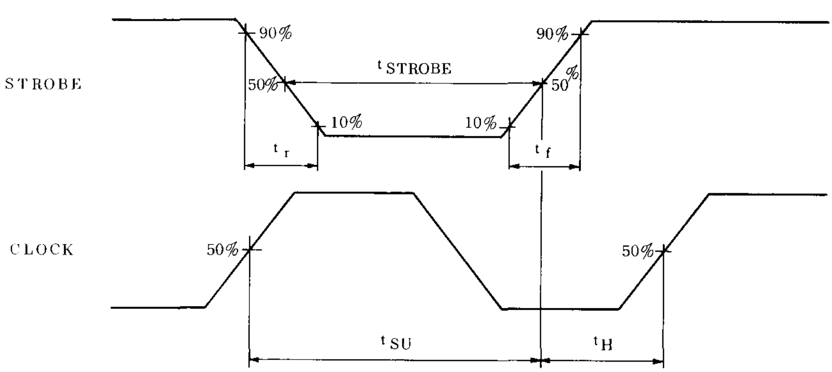


AC ELECTRICAL CHARACTERISTICS

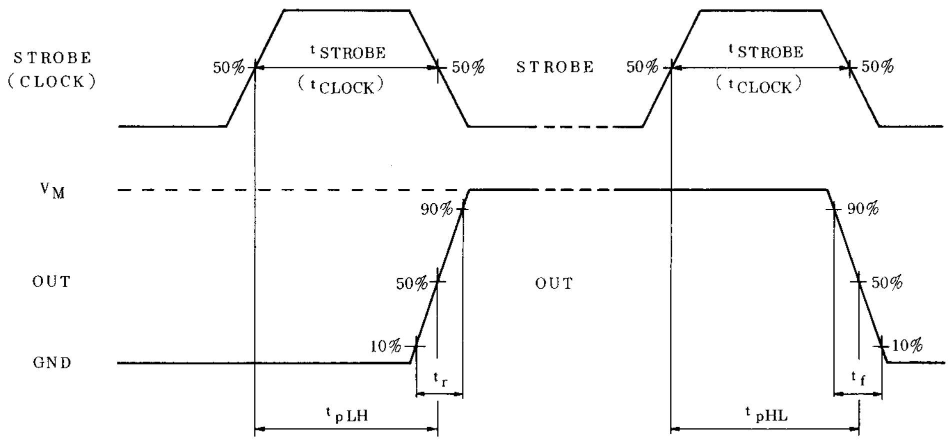
7-1 CLOCK-DATA



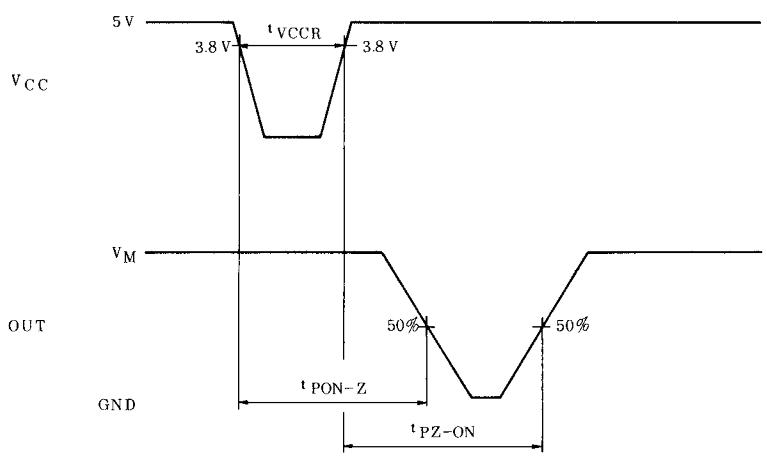
7-2 STROBE-CLOCK



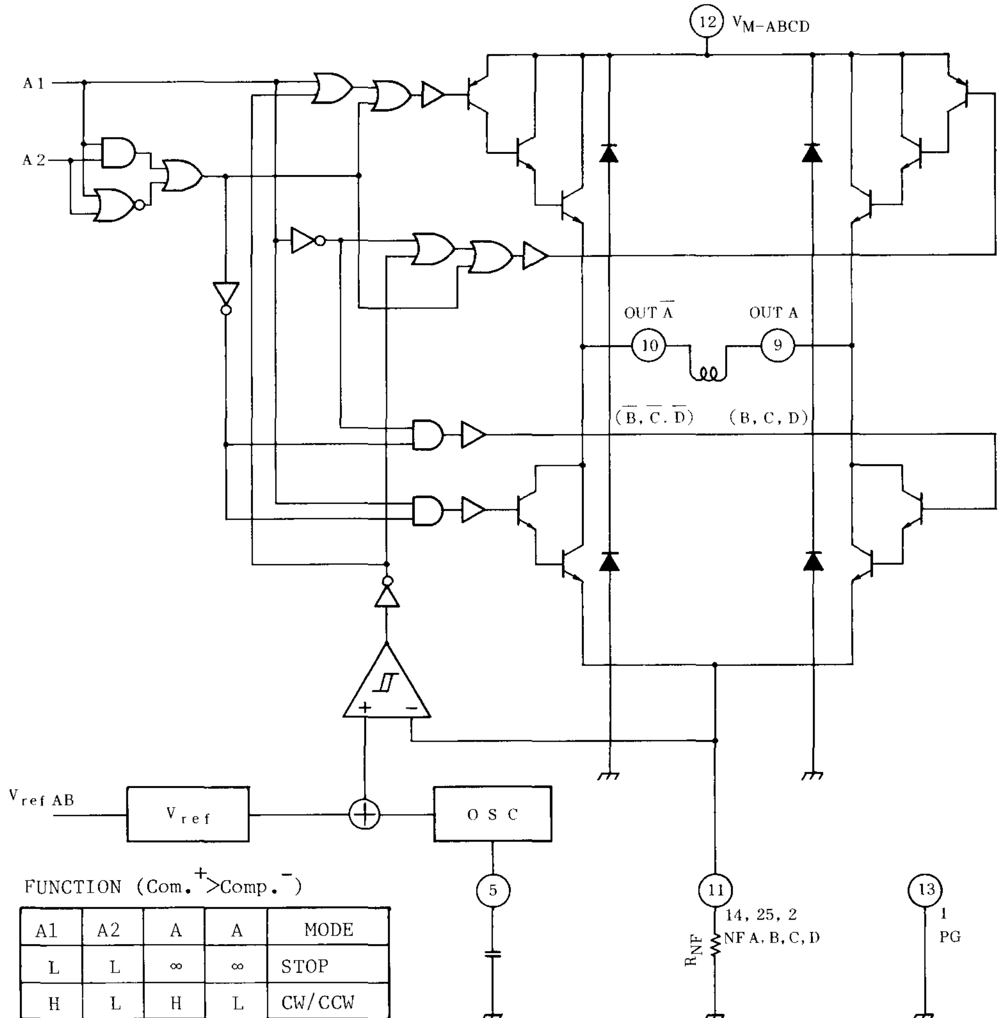
7-3 STROBE(CLOCK)-OUT



7-4 V_{CCR}-OUT



OUTPUT STAGE 1, 2 1/2 circuit



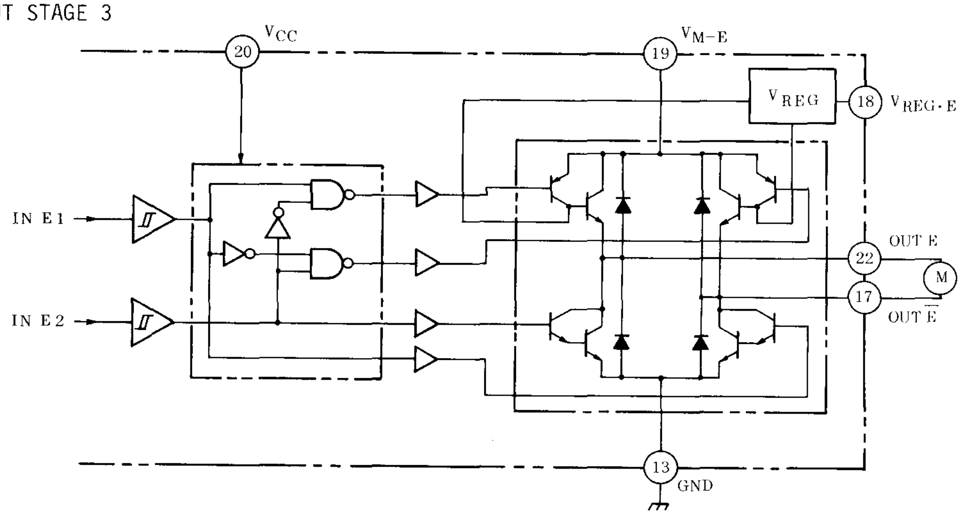
FUNCTION (Com.$^+$>Comp.$^-$)

A1	A2	A	A	MODE
L	L	∞	∞	STOP
H	L	H	L	CW/CCW
L	H	L	H	CCW/CW
H	H	∞	∞	STOP

Note 1. In case of Comp.$^+$<Comp.$^-$, Upper side Power Transistor turned off.

Note 2. Free wheeling diode connects between Output A terminal and GND is required for stable operations. And also recommend to connect free wheeling diodes other Output terminals for reliable operations.

OUTPUT STAGE 3

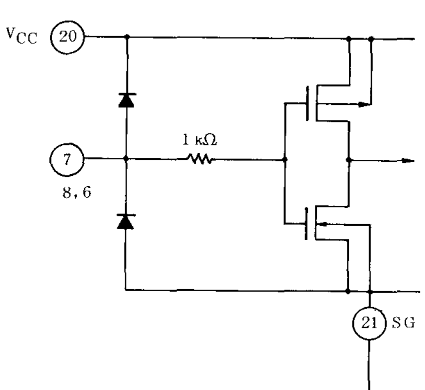


FUNCTION

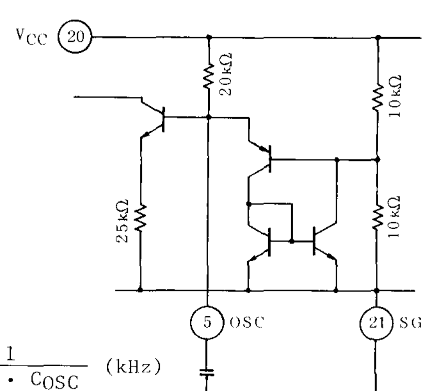
INPUT		OUTPUT		MODE
IN E1	IN E2	OUT E	OUT $\overline{E}$	MOTOR
L	L	∞	∞	STOP
H	L	H	L	CW/CCW
L	H	L	H	CCW/CW
H	H	L	L	BRAKE

∞ : High Impedance

INPUT STAGE (CK, S-IN, STROBE)

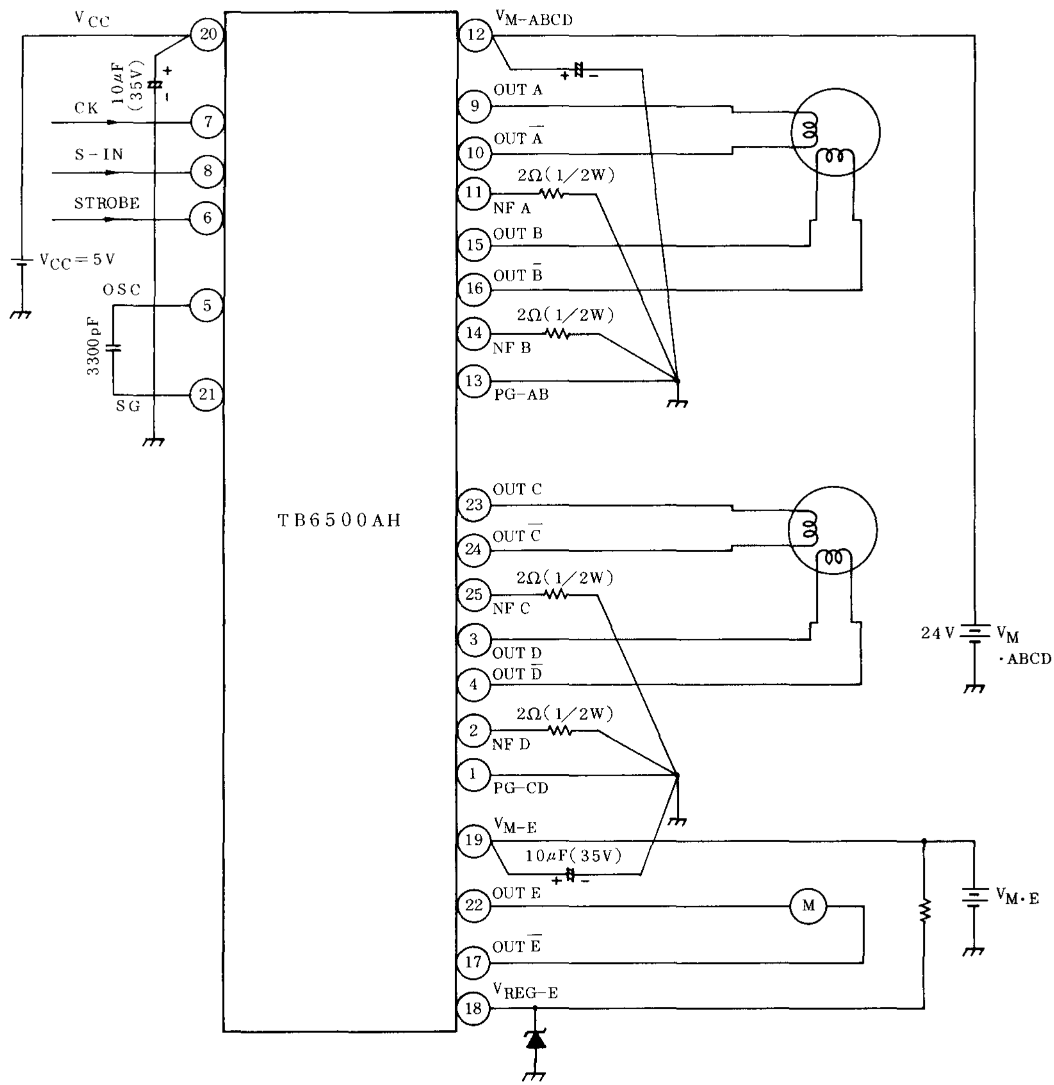


OSC STAGE (OSC)



$$f_{OSC} = \frac{1}{21.4 \cdot C_{OSC}} \quad (kHz)$$

APPLICATION CIRCUIT

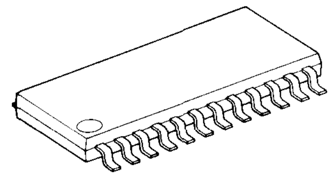


Note. Care should be taken not to have a common impedance with Output Current pass of each Motor (NF A, NF B for Motor 1, NF C, NF D for Motor 2 and PG for DC Motor) and any other signal lines.

And recommend to take One Point GND with each Output Current pass and corresponding PG terminal. (See Table 1 of Block Diagram)

PWM CHOPPER TYPE BIPOLAR STEPPING MOTOR DRIVER

TB6504F is PWM chopper type sinusoidal micro step bipolar stepping motor driver.
Sinusoidal micro step operation is accomplished only a clcok signal inputting by means of built-in jard ware.



SSOP24-P-300

Weight : 0.32g (Typ.)

- 1 chip bipolar sinusoidal micro step stepping motor driver.
- Output current up to 150mA
- PWM chopper type.
- Structured by high voltage Bi-CMOS process technology.
- Forward and reverse rotation are available.
- 2, 1-2, W1-2, 2W1-2, phase 1 or 2 clock drives are selectable.
- Package:SSOP24-P-300
- Input Pull-up Resistor equipped with RESET and ENABLE Terminal: R=200kΩ(Typ.)
- Output Monitor available with $\overline{MO}$. I)($\overline{MO}$)=±2mA MAX.
- Reset and Enable are available with $\overline{RESET}$ and $\overline{ENABLE}$.

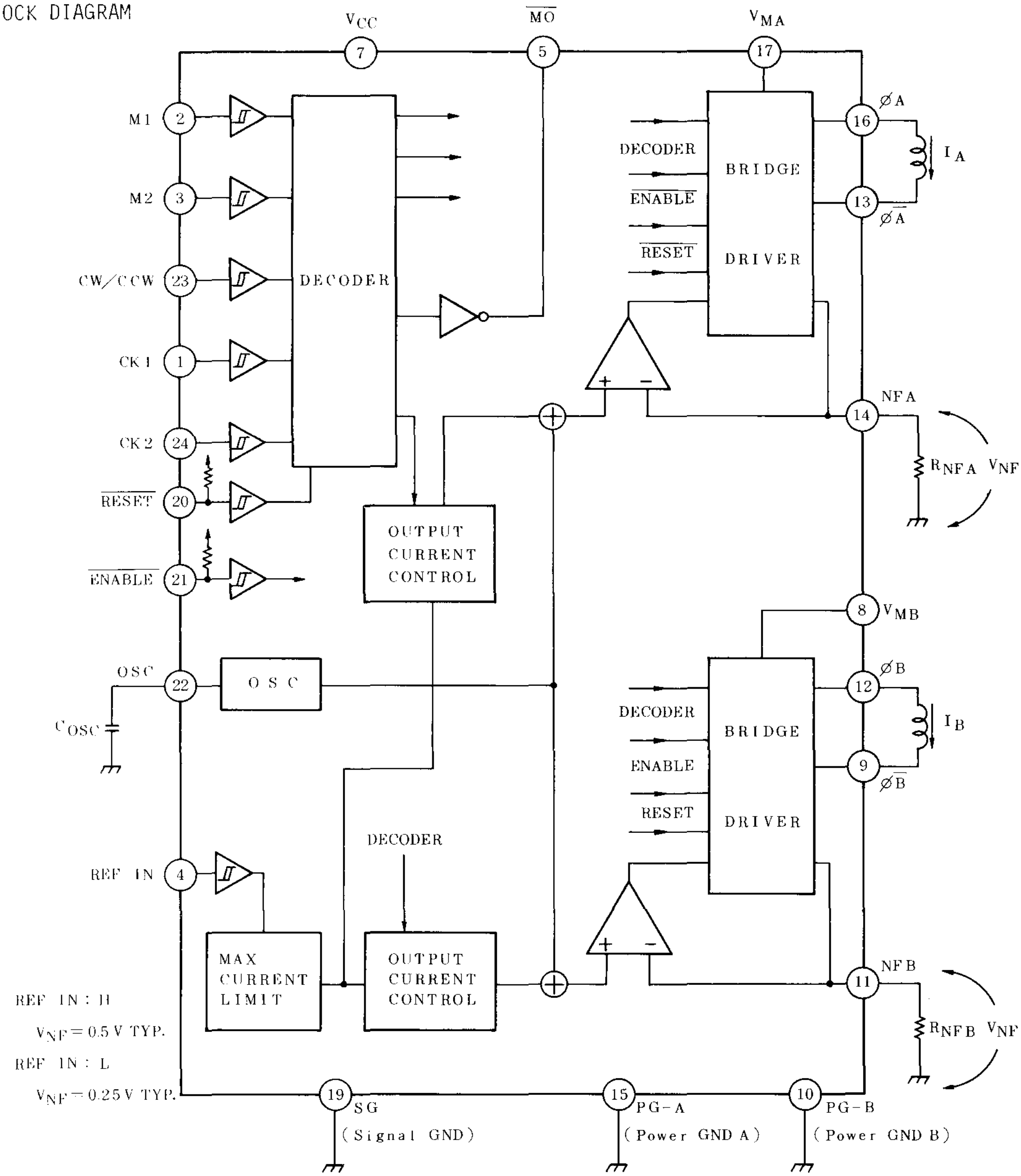
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	5.5	V
		$V_{M(opr)}$	V_{CC}-0.3~10	
		$V_{M(max)}$	18	
Output Current		$I_{O(max)}$	150	mA
	$\overline{MO}$	$I_O(\overline{MO})$	±2	
Input Voltage		V_{IN}	~V_{CC}	V
Power Dissipation		P_D	0.59*	W
			0.83**	
Operating Temperature		Topr	-10~70	°C
Storage Temperature		Tstg	-55~150	°C
Feed Back Voltage		V_I	1.0	V

* No heat sink

** With heat sink (50X50X1.6mm Cu 10%)

BLOCK DIAGRAM



Pull-up Resistance 20 , 21 pin : 200kΩ

6 , 18 pin : Non Connection

INPUT					MODE
CK1	CK2	CW/CCW	$\overline{RESET}$	$\overline{ENABLE}$	
↑	H	L	H	L	CW
⎍	L	L	H	L	INHIBIT
H	↑	L	H	L	CCW
L	⎍	L	H	L	INHIBIT
↑	H	H	H	L	CCW
⎍	L	H	H	L	INHIBIT
H	↑	H	H	L	CW
L	⎍	H	H	L	INHIBIT
X	X	X	L	L	INITIAL
X	X	X	X	H	Z

INPUT		MODE
M1	M2	(EXCITATION)
L	L	2 Phase
H	L	1-2 Phase
L	H	W1-2 Phase
H	H	2W1-2 Phase

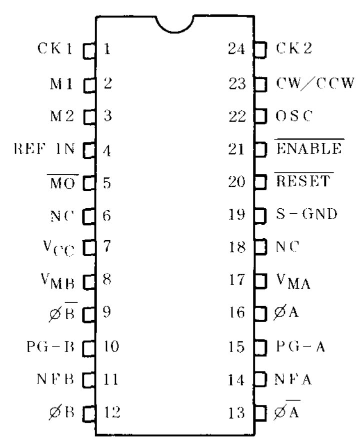
Z : High impedance

X : Don't Care

INITIAL MODE

MODE	I_{OUT} (A)	I_{OUT} (B)
2 Phase	100%	100%
1-2 Phase	100%	0%
W1-2 Phase	100%	0%
2W1-2 Phase	100%	0%

PIN CONNECTION (TOP VIEW)



Note. NC: Non connection

RECOMMENDED OPERATING CONDITIONS (Ta=-10~70°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{CC}		4.5	5.0	5.5	V
Output Voltage	V_M		5.5	–	8.0	V
Output Current	I_{OUT}		–	–	120	A
Input Voltage	V_{IN}		–	–	V_{CC}	V
Clock Frequency	f_{CLOCK}		–	–	5	kHz
OSC Frequency	f_{OSC}		15	–	80	kHz

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M=8V)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage	High	$V_{IN(H)}$	1	M1, M2, CW/CCW, REF IN, $\overline{ENABLE}$, CK1, CK2, $\overline{RESET}$	3.5	–	V_{CC} +0.4	V
	Low	$V_{IN(L)}$			GND -0.4	–	1.5	V
Input Hysteresis Voltage		V_H			–	600	–	mV
Input Current		$I_{IN-1(H)}$	1	M1, M2, REF IN, V_{IN}=5.0V	–	–	100	nA
		$I_{IN-1(L)}$		$\overline{RESET}$, V_{IN}=9V, $\overline{ENABLE}$ INTERNAL PULL-UP RESISTOR	10	50	100	μA
		$I_{IN-2(L)}$		SOURCE TYPE, V_{IN}=0V	–	–	100	nA
Quiescent Current	V_{CC}	I_{CC1}	2	Output Open $\overline{RESET}$:H $\overline{ENABLE}$:L (2,1-2 Phase excitation)	–	10	18	mA
	V_{CC}	I_{CC2}		Output Open (W1-2, 2W1-2 Phase excitation) $\overline{RESET}$:H, $\overline{ENABLE}$:L	–	10	18	mA
	V_{CC}	I_{CC3}		$\overline{RESET}$:L, $\overline{ENABLE}$:L	–	5	–	mA
		I_{CC4}		$\overline{RESET}$:H, $\overline{ENABLE}$:L	–	5	–	mA

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M= 8V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Comparator Reference Voltage	High	$V_{NF(H)}$	3	REF IN H R_{NF}=5Ω, C_{OSC}=0.0033μF	0.45	0.5	0.55	V
	Low	$V_{NF(L)}$		REF IN L R_{NF}=2.5Ω, C_{OSC}=0.0033μF	0.22	0.25	0.28	
Output Diffirencial		ΔV_O	–	B/A, C_{OSC}=0.0033μF R_{NF}=2.5Ω, REF IN=L	-10	–	10	%
$V_{NF(H)}$-$V_{NF(L)}$		ΔV_{NF}		$V_{NF(L)}/V_{NF(H)}$ C_{OSC}=0.0033μF	4.3	50	57	%
Output Voltage		$V_{OH(MO)}$	–	I_{OH}=-40μA	4.5	4.9	V_{CC}	V
		$V_{OL(MO)}$		I_{OL}=-40μA	GND	0.1	0.5	
OSC Frequency		f_{OSC}	–	C_{OSC}=0.0033μF	31	44	70	kHz
Maximum OSC Frequency		$f_{OSC(MAX)}$	–		100	–	–	kHz
Minimum OSC Frequency		$f_{OSC(MIN)}$	–		–	–	10	kHz

OUTPUT BLOCK

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Saturation Voltage	Upper Side	$V_{SAT\ U1}$	4	I_{OUT}=0.12A	–	0.90	1.25	V
	Lower Side	$V_{SAT\ L1}$			–	0.22	0.37	
	Upper Side	$V_{SAT\ U2}$		I_{OUT}=0.06A	–	0.83	–	
	Lower Side	$V_{SAT\ L2}$			–	0.12	–	
Diode Forward Voltage	Upper Side	$V_{F\ U1}$	5	I_{OUT}=0.12A	–	1.18	1.8	V
	Lower Side	$V_{F\ L1}$			–	0.92	1.6	
Output Dark Current (A+B Channels)		I_{M1}	2	$\overline{ENABLE}$: H Level $\overline{RESET}$: L Level	–	–	50	μA
		I_{M2}		$\overline{ENABLE}$: L Level $\overline{RESET}$: H Level Output Open	–	8	28	nA
NF Terminal Current		I_{NF}		$\overline{ENABLE}$: L Level $\overline{RESET}$: H Level Output Open	–	2.5	7	

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M=8V)

OUTPUT BOLOCK

CHARACTERISTIC				SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
A-B Chopping Current (Note 1)	2W1-2ϕ	W1-2ϕ	1-2ϕ	VECTOR	3	θ=0	REF IN : L R_{NF}=2.5Ω C_{OSC}=0.0033μF L=10mH/R=0.5Ω	–	100	–	%
	2W1-2ϕ	–	–			θ=1/8		–	100	–	
	2W1-2ϕ	W1-2ϕ	–			θ=2/8		86	91	96	
	2W1-2ϕ	–	–			θ=3/8		79	84	89	
	2W1-2ϕ	W1-2ϕ	1-2ϕ			θ=4/8		67.5	72.5	77.5	
	2W1-2ϕ	–	–			θ=5/8		52.5	57.5	62.5	
	2W1-2ϕ	W1-2ϕ	–			θ=6/8		37	42	47	
	2W1-2ϕ	–	–			θ=7/8		17	22	27	
	2 Phase excitation mode				–			–	141	–	
Feed Back Voltage Step				ΔV_{NF}	–	Δθ= 0/8-1/8	REF IN : L R_{NF}=2.5Ω C_{OSC}=0.0033μF	–	0	–	mV
						Δθ= 1/8-2/8		10	22.5	35	
						Δθ= 2/8-3/8		5	17.5	30	
						Δθ= 3/8-4/8		16.25	28.75	41.25	
						Δθ= 4/8-5/8		25	37.5	50	
						Δθ= 5/8-6/8		26.25	38.75	51.25	
						Δθ= 6/8-7/8		37.5	50	62.5	

Note 1. Maximum current (θ=0) : 100%

2W1-2ϕ : 2W1,2 phase excitation mode

W1-2ϕ : W1,2 phase excitation mode

1-2ϕ : 1,2 phase excitation mode

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=5V, V_M= 8V)

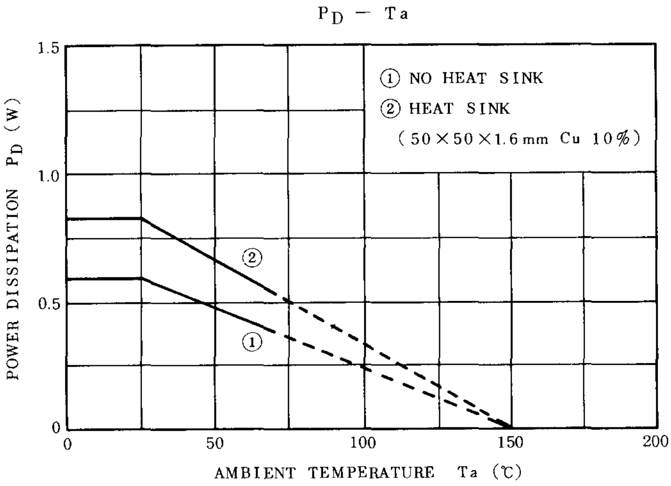
CHARACTERISTIC				SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
A-B Chopping Current (Note 1)	2W1-2ϕ	W1-2ϕ	1-2ϕ	VECTOR	3	θ=0	REF IN : L R_{NF}=3.3Ω C_{OSC}=0.0033μF L=20mH/R=60Ω	–	100	–	%
	2W1-2ϕ	–	–			θ=1/8		–	100	–	
	2W1-2ϕ	W1-2ϕ	–			θ=2/8		–	91.2	–	
	2W1-2ϕ	–	–			θ=3/8		–	84.2	–	
	2W1-2ϕ	W1-2ϕ	1-2ϕ			θ=4/8		–	73.6	–	
	2W1-2ϕ	–	–			θ=5/8		–	59	–	
	2W1-2ϕ	W1-2ϕ	–			θ=6/8		–	44.6	–	
	2W1-2ϕ	–	–			θ=7/8		–	25.6	–	
	2 phase excitation mode							–	141	–	
Output Tr Switching Characteristics				t_r		R_L=2Ω, V_{NF}=0V		–	0.3	–	μs
				t_f		C_L=15pF		–	2.2	–	
				t_{pLH}	7	CK~Output		–	1.5	–	
				t_{pHL}				–	2.7	–	
				t_{pLH}		OSC~Output		–	5.4	–	
				t_{pHL}				–	6.3	–	
				t_{pLH}		RESET~Output		–	2.0	–	
				t_{pHL}				–	2.5	–	
				t_{pLH}		ENABLE~Output		–	5.0	–	
				t_{pHL}				–	6.0	–	
Output Leakage Current	Upper Side			I_{OH}	6	V_M=18V		–	–	50	μA
	Lower Side			I_{OL}				–	–	50	

Note 1. Maximum current (θ=0) : 100%

2W1-2ϕ : 2W1,2 phase excitation mode

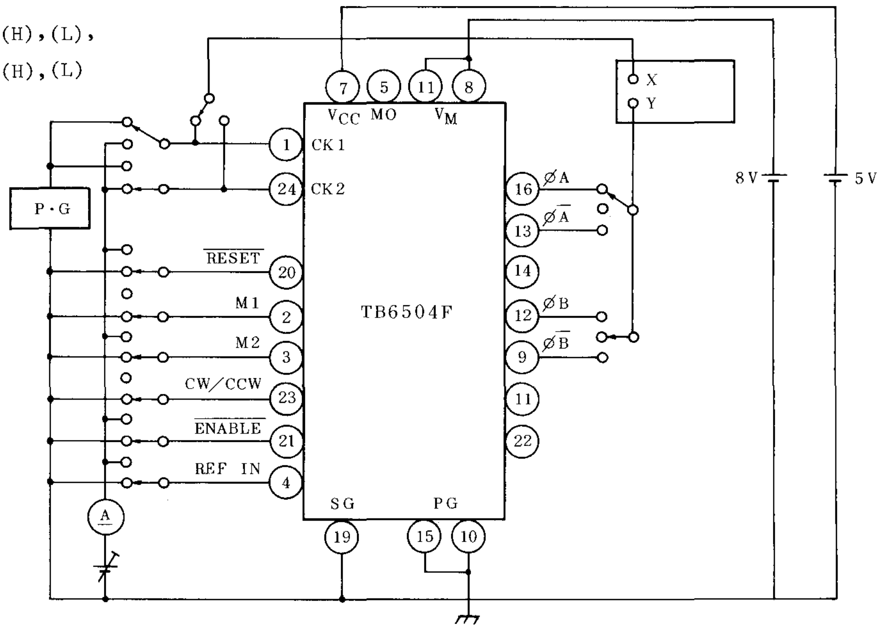
W1-2ϕ : W1,2 phase excitation mode

1-2ϕ : 1,2 phase excitation mode


PD − Ta
1.5
1.0
0.5
0
POWER DISSIPATION PD (W)
0
50
100
150
200
AMBIENT TEMPERATURE Ta (℃)
① NO HEAT SINK
② HEAT SINK
(50×50×1.6mm Cu 10%)
②
①

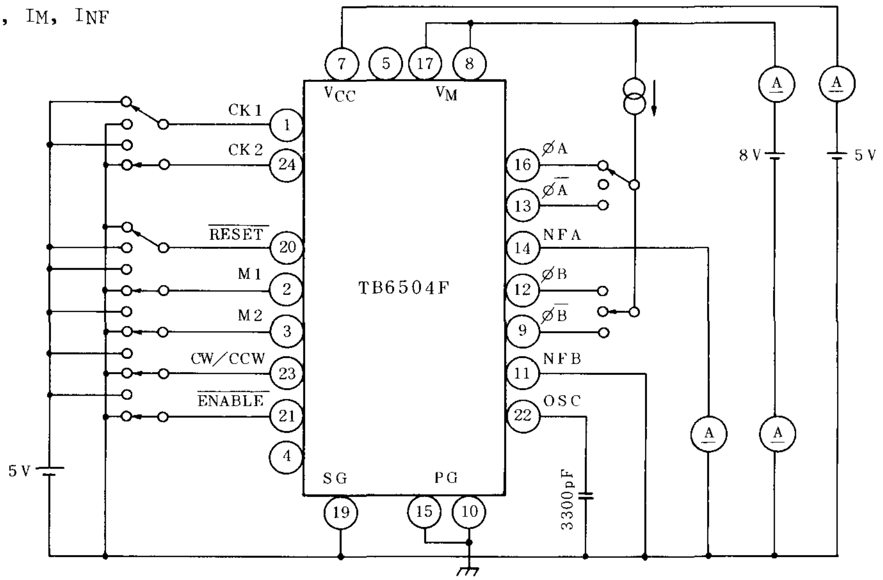
TEST CIRCUIT 1

$V_{IN(H),(L)}$,
$I_{IN(H),(L)}$



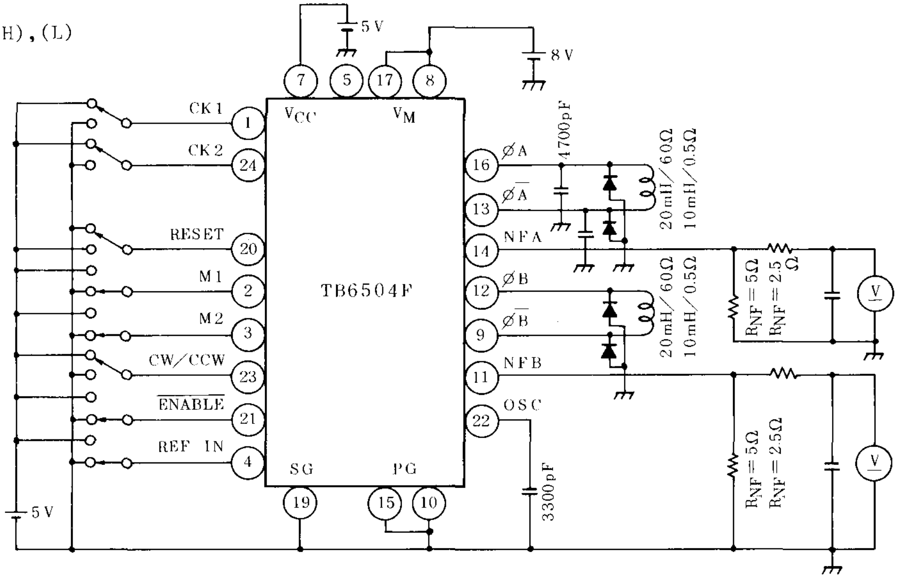
TEST CIRCUIT 2

I_{CC}, I_M, I_{NF}



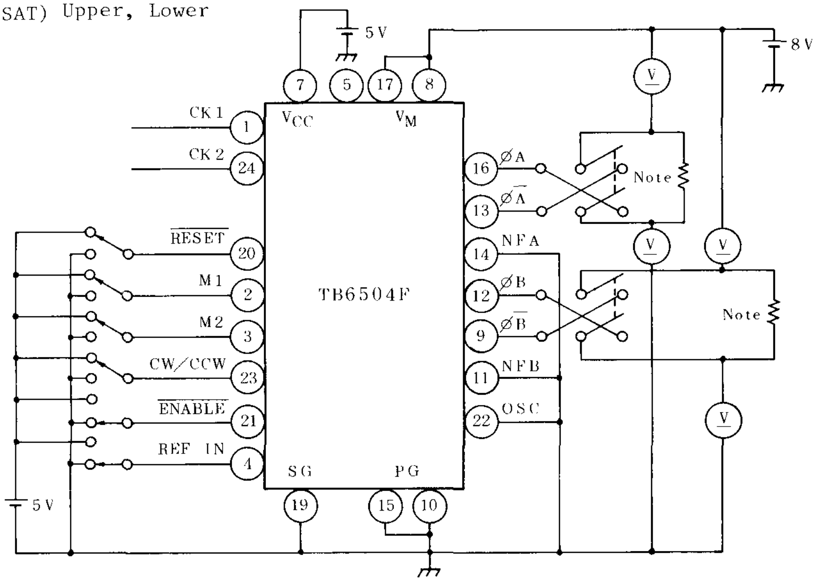
TEST CIRCUIT 3

$V_{NF(H),(L)}$



TEST CIRCUIT 4

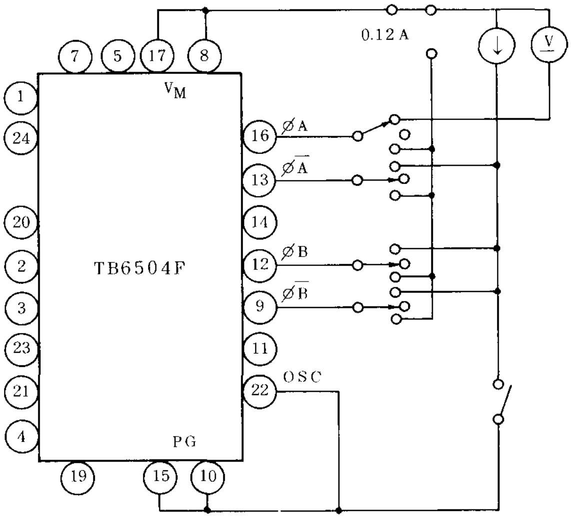
$V_{CE(SAT)}$ Upper, Lower



Note. Calibrate output current becomes 0.06A (or 0.12A) with this resistor.

TEST CIRCUIT 5

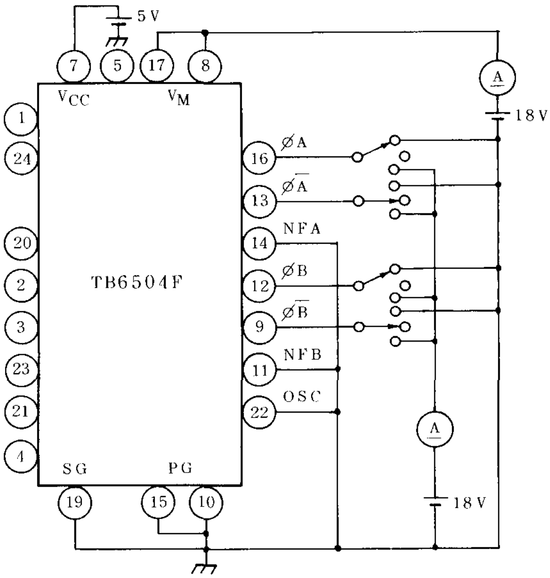
V_{F-U}, V_{F-L}



Note. Not to take a GND with any non-connecting Pins.

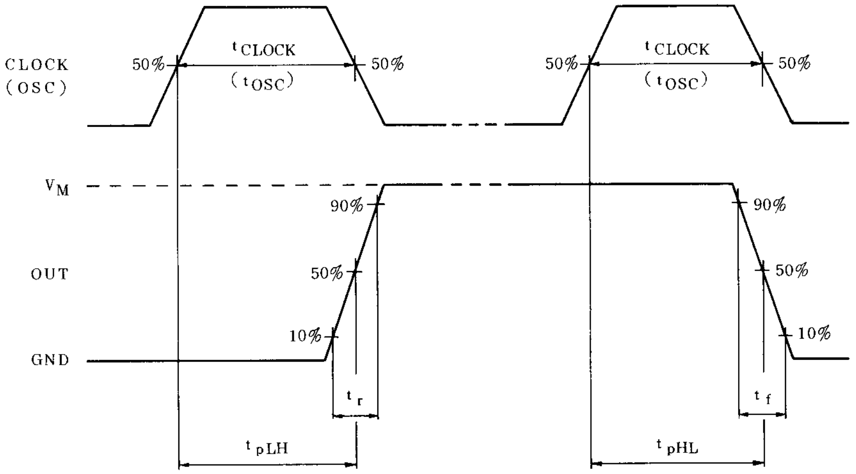
TEST CIRCUIT 6

I_{OH}, I_{OL}

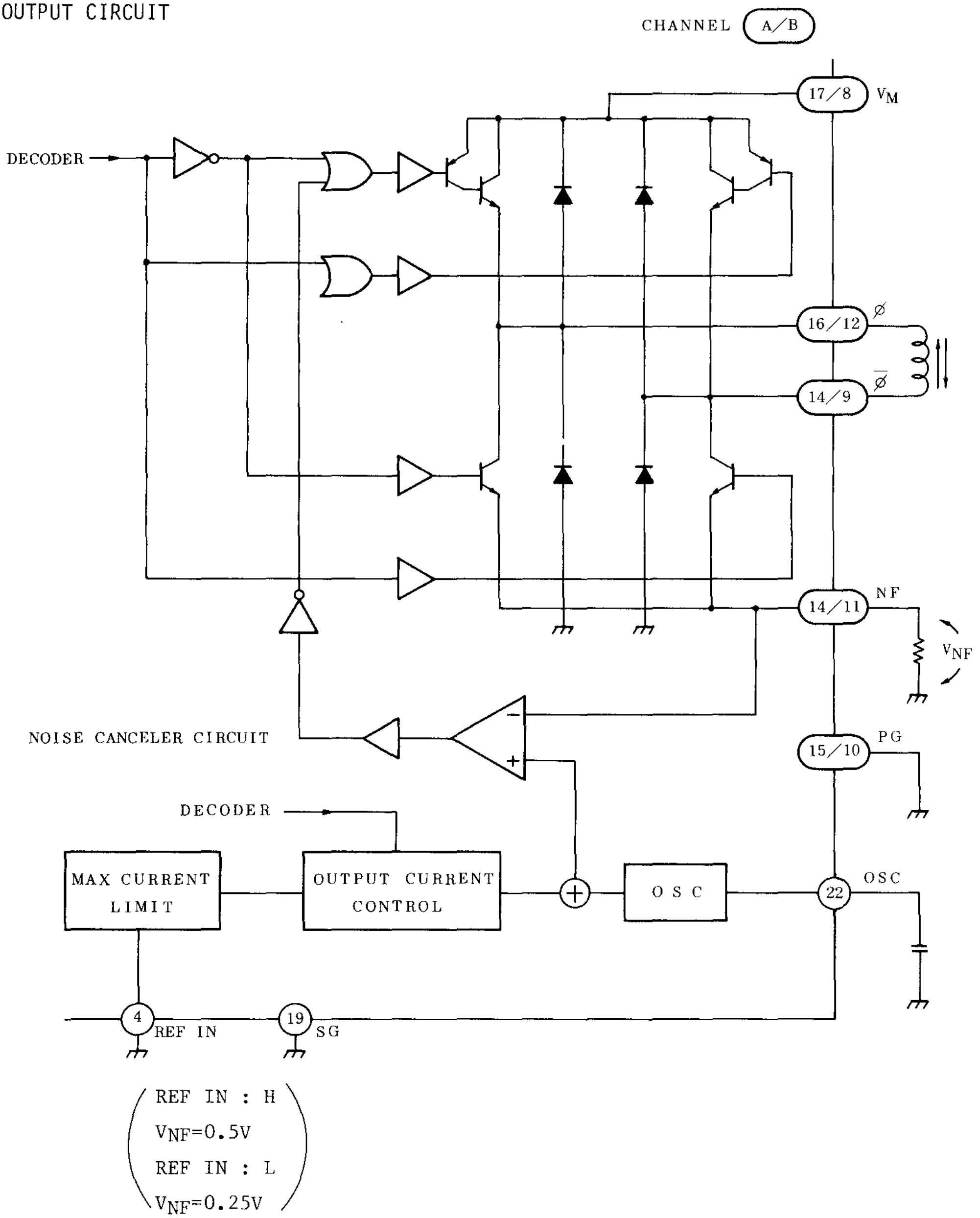


AC ELECTRICAL CHARACTERISTIC

. CK(OSC)-OUT

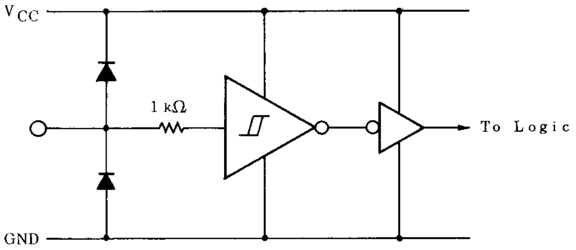


OUTPUT CIRCUIT

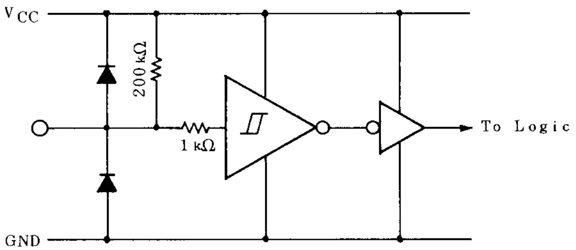


INPUT CIRCUIT

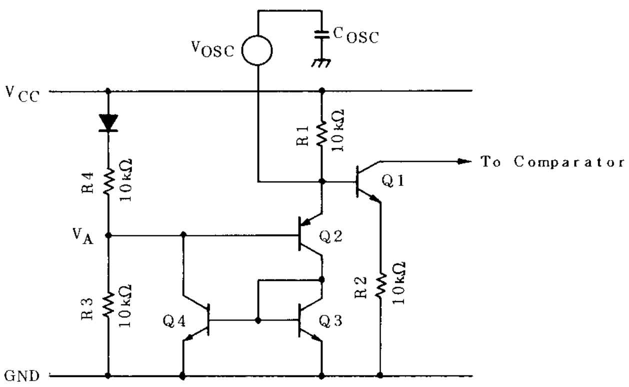
. CK1, CK2, CW/CCW, M1, M2, REF IN : Terminals



. $\overline{\text{RESET}}$, $\overline{\text{ENABLE}}$: Terminal



. OSC : Terminal



$$V_A = (V_{CC} - V_{BE}) \frac{R3}{R3+R4} \fallingdotseq 2.15V$$

OSC FREQUENCY CALCULATION

Sawtooth OSC circuit consists of Q1 through Q4 and R1 through R4.
Q2 is turned "off" when V_{OSC} is less than the voltage of $2.5V + V_{BE}$ Q2 approxiamtely equal to 2.85V.
V_{OSC} is increased by C_{OSC} charging through R1.
Q3 and Q4 are turned "on" when V_{OSC} becomes 2.85V(Higher level.)
Lower level of V 22 pin is equal to V_{BE} Q2+V_{SAT} Q4 approximately equal to 1.4V.
V_{OSC} is calculated by following equation.

$$V_{OSC} = 5 \cdot (1 - e^{-\frac{1}{C_{OSC} \cdot R1} t})$$

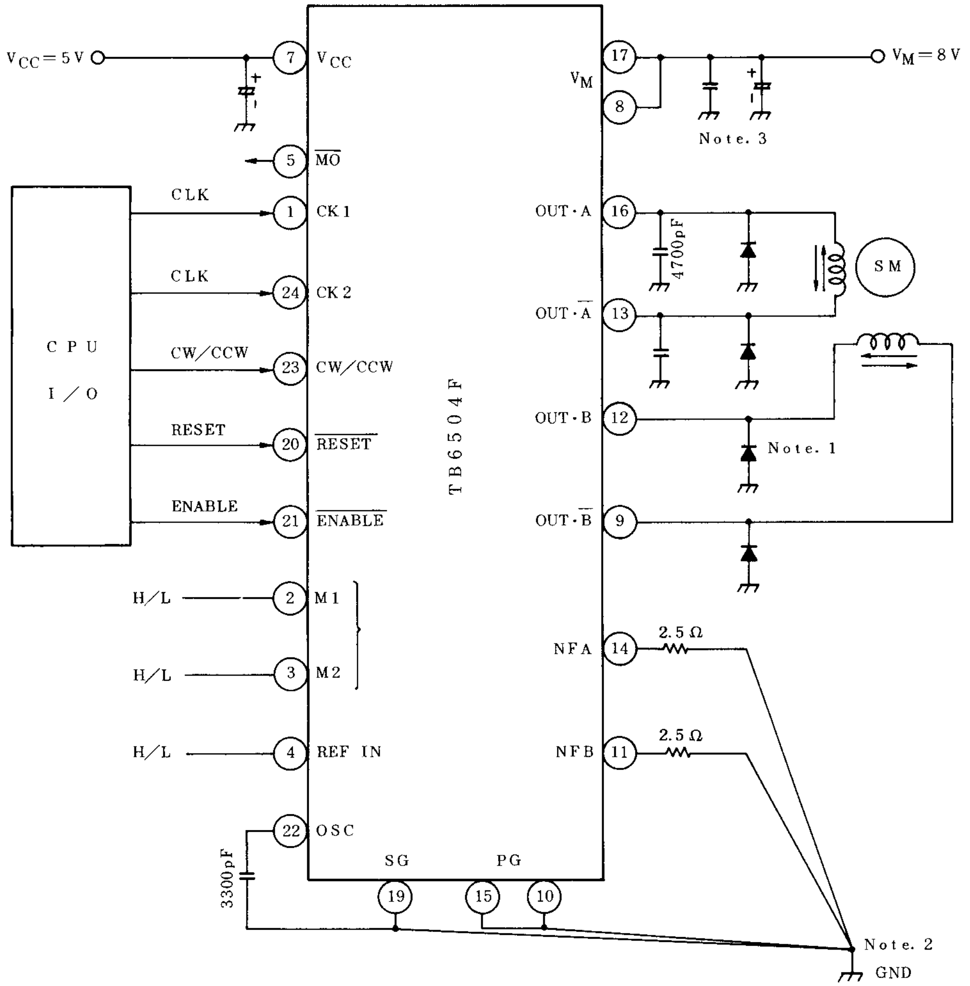
Assuming that V_{OSC}=1.4V (t=t1) and =2.85V (t=t2)
C_{OSC} is external capacitance connected to pin 22 and R1 is on-chip 10kΩ resistor.
Therefore, OSC frequency is calculated as follows.

$$t1 = -C_{OSC} \cdot R1 \cdot \ell n \left(1 - \frac{1.4}{5}\right)$$

$$t2 = -C_{OSC} \cdot R1 \cdot \ell n \left(1 - \frac{2.85}{5}\right)$$

$$f_{OSC} = \frac{1}{t2-t1} = \frac{1}{C_{OSC} \left(R1 \cdot \ell n \left(1 - \frac{1.4}{5}\right) - R1 \cdot \ell n \left(1 - \frac{2.85}{5}\right)\right)}$$

$$\div \frac{1}{5.15 \cdot C_{OSC}} \text{ (kHz) } (C_{OSC} : \mu F)$$



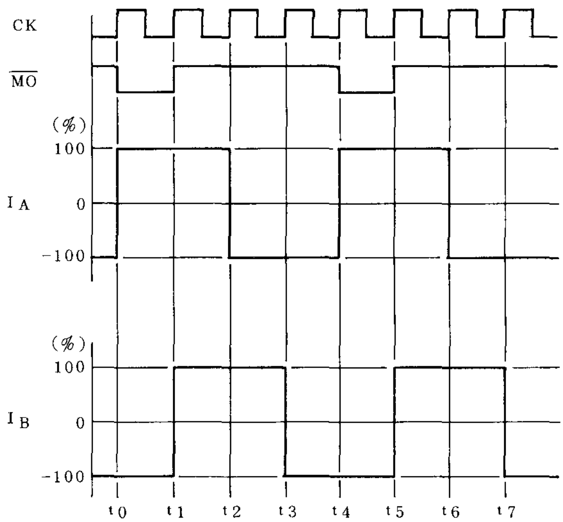
Note 1. Schottky diode(U1GWJ49) to be connected additionally between each output (pin 16/13/13/9) and GND for preventing Punch-through Current.

Note 2. GND pattern to be laid out at one point in order to prevent common impedance.

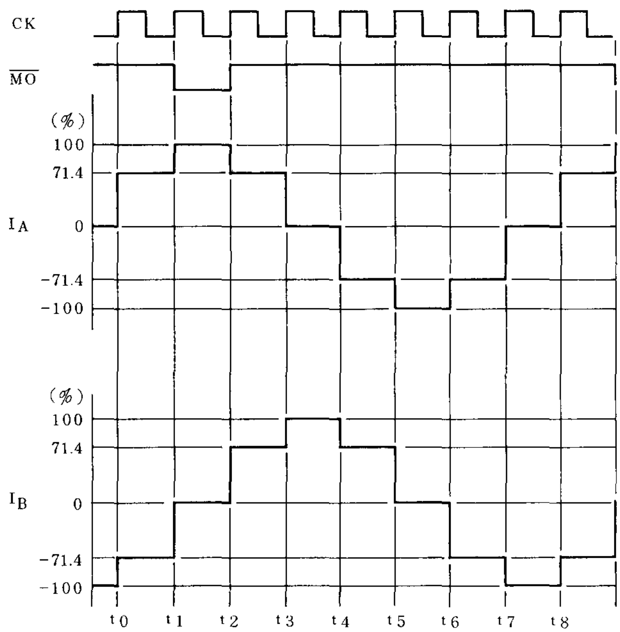
Note 3. Capasitor for noise suppression to be connected between the Power Supply(V_{CC},V_M) and GND to stabilize the operation.

EXCITATION

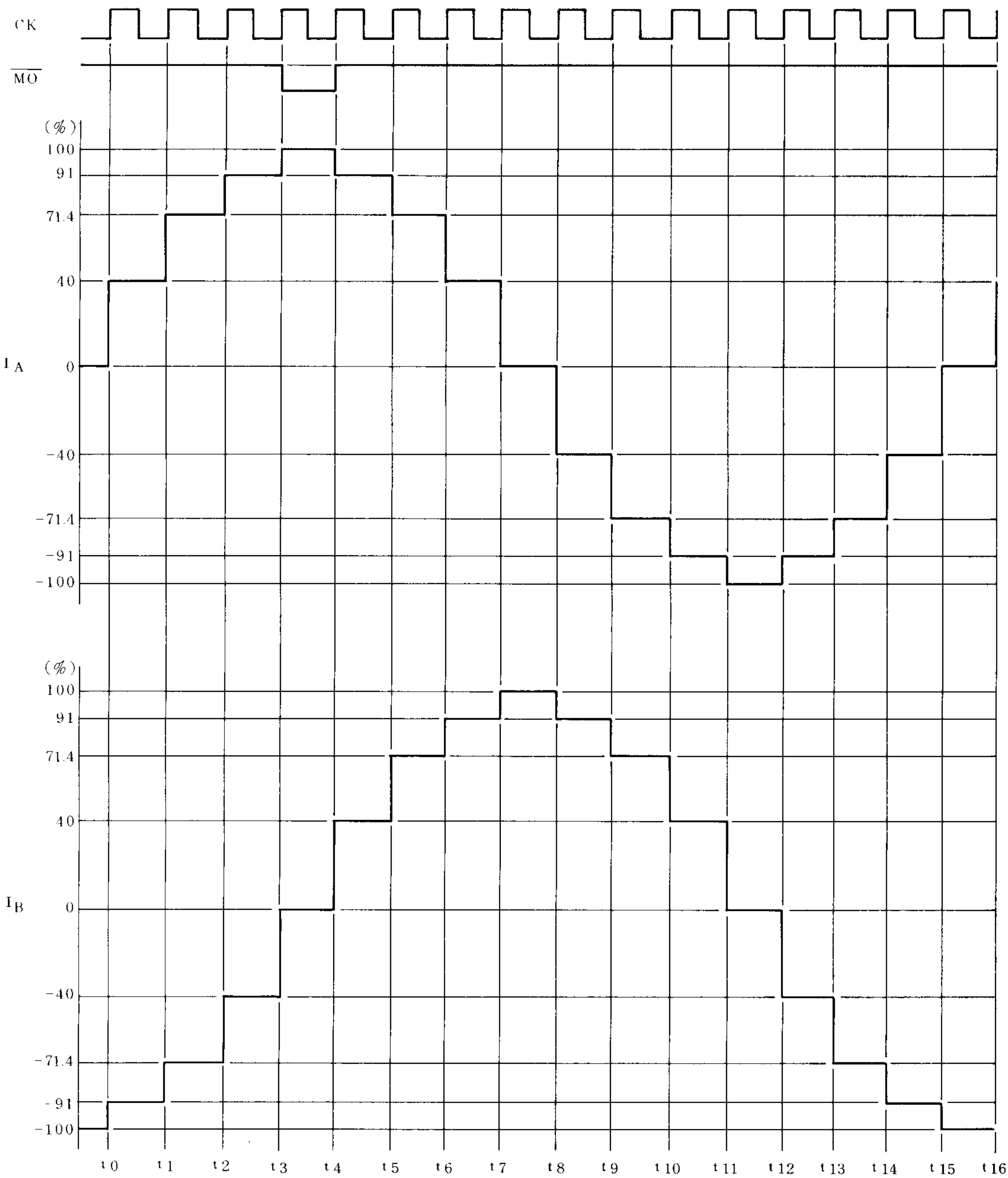
2 Phase Excitation (M1:L, M2:L, CW Mode)



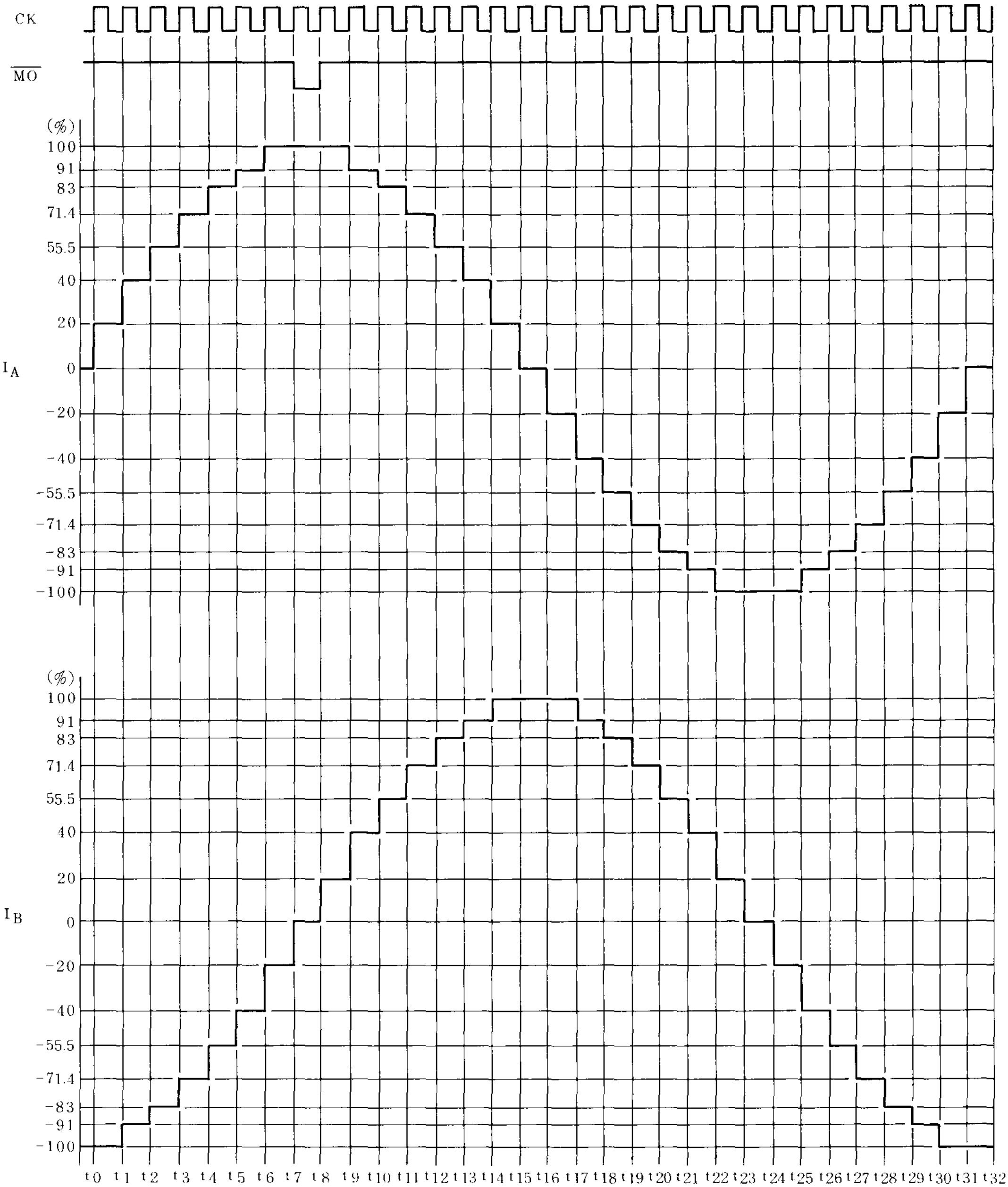
1-2 Phase Excitation (M1:H, M2:L, CW Mode)



W1-2 Phase Excitation (M1:L, M2:H, CW Mode)



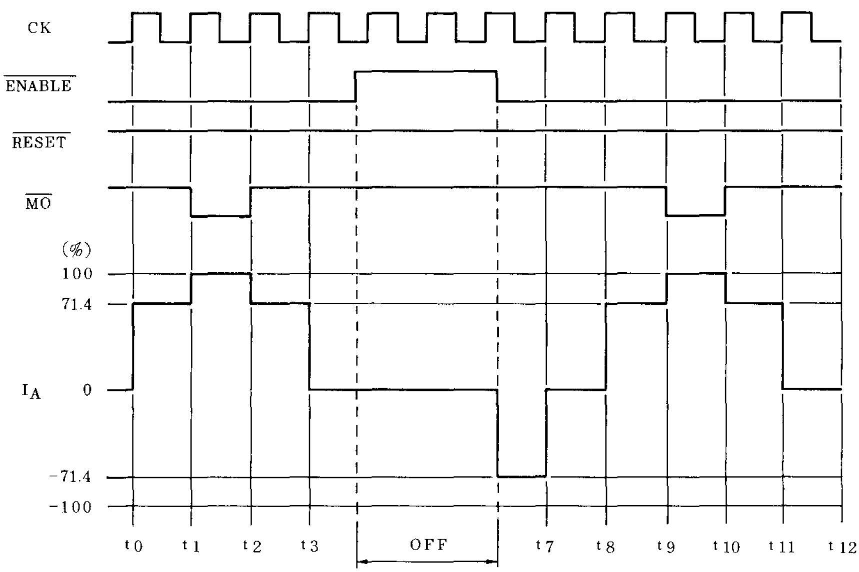
2W1-2 Phase Excitation (M1:H, M2:H, CW Mode)



$\overline{\text{ENABLE}}$ AND $\overline{\text{RESET}}$ FUNCTION AND $\overline{\text{MO}}$ SIGNAL

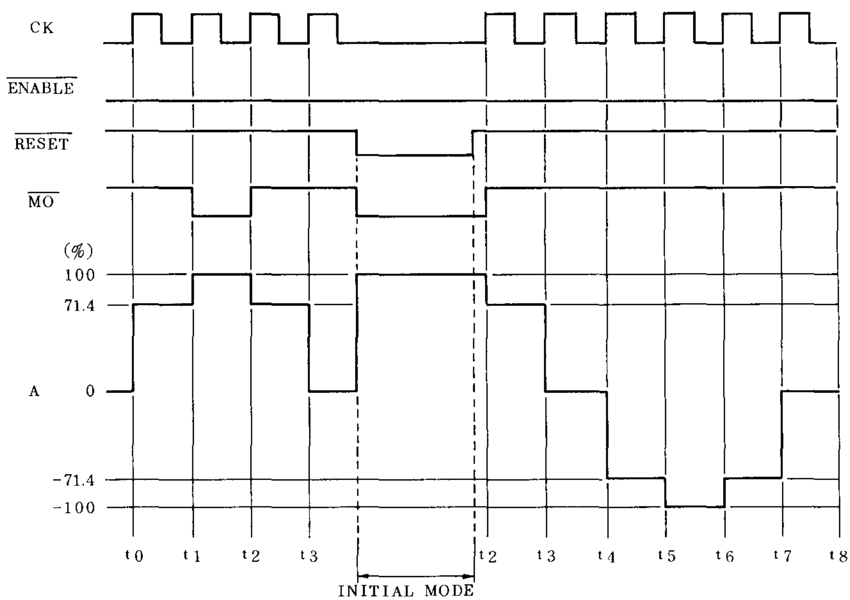
$\overline{\text{ENABLE}}$ Signal disables only Output Signal.
Internal logic functions are proceeded by CK signal without regard to $\overline{\text{ENABLE}}$ signal.
Therefore, Output Current is initiated from the proceeded timing point of internal logic circuit after release of disable mode.
Fig.1 shows the $\overline{\text{ENABLE}}$ functions, when the system is selected in 1-2 Phase drive mode.

Fig.1 1-2 Phase drive mode (M1:H, M2:L)



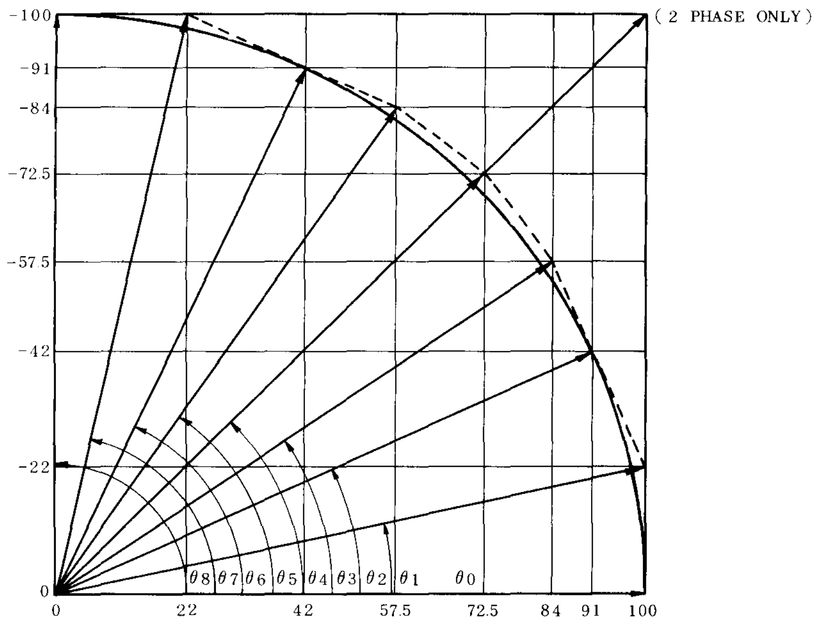
As $\overline{\text{RESET}}$ is low, the decoder is initialized and $\overline{\text{MO}}$ is low.
After $\overline{\text{RESET}}$ is high, the motion is resumed from next clock as shown in Fig.2.

Fig. 2 1-2 Phase drive mode (M1:H, M2:L)



$\overline{\text{MO}}$(Monitor Output) Signals is used as rotation and initial signal for stable rotation checking.

OUTPUT CURRENT VECTOR ORBIT (NORMALIZE TO 90 DEG FOR EACH ONE STEP)



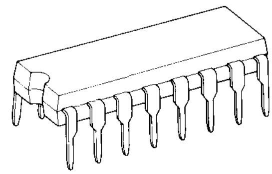
θ	ROTATION ANGLE		VECTOR LENGTH		
	Ideal	TB6504F	Ideal	TB6504F	
θ0	0°	0°	100	100.00	-
θ1	11.25°	12.41°	100	102.39	-
θ2	22.5°	27.78°	100	100.22	-
θ3	33.75°	34.39°	100	101.80	-
θ4	45°	45°	100	102.53	141.42
θ5	56.25°	55.61°	100	101.81	-
θ6	67.5°	65.22°	100	100.22	-
θ7	78.75°	77.59°	100	102.39	-
θ8	90°	90°	100	100.00	-
			1-2, W1-2, 2W1-2 Phase		2 Phase

TC9142AP

QUARTZ PLL MOTOR CONTROL

The TC9142AP is a C^2MOS LSI developed for controlling the motor of a quartz-lock D.D. record player. Since an 8-bit D/A converter system has been employed for each of the speed control system (AFC) and the phase control system (APC), a wide reduction of external parts can be made in comparison with conventional capacitor-type S/H systems, thus having realized adjustment free operation.

Unit in mm



DIP16-P-300A

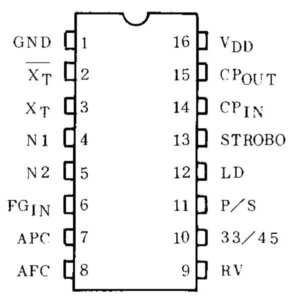
Weight : 1.00g (Typ.)

- Has built-in AFC and APC, for each of which 8-bit D/A converter system has been employed.
- Speed-changeover positions are available at 33 1/3 and 45-rpm.
- Crystal can be used up to 12MHz, and crystal reference dividing frequency is selectable from three positions of 1/4, 1/32 and 1/128 to increase the degree of freedom in the number of FG pulses of motor or crystal frequency, which allows a wide range of design to be made.
- External oscillator makes possible fine adjustment of speed.
- Provided with strobe reference output and reverse signal output.

MAXIMUM RATINGS (Ta=25°C)

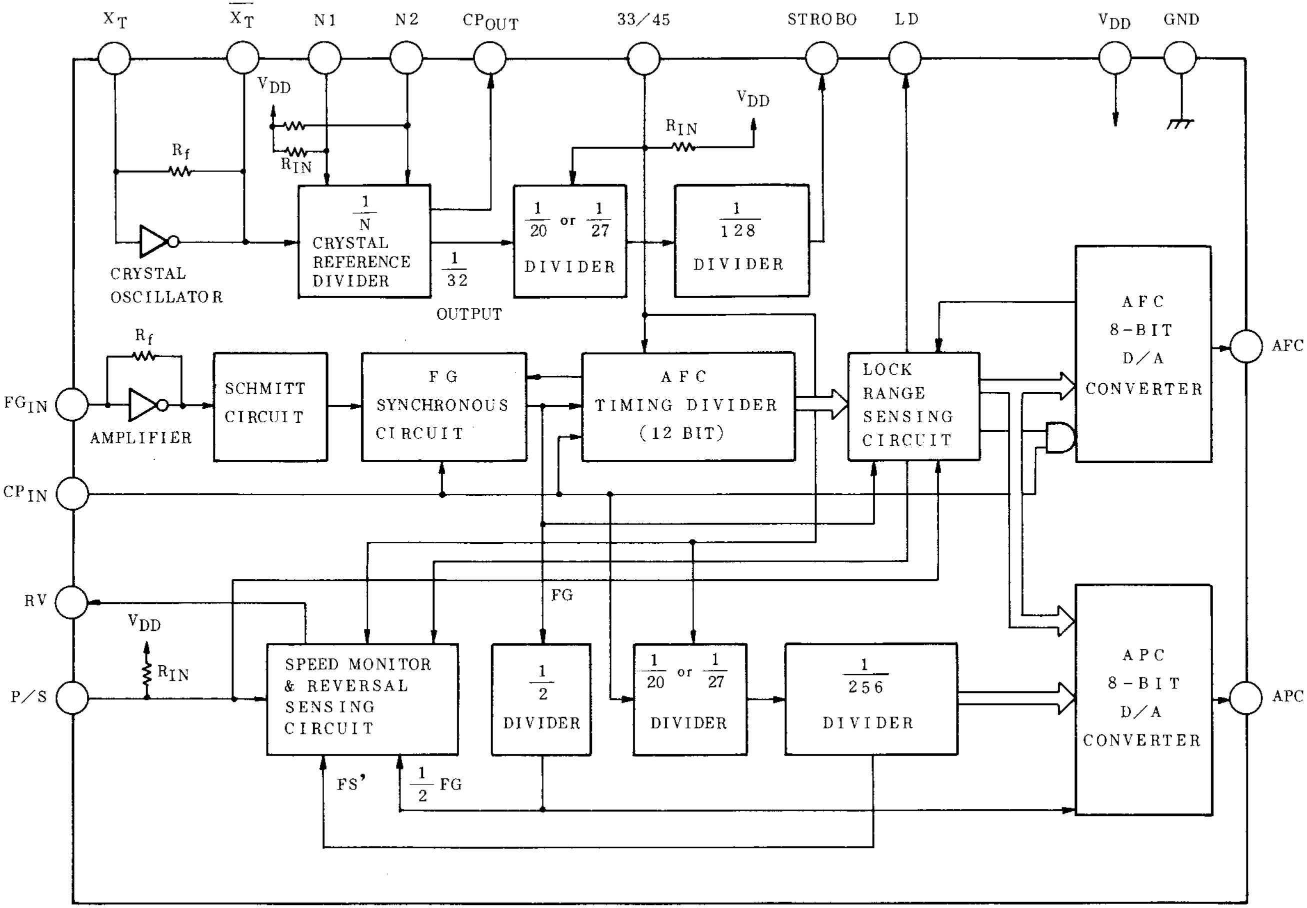
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	-0.3~10.0	V
Input Voltage	V_{IN}	-0.3~V_{DD}+0.3	V
Power Dissipation	PD	300	mW
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~125	°C

PIN CONNECTIONS



(TOP VIEW)

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{DD}=7.5V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		V_{DD}(1)		X'tal=6MHz CP_{IN}=1.5MHz *	5.0	~	9.5	V
		V_{DD}(2)		X'tal=12MHz CP_{IN}=3.0MHz *	7.5	~	9.5	
Operating Supply Current		I_{DD}	1	X'tal=12MHz CP_{IN}=3.0MHz *	–	5.5	12	mA
Operating Frequency Range	X_T	f_{MAX}(1)	2	V_{DD}=5.0~7.5V *	1.0	~	6.0	MHz
		f_{MAX}(2)		V_{DD}=7.5~9.5V *	1.0	~	12.0	
	CP_{IN}	f_{MAX}(3)	3	V_{DD}=5.0~7.5V *	–	~	1.5	
		f_{MAX}(4)		V_{DD}=7.5~9.5V *	–	~	3.0	
FG_{IN} Operating Frequency Range		f_{FG}		V_{DD}=5.0~9.5V V_{IN}=0.5Vpp *	–	~	10	kHz
FG_{IN} Input Amplitude Voltage	Operation	V_{IN}(1)	4	V_{DD}=5.0~9.5V f_{FG}~10kHz, Sine Wave *	0.5	~	V_{DD}-0.5	Vpp
	Non-Operation	V_{IN}(2)		f_{FG}~10kHz, Sine Wave *	0	~	30	mVpp
FG_{IN} Threshold Voltage Range		V_{TH}(FG)		V_{DD}=5.0~9.5V, At time of DC connection	0.2×V_{DD}	–	0.8×V_{DD}	V
VFC, APC D/A Converter	Max. Deviation			V_{DD}=5.0~9.5V, I_{OUT}=0	–	±2.5	±6.5	LSB
	Resolution				–	V_{DD}/256	–	V
	Ladder Resistor	$\overline{R_L}$	7		35	55	80	kΩ
	Temperature Drift			V_{DD}=5.0~9.5V *	–	±1	–	LSB
Ladder Resistor Temperature Factor				*	–	+0.55	+0.8	%/deg
Amplifier Feedback Resistor		Rf	5		100	200	500	kΩ

N1, N2, 33/45, P/S, CP_{IN}

Pullup Resistor		R_{IN}	6	Except CP_{IN} Terminal	15	35	70	kΩ
Input Voltage	"H" Level	V_{IH}		V_{DD}=5.0~9.5V Except N1 and N2 Terminal	0.7×V_{DD}	–	V_{DD}+0.3	V
	"L" Level	V_{IL}			-0.3	–	0.3×V_{DD}	

RV, LD, STROBE, CP_{OUT}

Output Current	"H" Level	I_{OH}	8	V_{OH}=6.5V	-0.5	–	–	mA
	"L" Level	I_{OL}	9	V_{OL}=1.0V	0.5	–	–	

* : Ta=Range of -30~+75°C

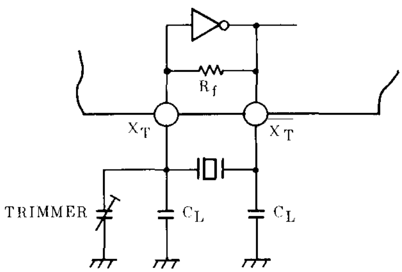
FUNCTIONAL EXPLANATION OF EACH TERMINAL

PIN No.	SYMBOL	TERMINAL NAME	FUNCTIONAL & OPERATION EXPLANATION	REMARKS
16	V_{DD}	Power Terminal	V_{DD}=5.0~9.5V is applied.	
1	GND	Ground Terminal	Ground	
2 3	$\overline{XT}$ XT	Crystal Oscillation Terminal	Crystal Oscillator is connected.	With a built-in feedback resistor.
6	FG_{IN}	FG Pulse Input Terminal	Input terminal for pulse showing motor speed.	With a built-in amplifier.
10	33/45	Speed Switching Terminal	Terminal for switching motor speed. L=33 1/3rpm, H or NC=45rpm.	With a built-in pull-up resistor.
11	P/S	PLAY/STOP Input Terminal	Motor PLAY/STOP signal input terminal L=PLAY, H or NC=STOP	With a built-in pull-up resistor.
14	CP_{IN}	Reference Frequency Input Terminal	Normally connected to CP_{OUT}. For external fine adjustment input from an external oscillator.	
15	CP_{OUT}	Reference Frequency Output Terminal	Terminal for divided output from the crystal reference frequency divider. Normally connected to CP_{IN}.	
13	STROBE	Strobe Output Terminal	Reference frequency output terminal for strobe. Duty is 1/8.	
12	LD	Lock Detecting Terminal	This terminal becomes H when the motor speed is within the lock range and otherwise L.	
8	AFC	AFC Output Terminal	Output terminal for motor speed control system. Output of 8 bit D/A converter.	
7	APC	APC Output Terminal	Output terminal for motor phase control system. Output of 8 bit D/A converter.	
9	RV	Reverse Signal Output Terminal	Terminal for motor reverse signal output.	
4 5	N1 N2	Reference Divided Frequency Switching Terminal	Switching of divided frequency from the crystal reference frequency divider into 1/4, 1/32 and 1/128 is possible.	With a built-in pull-up resistor.

EXPLANATION OF OPERATION

(1) Crystal oscillation terminals (X_T, $\overline{X_T}$)

- The crystal oscillator is used by connecting as shown below.



* C_L OF 10~30pF is appropriate.

Crystal oscillation frequency is calculated by the following equation according to number of FG pulses of a motor to be used.

$$f_X = 3/4FG' \times 128 \times 20 \times N = 5/9FG' \times 128 \times 27 \times N = 1920FG' \cdot N \quad (Hz)$$

(Note) 3/4FG' : FG_{IN} frequency at 45rpm.
5/9FG' : FG_{IN} frequency at $33\frac{1}{3}$ rpm.

Further, f_X: Crystal oscillation frequency, FG': No. of FG pulses generated per revolution of motor.

N : Ratio of frequency division of the crystal reference frequency divider. (Refer to Item (10).)

- Maximum operating frequency is above 12MHz and crystals up to 12MHz can be used.

(2) Reference frequency input/output terminals (CP_{OUT}, CP_{IN})

- Divided output $\frac{f_X}{N}$ from the crystal reference frequency divider is available at CP_{OUT}, which is normally connected to CP_{IN}.
- When an external oscillator (CR oscillator, etc.) is connected to CP_{IN}, motor speed can be finally adjusted.

(3) Strobe reference frequency output terminal (STROBE)

- This is the reference output terminal for strobe and $\frac{1}{32 \times (20 \text{ or } 27) \times 128}$ of crystal oscillation frequency is avalilabe at this terminal.
- Duty is 1/8 and suited to a single stripe strobe.

(4) FG pulse input terminal (FG_{IN})

- This is the input terminal of FG pulse that shows the motor speed. This FG pulse becomes comparison frequency.
- This terminal has built-in Amplifier and Schmitt circuit. FG pulses are applied through capacitor coupling and small amplitude is enough for proper operation.

(5) Speed switching terminal (33/45)

- This terminal is for switching the motor speed $33\frac{1}{3}$ rpm. and 45 rpm. with a pull-up resistor and chattering preventive circuit.

(TRUTH TABLE)

33/45	DIVIDED FREQUENCY	SPEED
L	$\frac{1}{27}$	$33\frac{1}{3}$rpm.
H or NC	$\frac{1}{20}$	45rpm.

(6) APC, AFC output terminal (APC, AFC)

- AFC (speed control output) is a F-V converter for FG frequency, and is consisting of a 8 bit D/A converter.
- APC (phase control output) is a phase comparator (ϕ-V converter) that compares phase difference ϕ between 1/2 FG and reference frequency FS', and is also consisting of a 8 bit D/A conveter.
- Both APC and AFC perform the following 3 operations according to FG_{IN} frequency.

a. When FG_{IN} frequency is within the lock range:

Both APC and AFC perform the normal operation for FG_{IN}.

Further, the Lock range is,

$$\begin{cases} \text{at 45rpm..... Reference cycle } \frac{1}{FS} \left\{ \begin{matrix} +4.6 \\ -5.3 \end{matrix} \right. \% \\ \text{at } 33\frac{1}{3} \text{ rpm ..... Reference cycle } \frac{1}{FS} \left\{ \begin{matrix} +3.4 \\ -3.9 \end{matrix} \right. \% \end{cases}$$

(Note)

$$\text{Reference frequency } FS = \frac{f_X}{N\ (20 \text{ or } 27)\ 128}\ (\text{Hz}),\quad FS' = \frac{1}{2}\ FS$$

b. When FG_{IN} frequency is below the lock range (under speed):

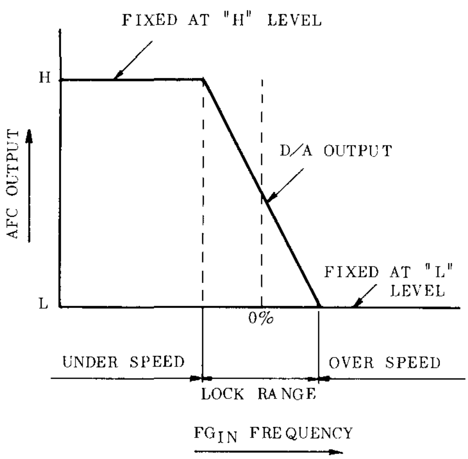
APC and AFC outputs are both fixed at "H" level.

c. When FG_{IN} frequency is above the lock range (over speed):

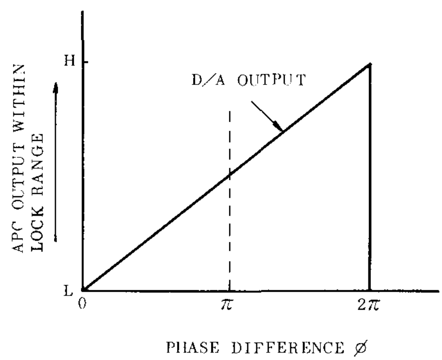
APC and AFC outputs are both fixed at "L" level.

· When a motor is in STOP state (P/S=H or NC), both AFC and APC are fixed "L" level.

AFC Output change status for FG_{IN} frequency

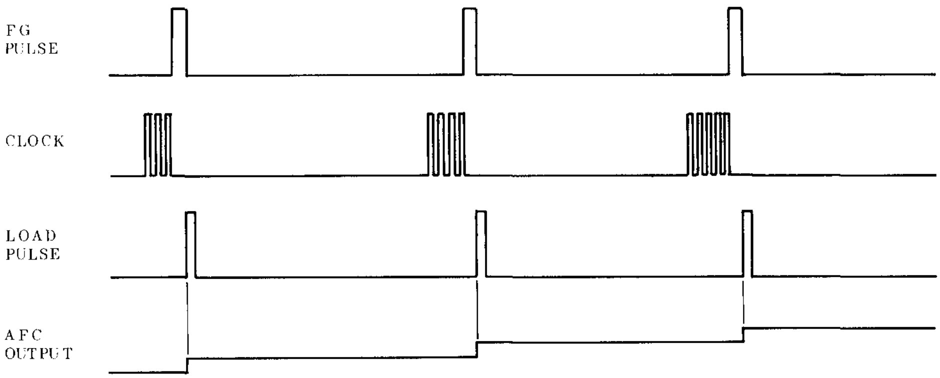


APC Output change status for phase difference ϕ.

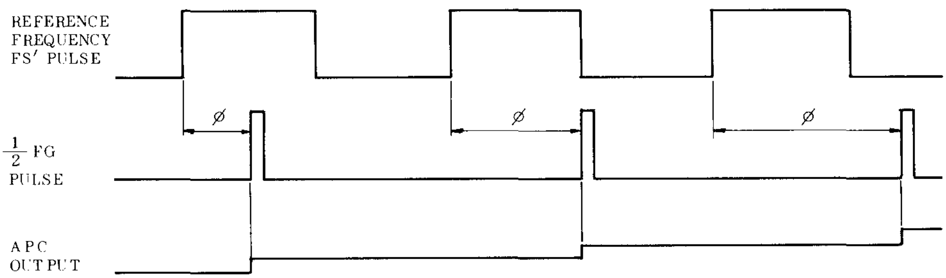


• AFC and APC timing chart within lock range.

a. AFC (SPEED CONTROL SYSTEM)



b. APC (PHASE CONTROL SYSTEM)



(7) Lock detecting terminal (LD)

- This terminal is the lock detecting output and is placed at "H" level when FG_{IN} frequency is within the lock range and otherwise, placed at "L" level.

(8) PLAY/STOP input terminal (P/S)

- PLAY/STOP signals of the motor are input to this terminal.

  PLAY=L, STOP=H or NC.

- This terminal has a pull-up resistor and a chattering proventive circuit.
- During PLAY (P/S=L), AFC, APC and LD perform the above-mentioned operations for FG_{IN} frequency, and during STOP (P/S=H or NC), AFC, APC and LD are all fixed at "L" level.

(9) Reverse signal output terminal (RV)

- Reverse signal for braking the motor at time of switching of motor speed from 45rpm to $33\frac{1}{3}$ rpm or the operation from PLAY to STOP is output through this terminal.
- Change of RV output status

PREVIOUS STATUS ⇨	RV OUTPUT CHANGE TO "H" LEVEL ⇨	RV OUTPUT CHANGE TO "L" LEVEL
During normal rotation (during lock) at 45rpm	When the motor speed is switched from 45rpm to $33\frac{1}{3}$ rpm	When the motor speed is locked at $33\frac{1}{3}$ rpm, or when $FG_{IN} \leq 1/8FS$, or when the motor speed is switched from $33\frac{1}{3}$ rpm to 45rpm.
During normal rotation (during lock) at $33\frac{1}{3}$ rpm or 45 rpm.	When the operation is switched from PLAY to STOP.	When $FG_{IN} \leq 1/8FS$ or when the operation is switched from STOP to PLAY.

- In other cases than above, RV output is not changed and fixed at "L" level.
- Further, if FG frequency rises up to 1.5 times of normal rotation at 45rpm. (2 times of normal rotation at 33rpm), RV output is reset.

(10) Reference divided frequency switching terminal (N1, N2)

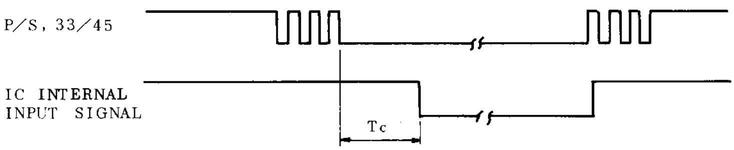
- Divided frequency 1/N of the crystal reference frequency divider can be switched to 1/4, 1/32 or 1/128 by number of FG pulses or a crystal used.
- This terminal has a built-in pull-up resistor.

(TRUTH TABLE)

N1	N2	$\frac{1}{N}$	STROBE OUTPUT FREQUENCY
H	H	$\frac{1}{32}$	$\frac{f_X \text{ [Hz]}}{32 \times (20 \text{ or } 27) \times 128}$
L	H	$\frac{1}{128}$	$\frac{f_X \text{ [Hz]}}{32 \times (20 \text{ or } 27) \times 128}$
H	L	$\frac{1}{4}$	$\frac{f_X \text{ [Hz)}}{32 \times (20 \text{ or } 27) \times 128}$

$\frac{1}{N}$: CRYSTAL REFERENCE DIVIDED FREQUENCY

(11) Chattering preventing time of P/S, 33/45 terminal: Tc

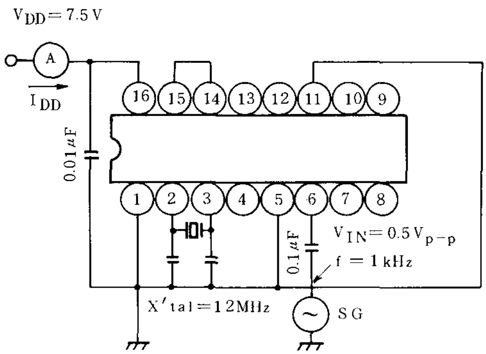


N1	N2	CHATTERING PREVENTING TIME Tc (S)	
		at 33rpm	at 45rpm
H	H	$\frac{1728}{f_{CPIN}} \times (1\sim2)$	$\frac{1280}{f_{CPIN}} \times (1\sim2)$
L	H	$\frac{432}{f_{CPIN}} \times (1\sim2)$	$\frac{320}{f_{CPIN}} \times (1\sim2)$
H	L	$\frac{6912}{f_{CPIN}} \times (1\sim2)$	$\frac{5120}{f_{CPIN}} \times (1\sim2)$

f_{CPIN} : CP_{IN} INPUT FREQUENCY (Hz)

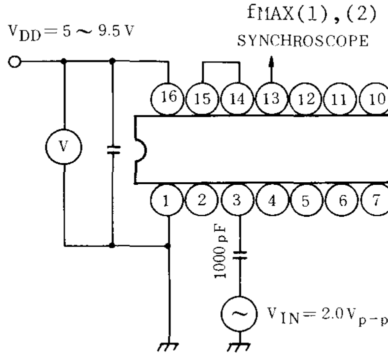
CHARACTERISTIC TEST CIRCUIT

(1) Operating supply current I_{DD}



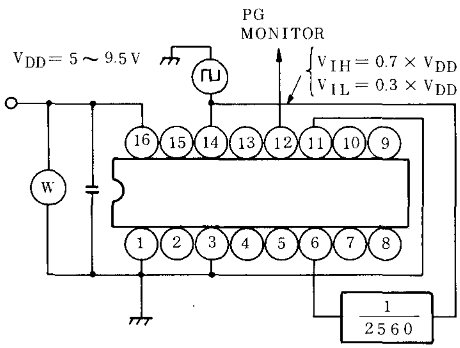
(2) XT Operating frequency range

$f_{MAX(1),(2)}$



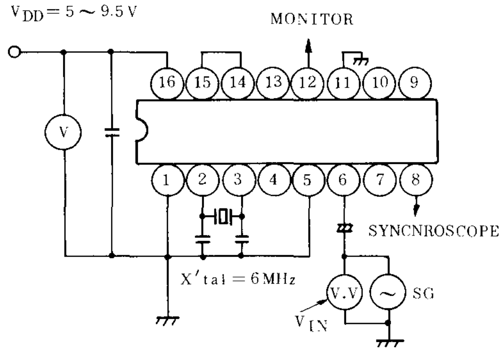
(3) CP_{IN} Operating frequency range

$f_{MAX(3),(4)}$

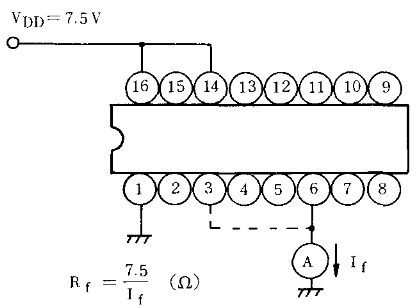


(4) FG_{IN} Input sensitivitiy

$V_{IN(1),(2)}$

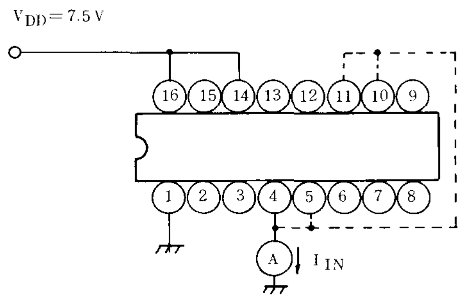


(5) Amplifier feedback resistor R_f



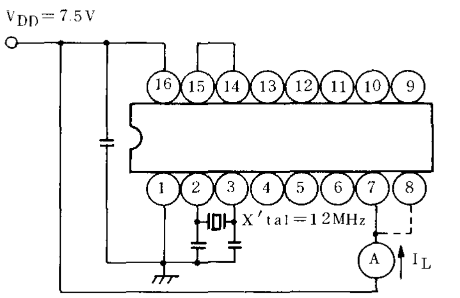
$R_f = \frac{7.5}{I_f}$ (Ω)

(6) Pullup resistor R_{IN}



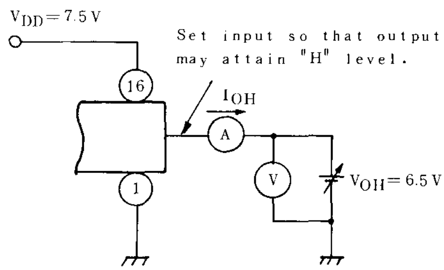
$R_{IN} = \frac{7.5}{I_{IN}}$ (Ω)

(7) D/A Converter ladder resistor $\overline{R_L}$

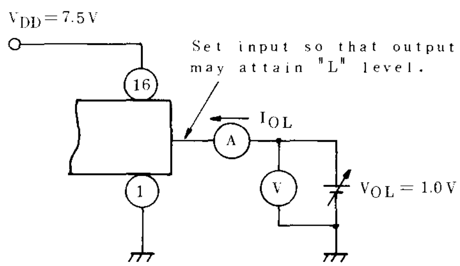


$$\overline{R_L} = \frac{7.5}{I_L} \quad (\Omega)$$

(8) Output current ("H" level) I_{OH}

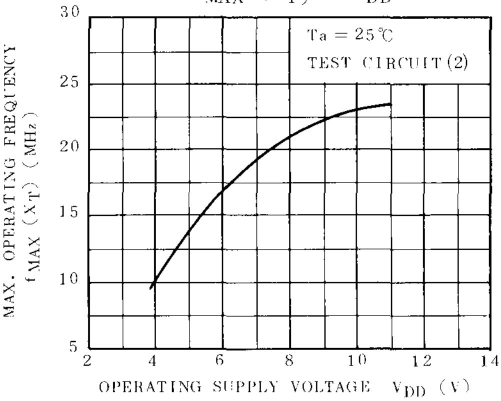


(9) Output current ("L" level) I_{OL}

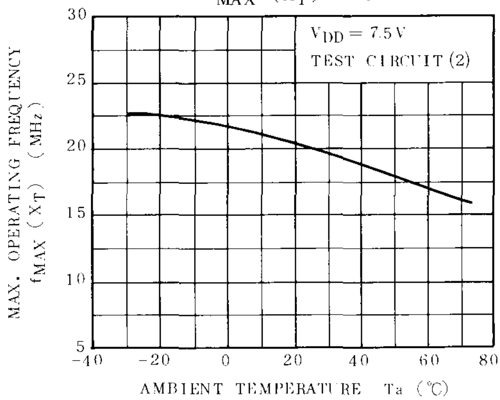


CHARACTERISTIC DATA

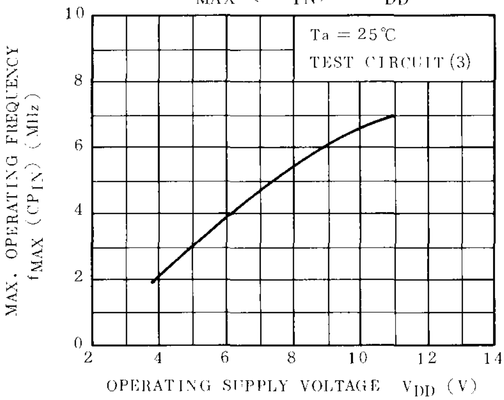
f_{MAX} (X_T) − V_{DD}



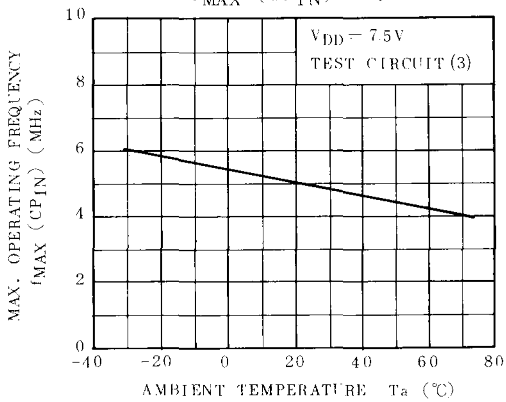
f_{MAX} (X_T) − Ta



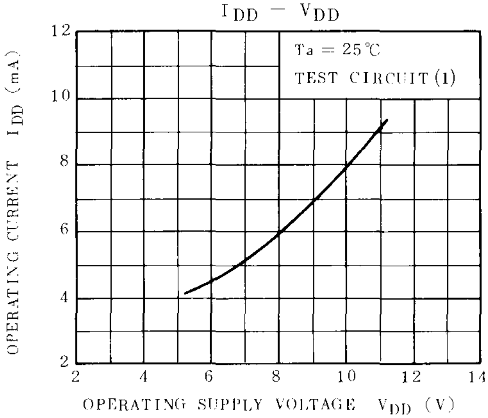
f_{MAX} (CP_{IN}) − V_{DD}



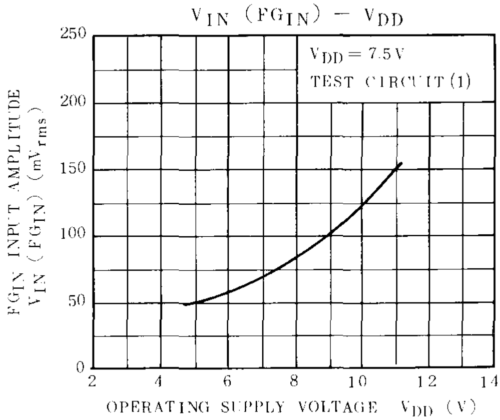
f_{MAX} (CP_{IN}) − Ta



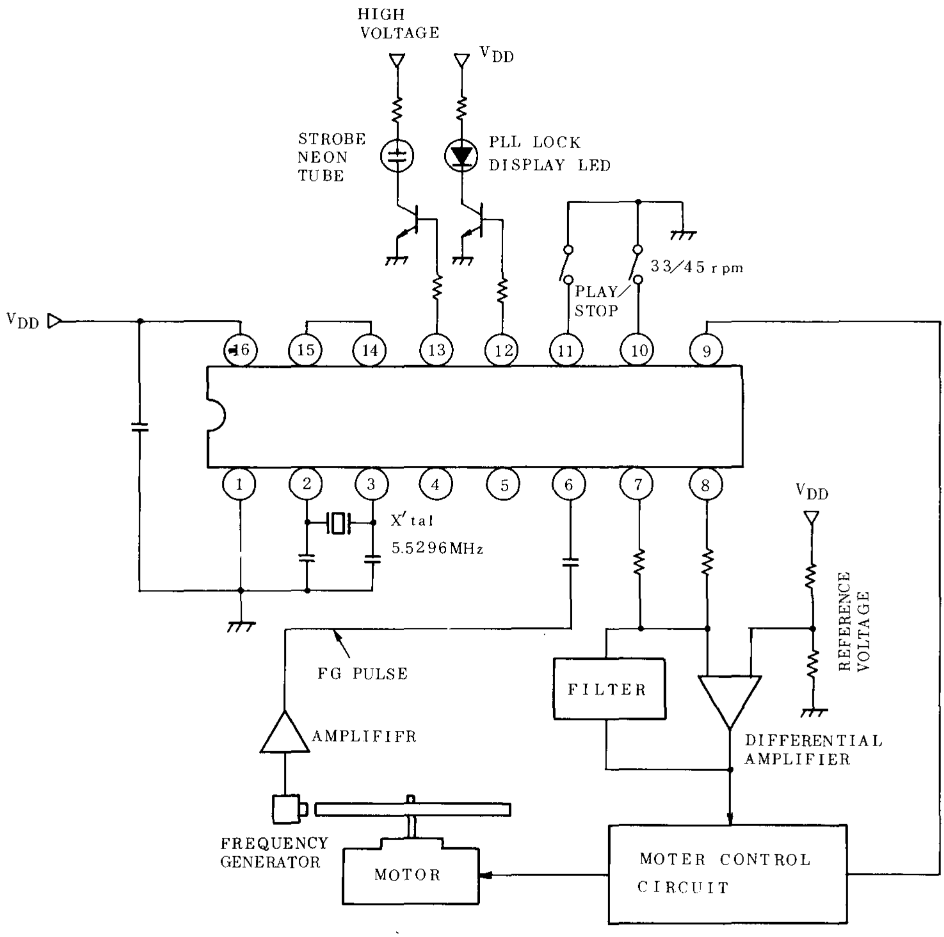
I_{DD} − V_{DD}



V_{IN} (FG_{IN}) − V_{DD}



EXAMPLE APPLICATION CIRCUIT



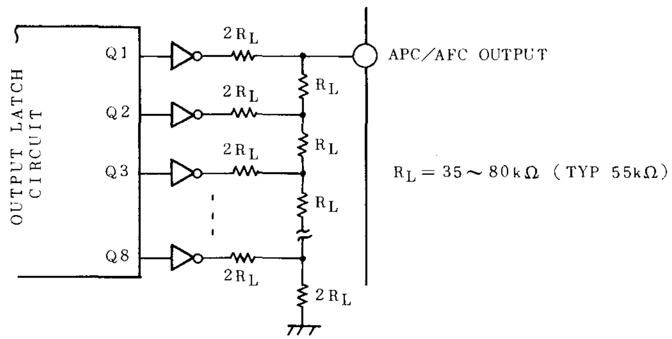
• Example of crystal oscillation frequency calculation

When FG' (number of FG pulse)=90 pulses, if the dividing frequency of reference divider is set at N=32 dividing frequency, the crystal oscillation frequency f_X is as follows:

$$f_X = 1920.FG'N = 1920 \times 90 \times 32 = 5,5296MHz$$

CAUTION IN APPLICATION

. APC and AFC terminals are for the 8-bit D/A converter outputs, which are directly output from the R-2R ladder type resistor network as shown in the following diagram. Impedance of these outputs becomes equal to the ladder resistor value R_L. Therefore, input impedance at the receiving side of these terminals shall be designed accordingly.



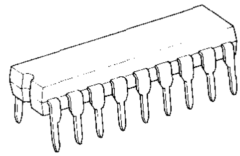
. A filter for an externally mounted differential amplifier on an application circuit shall be selected to meet the response characteristic of a motor to be used.

TC9192AP/AF

DOUBLE PLL FOR MOTOR CONTROL

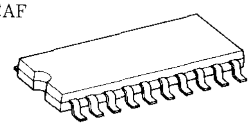
This is a LSI designed for motor-controlling the copying machine of which motor-rotation speed is necessary to be varied freely. With built-in PLL and VCO for reference signal generation, reference frequency can voluntarily be varied externally.

TC9192AP



DIP18-P-300A

TC9192AF



SOP20-P-300

Weight DIP18-P-300A:1.4g(Typ.)
SOP20-P-300 :0.48g(Typ.)

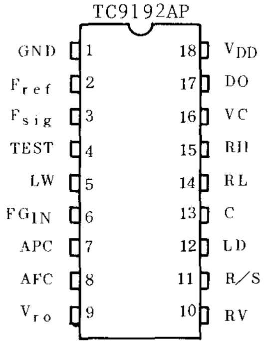
. Through using built-in VCO, P_D, phase comparator and divider reference frequencies can be obtained.
. AFC and APC applied with 8-bit D/A converter system is incorporated, and transistor of bipolar type is provided at the output for Buffer Amplifier.
. Lock range can be switched.
. 1/2 V_{DD} output for filter-amplifier is provided.
. Lock detection output and reverse rotation signal output are provided.

MAXIMUM RATINGS (Ta=25°C)

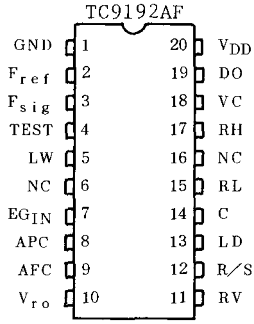
CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{DD}	-3.0~7.0	V
Input Voltage	V_{IN}	-0.3~V_{DD}+0.3	V
Power Dissipation	P_D	300	mW
Operating Temperature	T_{opr}	-30~75	°C
Storage Temperature	T_{stg}	-55~125	°C

PIN CONNECTION (TOP VIEW)

TC9192AP

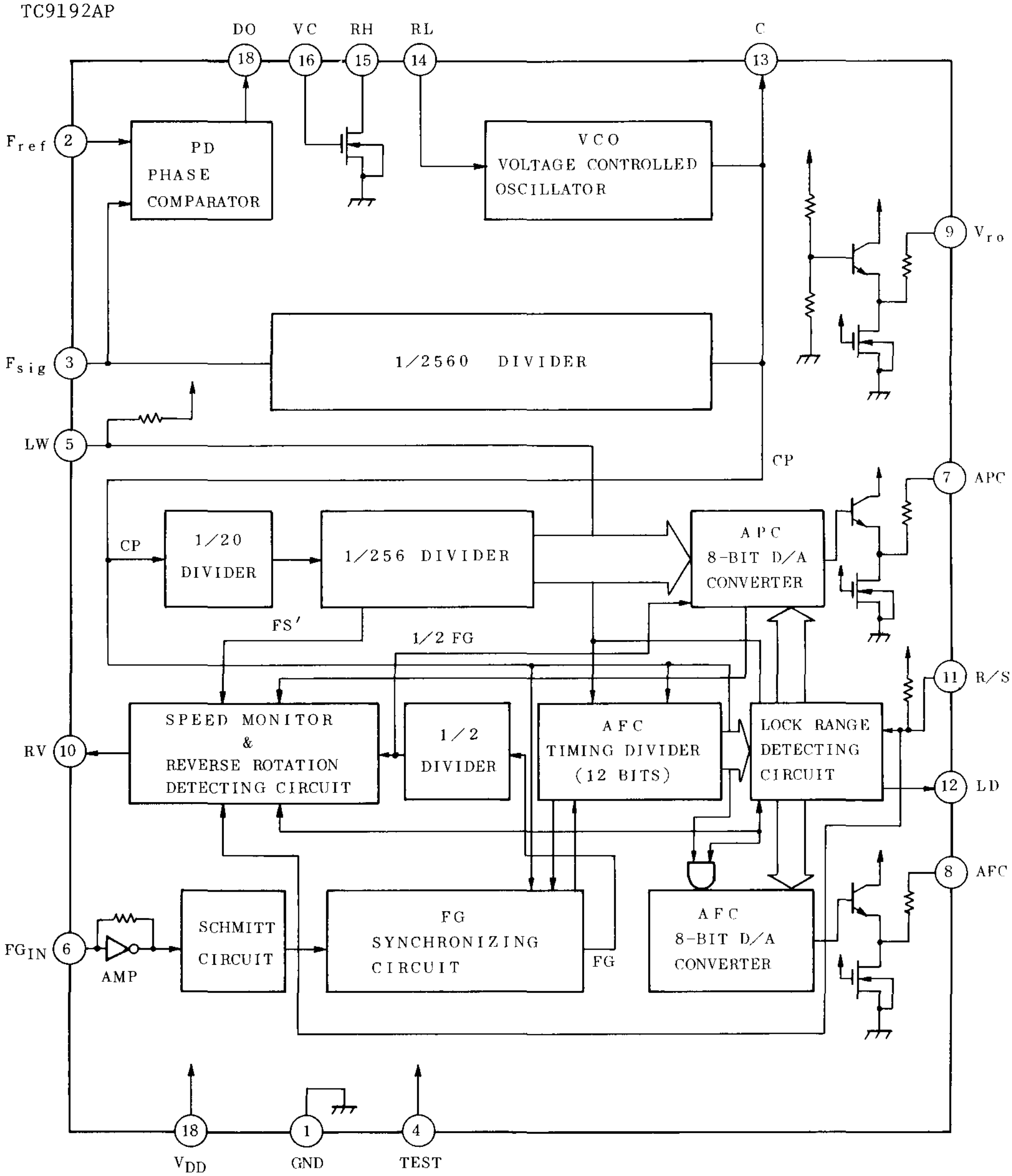


TC9192AF



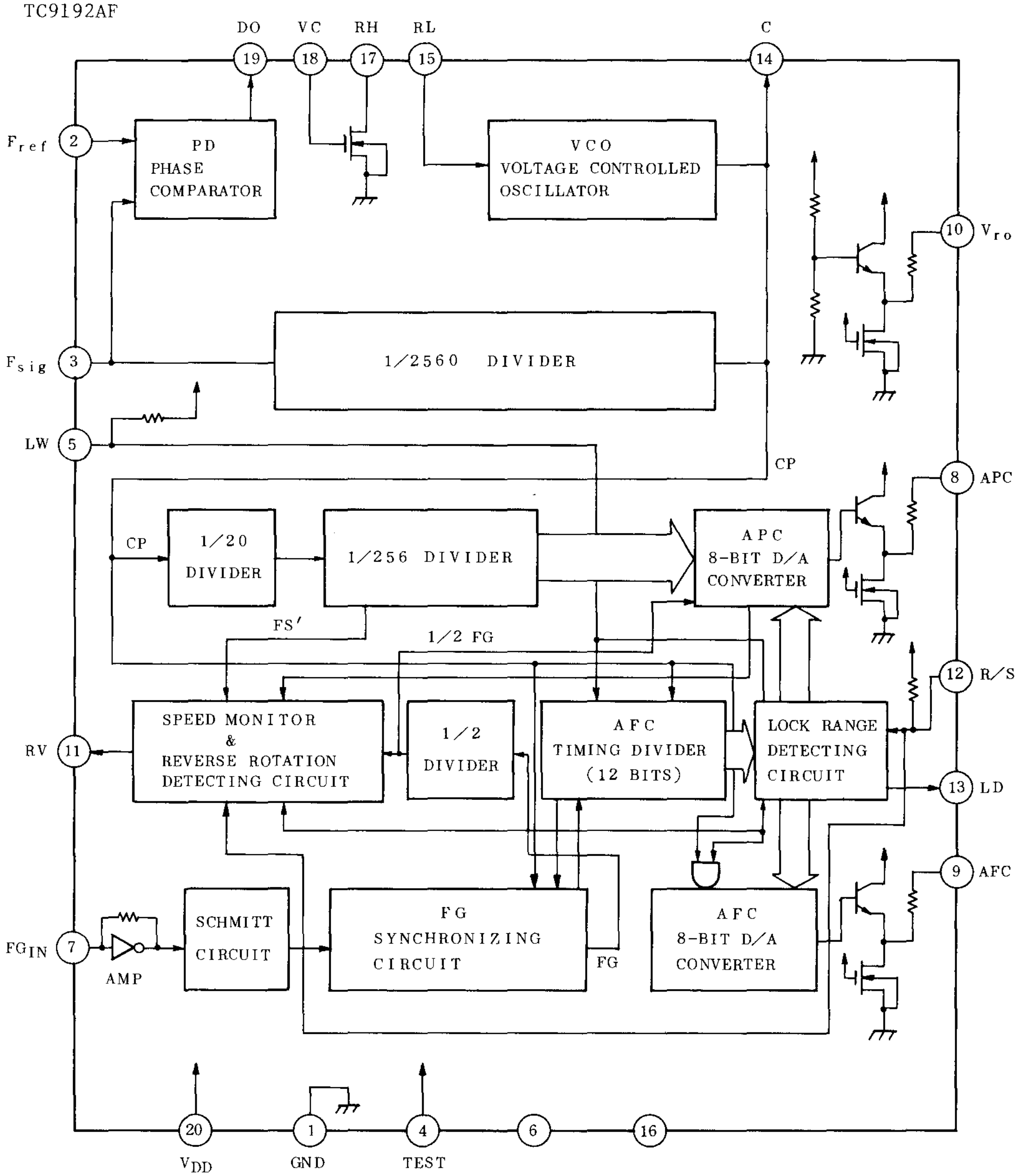
BLOCK DIAGRAM

TC9192AP



BLOCK DIAGRAM

TC9192AF



ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C, V_{DD}=5V)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Power Supply Voltage	V_{DD}	–		4.5	~	5.5	V
Power Supply Current	I_{DD}		*	–	7	20	mA

VCO BLOCK

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Max. Operating Frequency	f_{VCO} Max	–	C=33pF, R_L=0V *	2.5	–	–	MHz
VCO Applicable Range	f_{VCO}	–	Constant of C is varied with f_{VCO} *	0.5	~	2.5	MHz
VCO Deviation	Δf_{VCO}	–	C=Constant, R_L=2.0V *	–	±50	–	%
VCO Fsig Frequency Range	f_{CPIN}	–	Fsig N=2560 *	0.5	~	2.5	MHz

FG AMPLIFIER BLOCK

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Frequency Range	f_{FG}	–	V_{IN}=0.5Vp-p *	–	~	10	kHz
Input Operating Voltage	V_{FG}	–	f_{FG}=10kHz *	0.5	~	V_{DD}-0.5	Vp-p
Fref Frequency Range	fref	–	*	0.2	~	2.0	kHz

APC, AFC, D/A CONVERTER BLOCK

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Max. Deviation		–		–	±2.5	±6.5	LSB
Resolution		–		–	V_{DD}/256	–	

BIPOLAR TRANSFORMER OUTPUT CURRENT (APC, AFC, V_{ro} TERMINAL)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Current	"H" Level	I_{OHB}	–	V_{OH}=3V	-0.5	-0.8	–	mA
	"L" Level	I_{OLB}	–	V_{OL}=2V	30	50	200	μA
Output Voltage		V_{ro}	–	Reference output voltage	1.6	1.9	2.2	V

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C, V_{DD}=5V)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
PHASE COMPARATOR CHARACTERISTIC (DO TERMINAL)									
Output Current	"H" Level	I_{OHDO}	-	V_{OH}=4V		-1.0	-2.0	-	mA
	"L" Level	I_{OLDO}	-	V_{OL}=1V		1.0	2.0	~	
Output Leak Current at OFF		I_{OZDO}	-			-	-	±0.1	μA
Input Leak Current		I_{IH}/I_{IL}	-	Fref, V_C terminal		~	-	±1.0	μA
Pull-up Resistance		R_{IN}	-	LW, R_{IS} terminal		15	30	45	kΩ
Input Voltage	"H" Level	V_{IH}	-	Fref,LW,RS terminal		0.7XV_{DD}	~	V_{DD}	V
	"L" Level	V_{IL}	-			0	~	0.3XV_{DD}	
Output Current	"H" Level	I_{OH}	-	RV,LD terminal	V_{OH}=4V	-0.5	-1.0	-	mA
	"L" Level	I_{OL}	-		V_{OL}=1V	0.5	1.0	-	
Nch OPEN DRAIN CURRENT									
Nch ON Current		I_{OLD}	4	RH terminal	V_G=5V, V_D=1V	0.5	1.0	-	mA
Nch OFF Current		I_{OID}			V_G=0V, V_D=5V	-	-	1.0	μA

* : Guaranteed within the range of V_{DD}=4.5V~5.5V, Ta=-30~75°C.

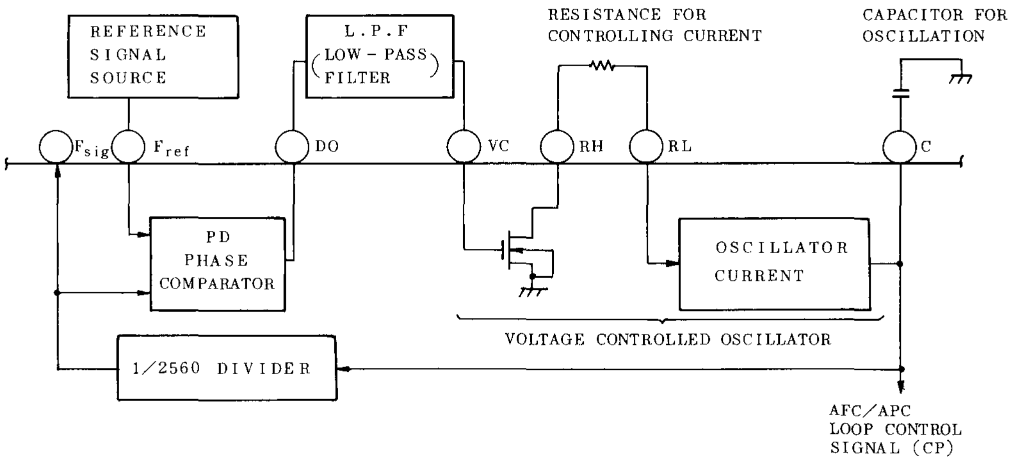
FUNCTIONAL DISCRIPTION OF EACH PIN

PIN No.	SYMBOL	FUNCTION, OPERATION	REMARKS
18	V_{DD}	Power supply voltage terminal and grounding terminal.	
1	GND		
2	F_{ref}	Reference frequency input terminal for phase comparator.	C-MOS input
3	F_{sig}	1/2560 dividing output terminal of VCO frequency, internally comparison signal is made.	C-MOS output
5	LW	Switching terminal of lock range. at LW="L", normal range. at LW="H", double range.	Built-in pull-up resistance speed
6	FG_{IN}	Pulse input terminal for indicating the rotation speed of motor.	Built-in amp.
7	APC	Output terminal of APC 8-bit D/A converter output.	Built-in bipolar transistor
8	AFC	Output terminal fo AFC 8-bit D/A converter output.	Built-in bipolar transistor
9	V_{ro}	Output terminal for reference voltage.	Built-in bipolar transistor
10	RV	Reverse rotation signal for output driver.	C-MOS output
11	RIS	RUN/STOP switching terminal of motor at RIS="L", RUN. at RIS="H", STOP	Built-in pull-up resistance
12	LD	Lock detecting terminal. When the rotation frequency is within lock range, "H" level, and in other cases, "L" level.	C-MOS output
13	C	Terminal attached with capacitor for adjusting frequency. Internal control signal is made.	
14	RL	Current control terminal for controlling VCO frequency.	
15	RH	Current control output terminal for VCO	Nch open drain
16	VC	Voltage control input terminal for VCO	
17	DO	Output terminal of phase comparator	C-MOS output
4	Test	Input terminal of internal test. Generally ground.	C-MOS input

EXPLANATION OF OPERATION

TC9192AP has double PLL which is consist of AFC/APC loop for motor-controlling and phase feedback loop for reference signal. In the following operation of respective block is explained.

1. Phase Feedback Loop



(1) Voltage controlled oscillator terminal (C,EL,RH,VC)

. Voltage controlled oscillator (VCO) is consist of the Nch open drain FET (VC,RH terminal) and current controlled oscillator (RL,C terminal) combinated. VCO is an oscillator of which oscillation frequency is controlled by given control voltage. The control voltage and oscillation frequency are proportional.

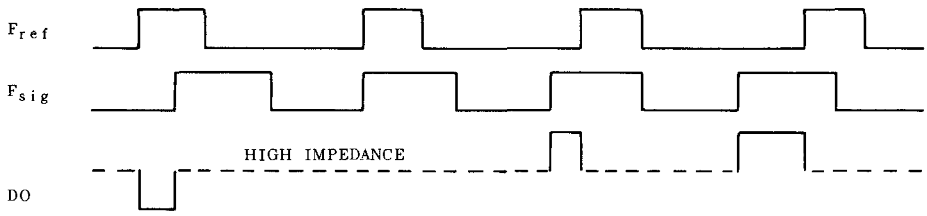
. The operation frequency range of VCO is 0.5~2.5MHz.

. Frequency which is obtained by VCO becomes control signal (CP) of AFC, APC loop in next step.

(2) Phase comparator output terminal (Fsig, Fref, DO)

. Phase comparator detects the input pulse difference, and outputs at DO the positive and the negative pulses proportioned with the phase difference.

PHASE COMPARATOR TIMING CHART



- F_{ref} terminal is reference signal input terminal of APC/AFC loop control signal (CP), the motor speed (the number of FG pulses of motor) is decided by it.
  The relations between FG, F_{ref} and FG are as follows;
  $f_x(CP)=2560\times F_{ref}[Hz]$: Relation between F_{ref} and control signal (CP)
  $f_x(CP)=20\times 128\times FG[Hz]$: Relation between FG and control signal (CP)
  $\therefore$This relation becomes "$FG=F_{ref}[Hz]$"
- F_{ref} input terminal is a C-MOS structure.
- F_{sig} output terminal is put out comparison signal of phase comparator.

2. APC/AFC Loop

(1) FG pulse input terminal (FG_{IN})

- This is the input terminal of FG pulse for indicating the motor speed, and this signal becomes the comparison frequency of internal PLL.
- Since the amplifier and the Schmitt circuit are incorporated, operation is made with the small amplitude through the coupling capacitor.

(2) Output terminals (APC, AFC) of phase control system (APC) and speed control system.

- AFC is F-V converter against FG_{IN} frequency and is fabricated with 8-bit D/A converter.
- APC is the phase comparator (ϕ-V converter) for comparing the phase difference ϕ between $\frac{1}{2}$FG signal and the reference signal FS', and is also fabricated with 8-bit D/A converter.
  (Note) $FS'=\frac{1}{2}FS$
- Both APC and AFC perform three kinds of operations described below.
  a) When FG_{IN} frequency is within the lock range, both APC and AFC perform the normal operation against FG_{IN}.

Against the reference synchronization FS, the lock range is

at LW="L", +9.3%, -10.6% (about ±10%)

at LW="H", +4.6%, -5.3% (about ±5%)

(Note) Reference frequency $FS = \frac{f_{VCO}}{20 \times 128}$ [Hz]

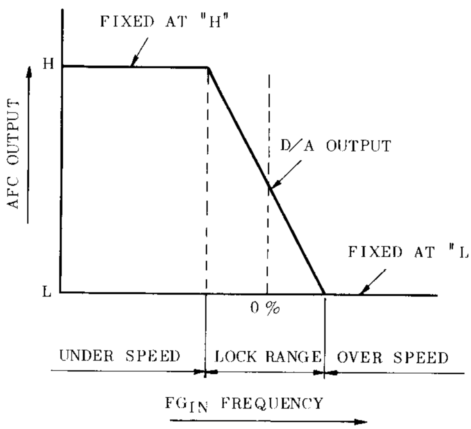
b) When FG_{IN} frequency is under the lock range (under speed), the outputs of APC and AFC are fixed at "H" level.

c) When FG_{IN} frequency is over the lock range (over speed), the outputs of APC and AFC are fixed at "L" level.

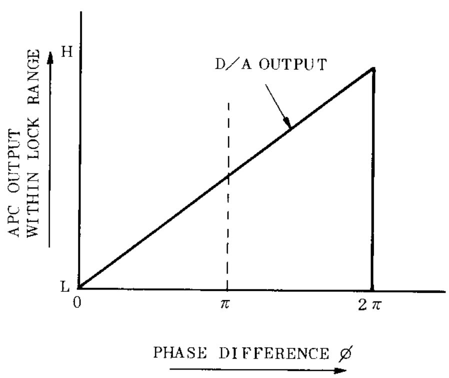
. When the motor is in STOP state (RIS=H or Open), both the outputs of AFC and APC are fixed at "L" level.

. Bipolar transformer is incorporated at the output stage of both APC and AFC.

CHANGE OF APC OUTPUT AGAINST FG_{IN} FREQUENCY

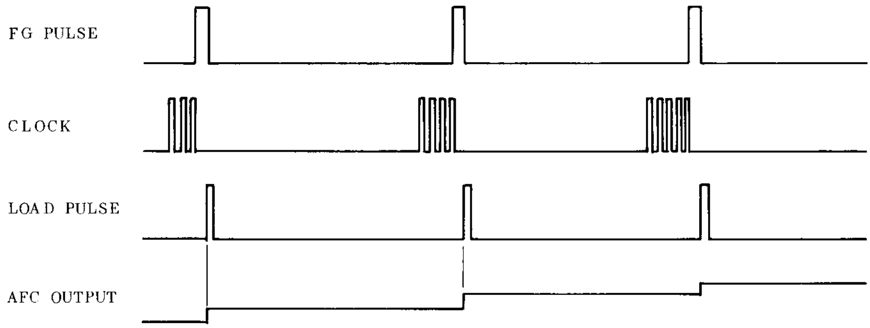


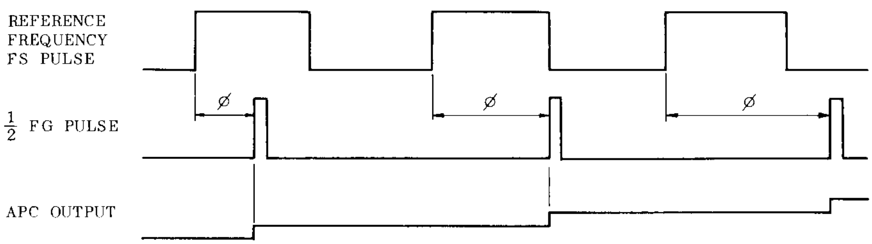
CHANGE OF APC OUTPUT AGAINST PHASE DIFFERENCE ϕ



. Timing charts of AFC and APC within lock range

a. AFC (speed control system)





(3) Output terminal for reference voltage generation (V_{ro})

. V_{ro} is the transistor output terminal for the reference voltage of the operational amplifier which controls the motor by means of synthesizing the outputs of APC and AFC.

. V_{ro} is fixed at $\frac{1}{2}$ V_{DD} internally through dividing the resistance, and the output is fabricated into bipolar transistor construction.

(4) Lock range switching input terminal (LW)

. This is the terminal for switching the lock range of APC and AFC, and two kinds of lock ranges can be selected through operating this terminal.

at LW="H", normal lock range (±5%)

at LW="L", double lock range (±10%)

(5) RUN/STOP input terminal (RIS)

. RUN/STOP signals of motor are input. RUN="L", STOP="H" or open.

. During RUN(RIS=L), APC, AFC and LD perform the normal operation against FG_{IN} frequency. During STOP(RIS=H or Open), APC, AFC and LD are all fixed at "L" level.

. Pull-up resistance and chattering prevention circuit are incorporated.

(6) Lock detection terminal (LD)

This is the output terminal for lock detection. When FG_{IN} frequency is within lock range, the terminal is at "H" level, and in other cases, at "L" level.

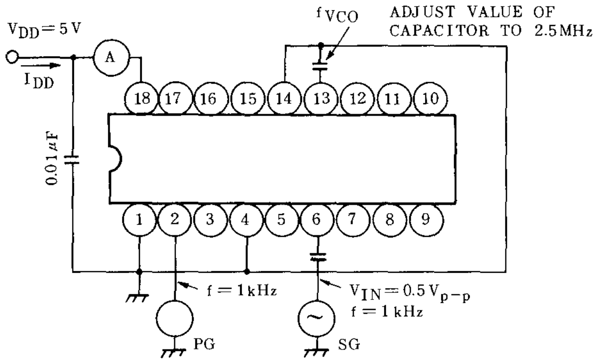
(7) Reverse rotation signal output terminal (RV)

. RV is the reverse rotation signal output for applying the brake to the motor when the motor is changed to STOP state.

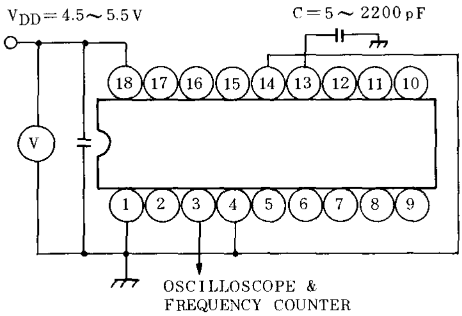
. When STOP state is turned out, RV becomes "H" level, and when the frequency of FG_{IN} becomes below $\frac{1}{2}$ FS, "L" level. In other cases, RV is fixed at "L" level.

CHARACTERISTIC TEST CIRCUIT

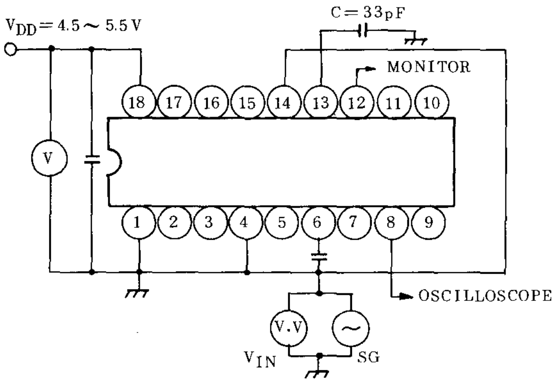
(1) Operating Supply Current (I_{DD})



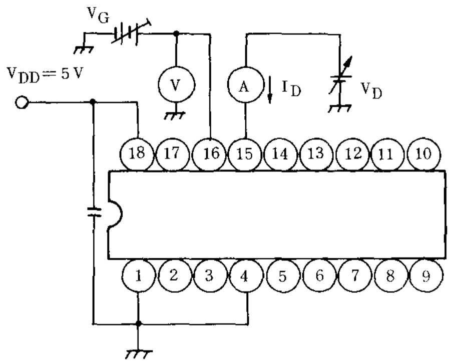
(2) VCO Operating Frequency Range (f_{VCO})



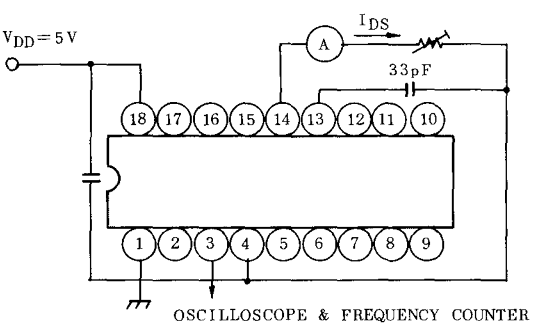
(3) FG_{IN} Input Sensitivity

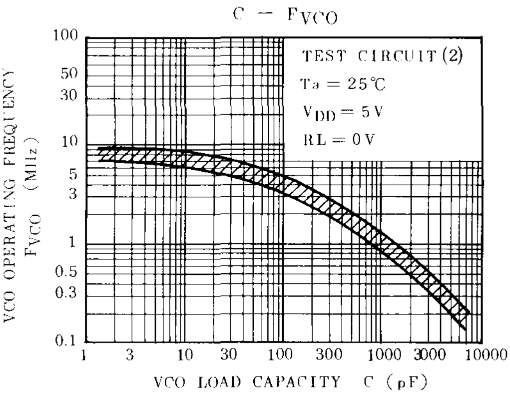


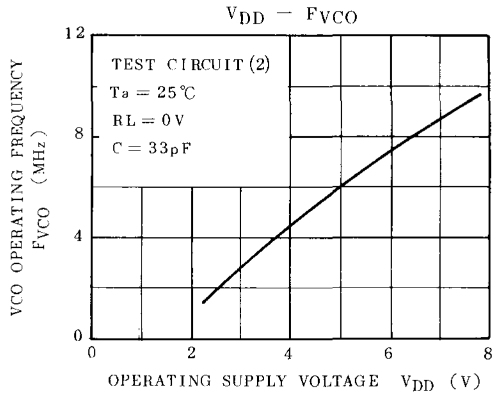
(4) Nch Open Drain Current (I_D)

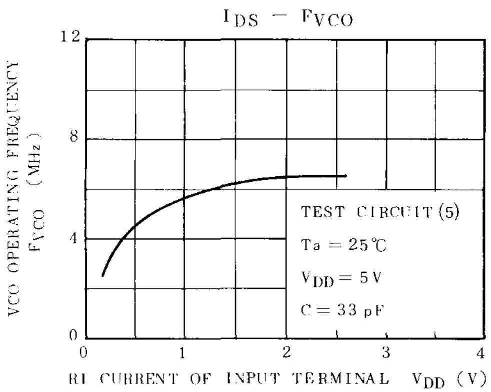


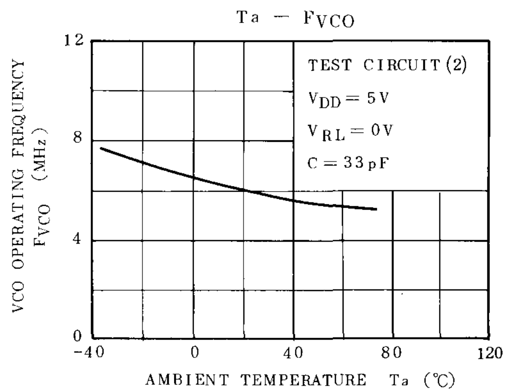
(5) VCO Operating Frequency Range (2) (f_{VCO})

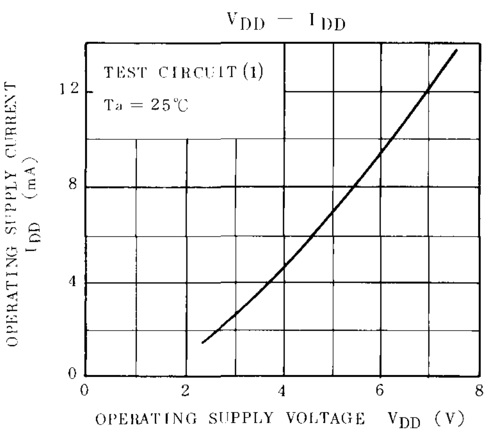


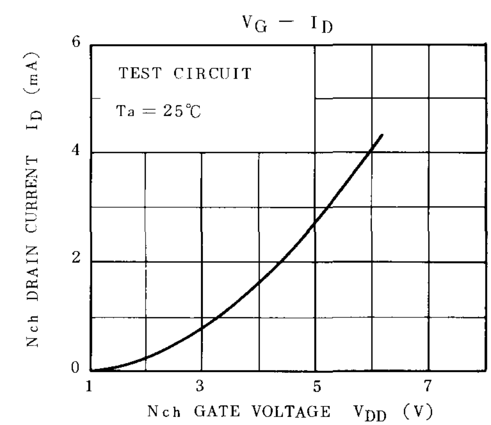

C − FVCO
TEST CIRCUIT (2)
Ta = 25℃
VDD = 5 V
RL = 0 V
100
50
30
10
5
3
1
0.5
0.3
0.1
1
3
10
30
100
300
1000
3000
10000
VCO LOAD CAPACITY C (pF)
VCO OPERATING FREQUENCY
FVCO (MHz)


VDD − FVCO
TEST CIRCUIT (2)
Ta = 25℃
RL = 0 V
C = 33 pF
12
8
4
0
0
2
4
6
8
OPERATING SUPPLY VOLTAGE VDD (V)
VCO OPERATING FREQUENCY
FVCO (MHz)

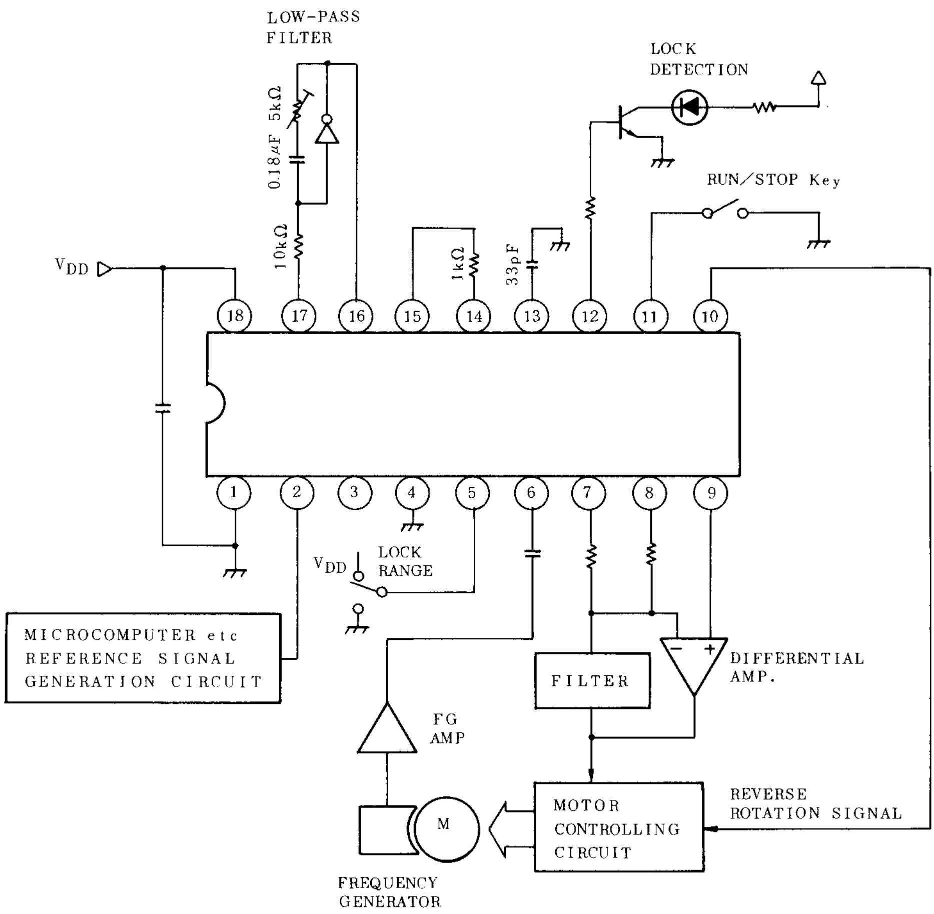

IDS − FVCO
TEST CIRCUIT (5)
Ta = 25℃
VDD = 5 V
C = 33 pF
12
8
4
0
0
1
2
3
4
RI CURRENT OF INPUT TERMINAL VDD (V)
VCO OPERATING FREQUENCY
FVCO (MHz)


Ta − FVCO
TEST CIRCUIT (2)
VDD = 5 V
VRL = 0 V
C = 33 pF
12
8
4
0
-40
0
40
80
120
AMBIENT TEMPERATURE Ta (℃)
VCO OPERATING FREQUENCY
FVCO (MHz)


VDD − IDD
TEST CIRCUIT (1)
Ta = 25℃
12
8
4
0
0
2
4
6
8
OPERATING SUPPLY VOLTAGE VDD (V)
OPERATING SUPPLY CURRENT
IDD (mA)


VG − ID
TEST CIRCUIT
Ta = 25℃
6
4
2
0
1
3
5
7
Nch GATE VOLTAGE VDD (V)
Nch DRAIN CURRENT ID (mA)

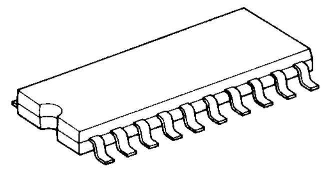
EXAMPLE OF APPLICATION CIRCUIT



TC9193AF

MOTOR CONTROL PLL FOR DISK DRIVE

This is a C^2MOS LSI designed for motor control of the floppy disk driver (FDD) and the winchester disk driver.
3-bit D/A convertor method is adopted for the speed control system (AFC) and the phase control system (APC) to make the remarkable reduction of the external part quantity and the complete freedom from the maintenance realized.



SOP20-P-300

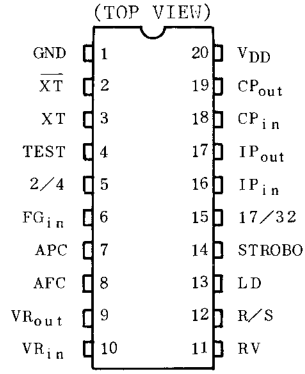
Weight : 0.48g(Typ.)

- Bipolar type transistors are provided to the outputs of AFC and APC.
- Sector detection signal generating circuit synchronized to index pulse is incorporated enabling the number of sectors changed over from outside.
- The number of X'tal reference dividing can be switched to $\frac{1}{2}$ and $\frac{1}{4}$
- The terminals for sector signal output, lock detection output and reverse rotation signal output are provided.
- Package is MFP of 20-pin.

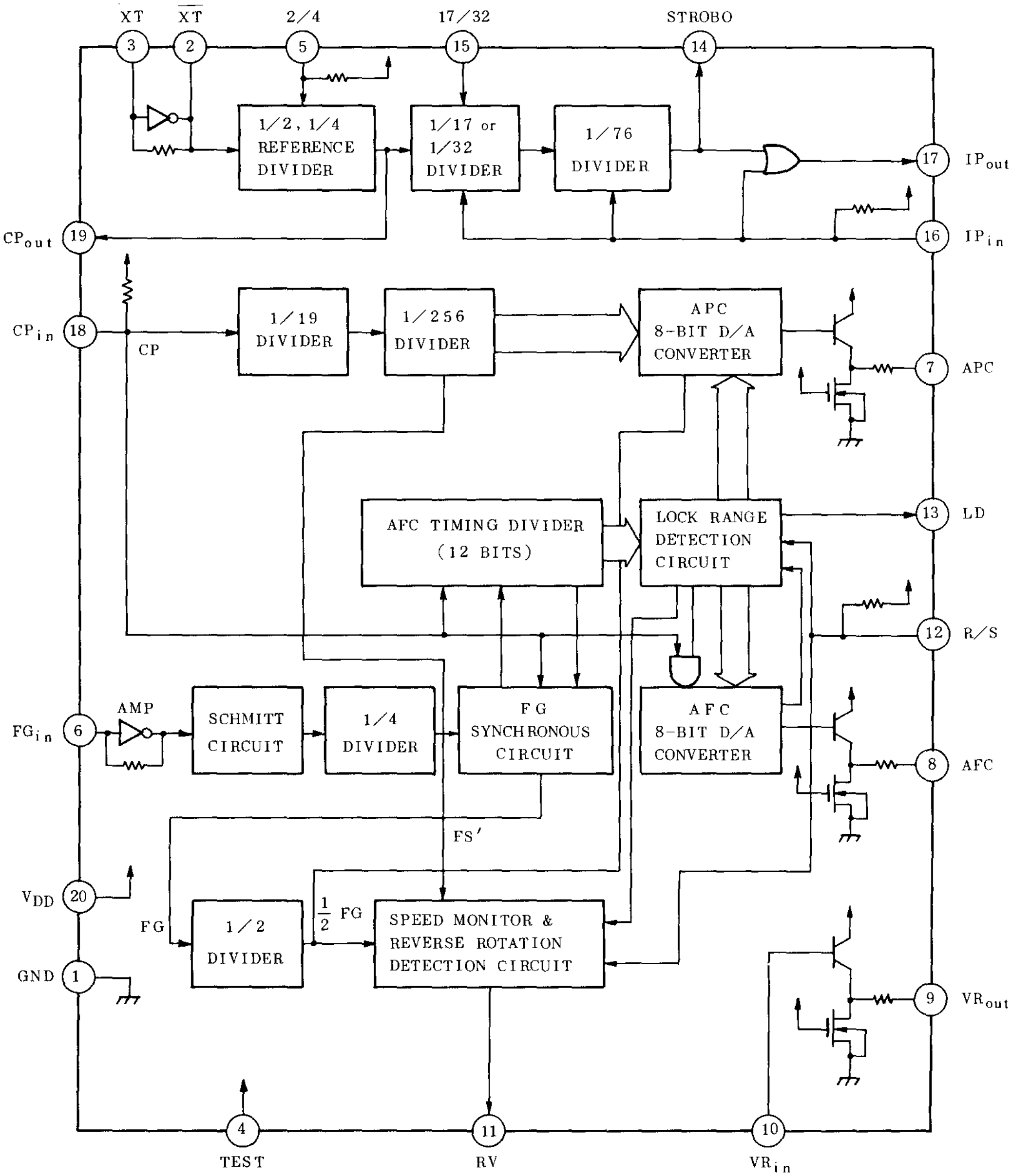
MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{DD}	7	V
Input Voltage	V_{IN}	$-0.3 \sim V_{DD}+0.3$	V
Power Dissipation	P_D	300	mW
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~125	°C

PIN CONNECTION
(TOP VIEW)



BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta=25°C, V_{DD}=5V)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		V_{DD}	-	*		4.5	~	5.5	V
Operating Supply Current		I_{DD}	-	X_T=8.0MHz CP_{in}=25MHz FG_{in}=1kHz		-	5	20	mA
Operating Frequency Range	XT	$f_{MAX(1)}$	-	V_{DD}=4.5~5.5V V_{IN}=1.0Vp-p *		1.0	~	8.0	MHz
	CP_{in}	$f_{MAX(2)}$	-	V_{DD}=4.5~5.5V *		0.5	~	2.5	MHz
FG_{IN} Operating Frequency Range		f_{FG}	-	V_{DD}=4.5~5.5V V_{IN}=0.5Vp-p *		-	~	10	kHz
FG_{IN} Input Amplitude Voltage		V_{FG}	-	V_{DD}=4.5~5.5V f_{FG}~10kHz * Sine wave		0.5	~	V_{DD}-0.5	Vp-p
AFC, APC D/A Converter	Max. Deviation		-	V_{DD}=4.5~5.5V		-	±2.5	±6.5	LSB
	Resolution		-	V_{DD}=4.5~5.5V		-	V_{DD}/256	-	V
Bipolar Tr. Output Current	"H" Level	$I_{OH\ B}$	-	APC, AFC VR_{out} terminal	V_{OH}=3V	-0.5	-0.8	-	mA
	"L" Level	$I_{OL\ B}$	-	APC, AFC VR_{out} terminal	V_{OL}=2V	30	50	200	μA
Input Leak Current	"H" Level	I_{IH}	-	VR_{in}, 17/32 terminal	V_{IH}=5V	-10	-	10	μA
	"L" Level	I_{IL}	-	VR_{in}, 17/32 terminal	V_{IL}=0V	-10	-	10	μA
Pull-up Resistance		R_{IN}	-	2/4, R/S, IPin CP_{in} terminal		15	30	45	kΩ
Input Voltage	"H" Level	V_{IH}	-	2/4, R/S, IPin CP_{in} terminal		0.7XV_{DD}	~	V_{DD}	V
	"L" Level	V_{IL}	-	2/4, R/S, IPin CP_{in} terminal		0	~	0.3XV_{DD}	V
Output Current	"H" Level	I_{OH}	-	RV, LD STROBO CP_{out}, IP_{out} terminal	V_{OH}=4V	-0.5	-1.0	-	mA
	"L" Level	I_{OL}	-	RV, LD STROBO CP_{out}, IP_{out} terminal	V_{OL}=1V	0.5	1.0	-	mA
Amp. Feedback Resistance		R_f	-			-	150	-	kΩ

* mark : Guaranteed within the range of Ta=-30~75°C

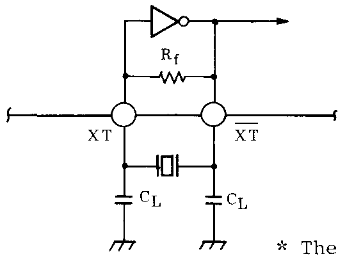
FUNCTIONAL DESCRIPTION OF EACH PIN

PIN No.	SYMBOL	FUNCTION · OPERATION	REMARKS
20	V_{DD}	Supply voltage applying terminal and grounding terminal.	
1	GND		
2	X_T	Crystal oscillating terminal to be connected with crystal oscillator which produces reference frequency.	Built-in feedback resistance
3	$\overline{X_T}$		
5	2/4	Reference frequency is divided into $\frac{1}{2}$ or $\frac{1}{4}$. at 2/4="L", 1/2 dividing. at 2/4="H" or OPEN, 1/4 dividing.	Built-in pull-up resistance
6	FG_{in}	Pulse input terminal indicating R.P.M. of motor.	Built-in Amp.
7	APC	Output terminal of motor phase control system. 8-bit D/A converter output.	Built-in bipolar Tr.
8	AFC	Output terminal of motor speed control system. 8-bit D/A converter output.	Built-in bipolar Tr.
9	VR_{out}	Input output terminal for generating reference voltage.	Built-in bipolar Tr.
10	VR_{in}		
11	RV	Reverse rotation signal of motor is output.	C-MOS output
12	R/S	RUN/STOP changeover terminal of motor. L=RUN, H or OPEN=STOP	Built-in pull-up resistance.
13	LD	Lock detection terminal of motor. When rpm of motor is within the lock range, this terminal goes into the state of "H" level and "L" level in other cases.	C-MOS output
14	STROBO	Sector detection signal synchronized to index pulse is generated.	C-MOS output
15	17/32	Changeover terminal of number of sectors. at 17/32="L", 1/17 dividing. at 17/32="H", 1/32 dividing.	C-MOS input
16	IP_{in}	Index pulse input terminal.	Built-in pull-up resistance.
17	IP_{out}	Index pulse is output synchronously with sector detection signal.	C-MOS output
18	CP_{in}	Reference frequency input terminal for internal control, which is usually connected to CP_{out}.	C-MOS input
19	CP_{out}	Output terminal of crystal reference divider, which is usually connected to CP_{IN}.	C-MOS output
4	TEST	Input terminal for internal test, which is usually connected with ground.	C-MOS input

OPERATIONAL DESCRIPTION

1) Crystal Oscillating Terminal (X_T, $\overline{X_T}$)

. The crystal oscillator is connected to be used as shown in the following figure.



* The value of 10~30pF is appropriate for C_L.

. The crystal oscillation frequency is calculated through the following formula according to the number of pulses of the motor to be used.

$$f_X = \frac{1}{4}FG' \times 128 \times 19 \times N = 608FG' \times N \quad [Hz]$$

f_X : Number of crystal oscillation frequency.

FG': Frequency to be input to FG_{in}.

N : Dividing ratio of reference divider. [2] or [4].

2) Reference Frequency Input-Output Terminal (CP_{out}, CP_{in})

. The dividing output $\frac{f_X}{N}$ of the reference divider is output to CP_{out} which is usually connected to CP_{in}.

. The motor speed can finely be adjusted through connecting the external oscillator (CR oscillator, etc.) with CP_{in}.

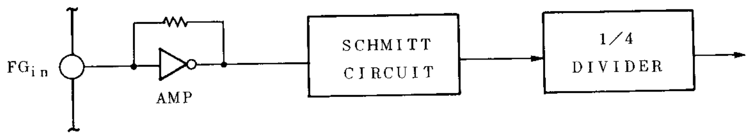
3) Changeover Terminal of Reference Frequency (2/4)

. The dividing number $\frac{1}{N}$ of the reference divider can be changed over to $\frac{1}{2}$ or $\frac{1}{4}$ by the number of FG pulses and the oscillation frequency to be used. (With pull-up resistance)

at 2/4 = "L", $N = \frac{1}{2}$

at 2/4 = "H", $N = \frac{1}{4}$

4) FG Pulse Input Terminal (FGin)

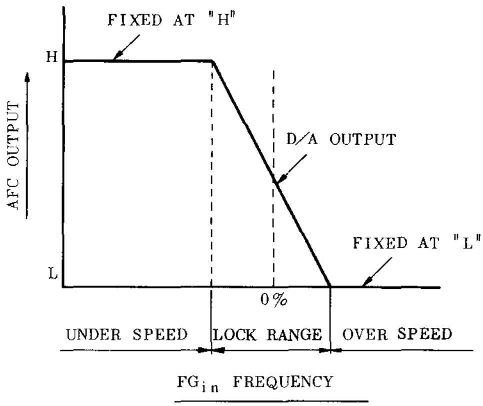


- FG pulse input indicating the r.p.m. of motor, of which signal becomes the comparative frequency of the internal PLL.
- Since the AMP and the schmitt circuit are incorporated, operation is made in small amplitude with C-connection.
- Since the $\frac{1}{4}$ divider is internally provided, care must be taken at calculating the reference frequency.

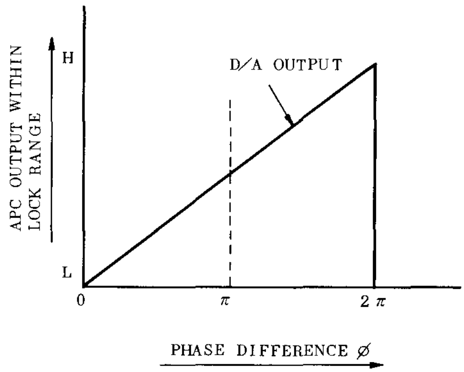
5) Output Terminals (APC and AFC) of Phase Control System (APC) and Speed Control System (AFC)

- AFC is an F-V converter for FGin frequency and is composed of an 8-bit D/A converter.
- APC is a phase comparator (ϕ-V converter) for detecting the phase-difference ϕ between $\frac{1}{2}$FG signal and the reference frequency FS', and is also composed of an 8-bit D/A converter.
- Both APC and AFC carry out the three kinds of operations described below according to FGin signal.
  a. When FGin frequency is within the lock range, both APC and AFC carry out the regular operation for FGin.
     The lock range is +4.9% to −5.6% of the reference frequency FS.
     (Note) Reference frequency = $\frac{fx}{N \times 19 \times 128}$ [Hz]
  b. In case FGin frequency is under the lock range (under speed), APC and AFC outputs are fixed at "H" level.
  c. In case FGin frequency is over the lock range (over speed), APC and AFC outputs are fixed at "L" level.
- When the motor is in the stop state (R/S=H or Open), AFC and APC outputs are fixed at "L" level.
- Both APC and AFC have the bipolar transistors incorporated in the output stage.

Changing pattern of AFC output against FG_{in} frequency

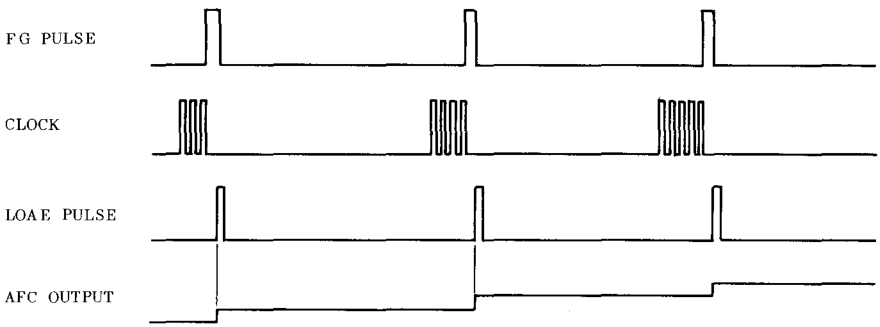


Changing pattern of APC output phase difference ϕ

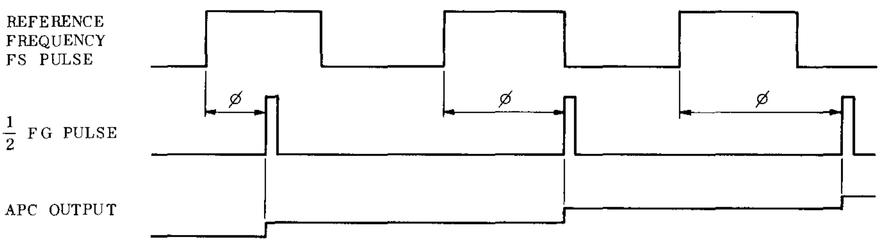


. Timing charts of AFC and APC within lock range

a. AFC (speed control system)



b. APC (phase control system)



6) Input/output Terminal for Generating Reference Voltage (VR_{out}, VR_{in})

VR_{out} (VR_{in}) is a transistor output (input) terminal for the reference voltage of the operational amplifier which controls the motor through making the APC (AFC) output synthesized.

7) RUN/STOP input terminal (R/S)

. RUN/STOP signal of the motor is input.

RUN="L", STOP="H" or OPEN

. During RUN (R/S=:), APC, AFC and LD perform the regular operation against FG_{in} frequency and during STOP (R/S=H or OPEN), APC, AFC and LD are fixed at "L" level.

. Pull-up resistance and chattering prevention circuit are incorporated.

8) Lock Detection Terminal (LD)

This is an output terminal for lock detection, which goes into the state of "H" level when FG_{in} frequency is within the lock range, and into "L" level in the other cases.

9) Reverse Signal Output Terminal (RV)

. This is a reverse signal output terminal for applying the brake to the motor when the locked RUN state is changed over to the STOP state (R/S=H or OPEN).

. RV goes into the state of "L" level when changed over to STOP state, and goes into "L" level when the frequency of FG_{in} becomes $\frac{1}{2}$FS or under. In the cases other than the above, this is fixed at "L" level.

10) Changeover Terminal of Number of Sectors (17/32)

This is an input terminal for changing over the number of sectors per track of the disk. The number of sectors are 17 and 32.

At 17/32="L", the number of sectors is 17.

At 17/32="H", the number of sectors is 32.

11) Sector Detection Signal Output Terminal (STROBO)

. This is a signal output terminal for detecting the sector of which output is as follows.

$$f_{STRB} = \frac{f_X}{N \times (17 \text{ or } 32) \times 76} \quad [\text{Hz}]$$

f_{STRB} = Sector detection frequency

N : Dividing ratio of reference divider

f_X : Crystal oscillation frequency

. Duty is 3/76.

12) Index Pulse Input Terminal (IP_{in})

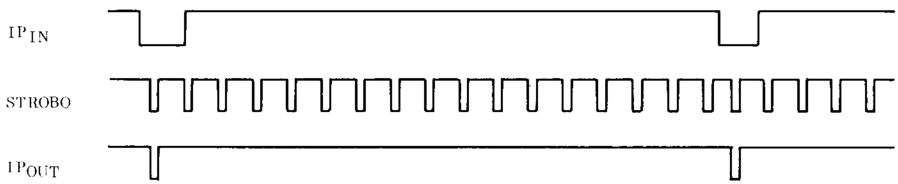
. This is a terminal for inputting the index pulse fetched from the motor.

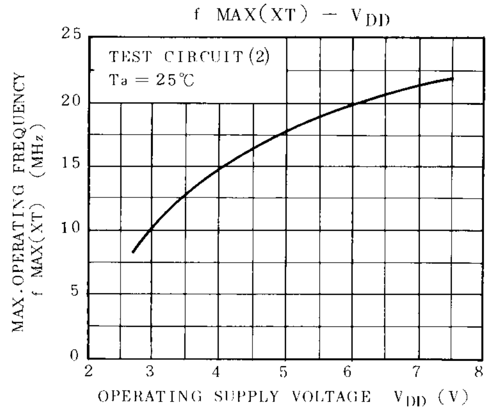
. Pull-up resistance is incorporated.

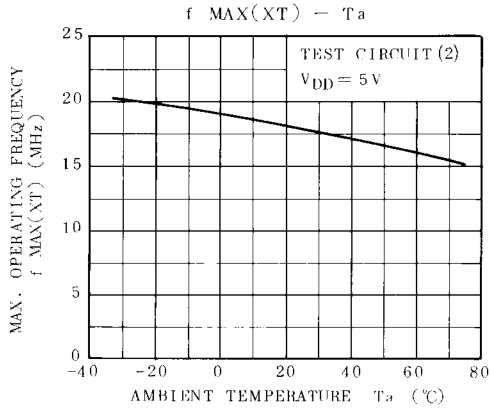
13) Index Pulse Output Terminal (IP_{out})

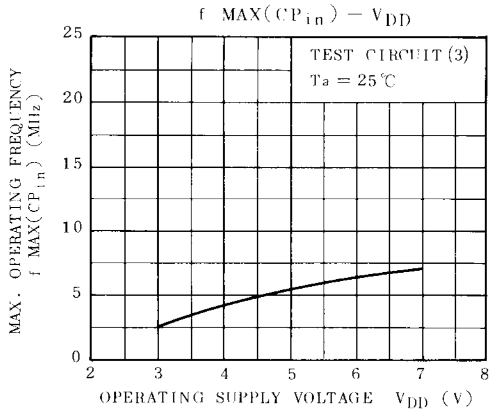
This is a terminal for outputting the index pulse, which is input to IP_{in}, after making the index pulse synchronized with the interval sector detection signal.

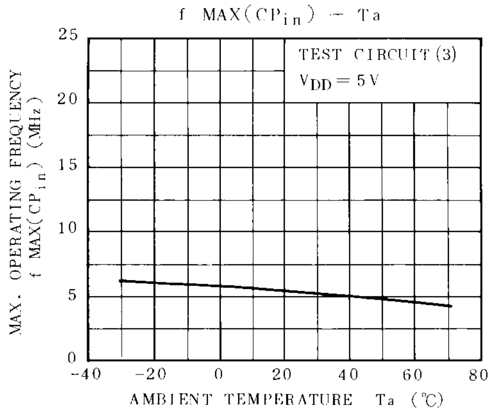
The relation between the index pulse and the sector detection signal (STROBO) is as shown below.

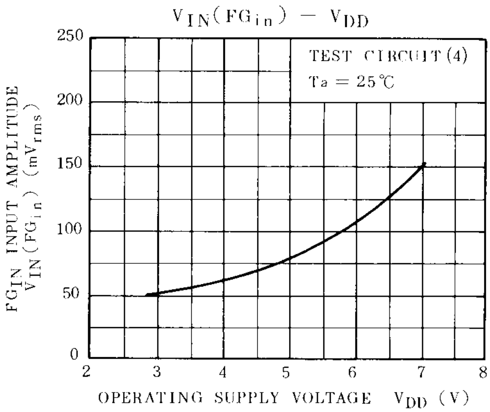


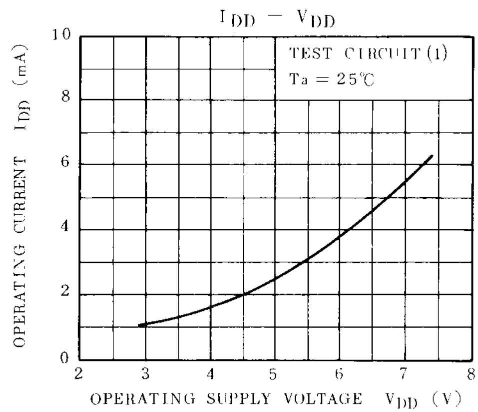

f MAX(XT) − VDD
TEST CIRCUIT (2)
Ta = 25℃
MAX. OPERATING FREQUENCY
f MAX(XT) (MHz)
25
20
15
10
5
0
2
3
4
5
6
7
8
OPERATING SUPPLY VOLTAGE VDD (V)


f MAX(XT) − Ta
TEST CIRCUIT (2)
VDD = 5 V
MAX. OPERATING FREQUENCY
f MAX(XT) (MHz)
25
20
15
10
5
0
−40
−20
0
20
40
60
80
AMBIENT TEMPERATURE Ta (℃)


f MAX(CPin) − VDD
TEST CIRCUIT (3)
Ta = 25℃
MAX. OPERATING FREQUENCY
f MAX(CPin) (MHz)
25
20
15
10
5
0
2
3
4
5
6
7
8
OPERATING SUPPLY VOLTAGE VDD (V)

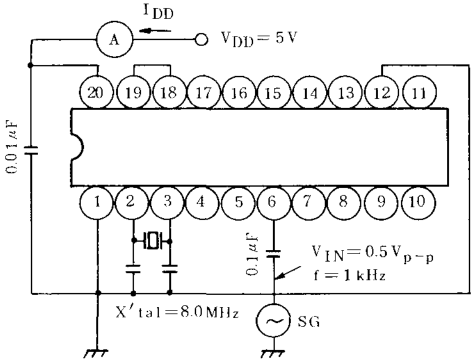

f MAX(CPin) − Ta
TEST CIRCUIT (3)
VDD = 5 V
MAX. OPERATING FREQUENCY
f MAX(CPin) (MHz)
25
20
15
10
5
0
−40
−20
0
20
40
60
80
AMBIENT TEMPERATURE Ta (℃)


VIN(FGin) − VDD
TEST CIRCUIT (4)
Ta = 25℃
FGIN INPUT AMPLITUDE
VIN(FGin) (mVrms)
250
200
150
100
50
0
2
3
4
5
6
7
8
OPERATING SUPPLY VOLTAGE VDD (V)

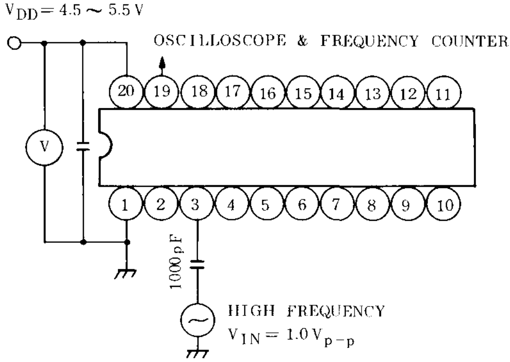

IDD − VDD
TEST CIRCUIT (1)
Ta = 25℃
OPERATING CURRENT IDD (mA)
10
8
6
4
2
0
2
3
4
5
6
7
8
OPERATING SUPPLY VOLTAGE VDD (V)

CHARACTERISTIC TEST CIRCUIT

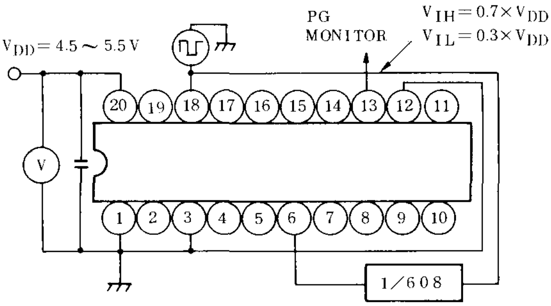
(1) Operating Supply Current (I_{DD})



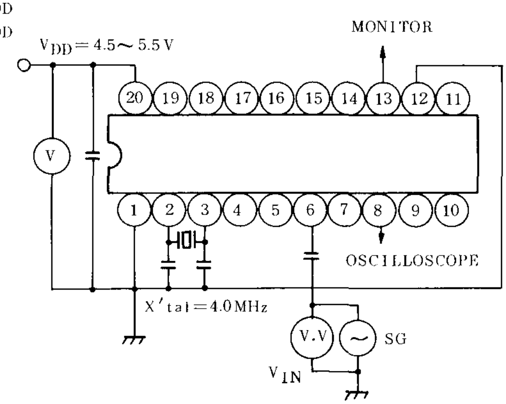
(2) XT Operating Frequency Range (f_{MAX-1})



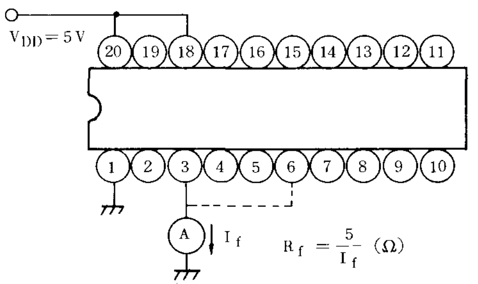
(3) CPin Operating Frequency Range (f_{MAX-2})



(4) FGin Input Sensitivity (V_{IN})



(5) Amplifier Feedback Resistance (Rf)



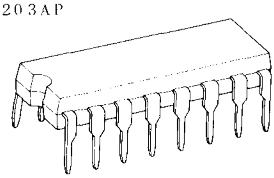
$$R_f = \frac{5}{I_f}\ (\Omega)$$

TC9203AP/AF

PLL MOTOR CONTROL FOR FDD

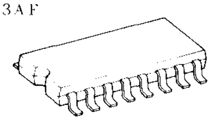
Unit in mm

TC9203AP



DIP16-P-300A

TC9203AF



SOP16-P-300

Weight TC9203AP : 1.00g (Typ.)
TC9203AF : 0.16g (Typ.)

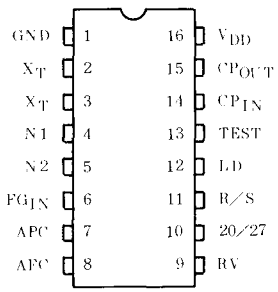
TC9203AP/AF are C^2MOS LSI designed for controlling the motor of especially for Disk Spindle Drive (FDD). 8-bit D/A converter system has been employed for each of the speed control system (AFC) and the phase control system (APC) and realize a wide reduction of external parts and free adjustment motor control system.

- Crystal can be used up to 8MHz, and crystal reference dividing frequency selected from three position of 1/5, 1/6 and 1/12 correspond to 8,5 and 3.5 inch FDD.
- Lock range can be selected from two position of 1/20 and 1/27.
- External oscillator makes possible fine adjustment of speed.
- Lock detection output and reverse rotation signal output are provided.
- Surface mount is available with TC9203AF.

MAXIMUM RATINGS (Ta=25°C)

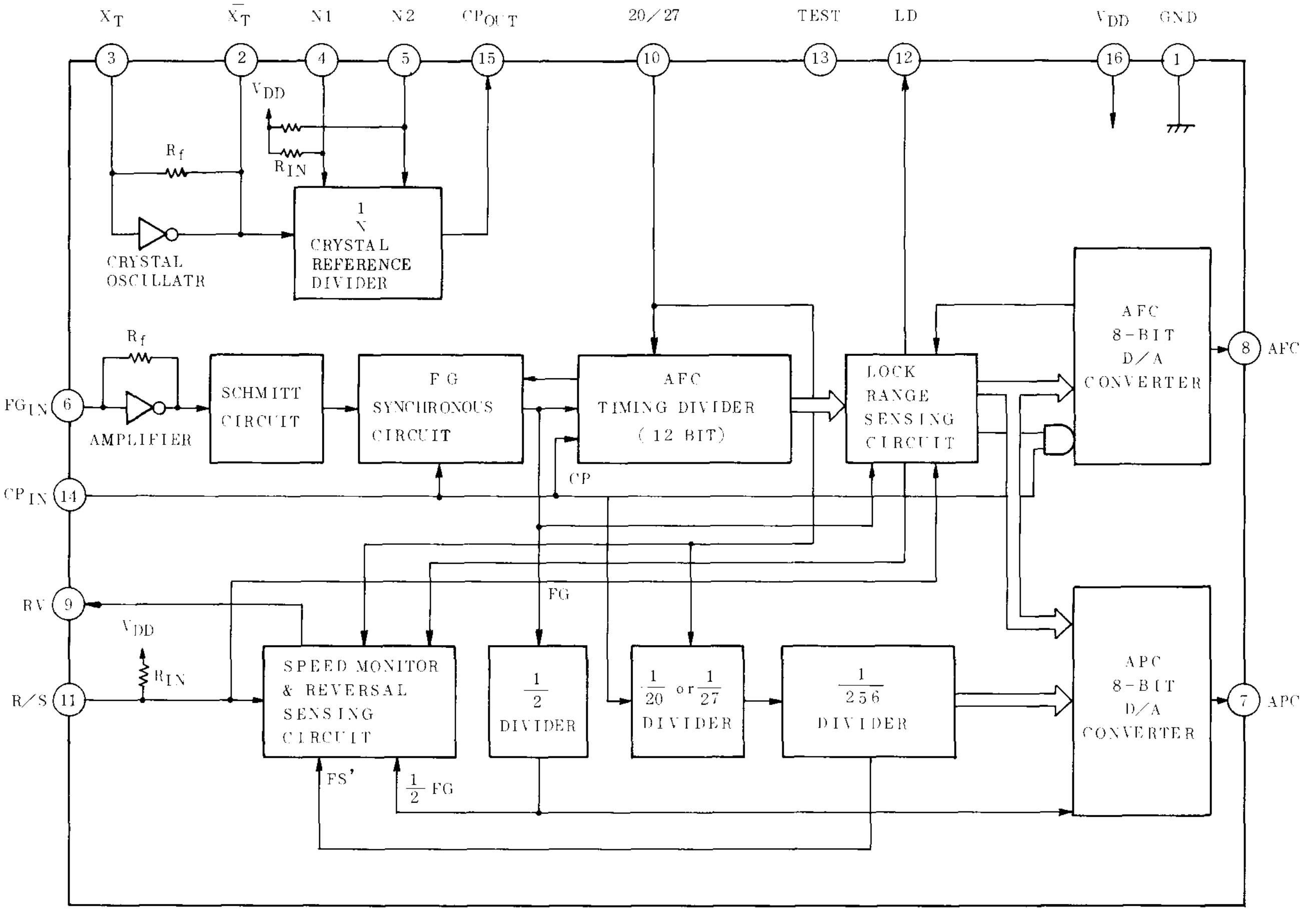
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	-0.3~7.0	V
Input Voltage	V_{IN}	-0.3~V_{DD}+0.3	V
Power Dissipation	P_D	300	mW
Operating Temperature	Topr	-30~75	°C
Storage Temperature	Tstg	-55~125	°C

PIN CONNECTIONS



(TOP VIEW)

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{DD}=5V, Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		V_{DD}	-		*	4.5	5.0	5.5	V
Operating Supply Current		I_{DD}	1	X'tal=8MHz CP_{IN}=CP_{OUT}	*	-	5.0	12.0	mA
Operating Frequency Range	X_T	f_{XT}	2		*	1.0	~	8.0	MHz
	CP_{IN}	f_{CP}	3	Square wave	*	0.05	~	4.0	MHz
	FG_{IN}	f_{FG}	-	V_{IN}=0.5Vp-p Sine wave	*	-	~	10	kHz
Input Operating Voltage	FG_{IN}	$V_{IN\ FG}$	4	f_{FG}=10kHz Sine wave	*	0.5	~	V_{DD}-0.5	Vp-p
AFC, APC D/A Converter	Ladder Resistor	R_L	6			30	50	75	kΩ
	Max. Deviation		-	V_{DD}=4.5~5.5V		-	±2.5	±6.5	LSB
	Resolution		-			-	V_{DD}/256	-	V
	Temperature Drift		-			-	±1	-	LSB
Pullup Resistor		R_{IN}	-	N1,N2,20/27,R/S	*	10	30	50	kΩ
Input Voltage	"H" Level	V_{IH}	-	N1,N2,20/27,R/S	*	V_{DD}×0.8	~	V_{DD}	V
	"L" Level	V_{IL}	-	CP_{IN}	*	0	~	V_{DD}×0.2	V
Input Leak Current		I_{IH}/I_{IL}	-	CP_{IN}	*	-	-	±1.0	μA
Output Current	"H" Level	I_{OH}	-	RV, LD	V_{OH}=4V	-0.5	-1.0	-	mA
	"L" Level	I_{OL}	-	CP_{OUT}	V_{OL}=1V	0.5	1.0	-	mA
Amplifier Feedback Resistor	X_T	R_f	5			100	200	500	kΩ
	FG_{IN}	R_f	5			300	500	800	kΩ

* : Guaranteed within the range of V_{DD}=4.5~5.5V, Ta=-40~85°C.

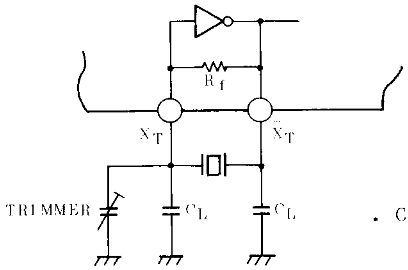
FUNCTION EXPLANATION OF EACH TERMINAL

PIN No.	SYMBOL	TERMINAL NAME	FUNCTIONAL & OPERATION EXPLANATION	REMARKS
16	V_{DD}		Power supply voltage terminal and grounding terminal.	
1	GND			
2	$\overline{X_T}$	Crystal Oscillation Terminal	Crystal oscillator is connected.	With a built-in feedback resistor.
3	X_T			
4	N1	Reference Divided Frequency Switching Terminal	Switching of divided frequency from the crystal reference frequency divider into 1/5, 1/6 and 1/12 is possible.	With a built-in pull-up resistor.
5	N2			
6	FG_{IN}	FG Pulse Input Terminal	Frequency generator input.	With a built-in amplifier.
7	APC	APC Output Terminal	8 bit DAC output terminal for phase-voltage conversion.	
8	AFC	AFC Output Terminal	8 bit DAC output terminal for frequency-voltage convension.	
9	RV	Reverse Signal Output Terminal	Terminal for motor reverse signal output.	
10	20/27	Lock Range Switching Terminal	Terminal for switching lock range. H of NC=1/20, L=1/27.	With a built-in pull-up resistor.
11	R/S	RUN/STOP Input Terminal	Motor RUN/STOP signal input terminal. H or NC=STOP, L=RUN.	With a built-in pull-up resistor.
12	LD	Lock Detecting Terminal	This terminal becomes H when the motor speed is within the lock range and otherwise L.	
14	CP_{IN}	Reference Frequency Input Terminal	Normally connected to CP_{OUT}. For external fine adjustment input from an external oscillator.	
15	CP_{OUT}	Reference Frequency Output Terminal	Terminal for divided output from the crystal reference frequency divider. Normally connected CP_{IN}.	
13	TEST	Test Terminal	Input terminal of internal test. Generally ground.	

OPERATION

1. Crystal oscillation terminals (X_T, $\overline{X_T}$)

. The crystal oscillator is used by connecting as shown below.



. C_L of 10~30pF is appropriate.

. Crystal oscillation frequency is calculated by the following equation according to number of FG pulses of a motor to be used.

$$f_X = \frac{R}{60} \times FG' \times 128 \times (20 \text{ or } 27) \times N \quad (Hz)$$

(Note) (20 or 27) : 20 at 20/27="H" or Open.
27 at 20/27="L".

f_X: Crystal oscillation frequency, FG': number of FG pulse generated per revolution of motor, R: revolution of motor per minute, N: Ratio of frequency division of the crystal reference frequency divider. (Refer to Item 9.)

. Maximum operating frequency is above 8MHz and crystals up to 8MHz can be used.

2. Reference frequency input/output terminals (CP_{IN}, CP_{OUT})

. Divided output $\frac{f_X}{N}$ from the crystal reference frequency divider is available at CP_{OUT}, which is normally connected CP_{IN}.

. When an external oscillator (CR oscillator, etc.) is connected to CP_{IN}, motor speed can be finally adjusted.

3. FG pulse input terminal (FG_{IN})

. This is the input terminal of FG pulse that shows the motor speed.
This FG pulse becomes comparison frequency.

. This terminal has built-in Amplifier and Schmitt circuit.
FG pulses are applied through capacitor coupling and small amplitude is enough for proper operation.

4. Lock range switching terminal (20/27)

. This terminal is for switching lock range of motor, with a pull-up resistor and chattering preventive circuit.

(TRUTH TABLE)

20/27	DIVIDED FREQUENCY	LOCK RANGE
L	1/27	+3.4 ~ -3.9% of reference cycle
H or NC	1/20	+4.6 ~ -5.3% of reference cycle

5. APC, AFC output terminal (APC, AFC)

. AFC (speed control output) is a F-V converter for FG frequency, and is consisting of a 8 bit D/A converter.

. APC (phase control output) is a phase comparator (ϕ-V converter) that compares phase difference ϕ between 1/2 FG and reference frequency FS', and is also consisting of a 8 bit D/A converter.

. Both APC and AFC perform the following 3 operations according to FG_{IN} frequency.

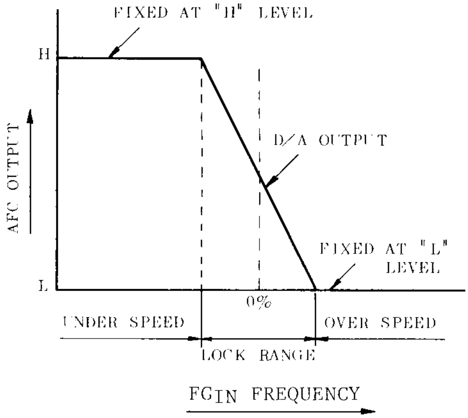
a. When FG_{IN} frequency is within the lock range:
Both APC and AFC perform the normal operation for FG_{IN}.

b. When FG_{IN} frequency is below the lock range (under speed):
APC and AFC outputs are both fixed at "H" level.

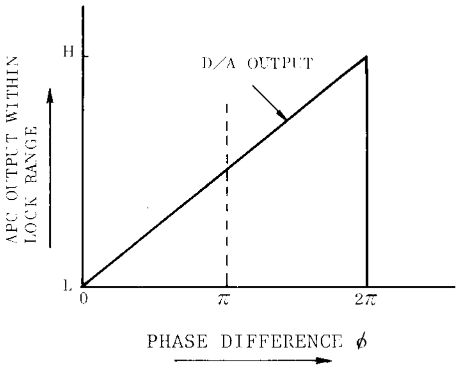
c. When FG_{IN} frequency is above the lock range (over speed):
APC and AFC outputs are both fixed at "L" level.

. When a motor is in STOP state (P/S=H or NC), both AFC and APC are fixed "L" level.

AFC Output change status for FG_{IN} frequency

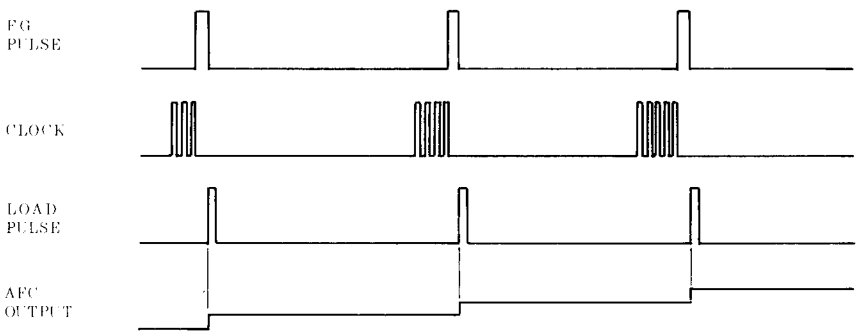


APC Output change status for phase difference ϕ.

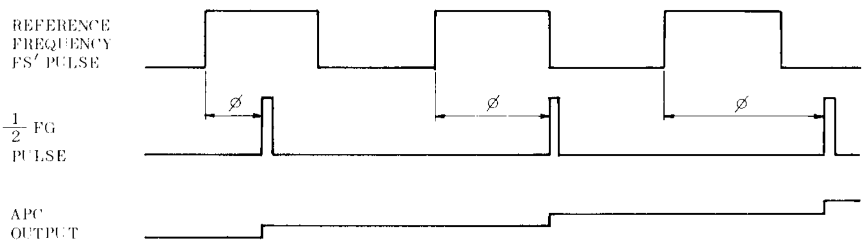


. AFC and APC timing chart within lock range.

a. AFC (SPEED CONTROL SYSTEM)



b. APC (PHASE CONTROL SYSTEM)



6. Lock detecting terminal (LD)

. This terminal is the lock detecting output and is placed at "H" level when FG_{IN} frequency is within the lock range and otherwise, placed at "L" level.

7. RUN/STOP input terminal (R/S)

. RUN/STOP signals of the motor are input to this terminal.
. This terminal has a pull-up resistor and a chattering proventive circuit.
. During RUN (R/S=L), AFC , APC and LD perform the above-mentioned operations for FG_{IN} frequency, and during STOP (R/S=H or NC), AFC, APC and LD are all fixed at "L" level.

8. Reverse signal output terminal (RV)

. At the switching of lock range from 1/20 to 1/27 or the operating from RUN to STOP, reverse signal for braking the motor is output through this terminal.
. Change of RV output status

PREVIOUS STATUS ⇨	RV OUTPUT CHANGE TO "H" LEVEL ⇨	RV OUTPUT CHANGE TO "L" LEVEL
During normal rotation (during lock) at 1/20.	When the lock range is switched from 1/20 to 1/27.	When the motor speed is locked at 1/27, or when FG_{IN} 1/8FS, or when the lock range is switched from 1/27 to 1/20.
During normal rotation (during lock) at 1/20 or 1/27.	When the operation is switched from RUN to STOP.	When FG_{IN} 1/8FS or when the operation is switched from STOP to RUN.

. In other cases than above, RV output is not changed and fixed at "L" level.
. Further, if FG frequency rises up to 1.5 times of normal rotation at 1/20 (20 times of normal rotation at 1/27), RV output is reset.

9. Reference divided frequency switching terminal (N1, N2)

. Divided frequency 1/N of the crystal reference frequency divider can be switched to 1/5, 1/6 or 1/12 by number of FG pulses or a crystal used.

. This terminal has a built-in pull-up resistor.

(TRUTH TABLE)

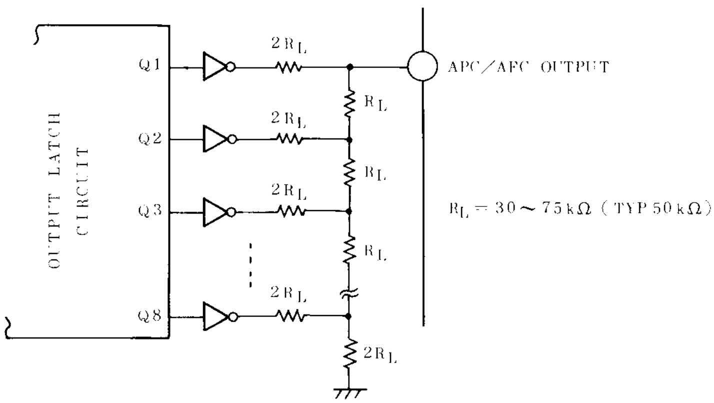
N1	N2	1/N
H	H	1/5
L	H	1/6
H	L	1/12

1/N: CRYSTAL REFERENCE DIVIDED FREQUENCY

(Note) Don't use mode, N1=N2="L", because this mode is test mode.

CAUTION IN APPLICATION

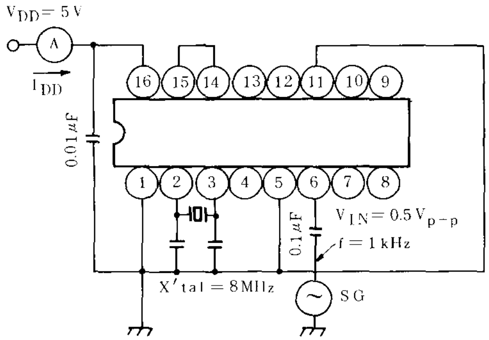
. APC and AFC terminals are for the 8-bit D/A converter outputs, which are directly output from the R-2R ladder type resistor network as shown in the following diagram. Impedance of these outputs becomes equal to the ladder resistor value R_L. Terefore, input impedance at the receiving side of these terminals shall be designed accordingly.



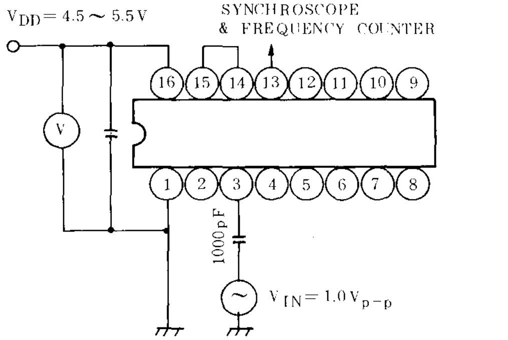
. A filter for an externally counted differential amplifier on an application circuit shall be selected to meet the response characteristic of a motor to be used.

CHARACTERISTIC TEST CIRCUIT

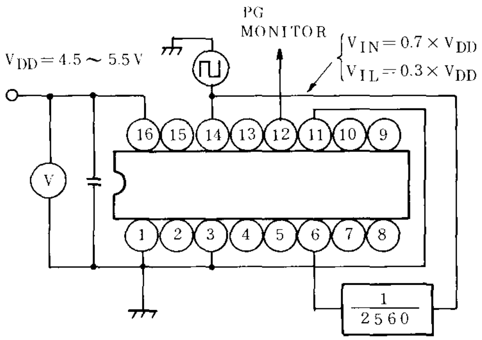
(1) Operating supply current I_{DD}



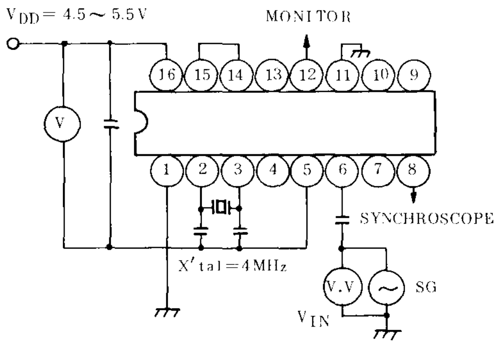
(2) X_T Operating frequency range $f_{MAX}(f_{XT})$



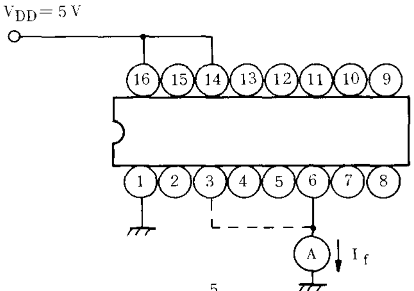
(3) CP_{IN} Operating frequency range $f_{MAX}(f_{CP})$



(4) FG_{IN} Input sensitivity V_{INFG}

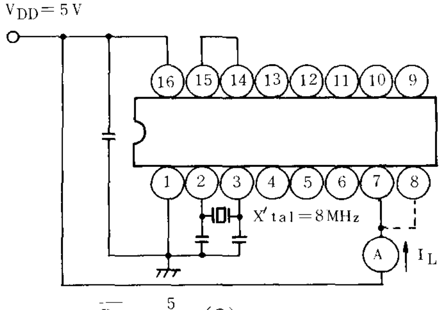


(5) Amplifier feedback resistor



$R_F = \frac{5}{I_f}$ (Ω)

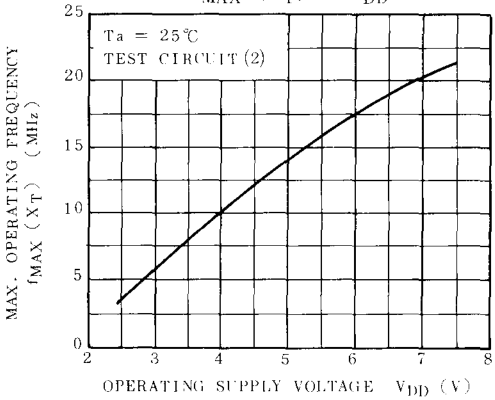
(6) D/A Converter ladder resistor $\overline{R_L}$



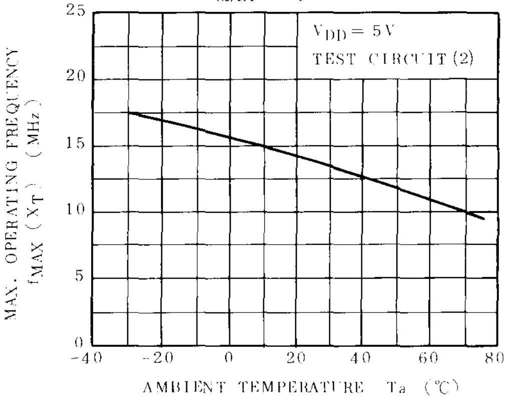
$\overline{R_L} = \frac{5}{I_L}$ (Ω)

CHARACTERISTIC DATA

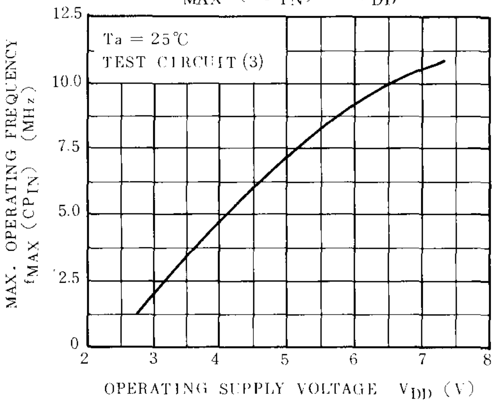
f_{MAX} (X_T) – V_{DD}



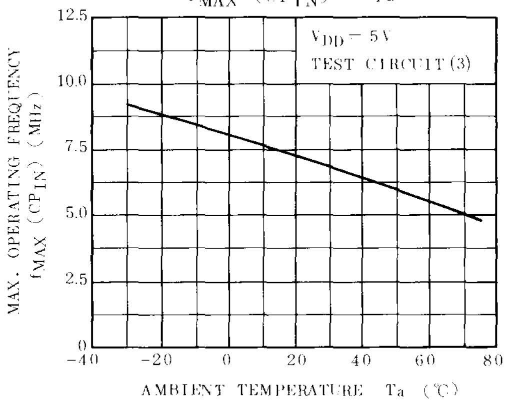
f_{MAX} (X_T) – Ta



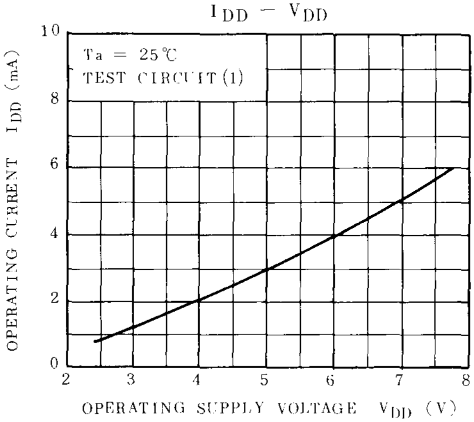
f_{MAX} (CP_{IN}) – V_{DD}



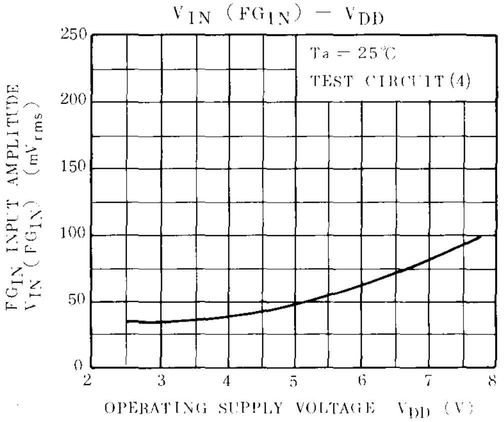
f_{MAX} (CP_{IN}) – Ta



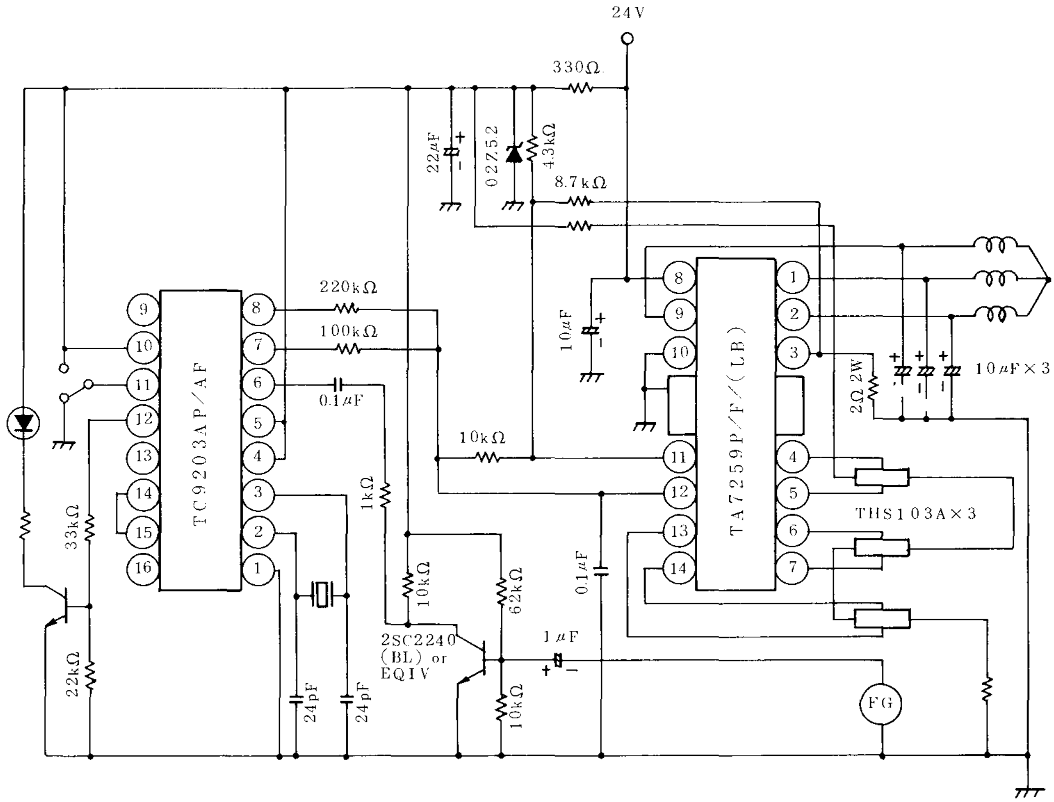
I_{DD} – V_{DD}



V_{IN} (FG_{IN}) – V_{DD}



EXAMPLE APPLICATION CIRCUIT



Example of crystal oscillation frequency calculation.

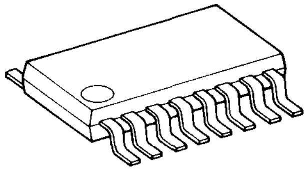
When FG' (number of FG pulse)=180 pulses and R (revolution of motor)=200r.p.m., if the dividing frequency of reference divider and lock range is set at N=5 dividing frequency and 20/27=20, the crystal oscillation frequency f_X is as follows:

$$f_X = \frac{R}{60} \times FG' \times 128 \times N = \frac{200}{60} \times 180 \times 128 \times 20 \times 5 = 7.680\text{MHz}$$

TD6303F

FOR SERVO MOTOR CONTROL

TD6303F is designed for small motor speed control. This is designed specially for low voltage and low current operation, and is suitable for FG servo control of small DC motor for portable equipment.



Weight : 0.16g(Typ.)

- Installed in a very small flat package
- Can operate with low voltage
  -Operating voltage : V_{CC}=1.8~6V
- Can operate at two speed levels
  (Example : 2.4cm/s and 1.2cm/s for micro cassette tape recorder)
- Can hold stand-by operation with very small current (i,e, 2μA nominal), beling provided with stand-by switch.
  Can be applicable to remote control and others.

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{CC}	7	V
Output Current	I_O MAX	10	mA
Power Dissipation (Note)	P_D	350	mW
Operating Temperature	Topr	-10~60	°C
Storage Temperature	Tstg	-55~150	°C

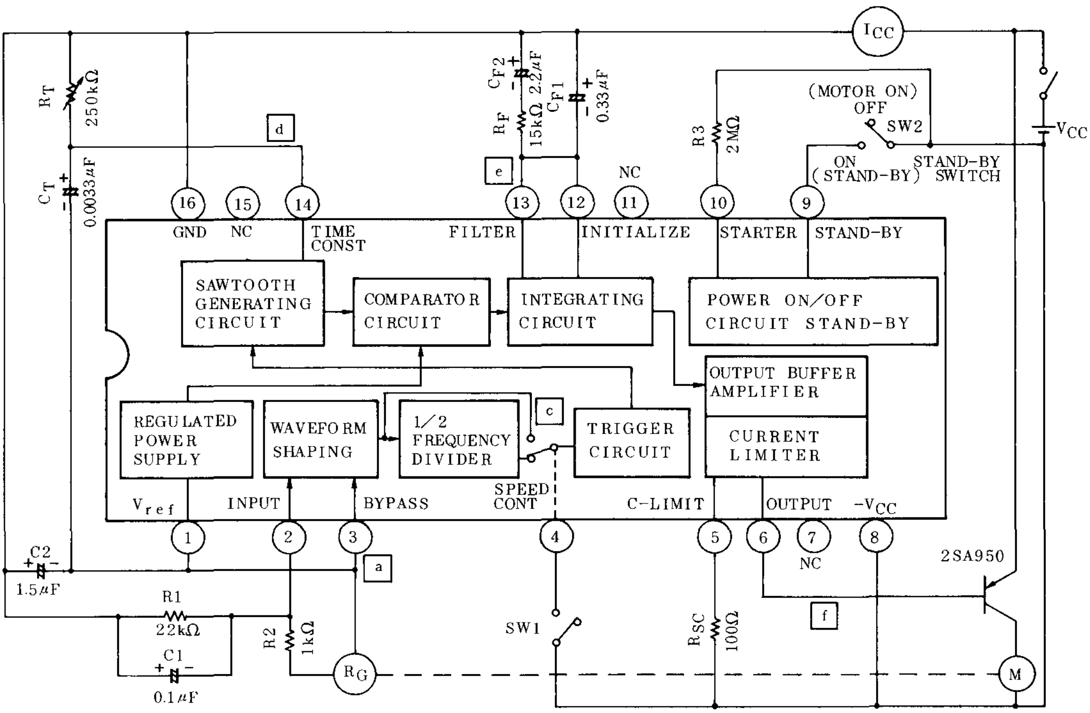
Note : When operating at 25°C or more, reduce 2.8mW per 1°C.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC}=3V, Ta=25°C)

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Power Supply Current	I_{CC}	1	SW2 : (Motor ON)	-	2	4	mA
Stand-by Current	$I_{CC(OFF)}$	1	SW2 : (Motor ON), R3=2MΩ	-	2	10	μA
Output Limit Current	$I_{O(SC)}$	1	R_{SC}=100Ω	-	7	-	mA
Regulated Power Supply Voltage	Vref	1	V_{REF}=V16-V1	1.1	1.25	1.4	V
Input Off-set Voltage	ΔV2-3	2	ΔV2-3=V2-V3, Rg=10kΩ	-	1	5	mV
Input Sensitivity	V_{TH}	3	-	-	50	-	mVp-p
Speed Power Supply Voltage Fluctuation	-	1	V_{CC}=1.8~6V	-	±0.3	-	%
Speed Load Fluctuation	-	1	Torque 0~8 g·cm	-	±0.2	-	%

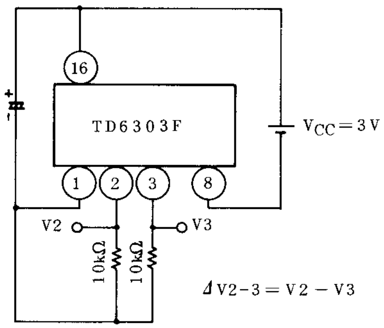
BLOCK DIAGRAM/TEST CIRCUIT 1

I_{CC}, $I_{CC(OFF)}$, $I_{O(SC)}$



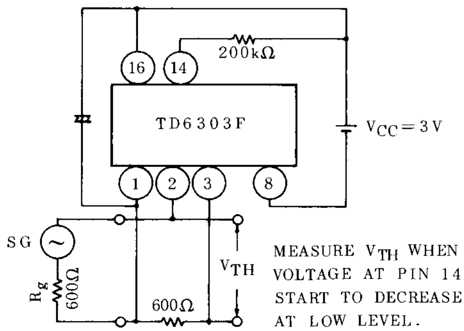
TEST CIRCUIT 2

ΔV2−3

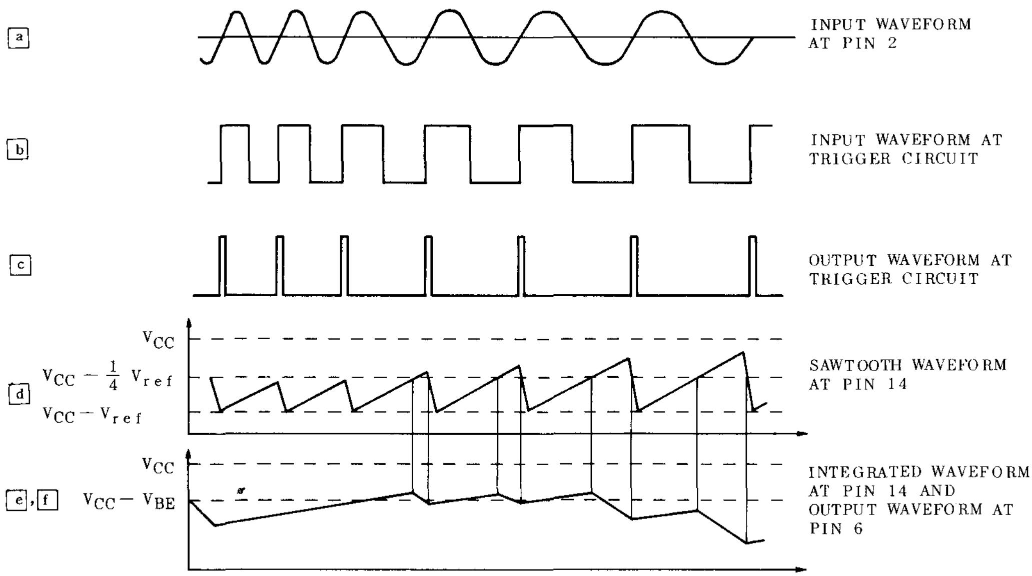


TEST CIRCUIT 3

V_{TH}



TIMING CHART



FUNCTIONAL EXPLANATION OF TERMINALS

PIN No.	SYMBOL	TERMINAL NAME	FUNCTION
1	V_{ref}	Regulated Voltage Output Terminal	Regulated voltage output terminal at V_{ref}=1.25V Having output current capacity of 15mA, this can be used for power supply for external circuit. Regulated at pin 16 (V_{CC}).
2	INPUT	FG Pulse Input Terminal	Input terminal for receiving FG pulse from motor.
3	BYPASS	Bypass Terminal	Reference (bypass) terminal of differential amplifier in waveform shaping circuit.
4	SPEED CONT	Tape Speed Selection Terminal	Input terminal for selecting tape speed, and can select either 1.2cm/sec or 2.4cm/sec.
5	C-UNIT	Current Limit Terminal	Terminal to connect output current limiting resistor for driver output. 7mA at 100Ω(Std.).
6	OUTPUT	Driver Output Terminal	Driver output terminal to drive external motor driving transistor.
8	$-V_{CC}$	Negativer Power Supply	Connect to make lowest voltage of IC.
9	STAND-BY	Stand-by Terminal	Switch terminal to electrically stand-by IC. Remove stand-by status by openning the terminal.
10	STARTER	Starter Terminal for Power Supply	Terminal to connect resistor for regulated power supply initial start. when it is not specially required to minimize the holding current during power off status, V_{EE} can be directly applied.
12	INITIALIZE	Initialize Terminal	Terminal to discharge the residual capacitance in the integrating capacitor at the time of power OFF.
13	FILTER	Integrating C and R Connection Terminal	Terminal to connect C and R in integrating circuit.
14	TIME CONST	Time Constant	Time constant for sawtooth wave is $C_T \cdot R_T$.
16	GND	Ground	Grounded to case or other with the maximum voltage of IC.

NOTES IN APPLICATIONS

1. In order to minimize the effect of noise generated from motor, this IC is grounded to the case at V_{CC}. Therefore, the external transistor is controlled with the voltage between pin 16 and 6.

2. The constant voltage at pin 1 is regulated with respect to pin 16 (GND: maximum voltage), but this is not regulated with respected to the minimum voltage of pin 8.

3. In waveform shaping circuit, there is no offset, and then, when the external bias resistors are the same as each other, the circuit will operate at zero cross operation. The circuit will erroneously operate responding to the noise, and show the performance degradation. Therefore, it is necessary to apply the pertinent offset by using R1 and R2 as shown in figure 1, in considering input voltage from FG.

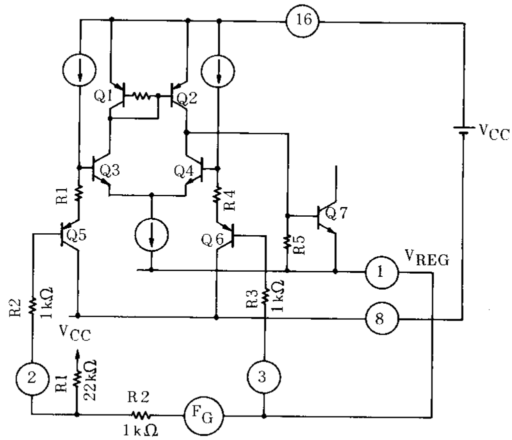


Figure 1. Waveform shaping circuit

4. Pin 12 (initialize termina) will detect voltage reduction in IC, and discharge the externally connected capacitor at pin 13. Therefore, pin 12 is shorted to pin 13.

5. Sawtooth generating circuit, comparator circuit and integrating circuit are shown in figure 2.

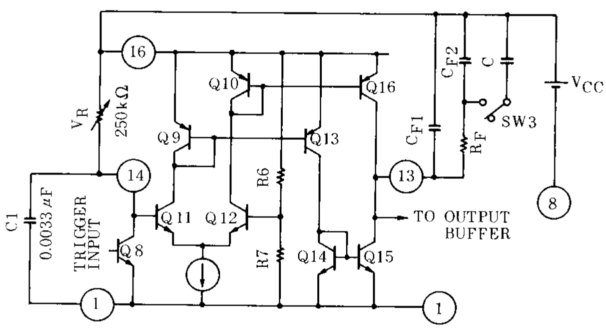


Figure 2. Sawtooth generating circuit, comparation circuit and integrating circuit

5.1 Setting of R_T and C_T

Motor speed is determined by R_T and C_T. The following equation is approxiamtely true for motor speed and $C_T \cdot R_T$.

$$f\left(\frac{NM}{60}\right) \simeq \frac{1}{1.69C_T \cdot R_T}$$

$$\left(\simeq \frac{1}{3.38C_T \cdot R_T} \quad \text{for double speed mode}\right)$$

where, N (rpm) for motor speed

M for poles at tachgenerator

R_T and C_T shall be set to satisfy the above equation, while keeping R_T between 10kΩ and 500kΩ.

5.2 Setting of R_F, C_{F1} and C_{F2}

C_{F1} is the integrating capacitor, and R_F and C_{F2} are respectively resistor and capacitor for phase compensation. If the circuit becomes unstable when double speed is selected, add C for phase compensation using SW3.

Motor speed performance is determined with these circuit constants. Select these constants considering such factors as motor inertia, required start-up performance and wow flatter characteristics。

The following constants are standard:

$R_F \simeq 1\sim20k$

$C_{F1} \simeq 0.01\sim5\mu F$

$C_{F2} \simeq 0.1\sim50\mu F$

6. Setting of R_{SC}

Output current limiting transistor is included in TD6303F, and output current is limited at the level where the voltage drop at R_{SC} becomes transistor base-emitter voltage V_{BE} (approximately 0.7V at Tj=25°C).

The output shorting current I_{SC} at this time is;

$$I_{SC}=V_{BE}/R_{SC}$$

where, $V_{BE}(Tj=t°C)=V_{BE}(Tj=25°C) - 2mV(t=25°)$

7. Setting of R3

Stand-by current, while TD6303F is stand-by condition, is determined by stand-by switch (S1)。 The stand-by current is approximated as :

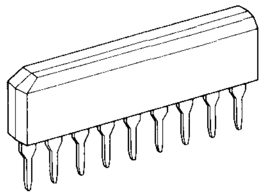
$$I3 = \frac{V_{CC}-0.6}{R3+150k\Omega} \quad \text{(Resistor of 150kΩ is already in.)}$$

TC5081AP

PHASE COMPARATOR

The TC5081AP consists of a digital phase comparator and an amplifier. Three state output connected to low pass filter (using an internal amplifier) will produce DC voltage to control a VCO.

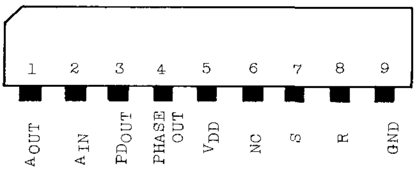
Low state pulses appear on phase out as long as the loop is unlocked and these can be utilized as lock indicator.



SIP9-P-A

Weight: 0.9g (Typ.)

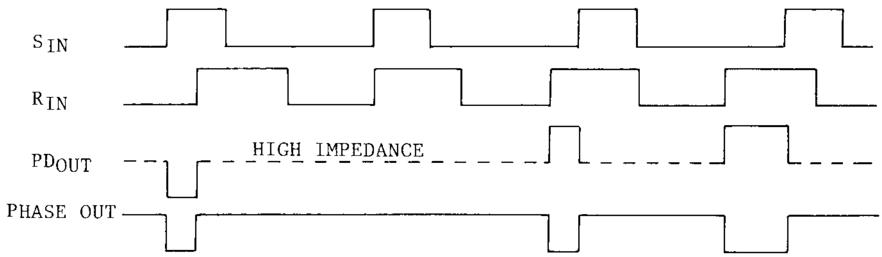
PIN CONNECTION (SIDE VIEW)



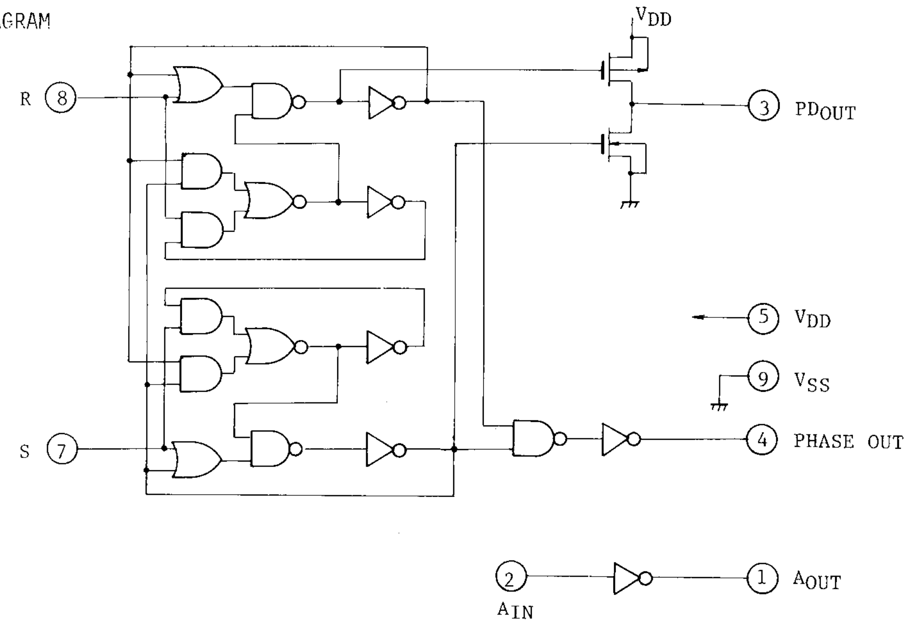
MAXIMUM RATING (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD}	10	V
Input Voltage	V_{IN}	$-0.3 \sim V_{DD}+0.3$	V
Operating Temperature	T_{opr}	$-30 \sim 75$	°C
Storage Temperature	T_{stg}	$-55 \sim 125$	°C

PHASE COMPARATOR TIMING CHART



LOGIC DIAGRAM

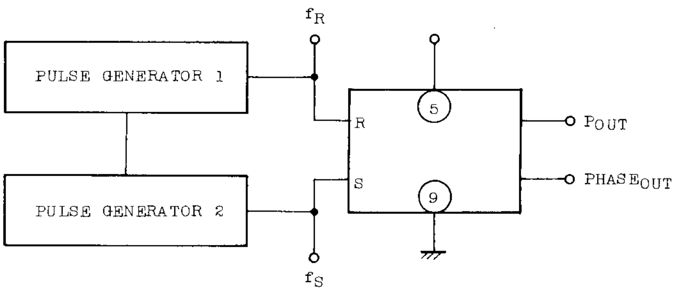


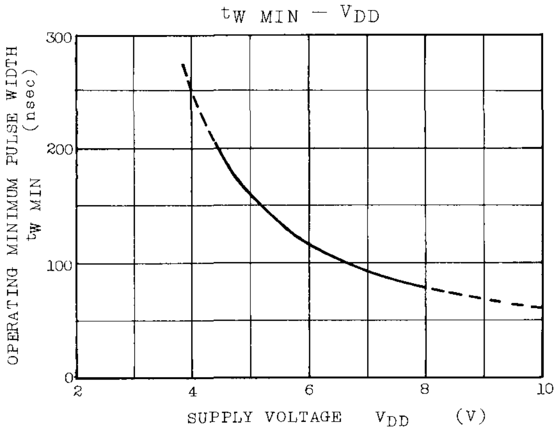
ELECTRICAL CHARACTERISTICS (Ta=-35 ∿ 75°C)

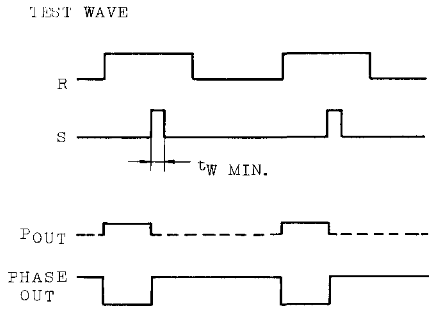
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		V_{DD}		–	4.5	–	8.0	V
Output Voltage	"H" Level	V_{OH}		V_{DD}=7.5V, V_{IL}=1.6V V_{IH}=6.6V, I_{OH}=-50μA	7.3	–	–	V
	"L" Level	V_{OL}		V_{DD}=7.5V, V_{IL}=1.6V V_{IH}=6.6V, I_{OL}=50μA	–	–	0.2	V
Quiescent Current		I_{DD}		V_{DD}=7.5V, V_{IH}=7.5V V_{IL}=0V	–	–	200	μA
3 State Leak Current		I_{TLH}		V_{DD}=7.5V	–	–	500	nA
		I_{TLL}		V_{DD}=7.5V	–	–	-500	nA
Filter Amp. Voltage Gain		A_V		V_{DD}=7.5V, R_{1-2}=1MΩ, f_{IN}=1kHz R_g=600Ω	–	30	–	dB

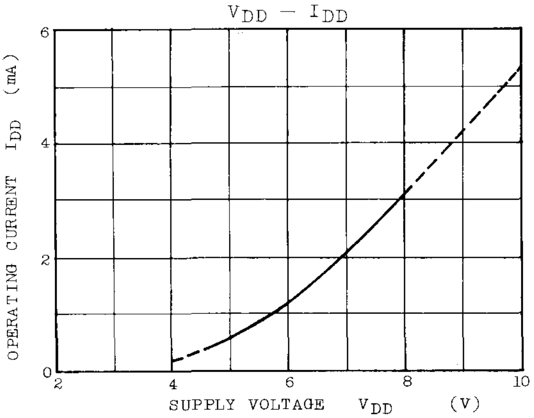
TEST CIRCUIT

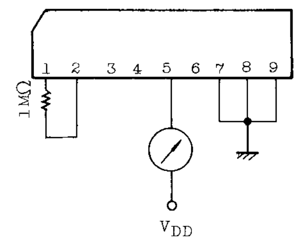
V_{DD} VS T_W MIN

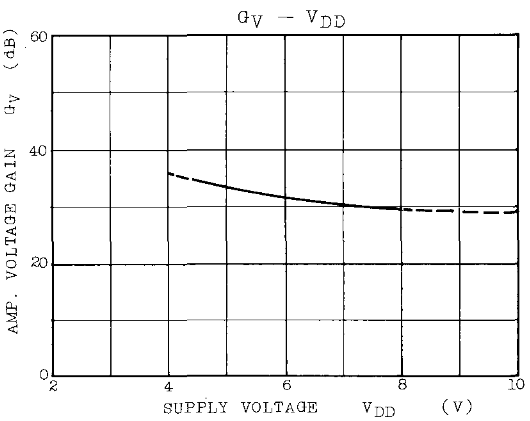


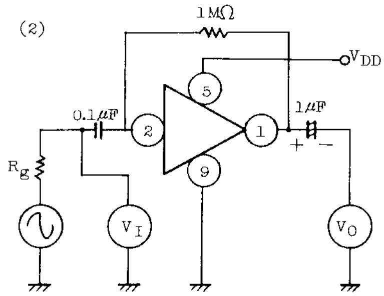










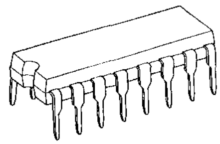


$G_V = 20 \log \frac{V_O}{V_I}$

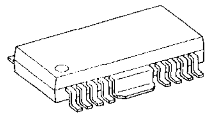
TD62064P/AP/F/AF
TD62074P/AP/F/AF

○ 4 HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62064P/AP/F/AF and TD62074P/AP/F/AF are high-voltage, high-current darlington drivers comprised of four NPN darlington pairs.
All units feature integral clamp diodes for swiching inductive loads and all units of TD62074P/AP/F/AF feature uncomitted collectors and emitters for isolated darlington applications.
For proper operation, the substrate (SUB) must be connected to the most negative voltage.
Applications include relay, hammer, lamp and stepping moter drivers.



DIP16-P-300A



HSOP16-P-300

Weight DIP16-P-300A : 1.11g
HSOP16-P-300: 0.50g

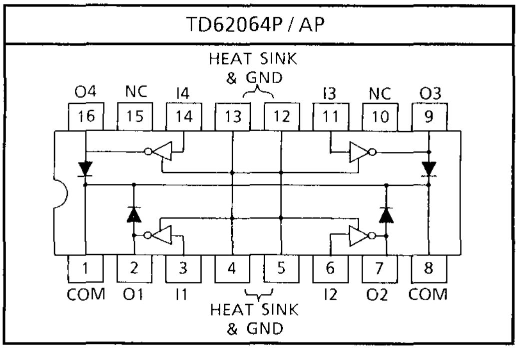
- Output current (Single Output) 1.5A MAX.
- High Sustaining Voltage Output 35V MIN. (TD62064P/F, 074P/F)
  50V MIN. (TD62064AP/AF, 074AP/AF)
- Output Clamp Diodes : TD62064P/AP/F/AF
- Isolated Darlington Array : TD62074P/AP/F/AF
- Input Compatible with TTL and 5V C-MOS
- GND and SUB Terminal = Heat Sink
- Package Type-P, AP: DIP-16 pin
- Package Type-F, AF: PFP-16 pin

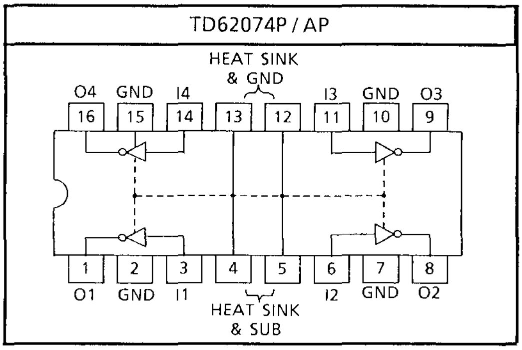
MAXIMUM RATINGS (Ta = 25°C unless otherwise noted)

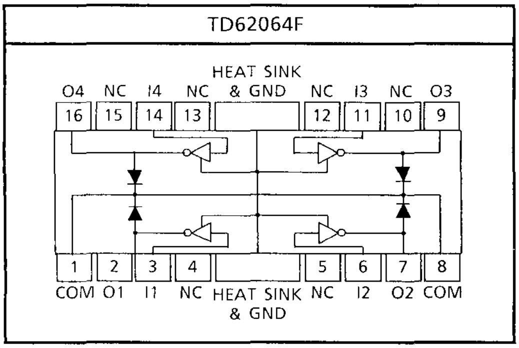
CHARACTERISTIC		SYMBOL	RATING	UNIT
Output Sustaining Voltage	P, F	$V_{CE(SUS)}$	−0.5~35	V
	AP, AF		−0.5~50	
Output Current		I_{OUT}	1.5	A/ch
Input Current		I_{IN}	50	mA
Input Voltage		V_{IN}	−0.5~17	V
Clamp Diode Reverse Voltage	P, F	V_R *1	35	V
	AP, AF		50	
Clamp Diode Forward Current		I_F *1	1.5	A/ch
Isolated Voltage	P, AP	V_{SUB} *2	35	V
	AP, AF		50	
Power Dissipation	P, AP	P_D	1.47/2.7 *3	W
	F, AF		0.9/1.4 *4	
Operating Temperature		T_{opr}	−40~85	°C
Storage Temperature		T_{stg}	−55~150	°C

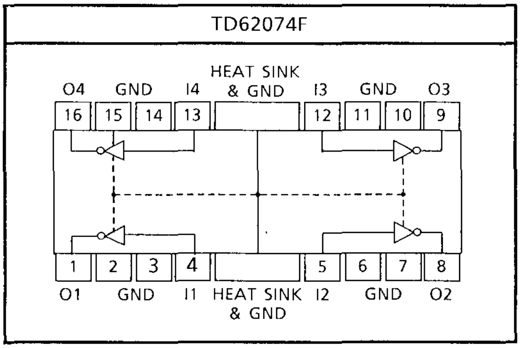
*1 TD62064P/AP/F/AF
*2 TD62074P/AP/F/AF
*3 On Glass Epoxy (50×50×1.6mm Cu 50%)
*4 On Glass Epoxy (60×30×1.6mm Cu 30%)

PIN CONNECTION (TOP VIEW)

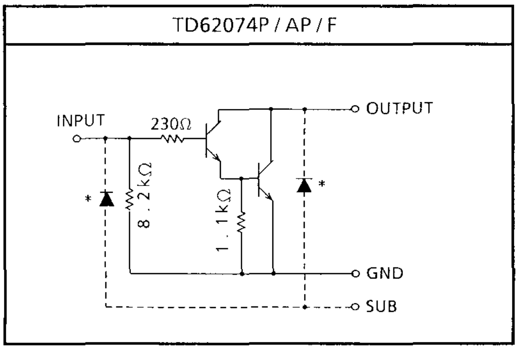


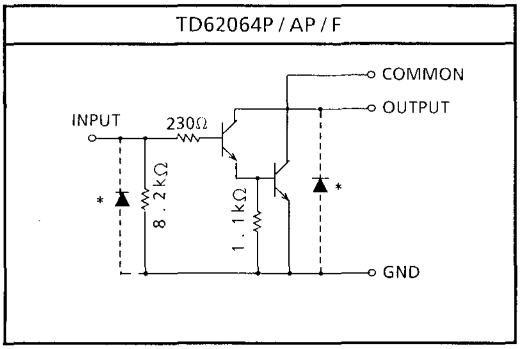






SCHEMATICS (EACH DRIVER)





* : Parasitic Diodes
The input and output parasitic diodes cannot be used as clamp diodes.

RECOMMENDED OPERATING CONDITIONS (Ta = −40~85°C and Ta = −35~75°C for Type-P)

CHARACTERISTIC		SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Output Sustaining Voltage	P, F	$V_{CE(SUS)}$			0	—	35	V
	AP, AF				0	—	50	
Output Current		I_{OUT}	DC 1 Circuit, Ta = 25°C		0	—	1250	mA / ch
	P		T_{pw} = 25ms, 4 Circuits Ta = 75°C	Duty = 10%	0	—	1250	
				Duty = 50%	0	—	760	
	AP		T_{pw} = 25ms, 4 Circuits Ta = 85°C	Duty = 10%	0	—	1250	
				Duty = 50%	0	—	700	
	F, AF			Duty = 10%	0	—	1250	
				Duty = 50%	0	—	450	
Input Voltage		V_{IN}			0	—	8	V
Input Voltage (Output On)		$V_{IN(ON)}$	I_{OUT} = 125A		2.5	—	8	V
Input Voltage (Output Off)		$V_{IN(OFF)}$			0	—	0.4	V
Input Current		V_{IN}			0	—	20	mA
Clamp Diode Reverse Voltage	P, F	V_R			0	—	35	V
	AP, AF				0	—	50	
Clamp Diode Forward Current		I_F			—	—	1.25	A
Isolation Voltage	P, F	V_{SUB}	Only TD62074P / AP / F / AF		—	—	35	V
	AP, AF				—	—	50	
Power Dissipation	P	P_D	Ta = 75°C *2		—	—	1.6	W
	AP		Ta = 85°C *2		—	—	1.4	
	F, AF		Ta = 85°C *1		—	—	0.7	

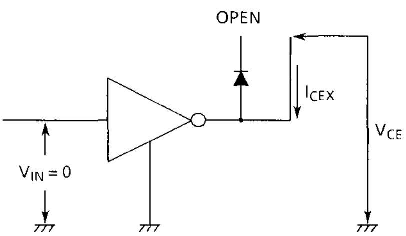
*1 On Glass Epoxy (50×50×1.6mm Cu 50%)
*2 On Glass Epoxy (60×30×1.6mm Cu 30%)

ELECTRICAL CHARATERISTICS (Ta = 25°C unless otherwise noted)

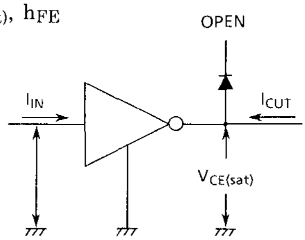
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP	MAX	UNIT
Output Leakage Current	P	I_{CEX}	1	V_{CE} = 35V, Ta = 25°C	—	—	50	μA
				V_{CE} = 35V, Ta = 75°C	—	—	100	
	AP, AF			V_{CE} = 50V, Ta = 25°C	—	—	50	
				V_{CE} = 50V, Ta = 85°C	—	—	100	
	F			V_{CE} = 35V, Ta = 25°C	—	—	50	
				V_{CE} = 35V, Ta = 85°C	—	—	100	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	2	I_{OUT} = 1.25A, I_{IN} = 2mA	—	—	1.6	V
				I_{OUT} = 0.75A, I_{IN} = 935μA	—		1.25	
DC Current Transfer Ratio		h_{FE}	2	V_{CE} = 2V, I_{OUT} = 1.0A	550	800	—	
				V_{CE} = 2V, I_{OUT} = 0.25A	1000	1500	—	
Input Voltage (Output On)		$V_{IN(ON)}$	3	I_{OUT} = 1.25A, I_{IN} = 2mA	—	—	2.4	V
Clamp Diode Leakege Current	P	I_R	4	V_R = 35V, Ta = 25°C	—	—	50	μA
				V_R = 35V, Ta = 75°C	—	—	100	
	AP, AF			V_R = 50V, Ta = 25°C	—	—	50	
				V_R = 50V, Ta = 85°C	—	—	100	
	F			V_R = 35V, Ta = 25°C	—	—	50	
				V_R = 35V, Ta = 85°C	—	—	100	
Clamp Diode Forward Voltage		V_F	5	I_F = 1.25A	—	—	2	V
Input Capacitance		C_{IN}	6	V_{IN} = 0V, f = 1MHz	—	15	—	pF
Turn-On Delay	P, F	t_{ON}	7	CL = 15pF, V_{OUT} = 35V, RL = 28Ω	—	0.1	—	μs
	AP, AF			CL = 15pF, V_{OUT} = 50V, RL = 40Ω				
Turn-Off Delay	P, F	t_{OFF}		CL = 15pF, V_{OUT} = 35V, RL = 28Ω	—	1.0	—	
	AP, AF			CL = 15pF, V_{OUT} = 50V, RL = 40Ω				

TEST CIRCUIT

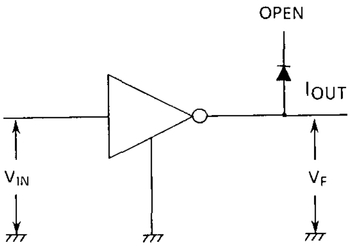
1. I_{CEX}



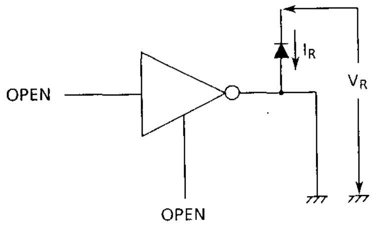
2. $V_{CE(sat)}$, h_{FE}



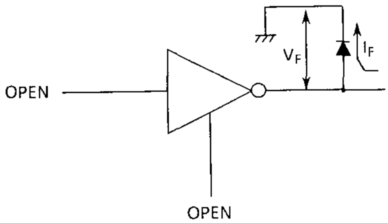
3. $V_{IN(ON)}$



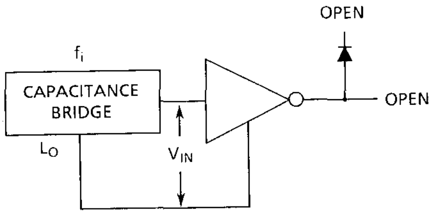
4. I_R



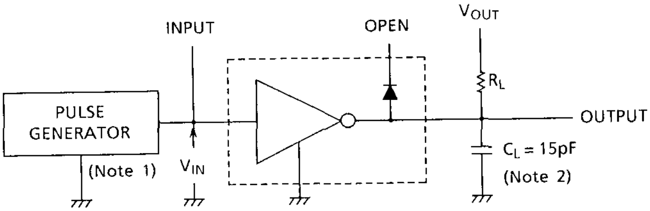
5. V_F

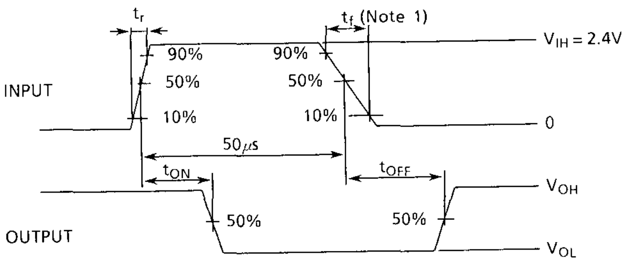


6. C_{IN}



7. t_{ON}, t_{OFF}

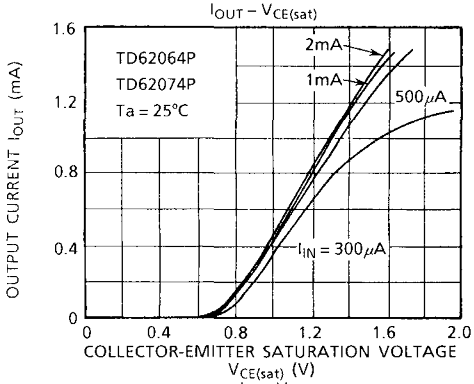




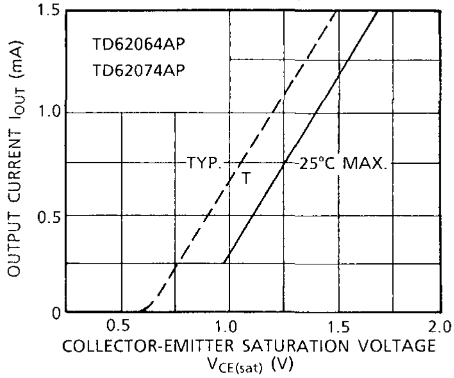
(Note 1) : Pulse Width 50μs, Duty Cycle 10%
Output Impedance 50Ω, $t_r \leqq 5ns$, $t_f \leqq 10ns$

(Note 2) : CL includes probe and jig capacitance

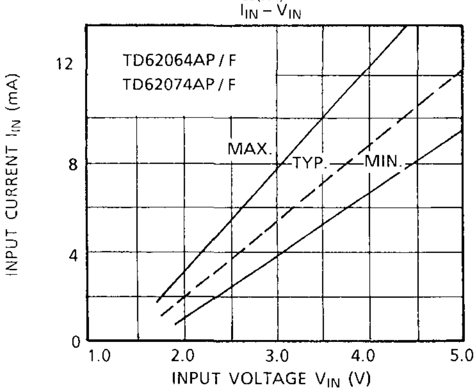
$I_{OUT} - V_{CE(sat)}$



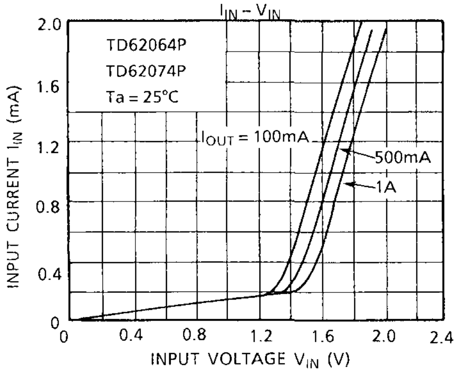
$I_{OUT} - V_{CE(sat)}$



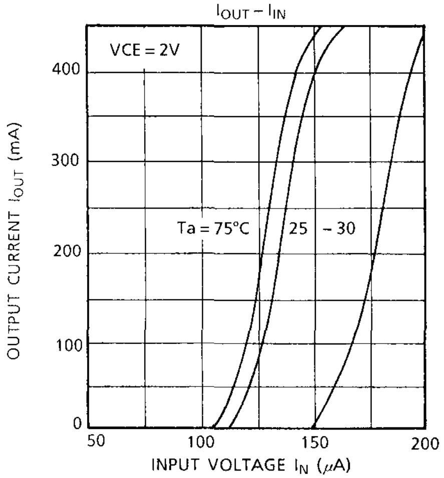
$I_{IN} - V_{IN}$



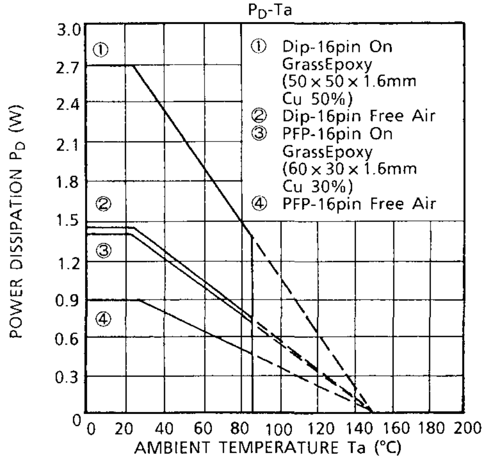
$I_{IN} - V_{IN}$

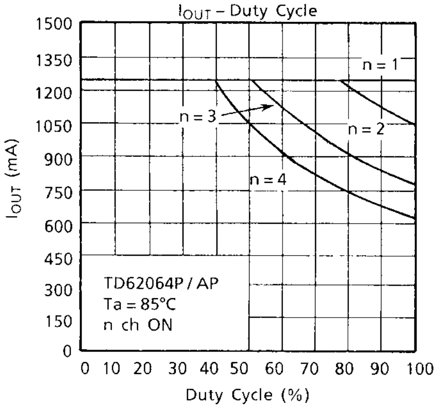


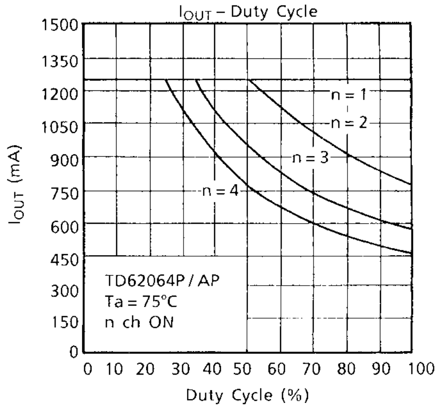
$I_{OUT} - I_{IN}$

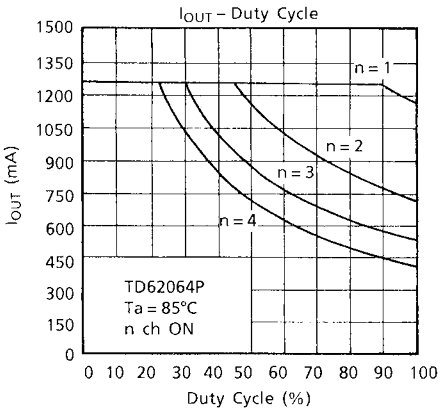


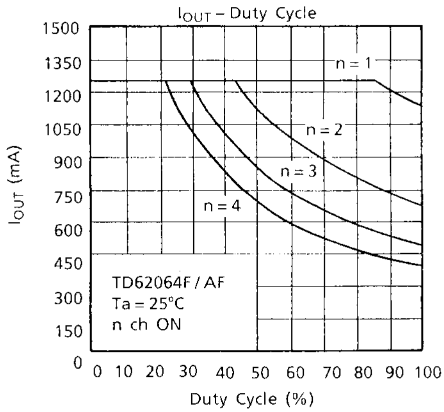
P_D-Ta

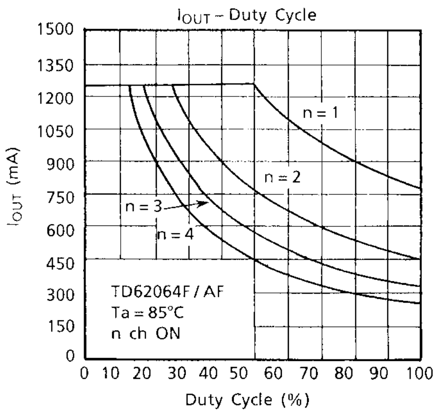



IOUT – Duty Cycle
IOUT (mA)
Duty Cycle (%)
n = 1
n = 2
n = 3
n = 4
TD62064P / AP
Ta = 85°C
n ch ON


IOUT – Duty Cycle
IOUT (mA)
Duty Cycle (%)
n = 1
n = 2
n = 3
n = 4
TD62064P / AP
Ta = 75°C
n ch ON


IOUT – Duty Cycle
IOUT (mA)
Duty Cycle (%)
n = 1
n = 2
n = 3
n = 4
TD62064P
Ta = 85°C
n ch ON


IOUT – Duty Cycle
IOUT (mA)
Duty Cycle (%)
n = 1
n = 2
n = 3
n = 4
TD62064F / AF
Ta = 25°C
n ch ON

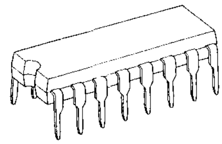

IOUT – Duty Cycle
IOUT (mA)
Duty Cycle (%)
n = 1
n = 2
n = 3
n = 4
TD62064F / AF
Ta = 85°C
n ch ON

TD62064BP-1

4 HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62064BP-1 is high-voltage, high-current darlington drivers comprised of four NPN darlington pairs.
All units feature integral clamp diodes for switching inductive loads.
Applications include relay, hammer, lamp and stepping moter drivers.

- Output Current (Single Output) 1.5A MAX.
- High Sustaining Voltage Output 80V MIN.
- Output Clamp Diodes
- Input Compatible with TTL and 5V C-MOS
- GND and SUB Terminal = Heat Sink
- Package Type-BP-1: DIP-16 pin



DIP16-P-300A

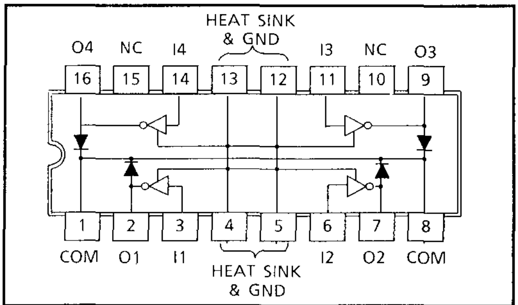
Weight : 1.11g

MAXIMUM RATINGS (Ta = 25°C unless otherwise noted)

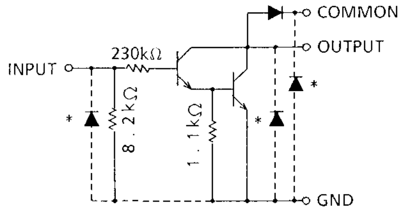
CHARACTERISTIC	SYMBOL	RATING	UNIT
Output Sustaining Voltage	$V_{CE(SUS)}$	−0.5~80	V
Parasitic Transistor Output Voltage	V_{CEF}(*1)	80	V
Output Current	I_{OUT}	1.5	mA / ch
Input Current	I_{IN}	50	mA
Input Voltage	V_{IN}	7	V
Clamp Diode Reverse Voltage	V_R	80	V
Clamp Diode Forward Current	I_F	1.5	A
Power Dissipation	P_D	1.47 / 2.7 ※1	W
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

*1 Parasitic Transistor (COMMON-GND-COMMON) Output Voltage
*2 On Glass Epoxy (50×50×1.6mm cu 50%)

PIN CONNECTION (TOP VIEW)



SCHEMATICS (EACH DRIVER)



* : Parasitic Diodes
(Note) The input and output parasitic diodes cannot be used as clamp diodes.

RECOMMENDED OPERATING CONDITIONS (Ta = −40~85°C)

CHARACTERISTIC	SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Output Sustaining Voltage	$V_{CE(SUS)}$			0	—	80	V
Output Current	I_{OUT}	DC 1 Circuit, Ta = 25°C		0	—	1.25	A / ch
		T_{pw} = 25ms, 4 Circuits Ta = 85°C	Duty = 10%	0	—	1.25	
			Duty = 50%	0	—	0.69	
Input Voltage	V_{IN}			2.5	—	5.5	V
Input Voltage (Output On)	$V_{IN(ON)}$	I_{OUT} = 1.25A		0	—	5.5	V
Input Voltage (IOutput Off)	$V_{IN(OFF)}$			0	—	0.4	V
Input Current	I_{IN}			0	—	20	mA
Clamp Diode Reverse Voltage	V_R			0	—	80	V
Clamp Diode Forward Current	I_F			—	—	1.25	A
Power Dissipation	P_D	Ta = 85°C ※1		—	—	1.4	W

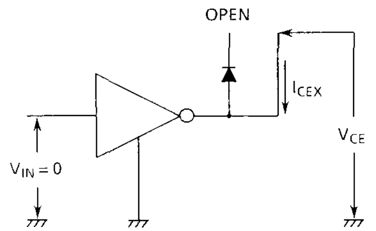
※1 On Glass Epoxy (50×50×1.6mm Cu 50%)

ELECTRICAL CHARATERISTICS (Ta = 25°C unless otherwise noted)

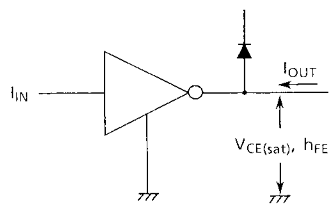
CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP	MAX	UNIT
Output Leakage Current	I_{CEX}	1	$V_{CE}=80V$, $Ta=25°C$	—	—	50	μA
			$V_{CE}=80V$, $Ta=85°C$	—	—	100	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	2	$I_{OUT}=1.25A$, $I_{IN}=2.4V$	—	—	1.6	V
			$I_{OUT}=0.75A$, $I_{IN}=2.4V$	—	—	1.25	
DC Current Transfer Ratio	h_{FE}	2	$V_{CC}=2V$, $I_{OUT}=1.25A$	1000	1500	—	
Input Voltage (Output On)	$V_{IN(ON)}$	3	$I_{OUT}=1.25A$, $I_{IN}=2mA$	2.4	—	—	V
Clamp Diode Reverse Current	I_R	4	$V_R=80V$, $Ta=25°C$	—	—	50	μA
			$V_R=80V$, $Ta=85°C$	—	—	100	
Clamp Diode Forward Voltage	C_F	5	$I_F=1.25A$	—	1.5	2.0	V
Input Capacitance	C_{IN}	6	$V_{IN}=0$, $f=1MHz$	—	15	—	pF
Turn-On Delay	t_{ON}	7	$V_{OUT}=80V$, $R_L=68\Omega$	—	0.1	—	μS
Turn-Off Delay	t_{OFF}			—	1.0	—	
Parasitic Transistor Output Voltage	V_{CEF}	8	$I_{CEF}=150mA$	80	—	—	V

TEST CIRCUIT

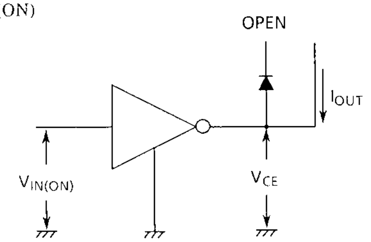
1. I_{CEX}



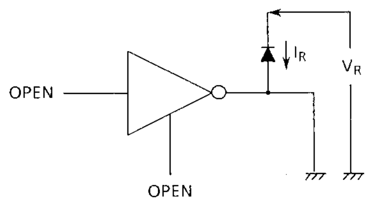
2. $V_{CE(sat)}$, h_{FE}



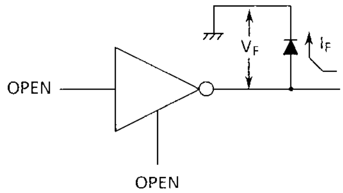
3. $V_{IN(ON)}$



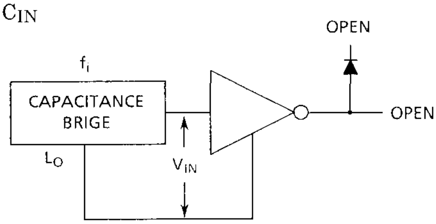
4. I_R



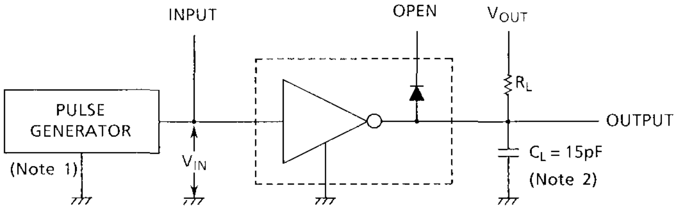
5. V_F

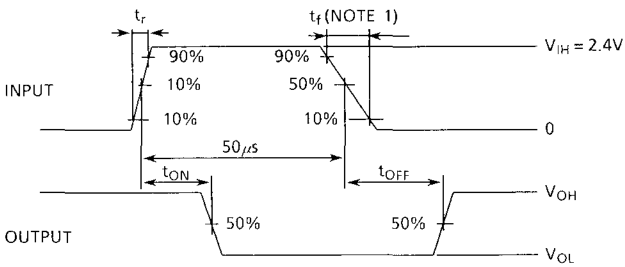


6. C_{IN}



7. t_{ON}, t_{OFF}

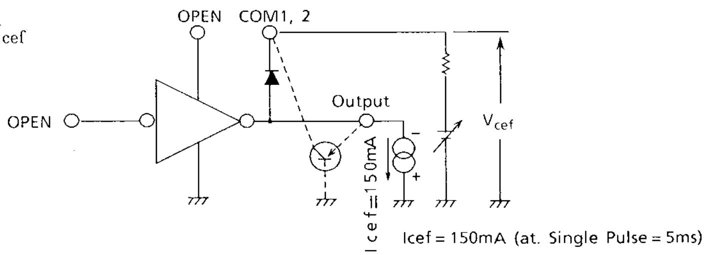


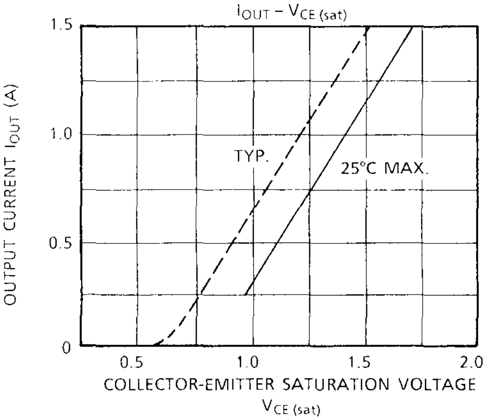


(Note 1) : Pulse Width $50\mu s$, Duty Cycle 10%
Output Impedance 50Ω, $t_r \leqq 5ns$, $t_f \leqq 10ns$

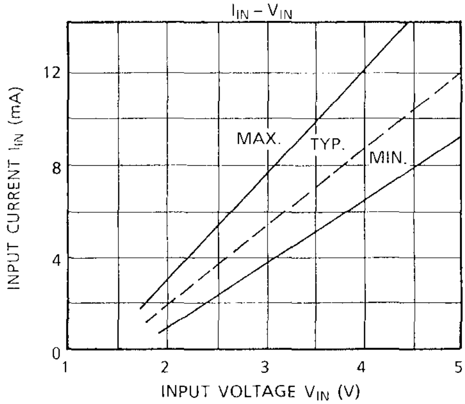
(Note 2) : CL includes probe and jig capacitance

8. V_{cef}

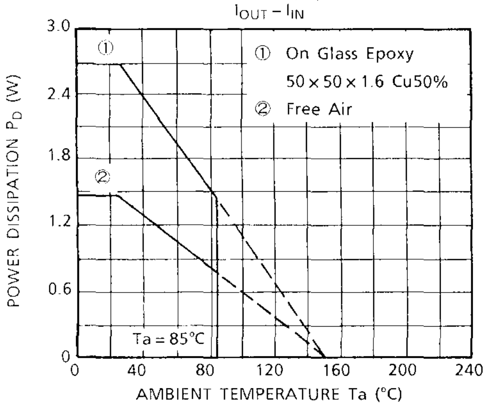




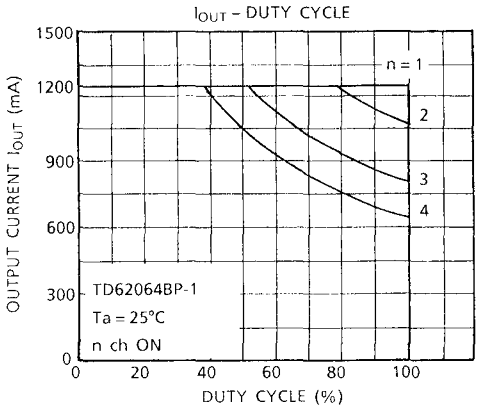
I_{OUT} – $V_{CE\,(sat)}$
OUTPUT CURRENT I_{OUT} (A)
1.5
1.0
0.5
0
TYP.
25°C MAX.
0.5
1.0
1.5
2.0
COLLECTOR-EMITTER SATURATION VOLTAGE
$V_{CE\,(sat)}$



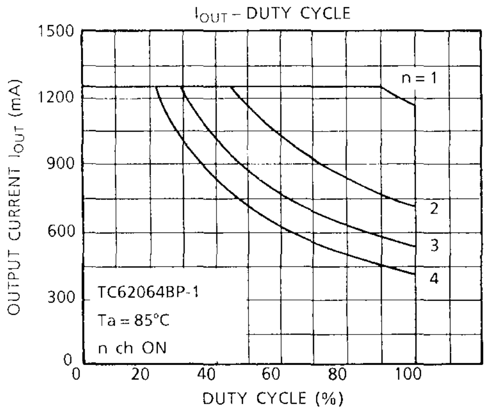
I_{IN} – V_{IN}
INPUT CURRENT I_{IN} (mA)
12
8
4
0
MAX.
TYP.
MIN.
1
2
3
4
5
INPUT VOLTAGE V_{IN} (V)



I_{OUT} – I_{IN}
POWER DISSIPATION P_D (W)
3.0
2.4
1.8
1.2
0.6
0
①
②
① On Glass Epoxy
50 × 50 × 1.6 Cu50%
② Free Air
Ta = 85°C
0
40
80
120
160
200
240
AMBIENT TEMPERATURE Ta (°C)



I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
1500
1200
900
600
300
0
n = 1
2
3
4
TD62064BP-1
Ta = 25°C
n ch ON
0
20
40
60
80
100
DUTY CYCLE (%)



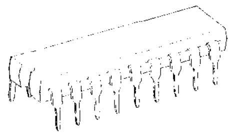
I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
1500
1200
900
600
300
0
n = 1
2
3
4
TC62064BP-1
Ta = 85°C
n ch ON
0
20
40
60
80
100
DUTY CYCLE (%)

TD62081AP/CP/F/AF, TD62082AP/CP/F/AF
TD62083AP/CP/F/AF, TD62084AP/CP/F/AF

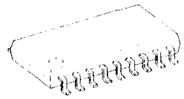
○ 8 HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62081AP / CP / F / AF Series are high-voltage, high-current darlington drivers comprised of eight NPN darlington pairs.
All units feature integral clamp diodes for swiching inductive loads.
Applications include relay, hammer, lamp and display (led) drivers.

- Output Current (Single Output) 500mA MAX. (TD62081AP / F / AF Series)
  400mA MAX. (TD62081CP Series)
- High Sustaining Voltage Output 35V MIN. (TD62081F Series)
  50V MIN. (TD62081AP / AF Series)
  100V MIN. (TD62081CP Series)
- Output Clamp Diodes
- Inputs campatible with Various Types OF Logic.
- Package Type-AP, CP: DIP-18 pin
- Package Type-F, AF: SOP-18 pin



DIP18-P-300D



SOP18-P-375

Weight DIP18-P-300D : 1.478g
SOP18-P-375 : 0.41g

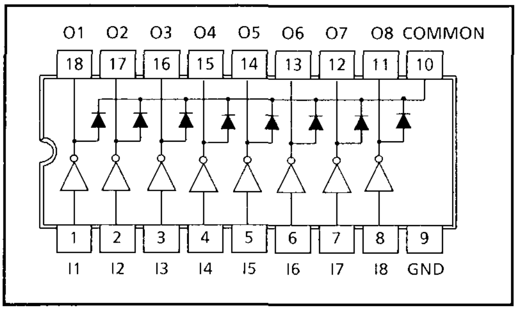
TYPE	INPUT BASE RESISTOR	DESIGNATION
TD62081AP / CP / F / AF	External	General Purpose
TD62082AP / CP / F / AF	10.5-kΩ + 7V Zenner diode	14~25V P-MOS
TD62083AP / CP / F / AF	2.7kΩ	TTL, 5V C-MOS
TD62084AP / CP / F / AF	10.5kΩ	6~15V P-MOS, C-MOS

MAXIMUM RATINGS (Ta = 25°C)

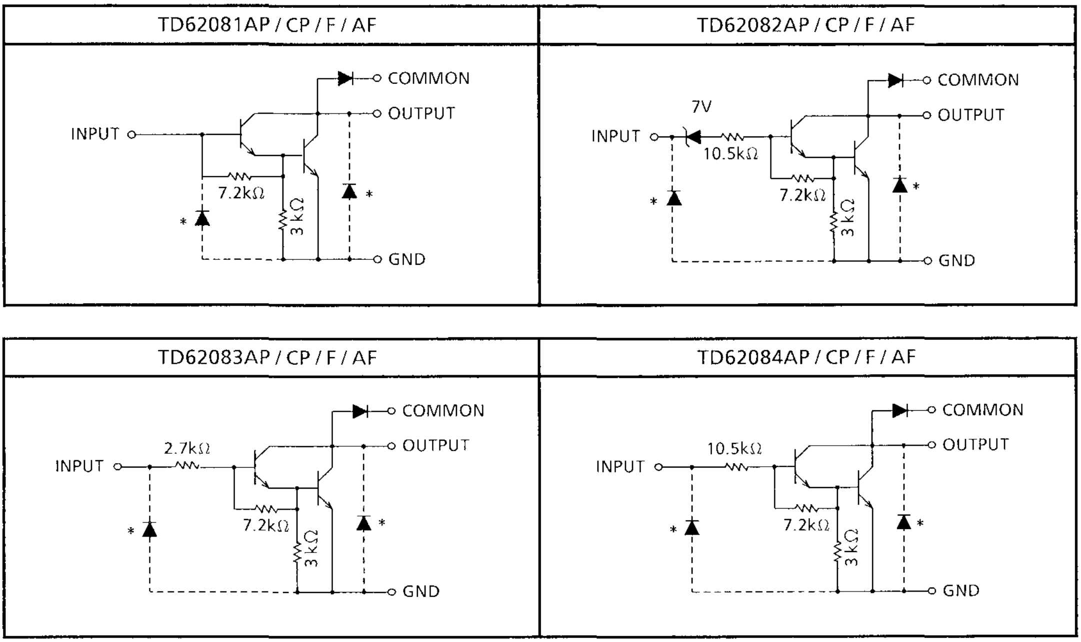
CHARACTERISTIC		SYMBOL	RATING	UNIT
Output Sustaining Voltage	AP, AF	$V_{CE(SUS)}$	−0.5~50	V
	CP		−0.5~100	
	F		−0.5~35	
Output Current		I_{OUT}	500	mA / ch
	CP		400	
Input Voltage		V_{IN} (*1)	−0.5~30	V
Input Current		I_{IN} (**2)	25	mA
Clamp Diode Reverse Voltage	AP, AF	V_R	50	V
	CP		100	
	F		35	
Clamp Diode Forward Current		I_F	500	mA
	CP		400	
Power Dissipation	AP, CP	P_D	1.47	W
	F, AF		0.96	
Operating Tesmperature		T_{opr}	−40~85	°C
Storage Temperature		T_{stg}	−55~150	°C

*1 Except TD62081AP / CP / F / AF **2 Only TD62081AP / CP / F / AF

PIN CONNECTION (TOP VIEW)



SCHEMATICS (EACH DRIVER)



* : Parasitic Diodes

NOTE. The input and output parasitic diodes cannot be used as clamp diodes.

RECOMMENDED OPERATING CONDITIONS (Ta = −40~85°C)

CHARACTERISTIC		SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Output Sustaining Voltage	AP, AF	$V_{CE(SUS)}$		0	—	50	V
	CP			0	—	100	
	F			0	—	35	
Output Current	AP, CP	I_{OUT}	T_{pw} = 25ms, Duty = 8%, 8 Circuits	0	—	400	mA / ch
			T_{pw} = 25ms, Duty = 25%, 8 Circuits	0	—	200	
	F, AF		T_{pw} = 25ms, Duty = 8%, 8 Circuits	0	—	350	
			T_{pw} = 25ms, Duty = 25%, 8 Circuits	0	—	140	
Input Voltage	Except TD62081AP / CP / F / AF	V_{IN}		14	—	30	V
Input Voltage (Output ON)	TD62082AP / CP / F / AF	$V_{IN(ON)}$		3.5	—	30	V
	TD62083AP / CP / F / AF			8	—	30	
	TD62084AP / CP / F / AF			0	—	30	
Input Current	Only TD62081AP / CP / F / AF	I_{IN}		—	—	5	mA
Clamp Diode Reverse Voltage	AP, AF	V_R		—	—	50	V
	CP			—	—	100	
	F			—	—	35	
Clamp Diode Forward Current		I_F		—	—	400	mA
	CP			—	—	320	
Power Dissipation	AP, CP	P_D		—	—	0.52	W
	F, AF			—	—	0.35	

ELECTRICAL CHARATERISTICS (Ta = 25°C unless otherwise noted)

CHARACTERISTIC			SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN	TYP	MAX	UNIT
Output Leakage Current		AP, AF	I_{CEX}	1	V_{CE} = 50V	Ta = 25°C	—	—	50	μA
		CP			VCE = 100V					
		F			VCE = 35V					
		AP, AF			VCE = 50V	Ta = 85°C	—	—	100	
		CP			VCE = 100V					
		F			VCE = 35V					
	TD62082	AP, AF			VCE = 50V	V_{IN} = 6V	—	—	500	
		CP			VCE = 100V					
		F			VCE = 35V					
	TD62084	AP, AF			VCE = 50V	V_{IN} = 1V	—	—	500	
		CP			VCE = 100V					
		F			VCE = 35V					

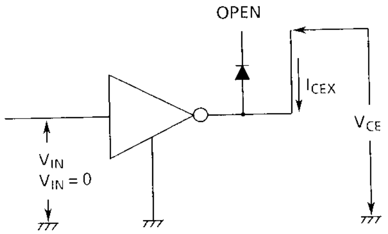
ELECTRICAL CHARATERISTICS (Ta = 25°C unless otherwise noted)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP	MAX	UNIT
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	2	I_{OUT} = 350mA, I_{IN} = 500μA	—	1.3	1.6	V
				I_{OUT} = 200mA, I_{IN} = 350μA	—	1.1	1.3	
				I_{OUT} = 100mA, I_{IN} = 250μA	—	0.9	1.1	
Input Current	TD62082AP / CP / F / AF	$I_{IN(ON)}$	3	V_{IN} = 17V	—	0.82	1.25	mA
	TD62083AP / CP / F / AF			V_{IN} = 3.85V	—	0.93	1.35	
	TD62084AP / CP / F / AF			V_{IN} = 5V	—	0.35	0.5	
				V_{IN} = 12V	—	1.0	1.45	
		$I_{IN(OFF)}$	4	I_{OUT} = 500μA, Ta = 85°C	50	65	—	μA
Input Voltage (Output On)	TD62082AP / CP / F /AF	$V_{IN(ON)}$	5	V_{CE} = 2V, I_{OUT} = 300mA	—	—	13	V
	TD62083AP / CP / F / AF			V_{CE} = 2V, I_{OUT} = 200mA	—	—	2.4	
				V_{CE} = 2V, I_{OUT} = 250mA	—	—	2.7	
				V_{CE} = 2V, I_{OUT} = 300mA	—	—	3.0	
	TD62084AP / CP / F / AF			V_{CE} = 2V, I_{OUT} = 125mA	—	—	5.0	
				V_{CE} = 2V, I_{OUT} = 200mA	—	—	6.0	
				V_{CE} = 2V, I_{OUT} = 275mA	—	—	7.0	
				V_{CE} = 2V, I_{OUT} = 350mA	—	—	8.0	
DC Current Transfer Ratio		h_{FE}	2	V_{CE} = 2V, I_{OUT} = 350mA	1000	—	—	
Clamp Diode Reverse Current		I_R	6	Ta = 25°C (*1)	—	—	50	μA
				Ta = 85°C (*1)	—	—	100	
Clamp Diode Forward Voltage		V_F	7	I_F = 350mA	—	—	2.0	V
	CP			I_F = 280mA	—	—	1.8	
Input Capacitance		C_{IN}	—		—	15	—	pF
Turn-On Delay	AP, AF	t_{ON}	8	R_L = 120Ω, V_{OUT} = 50V	—	0.1	—	μS
	CP			R_L = 240Ω, V_{OUT} = 100V	—	0.1	—	
	F			R_L = 85Ω, V_{OUT} = 35V	—	0.1	—	
Turn-Off Delay	AP, AF	t_{OFF}		R_L = 120Ω, V_{OUT} = 50V	—	0.2	—	
	CP			R_L = 240Ω, V_{OUT} = 100V	—	0.2	—	
	F			R_L = 85Ω, V_{OUT} = 35V	—	0.2	—	

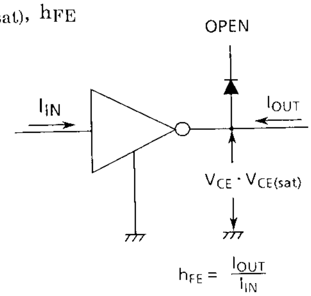
*1 VR = VR MAX.

TEST CIRCUIT

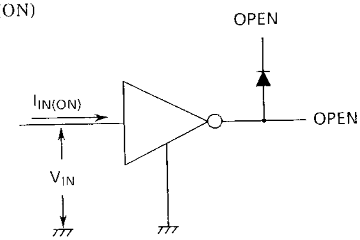
1. I_{CEX}



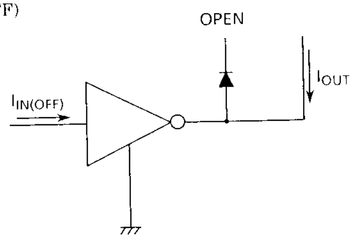
2. $V_{CE(sat)}$, h_{FE}



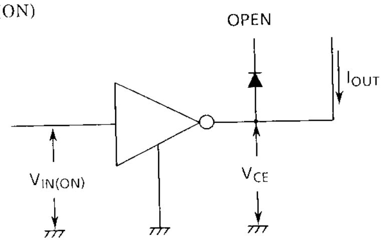
3. $I_{IN(ON)}$



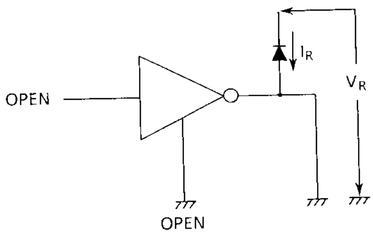
4. $I_{IN(OFF)}$



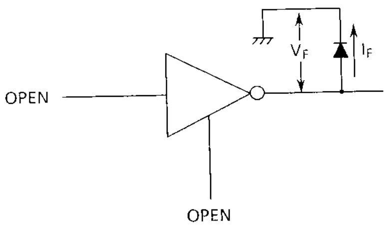
5. $V_{IN(ON)}$



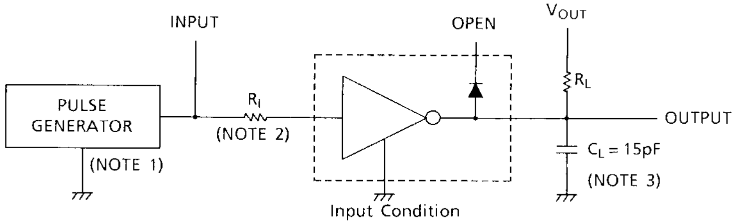
6. I_R

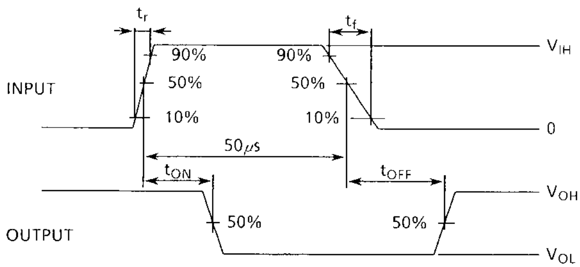


7. V_F



8. t_{ON}, t_{OFF}





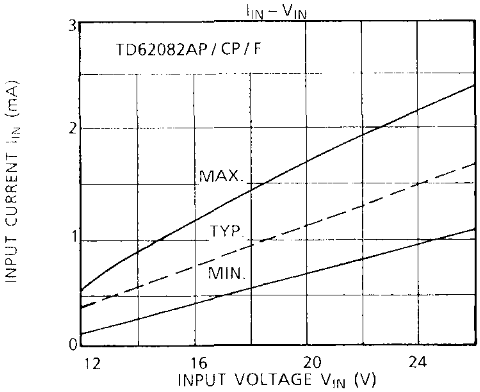
(Note 1) : Pulse Width 50μs, Duty Cycle 10%
Output Impedance 50Ω, $t_r \leqq 5ns$, $t_f \leqq 10ns$

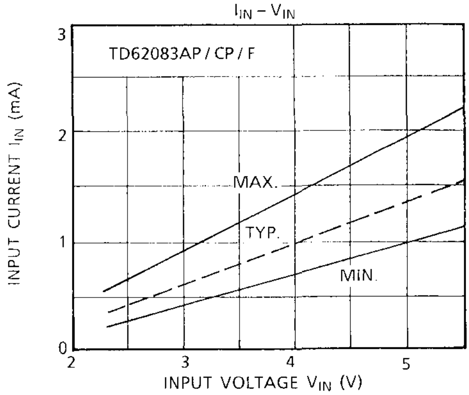
(Note 2) : See below

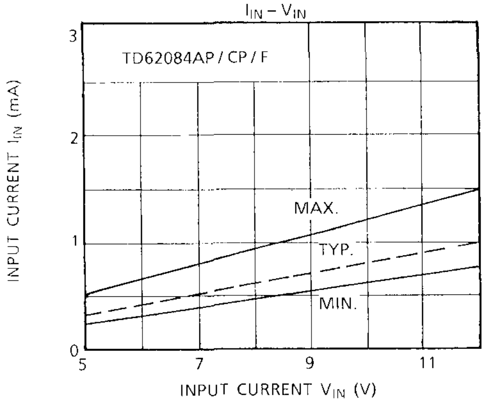
Input Condition

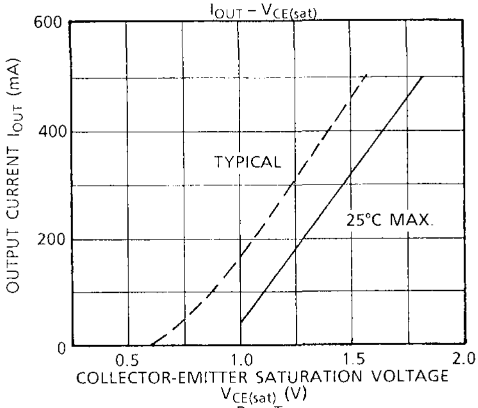
TYPE NUMBER	R1	V_{IH}
TD62081AP / CP / F / AF	2.7kΩ	3V
TD62082AP / CP / F / AF	0	13V
TD62083AP / CP / F / AF	0	3V
TD62084AP / CP / F / AF	0	8V

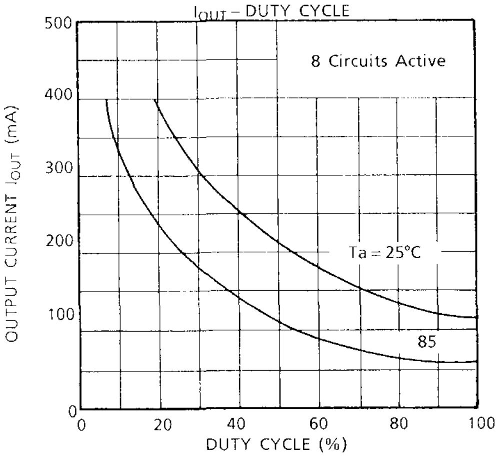
(Note 3) : CL includes probe and jig capacitance

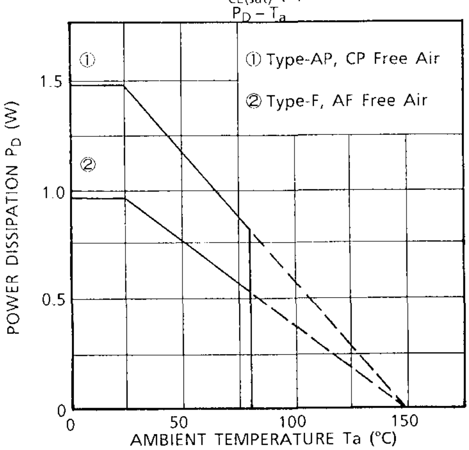

$I_{IN} - V_{IN}$
TD62082AP / CP / F
MAX.
TYP.
MIN.
INPUT CURRENT I_{IN} (mA)
INPUT VOLTAGE V_{IN} (V)
0
1
2
3
12
16
20
24


$I_{IN} - V_{IN}$
TD62083AP / CP / F
MAX.
TYP.
MIN.
INPUT CURRENT I_{IN} (mA)
INPUT VOLTAGE V_{IN} (V)
0
1
2
3
2
3
4
5


$I_{IN} - V_{IN}$
TD62084AP / CP / F
MAX.
TYP.
MIN.
INPUT CURRENT I_{IN} (mA)
INPUT CURRENT V_{IN} (V)
0
1
2
3
5
7
9
11


$I_{OUT} - V_{CE(sat)}$
TYPICAL
25°C MAX.
OUTPUT CURRENT I_{OUT} (mA)
COLLECTOR-EMITTER SATURATION VOLTAGE
$V_{CE(sat)}$ (V)
0
200
400
600
0.5
1.0
1.5
2.0


I_{OUT} – DUTY CYCLE
8 Circuits Active
Ta = 25°C
85
OUTPUT CURRENT I_{OUT} (mA)
DUTY CYCLE (%)
0
100
200
300
400
500
0
20
40
60
80
100

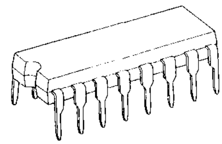

$P_D - T_a$
①
②
① Type-AP, CP Free Air
② Type-F, AF Free Air
POWER DISSIPATION P_D (W)
AMBIENT TEMPERATURE Ta (°C)
0
0.5
1.0
1.5
0
50
100
150

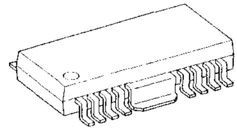
TD62164AP/AF

○ 4 HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62164AP / AF is high-voltage, high-current darlington drivers comprised of four NPN darlington pairs.
All units feature integral clamp diodes for swiching inductive loads.
Applications include relay, hammer, lamp and stepping moter drivers.

- Output Current (Single Output) 700mA MAX.
- High Sustaining Voltage Output 50V MIN.
- Output Clamp Diodes
- Input Compatible with TTL and 5V C-MOS
- GND and SUB Terminal Heat Sink
- Package Type-AP: DIP-16 pin
- Package Type-AF: PFP-16 pin


DIP16-P-300A


HSOP16-P-300

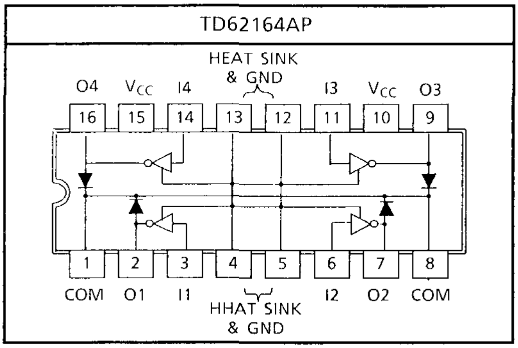
Weight DIP16-P-300A : 1.11g
SOP16-P-300 : 0.50g

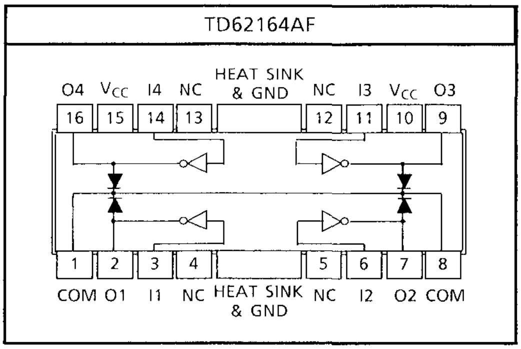
MAXIMUM RATINGS (Ta=25°C unless otherwise noted)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	−0.5~7	V
Output Sustaining Voltage		$V_{CE(SUS)}$	−0.5~50	V
Output Current		I_{OUT}	700	mA / ch
Input Current		I_{IN}	50	mA
Input Voltage		V_{IN}	17	V
Clamp Diode Reverse Voltage		V_R	50	V
Clamp Diode Forward Current		I_F	700	mA
Power Dissipation	AP	P_D	1.47 / 2.7 *1	W
	AF		0.9 / 1.4 *2	
Operating Temperature		T_{opr}	−40~85	°C
Storage Temperature		T_{stg}	−55~150	°C

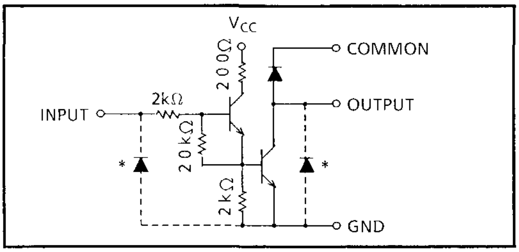
*1 On Glass Epoxy (50×50×1.6mm Cu 50%)
*2 On Glass Epoxy (60×60×1.6mm Cu 30%)

PIN CONNECTION (TOP VIEW)





SCHEMATICS (EACH DRIVER)



* : Parasitic Diodes
The input and output parasitic diodes cannot be used as clamp diodes.

RECOMMENDED OPERATING CONDITIONS (Ta = −40~85°C)

CHARACTERISTIC		SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Supply Voltage		V_{CC}			4.5	—	5.5	V
Output Sustaining Voltage		$V_{CE(SUS)}$			0	—	50	V
Output Current		I_{OUT}	DC 1 Circuit, Ta = 25°C		0	—	570	mA / ch
	AP		Tpw = 25ms 4 Circuits Ta = 85°C	Duty = 10%	0	—	570	
				Duty = 50%	0	—	570	
	AF			Duty = 10%	0	—	570	
				Duty = 50%	0	—	480	
Input Voltage		V_{IN}			0	—	15	V
Input Voltage	Output On	$V_{IN(ON)}$	I_{OUT} = 500mA	h_{FE} = 150	10.0	—	15	V
				h_{FE} = 2000	2.4	—	15	
	Output Off	$V_{IN(OFF)}$			0	—	0.4	
Input Current		I_{IN}			0	—	20	mA
Clamp Diode Reverse Voltage		V_R			—	—	50	V
Clamp Diode Forward Current		I_F			—	—	500	mA
Power Dissipation	AP	P_D	Ta = 85°C *1		—	—	1.4	W
	AF		Ta = 85°C *2		—	—	0.7	

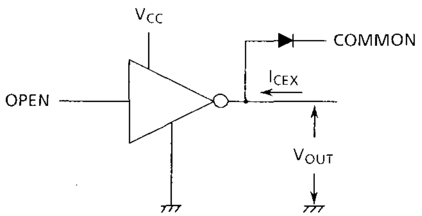
*1 On Glass Epoxy (50×50×1.6mm Cu 50%), *2 On Glass Epoxy (60×60×1.6mm Cu 30%)

ELECTRICAL CHARATERISTICS (Ta = 25°C unless otherwise noted)

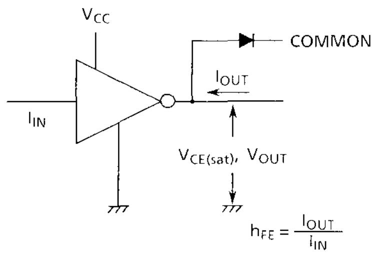
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP	MAX	UNIT
Output Leakage Current		I_{CEX}	1	V_{CE} = 50V, Ta = 25°C	—	—	50	μA
				V_{CE} = 50V, Ta = 85°C	—	—	100	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	2	I_{OUT} = 500mA, V_{CC} = 5V	—	—	0.8	V
				I_{OUT} = 200mA, V_{CC} = 5V	—	—	0.45	
DC Current Transfer Ratio		h_{FE}	2	V_{CE} = 2V, I_{OUT} = 500mA	2000	—	—	
Input Voltage (Output On)		$V_{IN(ON)}$	3	I_{OUT} = 500mA, h_{FE} = 150	7.0	—	10.0	V
				I_{OUT} = 500mA, h_{FE} = 2000	1.8	—	2.4	
Clamp Diode Reverse Current		I_R	4	V_R = 50V, Ta = 25°C	—	—	50	μA
				V_R = 50V, Ta = 85°C	—	—	100	
Clamp Diode Forward Voltage		V_F	5	I_F = 500mA	—	—	2.0	V
Supply Current	Output On	$I_{CC(ON)}$	3	V_{CC} = 5.5V, V_{IN} = 2.4V	—	35	40	mA/ch
	Output Off	$I_{CC(OFF)}$		V_{CC} = 5.5V, V_{IN} = 0.4V	—	—	10	μA
Input Capacitance		C_{IN}	6	V_{IN} = 0, f = 1MHz	—	15	—	pF
Turn-On Delay		t_{ON}	7	V_{OUT} = 50V, R_L = 72Ω	—	0.2	0.4	μs
Turn-Off Delay		t_{OFF}		V_{CC} = 5.0V, C_L = 15pF	—	4.0	8.0	

TEST CIRCUIT

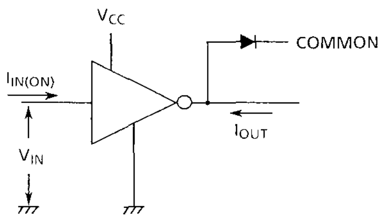
1. I_{CEX}



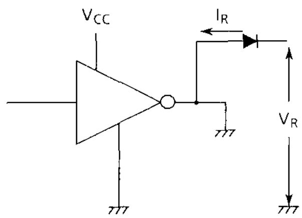
2. h_{FE}, $V_{CE(sat)}$



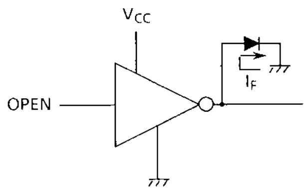
3. $I_{IN(ON)}$



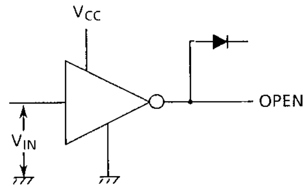
4. I_R



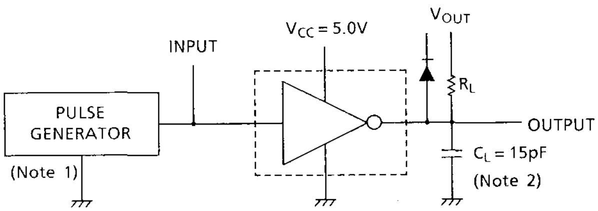
5. V_F

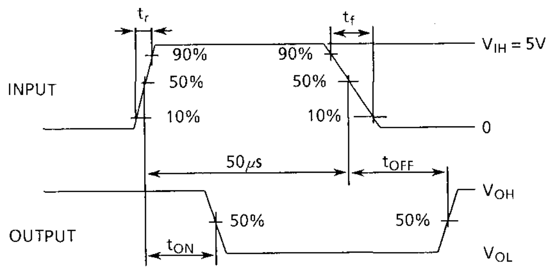


6. C_{IN}



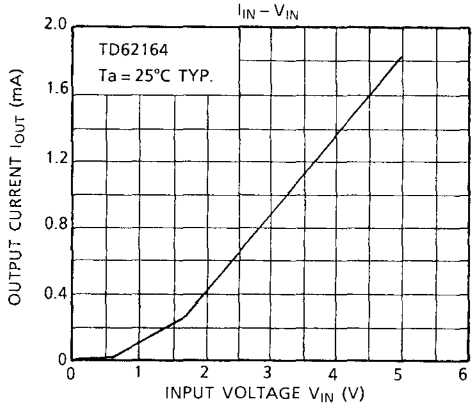
7. t_{ON}, t_{OFF}

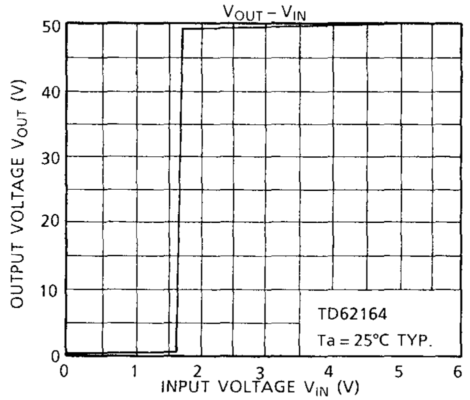


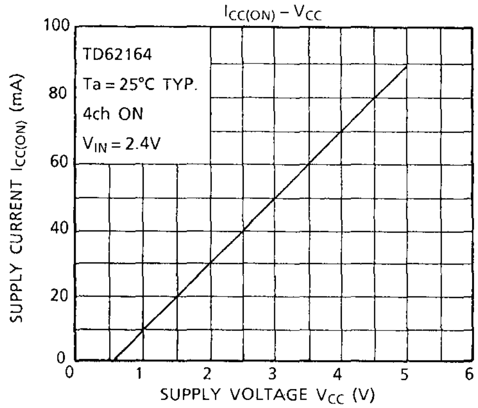


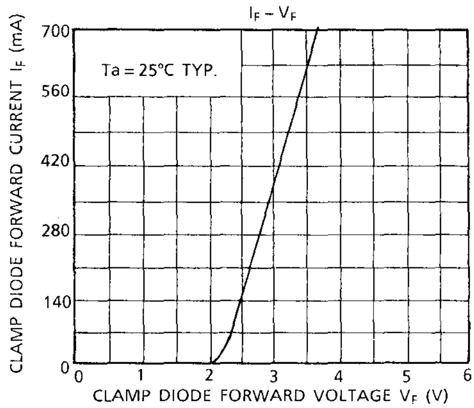
(Note 1) : Pulse Width 50μs, Duty Cycle 10%
Output Impedance 50Ω, $t_r \leqq 5ns$, $t_f \leqq 10ns$

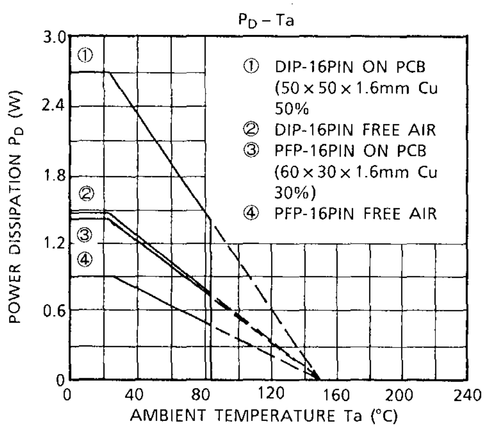
(Note 2) : CL includes probe and jig capacitance

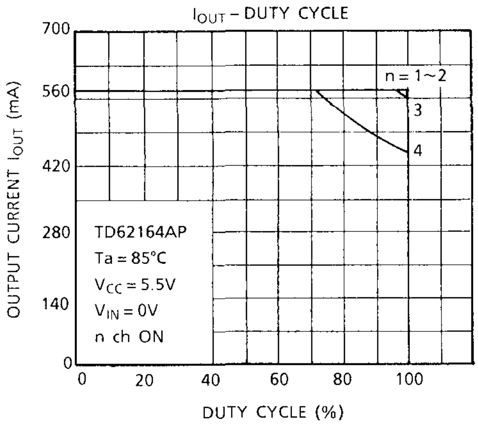

IIN – VIN
TD62164
Ta = 25°C TYP.
OUTPUT CURRENT IOUT (mA)
2.0
1.6
1.2
0.8
0.4
0
0
1
2
3
4
5
6
INPUT VOLTAGE VIN (V)


VOUT – VIN
TD62164
Ta = 25°C TYP.
OUTPUT VOLTAGE VOUT (V)
50
40
30
20
10
0
0
1
2
3
4
5
6
INPUT VOLTAGE VIN (V)

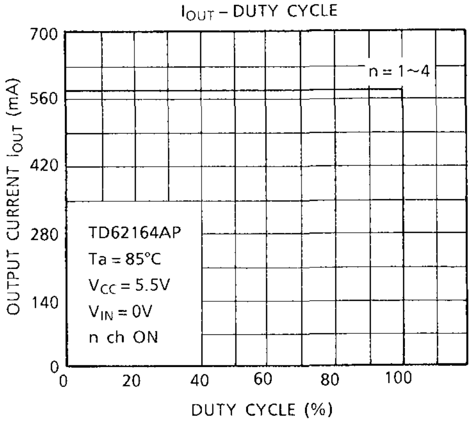

ICC(ON) – VCC
TD62164
Ta = 25°C TYP.
4ch ON
VIN = 2.4V
SUPPLY CURRENT ICC(ON) (mA)
100
80
60
40
20
0
0
1
2
3
4
5
6
SUPPLY VOLTAGE VCC (V)


IF – VF
Ta = 25°C TYP.
CLAMP DIODE FORWARD CURRENT IF (mA)
700
560
420
280
140
0
0
1
2
3
4
5
6
CLAMP DIODE FORWARD VOLTAGE VF (V)

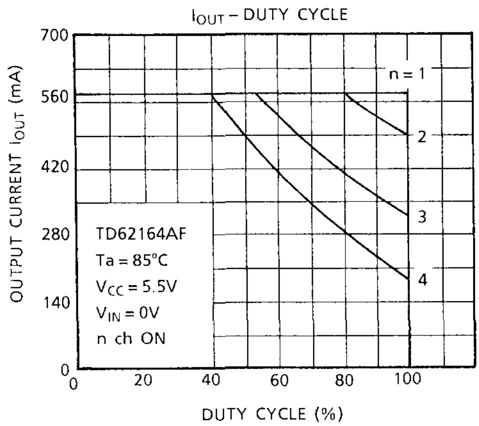

PD – Ta
① DIP-16PIN ON PCB
(50 × 50 × 1.6mm Cu
50%
② DIP-16PIN FREE AIR
③ PFP-16PIN ON PCB
(60 × 30 × 1.6mm Cu
30%)
④ PFP-16PIN FREE AIR
①
②
③
④
POWER DISSIPATION PD (W)
3.0
2.4
1.8
1.2
0.6
0
0
40
80
120
160
200
240
AMBIENT TEMPERATURE Ta (°C)



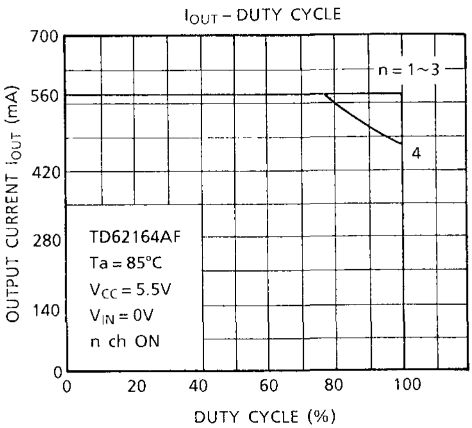
I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0 20 40 60 80 100
DUTY CYCLE (%)
n = 1~2
3
4
TD62164AP
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 0V
n ch ON



I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0 20 40 60 80 100
DUTY CYCLE (%)
n = 1~4
TD62164AP
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 0V
n ch ON



I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0 20 40 60 80 100
DUTY CYCLE (%)
n = 1
2
3
4
TD62164AF
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 0V
n ch ON



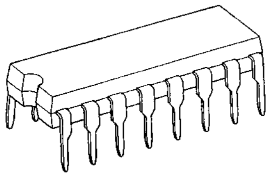
I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0 20 40 60 80 100
DUTY CYCLE (%)
n = 1~3
4
TD62164AF
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 0V
n ch ON

TD62164BP

○ 4 HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62164BP is high-voltage, high-current darlington drivers comprised of four NPN darlington pairs.
All units feature integral clamp diodes for swiching inductive loads.
Applications include relay, hammer, lamp and stepping moter drivers.

- Output Current (Single Output) 750mA MAX.
- High Sustaining Voltage Output 80V MIN.
- Output Clamp Diodes
- Input Compatible with TTL and 5V C-MOS
- GND and SUB Terminal = Heat Sink
- Package Type-BP: DIP-16 pin



DIP16-P-300A

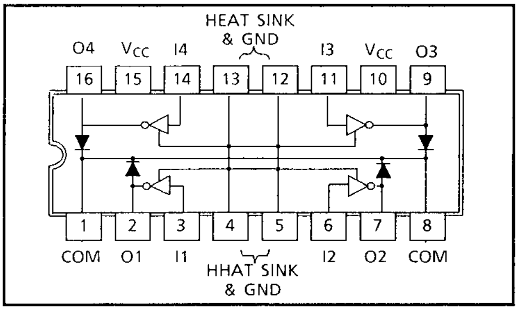
Weight : 1.11g

MAXIMUM RATINGS (Ta = 25°C unless otherwise noted)

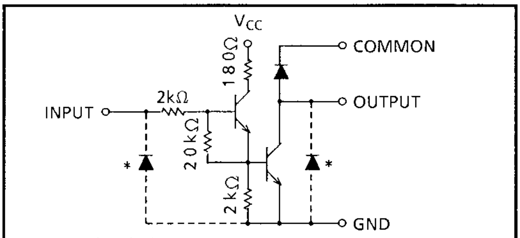
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	−0.5~7	V
Output Sustaining Voltage	$V_{CE(SUS)}$	−0.5~80	V
Output Current	I_{OUT}	700	mA / ch
Input Current	I_{IN}	50	mA
Input Voltage	V_{IN}	17	V
Clamp Diode Reverse Voltage	V_R	80	V
Clamp Diode Forward Current	I_F	700	mA
Power Dissipation	P_D	1.47 / 2.7 *1	W
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

*1 On Glass Epoxy (50×50×1.6mm Cu 50%)

PIN CONNECTION (TOP VIEW)



SCHEMATICS (EACH DRIVER)



* : Parasitic Diodes
(Note) The input and output parasitic diodes cannot be used as clamp diodes.

RECOMMENDED OPERATING CONDITIONS (Ta = −40~85°C)

CHARACTERISTIC		SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Supply Voltage		V_{CC}			4.5	—	5.5	V
Output Sustaining Voltage		$V_{CE(SUS)}$			0	—	80	V
Output Current		I_{OUT}	DC 1 Circuit, Ta = 25°C		0	—	570	mA / ch
			Tpw = 25ms, 4 Circuits Ta = 85°C	Duty = 10%	0	—	570	
				Duty = 50%	0	—	570	
Input Voltage		V_{IN}			0	—	5.5	V
	(Output On)	$V_{IN(ON)}$	I_{OUT} = 500mA	h_{FE} = 150	10	—	15	
				h_{FE} = 2000	2.4	—	15	
	(Output Off)	$V_{IN(OFF)}$			0	—	0.4	
Input Current		I_{IN}			0	—	20	mA
Clamp Diode Reverse Voltage		V_R			—	—	80	V
Clamp Diode Forward Current		I_F			—	—	700	mA
Power Dissipation		P_D	Ta = 85°C *1		—	—	1.4	W

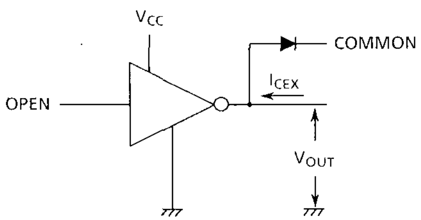
*1 On Glass Epoxy (50×50×1.6mm Cu 50%)

ELECTRICAL CHARATERISTICS (Ta = 25°C unless otherwise noted)

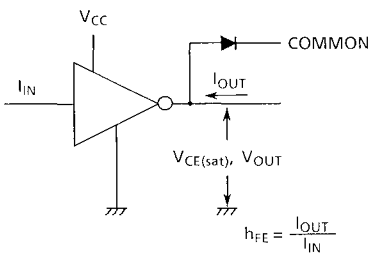
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP	MAX	UNIT
Output Leakage Current		I_{CEX}	1	$V_{CE}=80V$, $Ta=25°C$	—	—	50	μA
				$V_{CE}=80V$, $Ta=85°C$	—	—	100	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	2	$I_{OUT}=500mA$, $V_{CC}=5V$	—	—	0.8	V
				$I_{OUT}=200mA$, $V_{CC}=5V$	—	—	0.45	
DC Current Transfer Ratio		h_{FE}	2	$V_{CE}=2V$, $I_{OUT}=500mA$	2000	—	—	
Input Voltage (Output On)		$V_{IN(ON)}$	3	$I_{OUT}=500mA$, $h_{FE}=150$	7.0	—	10.0	V
				$I_{OUT}=500mA$, $h_{FE}=2000$	1.8	—	2.4	
Clamp Diode Reverse Current		I_R	4	$V_R=80V$, $Ta=25°C$	—	—	50	μA
				$V_R=80V$, $Ta=85°C$	—	—	100	
Clamp Diode Forward Voltage		V_F	5	$I_F=500mA$	—	—	2.0	V
Supply Current	(Output On)	$I_{CC(ON)}$	6	$V_{CC}=5.5V$, $V_{IN}=2.4V$	—	40	45	mA/ch
	(Output Off)	$I_{CC(OFF)}$		$V_{CC}=5.5V$, $V_{IN}=0.4V$	—	—	10	μA
Input Capacitance		C_{IN}	—	$V_{IN}=0$, $f=1MHz$	—	15	—	pF
Turn-On Delay		t_{ON}	7	$V_{OUT}=80V$, $R_L=120\Omega$, $Ta=60°C$ $V_{CC}=5.0V$, $C_L=15pF$	—	0.2	0.4	μs
Turn-Off Delay		t_{OFF}			—	4.0	8.0	

TEST CIRCUIT

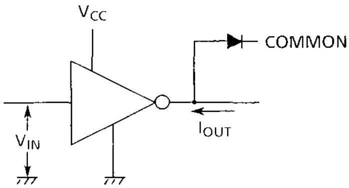
1. I_{CEX}



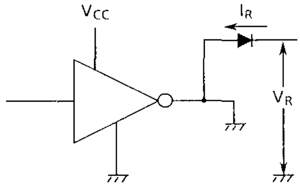
2. h_{FE}, $V_{CE(sat)}$



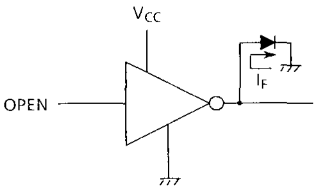
3. $V_{IN(ON)}$



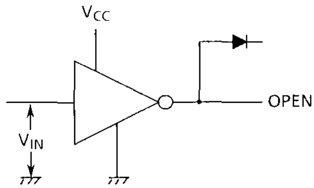
4. I_R



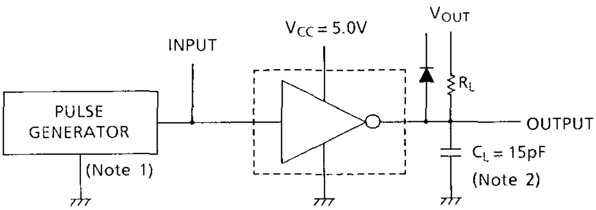
5. V_F

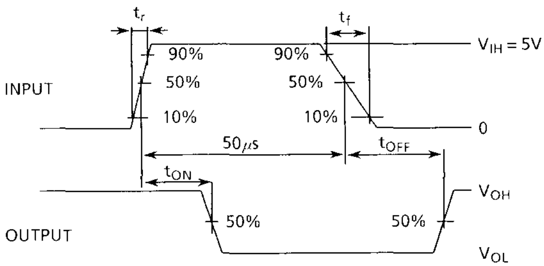


6. $I_{CC(ON)}$, (OFF)



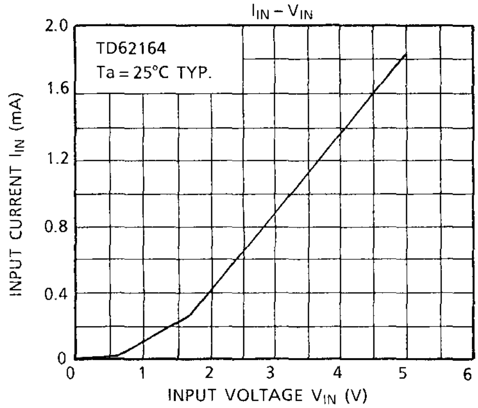
7. t_{ON}, t_{OFF}



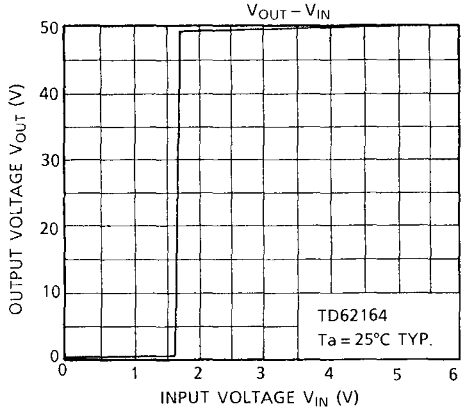


(Note 1) : Pulse Width 50μs, Duty Cycle 10% Output Impedance 50Ω, $t_r \leqq 5ns$, $t_f \leqq 10ns$

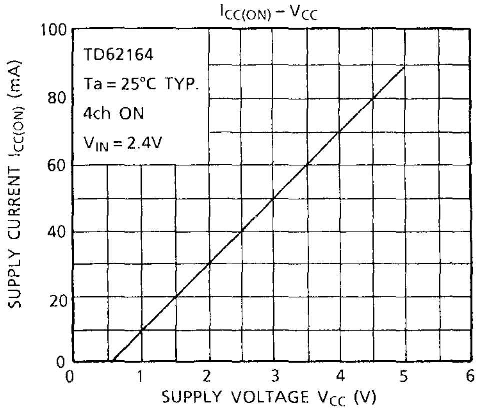
(Note 2) : CL includes probe and jig capacitance



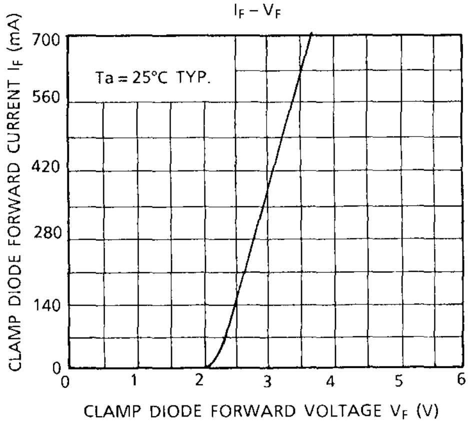
I_{IN} – V_{IN}
TD62164
Ta = 25°C TYP.
INPUT CURRENT I_{IN} (mA)
2.0
1.6
1.2
0.8
0.4
0
0
1
2
3
4
5
6
INPUT VOLTAGE V_{IN} (V)



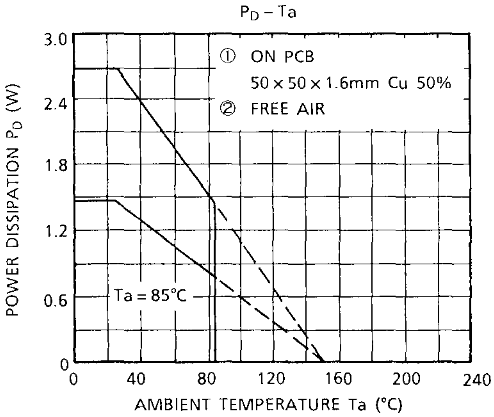
V_{OUT} – V_{IN}
OUTPUT VOLTAGE V_{OUT} (V)
50
40
30
20
10
0
TD62164
Ta = 25°C TYP.
0
1
2
3
4
5
6
INPUT VOLTAGE V_{IN} (V)



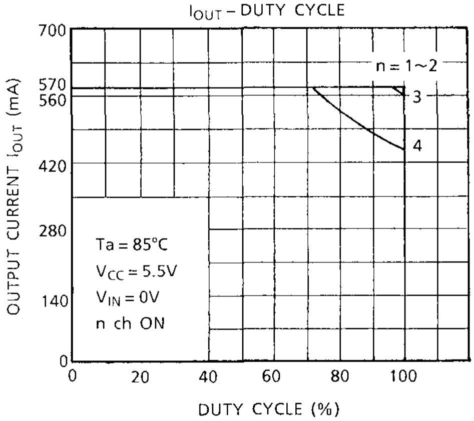
$I_{CC(ON)}$ – V_{CC}
TD62164
Ta = 25°C TYP.
4ch ON
V_{IN} = 2.4V
SUPPLY CURRENT $I_{CC(ON)}$ (mA)
100
80
60
40
20
0
0
1
2
3
4
5
6
SUPPLY VOLTAGE V_{CC} (V)

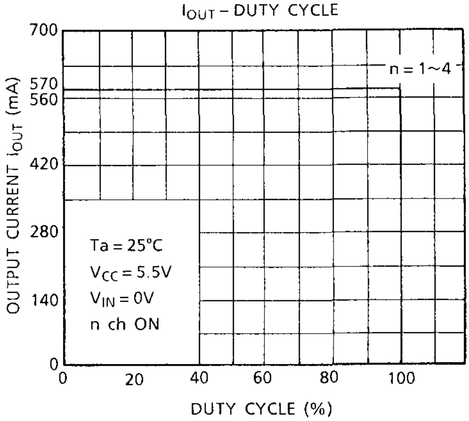


I_F – V_F
CLAMP DIODE FORWARD CURRENT I_F (mA)
Ta = 25°C TYP.
700
560
420
280
140
0
0
1
2
3
4
5
6
CLAMP DIODE FORWARD VOLTAGE V_F (V)



P_D – Ta
POWER DISSIPATION P_D (W)
① ON PCB
50 × 50 × 1.6mm Cu 50%
② FREE AIR
Ta = 85°C
3.0
2.4
1.8
1.2
0.6
0
0
40
80
120
160
200
240
AMBIENT TEMPERATURE Ta (°C)

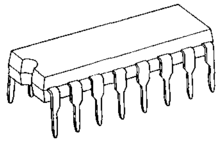

I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
570
560
420
280
140
0
n = 1~2
3
4
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 0V
n ch ON
0
20
40
60
80
100
DUTY CYCLE (%)


I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
570
560
420
280
140
0
n = 1~4
Ta = 25°C
V_{CC} = 5.5V
V_{IN} = 0V
n ch ON
0
20
40
60
80
100
DUTY CYCLE (%)

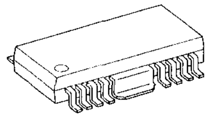
TD62308AP/F/AF

○ 4 LOW INPUT ACTIVE HIGE-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62308AP / F / AF are non-inverting transistor array which are comprised of four NPN darlington output stages and PNP input stages.
This device are low level input active driver and are suitable for operation with TTL, 5V C-MOS and 5V Microprocessor which have sink current output drivers.
Applications include relay, hammer, lamp and stepping moter drivers.



DIP16-P-300A



HSOP16-P-300

Weight DIP16-P-300A : 1.11g
SOP16-P-300 : 0.50g

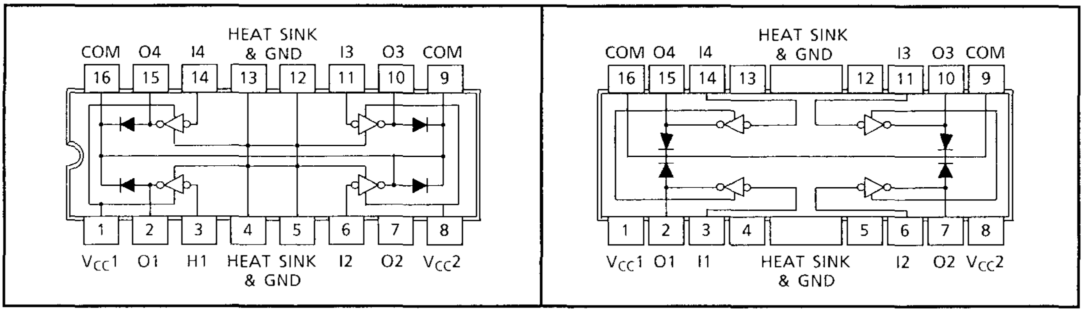
- Output Current (Single Output) 1.5A MAX.
- High Sustaining Voltage Output 35VMIN. (TD62308F)
  50V MIN. (TD62308AP / AF)
- Output Clamp Diodes
- Input Compatible with TTL and 5V C-MOS
- Low Level Active Inputs
- Standard Supply Voltage
- Two Vcc Terminals Vcc1, Vcc2 (Separeted)
- GND and SUB Terminal = Heat Sink
- Package Type-AP: DIP-16 pin
- Package Type-F, AF: PFP-16pin

MAXIMUM RATINGS (Ta = 25°C unless otherwise noted)

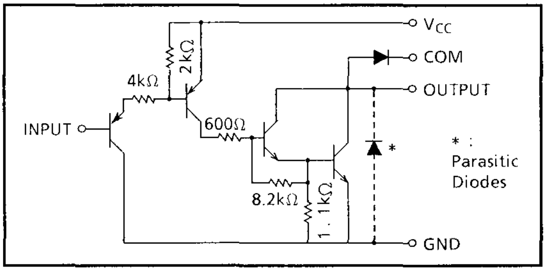
CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	−0.5~10	V
Output Sustaining Voltage	F	$V_{CE(SUS)}$	−0.5~35	V
	AP, AF		−0.5~50	
Output Current		I_{OUT}	1.5	A / ch
Input Current		I_{IN}	−10	mA
Input Voltage		V_{IN}	−0.5~30	V
Clamp Diode Reverse Voltage	F	V_R	35	V
	AP, AF		50	
Clamp Diode Forward Current		I_F	1.5	A
Common Terminal Current		I_{COM}	3.0	A
Power Dissipation	AP	P_D	1.47 / 2.7 (Note 1)	W
	F, AF		0.9 / 1.4 (Note 2)	
Operating Temperature		T_{opr}	−40~85	°C
Storage TemperatureTstg		T_{stg}	−55~150	°C

(Note 1) On Glass Epoxy (50×50×1.6mm Cu 50%)
(Note 2) On Glass Epoxy (60×30×1.6mm Cu 30%)

PIN CONNECTION (TOP VIEW)



SCHEMATICS (EACH DRIVER)



(NOTE) The input and output parasitic diodes cannot be used as clamp diodes.

RECOMMENDED OPERATING CONDITIONS (Ta = −40~85°C)

CHARACTERISTIC		SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Suuply Voltage		V_{CC}			4.5	—	5.0	V
Output Sustaining Voltage	F	$V_{CE(SUS)}$			0	—	35	V
	AP, AF				0	—	50	
Output Current		I_{OUT}	DC 1 Circuit, Ta = 25°C		0	—	1250	
	AP		Tpw = 25ms 4 Circuits Ta = 85°C	Duty = 10%	0	—	1250	A / ch
				Duty = 50%	0	—	700	
	F, AF			Duty = 10%	0	—	1250	
				Duty = 50%	0	—	390	V
Input Voltage		V_{IN}			0	—	25	
Input Voltage	Output On	$V_{IN(ON)}$			0	—	V_{CC}-3.6	V
	Output Off	$V_{IN(OFF)}$			V_{CC}-1.0	—	V_{CC}	
Clamp Diode Reverse Voltage	F	V_R			—	—	35	V
	AP, AF				—	—	50	
Clamp Diode Forward Current		I_F			—	—	1.25	A
Power Dissipation	AP	P_D	Ta = 85°C *1		—	—	1.4	W
	F, AF		Ta = 85°C *2		—	—	0.7	

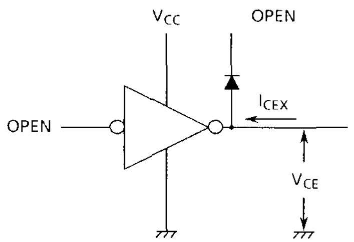
*1 On Glass Epoxy (50×50×1.6mm Cu 50%) *2 On Glass Epoxy (60×30×1.6mm Cu 30%)

ELECTRICAL CHARATERISTICS (Ta=25°C unless otherwise noted)

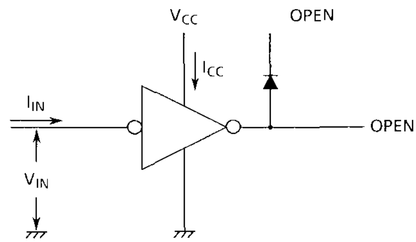
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN	TYP	MAX	UNIT
Output Leakage Current	AP, AF	I_{CEX}	1	V_{CE}=50V, Ta=25°C		—	—	50	μA
				V_{CE}=50V, Ta=85°C		—	—	100	
	F			V_{CE}=35V, Ta=25°C		—	—	50	
				V_{CE}=35V, Ta=85°C		—	—	100	
Output Voltage	"H" level	V_{OH}	3			V_{CC}-1.6	—	25	V
	"L" level	V_{OL}	3			—	—	V_{CC}-3.6	
Input Current	"H" level	I_{IH}	3			—	—	10	μA
	"L" level	I_{IL}				—	−0.05	−0.36	mA
Clamp Diode Reverse Current	AP, AF	I_R	4	V_R=50V, Ta=25°C		—	—	50	μA
	F			V_R=35V, Ta=25°C		—	—	50	
Clamp Diode Forward Voltage		V_F	5	I_F=1.25A		—	1.5	2.0	V
Supply Current	Output On	$I_{CC(ON)}$	2	V_{CC}=5.5V, V_{IN}=0V		—	8.5	12.5	mA/GATE
	Output Off	$I_{CC(OFF)}$		V_{CC}=5.5V, V_{IN}=V_{CC}		—	—	10	μA
Turn-On Delay	F	t_{ON}	6	C_L=15pF	V_{OUT}=35V R_L=28Ω	—	0.2	—	μs
	AP, AF				V_{OUT}=50V R_L=40Ω				
Turn-Off Delay	F	t_{OFF}			V_{OUT}=35V R_L=28Ω	—	5.0	—	
	AP, AF				V_{OUT}=35V R_L=40Ω				

TEST CIRCUIT

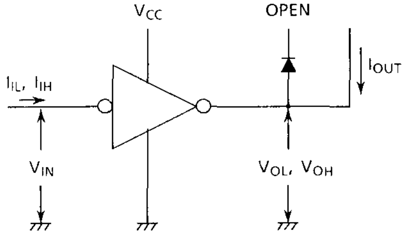
1. I_{CEX}



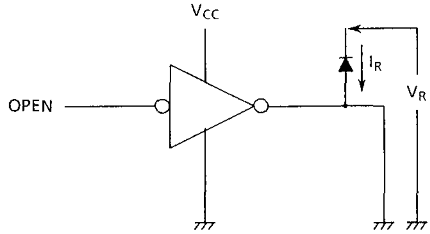
2. I_{CC}



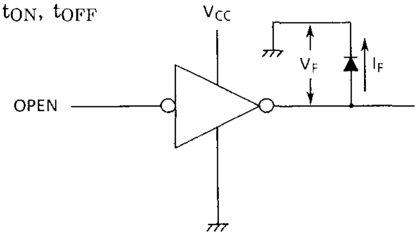
3. V_{OH}, V_{OL}, I_{IH}, I_{IL}



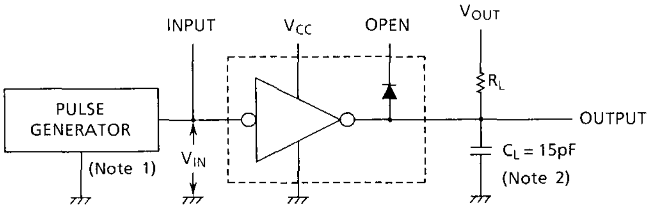
4. V_F

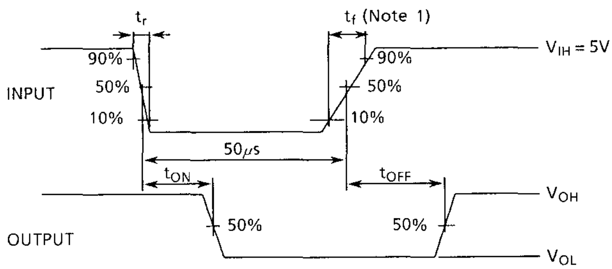


5. t_{ON}, t_{OFF}



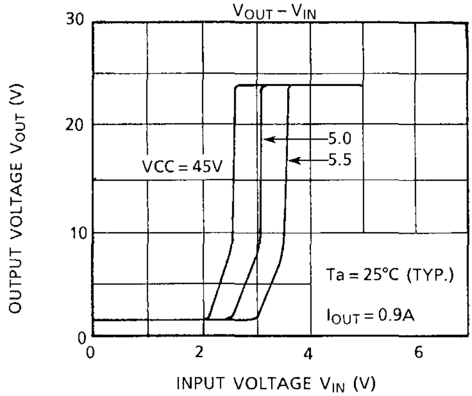
6. t_{ON}, t_{OFF}

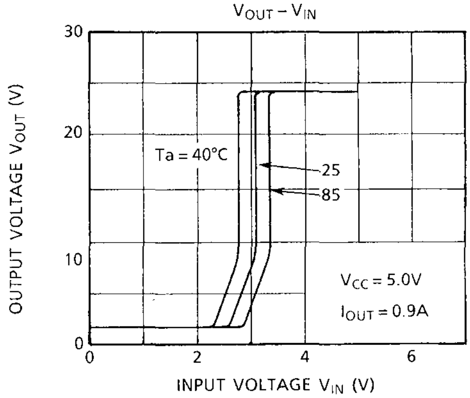


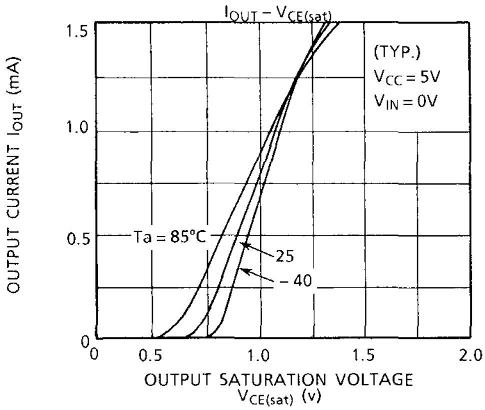


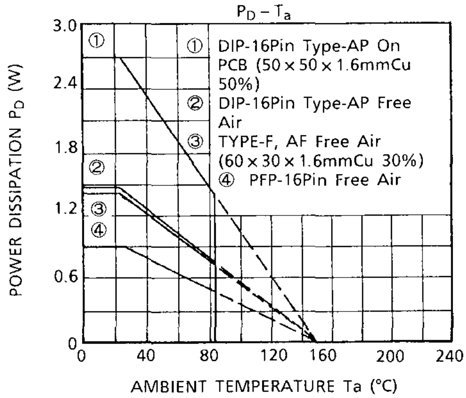
(Note 1): Pulse Width 50 μs, Duty Cycle 10%
Output Impedance 50Ω tr≦5ns, tf≦10ns

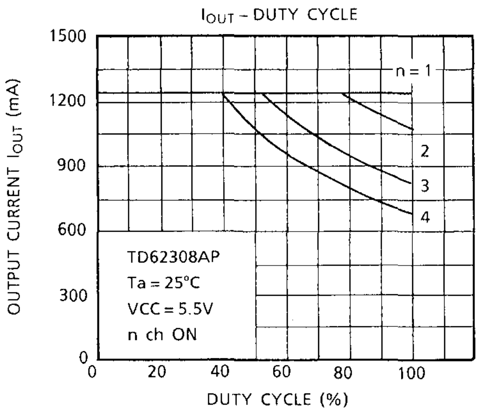
(Note 2): CL includes probe and jig capacitance

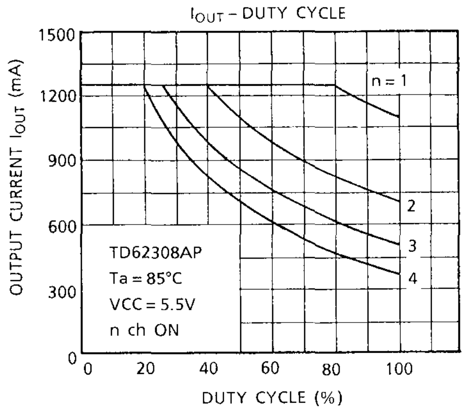

VOUT – VIN
OUTPUT VOLTAGE VOUT (V)
INPUT VOLTAGE VIN (V)
VCC = 45V
5.0
5.5
Ta = 25°C (TYP.)
IOUT = 0.9A
0
2
4
6
10
20
30

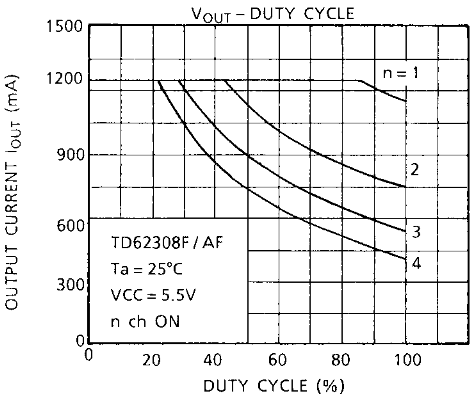

VOUT – VIN
OUTPUT VOLTAGE VOUT (V)
INPUT VOLTAGE VIN (V)
Ta = 40°C
25
85
VCC = 5.0V
IOUT = 0.9A
0
2
4
6
10
20
30

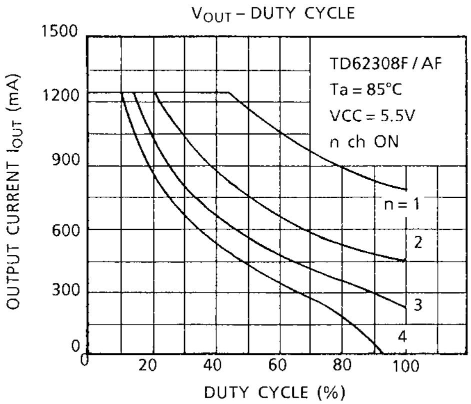

IOUT – VCE(sat)
OUTPUT CURRENT IOUT (mA)
OUTPUT SATURATION VOLTAGE VCE(sat) (v)
(TYP.)
VCC = 5V
VIN = 0V
Ta = 85°C
25
– 40
0
0.5
1.0
1.5
2.0


PD – Ta
POWER DISSIPATION PD (W)
AMBIENT TEMPERATURE Ta (°C)
① DIP-16Pin Type-AP On PCB (50 × 50 × 1.6mmCu 50%)
② DIP-16Pin Type-AP Free Air
③ TYPE-F, AF Free Air (60 × 30 × 1.6mmCu 30%)
④ PFP-16Pin Free Air
0
0.6
1.2
1.8
2.4
3.0
40
80
120
160
200
240


IOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
DUTY CYCLE (%)
n = 1
2
3
4
TD62308AP
Ta = 25°C
VCC = 5.5V
n ch ON
0
300
600
900
1200
1500
20
40
60
80
100


IOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
DUTY CYCLE (%)
n = 1
2
3
4
TD62308AP
Ta = 85°C
VCC = 5.5V
n ch ON
0
300
600
900
1200
1500
20
40
60
80
100


VOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
1500
1200
900
600
300
0
0
20
40
60
80
100
DUTY CYCLE (%)
n = 1
2
3
4
TD62308F / AF
Ta = 25°C
VCC = 5.5V
n ch ON

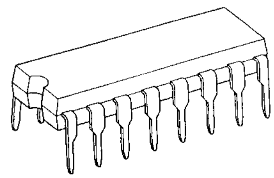

VOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
1500
1200
900
600
300
0
0
20
40
60
80
100
DUTY CYCLE (%)
TD62308F / AF
Ta = 85°C
VCC = 5.5V
n ch ON
n = 1
2
3
4

TD62308BP-1

○ 4 LOW INPUT ACTIVE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62308BP-1 is non-inverting transistor array which is comprised of four NPN darlington output stages and PNP input stages.
This device is low level input active driver and is suitable for operation with TTL, 5V C-MOS and5V Microprocessor which have sink current output drivers. Applications include relay, hammer, lamp and steppingmoter drivers.

- Output Current (Single Output) 1.5A MAX.
- High Sustaining Voltage Output 80V MIN.
- Output Clamp Diodes
- Input Compatible with TTL and 5V C-MOS
- Low Level Active Inputs
- Standard Supply Voltage
- Two Vcc Terminals Vcc1, Vcc2 (Separeted)
- GND and SUB Terminal=Heat Sink
- Package Type-BP-1: DIP-16 pin



DIP16-P-300A

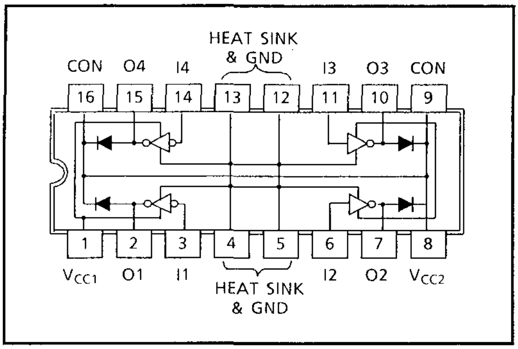
Weight : 1.11g

MAXIMUM RATING (Ta=25°C unless otherwise noted)

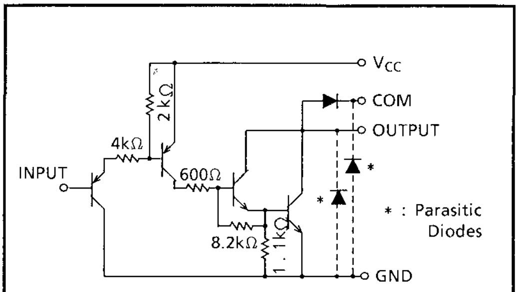
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	7	V
Output Sustaining Voltage	$V_{CE(SUS)}$	−0.5~80	V
Parasitic Transistor Output Voltage	V_{CEF}(*1)	80	V
Output Current	I_{OUT}	1.5	A / ch
Input Current	I_{IN}	−10	mA
Input Voltage	V_{IN}	7	V
Clamp Diode Reverse Voltage	V_R	80	V
Clmap Diode Forward Current	I_F	1.5	A
Common Terminal Current	I_{COM}	3.0	A
Power Dissipation	P_D	1.47 / 2.7 *2	W
Storage TemperatureTopr	T_{opr}	−40~85	°C
Storage TemperatureTstg	T_{stg}	−55~150	°C

*1 Parasitic Transistor
*2 On Glass Epoxy (50×50×1.6mm Cu 50%)

PIN CONNECTION (TOP VIEW)



SCHEMATICS (EACH DRIVER)



(Note) The input and output parasitic diodes cannot be used as clamp diodes.

RECOMMMENDED OPERATING CONDITIONS (Ta = −40~85°C)

CHARACTERISTIC		SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Supply Voltage		V_{CC}			4.5	—	5.5	V
Ourput Sustaining Votage		$V_{CE(SUS)}$			0	—	50	V
Output Current		I_{OUT}	DC 1 Circuit Ta = 25°C		0	—	1.25	A / ch
			T_{PW} = 25ms, 4 Circuits Ta = 85°C	Duty = 10%	0	—	1.25	
				Duty = 50%	0	—	0.69	
Input Voltage		V_{IN}			0	—	5.5	V
	Output On	$V_{IN(ON)}$			0	—	V_{CC}-3.6	
	Output Off	$V_{IN(OFF)}$			V_{CC}-1.0	—	V_{CC}	
Clamp Diode Reverse Voltage		V_R			—	—	80	V
Clamp Diode Forward Current		I_F			—	—	1.25	A
Power Dissipation		P_D	Ta = 85°C (*1)		—	—	1.4	W

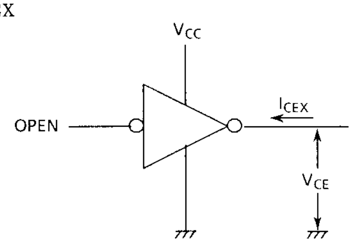
(*1) On Glass Epoxy (50×50×1.6mm Cu 50%)

ELECTRICAL CHARACTERISTICS (Ta = 25°C unless otherwise noted)

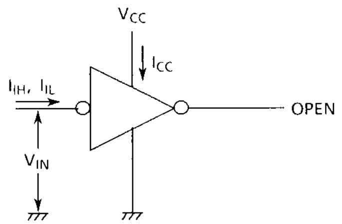
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP	MAX	UNIT
Input Voltage	"H" level	V_{IH}	3		V_{CC}-1.6	—	V_{CC}	V
	"L" level	V_{IL}	3		—	—	V_{CC}-3.6	
Input Current	"H" level	I_{IH}	2		—	—	10	μA
	"L" level	I_{IL}	2	$V_{CC}=5.5V$, $V_{IN}=0.4V$	—	−0.05	−0.36	mA
Output Leakage Current		I_{CEX}	1	$V_{OUT}=80V$, $Ta=85°C$	—	—	100	μA
Output Saturation Voltage		$V_{CE(sat)}$	3	$V_{CC}=4.5V$, $I_{OUT}=1.25A$	—	1.3	1.8	V
Clamp Diode Reverse Current		I_R	4	$V_R=80V$	—	—	50	μA
Clamp Diode Forward Voltage		V_F	5	$I_F=1.25A$	—	1.5	2.0	V
Supply Current	Output On	$I_{CC(ON)}$	2	$V_{CC}=5.5V$, $V_{IN}=0V$	—	8.5	12.5	mA/ch
	Output Off	$I_{CC(OFF)}$	2	$V_{CC}=5.5V$, $V_{IN}=V_{CC}$	—	—	10	μA
Turn-On Delay		t_{ON}	6	$V_{OUT}=80V$, $R_L=68\Omega$	—	0.2	—	μs
Turn-Off Delay		t_{OFF}			—	5.0	—	
Parasitic Transistor Output Voltage		V_{CEF}	7	$I_{CEF}=150mA$	80	—	—	V

TEST CIRCUIT

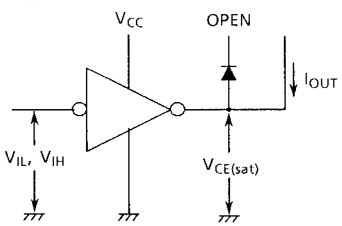
1. I_{CEX}



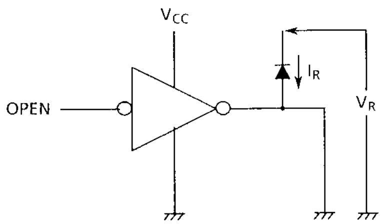
2. I_{CC}, I_{IH}, I_{IL}



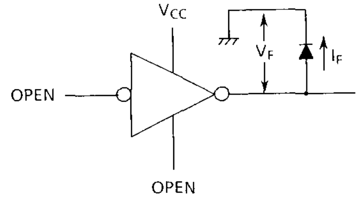
3. $V_{CE(sat)}$, V_{IL}, V_{IH}



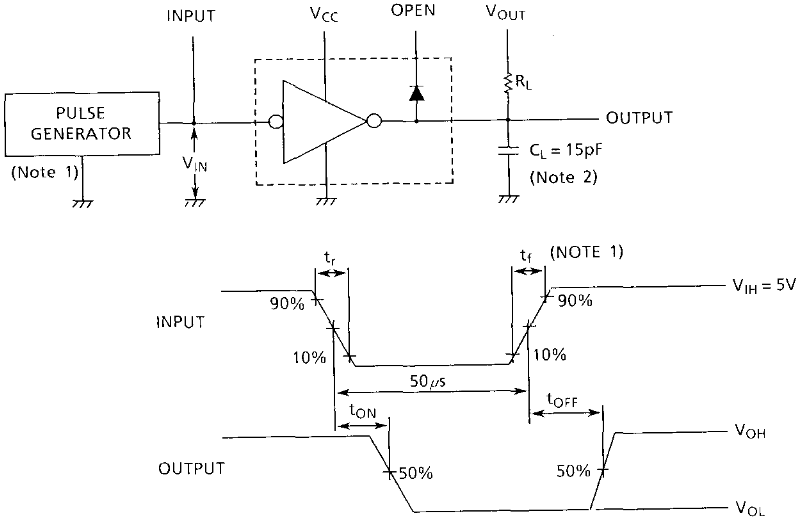
4. I_R



5. V_F



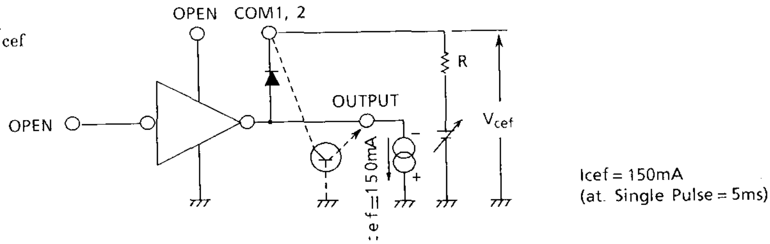
6. t_{ON}, t_{OFF}

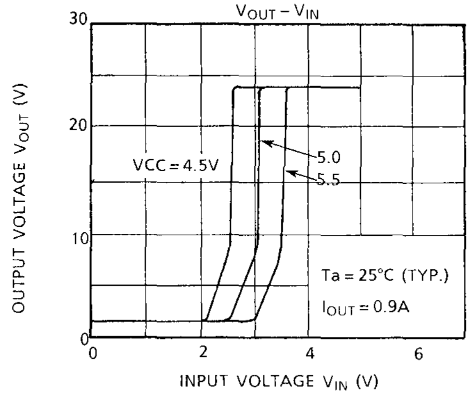


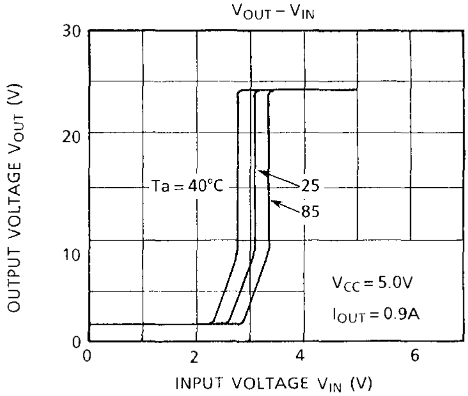
(Note 1) : Pulse Width 50μs, Duty Cycle 10%
Output Impedance 50Ω, $t_r \leqq 5ns$, $t_f \leqq 10ns$

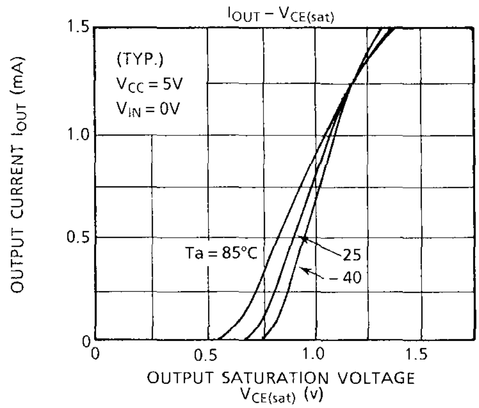
(Note 2) : CL includes probe and jig capacitance

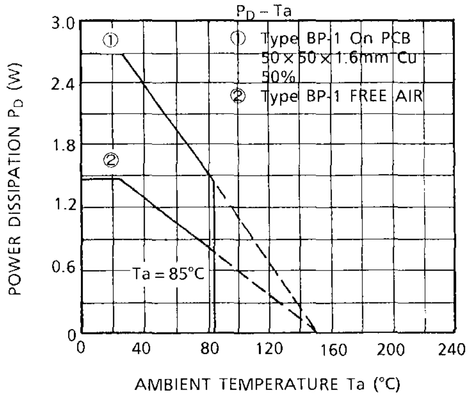
7. V_{cef}

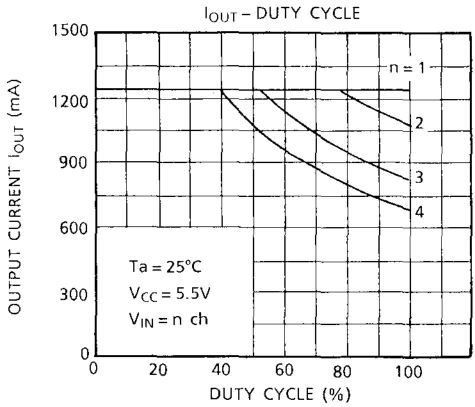


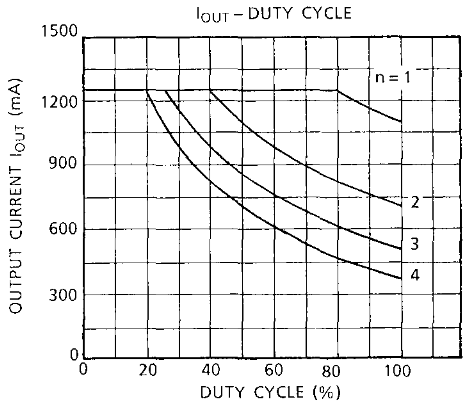

VOUT – VIN
OUTPUT VOLTAGE VOUT (V)
30
20
10
0
VCC = 4.5V
5.0
5.5
Ta = 25°C (TYP.)
IOUT = 0.9A
0
2
4
6
INPUT VOLTAGE VIN (V)


VOUT – VIN
OUTPUT VOLTAGE VOUT (V)
30
20
10
0
Ta = 40°C
25
85
VCC = 5.0V
IOUT = 0.9A
0
2
4
6
INPUT VOLTAGE VIN (V)


IOUT – VCE(sat)
OUTPUT CURRENT IOUT (mA)
1.5
1.0
0.5
0
(TYP.)
VCC = 5V
VIN = 0V
Ta = 85°C
25
– 40
0
0.5
1.0
1.5
OUTPUT SATURATION VOLTAGE
VCE(sat) (v)


PD – Ta
POWER DISSIPATION PD (W)
3.0
2.4
1.8
1.2
0.6
0
①
① Type BP-1 On PCB
50 × 50 × 1.6mm Cu
50%
② Type BP-1 FREE AIR
②
Ta = 85°C
0
40
80
120
160
200
240
AMBIENT TEMPERATURE Ta (°C)

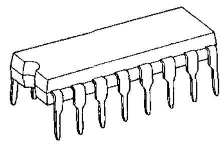

IOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
1500
1200
900
600
300
0
n = 1
2
3
4
Ta = 25°C
VCC = 5.5V
VIN = n ch
0
20
40
60
80
100
DUTY CYCLE (%)


IOUT – DUTY CYCLE
OUTPUT CURRENT IOUT (mA)
1500
1200
900
600
300
0
n = 1
2
3
4
0
20
40
60
80
100
DUTY CYCLE (%)

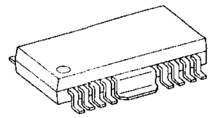
TD62318AP/AF

○ 4 LOW INPUT ACTIVE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62318AP/AF are non-inverting transistor array which are comprised of four NPN darlington output stages and PNP input stages.
This device are low level input active driver and are suitable for operation with TTL, 5V C-MOS and 5V Microprocessor which have sink current output drivers.
Applications include relay, hammer, lamp and stepping moter drivers.



DIP16-P-300A



HSOP16-P-300

Weight DIP16-P-300A : 1.11g
HSOP16-P-300: 0.50g

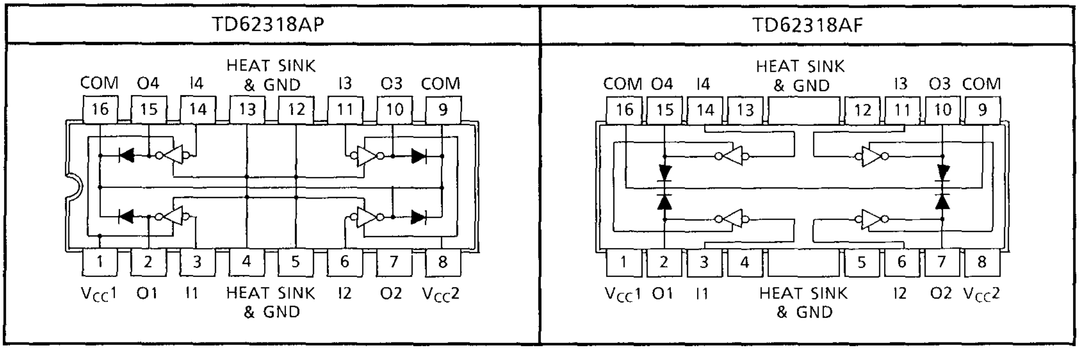
- Output Current (Single Output) 700mA MAX.
- High Sustaining Voltage Output 50VMIN.
- Output Clamp Diodes
- Input Compatible with TTL and 5V C-MOS
- Low Level Active Inputs
- Standard Supply Voltage
- Two Vcc Terminals Vcc1, Vcc2 (Separeted)
- GND and SUB Terminal=Heat Sink
- Packaga Type-AP: DIP-16 pin
- Packaga Type-AF: PFP-16 pin

MAXIMUM RATINGS (Ta=25°C unless otherwise noted)

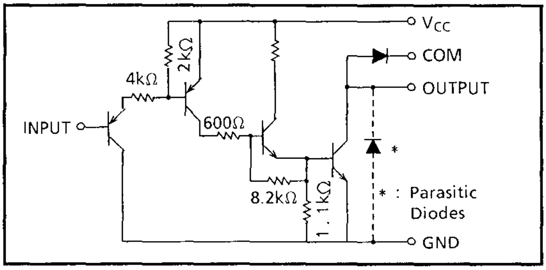
CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	−0.5~17	V
Output Sustaining Voltage		$V_{CE(SUS)}$	−0.5~50	V
Output Current		I_{OUT}	700	mA/ch
Input Current		I_{IN}	−10	mA
Input Voltage		V_{IN}	−0.5~17	V
Clamp Diode Reverse Voltage		V_R	50	V
Clamp Diode Forward Current		I_F	700	mA
	AP		1.47/2.7 *1	
Power Dissipation	AF	P_D	0.9/1.4 *2	W
	ture		−40~85	
Storage Temperature		T_{stg}	−55~150	°C

*1 On Glass Epoxy (50×50×1.6mm Cu 50%)
*2 On Glass Epoxy (60×30×1.6mm Cu 30%)

PIN CONNECTION (TOP VIEW)



SCHEMATICS (EACH DRIVER)



NOTE. The input and output parasitic diodes cannot be used as clamp diodes.

RECOMMENDED OPERATING CONDITIONS (Ta = −40~85°C)

CHARACTERISTIC		SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Supply Voltage		V_{CC}			4.5	—	5.5	V
Output Sustaining Voltage		$V_{CE(SUS)}$			0	—	50	V
Output Current		I_{OUT}	DC 1 Circuit, Ta = 25°C		0	—	570	mA / ch
	AP		Tpw = 25ms 4 Circuits Ta = 85°C	Duty = 10%	0	—	570	
				Duty = 50%	0	—	570	
	AF			Duty = 10%	0	—	570	
				Duyt = 50%	0	—	480	
Input Voltage		V_{IN}			0	—	15	V
Input Voltage	Output On	$V_{IN(ON)}$			0	—	$V_{CC}-3.6$	V
	Output off	$V_{IN(OFF)}$			$V_{CC}-1.6$	—	5.5	
Clamp Diode Reverse Voltage		V_R			—	—	50	V
Clamp Diode Forward Current		I_F			—	—	500	mA
Power Dissipation	AP	P_D	Ta = 85°C *1		—	—	1.4	W
	AF		Ta = 85°C *2		—	—	0.7	

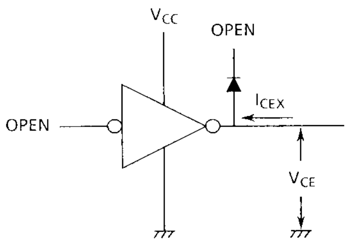
*1. On Glass Epoxy (50×50×1.6mm Cu 50%) *2. On Glass Epoxy (60×30×1.6mm Cu 30%)

ELECTRICAL CHARATERISTICS (Ta = 25°C unless otherwise noted)

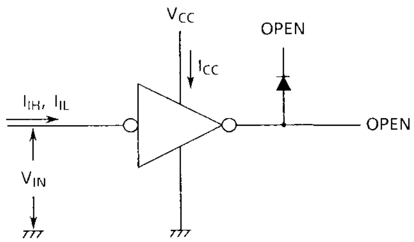
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP	MAX	UNIT
Input Voltage	"H" level	V_{IH}	3		V_{CC}-1.6	—	15	μA
	"L" level	V_{IL}			—	—	V_{CC}-3.6	
Input Current	"H" level	I_{IH}	2		—	—	10	μA
	"L" level	I_{IL}			—	−0.05	−0.36	mA
Output Leakage Current		I_{CEX}	1	V_{CE} = 50V, Ta = 25°C	—	—	50	μA
				V_{CE} = 50V, Ta = 85°C	—	—	100	
Output Saturation Voltage		$V_{CE(sat)}$	3	I_{OUT} = 0.5A, V_{CC} = 4.5V	—	—	0.8	V
				I_{OUT} = 0.2A, V_{CC} = 4.5V	—	—	0.45	
Clamp Diode Reverse Current		I_R	4	V_R = 50V, Ta = 25°C	—	—	50	μA
				V_R = 50V, Ta = 85°C	—	—	100	
Clamp Diode Forward Voltage		V_F	5	I_F = 500mA	—	—	2.0	V
Supply Current	Output On	$I_{CC(ON)}$	2	V_{CC} = 5.5V, V_{IN} = 0.0V	—	35	40	mA/ch
	Output Off	$I_{CC(OFF)}$	2	V_{CC} = 5.5V, V_{IN} = V_{CC}	—	—	10	μA
Turn-On Delay		t_{ON}	6	V_{OUT} = 50V, R_L = 72Ω V_{CC} = 5.0V, C_L = 15pF	—	0.4	0.8	μs
Turn-Off Delay		t_{OFF}			—	8.0	16.0	

TEST CIRCUIT

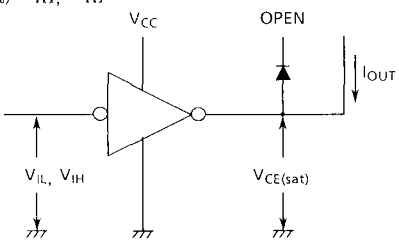
1. I_{CEX}



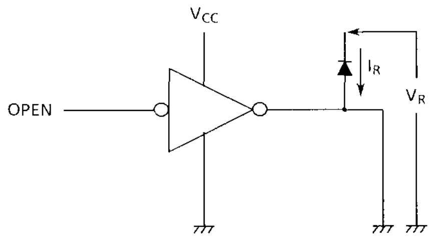
2. I_{CC}, I_{IH}, I_{IL}



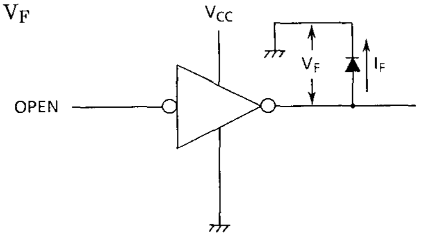
3. $V_{CE(sat)}$ V_{IH}, V_{IL}



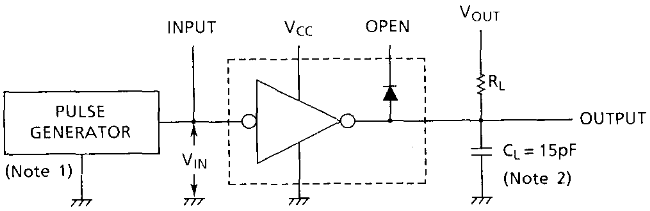
4. I_R

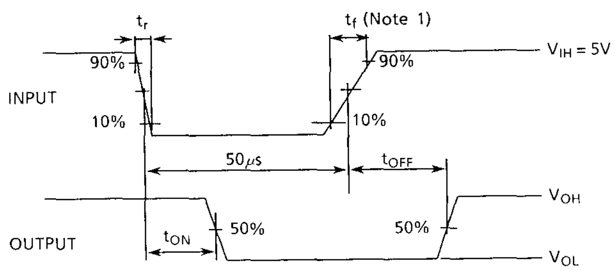


5. V_F



6. t_{ON}, t_{OFF}

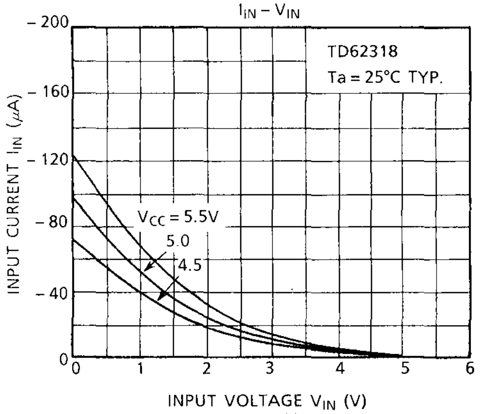




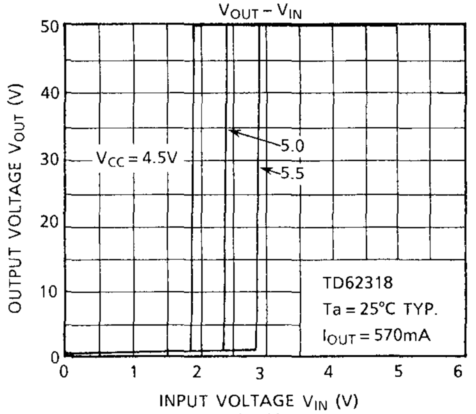
(Note 1): Pulse Width 50μs, Duty Cycle 10%
Output Impedance 50Ω tr≦5ns, tf≦10ns

(Noto 2): CL includes probe and jig capacitance.

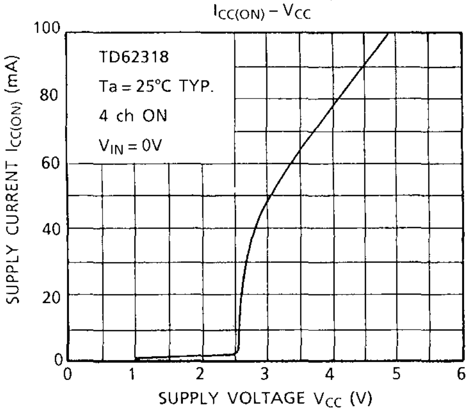
$I_{IN} - V_{IN}$



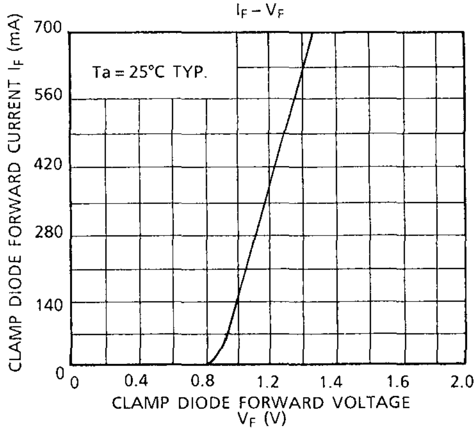
$V_{OUT} - V_{IN}$



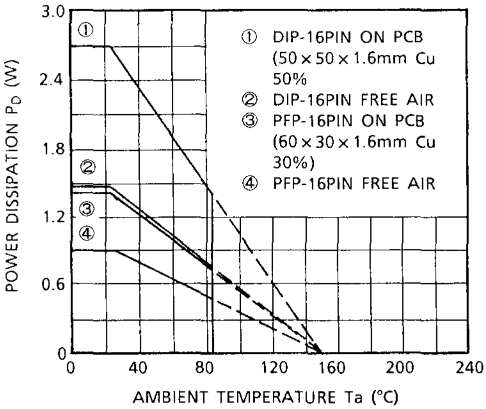
$I_{CC(ON)} - V_{CC}$

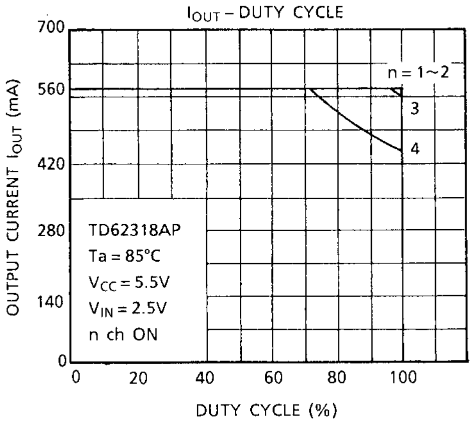


$I_F - V_F$

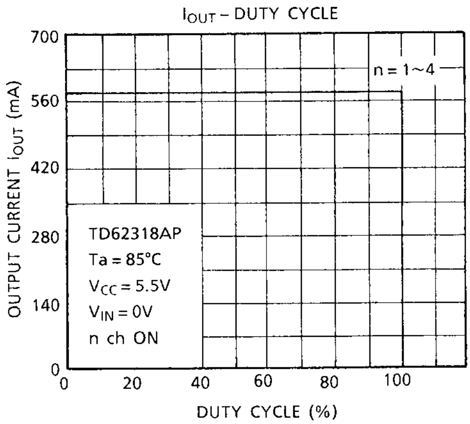


$P_D - Ta$

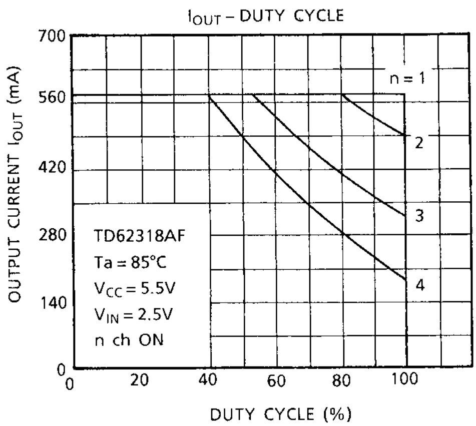




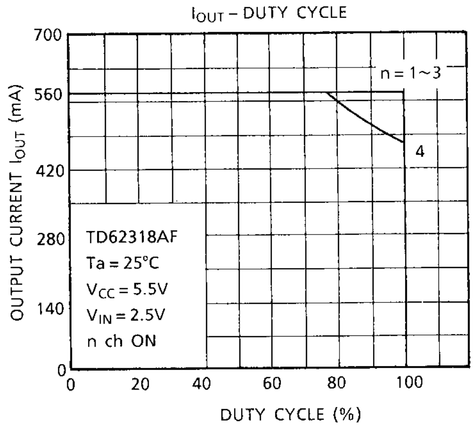
I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0
20
40
60
80
100
DUTY CYCLE (%)
n = 1~2
3
4
TD62318AP
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 2.5V
n ch ON



I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0
20
40
60
80
100
DUTY CYCLE (%)
n = 1~4
TD62318AP
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 0V
n ch ON



I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0
20
40
60
80
100
DUTY CYCLE (%)
n = 1
2
3
4
TD62318AF
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 2.5V
n ch ON

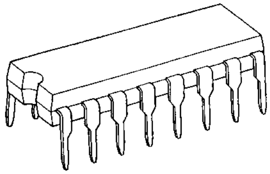


I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0
20
40
60
80
100
DUTY CYCLE (%)
n = 1~3
4
TD62318AF
Ta = 25°C
V_{CC} = 5.5V
V_{IN} = 2.5V
n ch ON

TD62318BP

○ 4 LOW INPUT ACTIVE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

The TD62318BP is non-inverting transistor array which is comprised of four NPN darlington output stages and PNP input stages.
This device is low level input active driver and is suitable for operation with TTL, 5V C-MOS and 5V Microprocessor which have sink current output drivers.
Applications include relay, hammer, lamp and stepping moter drivers.



DIP16-P-300A

Weight : 1.11g

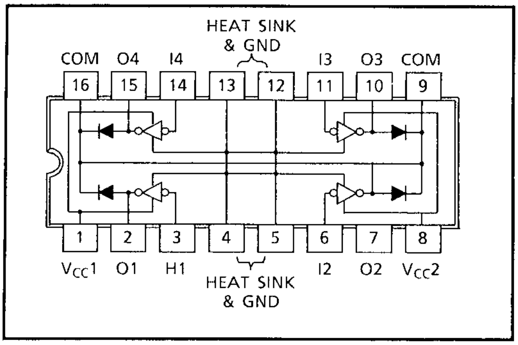
- Output Current (Single Output) 700mA MAX.
- High Sustaining Voltage Output 80V MIN.
- Output Clamp Diodes
- Input Compatible with TTL and 5V C-MOS
- Low Level Active Inputs
- Standard Supply Voltage
- Two Vcc Terminals Vcc1, Vcc2 (Separeted)
- GND and SUB Terminal=Heat Sink
- Package Type-BP: DIP-16 pin

MAXIMUM RATINGS (Ta=25°C unless otherwise noted)

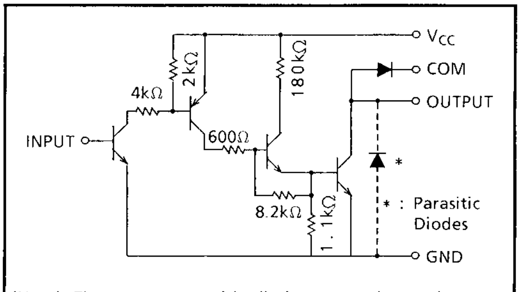
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	−0.5~17	V
Output Sustaining Voltage	$V_{CE(SUS)}$	−0.5~80	V
Output Current	I_{OUT}	700	A / ch
Input Current	I_{IN}	−10	mA
Input Voltage	V_{IN}	−0.5~17	V
Clamp Diode Reverse Voltage	V_R	80	V
Clamp Diode Forward Current	I_F	700	A
Power Dissipation	P_D	1.47 / 2.7 *1	W
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

*1 On Glass Epoxy (50×50×1.6mm Cu 50%)

PIN CONNECTION (TOP VIEW)



SCHEMATICS (EACH DRIVER)



(Note) The output parasitic diodes cannot be used.

RECOMMENDED OPERATING CONDITIONS (Ta = −40~85°C)

CHARACTERISTIC		SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Supply Voltage		V_{CC}			4.5	—	5.5	V
Output Sustaining Voltage		$V_{CE(SUS)}$			0	—	80	V
Output Current		I_{OUT}	DC 1 Circuit, Ta = 25°C		0	—	570	mA / ch
			Tpw = 25ms, 4 Circuits Ta = 85°C	Duty = 10%	0	—	570	
				Duty = 50%	0	—	570	
Input Voltage		V_{IN}			0	—	15.0	V
	Output On	$V_{IN(ON)}$			0	—	V_{CC}-3.6	
	Output Off	$V_{IN(OFF)}$			V_{CC}-1.6	—	15.0	
Clamp Diode Reverse Voltage		V_R			—	—	80	V
Clamp Diode Forward Current		I_F			—	—	700	mA
Power Dissipation		P_D	Ta = 85℃ (*1)		—	—	1.4	W

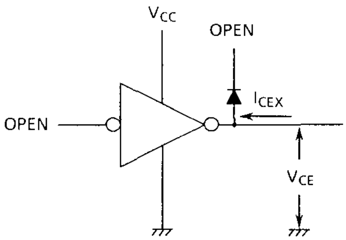
*1 On Glass Epoxy (50×50×1.6mm Cu 50%)

ELECTRICAL CHARATERISTICS (Ta = 25°C unless otherwise noted)

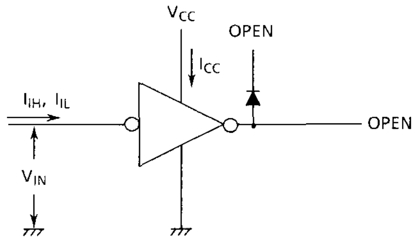
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP	MAX	UNIT
Input Voltage	"H" level	V_{IH}	—		V_{CC}-1.6	—	15.0	V
	"L" level	V_{IL}			0	—	V_{CC}-3.6	
Input Current	"H" level	I_{IH}	2		—	—	10	μA
	"L" level	I_{IL}		V_{CC} = 5.5V, V_{IN} = 0.4V	—	−0.05	−0.36	mA
Output Leakage Current		I_{CEX}	1	V_{CE} = 80V, Ta = 25°C	—	—	50	μA
				V_{CE} = 80V, Ta = 85°C	—	—	100	
Output Saturation Voltage		$V_{CE(sat)}$	3	I_{OUT} = 500mA, V_{CC} = 4.5V	—	—	0.8	V
				I_{OUT} = 200mA, V_{CC} = 4.5V	—	—	0.45	
Clamp Diode Reverse Current		I_R	4	V_R = 80V, Ta = 25°C	—	—	50	μA
				V_R = 80V, Ta = 80°C	—	—	100	
Clamp Diode Forward Voltage		V_F	5	I_F = 500mA	—	—	2.0	V
Supply Current	Output On	$I_{CC(ON)}$	2	V_{CC} = 5.5V, V_{IN} = 0.0V	—	40	45	mA/ch
	Output Off	$I_{CC(OFF)}$	2	V_{CC} = 5.5V, V_{IN} = V_{CC}	—	—	10	μA
Turn-On Delay		t_{ON}	6	V_{OUT} = 80V, R_L = 120Ω	—	0.4	0.8	μs
Turn-Off Delay		t_{OFF}		V_{CC} = 5.0V, C_L = 15pF	—	8.0	16.0	

TEST CIRCUIT

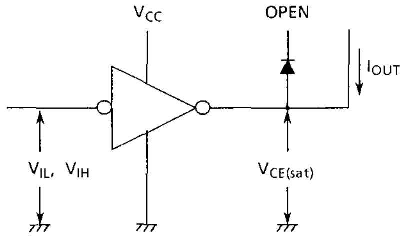
1. I_{CEX}



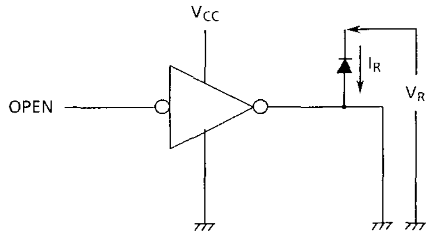
2. I_{CC}, I_{IH}, I_{IL}



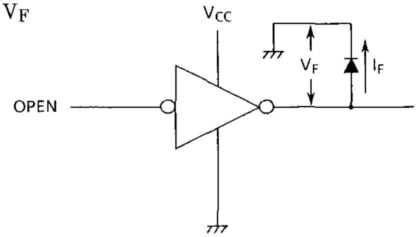
3. $V_{CE(sat)}$, V_{IL}, V_{IH}



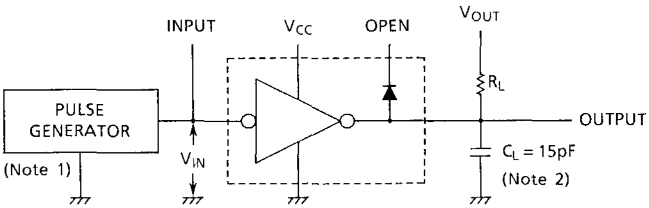
4. I_R

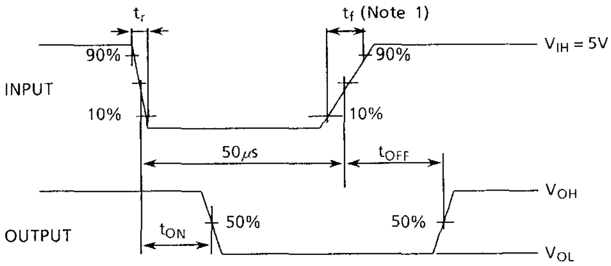


5. V_F



6. t_{ON}, t_{OFF}

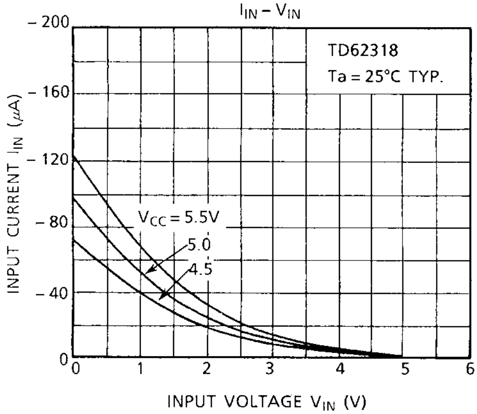




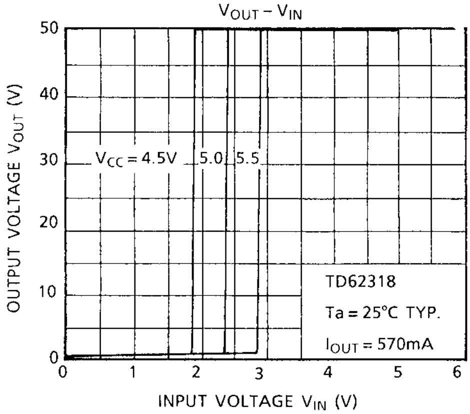
(Note 1): Pulse Width 50μs, Duty Cycle 10%
Output Impedance 50Ω tr$\leqq$5ns, tf$\leqq$10ns

(Note 2): CL includes probe and jig capacitance

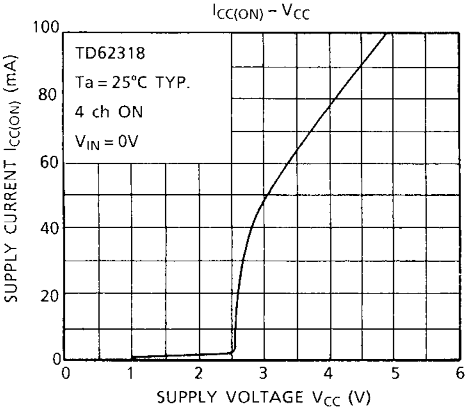
$I_{IN} - V_{IN}$



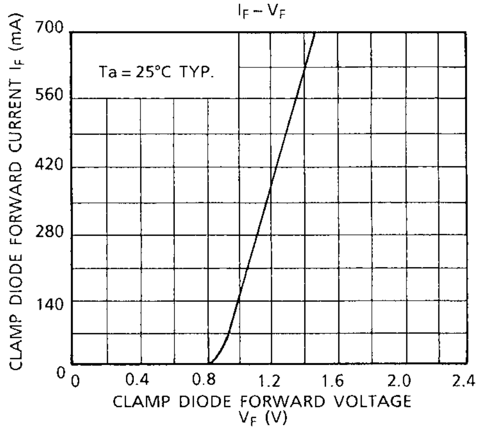
$V_{OUT} - V_{IN}$



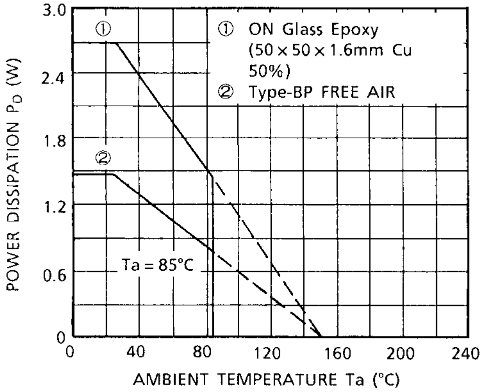
$I_{CC(ON)} - V_{CC}$

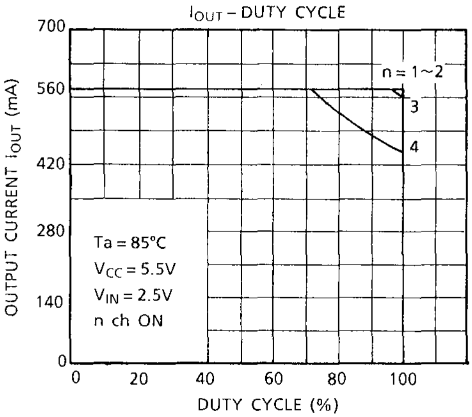


$I_F - V_F$

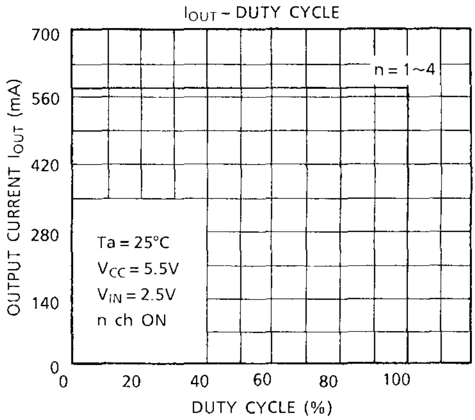


$P_D - Ta$





I_{OUT} – DUTY CYCLE
OUTPUT CURRENT i_{OUT} (mA)
700
560
420
280
140
0
0
20
40
60
80
100
DUTY CYCLE (%)
n = 1~2
3
4
Ta = 85°C
V_{CC} = 5.5V
V_{IN} = 2.5V
n ch ON



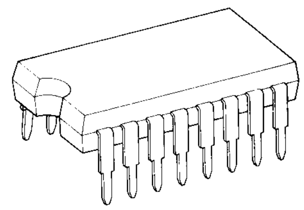
I_{OUT} – DUTY CYCLE
OUTPUT CURRENT I_{OUT} (mA)
700
560
420
280
140
0
0
20
40
60
80
100
DUTY CYCLE (%)
n = 1~4
Ta = 25°C
V_{CC} = 5.5V
V_{IN} = 2.5V
n ch ON

TD62803P

TD62803P STEPPING MOTOR CONTROLLER/DRIVER

Features

- High-Voltage, High-Current Outputs
  $V_{CE}(SUS)\phi$=28V(MIN), $I_{OUT}\phi$=400mA (MAX)
- 1,2, 1-2 Phase Excitation Mode Capable
- 3 Inputs Direction Control .. CK-1, CK-2 CW/CCW
- Output Enable Function ... E
- Initialized Status ..... $\overline{Mo}$ (Monitor out)
- Schmitt Trigger Inputs .... CK-1, CK-2, CW/CCW, $\overline{R}$
- Standard Supply Voltage



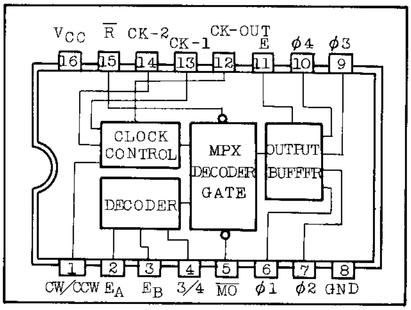
DIP16-P-600

Weight: 3.19g (Typ.)

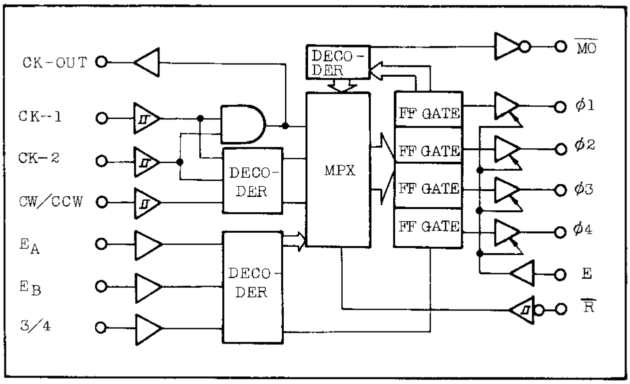
MAXIMUM RATINGS (Ta=25°C unless otherwise noted)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	-0.3 ∿ +7.0	V
Output Sustaining Voltage		$V_{CE}(SUS)\phi$	-0.3 ∿ +28	V
Output Current	ϕ_n	$I_{OUT}\phi$	400	mA
	$\overline{Mo}$, CK-OUT	I_{OUT} $\overline{Mo}$ CK-OUT	10	mA
Input Voltage		V_{IN}	-0.3 ∿ V_{CC}+0.3	V
Input Current		I_{IN}	±1	mA
Power Dissipation		P_D	2.7	W
Operating Temperature		T_{opr}	-30 ∿ +85	°C
Storage Temperature		T_{stg}	-55 ∿ +150	°C

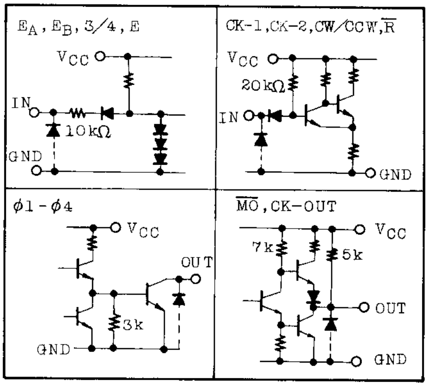
PIN CONNECTION (TOP VIEW)



BLOCK DIAGRAM



SCHEMATICS OF INPUTS AND OUTPUTS



RECOMMENDED OPERATING CONDITIONS (Ta=−30 ∿ +85°C)

CHARACTERISTIC		SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage		V_{CC}		4.5	5.0	5.5	V
Output Sustaining Voltage		$V_{CE(SUS)}$		0	–	26	V
"L" Level Output Current ϕn		$I_{OUT}ϕ$		–	–	400	mA
			Test Mode	–	–	250	mA
Output Current Mo, CK-OUT	"H" Level	I_{OH}		–	–	−0.4	mA
	"L" Level	I_{OL}		–	–	8	mA
Input Voltage		V_{IN}		0	–	V_{CC}	V
Clock Frequency		f_{CK}		0	–	100	kHz
Power Dissipation		P_D		–	–	1.0	W

ELECTRICAL CHARACTERISTICS (Ta=25°C)

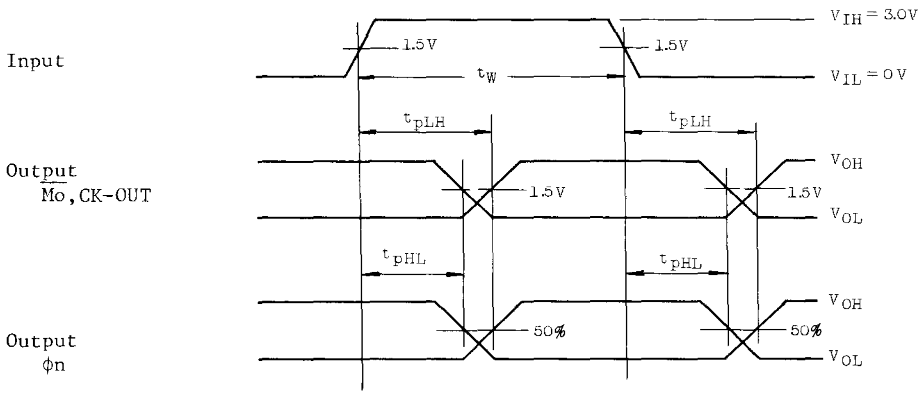
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
"H" Level Input Voltage		V_{IH}		2.0	–	–	V
"L" Level Input Voltage		V_{IL}		–	–	0.8	V
"H" Level Output Current ϕn		$I_{OH\phi}$	V_{CC}=5.5V, V_{OUT}=26V	–	–	100	μA
"H" Level Output Voltage $\overline{Mo}$, CK-OUT		V_{OH}	V_{CC}=4.5V, I_{OH}=−0.4mA	2.4	–	–	V
			V_{CC}=5.0V I_{OH}=−10μA	4.0	–	–	V
"L" Level Output Voltage	$\overline{Mo}$, CK-OUT	V_{OL}	V_{CC}=4.5V, I_{OL}=8mA	–	–	0.4	V
	ϕn	$V_{OUT\phi}$	V_{CC}=4.5V, I_{OUT}=400mA	–	–	1.1	V
			V_{CC}=4.5V, I_{OUT}=200mA	–	–	0.6	V
"H" Level Input Current		I_{IH}	V_{CC}=5.5V, V_{IH}=5.5V	–	–	10	μA
"L" Level Input Current		I_{IL}	V_{CC}=5.5V, V_{IL}=0.4V	–	–	−0.4	mA
Hysteresis		ΔV_T		–	150	–	mV
Supply Current		I_{CC}		–	–	100	mA

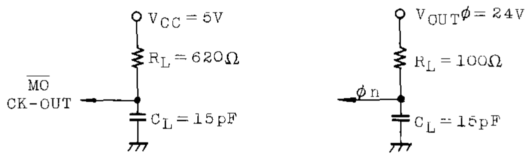
SWITCHING CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Propagation Delay Time, Low-to-High Level	CK-ϕn	t_{pLH}	V_{CC}=5.0V	–	2.0	–	μs
	CK–CK-OUT		R_L–CK-OUT, $\overline{Mo}$=620Ω	–	1.0	–	
	CK-$\overline{Mo}$		R_L–ϕ1∿ϕ4=100Ω	–	2.8	–	
	E-ϕn		C_L-All Outputs=15pF	–	1.0	–	
	$\overline{R}$-ϕn		$V_{OUT\phi}$=24V	–	2.0	–	

SWITCHING CHARACTERISTICS (Ta=25°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Propagation Delay Time High-to-Low Level	CK-ϕn	t_{pHL}	V_{CC}=5.0V	–	1.4	–	μS
	CK-CK-OUT		R_L-CK-OUT, $\overline{Mo}$=620Ω	–	0.7	–	
	CK-$\overline{Mo}$		R_L-ϕ_1∿ϕ_4=100Ω	–	2.1	–	
	E-ϕn		C_L-All Outputs = 15pF	–	1.2	–	
	$\overline{R}$-ϕn		$V_{OUT}\phi$=24V	–	1.0	–	
	$\overline{R}$-$\overline{Mo}$			–	2.0	–	
Maximum Clock Frequency		f_{max}		–	250	–	kHz
Set Up Time CK, CW/CCW		t_{set-up}		–	0.1	–	μS
Hold Time CK, CW/CCW		t_{hold}		–	0.1	–	
Minimum Clock Pulse Width		$t_{w(CK)}$		–	1.0	–	
Minimum Reset Pulse Width		$t_{w(\overline{R})}$		–	1.0	–	





LOAD CIRCUIT

PIN NAMES AND FUNCTIONS

PIN NO.	SYMBOL	NAME	FUNCTION	
1	CW/CCW	Clock Wise/Counter Clock Wise	Direction Control Input	Function Table A
2	EA	Excitation A	Phase Excitation Mode Input	Function Table B
3	EB	Excitation B		
4	3/4	3 Phases/4 Phases	Phase Control Input	
5	$\overline{Mo}$	Monitor Out	Initial Status Output $\overline{Mo}$="L" at Initial State	
6	ϕ_1	ϕ_1 Out	ϕ_1 Output	
7	ϕ_2	ϕ_2 Out	ϕ_2 Output	
8	GND	GND	GND	
9	ϕ_3	ϕ_3 Out	ϕ_3 Output	
10	ϕ_4	ϕ_4 Out	ϕ_4 Output	
11	E	Output Enable	Outputs are Enable at E="H"	
12	CK-OUT	Clock-Out	Clock Output	
13	CK1	Clock In-1	Clock Input 1	Function Table A
14	CK2	Clock In-2	Clock Input 2	
15	$\overline{R}$	Reset	Reset Input	
16	V_{CC}	V_{CC}	V_{CC}	

FUNCTION TABLE A

CK1	CK2	CW/CCW	FUNCTION
↑	H	L	CW
⎍	L	L	Inhibit
H	↑	L	CCW
L	⎍	L	Inhibit
↑	H	H	CCW
⎍	L	H	Inhibit
H	↑	H	CW
L	⎍	H	Inhibit

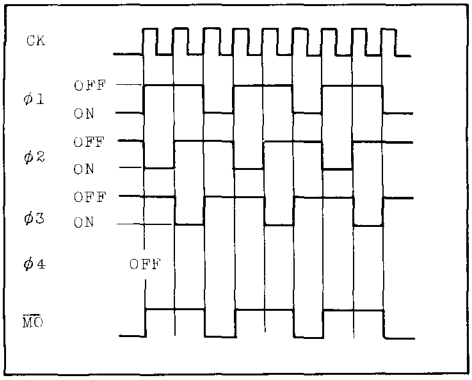
FUNCTION TABLE B

EA	EB	3/4	FUNCTION	
L	L	L	4 Phases	1 Phase Excitation
H	L	L		2 Phase Excitation
L	H	L		1-2 Phase Excitation
H	H	L	Test Mode	$\phi_1 \sim \phi_4$ ON
L	L	H	3 Phases	1 Phase Excitation
H	L	H		2 Phase Excitation
L	H	H		1-2 Phase Excitation
H	H	H	Test Mode	$\phi_1 \sim \phi_4$ ON

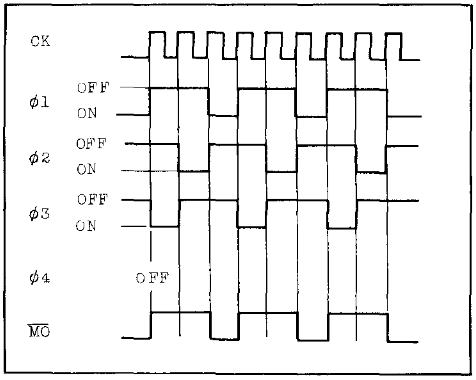
NOTE) Conversion of Phase Excitation Mode must be made after the Reset Mode is established.

3 PHASES METHOD

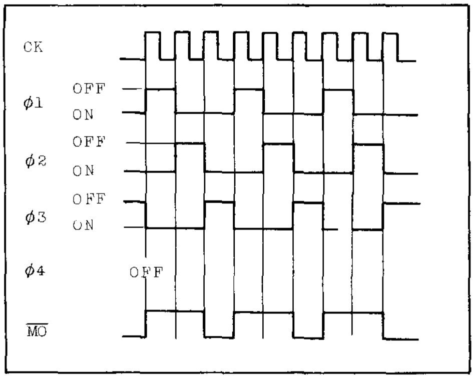
1 PHASE EXCITATION CW



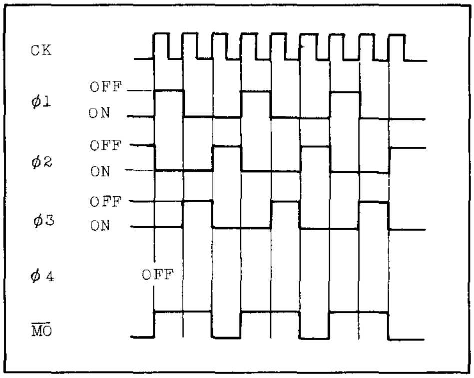
1 PHASE EXCITATION CCW



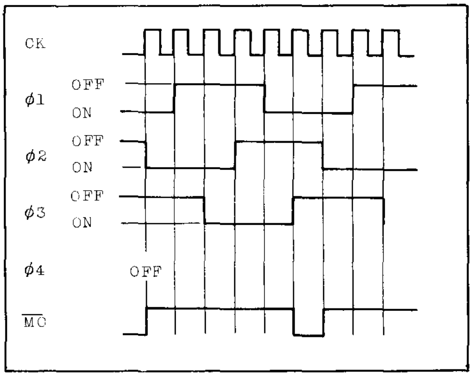
2 PHASE EXCITATION CW



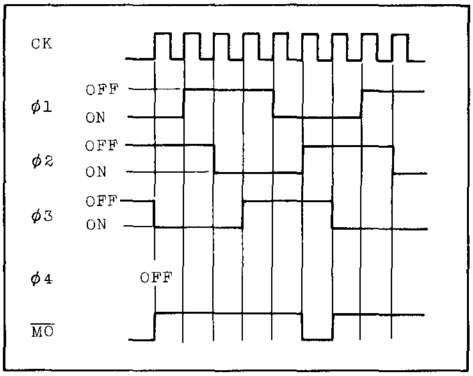
2 PHASE EXCITATION CCW



1-2 PHASE EXCITATION CW

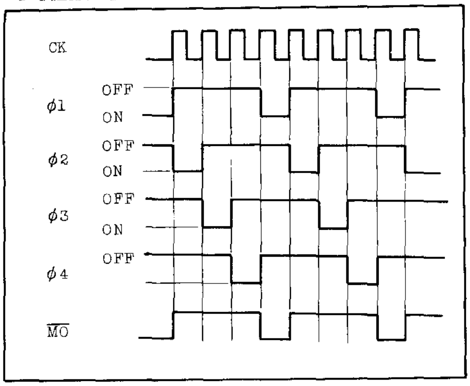


1-2 PHASE EXCITATION CCW

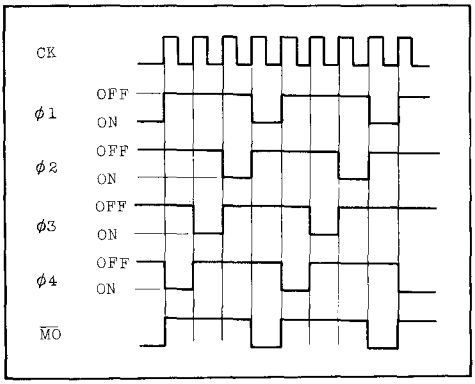


4 PHASES METHOD

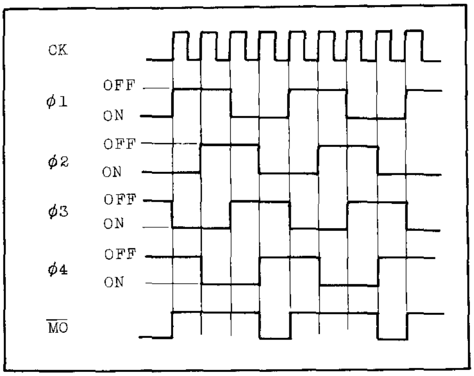
1 PHASE EXCITATION CW



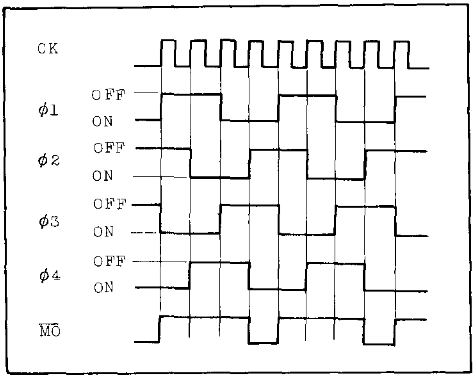
1 PHASE EXCITATION CCW



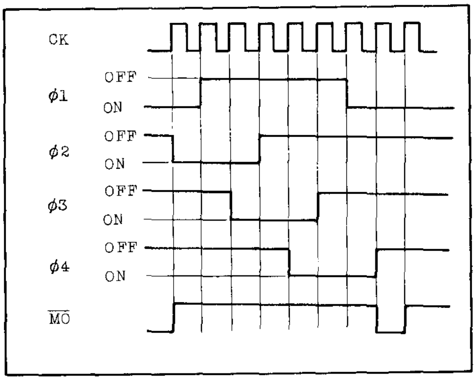
2 PHASE EXCITATION CW



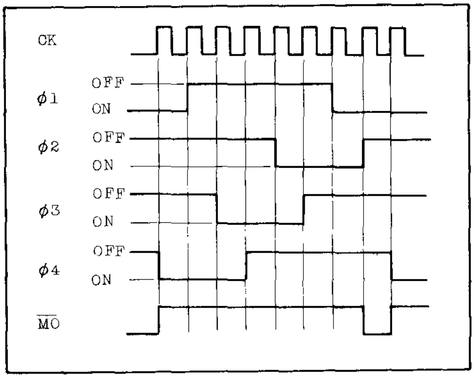
2 PHASE EXCITATION CCW



1-2 PHASE EXCITATION CW



1-2 PHASE EXCITATION CCW

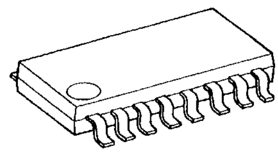


TD62M2701F

○ LOW SATURATION VOLTAGE H-BRIDGE DRIVER

TD62M2701F is Multi-Chip H-Bridge Driver IC incorporates 4 low saturation discrete transistors which equipped bias-resistor and fly-wheel diode. This IC is suitable for forward-reverse control on a battery use motor drive applications.

- Suitable for High Efficiency Motor Drive Circuit
- Built-in Fly-wheel Diode (lower side)
- Built-in Bias Resistor (lower side)
  : R = 10kΩ (Typ.)
- SSOP 16 1mm pitch package sealed
- Low Saturation Voltage
  : $V_{CE(sat)\,(Upper+Lower)} = 0.23V$ (Typ.): $I_O = 1A$
  $= 0.45V$ (Typ.): $I_O = 2A$



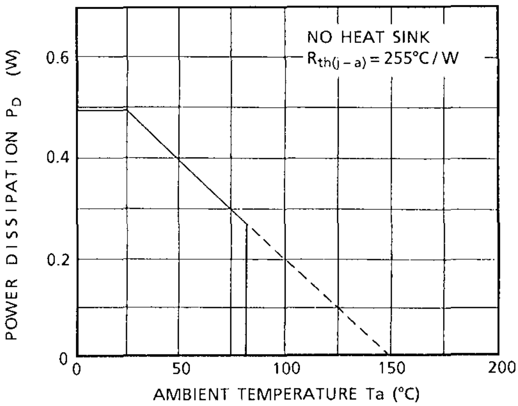
SSOP16-P-225A

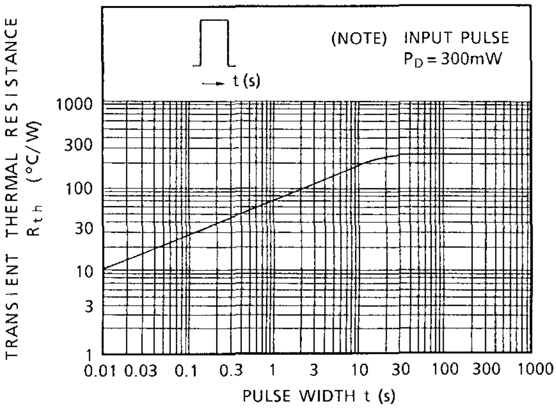
Weight:
SSOP16-P-225A: 0.14g (Typ.)

MAXIMUM RATINGS (Ta = 25°C)

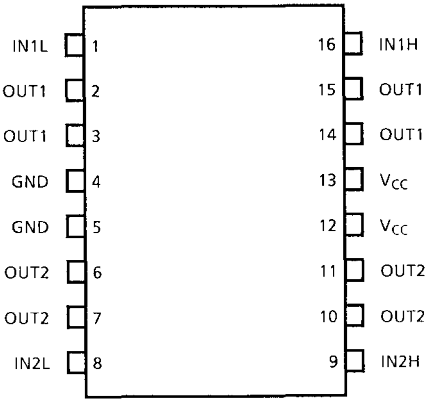
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	10	V
Breakdown Voltage	V_{CBO}	10	V
	V_{CER}	10	
	V_{EBO}	6	
Output Current	I_{OUT}	2	A
	$I_{OUT(PEAK)}$	4 (Note 1)	
Base Current	I_B	±0.4	A
	$I_{B(PEAK)}$	±0.8 (Note 1)	
Diode Forward Current	I_F	2 (Note 2)	A
Power Dissipation	P_D	490	mW
Junction Temperature	T_j	150	°C
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

(Note 1) T = 10ms Max. and maximum duty is less than 30%.
(Note 2) T = 10ms single pulse





PIN CONNECTION

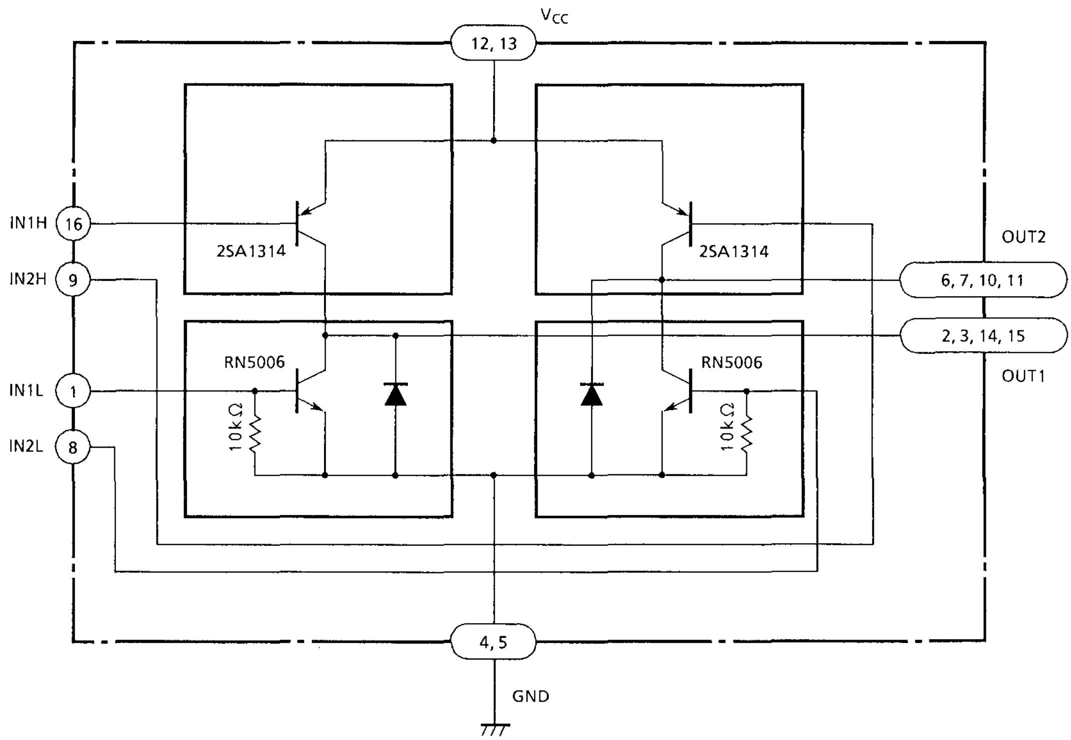


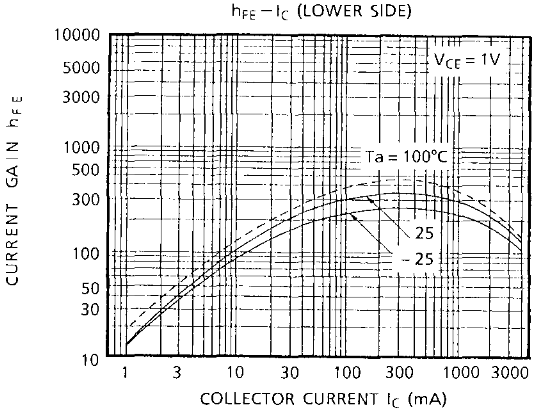
(TOP VIEW)

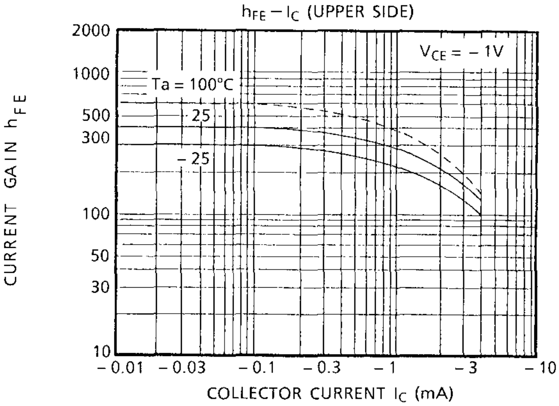
ELECTRICAL CHARACTERISTICS (Ta = 25°C)

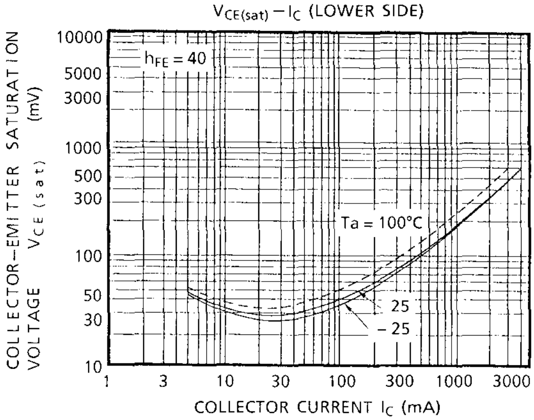
CHARACTERISTIC		SYMBOL	TEST CIRCUIT	CONDITION	MIN.	TYP.	MAX.	UNIT
Current Gain	Upper Side	$h_{FE(1)}$	—	$V_{CE} = -1V$, $I_C = -0.5A$	200	—	700	
	Lower Side	$h_{FE(1)}$	—	$V_{CE} = 1V$, $I_C = 0.5A$	160	—	700	
		$h_{FE(2)}$	—	$V_{CE} = 1V$, $I_C = 2.0A$	60	130	—	
Saturation Voltage	Upper Side	$V_{CE(sat)}$	—	$I_C = -1A$, $I_B = -25mA$	—	0.10	0.22	V
				$I_C = -2A$, $I_B = -50mA$	—	0.20	0.45	
	Lower Side			$I_C = 1A$, $I_B = 25mA$	—	0.13	0.22	
				$I_C = 2A$, $I_B = 50mA$	—	0.25	0.45	
	Summing Total			$I_C = 0.5A$, $I_B = 12.5mA$	—	—	0.20	
				$I_C = 1A$, $I_B = 25mA$	—	0.23	0.42	
				$I_C = 2A$, $I_B = 50mA$	—	0.45	0.85	
Transition Frequency		f_T	—	$V_{CE} = 2V$, $I_C = 0.5A$	—	150	—	MHz
Leakage Current	Upper Side	I_{OL}	—	$V_{CC} = 10V$	—	0	5	μA
	Lower Side				—	0	5	
Diode Forward Voltage (Lower Side)		V_F	—	$I_F = 300mA$	—	0.89	1.2	V
				$I_F = 450mA$, 10msec	—	1.60	—	
Base-Emitter Resistance		R_{BE}	—		7	10	13	kΩ
Base-Emitter Forward Voltage	Upper Side	$V_{BE(PNP)}$	—	$V_{CE} = -1V$, $I_C = -2A$	—	−0.84	−1.5	V
	Lower Side	$V_{BE(NPN)}$	—	$V_{CE} = 1A$, $I_C = 2A$	—	0.84	1.5	

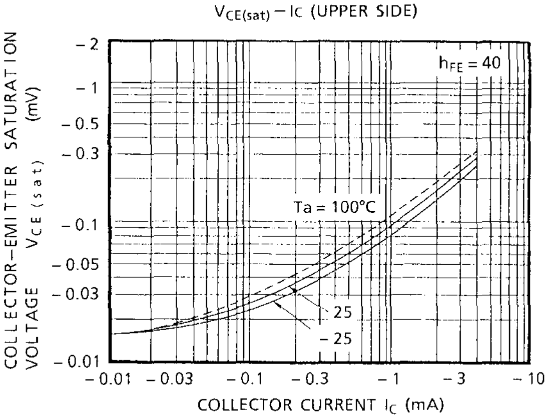
BLOCK DIAGRAM




$h_{FE} - I_C$ (LOWER SIDE)
CURRENT GAIN h_{FE}
$V_{CE} = 1V$
Ta = 100°C
25
- 25
10000
5000
3000
1000
500
300
100
50
30
10
1
3
10
30
100
300
1000
3000
COLLECTOR CURRENT I_C (mA)


$h_{FE} - I_C$ (UPPER SIDE)
CURRENT GAIN h_{FE}
$V_{CE} = -1V$
Ta = 100°C
25
- 25
2000
1000
500
300
100
50
30
10
- 0.01
- 0.03
- 0.1
- 0.3
- 1
- 3
- 10
COLLECTOR CURRENT I_C (mA)


$V_{CE(sat)} - I_C$ (LOWER SIDE)
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (mV)
$h_{FE} = 40$
Ta = 100°C
25
- 25
10000
5000
3000
1000
500
300
100
50
30
10
1
3
10
30
100
300
1000
3000
COLLECTOR CURRENT I_C (mA)

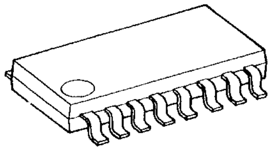

$V_{CE(sat)} - I_C$ (UPPER SIDE)
COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (mV)
$h_{FE} = 40$
Ta = 100°C
25
- 25
- 2
- 1
- 0.5
- 0.3
- 0.1
- 0.05
- 0.03
- 0.01
- 0.01
- 0.03
- 0.1
- 0.3
- 1
- 3
- 10
COLLECTOR CURRENT I_C (mA)

TD62M2702F

○ LOW SATURATION VOLTAGE H-BRIDGE DRIVER

TD62M2702F is short break use Multi-Chip driver IC incorporates 2 schottky barrier diodes and 4 low saturation discrete transistors which equipped bias-resistor and fly-wheel diode.
This IC is suitable for forward-reverse control on a battery use motor drive applications.

- Built-in Fly-wheel Diode (upper side)
- Built-in Schottky Barrier Diode (lower side)
- Built-in Bias Resistor (upperr side)
  : R=10kΩ(Typ.)
- SSOP16 1mm pitch small package sealed
- Low Saturation Voltage



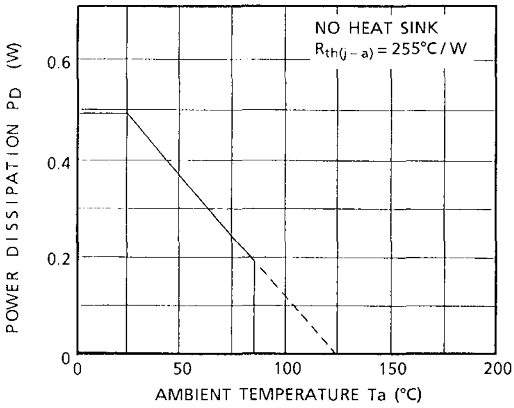
SSOP16-P-225A

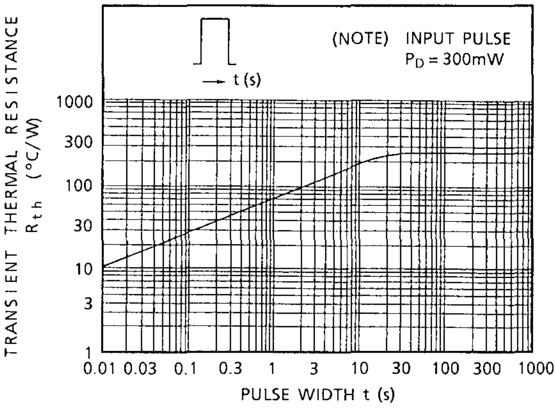
Weight:
SSOP16-P-225A: 0.14g (Typ.)

MAXIMUM RATINGS (Ta=25°C)

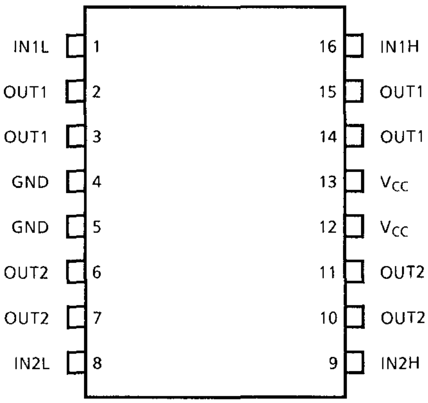
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	10	V
Breakdown Voltage	V_{CBO}	10	V
	V_{CER}	10	
	V_{EBO}	6	
Output Current	I_{OUT}	2	A
	$I_{OUT(PEAK)}$	4 (Note 1)	
Base Current	I_B	±0.4	A
	$I_{B(PEAK)}$	±0.8 (Note 1)	
Diode Forward Current	I_F	2 (Note 2)	A
Power Dissipation	P_D	490	mW
Junction Temperature	T_j	125	°C
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

(Note 1) T=10ms Max. and maximum duty is less than 30%.
(Note 2) T=10ms single pulse





PIN CONNECTION



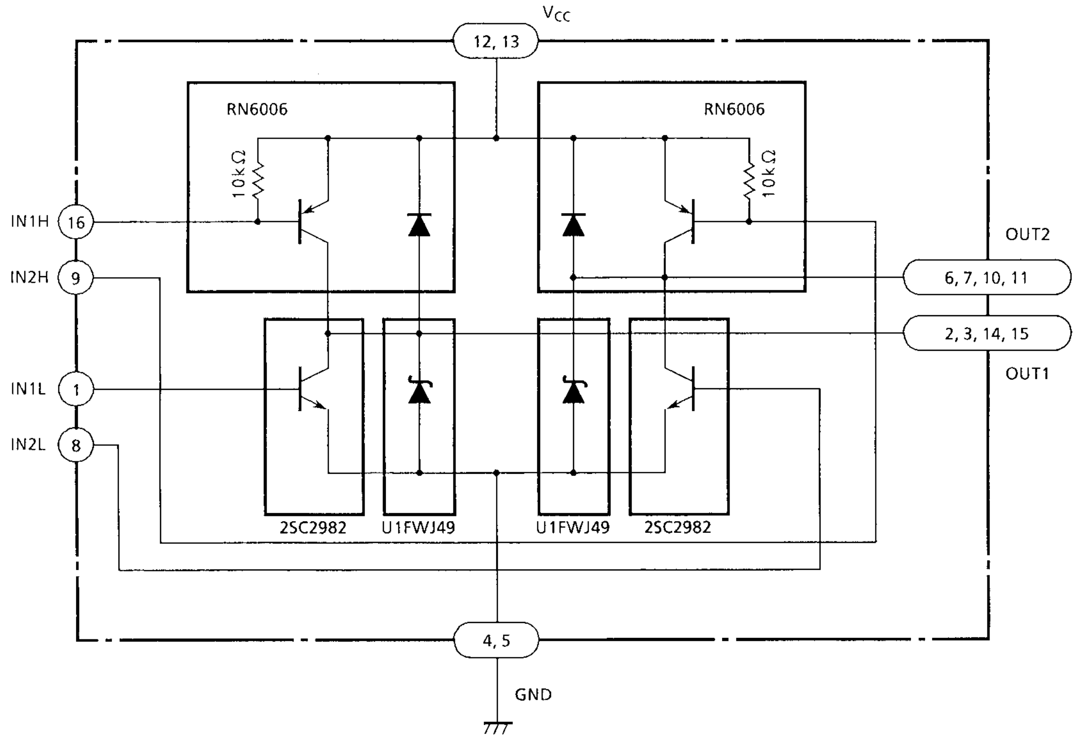
(TOP VIEW)

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

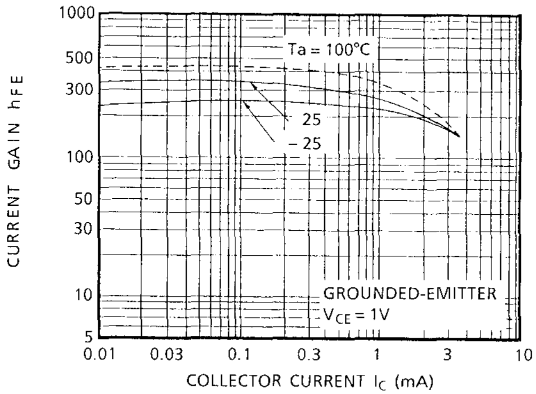
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	CONDITION	MIN.	TYP.	MAX.	UNIT
Current Gain	Upper Side	$h_{FE(1)}$	—	$V_{CE} = -1V$, $I_C = -0.5A$	160	—	600	
	Lower Side	$h_{FE(1)}$	—	$V_{CE} = 1V$, $I_C = 0.5A$	200	—	650	
		$h_{FE(2)}$	—	$V_{CE} = 1V$, $I_C = 2.0A$	60	130	—	
Saturation Voltage	Upper Side	$V_{CE(sat)}$	—	$I_C = -1A$, $I_B = -25mA$	—	0.1	0.22	V
				$I_C = -2A$, $I_B = -50mA$	—	0.2	0.45	
	Lower Side			$I_C = 1A$, $I_B = 25mA$	—	0.1	0.22	
				$I_C = 2A$, $I_B = 50mA$	—	0.2	0.45	
	Summing Total			$I_C = 1A$, $I_B = 25mA$	—	0.2	0.42	
				$I_C = 2A$, $I_B = 50mA$	—	0.4	0.85	
Transition Frequency		f_T	—	$V_{CE} = 2V$, $I_C = 0.5A$	—	150	—	MHz
Leakage Current	Upper Side	I_{OL}	—	$V_{CC} = 10V$	—	0	5	μA
	Lower Side				—	—	10	
	V_{CC} − GND				—	—	5	
Diode Forward Voltage (Note)	Upper Side	V_F	—	$I_F = 300mA$	—	0.89	1.2	V
				$I_F = 450mA$, 10m	—	1.60	—	
	Lower Side			$I_F = 1A$	—	—	0.58	
Base-Emitter Resistance		R_{BE}	—		7	10	13	kΩ
Base-Emitter Forward Voltage		V_{BE}	—	$V_{CE} = 1V$, $I_C = 2A$	—	0.84	1.5	V

Note) Schottky Diode U1FW49 (No Heat Sink) is guaranteed at V_F (Lower Side) = 0.55V (max.) but the TD62M2702F is guarantee at V_F (Lower Side) = 0.58V (max.)
(Voltage shift of 0.03V ($I_F = 1A$) is due t different package.)

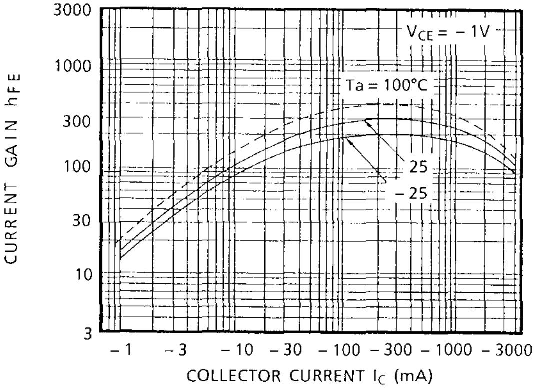
BLOCK DIAGRAM



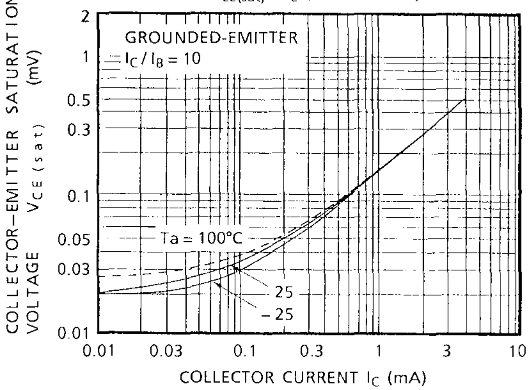
$h_{FE} - I_C$ (LOWER SIDE)



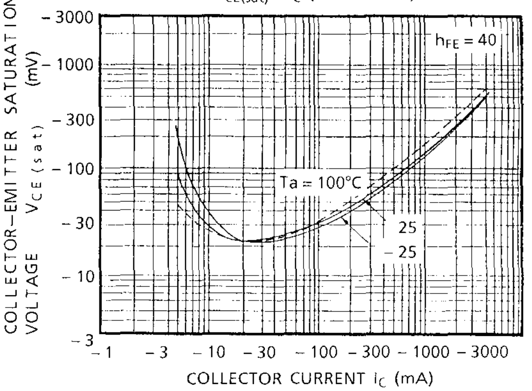
$h_{FE} - I_C$ (UPPER SIDE)



$V_{CE(sat)} - I_C$ (LOWER SIDE)



$V_{CE(sat)} - I_C$ (UPPER SIDE)

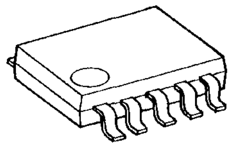


TD62M3600F

○ 3CH LOW SATURATION VOLTAGE SOURCE DRIVER

TD62M3600F is Multi Chip driver IC incorporates 3 low saturation voltage discrete PNP transistors which equipped bias resistor and free-wheeling diode.

- Built-in Free-wheeling Diode
- Built-in Bias Resistor
  R = 10kΩ (typ.)
- SSOP10 1mm pitch small package sealed
- Low Saturation Voltage
  $V_{CE(sat)} = 0.16V$(typ.) at $I_O = 1A$
  $V_{CE(sat)} = 0.28V$(typ.) at $I_O = 2A$



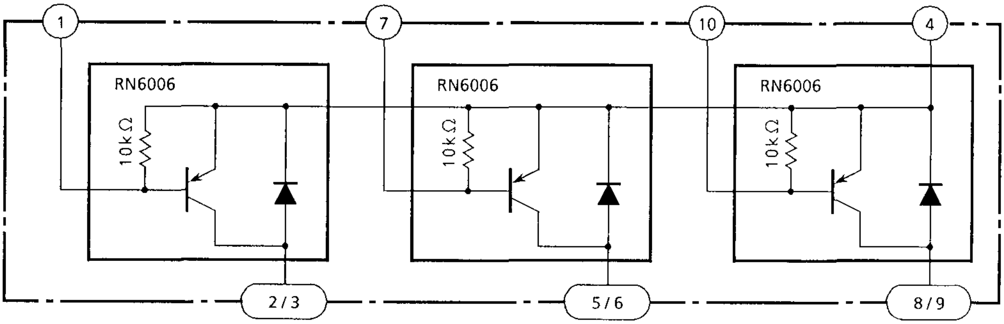
SSOP10-P-225

MAXIMUM RATINGS (Ta = 25°C)

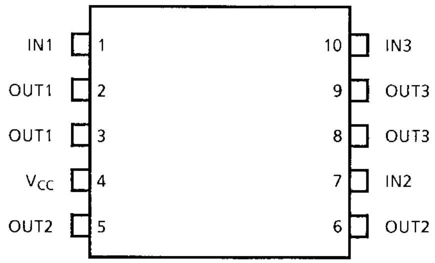
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	10	V
Breakdown Voltage	V_{CBO}	10	V
	V_{CER}	10	V
	V_{EBO}	6	V
Output Current	$I_{OUT(AVE)}$	2	A
	$I_{OUT(PEAK)}$	4 (Note 1)	
Base Current	I_B	±0.4	A
	$I_{B(PEAK)}$	±0.8 (Note 1)	
Diode Forward Current	I_F	2 (Note 2)	A
Power Dissipation	P_D	590	mW
Junction Temperature	T_j	150	°C
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

(Note 1) T = 10ms Max. and maximum duty is less than 30%.
(Note 2) T = 10ms single pulse

BLOCK DIAGRAM



PIN CONNECTION

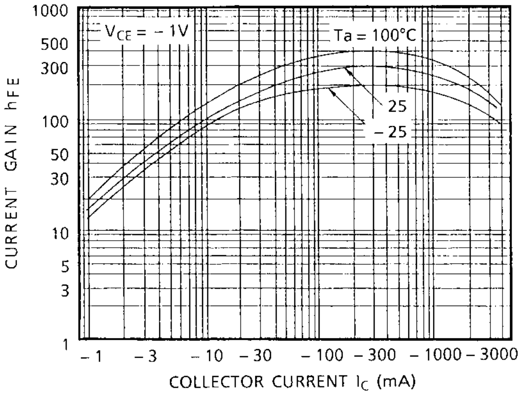


ELECTRICAL CHARACTERISTICS (Ta = 25°C)

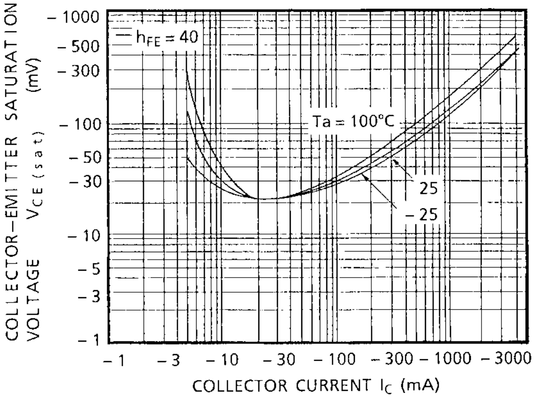
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Current Gain	$h_{FE(1)}$	—	$V_{CE}=1V$, $I_C=0.5A$	160	—	600	—
	$h_{FE(2)}$	—	$V_{CE}=1V$, $I_C=2.0A$	60	130	—	
Saturation Voltage	$V_{CE(sat)}$	—	$V_C=1A$, $I_B=25mA$	—	0.16	0.25	V
		—	$V_C=2A$, $I_B=50mA$	—	0.28	0.50	
Transition Frequency	f_T	—	$V_{CE}=2V$, $I_C=0.5A$	—	150	—	MHz
Leakage Current	I_{OL}	—	$V_{CC}=10V$	—	0	10	μA
Diode Forward Voltage	V_F	—	$I_F=300mA$	—	0.89	1.2	V
			$I_F=400mA$, 10m		1.60	—	
Base-Emitter Resistance	R_{BE}	—		7	10	13	kΩ
Base-Emitter Forward Voltage	V_{BE}	—	$V_{CE}=1V$, $I_C=2A$	—	0.84	1.5	V

REFERENCE DATA

TRANSISTOR (RN6006)
h_{FE} CHARACTERISTIC



TRANSISTOR (RN6006)
$V_{CE(sat)} - I_C$

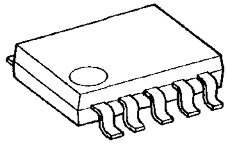


TD62M3601F

○ 3CH LOW SATURATION VOLTAGE SOURCE DRIVER

TD62M3601F is Multi Chip IC incorporates 3 low saturation voltage discrete transistor (PNP).

- Suitable for High Efficiency Motor Drive Circuit
- SSOP10 1mm pitch small package sealed
- High Output Currentage
  $I_{OUT(AVE)} = 1.5A$
  $I_{OUT(PEAK)} = 3.0A$



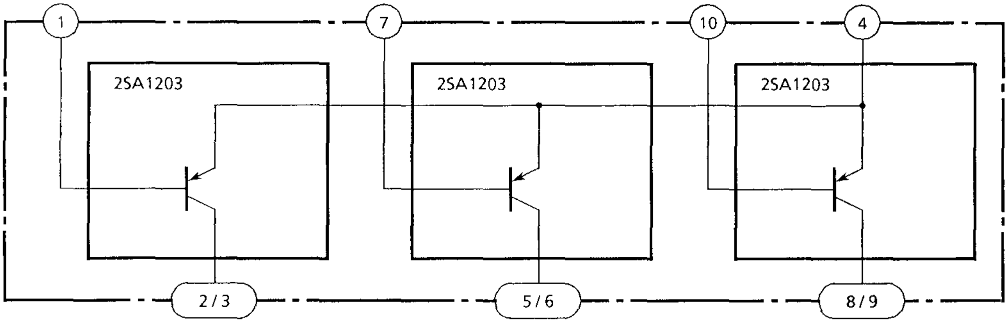
SSOP10-P-225

MAXIMUM RATINGS (Ta=25°C)

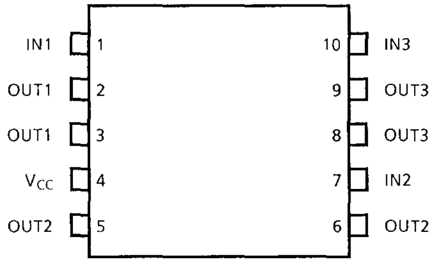
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	30	V
Breakdown Voltage	V_{CBO}	30	V
	V_{CEO}	30	V
	V_{EBO}	5	V
Output Current	$I_{OUT(AVE)}$	1.5	A
	$I_{OUT(PEAK)}$	3.0 (Note)	
Base Current	I_B	0.3	A
Power Dissipation	P_D	590	mW
Junction Temperature	T_j	150	°C
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

(Note) T=10ms Max. and maximum duty is less than 30%.

BLOCK DIAGRAM



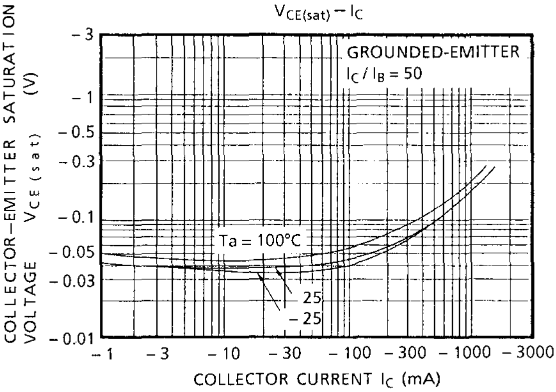
PIN CONNECTION

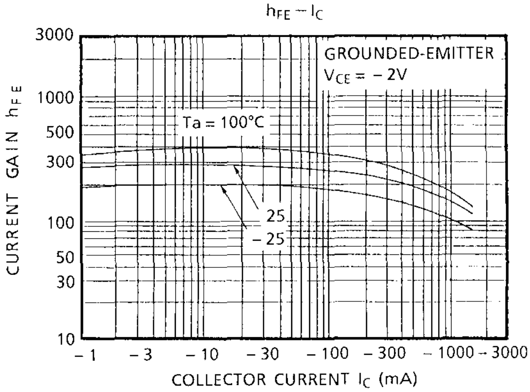


ELECTRICAL CHARACTERISTICS ($Ta = 25°C$)

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Current Gain	$h_{FE(1)}$	—	$V_{CE} = 2V$, $I_C = 0.5A$	160	—	320	—
	$h_{FE(2)}$	—	$V_{CE} = 2V$, $I_C = 1.5A$	50	100	—	
Saturation Voltage	$V_{CE(sat)}$	—	$I_C = 0.5A$, $I_B = 10mA$	—	0.2	0.5	V
		—	$I_C = 1.5A$, $I_B = 30mA$	—	—	2.0	
Transition Frequency	f_T	—	$V_{CE} = 2V$, $I_C = 0.5A$	—	120	—	MHz
Leakage Current	I_{OL}	—	$V_{CC} = 30V$	—	0	10	μA
Base-Emitter Forward Voltage	V_{BE}	—	$V_{CE} = 2V$, $I_C = 0.5A$	—	—	1.0	V

REFERENCE DATA



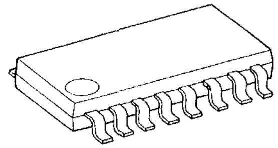


TD62M3700F

○ 3 PHASE FULL-WAVE INVERTER

TD62M3700F is low saturation, high current 3 phase full-wave type inverter IC designed especially for battery use motor drive applications.

- High Current: $I_{O\ MAX(AVE)} = 1.5A$
  $I_{O\ MAX(PEAK)} = 3.0A$
- Sealed in 1 mm pitch 16 pin surface mountable package (SSOP 16)


SSOP16-P-225A

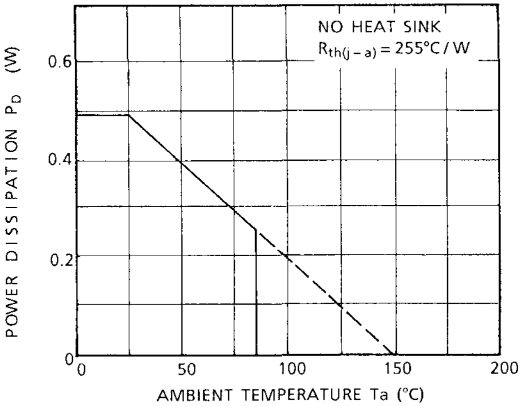
Weight:
SSOP16-P-225A: 0.14g (Typ.)

MAXIMUM RATINGS (Ta = 25°C)

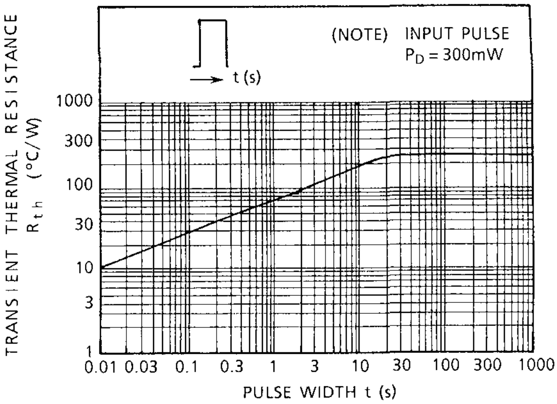
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	30	V
Breakdown Voltage	V_{CBO}	30	V
	V_{CEO}	30	
	V_{EBO}	5	
Output Current (Average)	$I_{OUT(AVE)}$	1.5	A
Output Current (Peak)	$I_{OUT(Peak)}$	* 3.0	A
Base Current	I_B	0.3	A
Power Dissipation	P_D	490	mW
Junction Temperature	T_j	150	°C
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

* t = 10ms single pulse

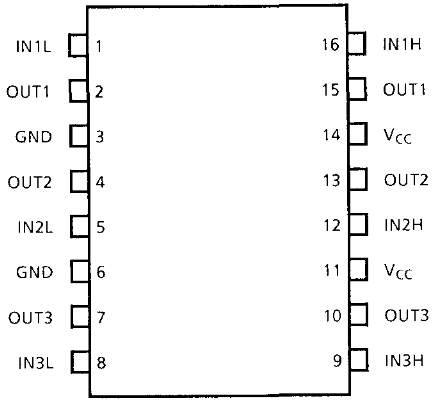
$P_D - Ta$



$R_{th} - t$



PIN CONNECTION

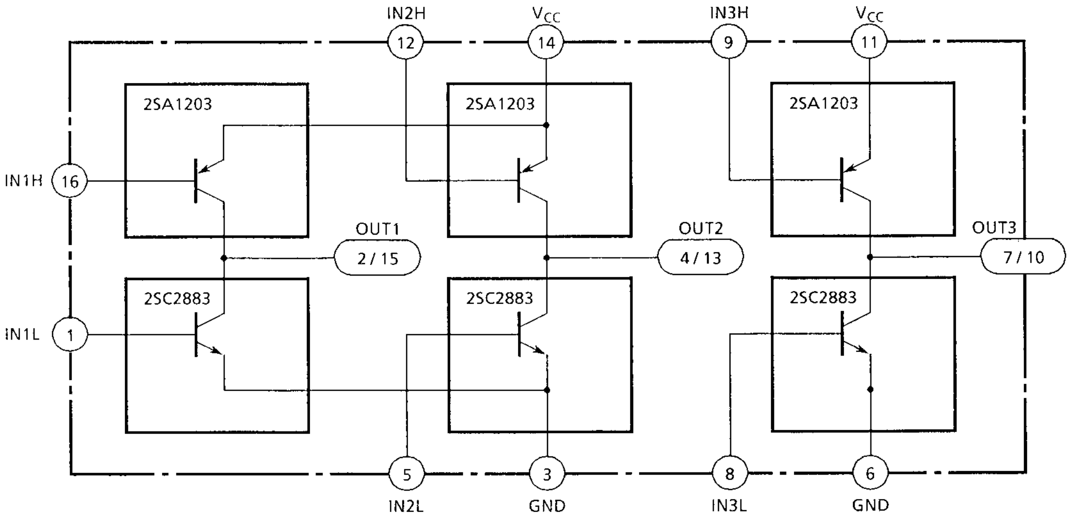


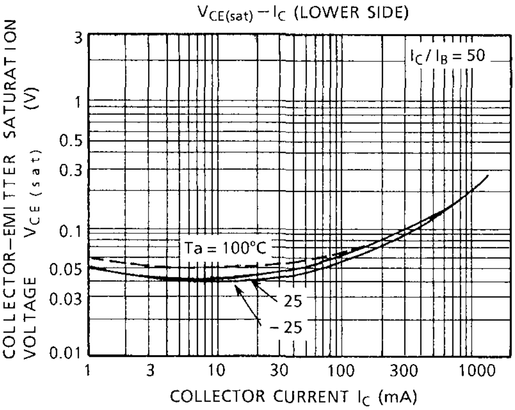
(TOP VIEW)

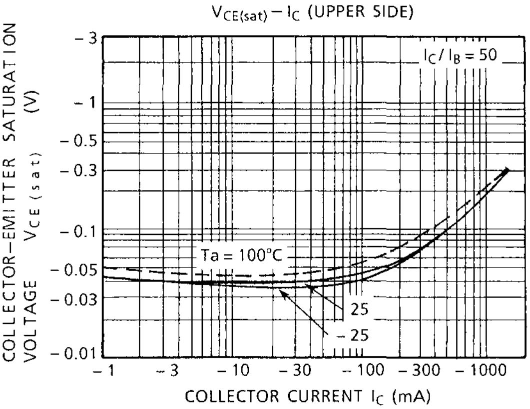
ELECTRICAL CHARACTERISTICS (Ta = 25°C)

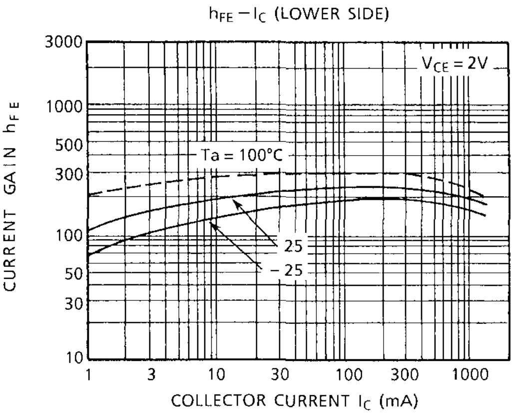
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	CONDITION	MIN.	TYP.	MAX.	UNIT
Current Gain		$h_{FE(1)}$	—	$V_{CE} = -1V$, $I_C = -0.5A$	200	—	600	
		$h_{FE(1)}$	—	$V_{CE} = 1V$, $I_C = 0.5A$	160	—	600	
h_{FE} Ratio		$h_{FE(1)} / h_{FE(2)}$	—	$V_{CE} = 0.4V$, $I_C = 30mA$ / $V_{CE} = 0.4V$, $I_C = 0.2A$	0.75	—	1.25	
Saturation Voltage	Upper Side	$V_{CE(sat)}$	—	$I_C = 0.5A$, $I_B = 5mA$	—	0.35	0.50	V
				$I_C = 1.5A$, $I_B = 30mA$	—	—	2.0	
	Lower Side			$I_C = 0.5A$, $I_B = 5mA$	—	0.2	0.35	
				$I_C = 1.5A$, $I_B = 30mA$	—	—	2.0	
	Summing Total			$I_C = 0.5A$, $I_B = 5mA$	—	0.55	0.85	
				$I_C = 1.5A$, $I_B = 30mA$	—	—	4.0	
Transition Frequency		f_T	—	$V_{CE} = 2V$, $I_C = 0.5A$	—	120	—	MHz
Leakage Current	Upper Side	I_{OL}	—	$V_{CC} = 30V$	—	0	5	μA
	Lower Side				—	0	5	
Base-Emitter Forward Voltage	Upper Side	$V_{BE(PNP)}$	—	$V_{CE} = -1V$, $I_C = 2A$	—	0.84	1.5	V
	Lower Side	$V_{BE(NPN)}$	—	$V_{CE} = 1V$, $I_C = 2A$	—	0.84	1.5	

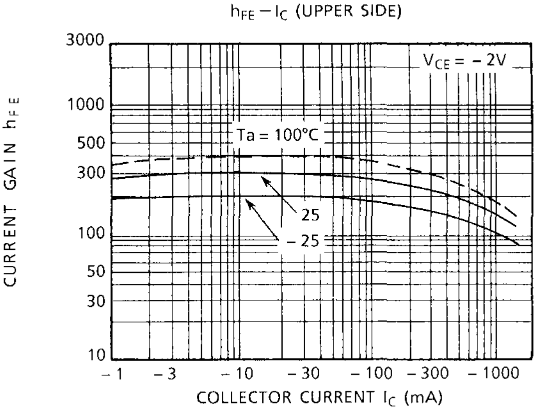
INTERNAL BLOCK CONNECTION




$V_{CE(sat)} - I_C$ (LOWER SIDE)
$I_C / I_B = 50$
Ta = 100°C
25
−25
COLLECTOR−EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
COLLECTOR CURRENT I_C (mA)


$V_{CE(sat)} - I_C$ (UPPER SIDE)
$I_C / I_B = 50$
Ta = 100°C
25
−25
COLLECTOR−EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
COLLECTOR CURRENT I_C (mA)


$h_{FE} - I_C$ (LOWER SIDE)
$V_{CE} = 2V$
Ta = 100°C
25
−25
CURRENT GAIN h_{FE}
COLLECTOR CURRENT I_C (mA)

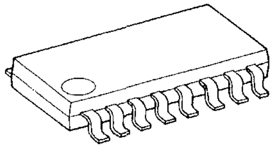

$h_{FE} - I_C$ (UPPER SIDE)
$V_{CE} = -2V$
Ta = 100°C
25
−25
CURRENT GAIN h_{FE}
COLLECTOR CURRENT I_C (mA)

TD62M3701F

○ LOW SATURATION VOLTAGE DRIVER FOR MOTOR

TD62M3701F is Multi Chip IC incorporates 6 low saturation discrete transistors which equipped bias resistor and fly-wheel diode.
This IC is suitable for a battery use motor drive applications.

- Suitable for High Efficiency Motor Drive Circuit
- Built-in Fly-wheel Diode
- Built-in Bias Resistor: R = 10kΩ(Typ.)
- SSOP16 1mm pitch small package sealed
- Low Saturation Voltage
  : $V_{CE(sat)} = 0.29V$(Typ.) at $I_O = 1A$
  $V_{CE(sat)} = 0.53V$(Typ.) at $I_O = 2A$
  (Upper and Lower side total)



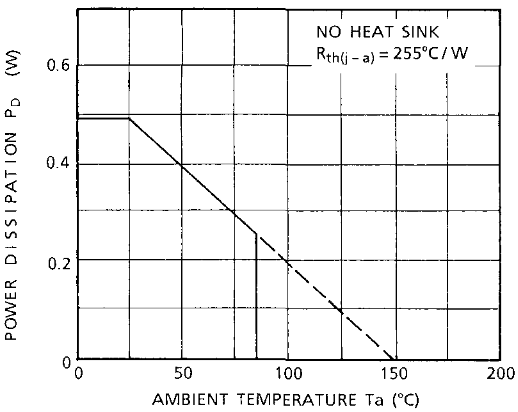
SSOP16-P-225A

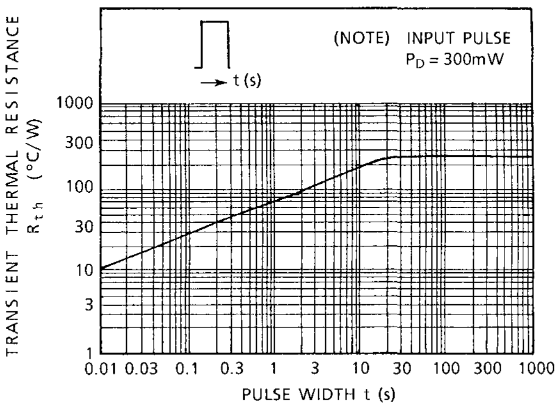
Weight: 0.14g (Typ.)

MAXIMUM RATINGS (Ta = 25°C)

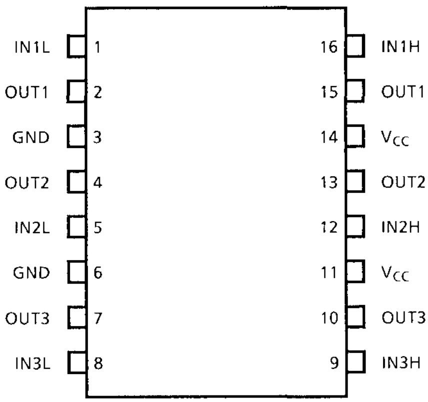
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	10	V
Breakdown Voltage	V_{CBO}	10	V
	V_{CER}	10	
	V_{EBO}	6	
Output Current	I_{OUT}	2	A
	$I_{OUT(PEAK)}$	4 (Note 1)	
Base Current	I_B	±0.4	A
	$I_{B(PEAK)}$	±0.8 (Note 1)	
Diode Forward Current	I_F	2 (Note 2)	A
Power Dissipation	P_D	490	mW
Junction Temperature	T_j	150	°C
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

(Note 1) T = 10ms Max. and maximum duty is less than 30%.
(Note 2) T = 10ms single pulse





PIN CONNECTION

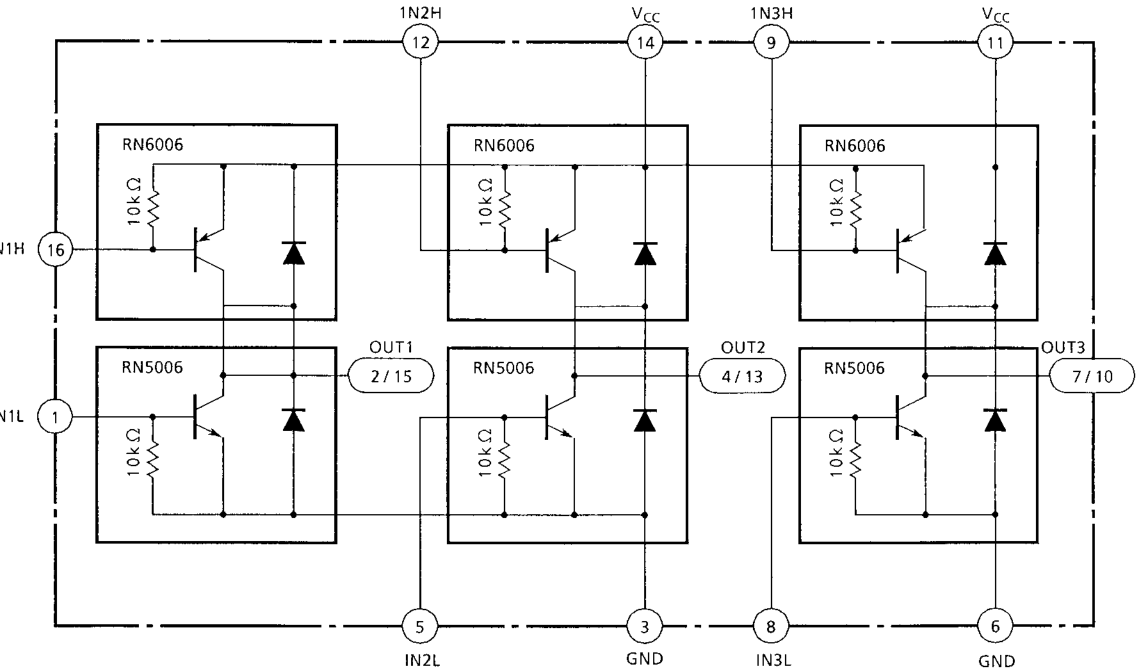


(TOP VIEW)

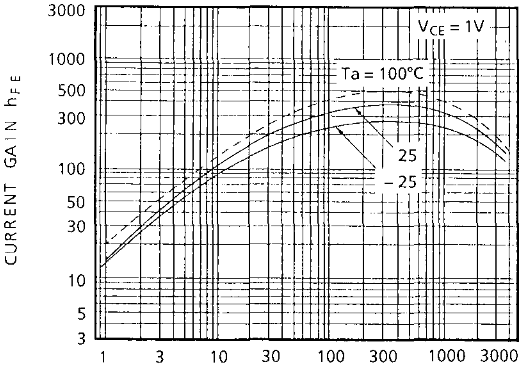
ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CIRCUIT	CONDITION	MIN.	TYP.	MAX.	UNIT
Current Gain		$h_{FE(1)}$	—	$V_{CE}=1V$, $I_C=0.5A$	160	—	600	
		$h_{FE(2)}$	—	$V_{CE}=1V$, $I_C=2.0A$	60	130	—	
Saturation Voltage	Upper Side	$V_{CE(sat)}$	—	$I_C=-1A$, $I_B=-25mA$	—	0.16	0.22	V
				$I_C=-2A$, $I_B=-50mA$	—	0.28	0.45	
	Lower Side			$I_C=1A$, $I_B=25mA$	—	0.13	0.22	
				$I_C=2A$, $I_B=50mA$	—	0.25	0.45	
	Summing Total			$I_C=1A$, $I_B=25mA$	—	0.29	0.42	
				$I_C=2A$, $I_B=50mA$	—	0.53	0.85	
Transition Frequency		f_T	—	$V_{CE}=2V$, $I_C=0.5A$	—	150	—	MHz
Leakage Current	Upper Side	I_{OL}	—	$V_{CC}=10V$	—	0	5	μA
	Lower Side		—	$V_{CC}=10V$	—	0	5	
Diode Forward Voltage	Upper Side	V_F	—	$I_F=300mA$	—	0.89	1.2	V
				$I_F=450mA$, 10ms	—	1.60	—	
	Lower Side			$I_F=300mA$	—	0.89	1.2	
				$I_F=450mA$, 10ms	—	1.60	—	
Base-Emitter Resistor		R_{BE}	—		7	10	13	kΩ
Base-Emitter Forward Voltage	Upper Side	$V_{BE(PNP)}$	—	$V_{CE}=-1V$, $I_C=-2A$	—	0.84	1.5	V
	Lower Side	$V_{BE(NPN)}$	—	$V_{CE}=1V$, $I_C=2A$	—	0.84	1.5	

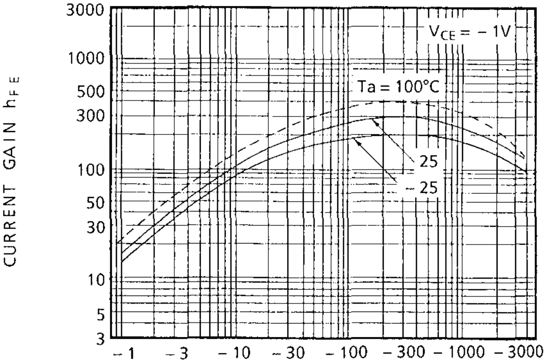
BLOCK DIAGRAM



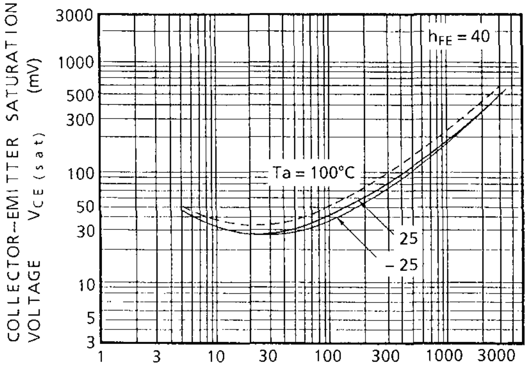
TRANSISTOR (RN5006)
$h_{FE}-I_C$ (LOWER SIDE)



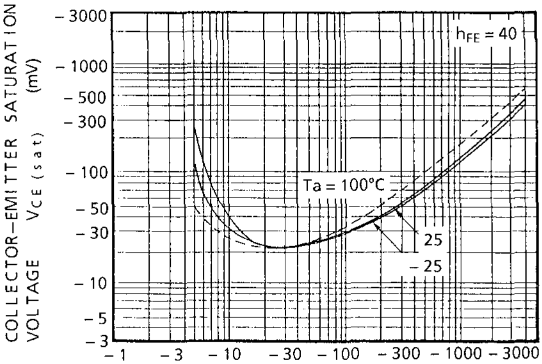
TRANSISTOR (RN6006)
$h_{FE}-I_C$ (UPPER SIDE)



TRANSISTOR (RN5006)
$V_{CE(sat)}-I_C$ (LOWER SIDE)



TRANSISTOR (RN6006)
$V_{CE(sat)}-I_C$ (LOWER SIDE)

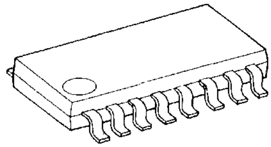


TD62M3702F

○ LOW SATURATION VOLTAGE DRIVER FOR MOTOR

TD62M3702F is Multi Chip IC incorporates 6 low saturation discrete transistors.
This IC is suitable for a battery use motor drive applications.

- Suitable for High Efficiency Motor drive circuit
- External Input Resistor
- SSOP16 1mm pitch small package sealed
- Low Saturation Voltage
  : $V_{ce(sat)} = 0.20V$(Typ.) at $I_O = 1A$
  $V_{ce(sat)} = 0.40V$(Typ.) at $I_O = 2A$
  (Upper and Lower side total)



SSOP16-P-225A

Weight: 0.14g (Typ.)

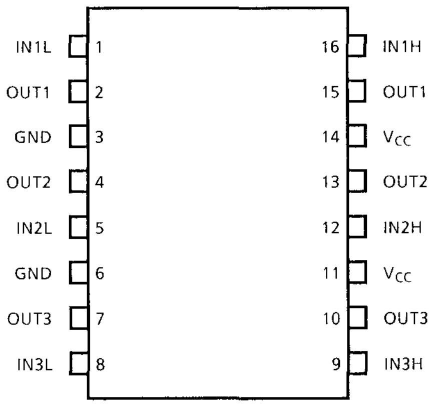
MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	15	V
Breakdown Voltage	V_{CBO}	15	V
Breakdown Voltage	V_{CEO}	15	V
Breakdown Voltage	V_{BEO}	6	V
Output Current	$I_{O(AVE)}$	2	A
	$I_{O(PEAK)}$	4 (Note 1)	
Base Current	I_B	0.4	A
Power Dissipation	P_D	700 (Note 2)	mW
Junction Temperature	T_j	150	°C
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

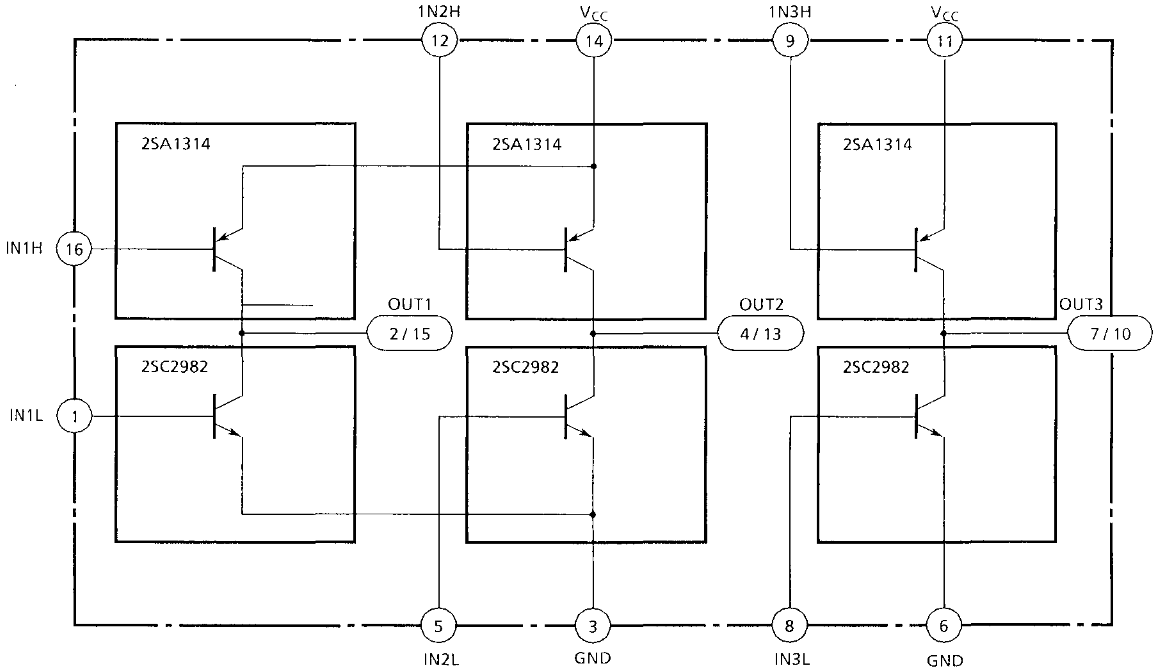
(Note 1) T = 10ms single pulse
(Note 2) Free Air

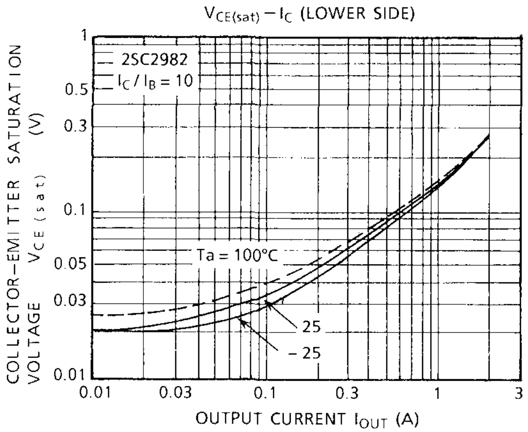
ELECTRICAL CHARACTERISTICS ($Ta = 25°C$)

CHARACTERISTIC	SYMBOL		TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Current Gain	$h_{FE(1)}$		—	$V_{CE} = 0.4V$, $I_C = 30mA$	160	—	600	
	$h_{FE(2)}$		—	$V_{CE} = 0.4V$, $I_C = 0.2A$	160	—	600	
Current Gain Ratio	$h_{FE(1)} / h_{FE(2)}$		—	$V_{CE} = 0.4V$, $I_C = 30mA$ / $V_{CE} = 0.4V$, $I_C = 0.2A$	0.75	—	1.25	
Saturation Voltage	$V_{CE(sat)}$ (Upper side)		—	$V_C = 1A$, $I_B = 25mA$	—	0.1	0.25	V
				$V_C = 2A$, $I_B = 50mA$	—	0.2	0.50	
	$V_{CE(sat)}$ (Lower side)		—	$V_C = 1A$, $I_B = 25mA$	—	0.1	0.30	
				$V_C = 2A$, $I_B = 50mA$	—	0.2	0.50	
	$V_{CE(sat)}$ (Summing Total)		—	$V_C = 1A$, $I_B = 25mA$	—	0.2	0.55	
				$V_C = 2A$, $I_B = 50mA$	—	0.4	1.0	
Transition Frequency	f_T		—	$V_{CE} = 2V$, $I_C = 0.5A$	—	140	—	MHz
Leakage Current	I_{OL}	(Upper side)	—	$V_{CC} = 15V$	—	0	10	μA
		(Lower side)			—	0	10	
Base-Emitter Forward Voltage	$V_{BE(PNP)}$		—	$V_{CE} = -1V$, $I_C = -2A$	—	0.84	1.5	V
	$V_{BE(NPN)}$		—	$V_{CE} = 1V$, $I_C = 2A$	—	0.84	1.5	

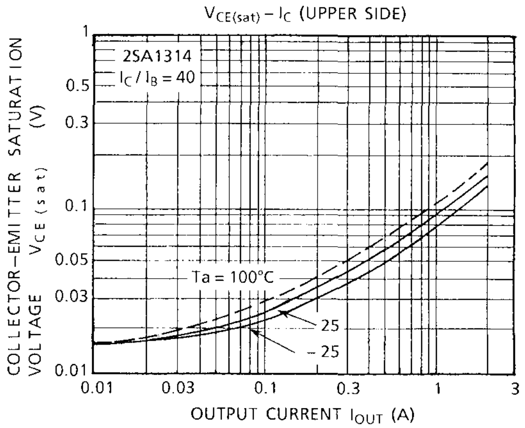


BLOCK DIAGRAM

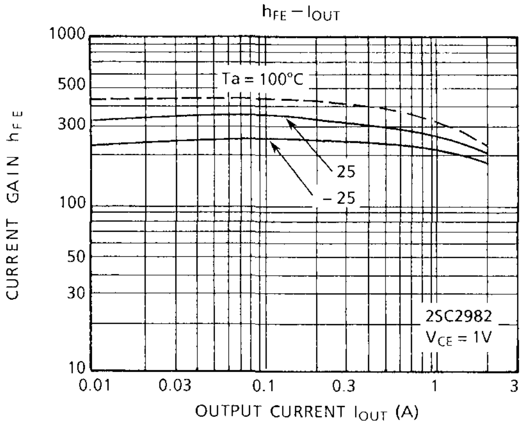




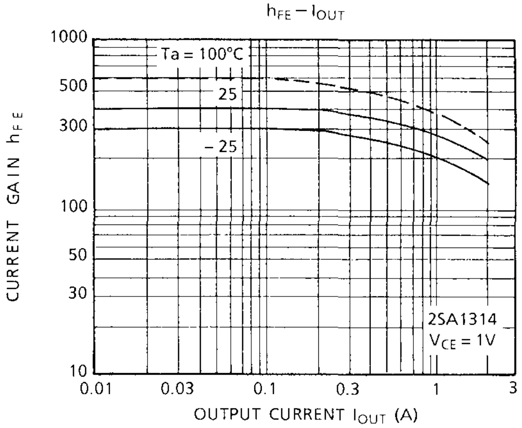
$V_{CE(sat)} - I_C$ (LOWER SIDE)
2SC2982
$I_C / I_B = 10$
Ta = 100°C
25
– 25
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
OUTPUT CURRENT I_{OUT} (A)



$V_{CE(sat)} - I_C$ (UPPER SIDE)
2SA1314
$I_C / I_B = 40$
Ta = 100°C
25
– 25
COLLECTOR–EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)
OUTPUT CURRENT I_{OUT} (A)



$h_{FE} - I_{OUT}$
Ta = 100°C
25
– 25
2SC2982
V_{CE} = 1V
CURRENT GAIN h_{FE}
OUTPUT CURRENT I_{OUT} (A)



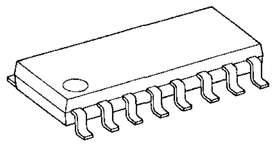
$h_{FE} - I_{OUT}$
Ta = 100°C
25
– 25
2SA1314
V_{CE} = 1V
CURRENT GAIN h_{FE}
OUTPUT CURRENT I_{OUT} (A)

TD62M4700F

○ EXCELLENT LOW SATURATION H-BRIDGE DRIVER

TD62M4700F is low voltage use Multi Chip H-Bridge Driver IC incorporates 4 low saturation discrete Transistors which equipped bias resistor and diode. This IC is designed especially for Camera Winding Motors, FDD Stepper Motors and other portable equipments.

- MFP-16 1mm pitch small package sealed
- Bias resistor and diodes are equipped
  R = 10kΩ
- Excellent Low Saturation Voltage
  $V_{CE(SAT)} = 0.29V(TYP.)$ at $I_O = 1A$
  $V_{CE(SAT)} = 0.53V(TYP.)$ at $I_O = 2A$
  (Upper and Lower side total)



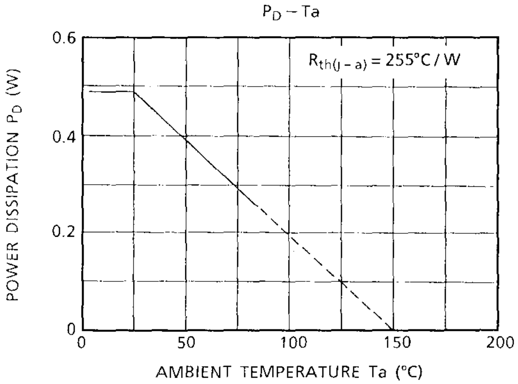
SSOP16-P-225A

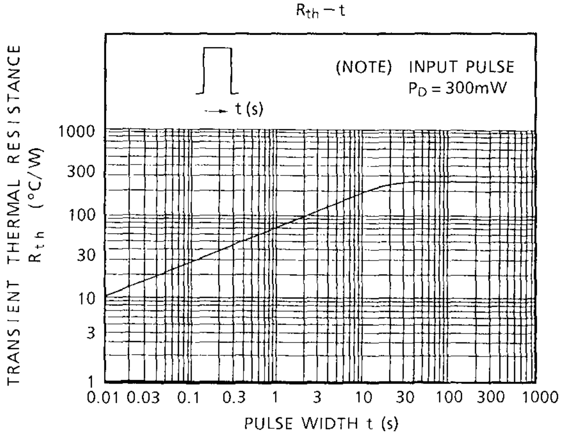
Weight : 0.2g

MAXIMUM RATINGS (Ta = 25°C)

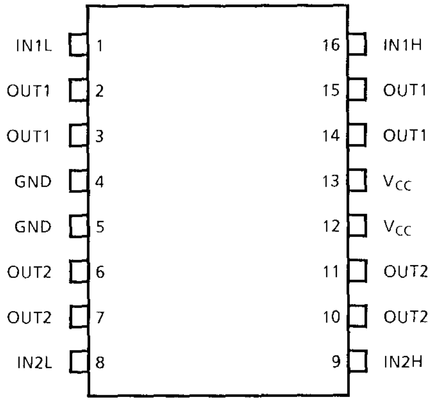
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	10	V
Breakdown Voltage	V_{CBO}	10	V
	V_{CER}	10	V
	V_{EBO}	6	V
Output Current (Average)	$I_{OUT(AVE)}$	2	A
Output Current (Peak)	$I_{OUT(Peak)}$	* 4	A
Base Current	I_B	±0.4	A
Base Current (Peak)	$I_{B(Peak)}$	* ±0.8	A
Diode Forward Current	I_F	** 2	A
Power Dissipation	P_D	490	mW
Junction Temperature	T_j	150	°C
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

* t = 10ms MAX. and maximum duty is less than 30%.
** t = 10ms Single pulse





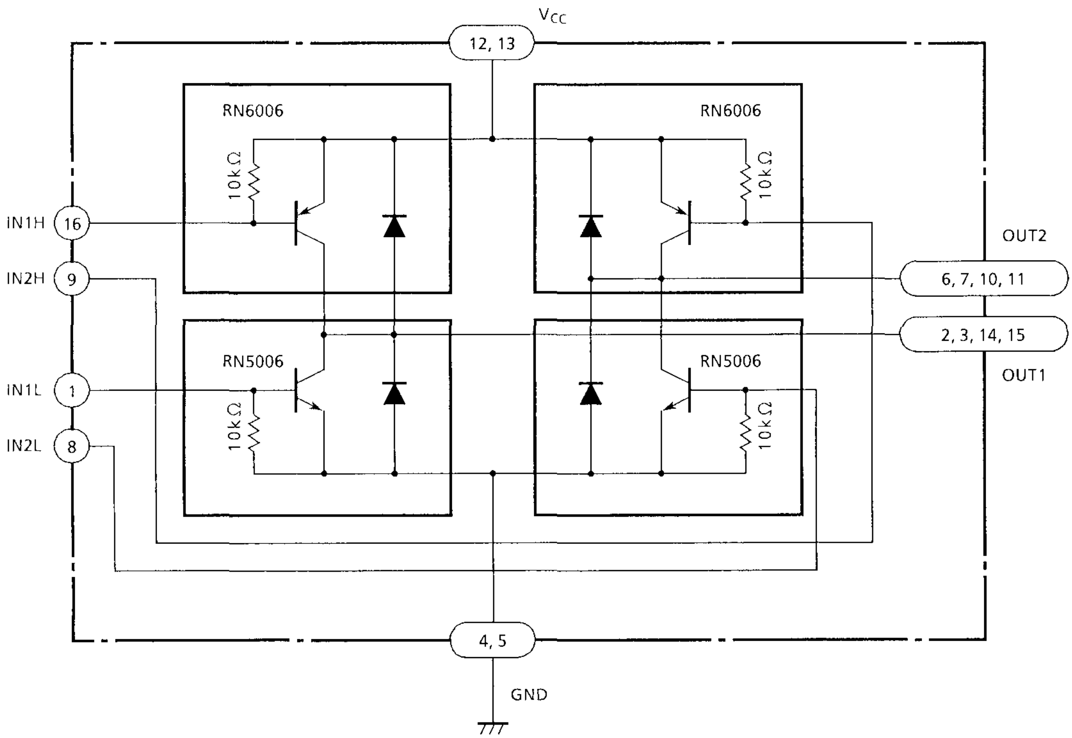
PIN CONNECTION (TOP VIEW)



ELECTRICAL CHARACTERISTICS (Ta = 25°C)

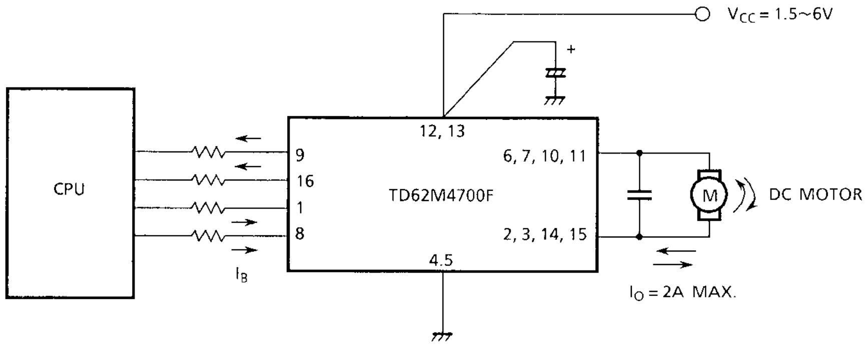
CHARACTERISTIC		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Current Gain		$h_{FE(1)}$	$V_{CE}=1V$, $I_C=0.5A$	160	—	600	
		$h_{FE(2)}$	$V_{CE}=1V$, $I_C=2.0A$	60	130	—	
Saturation Voltage	Upper Side	$V_{CE(sat)}$	$I_C=1A$, $I_B=25mA$	—	0.16	0.22	V
			$I_C=2A$, $I_B=50mA$	—	0.28	0.45	
	Lower Side		$I_C=1A$, $I_B=25mA$	—	0.13	0.22	
			$I_C=2A$, $I_B=50mA$	—	0.25	0.45	
	Summing Total		$I_C=1A$, $I_B=25mA$	—	0.29	0.42	
			$I_C=2A$, $I_B=50mA$	—	0.53	0.85	
Transition Frequency		f_T	$V_{CE}=2V$, $I_C=0.5A$	—	150	—	MHz
Leakage Current	Upper Side	I_{OL}	$V_{CC}=10V$	—	0	5	μA
	Lower Side			—	0	5	
Diode Forward Voltage	Upper Side	V_F	$I_F=300mA$	—	0.89	1.2	V
			$I_F=450mA$, 10msec	—	1.60	—	
	Lower Side		$I_F=300mA$	—	0.89	1.2	
			$I_F=450mA$, 10msec	—	1.60	—	
Base-Emitter Resistor		R_{BE}		7	10	13	kΩ
Base-Emitter Forward Voltage	Upper Side	$V_{BE(PNP)}$	$V_{CE}=-1V$, $I_C=2A$	—	0.84	1.5	V
	Lower Side	$V_{BE(NPN)}$	$V_{CE}=1V$, $I_C=2A$	—	0.84	1.5	

INTERNAL BLOCK CONNECTION

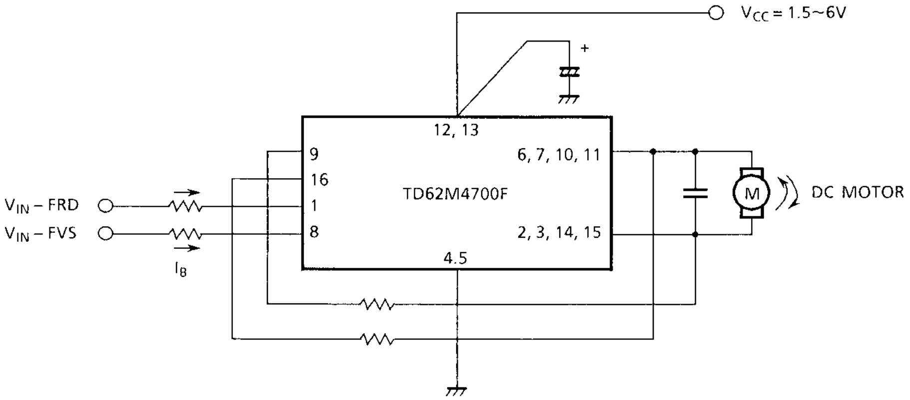


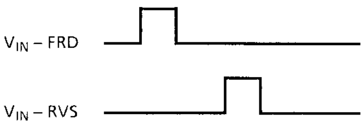
APPLICATION CIRCUIT

(1) CAMERA WINDING AND FEEDING MOTOR



(2) $I_B > K_O - \frac{I_O}{hfe}$ K_O: Over Drive Factor ≧ 2





HANDLING PRECAUTIONS

5. HANDLING PRECAUTIONS

Designed and manufactured under Toshiba's high quality assurance system, semiconductor products offer satisfactory properties and quality for users. However, if such devices are selected inappropriately or are subjected to heavy thermal, mechanical, or electrical stress, their properties, quality, and reliability may be greatly affected.

The following are precautions to be taken to achieve up to 100% performance and to ensure satisfactory reliability of the devices mentioned herein.

If semiconductor elements are incorporated in units, there are particularly several aspects to which due consideration must be given concerning designing or assembly. These are also described below.

5-1 Common Items for Packages

(1) When a lead is bent or cut

The IC may be damaged mainly due to loss of adhesion resulting from relative stress applied between the main IC body and the lead. Take care to confine stress to the lead.

When bending a lead, bend it at a point more than 3 mm away from the IC body, not exceeding 90°C. Also, a suitable R (e. g., 0.5 Rmm) should be applied to permit safe usage without damage to surface treatment by the bending jig.

(2) When mounting an IC on a printboard, check the position of the IC.

If an IC is mounted in a wrong position, it may be broken when energized.

(3) When soldering using flux

Some constituents in flux may corrode package materials. To ensure the reliability of units, flux must be removed. For this purpose, a detergent or ultrasonic waves must be applied.

Generally, freon agents such as freon TF and Di-Freon solvent S3-E are recommended. If ultrasonic waves are used for cleaning, care must be taken to limit the output, while selecting 28 to 29 kHz, keep the devices and printboards away from the resonator, and limit processing time to 30 sec. so that no stress caused by resonance will be applied to the related devices and printboards.

(4) Mounting on printboards

When soldering the leads of an element onto a printboard, care must be taken not to leave stress applied to the leads. Reduce stress by shaping the leads to the holes, or by using a spacer between the device body and the printboard. Stress will persist if the leads, rather than being carefully shaped, are forced into the holes or pulled through with a tool (see Fig. 5-1). Parts subjected to stress may occasionally cause stress corrosion or whiskers, resulting in wire breakage or short-circuiting.

Thus, it is also necessary to adapt the hole size to the lead spacing.

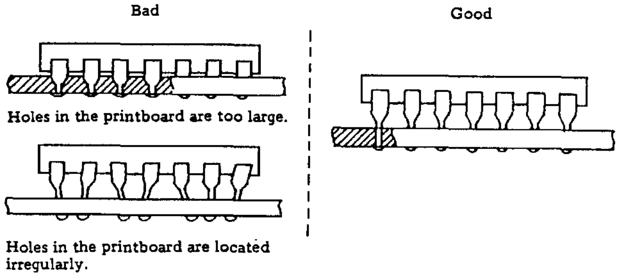


Fig. 5-1

(5) IC resistance to soldering heat is specified as 10 sec. at 260°C, and 3 sec. at 350°C when applied 1.5mm from the body. While soldering, lower temperature to a minimum by using jigs.

(6) Thermal IC design

When heated above their maximum allowable junction temperature, IC's may deteriorate or destroy. Due consideration must be given to thermal designing. Pay attention to the following:

The absolute maximum rating of each IC represents its maximum junction temperature (T_j max.) or its operating temperature range (Topr). On the basis of both values, obtain max. allowable junction temperature by using the P_D-T_a characteristics.

Using a large radiator will not achieve sufficient radiation if the radiator is not tightened properly. This also should be considered at the design stage.

5-2 Special Notes on Packages

(1) Power consumption of power IC

Concerning integrated circuits, their circuit design, circuit constants, and supply voltages often are already determined, while power consumed under a specified supply voltage also can be determined.

Supply current and power consumption vary widely depending on individual elements. For small-signal IC's, thermal resistance of their peripheral units are designed so that even at the rated maximum, the maximum operating ambient temperature will not be exceeded.

However, for power integrated circuits that involve large variations in power consumption under external loading conditions, their maximum power consumption is specified by allowable power dissipation/ambient temperature characteristics as shown in Fig. 5-2. It is necessary to obtain power consumption under the worst conditions from this figure, and to design a heat radiator by calculating the max. ambient temperature.

Let's try designing a heat sink for TA7267BP.

[Example of heat sink designing: TA7267BP]

Refer to the thermal resistance data in Fig. 5-3.

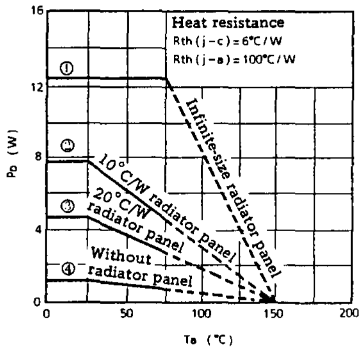


Fig. 5-2

The saturated thermal resistance of this IC can be obtained from Fig. 5-2 (1)

$$\theta_{j-c} = \frac{150°C - 75°C}{12.5W} = 6°C/W \text{ (thermal resistance from junction to case)} \quad \cdots\cdots\cdots \quad (1)$$

Assuming that the IC is operated up to V_{CC} = 18V, I_{OUT} = 1.0A and Ta = 75°C, we have P_D (max.) = 3.1W. The thermal resistance θ_{HS} of the radiator to be mounted can be calculated by equation (3).

$$P_D\ (\text{max.}) = V_{CC} \times I_{CC} + I_{OUT} \times (V_{CE(SAT)}\ \text{upper} + V_{CE(SAT)}\ \text{lower}) \quad \cdots\cdots\ (2)$$

$$\theta_{HS} = \frac{T_{jmax} - Ta}{P_D\,max} - Rth_{(j-c)} \quad \cdots\cdots\ (3)$$

$$= \frac{150°C - 75°C}{3.1W} - 6°C/W$$

$$= 18°C/W$$

This calls for use of a radiator having a thermal resistance of 18°C/W. The size (size, thickness, amd material) can be determined by referring to Fig. 5-3 as about 15 cm^2 × 2mm aluminum from 18°C/W.

Note that when a radiator is joined to the IC, contact resistance is caused at the contact surface, resulting in lowered thermal conductivity. Thus, some allowances should be made in designing.

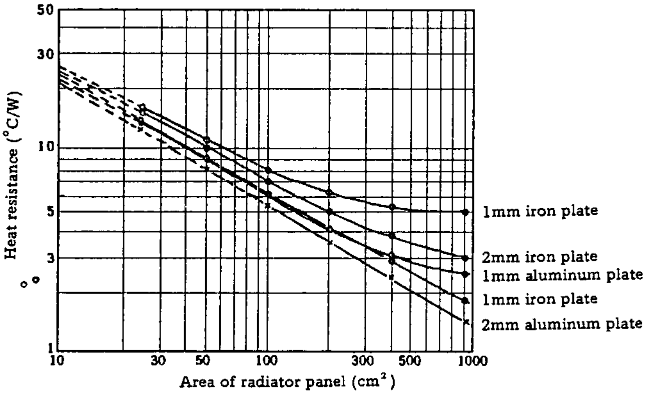


Fig. 5-3 Examples of radiator area versus thermal resistance

(2) Mounting of power devices on radiator

As for power devices, to allow power losses to thermally radiate efficiently through radiator, give due consideration to the following:

- Tightening torque

If devices are not completely tightened to the radiator, thermal resistance will increase, causing the device temperature to rise, which from the viewpoint of reliability, is unfavorable. On the other hand, with resin sealing packages, if the devices be excessively tightened, the pellets may be broken or the internal leads may be torn. To prevent such trouble, torque must be limited to levels recommended by manufacturers. As an example, Table 5-1 shows recommended torques for packages.

Table 5-1

Package	Recommended torque
TO-220	4 ~ 6 Kg·cm (0.4 ~ 0.6N·m)
Power IC	4 ~ 6 Kg·cm (0.4 ~ 0.6N·m)
Power IC with radiator fin	4 ~ 6 Kg·cm (0.4 ~ 0.6N·m)

- Flatness of radiator

When elements are mounted on radiators, adhesion should be investigated. Adhesion between the elements must be perfect with rigidity and no distortion. The maximum tolerance is 0.05mm. Should foreign matter such as cutting dust lodge between them, it will cause the pellets and resin parts to crack.

- Coherence

The most common procedure to achieve good cohesion between elements and radiator panels is to coat the contact surfaces with silicone grease. With plastic-sealed types, manufacturers' instructions must be followed as to the selection and quantity of grease used. With some greases, silicone will become separated from fat and oil, and if the resin and the fat and oil are in the some system, the fat and oil will permeate the resin, causing the chip protector films to swell, resulting in breakage of the bonding wire. Also an appropriate quantity must be used to prevent unwanted contact with the resin.

As an alternative to silicone grease, heat-conductive insulators (silicone rubber or etc.) are also effective with respect to cohesion and heat dissipation. They allow no permeation as previously mentioned above, but involve a problem to be noted in that they sometimes suffer from uneven tightening. (Uneven tightening is not a problem limited only to heat-conductive insulators, but also a problem with tightening in all cases.) If one side is tightened completely, the rubber sheet will be pushed out, and when the other side is tightened, the parts become as though foreign matter has been included, causing the pellet to crack.

(3) Mounting

If elements are soldered to leads and the printboard, and then mounted on radiators, take care to eliminate deviations between the radiators and mounting holes and the chassis. If such deviations exist, a large force will be applied, causing the internal leads to break or slacken, or the packages to break.

(4) Power flat package

The PFP enables P_D (power demand) to be enlarged compared with conventional DIP by certain effective mounting. The PFP is applicable in surface mounting, offers space convenience, and is most suitable for small motor drive circuits.

Shown below is an example of mounting.

Mounting on glass epoxy PCB

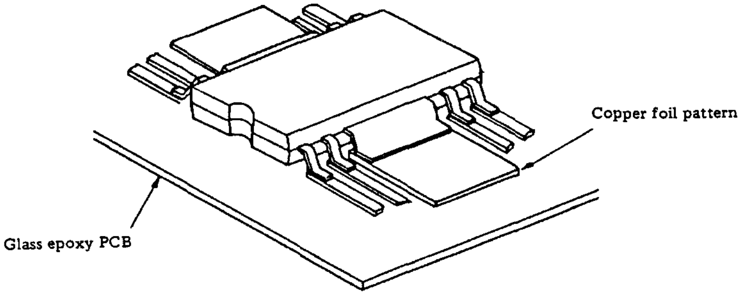
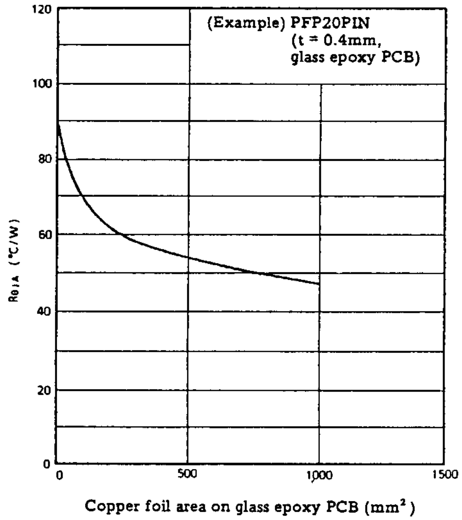


Fig. 5-4

As shown in Fig. 5-4, the PFP can be formed into a copper foil pattern on the PCB, and is usable as a radiator fin for the elements. The shape and dimensions of the copper foils are determined by thermal design of the elements. For mounting efficiency, refer to Fig. 5-5.

Fig. 5-5 $R\theta_{JA}$ mounting efficiency



5-3 Mounting of Flat Packages

For mounting Toshiba flat-type bipolar IC's, mounting methods conventionally used by our customers for mini-mold transistors and other small elements can be applied. Select the most appropriate one from among them.

(1) Method using soldering iron

Flat-type IC's should be secured with flux, adhesive or similar means. Use a soldering iron with a thin tip. Solder beads should be below 0.5 mm in dia., and soldering conditions should be 10 sec. at 260°C or 3 sec. less at 350°C. The second soldering condition is more applicable to tests and repairs—not to volume soldering.

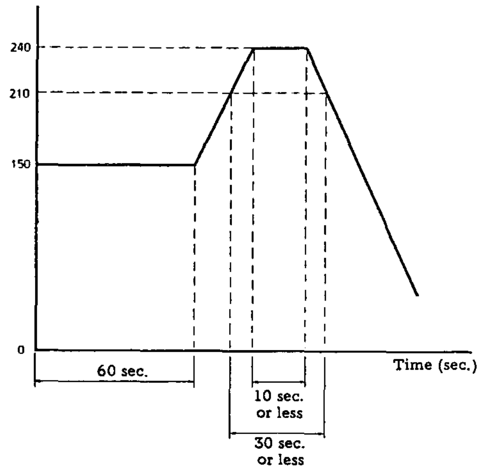
(2) Reflow soldering

Reflow soldering, the most common method for mounting chips (such as IC's, transistors, diodes, and resistors) on PCB's, is appropriate for volume soldering.

Those areas for parts to be mounted onto PCB's are coated with cream solder, and flat type IC's are mounted on them. The IC's are secured with the cream solder. Then the loaded PCB's are passed through a heating system (heat plate, tunnel kiln, or conveyor heater) to fuse the solder and join the IC's securely. An appropriate temperature range for this process is 210°C to 240°C. This method has the advantage of dislocations being corrected automatically when the solder is fused. Fig. 5-6 shows a recommended temperature profile for reflow soldering.

Precautions involved in reflow soldering are conducting sufficient preheating to remove thermal strain, and where infrared heaters are used, effect complete temperature control while duly considering the endothermic effect of black resin.

Fig. 5-6 Recommended temperature profile for reflow soldering



(3) Conductive pasting

Conductive pasting is a method that employs conductive paste instead of solder to mount parts. The paste is an epoxy mixed with gold of silver, which is coated on the contact areas. Parts are placed on them and cured at 100°C to 150°C for 1 to 3 hrs. This completes the process.

Compared with soldering methods, this method involves some difficulties in adhesion reliability. In this respect, adequate care must be taken.

(4) Mounting by dipping in solder

Mounting by dipping in solder cannot be recommended because it involves certain difficulties of thermal stress in pellets and a weakening of humidity resistance. However, it may be applicable for certain temperatures and for certain levels of reliability. Please consult Toshiba's Engineering or Quality Assurance Department.

6. PACKING INFORMATION

6. PACKING INFORMATION

To deliver flat IC packages, three package method are available: the same stick packages as the ordinary DIP type, taping, and embossed taping.

6-1 Stick Specifications for Flat Packages

- Shape and dimensions (Example: FLP type)

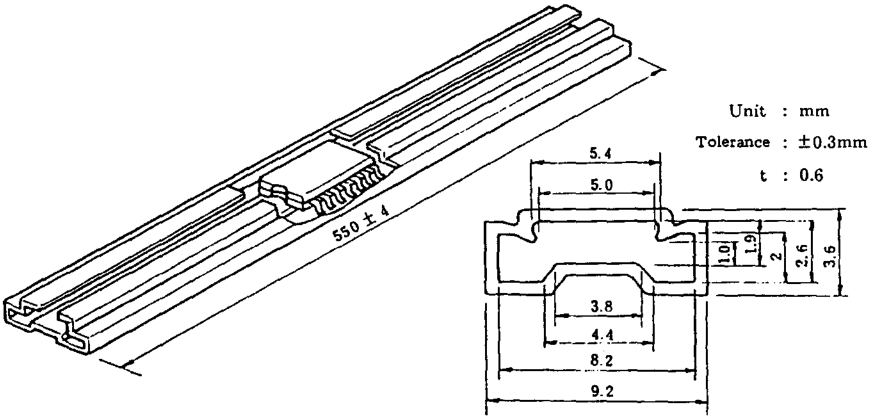


Fig. 6-1 Dimensions of Toshiba FLP bipolar IC stick

Material : Antistatic treated chloride vinyl
No. of IC's: 8-pin → 100 IC's/stick
14-/16-pin → 50 IC's/stick

* Both sides are fitted with synthetic-rubber stoppers.

6-2 Taping Specifications for Flat Packages

(1) Tape shape and dimensions (Fig. 6-2)

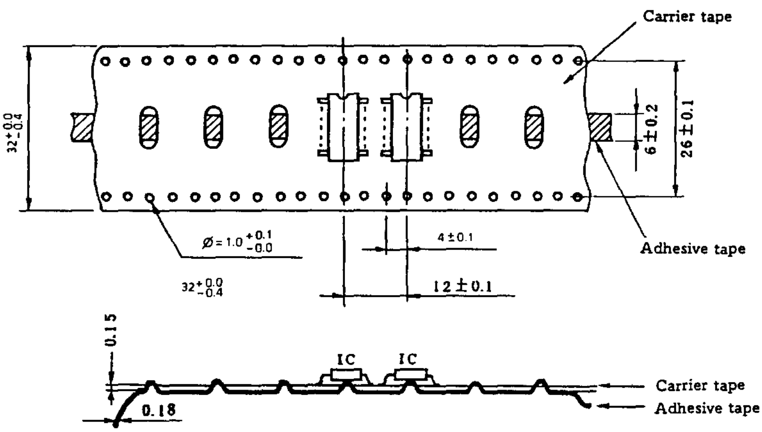


Fig. 6-2 Taping

(2) Winding reel shape and dimensions (Fig. 6-3)

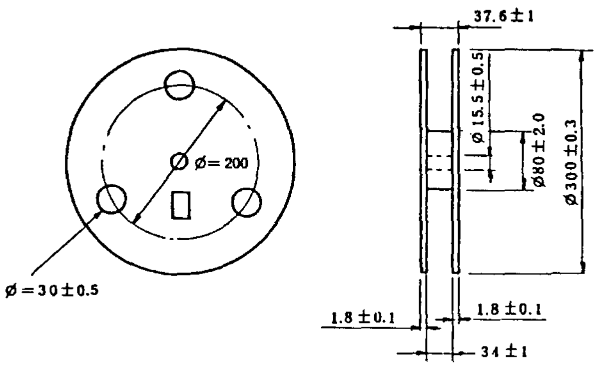


Fig. 6-3 Reel for taping

(3) Direction of tape winding

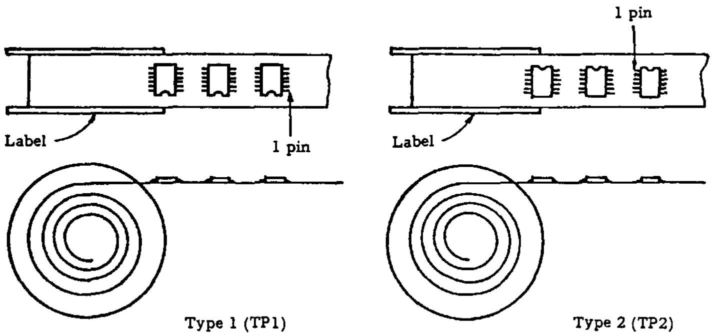


Fig. 6-4 Direction of tape winding

(4) Standard quantity

The standard unit is 2,000 IC's per reel.

Kindly place orders in quantities equal to multiples of 2,000.

(An exception is 1,000-IC reels. For motor IC's, these include PFP16, PFP20, sealed IC's, for examples TA7736F, and TA7259F.)

(5) How to order

When ordering flat-type bipolar IC's on taping, specify the product name, taping direction, and quantity as follows:

(Example)

TA7745F TP1 12,000

- Quantity (see item 4 above)
- Type of taping
- Product name

6-3 Embossed Taping Specifications for Flat Packages

(1) General information

Generally, for embossed taping packaging specifications and related matters for bipolar flat package IC's, applicable are EIAJ (RC-1009B) and JEDEC (EIA-481A).

(2) Tape shape and dimensions

a) Types TE1204, 1208 (Fig. 6-5)

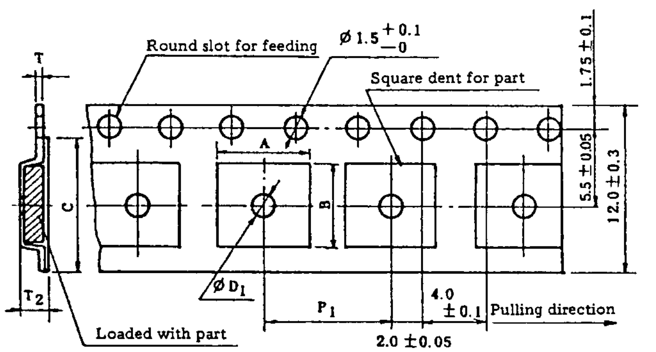


Fig. 6-5 Embossed taping types TE1204 and 1208

b) Types TE1604, 1608, 1612 (Fig. 6-6)

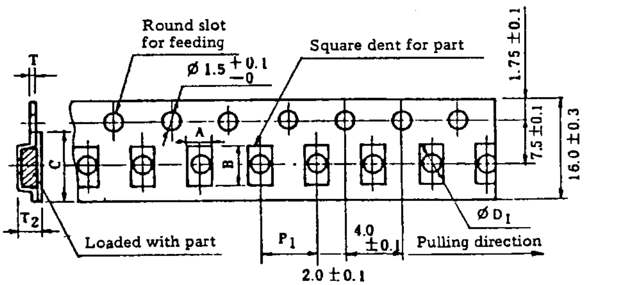


Fig. 6-6 Embossed taping types TE1604, 1608 and 1612

c) Types TE2412, 2416, 2420 (Fig. 6-7)

(Unit: mm)

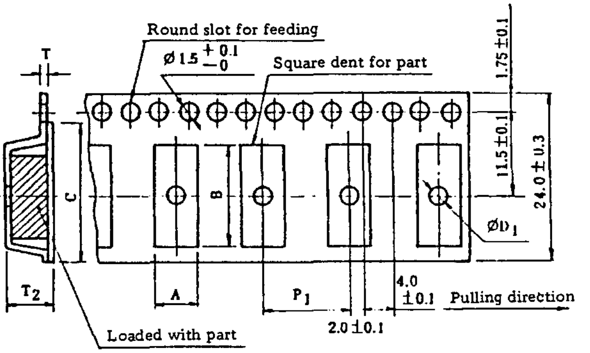


Fig. 6-7 Embossed taping types TE2412, 2416 and 2420

d) Types TE3212, 3216, 3220, 3224, 3228, 3232 (Fig. 6-8)

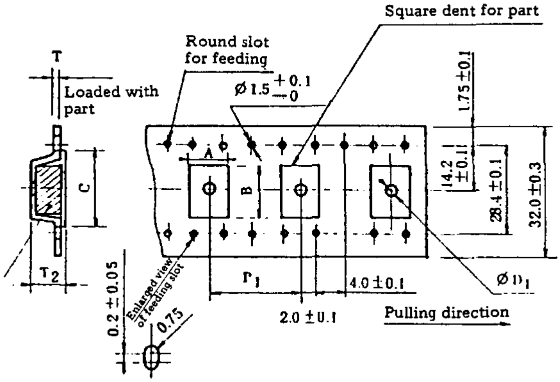


Fig. 6-8 Embossed taping types TE3212, 3216, 3220, 3224, 3228, and 3232

- For IC package shapes, the IC types listed above are selected, and the dimensions of A, B, C, D1, P1, T, and T2 are determined for packages. Please understand that, as for the standards for type selection and determination of dimensions, EIAJ [RC-1009B] is generally applied, with some exceptions involving handling.

(3) Seal tape dimensions

- Seal tape dimensions are appropriately determined for IC package shaped.

(4) Reel shape and dimensions (Fig. 6-9)

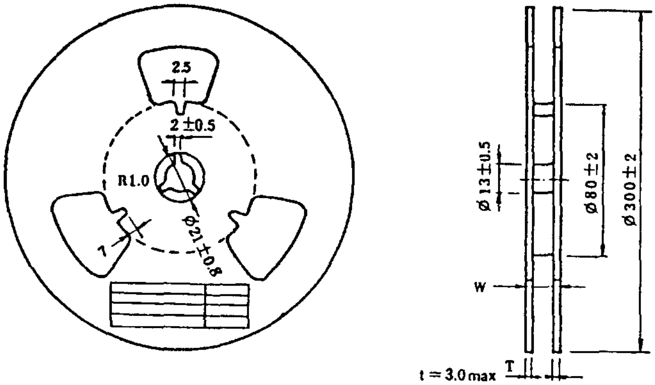


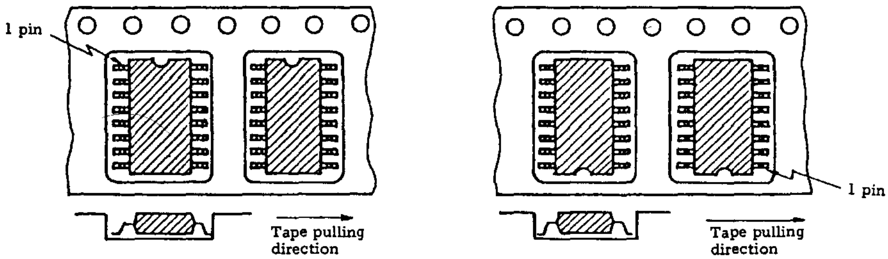
Fig. 6-9 Reel for embossed taping

- Length W varies with tape types as follows:

Tape shape	W	Reel
TE12□□ Type	$12.4^{+2.0}_{-0}$	
TE16□□ Type	$16.4^{+2.0}_{-0}$	R33
TE24□□ Type	$24.4^{+2.0}_{-0}$	R53
TE32□□ Type	$32.4^{+2.0}_{-0}$	R74

(5) Sealing direction (Fig. 6-10)

(Standard sealing direction)



Type L(EL) Type R(ER)

Fig. 6-10 Winding direction for embossed taping

- Two sealing methods, types L and R, are applicable. The use of the standard direction type L (EL) can be recommended.

(6) How to order

- When ordering IC's on embossed taping, specify the product name, type of taping, sealing direction, and quantity as follows.

  (Example) An order for 10,000 TA7745F IC's on embossed taping, sealing direction L:

  TA7745F (FL) 10000

  - Quantity*
  - Sealing direction (L or R)
  - Type of taping
  - Name of IC

  * One reel contains 2,000 IC's. Please specify in multiples of 2,000.

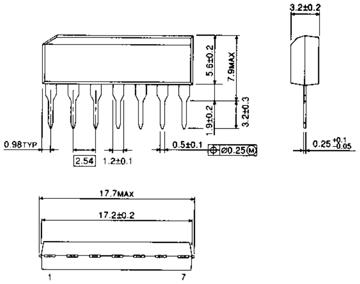
(7) Transport and maintenance

- During transportation, take care to avoid subjecting the tape to heavy vibration.
- As for transportation and storage, keep the goods away from direct sunlight and at ambient temperatures below 45°C to prevent aging of seal tape separation resistance, and/or tape deformation.

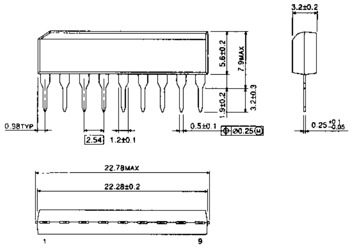
7. PACKAGE LIST

7. Package List

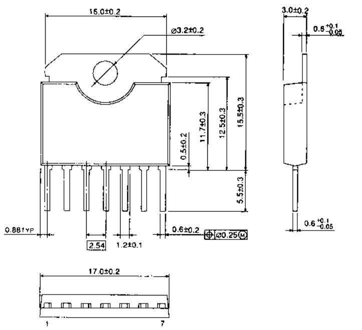
○ SIP 7-P-A



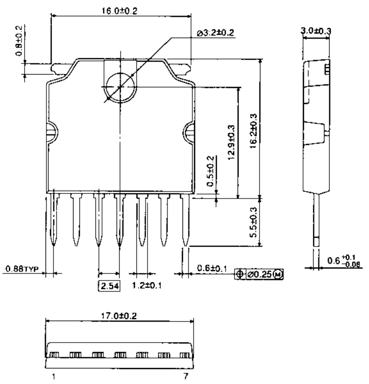
○ SIP 9-P-A



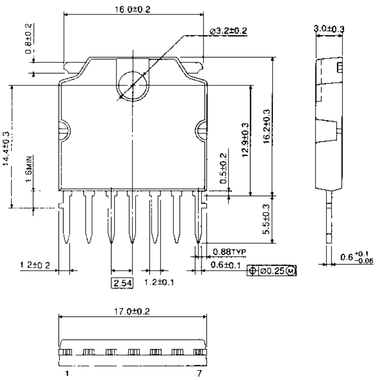
○ HSIP 7-P



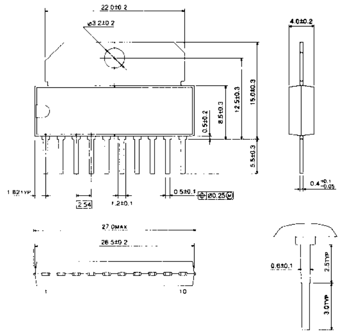
○ HSIP 7-P-A



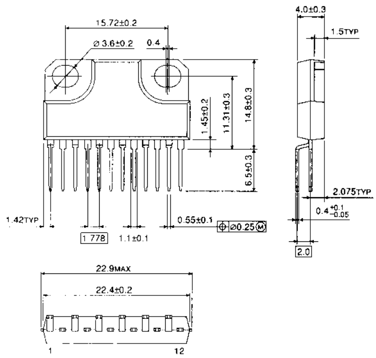
◯ HSIP 7-P-B



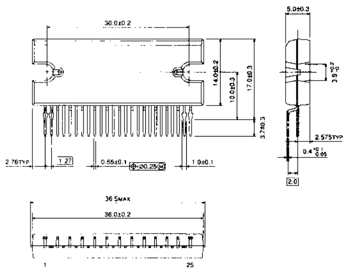
◯ HSIP 10-P



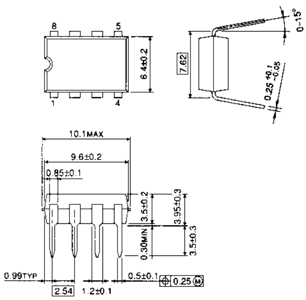
◯ HZIP 12-P-B



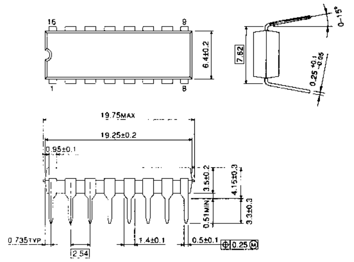
◯ HZIP 25-P



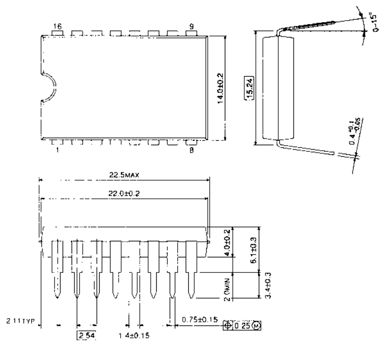
DIP 8-P-300A



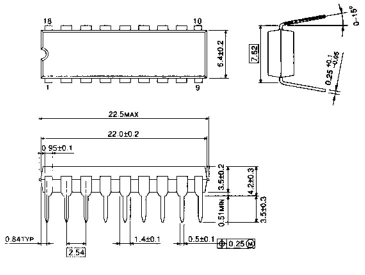
DIP 16-P-300A



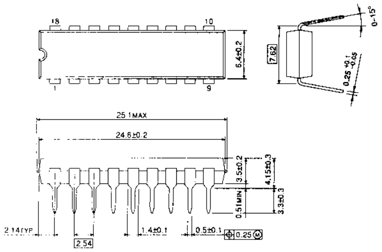
DIP 16-P-600



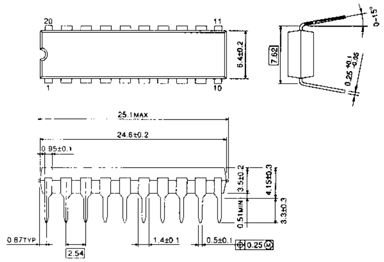
DIP 18-P-300A



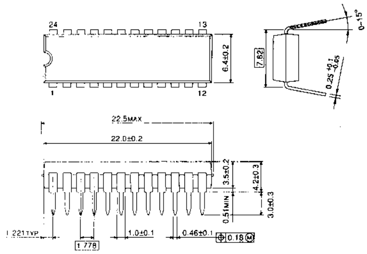
DIP 18-P-300D



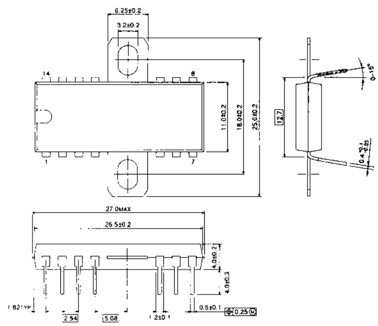
DIP 20-P-300A



SDIP 24-P-300



HDIP 14-P-500



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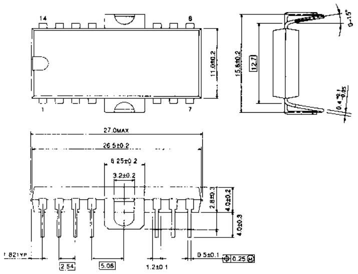
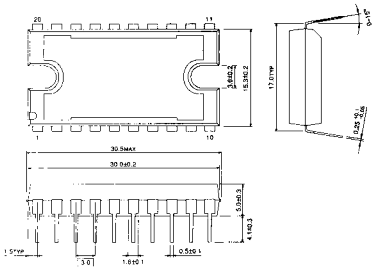


◯ HDIP 20-P



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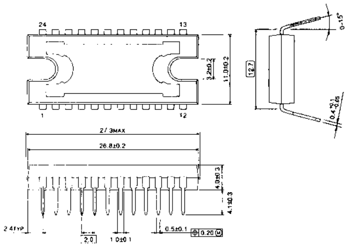
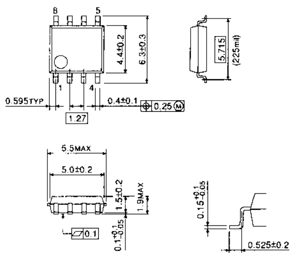
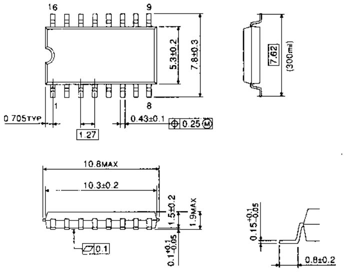


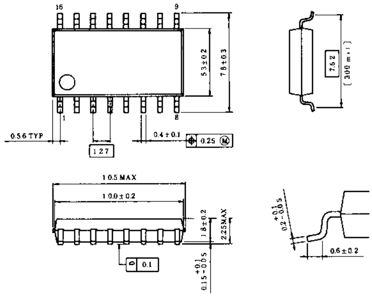
◯ SOP 8-P-225



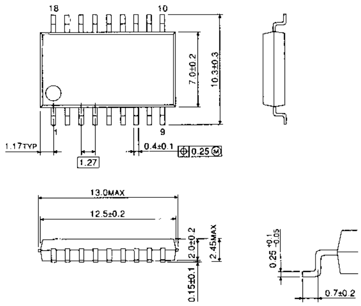
SOP 16-P-300



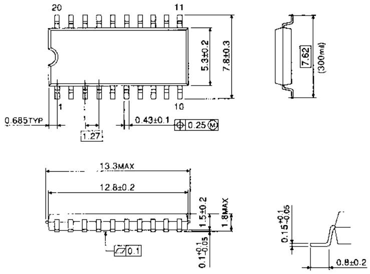
SOP 16-P-300A



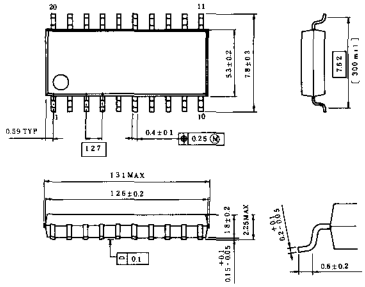
SOP 18-P-375



SOP 20-P-300



○ SOP 20-P-300A



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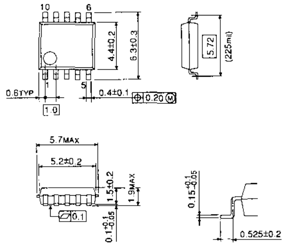

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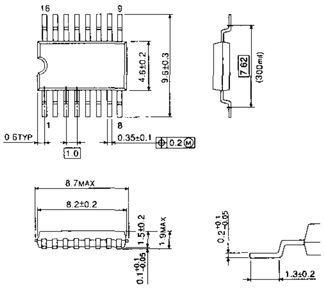
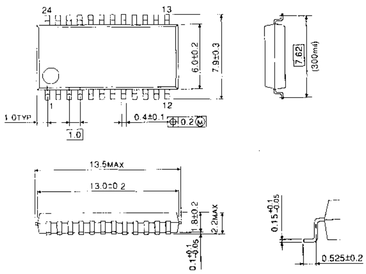


○ SSOP 24-P-300



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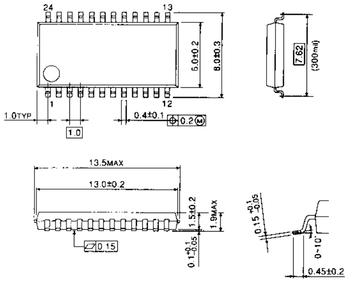

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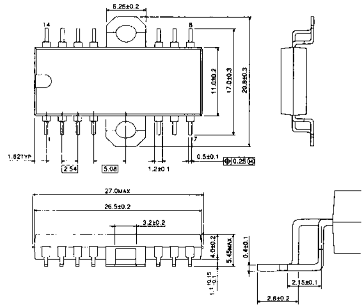

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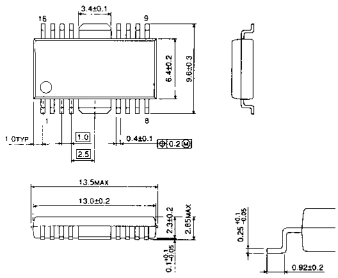

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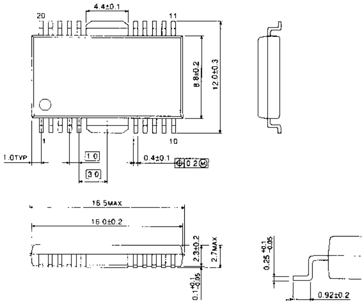
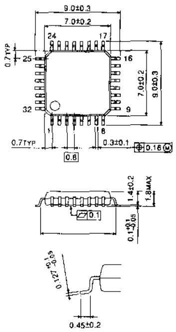


◯ QFP 32-P-0707



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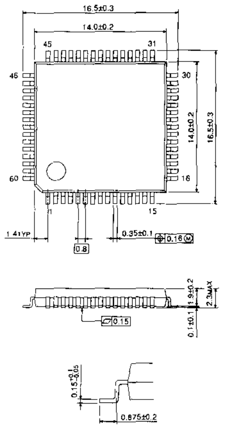

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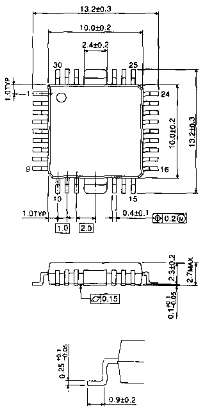
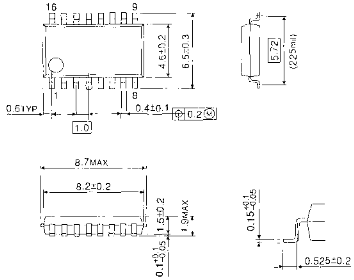


◯ SSOP 16 -P-225A



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