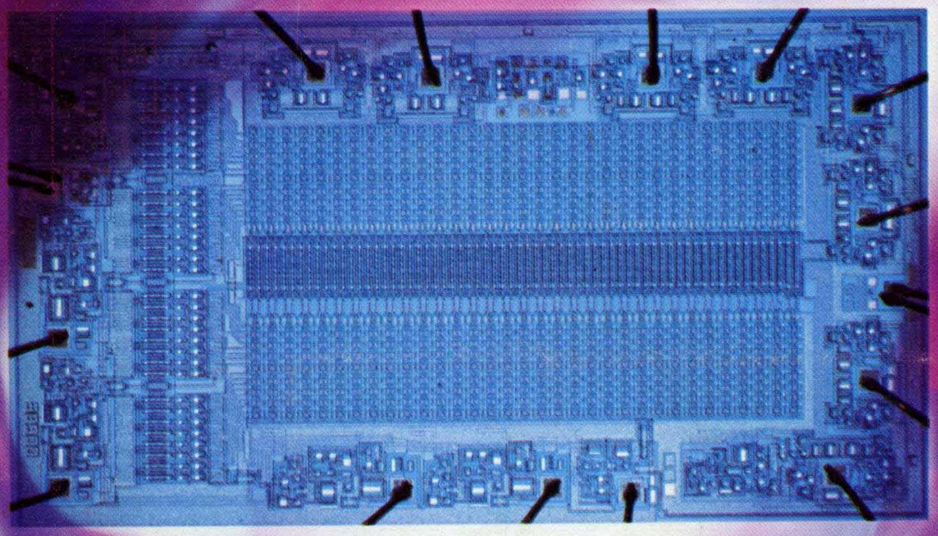
AUGUST 1975

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

INTEGRATED CIRCUITS



HARRIS SEMICONDUCTOR – IC's

Harris

INTEGRATED CIRCUITS DATA BOOK

This DATA BOOK contains complete technical information on linear and memory integrated circuits presently available from Harris Semiconductor as standard products. A similar catalog dedicated to digital products specifies the complete line of Harris CMOS logic devices. By the use of the tear-out card provided in the back of this catalog, speciality information such as application notes, chip data sheets, and information about all new products introduced since publication of this catalog, are available directly through your local Harris sales office. They are also available from your nearest Harris representative or distributor.

For your convenience a complete index of Harris integrated circuits is provided in both an alpha-numeric sequence organized by major product catagories such as linear and memory, and by a functional sequence. Although the alpha-numeric index tracks very closely with the organization of the data book, some exceptions do occur due to products combined on single data sheets. Warranting special attention for users of military product is the section on Harris Semiconductor's Dash 8 program. This section gives a complete description of processing used for 883 product available "off-the-shelf" from Harris. Complete physical dimensions of all packaging options are detailed in the section on package outlines. For ease of use, each major product section of this data book includes a complete industry cross reference index identifying industry cross reference numbers.

Harris is pleased that you would take this time to review our product line. We stand ready to support your production with world wide points of distribution. For your design convenience we offer a complete capability in applications assistance. Just call your local Harris office.

Thank you for thinking Harris.

AUGUST 1975

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

Printed in USA/8-75

Harris Semiconductor, Box 883, Melbourne, Florida, U.S.A. 32901
Harris Semiconductor, 53 Bd de Waterloo, B-1000 Brussels, Belgimum
Harris Semiconductor, Time-Life Building
2-3-6 Otemachi Chiyodaku, Tokyo, Japan

HARRIS SEMICONDUCTOR

HISTORY

A look at Harris Semiconductor is a look at one of the Semiconductor success stories of the past two decades. Originally a three man laboratory organized to develop proprietary and custom circuits, this small nucleus increased in size until by 1966 it was known throughout the industry as the Microelectronics Division (MED) of Radiation, Inc., a military systems house located in Melbourne, Florida. As MED, the division fostered high technology and was an industry leader in the manufacturing of hardened devices.

In many respects, the Division, as it is known today, was born in July 1967. It was then that the entire 320 acre Melbourne complex became part of Harris-Intertype Corporation. With a new corporate identity the semiconductor operation dedicated its proficiency in high technology to the development of a series of state-of-the-art devices aimed specifically at the industrial marketplace.

In September of 1970, the firm chose its present name of Harris Semiconductor, became an independent division reporting directly to corporate headquarters in Cleveland, Ohio, and was well intrenched as a leading supplier of sophisticated industrial ICs as well as of ICs used on major military and NASA programs.

The past few years has been a major growth in Harris Semiconductor's participation within the industrial IC marketplace. While continuing as a major supplier of military and DOD products, efforts to penetrate the industrial marketplace has grown to where industrial customers now constitute approximately 80 percent of the Division's total effort.

To support its present position within the industrial marketplace, Harris Semiconductor has developed highly refined national and international lines of distribution. Included is a network of OEM sales offices, technically proficient manufacturers' representatives, and a family of distributors consisting of leaders within the electronic industry.

The Division now provides multiple product and service outlets within each significant market location and has opened direct sales offices in both Brussels, Belgium and Tokyo, Japan. Each outlet, through the combined efforts of OEM, manufacturer's representatives, and distributors, offers a complete line of complimenting product, literature and applications support.

FOR THE FUTURE

Harris Semiconductor now occupies over 225,000 square feet of floor space in five modern buildings located on the corporations's 320 acre site in Palm Bay, Florida. These facilities are equipped to perform the entire scope of Harris Semiconductor's operations but are augmented by offshore assembly facilities. Each operational site is designed for expansion. A recently completed 8 million dollar expansion and referbishment program resulted in three-inch waffer processing across all product lines assuring customers with optimum in both pricing and delivery. Every effort is being made to guarantee that your association with Harris Semiconductor represents the finest in quality, reliability, delivery and price considerations.

TECHNOLOGY

Harris Semiconductor's significant contributions in process technology serve both the industrial and the military markets. In addition to pioneering the dielectric isolation process, Harris wields expertise in thin-film deposited on silicon dioxide, selective gold doping, buried n^+ and p^+ epitaxial layers, junction FETs, vertical npn and pnp transistors in the same monolithic structure, metallic aluminum bonding, multilevel interconnect processes, complementary MOS, junction isolated complementary MOS and p-channel MOS processes.

PRODUCTS

Harris produces a wide family line of devices embracing linear, digital and memory functions. Within the family of operational amplifiers, Harris has long offered state-of-the-art parameters without peer in monolithic circuitry. Now, this rapidly expanding linear line includes: phase locked loops, A/D and D/A encoders, and a rapidly expanding line of interface circuits. Harris is the largest single industry source of CMOS analog switches and multiplexers with a complete complement of alternate sources in addition to a strongly established proprietary line.

For the Digital world Harris Semiconductor is a leading supplier of standard logic CMOS. Nearly 100 devices are included to offer designers as comprehensive a CMOS logic selection as is available from industry. In addition to full alternate sourcing of the 54/74C family, product selection includes viable product from both the 4000 and 14500 families. Harris is actively pursuing JAN qualification of the entire CMOS product line. In the field of memories Harris pioneered and developed the concept of field programmable read only memories (PROM). Now available as a Harris exclusive is the complete family of "Generic" PROMs featuring a wide selection of organizations with identical programming requirements, input/output characteristics, fuse geometries and technology, as well as circuit configuration. The company is also aggresively pursuing development of a family of RAM products in both bipolar and MOS technology.

CHIP POLICY

Wherever practical the Harris product line is also made available in chip form. For further detail, contact either the Digital, Linear or Memory Product Marketing Managers respectively.

DASH 8 NOTICE

As a special serivce to users of high rel products Harris makes instantly available high reliability on many of our product lines. Simply by adding its postscript -8 to appropriate Harris part numbers "off the shelf" delivery can be obtained of product screened to MIL-STD-883 Method 5004 Class B. For details concerning this special Harris program for High Rel users, see the Dash 8 section of this catalog.

EXPLANATION OF HARRIS PRODUCT CODE

Harris products are designated by "Product Code". When ordering, please refer to products by the full code. Harris products will always begin with "H", except in the case of chip products. Specific device numbers will always be isolated by hyphens.

H M 1 - 7620 - 5

PREFIX:
H (Harris)

FAMILY:
A – Analog
CF – Chip Form
D – Digital
I – Interface
M – Memory(1)

Note 1:
EXCEPT –
HPROM X-1024-X
HPROM X-8256-X
HPROM X-0152-X

PACKAGE:
1 – Dual In-Line
2 – TO-5 Type
7 – Mini DIP
9 – Flat Pack
0 – Chip Form

DEVICE NUMBER

TEMPERATURE:(2)

2	-55°C to 125°C
4	-25°C to 85°C
5	0°C to 75°C
6	100% 25°C Probe (Dice Only)
8	Dash 8 Program MIL-STD-883 Class B HA-2700-8 (Example Only)
9	-40°C to 85°C (4000 Series CMOS)

Note 2:
The 54C/74C CMOS Family temperature designation is contained in the Part Number:

54CXX	-55°C to 125°C
74CXX	0°C to 70°C

HARRIS ALPHA-NUMERIC INDEX

Linear (Continued)

PRODUCT NUMBER	DESCRIPTION	PAGE
HA-2700	Low Power, High Performance Operational Amplifier	Li-79
HA-2704	Low Power, High Performance Operational Amplifier	Li-79
HA-2705	Low Power, High Performance Operational Amplifier	Li-79
HA-2720	Low Power, Current Programmable Operational Amplifier	Li-83
HA-2725	Low Power, Current Programmable Operational Amplifier	Li-83
HA-2730	Low Power, Dual, Current Programmable Operational Amplifier	Li-89
HA-2735	Low Power, Dual, Current Programmable Operational Amplifier	Li-89
HA-2820	Phase Locked Loop	Li-95
HA-2825	Phase Locked Loop	Li-95
HA-2900	Chopper Stabilized Operational Amplifier	Li-99
HA-2904	Chopper Stabilized Operational Amplifier	Li-99
HA-2905	Chopper Stabilized Operational Amplifier	Li-99
HD-0165	Key Board Encoder	Li-103
HD-245	Triple Line Transmitter	Li-107
HD-246	Triple Line Receiver	Li-107
HD-248	Triple Party-Line Receiver	Li-107
HD-249	Triple Line Receiver	Li-107
HD-545	Triple Line Transmitter	Li-107
HD-546	Triple Line Receiver	Li-107
HD-548	Triple Party-Line Receiver	Li-107
HD-549	Triple Line Receiver	Li-107
HD-1488	Quad Line Driver	Li-111
HD-1489	Quad Line Receiver	Li-113
HD-1489A	Quad Line Receiver	Li-115
HI-200	Dual SPST Analog Switch	Li-117
HI-201	Quad SPST Analog Switch	Li-123
HI-506A	CMOS 16 Channel Analog Multiplexer	Li-129
HI-507A	Dual -8 CMOS Multiplexer	Li-129
HI-508A	8 Channel Analog Multiplexer	Li-135
HI-509A	8 Channel Analog Multiplexer	Li-135
HI-1080	8-Bit, D to A Convertor High Speed Monolithic	Li-141
HI-1085	8-Bit, D to A Convertor High Speed Monolithic	Li-141
HI-1800A	DPDT - Low Leakage 4-Channel Analog Switch	Li-145
HI-1818A	8 Channel/Differential, 8-Channel Multiplexer	Li-149
HI-1828A	Dual 4-Channel Multiplexer	Li-149
HI-5040 – 5051	CMOS Analog Switches	Li-153
HI-5046A	CMOS Analog Switches	Li-153
HI-5047A	CMOS Analog Switches	Li-153

Memory

PRODUCT NUMBER	DESCRIPTION	PAGE
HD-234	Low V Hex Interface Inverters	Me-3
HD-235	HI V Hex Interface Driver	Me-3
HD-534	Low V Hex Interface Inverters	Me-3
HD-535	HI V Hex Interface Driver	Me-3
HD-6600	Quad Power Strobe	Me-9
HD-6605	Quad Logic Strobe	Me-9
HM-010	5 x 8 MIL-TEMP Diode Matrices	Me-13
HM-030	6 x 8 MIL-TEMP Diode Matrices	Me-13

Memory (Continued)

FUNCTIONAL CROSS REFERENCE

Linear

ANALOG MULTIPLEXERS AND SWITCHES

MULTIPLEXERS

		PAGE
HI-506A	CMOS 16 Channel Analog Multiplexer	Li-129
HI-507A	Dual - 8 CMOS Multiplexer	Li-129
HI-508A	8 Channel Analog Multiplexer	Li-135
HI-509A	8 Channel Analog Multiplexer	Li-135
HI-1818A	8 Channel/Differential, 8-Channel Multiplexer	Li-149
HI-1828A	Dual 4-Channel Multiplexer	Li-149

SWITCHES

HI-200	Dual SPST Analog Switch	Li-117
HI-201	Quad SPST Analog Switch	Li-123
HI-1800A	DPDT-Low Leakage 4-Channel Analog Switch	Li-145
HI-5040 – 5051	CMOS Analog Switches	Li-153
HI-5046A	CMOS Analog Switches	Li-153
HI-5047A	CMOS Analog Switches	Li-153

OPERATIONAL AMPLIFIERS

F. E. T. INPUT

HA-2000	F. E. T. Input Preamplifier	Li-15
HA-2000A	F. E. T. Input Preamplifier	Li-15
HA-2005	F. E. T. Input Preamplifier	Li-15
HA-2005A	F. E. T. Input Preamplifier	Li-15
HA-2050	High Slew Rate F. E. T. Input Operational Amplifiers	Li-19
HA-2050A	High Slew Rate F. E. T. Input Operational Amplifiers	Li-19
HA-2055	High Slew Rate F. E. T. Input Operational Amplifiers	Li-19
HA-2055A	High Slew Rate F. E. T. Input Operational Amplifiers	Li-19
HA-2060	Wide Band F. E. T. Input Operational Amplifiers	Li-23
HA-2060A	Wide Band F. E. T. Input Operational Amplifiers	Li-23
HA-2065	Wide Band F. E. T. Input Operational Amplifiers	Li-23
HA-2065A	Wide Band F. E. T. Input Operational Amplifiers	Li-23

HIGH SLEW RATE

HA-2500	High Slew Rate Operational Amplifiers	Li-43
HA-2502	High Slew Rate Operational Amplifiers	Li-43
HA-2505	High Slew Rate Operational Amplifiers	Li-43
HA-2510	High Slew Rate Operational Amplifiers	Li-47
HA-2512	High Slew Rate Operational Amplifiers	Li-47
HA-2515	High Slew Rate Operational Amplifiers	Li-47
HA-2520	High Slew Rate Operational Amplifiers	Li-51
HA-2522	High Slew Rate Operational Amplifiers	Li-51
HA-2525	High Slew Rate Operational Amplifiers	Li-51
HA-2530	Wide Band High Slew Inverting Amplifiers	Li-55
HA-2535	Wide Band High Slew Inverting Amplifiers	Li-55

LOW NOISE WIDE BAND

HA-909	Low Noise, Operational Amplifiers	Li-11
HA-911	Low Noise, Operational Amplifiers	Li-11

LOW POWER

HA-2700	Low Power, High Performance Operational Amplifiers	Li-79
HA-2704	Low Power, High Performance Operational Amplifiers	Li-79
HA-2705	Low Power, High Performance Operational Amplifiers	Li-79
HA-2720	Low Power, Current Programmable Operational Amplifiers	Li-83
HA-2725	Low Power, Current Programmable Operational Amplifiers	Li-83
HA-2730	Low Power, Dual, Current Programmable Operational Amplifiers	Li-89
HA-2735	Low Power, Dual, Current Programmable Operational Amplifiers	Li-89

PRECISION HIGH ZIN WIDE BAND

HA-2600	High Impedance Operational Amplifiers	Li-59
HA-2602	High Impedance Operational Amplifiers	Li-59

Memory

DIGITAL DATA SHEETS

Harris is proud to be a fully qualified supplier of both the 4000 and 54/74C standard CMOS logic families. For that reason a special separate catalog has been prepared giving full technical descriptions of all CMOS devices. Included in the catalog is a cross reference guide identifing alternate sources both by manufacturer and by device function. Users of CMOS will decide for themselves the relative merits of competing logic families. The current trend is to mix the advantages of both. Regardless of choice, users of Harris CMOS will benefit from obtaining both their requirements from one supplier. Should you require use of a Harris CMOS catalog please complete the appropriate information on the Literature Request tear-out card found at the back of this catalog and return it to your nearest sales office for immediate action.

HD-54C/74* SERIES
MANUFACTURER CROSS REFERENCE

FUNCTION	HARRIS	NATIONAL	TELEDYNE
Quad 2 Input NAND	HD-74C00	MM74C00	MM74C00
Quad 2 Input NOR	HD-74C02	MM74C02	MM74C02
Hex Inverter	HD-74C04	MM74C04	MM74C04
Quad 2 Input AND	HD-74C08	MM74C08	MM74C08
Triple 3 Input NAND	HD-74C10	MM74C10	MM74C10
Hex Schmitt Trigger	HD-74C14	MM74C14	MM74C14
Dual 4 Input NAND	HD-74C20	MM74C20	MM74C20
8 Input NAND	HD-74C30	MM74C30	–
Quad 2 Input OR	HD-74C32	MM74C32	–
BCD to Decimal Decoder	HD-74C42	MM74C42	MM74C42
BCD to 7 Segment Decoder	HD-74C48	MM74C48	–
Dual J-K Flip-Flops with Clear	HD-74C73	MM74C73	MM74C73
Dual D Flip-Flop	HD-74C74	MM74C74	MM74C74
Dual J-K Flip-Flops with Clear and Preset	HD-74C76	MM74C76	MM74C76
4-Bit Binary Full Adder	HD-74C83	MM74C83	–
4-Bit Magnitude Comparator	HD-74C85	MM74C85	–
Quad 2 Input Exclusive OR	HD-74C86	MM74C86	–
64-Bit Three State Random Access Read/Write Memory	HD-74C89	MM74C89	–
4-Bit Right-Shift Left-Shift Register	HD-74C95	MM74C95	MM74C95
Dual J-K Flip-Flops with Clear	HD-74C107	MM74C107	MM74C107
8 Channel Digital Multiplexer	HD-74C151	MM74C151	MM74C151
4 Line to 16 Line Decoder/ Demultiplexer	HD-74C154	MM74C154	MM74C154
Quad 2 Input Multiplexers	HD-74C157	MM74C157	MM74C157
Decade Counter with Asynchronous Clear	HD-74C160	MM74C160	MM74C160
Binary Counter with Asynchronous Clear	HD-74C161	MM74C161	MM74C161
Decade Counter with Synchronous Clear	HD-74C162	MM74C162	MM74C162
Binary Counter with Synchronous Clear	HD-74C163	MM74C163	MM74C163
8-Bit Parallel Out Serial Shift Register	HD-74C164	MM74C164	MM74C164
Parallel Load 8 Bit Shift Register	HD-74C165	MM74C165	–

*All Listed 74C Devices Are Available Also As 54C

FUNCTION	HARRIS	NATIONAL	TELEDYNE
Three State Quad D Flip-Flop	HD-74C173	MM74C173	MM74C173
Hex D Flip-Flop	HD-74C174	MM74C174	–
Quad D Flip-Flop	HD-74C175	MM74C175	–
Synchronous 4-Bit Up/ Down Decade Counter	HD-74C192	MM74C192	MM74C192
Synchronous 4-Bit Up/ Down Binary Counter	HD-74C193	MM74C193	MM74C193
4-Bit Registers	HD-74C195	MM74C195	MM74C195
256-Bit Three State Random Access Read/Write Memory	HD-74C200	MM74C200	–
Dual Monostable Multivibrator	HD-74C221	MM74C221	–
Hex Inverting TTL Buffer	HD-74C901	MM74C901	–
Hex Non-Inverting TTL Buffer	HD-74C902	MM74C902	–
Hex Inverting PMOS Buffer	HD-74C903	MM74C903	–
Hex Non-Inverting PMOS Buffer	HD-74C904	MM74C904	–
Three State Hex Non-Inverting Buffer	HD-80C95**	MM80C95	–
Three State Hex Non-Inverting Buffer	HD-80C97**	MM80C97	–

*All Listed 74C Devices Are Also Available As 54C.

**All Listed 80C Devices Are Also Available As 70C.

HD-4000 SERIES
MANUFACTURER CROSS REFERENCE

FUNCTION	HARRIS	RCA	NATIONAL	MOTOROLA
Dual 3 Input NOR Gate + Inverter	HD-4000	CD4000	–	MC14000
Quad 2 Input NOR	HD-4001	CD4001	MM4601	MC14001
Dual 4 Input NOR	HD-4002	CD4002	MM4602	MC14002
18 Stage Static Shift Register	HD-4006	CD4006	MM4606	MC14006
Dual Complementary Pair + Inverter	HD-4007	CD4007	–	MC14007
4-Bit Full Adder	HD-4008	CD4008	–	MC14008
Quad 2 Input NAND	HD-4011	CD4011	MM4611	MC14011
Dual 4 Input NAND	HD-4012	CD4012	MM4612	MC14012
Dual D Flip-Flop	HD-4013	CD4013	MM4613	MC14013
8 Stage Static Shift Register	HD-4014	CD4014	MM4614	MC14014
Dual 4 Static Shift Register	HD-4015	CD4015	–	MC14015
Decade Counter	HD-4017	CD4017	MM4617	MC14017
Preset/Divide by N Counter	HD-4018	CD4018	–	–
Quad AND/OR Select	HD-4019	CD4019	MM4619	–
14 Stage Binary/ Ripple Counter	HD-4020	CD4020	MM4620	MC14020
8 Stage Static Shift Register	HD-4021	CD4021	MM4621	MC14021
Divide by 8 Counter	HD-4022	CD4022	MM4622	MC14022
Triple 3 Input NAND	HD-4023	CD4023	MM4623	MC14023
7 Stage Binary Counter	HD-4024	CD4024	–	MC14024
Triple 3 Input NOR	HD-4025	CD4025	MM4625	MC14025
Dual J=K Flip-Flop	HD-4027	CD4027	MM4627	MC14027
BCD/Decimal Decoder	HD-4028	CD4028	–	MC14028
Preset Up-Down Counter	HD-4029	CD4029	–	–
Quad Exclusive OR	HD-4030	CD4030	MM4630	–
4 Stage Parallel In/ Parallel Out Shift Register	HD-4035	CD4035	MM4635	MC14035
12 Stage Binary/ Ripple Counter	HD-4040	CD4040	–	MC14040
Quad Clocked "D" Latch	HD-4042	CD4042	–	MC14042
Quad Three State R/S Latch NOR	HD-4043	CD4043	–	–
Quad Three State NAND R/S Latch	HD-4044	CD4044	–	–
Hex Buffer, Inverting	HD-4049	CD4049	MM4649	MC14049
Hex Buffer, Non-Inverting	HD-4050	CD4050	MM4650	MC14050
Quad Bilateral Switch	HD-4066	CD4066	MM4666	MC14066

FUNCTIONAL CROSS REFERENCE OF HD-4000 SERIES AND HD-54C/74C SERIES

ARITHMETIC FUNCTIONS	4000 SERIES	54C/74C* SERIES
Four-Bit Binary Full Adder	HD-4008	HD-74C83
Four-Bit Magnitude Comparator	–	HD-74C85
COUNTERS		
7 Stage Binary	HD-4024	–
12 Stage Ripple-Carry Binary	HD-4040	–
14 Stage Ripple-Carry Binary	HD-4020	–
Decade Counter/ Divider +10 Decoded Decimal Outputs	HD-4017	–
Divide by 8 Counter/Divider with 8 Decimal Outputs	HD-4022	–
Presettable Divide by "N" Counter Fixedor Programmable	HD-4018	–
Presettable Up/Down Counter Binary or BCD Decade	HD-4029	–
Synchronous Decade	–	HD-74C160
Synchronous Binary	–	HD-74C161
Fully Synchronous Decade	–	HD-74C162
Fully Synchronous Binary	–	HD-74C163
Synchronous Up/Down Decade	CD40192 (RCA)**	HD-74C192
Synchronous Up/Down Binary	CD40193 (RCA)**	HD-74C193
DECODERS/MULTIPLEXERS		
Quad Bilateral Switch	HD-4066	–
BCD to Decimal Decoders	HD-4028	HD-74C42
BCD to 7 Segment Decoder	–	HD-74C48
8 Channel Digital Multiplexer	–	HD-74C151
4 Line to 16 Line	–	HD-74C154
Quad 2 Input	–	HD-74C157
FLIP-FLOPS		
Dual "D" with Set/Reset	HD-4013	HD-74C74
Dual "J-K" with Set/Reset	HD-4027	–
Quad Clocked "D" Latch	HD-4042	–
Quad Three State NOR Reset/Set Latch	HD-4043	–
Quad Three State NAND Rest/Set Latch	HD-4044	–
Dual "J-K" Master/Slave	–	HD-74C73
Dual "J-K" Master/Slave with Preset	–	HD-74C76
Dual "J-K"	–	HD-74C107
Quad "D" Three State (Quad Latch)	CD4076 (RCA)**	HD-74C173
Hex "D"	–	HD-74C174
Quad "D"	–	HD-74C175

*All Listed 74C Devices Are Available Also As 54C.

**Pin Compatible with 54C/74C.

GATES/BUFFERS/INVERTERS

Dual 3 Input NOR Gate + Inverter	HD-4000	–
Quad 2 Input NOR	HD-4001	HD-74C02
Dual 4 Input NOR	HD-4002	–
Quad 2 Input NAND	HD-4011	HD-74C00
Dual 4 Input NAND	HD-4012	HD-74C20
Triple 3 Input NAND	HD-4023	HD-74C10
Triple3 Input NOR	HD-4025	–
Hex Inverter	CD4069 (RCA)**	HD-74C04
Quad 2 Input AND	–	HD-74C08
8 Inputs NAND	–	HD-74C30
Quad 2 Input OR	–	HD-74C32
Quad 2 Input Exclusive OR	HD-4030 MC14507 (MOTO)**	HD-74C86
Quad AND-OR Select	HD-4019	–
Dual Complementary Pair + Inverter	HD-4007	–
Hex Buffer/Converter, Inverting	HD-4049	HD-74C901
Hex Buffer/Converter, Non-Inverting	HD-4050	HD-74C902
Hex Inverting PMOS Buffer	–	HD-74C903
Hex Non-Inverting PMOS Buffer	–	HD-74C904
Three State Hex Buffer	–	HD-80C95***
Three State Hex Buffer	–	HD-80C97***

SHIFT REGISTERS

18 Stage Static Shift Register	HD-4006	–
Dual 4 Stage with Serial Input/ Parallel Output	HD-4015	–
8 Stage Synchronous Parallel Input/ Serial Output	HD-4014	HD-74C165
8 Stage Asynchronous Parallel Input/ Serial Output	HD-4021	–
4 Stage with J-$\overline{K}$ Input and True/ Complement Output	HD-4035	–
4-Bit Right-Shift Left-Shift	–	HD-74C95
8-Bit Serial-In Parallel Out	–	HD-74C164
4-Bit Parallel-In Parallel-Out	–	HD-74C195

SPECIAL FUNCTIONS

Hex Schmitt Trigger	CD40106 (RCA)** MC14584 (MOTO)**	HD-74C14
Dual Monostable Multivibrator	–	HD-74C221
64-Bit Three State Random Access Read/Write Memory	–	HD-74C89
256-Bit Three State Random Access Read/Write Memory	–	HD-74C200

*All Listed 74C Devices Are Also Available As 54C.

**Pin Compatible with 54C/74C.

***All Listed 80C Devices Are Available Also As 70C.

LINEAR DATA SHEETS

The Harris family of analog devices ... a select line of linears featuring state-of-the-art performance and monolithic reliability at realistic prices.

Harris Semiconductor has long been synonymous with high performance state-of-the-art linear intergrated circuits. And, indeed, wherever monolithic performance is measured in terms of slew rate, bandwidth, and power consumption, Harris operational amplifiers still represent the leading edge of monolithic technology.

Linears from the Harris family can also lower your instrumentation systems costs substantially, improve performance, lower parts count, reduce design time, and increase system reliability. In the past, the speed and accuracy of most of these linears could only be approached with discrete devices, hybrids, or modules.

Excellent applications for Harris linears include: data acquisition, test equipment, telemetry, medical instruments, and process control.

Harris is now the industry's leading manufacturer of CMOS analog switches and multiplexers featuring devices both with and without built-in overvoltage protection. All Harris switches and multiplexers utilize a special process that completely eliminates latchup while greatly reducing chances of channel interaction.

Technical advantage and volume production are both backed up by immediate nation wide applications support. When you think linears ... think Harris.

LINEAR ALPHA-NUMERICAL INDEX

HARRIS OPERATIONAL AMPLIFIERS

Selection Guide for Military Applications

PARAMETER†	-55°C to +125°C													UNITS
		F.E.T. PREAMP						PRAM™	S/H					
	HA-909	HA-2000	HA-2000A	HA-2050	HA-2050A	HA-2060	HA-2060A	HA-2400	HA-2420	HA-2500	HA-2502	HA-2510	HA-2512	
INPUT CHARACTERISTICS														
Offset Voltage	6	25	12	30	17	30	15	7	6	8	10	11	14	mV
Drift (Typ.)	10	50	20	50	20	50	20	20	5	20	20	20	25	μV/°C
Bias Current	300 (1)	10	10	10	10	10	10	400	400	400	500	400	500	nA
Offset Current	300	5	5	5	5	5	5	100	100	50	100	50	100	nA
Common Mode Range	±12	±10	±10	±10	±10	±10	± 10	±10	±10	±10	±10	± 10	±10	V
INPUT NOISE (1)	5													μVRMS
TRANSFER CHARACTERISTICS														
Large Signal Voltage Gain	25K	.98	.98	5K	5K	60K	60K	25K	25K	15K	10K	7.5K	5K	V/V
Common Mode Rejection Ratio	80	80	80	74	74	74	74	80	80	80	74	80	74	dB
Bandwidth (Typ.) (1)	7	10	10	20(3)	20(3)	24(3)	24(3)	16(3)	2	12	12	12	12	MHz
OUTPUT CHARACTERISTICS														
Output Voltage Swing	± 12	± 10	±10	± 10	± 10	±10	± 10	±10	±10	± 10	± 10	±10	± 10	V
Output Current (1)	±20	+5(1)	+5(1)	± 10(1)	± 10(1)	± 10(1)	± 10(1)	± 20(1)	±10	± 10	±10	±10	± 10	mA
Full Power Bandwidth (Typ.) (1)	25	1,000(3)	1,000(3)	2,000(3)	2,000 (3)	600 (3)	600(3)	500(3)	70	500	500	1,000	1,000	kHz
TRANSIENT RESPONSE														
Rise Time (1)	75	50(3)	50(3)	50(3)	50 (3)	50(3)	50(3)	20(3)	100(3)	50	50	50	50	ns
Overshoot (1)	40	5(3)	5(3)	25(3)	25(3)	25(3)	25(3)	25(3)	20(3)	40	50	40	50	%
Slew Rate (1)	± 1.2	100(3)	100(3)	120(3)	120(3)	35(3)	35(3)	50(3)	5(3)	± 25	±20	± 50	± 40	V/μs
Settling Time (Typ.) (1)	(2)	(3) 0.4	(3) 0.4	(3) 0.4	(3) 0.4	(3) 0.8	(3) 0.8	(3) 1.5		0.33	0.33	0.25	0.25	μs
POWER SUPPLY CHARACTERISTICS														
Supply Current (1)	2.5	(1) 1.7	(1) 1.7	(1) 8.0	(1) 8.0	(1) 6.0	(1) 6.0	(1) 6.0	5.0	6.0	6.0	6.0	6.0	mA
Power Supply Rejection Ratio	80	80	80	74	74	74	74	80	80	80	74	80	74	dB
FUNCTIONAL CHARACTERISTICS														
Offset Adjust	Yes*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	
Compensation Components	0	0	0	0AV>3	0AV>3	0AV>5	0AV >5	0AV>10	0	0	0	0	0	
Output Protection	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	

PARAMETER†	-55°C to +125°C													UNITS
	HA-2520	HA-2522	HA-2530	HA-2600	HA-2602	HA-2620	HA-2622	HA-2630	HA-2640	HA-2650	HA-2700	HA-2720	HA-2730	HA-2900
INPUT CHARACTERISTICS												(5)	(5)		
Offset Voltage	11	14	3	6	7	6	7	± 300	6	± 5	5	5	5	.06	mV
Drift (Typ.)	20	25	5	5	5	5	5	(2)	15	8	5	8 to 10	8 to 10	.3	μV/°C
Bias Current	400	500	100	30	60	35	60	200	50	200	50	10 to 40	10 to 40	1	nA
Offset Current	50	100	20	30	60	35	60	(2)	35	60	30	7.5 to 20	7.5 to 20	.5	nA
Common Mode Range	±10	± 10	± .5	±11	± 11	± 11	11	± 10	± 35(4)	± 13	±11	± 10	± 10	±10	V
INPUT NOISE (1)															μVRMS
TRANSFER CHARACTERISTICS												(5)	(5)		
Large Signal Voltage Gain	7.5K	5K	100K	70K	60K	70K	60K	.85	75K	20K	100K	25K	25K	10^6	V/V
Common Mode Rejection Ratio	80	74	86	80	74	80	74	(2)	80	80	86	80	80	120	dB
Bandwidth (Typ.) (1)	25	25	20	12	12	35	35	8	4	8	1	.01 to 10	.01 to 10	3	MHz
OUTPUT CHARACTERISTICS												(5)	(5)		
Output Voltage Swing	±10	± 10	± 10	±10	±10	±10	±10	± 10	±35(4)	±13	±11	± 13.5(3)	± 13.5(3)	±10	V
Output Current (1)	±10	± 10	±25	±15	±10	±10	± 10	±400	±12	20(3)	±22(3)	± .5 to 5.0(3)	± .5 to 5.0(3)	±10	mA
Full Power Bandwidth (Typ.) (1)	1,500	1,500	5,000	75	75	600	600	8,000	23	30	50	1.5 to 80(3)	1.5 to 80(3)	40	kHz
TRANSIENT RESPONSE												(5)	(5)		
Rise Time (1)	50	50	40	60	60	45	45	30(3)	60(3)	40(3)	(2)	200 to 2,000(3)	200 to 2,000(3)	200(3)	ns
Overshoot (1)	40	50	45	40	40	(2)	(2)	25(3)	15(3)	15(3)	(2)	5 to 15(3)	5 to 15 (3)	20(3)	%
Slew Rate (1)	±100	± 80	±280	± 4	± 4	±25	± 20	200	5(3)	± 2	±10	.1 to .8(3)	.1 to .8(3)	2.5(3)	V/μs
Settling Time (Typ.) (1)	0.20	0.20	.5	1.5	1.5	0.30	0.30	.5(3)	1.5(3)	1.5(3)	5.0	(2)	(2)	(2)	μs
POWER SUPPLY CHARACTERISTICS												(5)	(5)		
Supply Current (1)	6.0	6.0	6	3.7	4.0	3.7	4.0	20	3.8	3	0.15	.02 to .2	.02 to .2	5	mA
Power Supply Rejection Ratio	80	74	86	80	74	80	74	66	80	80	86	80	80	120	dB
FUNCTIONAL CHARACTERISTICS															
Offset Adjust	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Dip Pkg. Only	Yes	Yes	Yes	No	
Compensation Components	0 AV>3	0 AV>3	1	0	0	0 AV>5	0 AV>5	0	0	0	0	0	0	3	
Output Protection	No	No	No	Yes	Yes	Yes	Yes	External	Yes	Yes	Yes	Yes	Yes	Yes	

(1) At +25°C

(2) Not applicable or not specified

(3) Typical

(4) V supply = ± 40V

(5) Dependent upon Iset value

* TO-86 only

† Guaranteed for ± 15V supplies and applicable temperature range unless otherwise specified

HARRIS OPERATIONAL AMPLIFIERS

Selection Guide for Commercial/Industrial Applications

PARAMETER †	0°C to +75°C													UNITS
		F.E.T. PREAMP						PRAM™	S/H					
	HA-911	HA-2005	HA-2005A	HA-2055	HA-2055A	HA-2065	HA-2065A	HA-2405	HA-2425	HA-2505	HA-2515	HA-2525	HA-2535	
INPUT CHARACTERISTICS														
Offset Voltage	7.5	55	12	65	17	65	15	11	8	10	14	14	5	mV
Drift (Typ.)	15	60	40	60	40	60	40	30	5	20	30	20	5	μV/°C
Bias Current	750	1	1	1	1	1	1	500	400	500	500	500	200	nA
Offset Current	450	.5	.5	.5	.5	.5	.5	100	100	100	100	100	20	nA
Common Mode Range	±12	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	± .5	V
INPUT NOISE (3)	1													μVRMS
TRANSFER CHARACTERISTICS														
Large Signal Voltage Gain	15K	.98	.98	5K	5K	70K	70K	25K	25K	10K	5K	5K	100K	V/V
Common Mode Rejection Ratio	74	70	70	70	70	70	70	74	74	74	74	74	80	dB
Bandwidth (Typ.)	7	10(3)	10(3)	20(3)	20(3)	24(3)	24(3)	18(3)	2 (3)	12(3)	12(3)	25	20	MHz
OUTPUT CHARACTERISTICS														
Output Voltage Swing	±11	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	V
Output Current (1)	±15	± 5	± 5	±10(1)	±10 (1)	±10(1)	±10(1)	20(3)	±10	±10	±10	±10	±25	mA
Full Power Bandwidth (Typ.)(1)	35	1,000(3)	1,000(3)	2,000(3)	2,000(3)	600(3)	600(3)	200(3)	70(3)	500	1,000	1,500	5,000	kHz
TRANSIENT RESPONSE														
Rise Time (1)	75	50(3)	50(3)	50(3)	50(3)	50(3)	50(3)	20	100(3)	50	50	50	40	ns
Overshoot (1)	40	5(3)	5 (3)	25(3)	25(3)	25(3)	25(3)	25	20(3)	50	50	50	50	%
Slew Rate (1)	± 2.3	100(3)	100(3)	120(3)	120(3)	35(3)	35(3)	15	5(3)	± 20	±40	± 80	±250	V/μs
Settling Time (Typ.) (1)	(2)	0.4(3)	0.4(3)	(3) 0.4	0.4(3)	.8(3)	.8(3)	1.5		0.33	0.25	0.20	.5	μ s
POWER SUPPLY CHARACTERISTICS														
Supply Current (1)	2.5	1.7	1.7	8.0	8.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0	6	mA
Power Supply Rejection Ratio	74	70	70	70	70	70	70	74	74	74	74	74	80	dB
FUNCTIONAL CHARACTERISTICS														
Offset Adjust	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	
Compensation Components	0	0	0	0 AV>3	0 AV>5	0AV>5	0AV>5	0 AV>10	0	0	0	0AV>3	1	
Output Protection	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No	No	

PARAMETER†	0°C to +75°C									-25°C to +85°C			UNITS
										PRAM™			
	HA-2605	HA-2625	HA-2635	HA-2645	HA-2655	HA-2705	HA-2725	HA-2735	HA-2905	HA-2404	HA-2704	HA-2904	
INPUT CHARACTERISTICS													
Offset Voltage	7	7	300	7	7	7	7	7	.08	7	6	.05	mV
Drift (Typ.)	5	5	(2)	15	8	5	8 to 10	8 to 10	.2	20	5	.2	μV/°C
Bias Current	40	40	200	50	300	70	10 to 40	10 to 40	1	400	50	1	nA
Offset Current	40	40	(2)	50	100	40	7.5 to 20	7.5 to 20	.5	100	30	.5	nA
Common Mode Range	±11	±11	(2)	±35(4)	±13	±11	±10	±10	±10	±10	±11	±10	V
INPUT NOISE (3)													μVRMS
TRANSFER CHARACTERISTICS													
Large Signal Voltage Gain	70K	70K	.85	75K	15K	100K	20K	20K	10^6	25K	100K	10^7	V/V
Common Mode Rejection Ratio	74	74	(2)	74	74	80	74	74	120	80	86	130	dB
Bandwidth (Typ.) (1)	12	35	8	4	8	1	.01 to 10	.01 to 10	3	16 (3)	1	3	MHz
OUTPUT CHARACTERISTICS													
Output Voltage Swing	±10	± 10	± 10	±35 (4)	±13	±11	± 13.5(3)	±13.5(3)	±10	±10	±11	± 10	V
Output Current (1)	±10	±10	±300	±10	18 (3)	±22 (3)	.5 to 5.0(3)	.5 to 5.0(3)	± 7	20 (1)	±22 (3)	±10	mA
Full Power Bandwidth (typ.)	75	600	8,000	23	30	50	1.5 to 80(3)	1.5 to 80	40	500 (3)	50	40	kHz
TRANSIENT RESPONSE													
Rise Time (1)	60	45	30 (3)	60 (3)	40 (3)	(2)	200 to 2,000 (3)	200 2,000 (3)	200 (3)	20 (3)	(2)	200 (3)	ns
Overshoot (1)	40	(2)	25 (3)	15 (3)	15 (3)	(2)	5 to 15 (3)	5 to 15(3)	20 (3)	25 (3)	(2)	20 (3)	%
Slew Rate (1)	±4	±20	200	5 (3)	2	±10	.1 to .8 (3)	.1 to .8	2.5 (3)	50	10	2.5 (3)	V/μs
Settling Time (Typ.) (1)	1.5	0.30	.5 (3)	1.5 (3)	1.5 (3)	5.0	(2)	(2)	(2)	1.5 (3)	5.0	(2)	μs
POWER SUPPLY CHARACTERISTICS													
Supply Current (1)	4.0	4.0	23	4.5	4	0.150	.02 to .2	.02 to .2	5	6.0 (1)	0.150	5	mA
Power Supply Rejection Ratio	74	74	66	74	74	80	76	76	120	80	86	130	dB
FUNCTIONAL CHARACTERISTICS													
Offset Adjust	Yes	Yes	No	Yes	Dip Pkg. Only	Yes	Yes	Yes	No	No	Yes	No	
Compensation Components	0	0(AV≥5)	0	0	0	0	0	0	3	0 AV>10	0	3	
Output Protection	Yes	Yes	External	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

(1) At +25°C
(2) Not applicable or not specified
(3) Typical
(4) V supply = ± 40V
(5) Dependent upon Iset value

* TO-86 only

† Guaranteed for ± 15V supplies and applicable temperature range unless otherwise specified

SELECTION GUIDE
Interface Circuits

COMPARATORS

PARAMETER +	-55°C to +125°C HA - 2111	-25°C to +85°C HA - 2211	0°C to +75°C HA - 2311	UNITS
Offset Voltage	4	4	10	mV
Bias Current	150	150	300	nA
Offset Current	20	20	70	nA
Response Time (TYP)	200	200	200	nS
Output Current (+25°C)	50	50	50	mA
Supply Current (1)	6	6	7.5	mA

DIGITAL TO ANALOG CONVERTERS

	HI - 1080		HI - 1085	
Resolution	8		8	Bits
Absolute Accuracy	1		1	L.S.B.
Full Scale Output	-5, +5, ±5		-5, +5, ±5	Volts
Settling Time (TYP)	1.5		1.5	μS
Inputs	TTL		TTL	

PHASE LOCKED LOOPS

	HA - 2820		HA - 2825	
Frequency Range	0–3		0–3	MHz
Tracking Range (Typ)	±25		±25	Percent of fo)
Drift of fo (TYP)	100		100	PPM/°C

+ Guaranteed for Applicable Temperature range, unless otherwise specified

(1) At +25°C

PRAM PROGRAMMABLE AMPLIFIER
HA - 2400/2404/2405

One of four op amp input stages may be digitally selected to be connected to a single output. Replaces 5 op amps and a four channel multiplexer to obtain programmable gain, signal selection or countless other functions.

SAMPLE – AND – HOLD/GATED OP AMP
HA - 2420/2425

Replaces two high performance op amps and a digitally controlled analog switch to form a high accuracy, versatile sample – and – hold, or a switchable op amp.

CURRENT BOOSTER AMPLIFIER
HA - 2630/2635

A unity gain amplifier with output current up to ±400 mA, and 600V/μS slew rate, designed for use in series with any op amp output. For Coax line drivers, servo amps, audio amps, clock drivers, etc.

DIGITAL LINE DRIVERS/RECEIVERS
HD - 245/246/248/249 (-55°C to +125°C)
HD - 545/546/548/549 (0°C to + 75°C)

Triple - balanced line - current mode drivers/receivers with party line capability for high speed (to 15 MHz) or long distance (to 3,000 feet) with superior noise immunity.

HD - 1488/1489/1489A

Industry standard quad drivers/receivers for E.I.A. spec. RS - 232C interfaces.

KEYBOARD ENCODER
HD - 0165

Universal 16 key inputs, 4 parallel outputs with strobe and Key rollover output.

CROSS-REFERENCE
Linear and Interface Devices

MANUFACTURER	PART NUMBER	HARRIS EQUIVALENT	NOTES
Advanced Micro Devices	AM111/211/311	HA-2111/2211/2311	A1
	AM118/318	HA-2510/2515	B2
	AM715	HA-2520/2525	B2
	AM1660	HA-2500/2505	B2
		HA-2600/2605	B2
		HA-2700/2705	B2
	AM1488	HD-1488	A1
	AM1489	HD-1489	A1
	AM1489A	HD-1489A	A1
	AM9616	HD-1488	C2
	AM9617	HD-1489A	C2
Analog Devices	AD505	HA-2530/2535	C2
	AD507J*	HA-2625	A1
	AD507S	HA-2620	A1
	AD509J*	HA-2525	A1
	AD509S	HA-2520	A1
	AD518	HA-2510/2515	B2
	AD7501	HI-1818A	B2
	AD7502	HI-1828A	B2
	AD7503	HI-1818A	B2
	AD7506	HI-506	A1
	AD7507	HI-507	A1
	AD7510	HI-201	C2
	AD7511	HI-201	C2
	AD7512	HI-5043	C2
	AD7513	HI-200	A1
Burr Brown	3500A	HA-2605	B2
	3500R	HA-2600	B2
	3505J	HA-2505	A1
	3506J	HA-2605	A1
	3507J	HA-2525	A1
	3508J	HA-2625	A1
	3550J	HA-2055	B2
	3550K	HA-2050	B2
	3550S	HA-2055	B2
	MPCBD	HI1-507A-5	A1
	MPC16S	HI1-506A-5	A1
Datel	AM-405-2	HA2-2055-5	A1
	AM-406-2	HA2-2065-5	A1
	AM-452-2	HA2-2525-5	A1
	AM-462-1	HA1-2625-5	A1
	AM-462-2	HA2-2625-5	A1
	SHM-1C-1	HA-2425	A1
Exar	XR215	HA-2820/2825	C3
	XR1488	HD-1488	A1
	XR1489A	HD-1489A	A1

* "K" equivalent is either military device or selected commerical device

NOTES:
- A. Pin-for-pin replacement
- B. Minor pin-out difference (offset adj., compensation, etc.)
- C. Not pin compatible — consult data sheets.

1. Identical electrical specifications
2. Harris part superior in most parameters
3. Parameter tradeoffs — consult data sheets

MANUFACTURER	PART NUMBER	HARRIS EQUIVALENT	NOTES
Fairchild Semiconductor	µA702	HA-2620/2625	C2
	µA709	HA-909/911	B2
	µA715	HA-2520/2525	B2
	µA725	HA-2700/2705	A3
	µA727	HA-2900/2905	C2
	µA734	HA-2111/2311	C2
	µA740	HA-2060/2065	B2
	µA741	HA-909/911, 2600/2605	B2
		2700/2705	B2
		2640/2645	A2
	µA747	HA-2650/2655	C2
	µA748	HA-2620/2625	B2
	µA772	HA-2510/2515	A2
	µA776	HA-2720/2725	A2
	µA791	HA-2630/2635	C2
	SH3002	HI-1800A	C2
	1558/1458	HA-2650/2655	A2
	9616	HD-1488	C2
	9617	HD-1489/A	C2
Intersil	111/211/311	HA-2111/2211/2311	A1
	IH5040*	HI-5040	A1
	thru	thru	
	IH-5051	HI-5051	
	8007	HA-2060/2065	B2
	8008	HA-2600/2605	B2
	8017	HA-2520/2525	B2
	IH5110/5111	HA-2420/2425	C2
	IH5060	HI-506A	A2
	IH5070	HI-507A	A2
		M = -2 C = -5	
		DE = HI 1 PE = HI 1 TW = HI 2	
	* Part Numbers: Intersil	IH5040MDE	
	Harris	HI1-5040-2	
Intronics	FA-550	HA-2055	A1
	FA-551	HA-2065	A1
	A-560	HA-2525	A1
	A-561	HA-2625	A1
	A-570	HA-2535	A1
	CA-580	HA-2905	A1
Motorola	MC1508/1408	HI-1080/1085	C2
	MC1520/1420	HA-2600/2605	C2
	MC1530/1531/1430/1431	HA-2600/2605	C2
	MC1533/1433	HA-2700/2705	C2
	MC1536/1436	HA-2640/2645	A2
	MC1538/1438	HA-2630/2635	C2
	MC1539/1439	HA-2620/2625	B2

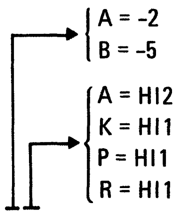
NOTES:
A. Pin-for-pin replacement
B. Minor pin-out difference (offset adj., compensation, etc.)
C. Not pin compatible – consult data sheets.

1. Identical electrical specifications
2. Harris part superior in most parameters
3. Parameter tradeoffs – consult data sheets

MANUFACTURER	PART NUMBER	HARRIS EQUIVALENT	NOTES
Motorola (continued)	MC1545/1445	HA-2400/2405	C3
	MC1554/1454	HA-2630/2635	C3
	MC1556/1456	HA-2600/2605	B2
	MC1558/1458	HA-2650/2655	A2
	MC1582L	HD-245	C2
	MC1583L	HD-246	C2
	MC1584L	HD-249	C2
	MC1488L	HD-1488	A1
	MC1489L	HD-1489	A1
	MC1489AL	HD-1489A	A1
National Semiconductor	LH0001	HA-2700	C2
	LH0002	HA-2630	C2
	LH0003	HA-2520	C2
	LH0004	HA-2640	C2
	LH0005	HA-2620	C2
	LH0022/42/52	HA-2060/2065	B2
	LH0023/43	HA-2420/2425	C2
	LH0024	HA-2530/2535	B2
	LH0032	HA-2050/2055	C3
	LH0033/63	HA-2630/2635	C3
	LH0062	HA-2050/2055	B2
	LM101/301/107/307	HA-909/911, 2600/2605, 2700/2705	B2
	LM102/302	HA-2600/2605	B2
	LM108/208/308	HA-2700/2704/2705	B3
	LM110/310	HA-2500/2505	B2
	LM111/211/311	HA-2111/2211/2311	A1
	LM112/212/312	HA-2700/2704/2705	B3
	LM216/316	HA-2060/2065	B3
	LM118/318	HA-2510/2515	B2
	LM143/343	HA-2640/2645	A2
	LM163/363	HD-248/548	C3
	LM1488	HD-1488	A1
	LM1489/A	HD-1489/A	A1
Precision Monolithics	OP-01	HA-2600/2605/2500/2505	B2
	OP-05/07	HA-2900/2905	B2
	CMP-01/02	HA-2111/2311	B3
	SSS1558/1458	HA-2650/2655	A2
	DAC-02/04/100	HI-1080/1085	C3
RCA	111/211/311	HA-2111/2211/2311	A1
	CA3020	HA-2630/2635	C2
	CA3078	HA-2720/2730	B2
	CA3100	HA-2520/2525	B2
	CA3130	HA-2060/2065	B2
	CA3558/3458	HA-2650/2655	A2
	CA6078	HA-2720/2730	B2
	CD4016	HI-201	C2
	CD4046	HA-2820/2825	C2

NOTES:
- A. Pin-for-pin replacement
- B. Minor pin-out difference (offset adj., compensation, etc.)
- C. Not pin compatible – consult data sheets.

1. Identical electrical specifications
2. Harris part superior in most parameters
3. Parameter tradeoffs – consult data sheets

MANUFACTURER	PART NUMBER	HARRIS EQUIVALENT	NOTES
Raytheon	RM/RC1556A	HA-2600/2605	B2
	RM/RC4131	HA-2600/2605	B2
	RM/RC4132	HA-2700/2705	B2
	RM/RC4531	HA-2500/2505	B2
	RM/RC4558	HA-2650/2655	A2
	111/211/311	HA-2111/2211/2311	A1
	1488	HD-1488	A1
	1489/1489A	HA-1489/1489A	A1
Signetics	531	HA-2510/2515	B2
	536	HA-2060/2065	B2
	560	HA-2820/2825	C2
	561	HA-2820/2825	C2
	562	HA-2820/2825	C2
	565	HA-2820/2825	C2
	5556	HA-2600/2605	B2
	5558	HA-2650/2655	A2
Silicon General	SG741S	HA-2500	B2
	SG741SG	HA-2505	B2
Siliconix	DG181*	HI-5048	C2
	DG184	HI-5049	A2
	DG185	HI-5045	A2
	DG187	HI-5050	C2
	DG188	HI-5042	C2
	DG190	HI-5051	A2
	DG191	HI-5043	A2
	DG200	HI-200	A2
	DG201	HI-201	A2
	DG506	HI-506	A1
	DG507	HI-507	A1
	DG508	HI-508A	A3
	DG509	HI-509A	A3
	L120	HA-2060/2065	B2
	L140	HA-2720/2725	B2
			
	* Part Numbers: Siliconix	DG200AA	
	Harris	HI2-200-2	

NOTES:
A. Pin-for-pin replacement
B. Minor pin-out difference (offset adj., compensation, etc.)
C. Not pin compatible — consult data sheets.

1. Identical electrical specifications
2. Harris part superior in most parameters
3. Parameter tradeoffs — consult data sheets

MANUFACTURER	PART NUMBER	HARRIS EQUIVALENT	NOTES
Solitron	CM4016A	HI-201	C2
	μc4000/4001/4002	HA-2600	C2
	μc4000C/4001C/4002C	HA-2605	C2
	μc4250	HA-2720	A2
	μc4250c	HA-2725	A2
Sprague	μLS/μLN2139	HA-2600/2605	B2
	μLS/μLN2151	HA-2600/2605	B2
	μLS/μLN2156	HA-2600/2605	B2
	μLS/μLN2157	HA-2650/2655	B2
	μLS/μLN2158	HA-2620/2625	B2
	μLS/μLN2171	HA-2600/2605	B2
	μLS/μLN2172	HA-2620/2625	B2
	μLS/μLN2173	HA-2600/2605	B2
	μLS/μLN2174	HA-2620/2625	B2
	μLS/μLN2175	HA-2600/2605	B2
	μLS/μLN2176	HA-2620/2625	B2
	μLS/μLN2177	HA-2060/2065	B2
	μLS/μLN2178	HA-2060/2065	B2
Teledyne Philbrick	1321	HA-2625	A1
	1322	HA-2525	A1
	1323	HA-2705	A1
	1324	HA-2505	B2
	1422	HA-2055/2065	B2
	1427	HA-2065	C2
	1431	HA-2065A	A1
	143101	HA-2060A	A1
Texas Instruments	51/72L022	HA-2730/2735	B2
	52/72088	HA-2904/2905	C2
	52/72310	HA-2500/2505	B2
	52111/72311	HA-2111/2311	A1
	52/72558	HA-2650/2655	A2
	52/72660	HA-2700/2705	B2
	52/72770	HA-2600/2605	B2
	52/72771	HA-2620/2625	B2
	75107A/108A	HD-549	C2
	75109/110	HD-545	C2
	75150	HD-1488	C2
	75152	HD-1489/A	C2
	75154	HD-1489/A	C2
Transitron	TOA7709	HA-2600	B2
	TOA8709	HA-2605	B2
	TOA7809	HA-2060A	B2
	TOA8809	HA-2065A	B2

NOTES:
A. Pin-for-pin replacement
B. Minor pin-out difference (offset adj., compensation, etc.)
C. Not pin compatible — consult data sheets.

1. Identical electrical specifications
2. Harris part superior in most parameters
3. Parameter tradeoffs — consult data sheets

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-909/911

Operational Amplifiers

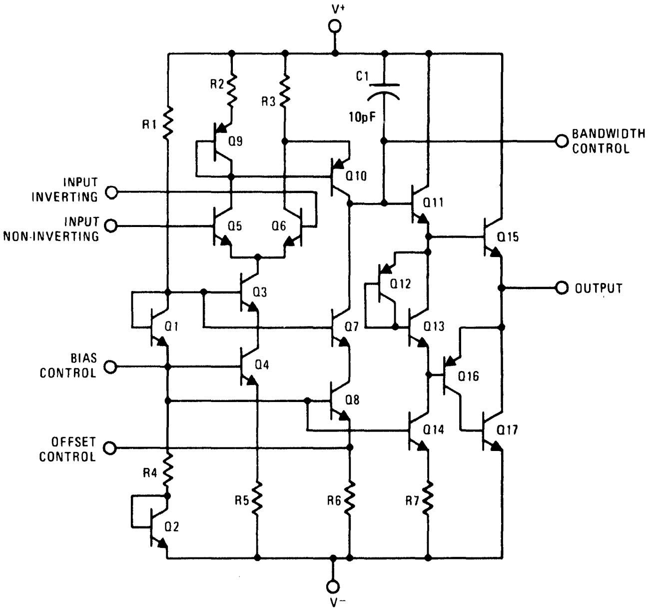
GENERAL DESCRIPTION

The integrated circuit covered by this data sheet forms a part of Harris' family of linear circuits intended for use as universal building blocks for analog circuitry. This Low Noise Operational Amplifier provides the 6dB per octave high frequency roll-off required for unconditional stability in operational feedback connections without the use of external compensation networks.

Simple resistive trim adjustment for zeroing input offset voltage is provided on the TO-86 package. The circuit is comprised of vertical NPN and PNP transistors in separate dielectrically isolated islands using advanced isolation techniques. These advanced production processes give the designer access to high performance integrated circuits without the technical compromises necessary with conventional junction isolation and lateral PNP fabrication methods.

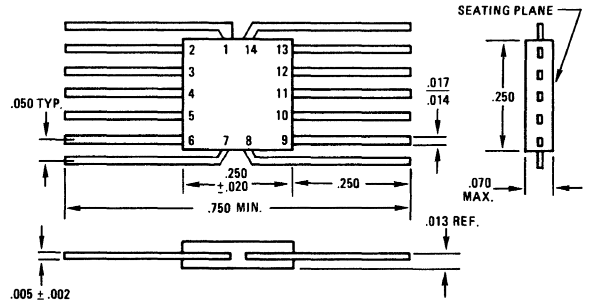
The circuit is designed to meet or exceed the mechanical and environmental requirements of MIL-STD-883.

SCHEMATIC



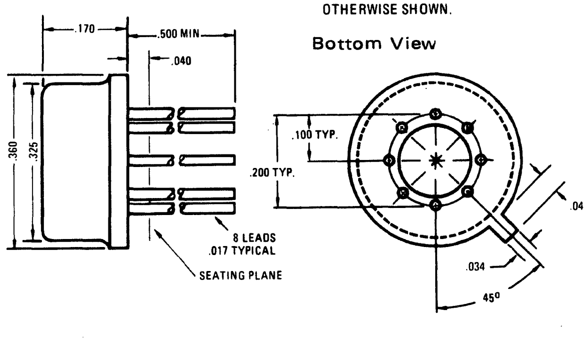
PACKAGES

CODE 9V TO-86 (METAL BOTTOM)



CODE 2A

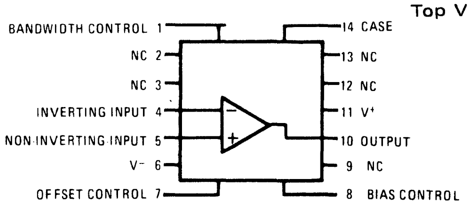
ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.



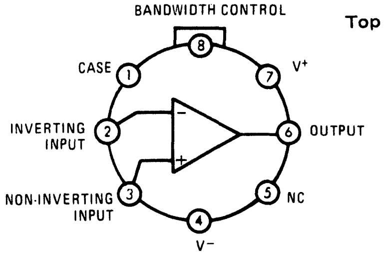
Bottom View

PIN OUT

TO-86
Top View



TO-99
Top View



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals		50.0V
Differential Input Voltage		±7.0V
Peak Output Current		±50mA
Internal Power Dissipation (Note 10)		300mW
Operating Temperature Range –	HA-909	$-55^oC \le T_A \le +125^oC$
	HA-911	$0^oC \le T_A \le +75^oC$
Storage Temperature Range		$-65^oC \le T_A \le +150^oC$

ELECTRICAL CHARACTERISTICS

TEST CONDITIONS: $V_{Supply} = \pm 15.0V$ unless otherwise specified.

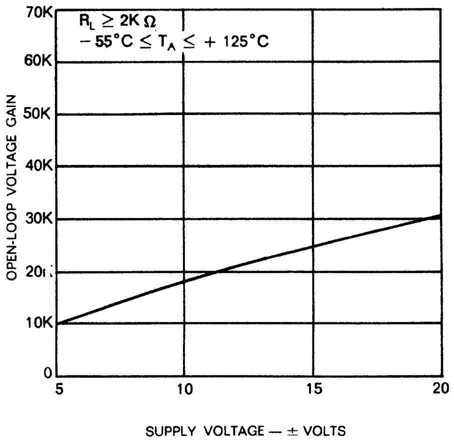
PARAMETER	TEMPERATURE	HA-909 -55^oC to $+125^oC$			HA-911 0^oC to $+75^oC$			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS								
* Offset Voltage	+25°C		2.0	5.0		2.0	6.0	mV
	Full			6.0			7.5	mV
Equivalent Input Noise (Note 9)			1.0	5.0		1.0		μV
* Bias Current	+25°C		87	300		200	500	nA
	Full			750		300	750	nA
* Offset Current	+25°C		25	150		100	300	nA
	Full		50	300		150	450	nA
Offset Current Average Drift	Full		1.0			1.0		nA/°C
Input Resistance	+25°C	200	600		100	250		KΩ
	Full	100	300					KΩ
Common Mode Range	Full	±12.0			±12.0			V
TRANSFER CHARACTERISTICS								
* Large Signal Voltage Gain (Notes 1, 4)	+25°C	25K	45K		20K	45K		V/V
	Full	25K	45K		15K	45K		V/V
* Common Mode Rejection Ratio (Note 2)	Full	80	96		74	90		dB
Unity Gain Bandwidth (Note 3)	+25°C		7			7		MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 1)	Full	±12.0			±11.0			V
* Output Current (Note 4)	+25°C	±20			±15			mA
Output Resistance	+25°C		150			500		Ohms
TRANSIENT RESPONSE								
Rise Time (Notes 1, 5, 6 & 8)	+25°C		40	75		40	75	ns
Overshoot (Notes 1, 5, 6 & 8)	+25°C		15	40		15	40	%
* Slew Rate (Notes 1, 5 & 8)	+25°C	+3.5 −1.2	+5.0 −2.0			+5.0		V/μs
POWER SUPPLY CHARACTERISTICS								
* Supply Current	+25°C		1.8	2.5		1.8	2.5	mA
* Power Supply Rejection Ratio (Note 7)	Full	80	92		74	90		dB

NOTES:
1. $R_L = 2K\Omega$
2. $V_{CM} = \pm 5.0V$
3. $V_O < 90mV$
4. $V_O = \pm 10.0V$
5. $C_L = 100pF$
6. $V_O = \pm 200mV$
7. $V_{Sup} = \pm 9.0V$ to $\pm 15.0V$
8. See Transient Response test circuits and waveforms – page 3.
9. 10 – 1000Hz, $R_S = 10K\Omega$
10. Derate by 6.6mW/°C above 105°C

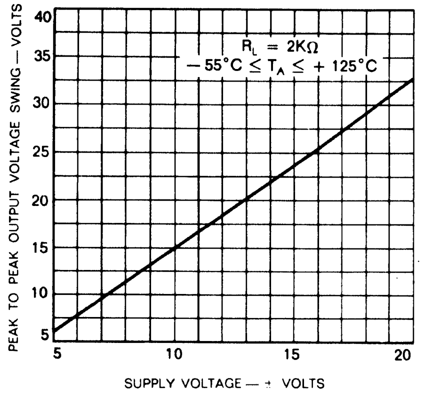
*100% Tested For DASH 8

GUARANTEED ELECTRICAL CHARACTERISTICS

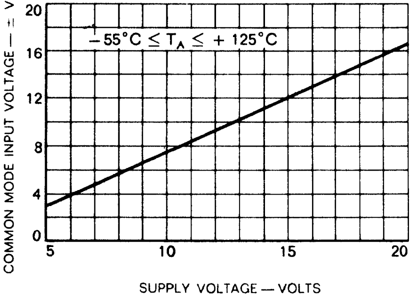
OPEN LOOP VOLTAGE GAIN VS. SUPPLY VOLTAGE



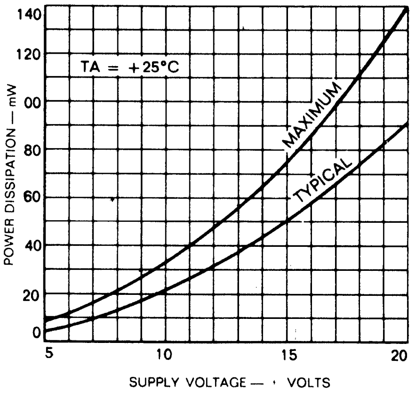
OUTPUT VOLTAGE SWING VS. SUPPLY VOLTAGE



COMMON MODE INPUT VOLTAGE VS. SUPPLY VOLTAGE

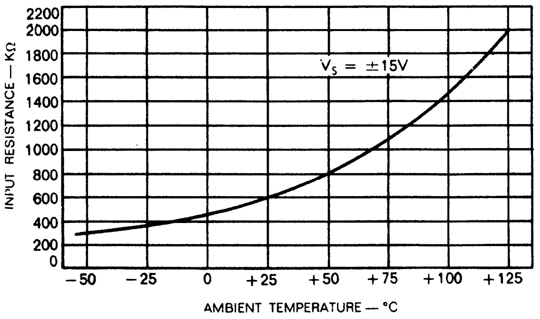


POWER DISSIPATION VS. SUPPLY VOLTAGE

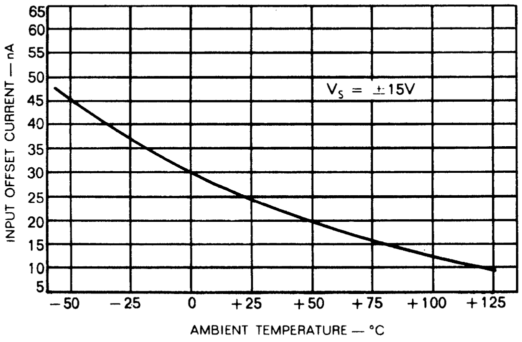


TYPICAL PERFORMANCE CURVES

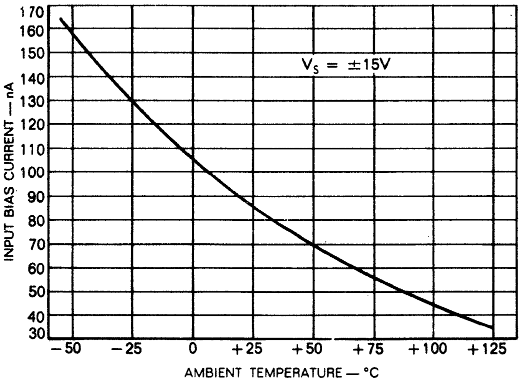
INPUT RESISTANCE VS. AMBIENT TEMPERATURE



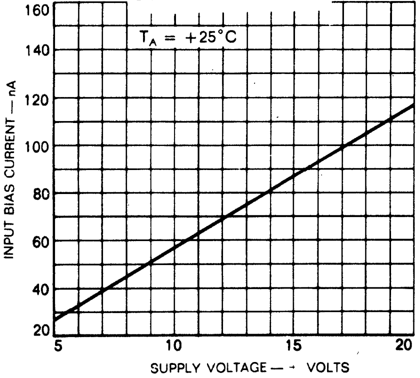
INPUT OFFSET CURRENT VS. AMBIENT TEMPERATURE

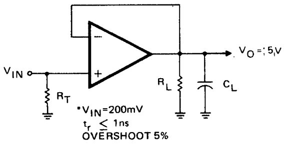


INPUT BIAS CURRENT VS. AMBIENT TEMPERATURE

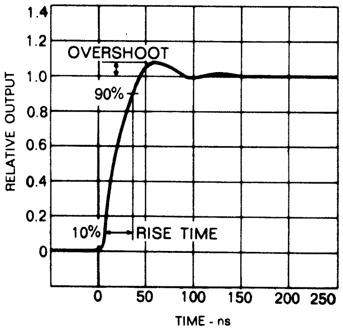


INPUT BIAS CURRENT VS. SUPPLY VOLTAGE



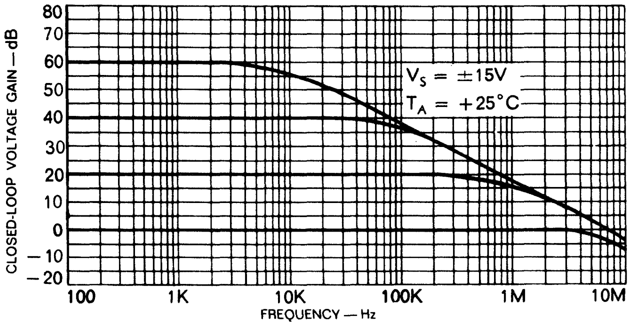


TRANSIENT RESPONSE

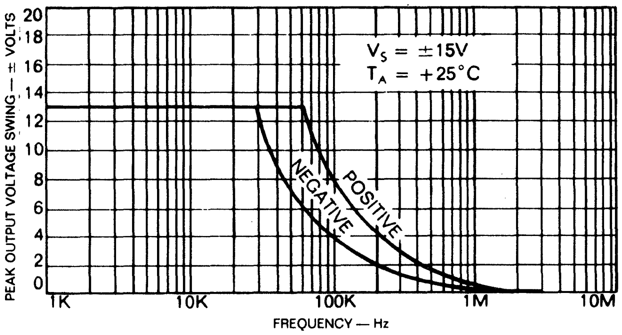


TYPICAL PERFORMANCE CURVES(continued)

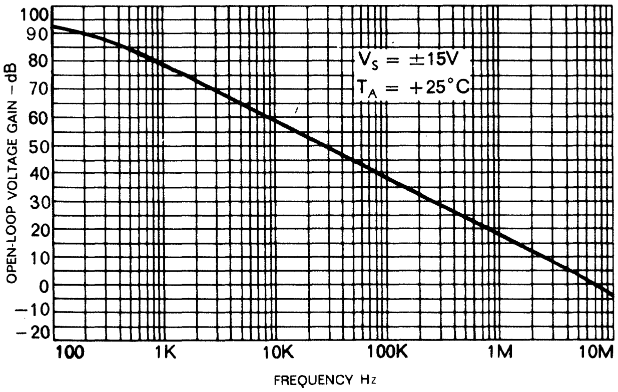
FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS



OUTPUT VOLTAGE SWING VS. FREQUENCY



OPEN LOOP FREQUENCY RESPONSE



DEFINITIONS

Input Offset Voltage — That voltage which must be applied between the input terminals through two equal resistances to force the output voltage to zero.

Input Offset Current — The difference in the currents into the two input terminals when the output is at zero voltage.

Input Bias Current — The average of the currents flowing into the input terminals when the output is at zero voltage.

Input Common Mode Voltage — The average referred to ground of the voltages at the two input terminals.

Common Mode Range — The range of voltages which if exceeded at either input terminal will cause the amplifier to cease operating.

Common Mode Rejection Ratio — The ratio of a specified range of input common mode voltage to the peak to peak change in input offset voltage over this range.

Output Voltage Swing — The peak symmetrical output voltage swing, referred to ground, that can be obtained without clipping.

Input Resistance — The ratio of the change in input voltage to the change in input current.

Output Resistance — The ratio of the change in output voltage to the change in output current.

Positive Output Voltage Swing — The peak positive output voltage swing, referred to ground, that can be obtained without clipping.

Negative Output Voltage Swing — The peak negative output voltage swing, referred to ground, that can be obtained without clipping.

Voltage Gain — The ratio of the change in output voltage to the change in input voltage producing it.

Bandwidth — The frequency at which the voltage gain is 3 dB below its low frequency value.

Unity Gain Bandwidth — The frequency at which the voltage gain of the amplifier is unity.

Power Supply Rejection Ratio — The ratio of the change in input offset voltage to the change in power supply voltage producing it.

Transient Response — The closed loop step function response of the amplifier under small signal conditions.

Phase Margin — $[180° - (\phi_1 - \phi_2)]$ where ϕ_1 is the phase shift at the frequency where the absolute magnitude of gain is unityo_2 is the phase shift at a frequency much lower than the open loop bandwidth.

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2000/2005/2000A/2005A

F.E.T. Input Preamplifier

FEATURES

- CONVERTS ANY OP AMP OR COMPARATOR TO F.E.T. INPUT

INPUT BIAS CURRENT:	1pA
INPUT RESISTANCE:	10^{12} OHMS
SLEW RATE:	100 V/μS
BANDWIDTH:	10 MHz

- MEETS MIL-STD-883 REQUIREMENTS

DESCRIPTION

The HA-2000/2005 is a monolithic unity gain differential amplifier stage with J.F.E.T. inputs and bipolar transistor outputs. It is intended for use as a preamplifier for operational amplifiers and comparators to produce high input resistance and low bias currents without sacrificing high speed performance. The circuit has a much wider common mode range than simple F.E.T. pairs, allowing op amps to be connected as voltage followers with full output swing. The circuit can also be used as a high impedance unity gain buffer for differential or two single-ended signals for frequencies from D.C. to R.F.

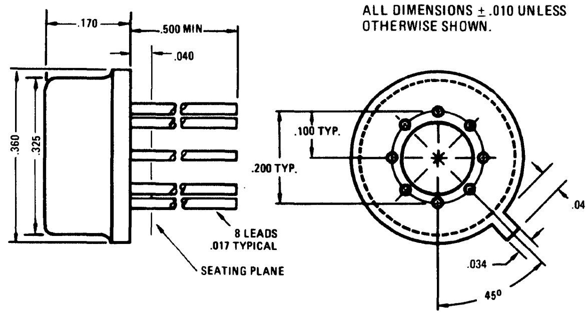
The HA-2000 is guaranteed for operation from -55°C to +125°C while the HA-2005 is guaranteed from 0°C to +75°C.

PACKAGES

CODE 2A

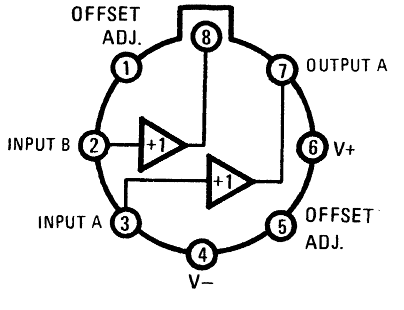
Bottom View TO-99

ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

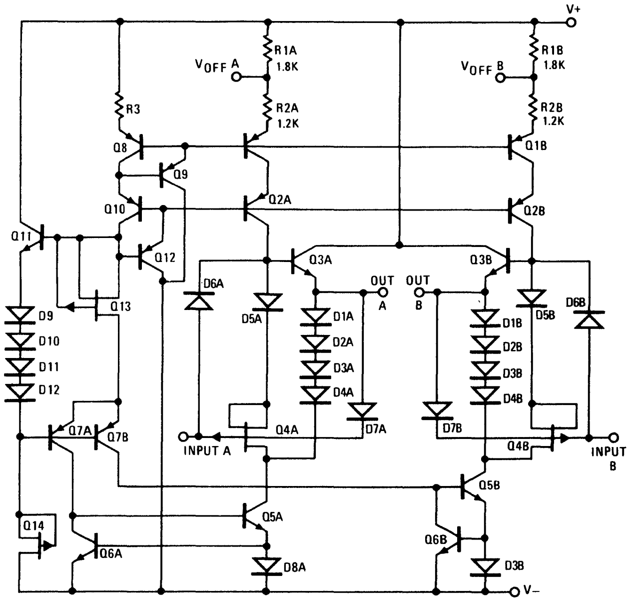


NOTES. 1. All leads gold plated KOVAR
2. All dimensions in inches

PIN-OUT Top View



SCHEMATIC



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V− Terminals	35V	Internal Power Dissipation (Note 8)	300mW
Differential Input Voltage	±V_{Supply}	Operating Temp. Range	-55°C ≤ T_A ≤ +125°C (HA-2000)
Output Current	30mA		0°C ≤ T_A ≤ +75°C (HA-2005)
		Storage Temp. Range	-65°C ≤ T_A ≤ +150°C

ELECTRICAL CHARACTERISTICS

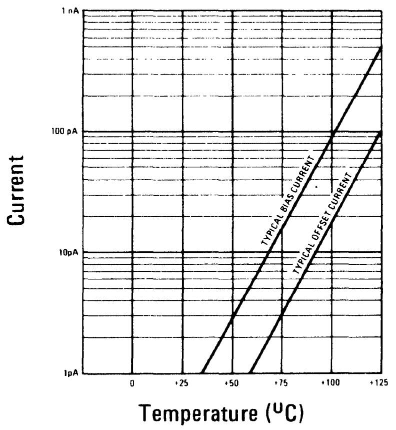
PARAMETER	TEMP.	HA-2000/HA-2000A			HA-2005/HA-2005A			UNITS
		-55°C to +125°C			0°C to +75°C			
			LIMITS			LIMITS		
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS								
Offset Voltage (Note 1)								
HA-2000 / HA-2005	+25°C		12	20		25	50	mV
	Full			25			55	mV
HA-2000A / HA-2005A	+25°C		5	10		5	10	mV
	Full			12			12	mV
Bias Current	+25°C		1	20		1	20	pA
	Full		0.5	10		0.02	1	nA
Offset Current	+25°C		0.5	20		0.5	20	pA
	Full		0.1	5		.005	.5	nA
Input Resistance	+25°C		10^{12}			10^{12}		Ω
Input Capacitance	+25°C		5			5		pF
Common Mode Range	Full	±10.0			±10.0			V
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Note 2)	+25°C	.98	.999		.98	.999		V/V
	Full	.98			.98			V/V
Common Mode Rejection Ratio (Note 3)	Full	80	90		70	90		dB
-3dB Bandwidth	+25°C		10			10		MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 2)	Full	±10			±10			V
Output Current Source	+25°C	+5			+5			mA
Sink	+25°C	-65			-65			μA
Output Common Mode Offset Voltage	Full			0.5			0.5	V
Full Power Bandwidth (Notes 4,5)	+25°C		1,000			1,000		kHz
TRANSIENT RESPONSE								
Rise Time (Notes 4,6)	+25°C		50			50		ns
Overshoot (Notes 4,6)	+25°C		5			5		%
Slew Rate (Notes 4,5)	+25°C		100			100		V/μs
POWER SUPPLY CHARACTERISTICS								
Supply Current	+25°C		0.7	1.7		0.7	1.7	mA
Power supply Rejection Ratio (Note 7)	Full	80	90		70	90		dB

NOTES:
1. Adjustable to 0 with 100KΩ pot between pins 1 and 5 wiper to V+
2. R_L = 1M
3. V_{CM} = ±5.0V
4. R_L = 10K to V−
5. V_O = ±10V
6. V_O = ±200mV
7. V_S = ±9V to ±15V
8. Derate by 6.6 mW/°C above 105°C

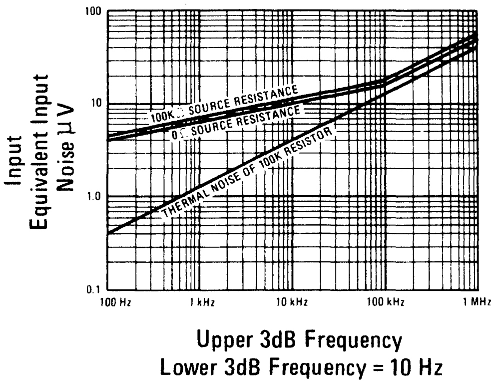
PERFORMANCE CURVES

V+ = 15 VDC, V− = 15 VDC, T_A = 25°C UNLESS OTHERWISE STATED.

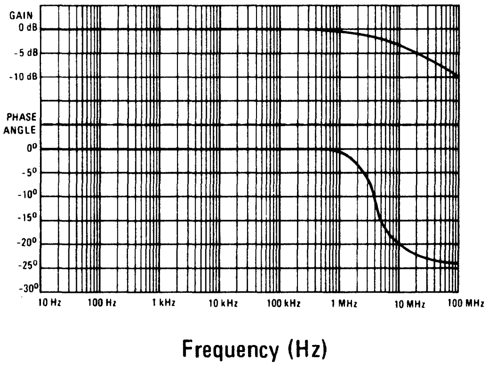
INPUT BIAS AND OFFSET CURRENT VS. TEMPERATURE



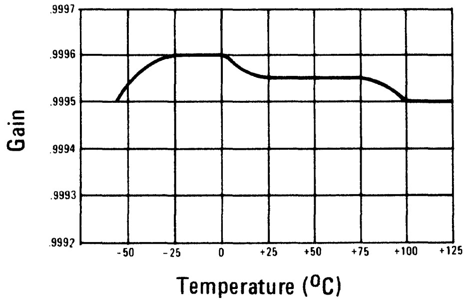
EQUIVALENT INPUT NOISE VS. BANDWIDTH



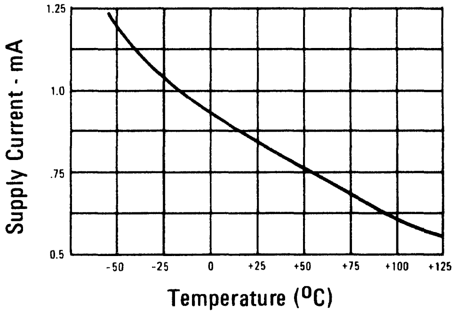
GAIN, PHASE ANGLE VS. FREQUENCY



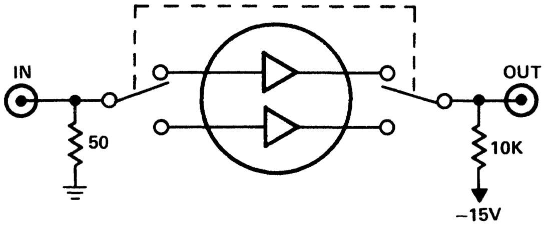
D.C. GAIN VS. TEMPERATURE



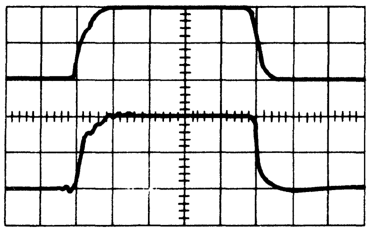
POWER SUPPLY CURRENT VS. TEMPERATURE



TRANSIENT RESPONSE, SLEW RATE TEST HOOK-UP



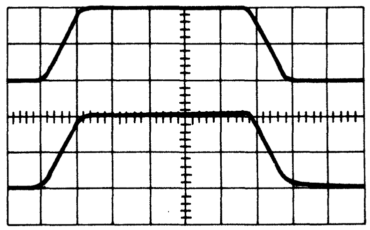
TYP. TRANSIENT RESPONSE WAVEFORM



Typical Transient Response Waveforms

Upper Trace: Input
Lower Trace: Output
Vertical Scale: 100mV/Div.
Horizontal Scale: 100ns/Div.

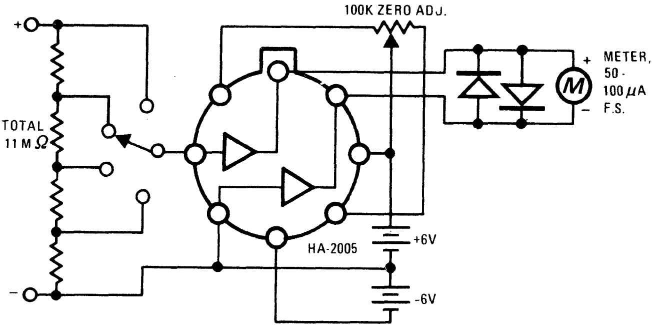
TYP. SLEWING RESPONSE WAVEFORM



Typical Slewing Response Waveforms

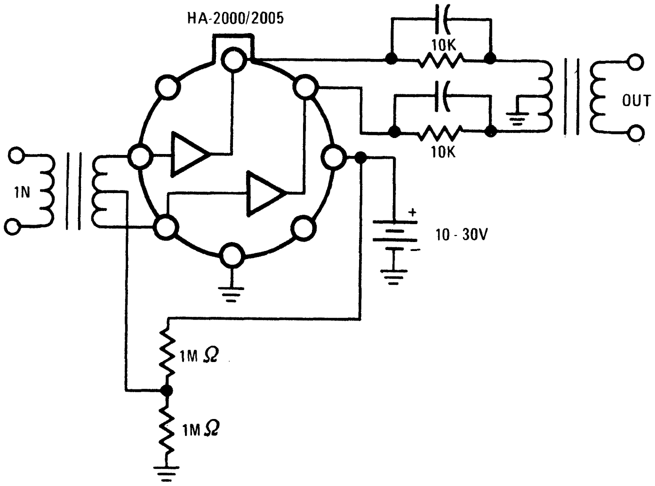
Upper Trace: Input
Lower Trace: Output
Vertical Scale: 5V/Div.
Horizontal Scale: 100ns/Div.

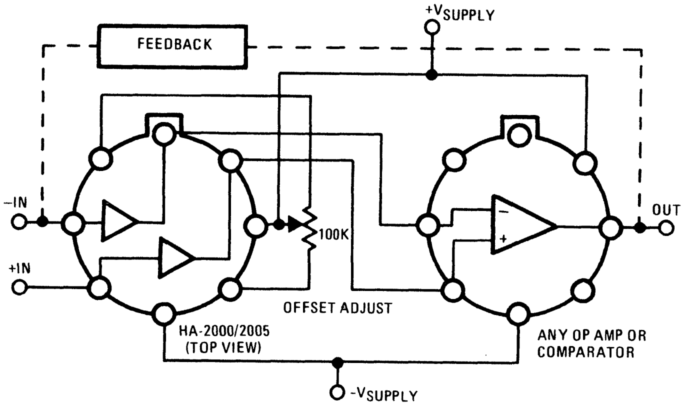
TYPICAL APPLICATIONS



F.E.T. VOLTMETER

BALANCED LINE AMPLIFIER FOR AUDIO TO 100MHz SIGNALS

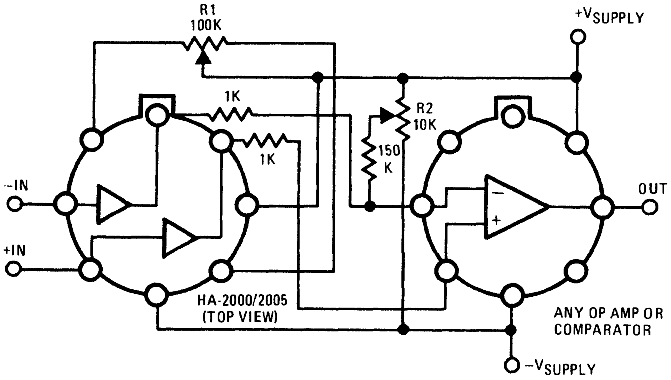




HOOKUP TO CREATE F.E.T. INPUT OP AMP OR COMPARATOR

ALTERNATE HOOKUP TO ADJUST FOR MINIMUM OFFSET VOLTAGE TEMPERATURE COEFFICIENT

Adjust R_1 to point of minimum offset voltage change over temperature range. Adjust R_2 to zero offset voltage. Drifts of less than 10μ V/o_C can typically be achieved.



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2050/2055/2050A/2055A

High Slew Rate F.E.T. Input Operational Amplifiers

FEATURES

● HIGH SLEW RATE	120V/μs
● FAST SETTLING	400ns
● WIDE POWER BANDWIDTH	2 MHz
● HIGH GAIN BANDWIDTH	20 MHz
● HIGH INPUT IMPEDANCE	10^{12} OHMS
● LOW BIAS CURRENT	1 pA

- TRUE OP AMP – CAN BE OPERATED INVERTING OR NON-INVERTING
- MEETS MIL-STD-883 REQUIREMENTS

DESCRIPTION

The HA-2050/2055 is an operational amplifier combining the advantages of very high slew rate and wide bandwidth with ultra-low input current and high input resistance. These devices are ideal for use in sample-and-hold circuits, A/D, D/A and sampled data systems; and for use in wide band R.F. or video systems where wide bandwidth at high output levels is required. The device may be operated inverting or non-inverting; and external compensation is required only when operated at closed loop gains less than three. An internal feedback capacitor is provided to cancel phase shift in the feedback loop due to input capacitance.

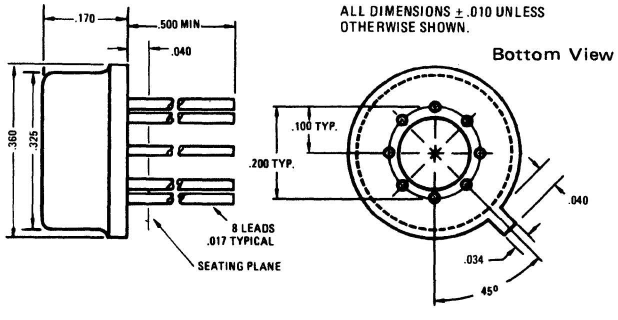
The HA-2050 is guaranteed for operation from -55°C to +125°C and the HA-2055 is guaranteed from 0°C to +75°C.

PACKAGE

CODE 2A TO-99

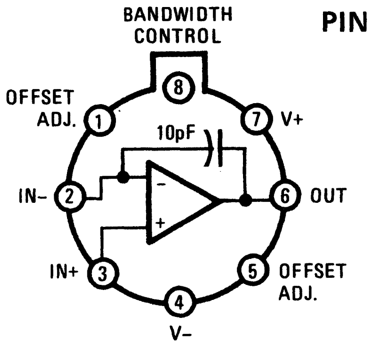
ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

Bottom View



NOTES: 1. All leads gold plated KOVAR
2. All dimensions in inches

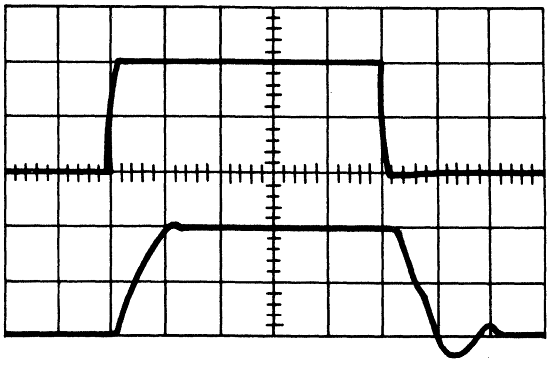
PIN-OUT



Case Connected to V+

Top View

SLEWING WAVEFORM



Horizontal Scale:	100ns/Div.
Upper Trace:	Input; 1.67V/Div.
Lower Trace:	Output; 5.0V/Div.

Gain = +3, R_L = 2K Ohms, C_L = 50pF

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V− Terminals	35.0V	Internal Power Dissipation (Note 10)	300mW	
Differential Input Voltage	±15.0V	Operating Temp. Range	$-55^{\circ}C \leq T_A \leq +125^{\circ}C$	(HA-2050)
Output Current	50mA		$0^{\circ}C \leq T_A \leq +75^{\circ}C$	(HA-2055)
		Storage Temp. Range	$-65^{\circ}C \leq T_A \leq +150^{\circ}C$	

ELECTRICAL CHARACTERISTICS

Test Conditions: $V_{Supply} = \pm 15.0V$ unless otherwise specified.

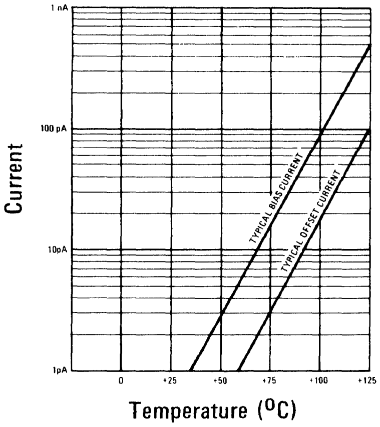
		HA-2050/HA-2050A -55°C to +125°C			HA-2055/HA-2055A 0°C to +75°C			
		LIMITS			LIMITS			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS								
Offset Voltage (Note 1)								
HA-2050 / HA-2055	+25°C		15	25		30	60	mV
	Full			30			65	mV
HA-2050A / HA-2055A	+25°C		7	14		7	14	mV
	Full			17			17	mV
Bias Current	+25°C		1	20		1	20	pA
	Full		0.5	10		0.02	1	nA
Offset Current	+25°C		0.5	20		0.5	20	pA
	Full		0.1	5		.005	0.5	nA
Input Resistance	+25°C		10^{12}			10^{12}		Ω
Input Capacitance	+25°C		5			5		pF
Common Mode Range	Full	±10.0			±10.0			V
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Note 2,5)	+25°C	7.5K	15K		7.5K	15K		V/V
	Full	5K			5K			V/V
Common Mode Rejection Ratio (Note 3)	Full	74	90		70	90		dB
Gain Bandwidth Product (Note 4)	+25°C		20			20		MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 2)	Full	±10	±12		±10	±12		V
Output Current	+25°C	±10	±20		±10	±20		mA
Full Power Bandwidth (Note 5)	+25°C		2,000			2,000		kHz
TRANSIENT RESPONSE (NOTES 2, 8, 9)								
Rise Time (Note 6)	+25°C		50			50		ns
Overshoot (Note 6)	+25°C		25			25		%
Slew Rate (Note 5)	+25°C		120			120		V/μs
Settling Time	+25°C		0.4			0.4		μs
POWER SUPPLY CHARACTERISTICS								
Supply Current	+25°C		6.0	8.0		6.0	8.0	mA
Power Supply Rejection Ratio (Note 7)	Full	74	90		70	90		dB

NOTES:
1. Adjustable to zero with 100KΩ pot between pins 1 and 5; wiper to V+.
2. $R_L = 2K$
3. $V_{CM} = \pm 5.0V$
4. $A_V > 10$
5. $V_O = \pm 10V$
6. $V_O = \pm 200mV$
7. $\Delta V = \pm 5.0V$
8. $C_L = 50pF$
9. $A_V = +3$, See transient response test circuit and wave forms, page 4.
10. Derate by 6.6mW/°C above 105°C

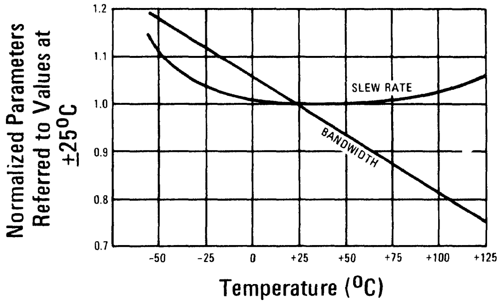
PERFORMANCE CURVES

V+ = 15 VDC, V- = 15 VDC, T_A = 25°C UNLESS OTHERWISE STATED.

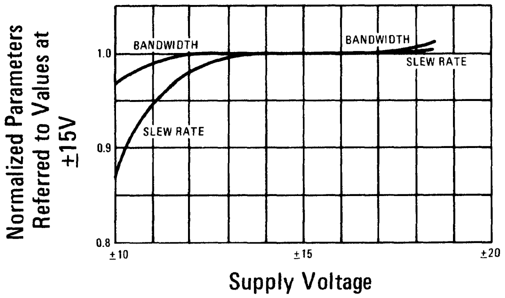
INPUT BIAS AND OFFSET CURRENT
VS. TEMPERATURE



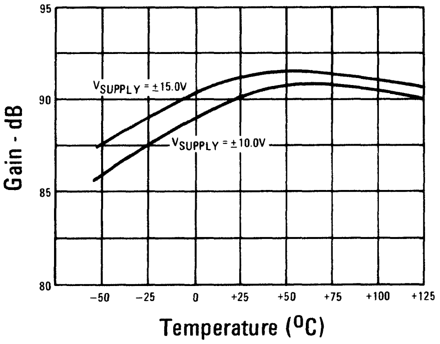
NORMALIZED AC PARAMETERS
VS. TEMPERATURE



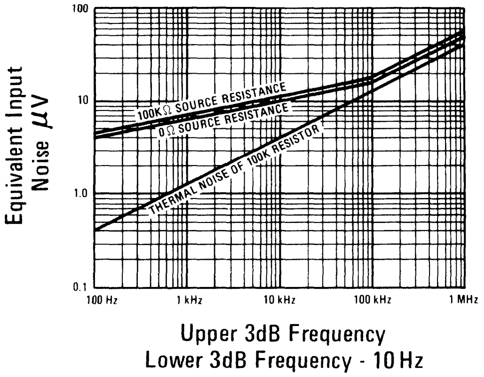
NORMALIZED AC PARAMETERS
VS. SUPPLY VOLTAGE AT +25°C



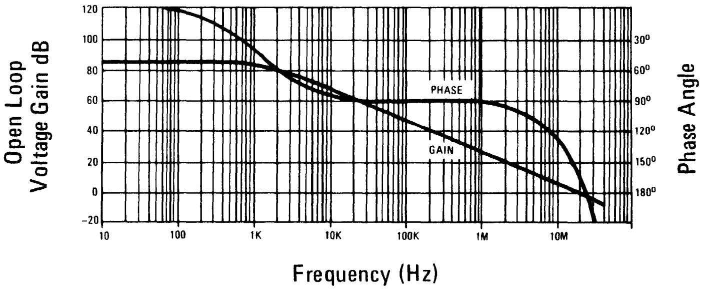
OPEN LOOP VOLTAGE GAIN
VS. TEMPERATURE



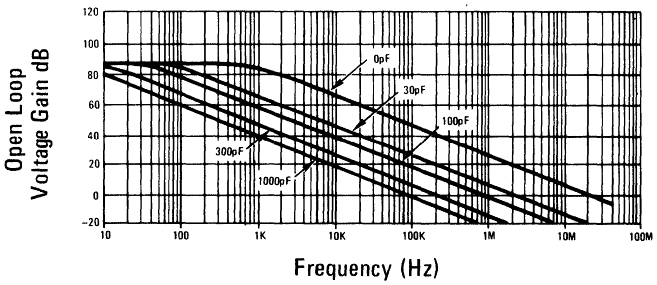
EQUIVALENT INPUT NOISE
VS. BANDWIDTH



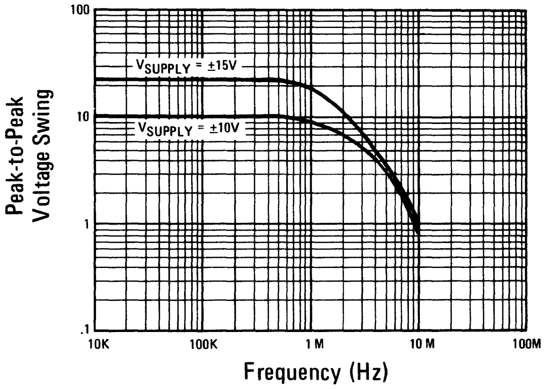
OPEN-LOOP FREQUENCY AND PHASE RESPONSE



OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND

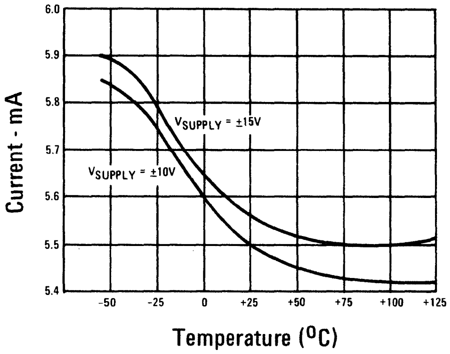


OUTPUT VOLTAGE SWING
VS. FREQUENCY AT +25°C

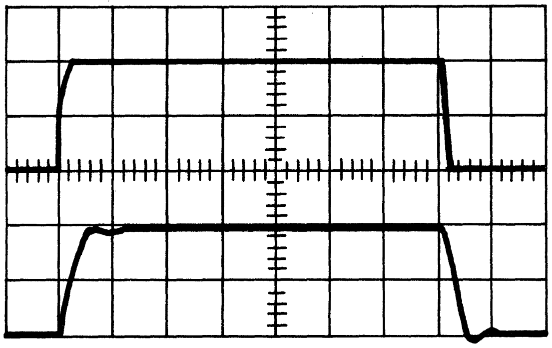


PERFORMANCE CURVES (continued)

POWER SUPPLY CURRENT
VS. TEMPERATURE

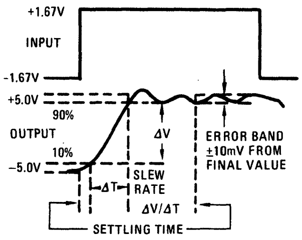


TRANSIENT RESPONSE; $A_V = +3$

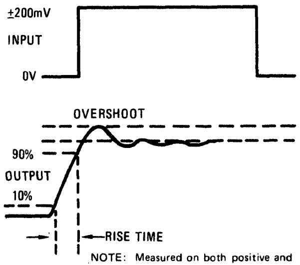


R_L = 2K Ohms, C_L = 50pF
Upper Trace: Input; 33mV/Div.
Lower Trace: Output; 100mV/Div.
Horizontal = 100ns/Div.
T_A = +25°C, V_S = ±15V

SLEW RATE AND
SETTLING TIME

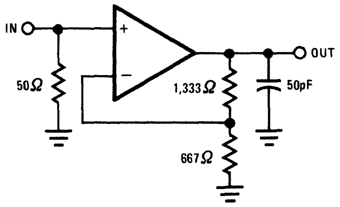


TRANSIENT
RESPONSE

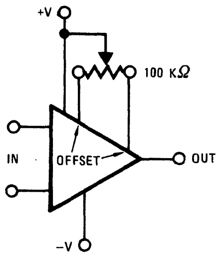


NOTE: Measured on both positive and negative transitions.

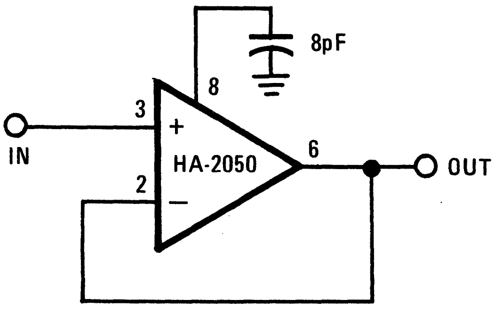
SLEW RATE AND
TRANSIENT RESPONSE



SUGGESTED
OFFSET ZERO
ADJUST HOOK-UP



TYPICAL APPLICATIONS



COMPENSATION CIRCUIT FOR UNITY GAIN

Slew Rate ≈ 40V/μs

Bandwidth ≈ 8 MHz

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2060/2065/ 2060A/2065A

Wide Band F.E.T. Input Operational Amplifier

FEATURES

● GAIN BANDWIDTH PRODUCT	100 MHz
● HIGH INPUT IMPEDANCE	10^{12} OHMS
● LOW BIAS CURRENT	1 pA
● HIGH SLEW RATE	35V/μs
● WIDE POWER BANDWIDTH	600 kHz

- TRUE OP AMP - CAN BE OPERATED INVERTING OR NON-INVERTING
- MEETS MIL-STD-883 REQUIREMENTS

DESCRIPTION

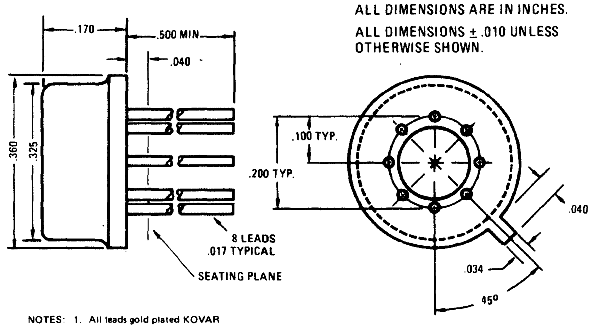
The HA-2060/2065 is an operational amplifier combining the advantages of very wide bandwidth and high slew rate with ultra-low input current and high input resistance. These devices are ideal for use in sample-and-hold circuits, active filters, wide band amplifiers, high gain amplifiers with superior bandwidth, and wherever very low closed loop gain and phase shift errors are required. The device may be operated inverting or non-inverting; and external compensation is required only when operated at closed loop gains less than five. An internal feedback capacitor is provided to cancel phase shift in the feedback loop due to input capacitance.

The HA-2060 is guaranteed for operation from -55°C to +125°C and the HA-2065 is guaranteed from 0°C to +75°C.

PACKAGE

CODE 2A Bottom View TO-99

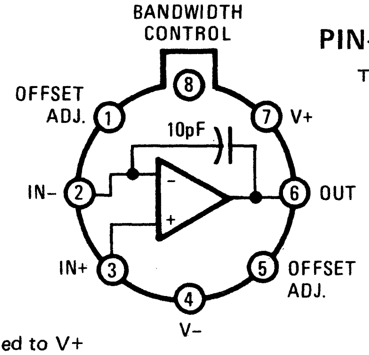
ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.



NOTES: 1. All leads gold plated KOVAR
2. All dimensions in inches

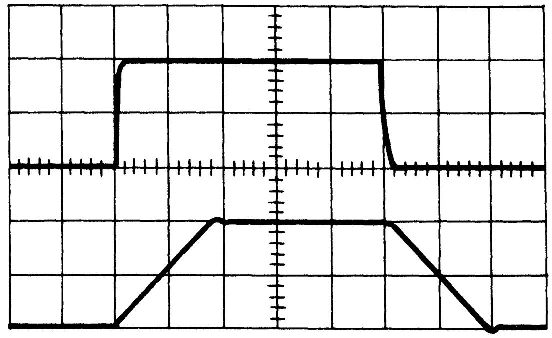
PIN-OUT

Top View



Case Connected to V+

SLEWING WAVEFORM



Horizontal Scale:	200ns/Div.
Upper Trace:	Input; 1.0V/Div.
Lower Trace:	Output; 5.0V/Div.

Gain = +5, R_L = 2K Ohms, C_L = 50pF

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	35.0V	Internal Power Dissipation (Note 10)	300mW	
Differential Input Voltage	±12V	Operating Temp. Range	$-55^oC \leq T_A \leq +125^oC$	(HA-2060)
Output Current / Full Short Circuit Protection			$0^oC \leq T_A \leq +75^oC$	(HA-2065)
		Storage Temp. Range	$-65^oC \leq T_A \leq +150^oC$	

ELECTRICAL CHARACTERISTICS

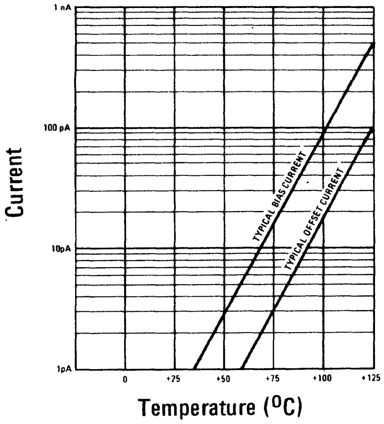
Test Conditions: V_{Supply} = ±15.0V unless otherwise specified.

PARAMETER	TEMP.	HA-2060/HA-2060A -55°C to +125°C LIMITS MIN.	TYP.	MAX.	HA-2065/HA-2065A 0°C to +75°C LIMITS MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS								
Offset Voltage (Note 1)								
HA-2060 / HA-2065	+25°C		15	25		15	60	mV
	Full			30			65	mV
HA-2060A / HA-2065A	+25°C		7	12		7	12	mV
	Full			15			15	mV
Bias Current	+25°C		1	20		1	20	ρA
	Full		0.5	10		0.02	1	nA
Offset Current	+25°C		0.5	20		0.5	20	ρA
	Full		0.1	5		.005	.5	nA
Input Resistance	+25°C		10^{12}			10^{12}		Ω
Input Capacitance	+25°C		5			5		ρF
Common Mode Range	Full	±10.0			±10.0			V
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Note 2, 5)	+25°C	80K	150K		80K	150K		V/V
	Full	60K			70K			V/V
Common Mode Rejection Ratio (Note 3)	Full	74	90		70	90		dB
Gain Bandwidth Product (Note 4)	+25°C		100			100		MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 2)	Full	±10	±12		±10	±12		V
Output Current	+25°C	±10	±18		±10	±18		mA
Full Power Bandwidth (Note 5)	+25°C		600			600		kHz
TRANSIENT RESPONSE (NOTES 2, 8, 9)								
Rise Time (Note 6)	+25°C		50			50		ns
Overshoot (Note 6)	+25°C		25			25		%
Slew Rate (Note 5)	+25°C		35			35		V/μs
POWER SUPPLY CHARACTERISTICS								
Supply Current	+25°C		4.0	6.0		4.0	6.0	mA
Power Supply Rejection Ratio (Note 7)	Full	74	90		70	90		dB

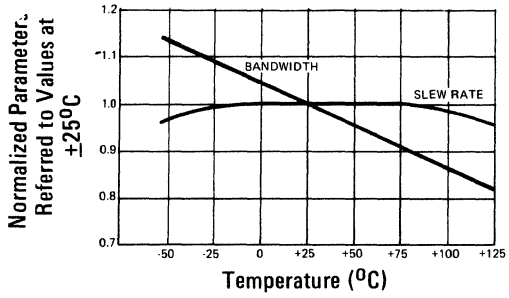
NOTES:
1. Adjustable to zero with 100K Ω pot between pins 1 and 5; wiper to V+.
2. R_L = 2K
3. V_{CM} = ±5.0V
4. $A_V > 10$
5. V_O = ±10V
6. V_O = ±200mV
7. ΔV = ±5.0V
8. C_L = 50ρF
9. A_V = +5, See transient response test circuits and waveforms, page 4.
10. Derate by 6.6mW/°C above 105°C

V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED

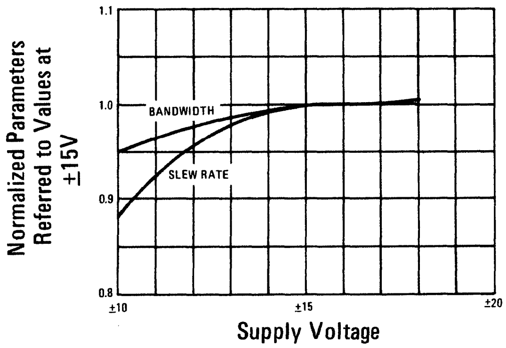
INPUT BIAS AND OFFSET CURRENT VS. TEMPERATURE



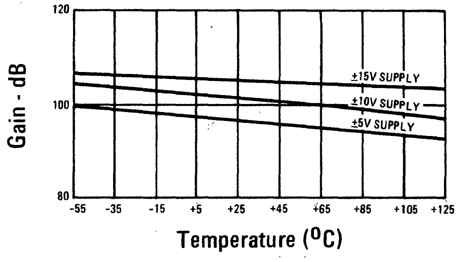
NORMALIZED AC PARAMETERS VS. TEMPERATURE



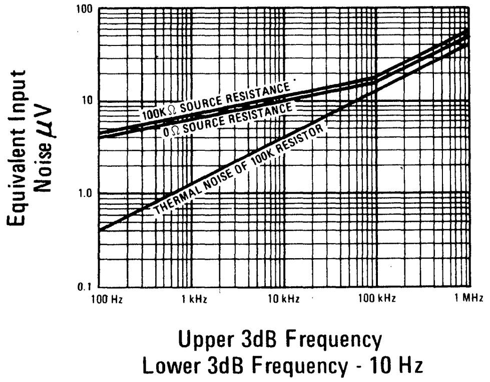
NORMALIZED AC PARAMETERS VS. SUPPLY VOLTAGE AT +25°C



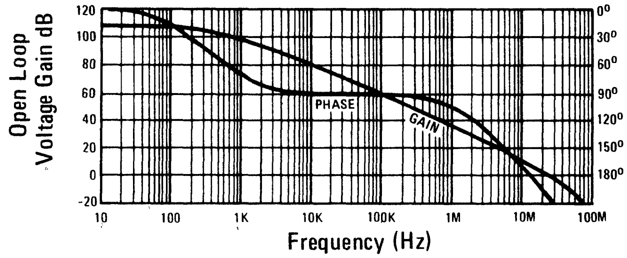
OPEN LOOP VOLTAGE GAIN VS. TEMPERATURE



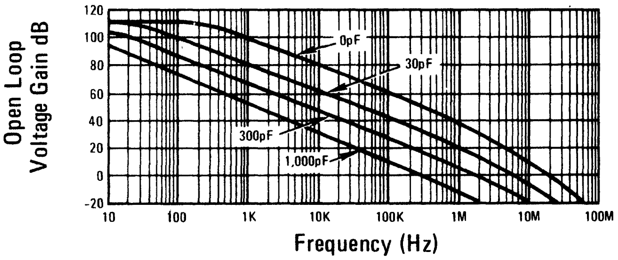
EQUIVALENT INPUT NOISE VS. BANDWIDTH



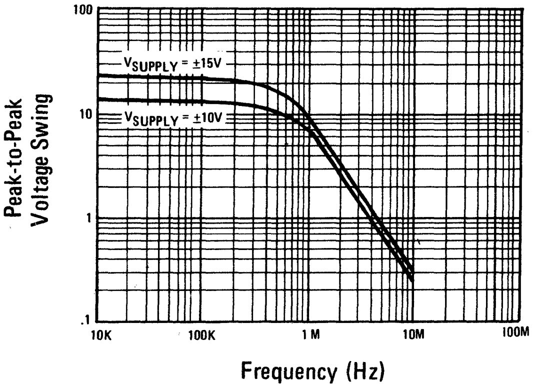
OPEN-LOOP FREQUENCY AND PHASE RESPONSE



OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND

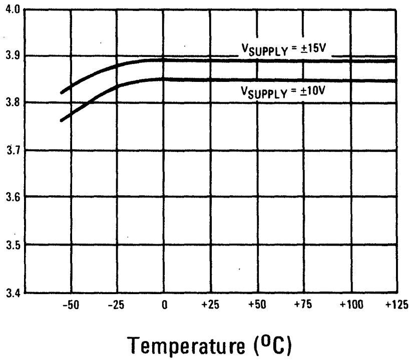


OUTPUT VOLTAGE SWING VS. FREQUENCY AT +25°C

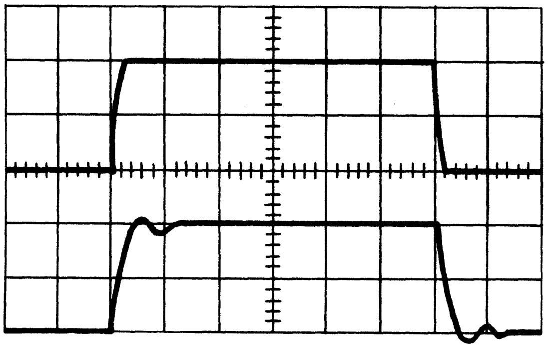


PERFORMANCE CURVES (continued)

POWER SUPPLY CURRENT VS. TEMPERATURE

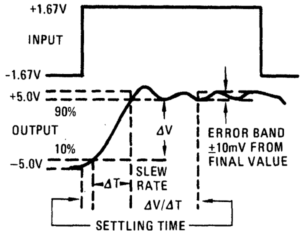


TRANSIENT RESPONSE; $A_V = +5$

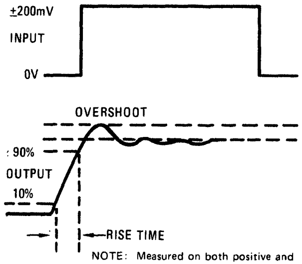


R_L = 2K Ohms, C_L = 50pF
Upper Trace: Input; 20mV/Div.
Lower Trace: Output; 100mV/Div.
Horizontal = 100ns/Div.
$T_A = +25°C$, $V_S = \pm 15V$

SLEW RATE AND SETTLING TIME

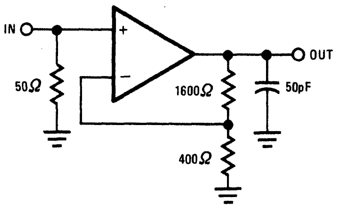


TRANSIENT RESPONSE

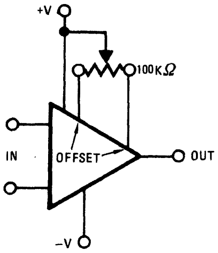


NOTE: Measured on both positive and negative transitions.

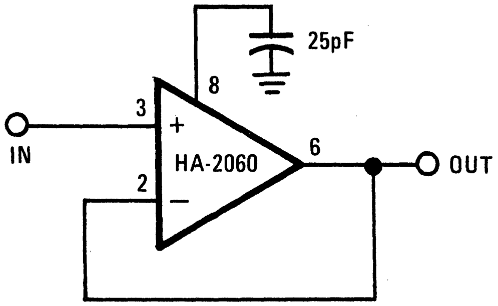
SLEW RATE AND TRANSIENT RESPONSE



SUGGESTED OFFSET ZERO ADJUST HOOK-UP



TYPICAL APPLICATIONS



COMPENSATION CIRCUIT FOR UNITY GAIN

SLEW RATE ≈ 5 V/μs

BANDWIDTH ≈ 10 MHz

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2111/2211

Voltage Comparators

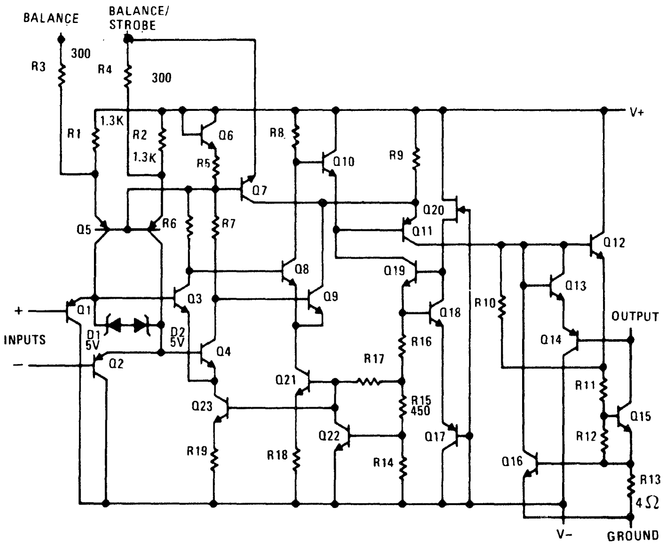
FEATURES

• INPUT BIAS CURRENT	60nA
• INPUT OFFSET CURRENT	4nA
• DIFFERENTIAL INPUT VOLTAGE	±30.0V
• POWER SUPPLY VOLTAGES	A SINGLE 5.0V SUPPLY TO ±15.0V
• OFFSET VOLTAGE NULL CAPABILITY	
• STROBE CAPABILITY	

GENERAL DESCRIPTION

The HA-2111 and HA-2211 are voltage comparators which have low input bias currents. They operate over a wide range of power supply voltages, from the standard ±15.0V down to a single 5.0V power supply. A very flexible output stage is employed, which is compatible with RTL, DTL, TTL and MOS logic circuits.

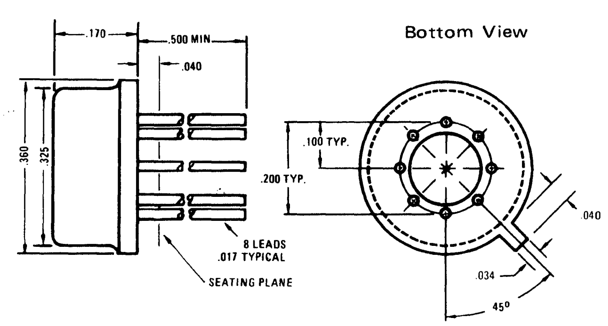
SCHEMATIC



PACKAGES

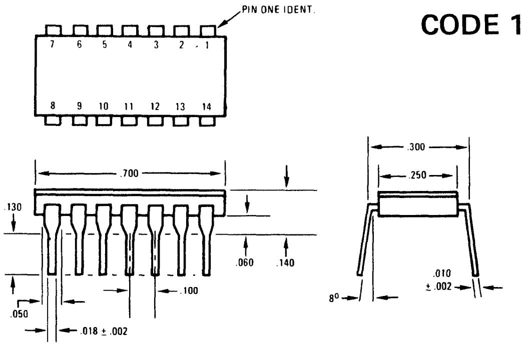
CODE 2A

TO-99



ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

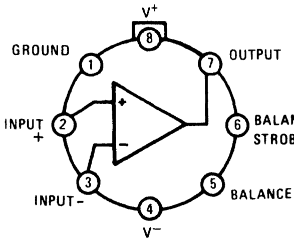
CODE 1S



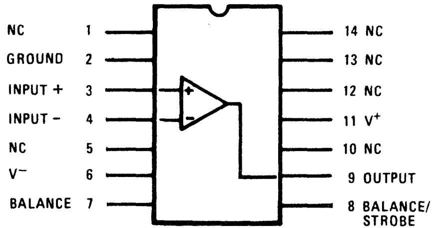
PIN OUT

TO-99

Case Connected to V−



TO-116



Case Connected to V−

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	36.0V
Output to V^-	50.0V
Ground to V^-	30.0V
Differential Input Voltage	±30.0V
Input Voltage (Note 1)	±15.0V
Internal Power Dissipation (Note 7)	500mW
Output Short Circuit Duration	10 sec.
Storage Temperature Range	−65°C to +150°C

ELECTRICAL CHARACTERISTICS

$V^+ = +15.0$ V.D.C. $V^- = -15.0$ V.D.C.

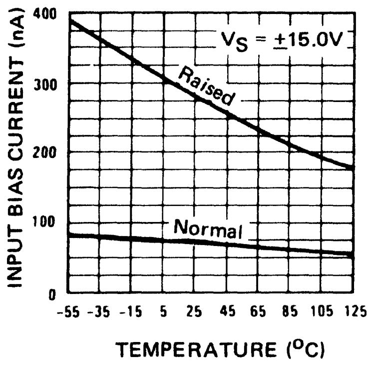
PARAMETER	TEMPERATURE	HA-2111 −55°C to +125°C			HA-2211 −25°C to +85°C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS								
* Offset Voltage	+25°C		0.7	3.0		0.7	3.0	mV
(Note 2)	Full			4.0			4.0	mV
* Bias Current	+25°C		60	100		60	100	nA
	Full			150			150	nA
* Offset Current	+25°C		4.0	10.0		4.0	10.0	nA
(Note 2)	Full			20.0			20.0	nA
Common Mode Range	Full		±14.0			±14.0		V
Strobe Current	+25°C		3.0			3.0		mA
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain	+25°C		200K			200K		V/V
Response Time (Note 3)	+25°C		200			200		ns
OUTPUT CHARACTERISTICS								
* Leakage Current	+25°C		0.2	10.0		0.2	10.0	nA
(Note 4)	Full			500			500	nA
* Saturation Voltage (Note 5)	+25°C		0.75	1.5		0.75	1.5	V
(Note 6)	Full		0.23	0.4		0.23	0.4	V
POWER SUPPLY CHARACTERISTICS								
* Positive Supply Current	+25°C		5.1	6.0		5.1	6.0	mA
* Negative Supply Current	+25°C		4.1	5.0		4.1	5.0	mA

NOTES:
1. This rating applies for ±15.0V supplies. The positive input voltage limit is 30.0V above the negative supply. The negative input voltage is equal to the negative supply voltage or 30.0V below the positive supply, whichever is less.
2. The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with a 1mA load. Thus, these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.
3. 100mV input step; 5mV overdrive.
4. $V_{OUT} = 35.0V$; $V_{IN} = 5mV$
5. $I_{OUT} = 50mA$; $V_{IN} = -5mV$
6. $I_{Sink} = 8mA$; $V^+ = 4.5V$; $V^- = 0V$; $V_{IN+} = +1.00V$; $V_{IN-} = +1.006V$
7. Derate by 6.6mW/°C above 105°C

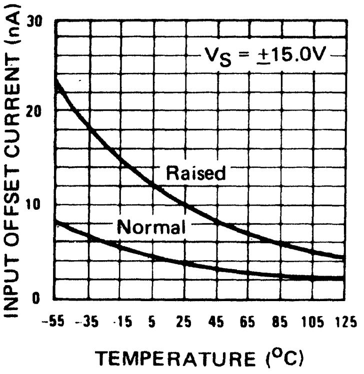
*100% Tested For DASH 8

TYPICAL PERFORMANCE CURVES

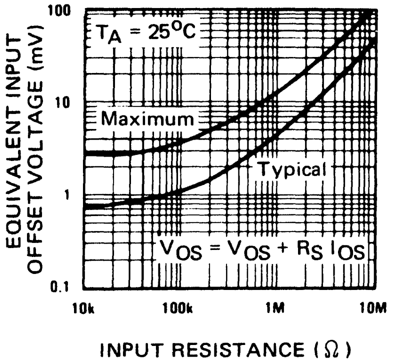
INPUT BIAS CURRENT



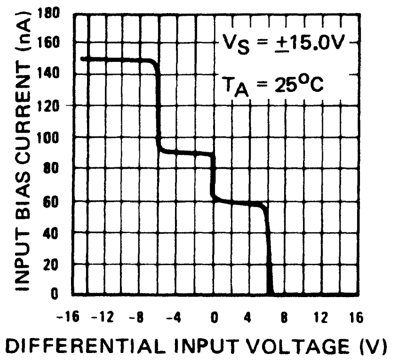
INPUT OFFSET CURRENT



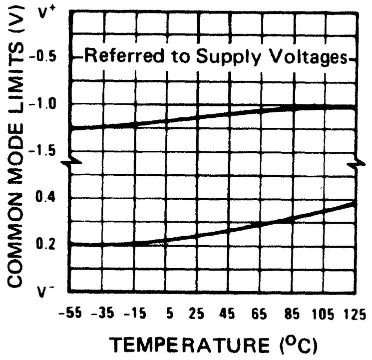
OFFSET ERROR



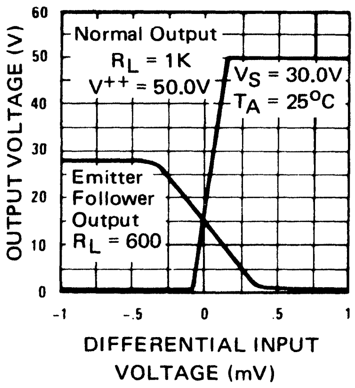
INPUT CHARACTERISTICS



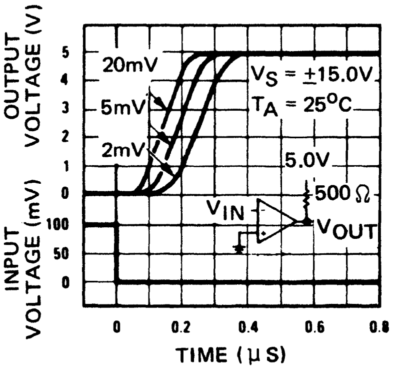
COMMON MODE LIMITS



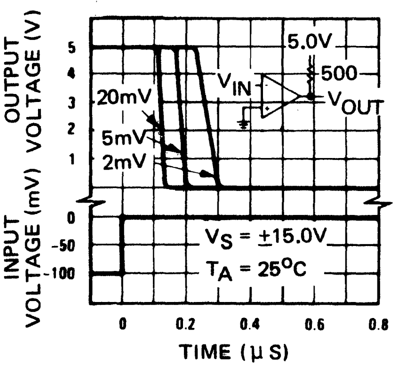
TRANSFER FUNCTION



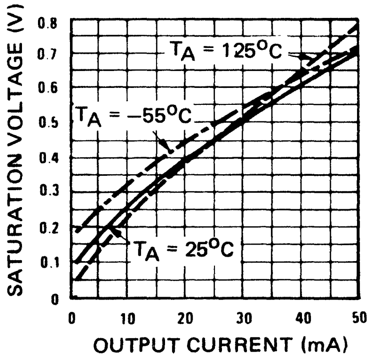
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



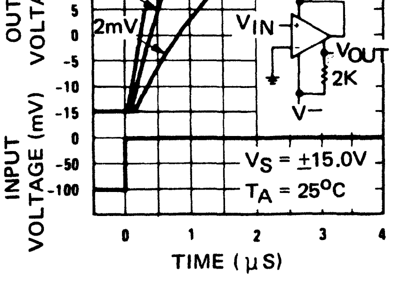
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



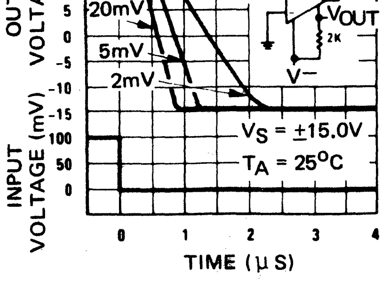
OUTPUT SATURATION VOLTAGE



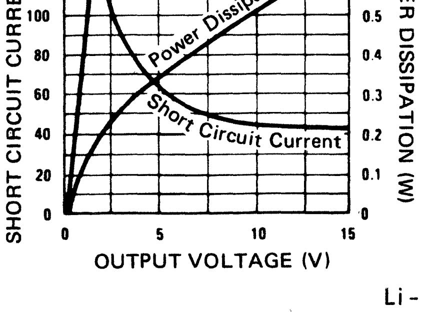
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES

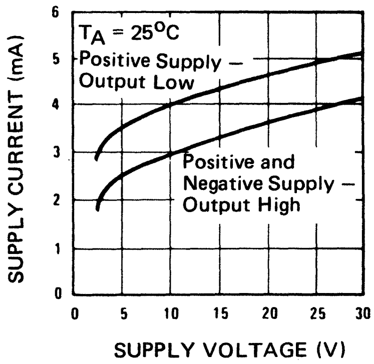


OUTPUT LIMITING CHARACTERISTICS

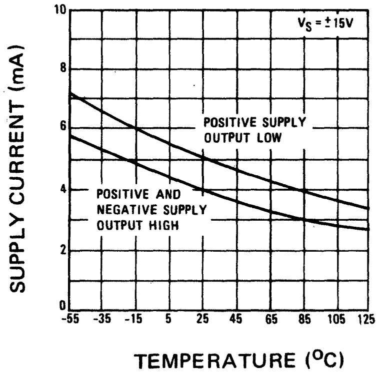


TYPICAL PERFORMANCE CURVES(continued)

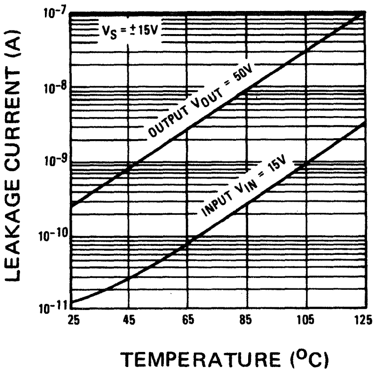
SUPPLY CURRENT



SUPPLY CURRENT

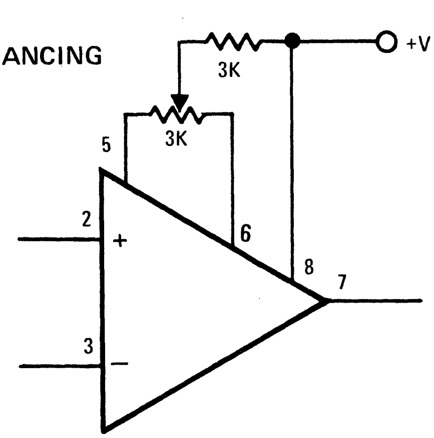


LEAKAGE CURRENTS

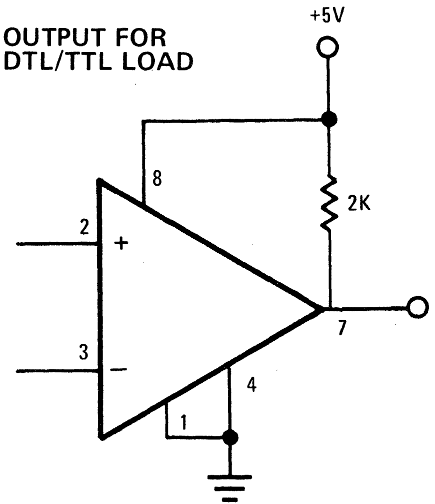


APPLICATION INFORMATION

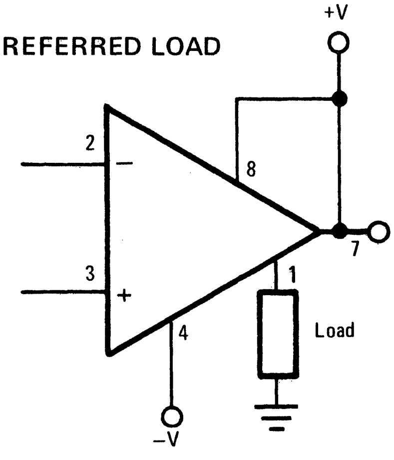
OFFSET BALANCING



OUTPUT FOR DTL/TTL LOAD

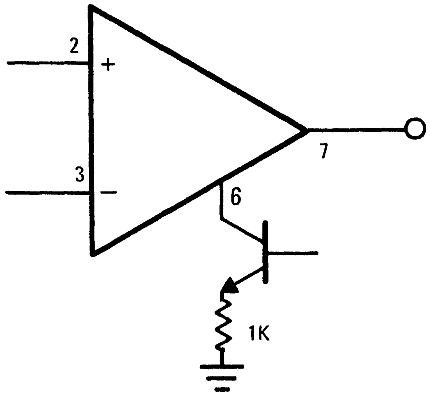


GROUND REFERRED LOAD



NOTE: INPUT POLARITIES REVERSED

TTL STROBE



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2311

Voltage Comparator

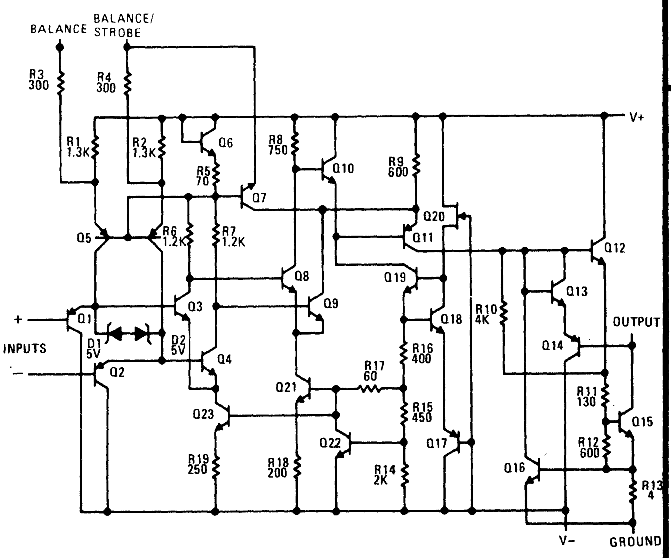
FEATURES

• INPUT BIAS CURRENT	100nA
• INPUT OFFSET CURRENT	6nA
• DIFFERENTIAL INPUT VOLTAGE	±30.0V
• POWER SUPPLY VOLTAGES	A SINGLE +5.0V SUPPLY TO ±15.0V
• OFFSET VOLTAGE NULL CAPABILITY	
• STROBE CAPABILITY	

GENERAL DESCRIPTION

The HA-2311 is a voltage comparator which has low input bias currents. It operates over a wide range of power supply voltages, from the standard ±15.0V down to a single 5.0 V power supply. A very flexible output stage is employed which is compatible with RTL, DTL, TTL and MOS logic circuits.

SCHEMATIC

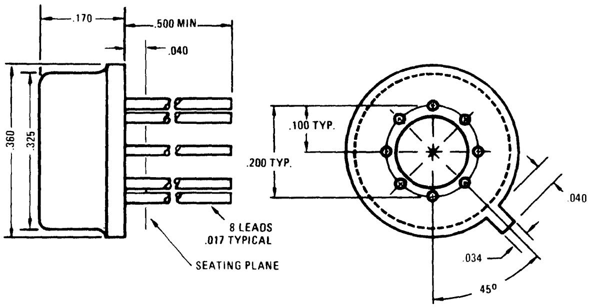


PACKAGES

CODE 2A

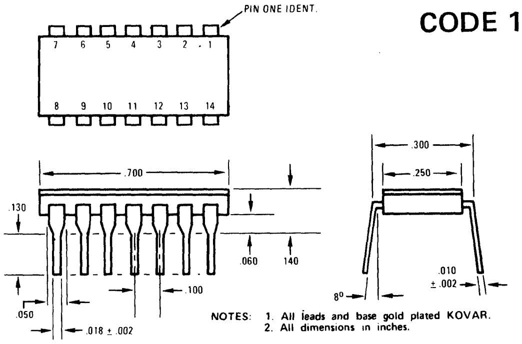
TO-99

Bottom View



ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

CODE 1S

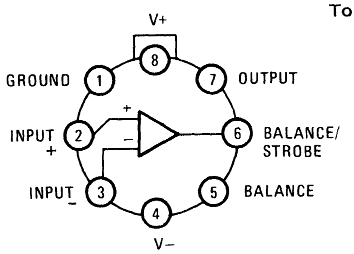


NOTES: 1. All leads and base gold plated KOVAR.
2. All dimensions in inches.

PIN OUT

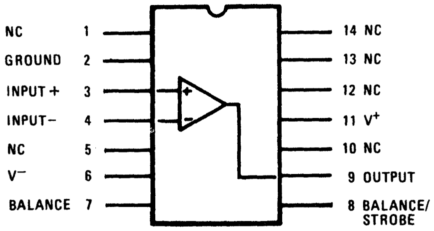
Top View

TO-99



Case Connected to V−

TO-116



Case Connected to V−

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	36.0V
Output to V^-	40.0V
Ground to V^-	30.0V
Differential Input Voltage	±30.0V
Input Voltage (Note 1)	±15.0V
Internal Power Dissipation	500mW
Output Short Circuit Duration	10 sec.
Storage Temperature Range	−65°C to +150°C

ELECTRICAL CHARACTERISTICS

$V^+ = +15.0$ V.D.C. $V^- = -15.0$ V.D.C.

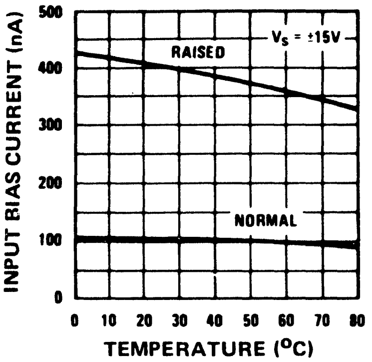
PARAMETER	TEMPERATURE	HA-2311 0°C to +75°C			UNITS
		MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS					
Offset Voltage (Note 2)	+25°C		2.0	7.5	mV
	0°C to +75°C			10.0	mV
Bias Current	+25°C		100	250	nA
	0°C to +75°C			300	nA
Offset Current (Note 2)	+25°C		6.0	50.0	nA
	0°C to +75°C			70.0	nA
Common Mode Range	0°C to +75°C		±14.0		V
Strobe Current	+25°C		3.0		mA
TRANSFER CHARACTERISTICS					
Large Signal Voltage Gain	+25°C		200K		V/V
Response Time (Note 3)	+25°C		200		ns
OUTPUT CHARACTERISTICS					
Leakage Current (Note 4)	+25°C		0.2	50.0	nA
Saturation Voltage (Note 5)	+25°C		0.75	1.5	V
(Note 6)	0°C to +75°C		0.23	0.4	V
POWER SUPPLY CHARACTERISTICS					
Positive Supply Current	+25°C		5.1	7.5	mA
Negative Supply Current	+25°C		4.1	5.0	mA

NOTES:

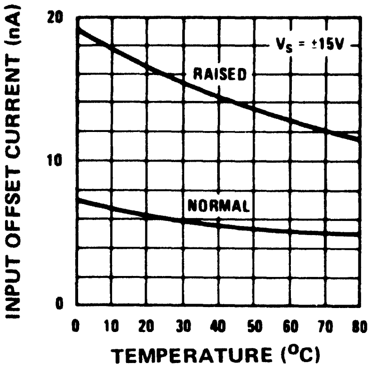
1. This rating applies for ±15.0V supplies. The positive input voltage limit is 30.0V above the negative supply. The negative input voltage is equal to the negative supply voltage or 30.0V below the positive supply, whichever is less.
2. The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with a 1mA load. Thus, these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.
3. 100mV input step; 5mV overdrive.
4. $V_{OUT} = 35.0V$; $V_{IN} = 10mV$
5. $I_{OUT} = 50mA$; $V_{IN} = -10mV$
6. $I_{SINK} = 8mA$, $V^+ = 4.5V$, $V^- = 0.0V$, $V_{IN}{}^+ = +1.0V$ $V_{IN}{}^- = +1.01V$

TYPICAL PERFORMANCE CURVES

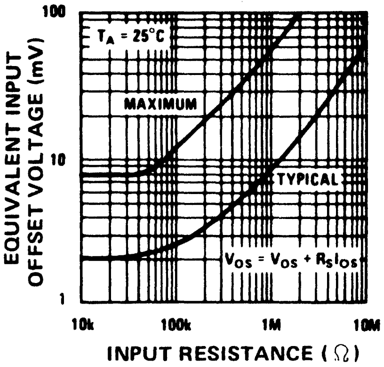
INPUT BIAS CURRENT



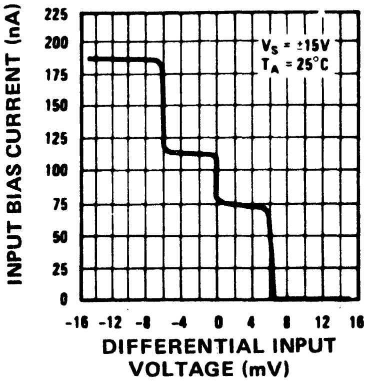
INPUT OFFSET CURRENT



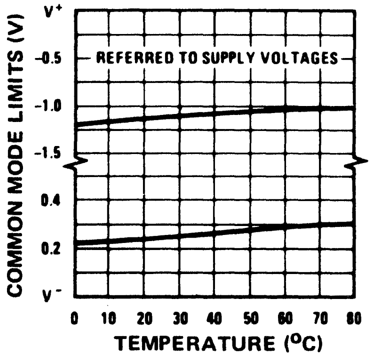
OFFSET ERROR



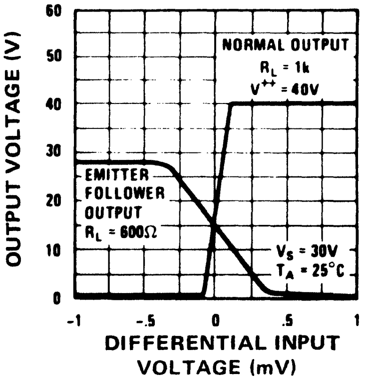
INPUT CHARACTERISTICS



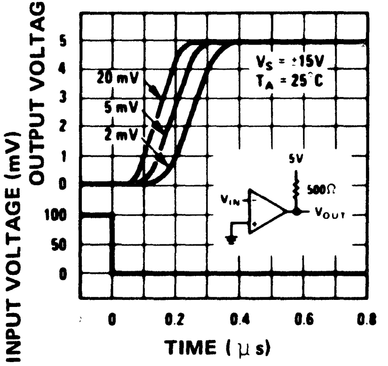
COMMON MODE LIMITS



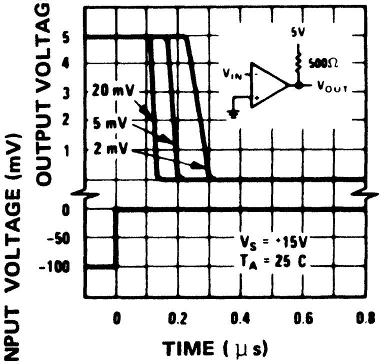
TRANSFER FUNCTION



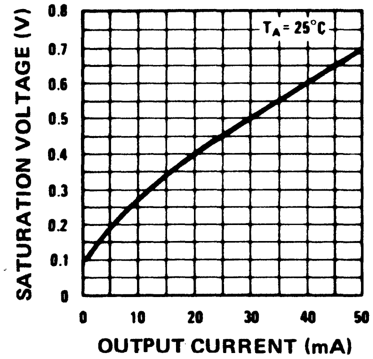
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



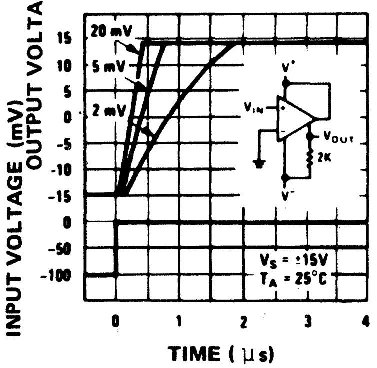
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



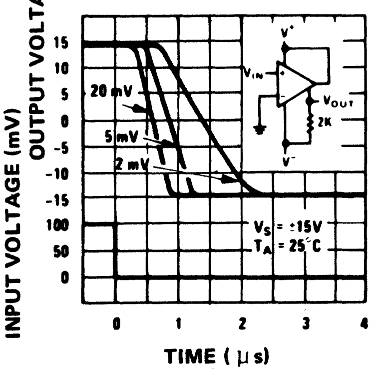
OUTPUT SATURATION VOLTAGE



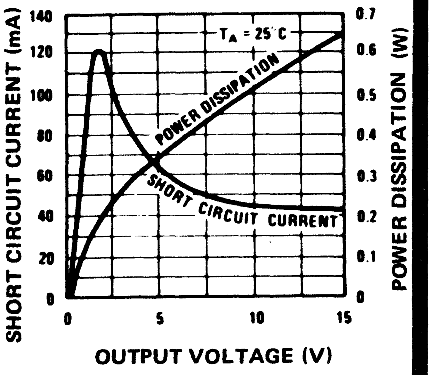
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



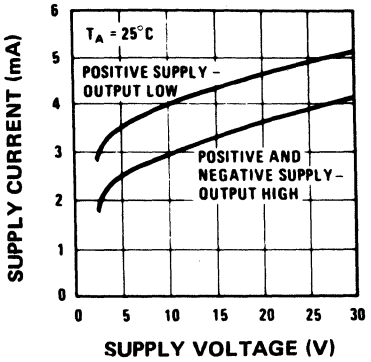
OUTPUT LIMITING CHARACTERISTICS



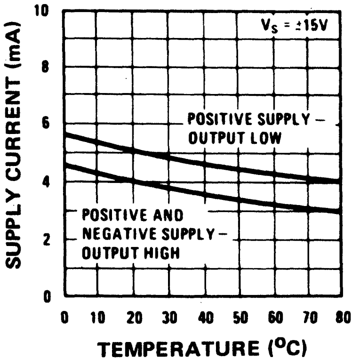
LINEAR

TYPICAL PERFORMANCE CURVES (continued)

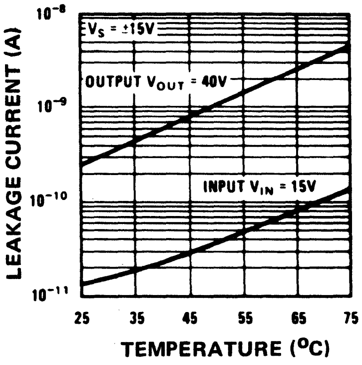
SUPPLY CURRENT



SUPPLY CURRENT

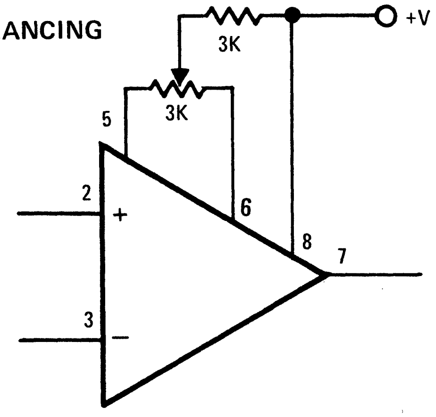


LEAKAGE CURRENTS

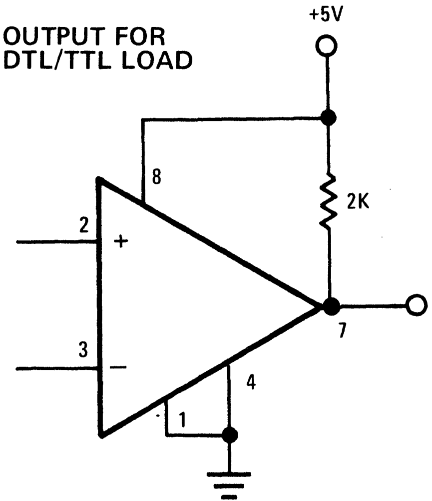


APPLICATION INFORMATION

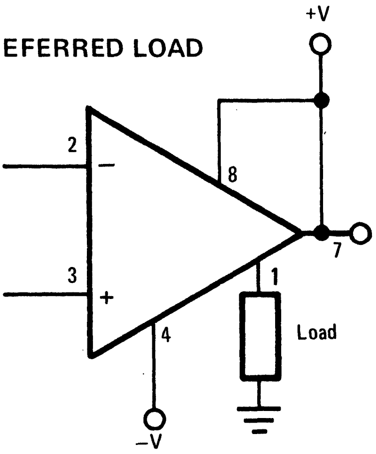
OFFSET BALANCING



OUTPUT FOR DTL/TTL LOAD

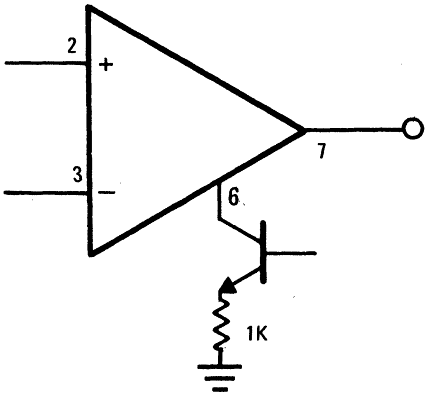


GROUND REFERRED LOAD



NOTE: INPUT POLARITIES REVERSED

TTL STROBE



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2400/2404/2405

PRAM™ Four Channel Programmable Amplifier

FEATURES

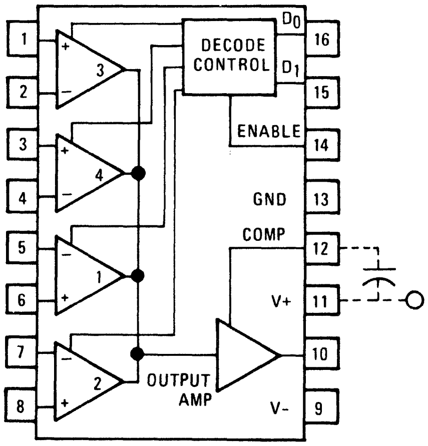
- THOUSANDS OF NEW APPLICATIONS; PROGRAM:
  - SIGNAL SELECTION/MULTIPLEXING
  - OP AMP GAIN
  - OSCILLATOR FREQUENCY
  - FILTER CHARACTERISTICS
  - ADD-SUBTRACT FUNCTIONS
  - INTEGRATOR CHARACTERISTICS
  - COMPARATOR LEVELS
  - ETC., ETC.

• HIGH SLEW RATE	50V/μs
• WIDE GAIN BANDWIDTH	40MHz
• HIGH GAIN	150,000
• LOW OFFSET CURRENT	5nA
• HIGH INPUT IMPEDANCE	30MΩ
• SINGLE CAPACITOR COMPENSATION	
• DTL/TTL COMPATIBLE INPUTS	

GENERAL DESCRIPTION

The HA-2400 is an operational amplifier with four identical input stages, any one (or none) of which may be electronically connected to the single output stage. The "ON" channel is selected through DTL/TTL compatible address inputs. The amplifier formed by the output and the selected pair of amplifier inputs is a high performance operational amplifier which can be operated with suitable feedback networks in any of the well known op amp configurations. The device is an extremely versatile analog building block. It can be used as an analog signal selector, sampler, or multiplexer with built in buffering or signal conditioning. By connecting different feedback networks from the output to each input pair, it can be used as a single or multiple channel amplifier with programmable feedback characteristics. The device is packaged in a hermetic 16 pin dual in-line package. The HA-2400 operates over the temperature range of -55°C to +125°C, the HA-2404 operates over -25°C to +85°C, while the HA-2405 operates over 0°C to +75°C.

FUNCTIONAL DIAGRAM



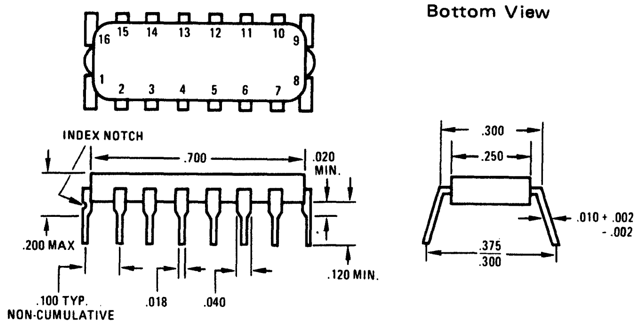
TRUTH TABLE

D_1	D_0	EN	SELECTED CHANNEL
L	L	H	1
L	H	H	2
H	L	H	3
H	H	H	4
X	X	L	NONE

PACKAGE

CODE 1F

TO-99



ALL DIMENSIONS ARE IN INCHES.

ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

Case Connected to V−

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V– Terminals	45.0V	Internal Power Dissipation (Note 13)	300mW
Differential Input Voltage	±V_{Supply}	Operating Temperature Range	$-55^{\circ}C \leq T_A \leq +125^{\circ}C$ (HA-2400)
Digital Input Voltage	–0.76V to +10.0V		$-25^{\circ}C \leq T_A \leq +85^{\circ}C$ (HA-2404)
Output Current	Short Circuit Protected		$0^{\circ}C \leq T_A \leq +75^{\circ}C$ (HA-2405)
		Storage Temperature Range	$-65^{\circ}C \leq T_A \leq +150^{\circ}C$

ELECTRICAL CHARACTERISTICS

Test Conditions: $V_{Supply} = \pm 15.0V$ unless otherwise specified.

Digital inputs: $V_{IL} = +0.5V$, $V_{IH} = +2.4V$
Limits apply to each of the four channels, when addressed.

PARAMETER	TEMP.	HA-2400/HA-2404 LIMITS			HA-2405 LIMITS			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS								
* Offset Voltage	+25°C		2	5		4	9	mV
	Full			7			11	mV
* Bias Current (Note 12)	+25°C		50	200		50	250	nA
	Full			400			500	nA
* Offset Current (Note 12)	+25°C		5	50		5	50	nA
	Full			100			100	nA
Input Resistance (Note 12)	+25°C		30			30		MΩ
Common Mode Range	Full	±10.0			±10.0			V
TRANSFER CHARACTERISTICS								
* Large Signal Voltage Gain (Note 1,5)	+25°C	50K	150K		50K	150K		V/V
	Full	25K			25K			V/V
* Common Mode Rejection Ratio (Note 2)	Full	80	100		74	100		dB
Gain Bandwidth (Note 3)	+25°C		40			40		MHz
(Note 4)	+25°C		8			8		MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 1)	Full	±10.0	±12.0		±10.0	±12.0		V
Output Current	+25°C		20			20		mA
Full Power Bandwidth (Notes 3, 5)	+25°C		500			500		kHz
(Notes 4,5)	+25°C		200			200		kHz
TRANSIENT RESPONSE								
Rise Time (Notes 4,6)	+25°C		20			20		ns
Overshoot (Notes 4,6)	+25°C		25			25		%
* Slew Rate (Notes 3,7)	+25°C		50			50		V/μs
(Notes 4,7)	+25°C		15			15		V/μs
Settling Time (Notes 4, 7, 8)	+25°C		1.5			1.5		μs
CHANNEL SELECT CHARACTERISTICS								
Digital Input Current (V_{IN} = 0V)	Full		1			1		mA
Digital Input Current (V_{IN} = +5.0V)	Full		5			5		nA
Output Delay (Note 9)	+25°C		100			100		ns
Crosstalk (Note 10)	+25°C	-80	-110		-74	-110		dB
POWER SUPPLY CHARACTERISTICS								
* Supply Current	+25°C		4.8	6.0		4.8	6.0	mA
* Power Supply Rejection Ratio (Note 11)	Full	80	90		74	90		dB

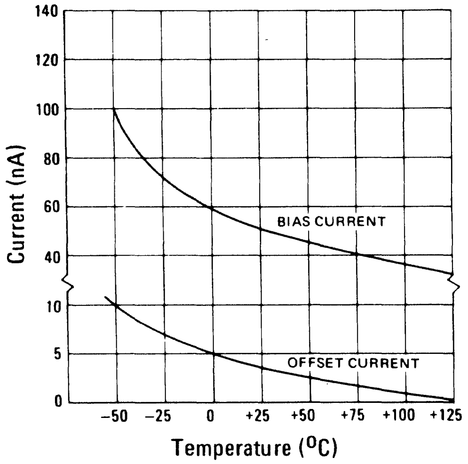
NOTES:
1. $R_L = 2K\Omega$
2. $V_{CM} = \pm 5$ V.D.C.
3. $A_V = +10$, $C_{COMP} = 0$, $R_L = 2K\Omega$, $C_L = 50pF$
4. $A_V = +1$, $C_{COMP} = 15pF$, $R_L = 2K\Omega$, $C_L = 50pF$
5. V_{OUT} = 20V peak-to-peak
6. V_{OUT} = 400 mV peak-to-peak
7. V_{OUT} = 10.0V peak-to-peak
8. To 0.1% of final value
9. To 10% of final value; output then slews at normal rate to final value.
10. Unselected input to output; $V_{IN} = \pm 10$ V.D.C.
11. $V_{SUPP} = \pm 10$V.D.C. to ± 20V.D.C.
12. Unselected channels have approximately the same input parameters.
13. Derate by 4.3mW/°C above 105°C

*100% Tested For DASH 8

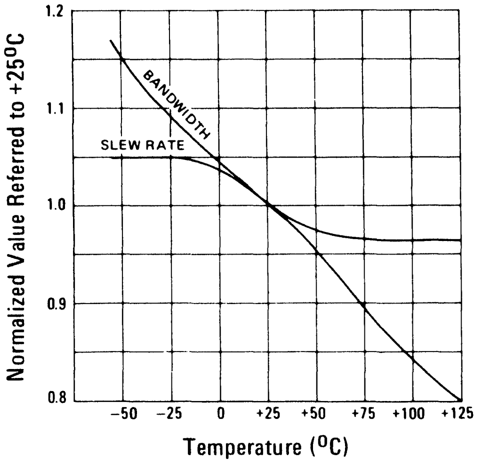
CHARACTERISTIC CURVES

V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED.

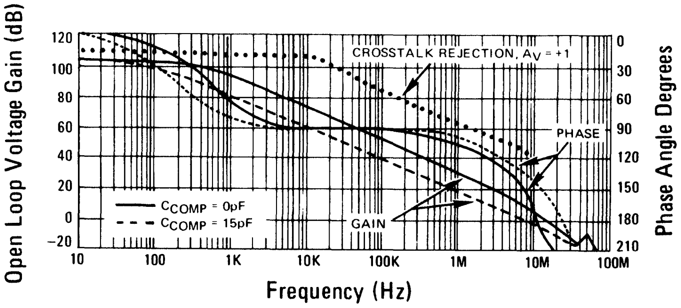
INPUT BIAS CURRENT AND OFFSET CURRENT AS A FUNCTION OF TEMPERATURE



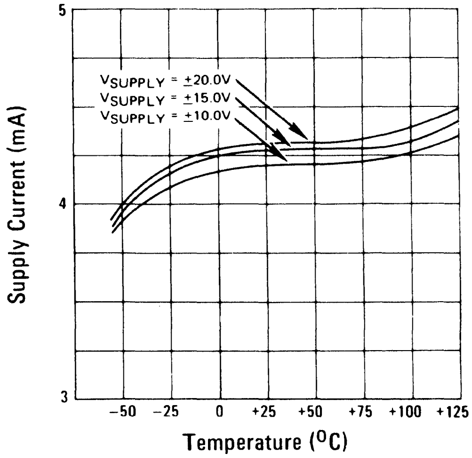
NORMALIZED A.C. PARAMETERS VS. TEMPERATURE



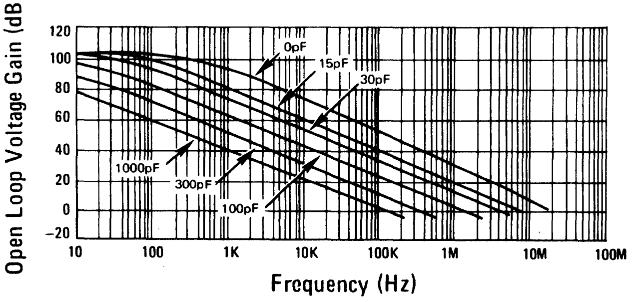
OPEN LOOP FREQUENCY AND PHASE RESPONSE



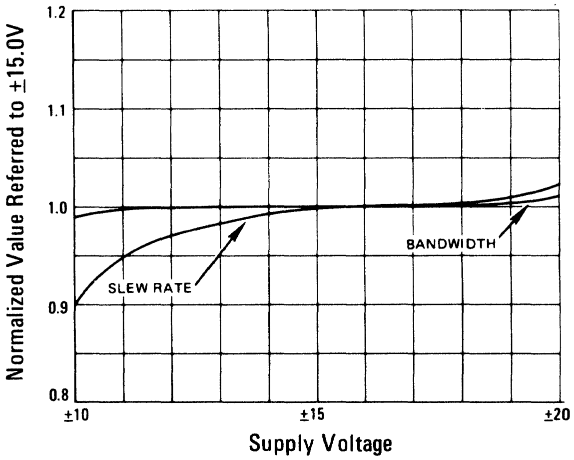
POWER SUPPLY CURRENT DRAIN AS A FUNCTION OF TEMPERATURE



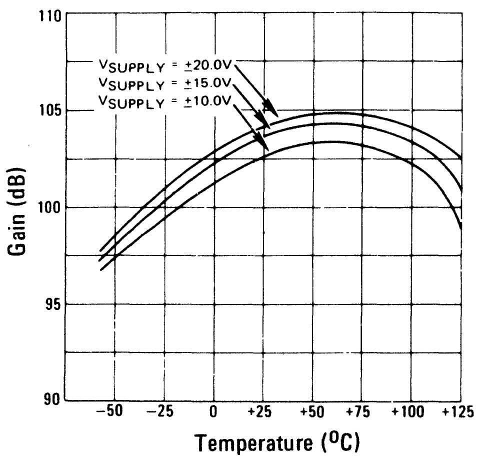
FREQUENCY RESPONSE VS. C_{COMP}



NORMALIZED A.C. PARAMETERS VS. SUPPLY VOLTAGE

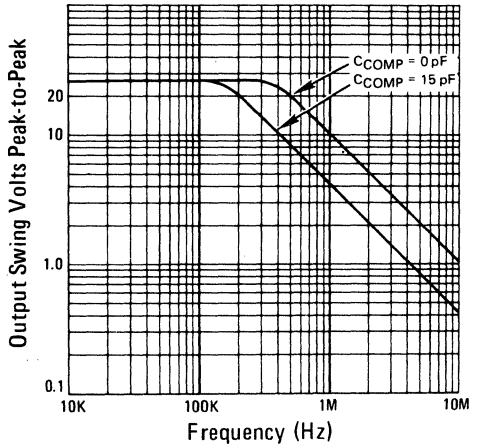


OPEN LOOP VOLTAGE GAIN VS. TEMPERATURE

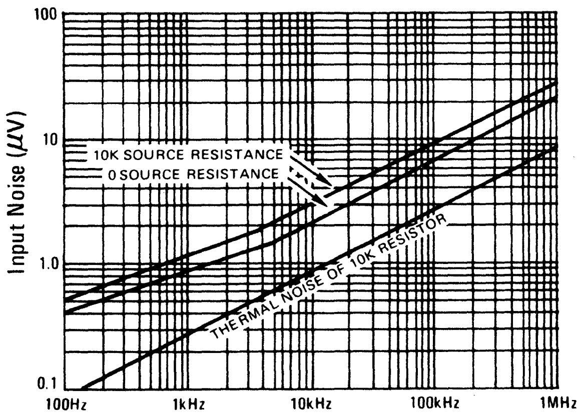


CHARACTERISTC CURVES (continued)

OUTPUT VOLTAGE SWING VS. FREQUENCY

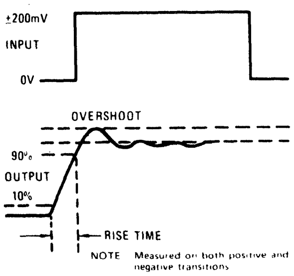


EQUIVALENT INPUT NOISE VS. BANDWIDTH



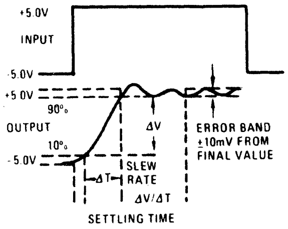
Upper 3dB Frequency
Lower 3dB Frequency - 10Hz
Broadband Noise Characteristics

TRANSIENT RESPONSE

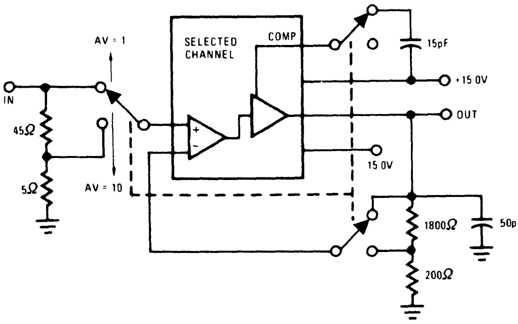


NOTE Measured on both positive and negative transitions

SLEW RATE AND SETTLING

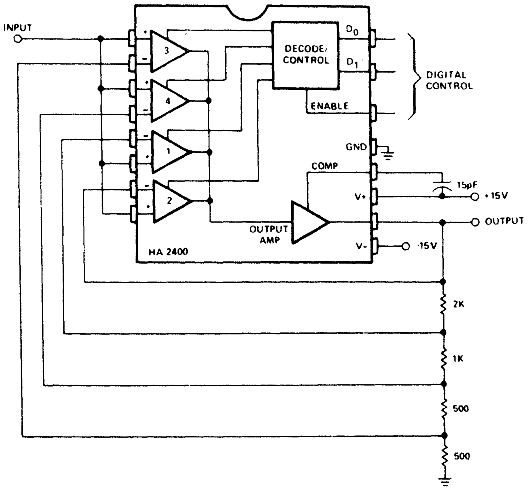


SLEW RATE AND TRANSIENT RESPONSE

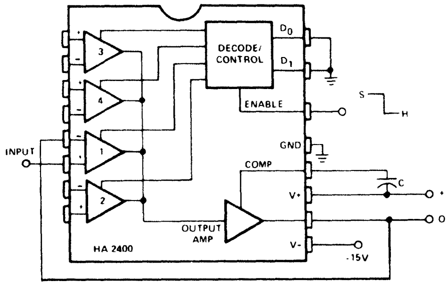


TYPICAL APPLICATIONS

AMPLIFIER, NON-INVERTING PROGRAMMABLE GAIN



SAMPLE AND HOLD



Sample charging rate = $\frac{I_1}{C}$ V/sec.

Hold drift rate = $\frac{I_2}{C}$ V/sec.

Switch pedistal error = $\frac{Q}{C}$ Volts

$I_1 \approx 150 \times 10^{-6}$ A

$I_2 \approx 200 \times 10^{-9}$ A @ +25°C

$\approx 600 \times 10^{-9}$ A @ -55°C

$\approx 100 \times 10^{-9}$ A @ +125°C

$Q \approx 2 \times 10^{-12}$ Coul.

FOR MORE EXAMPLES, SEE HARRIS APPLICATION NOTE 514.

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2420/2425

Sample and Hold Gated Operational Amplifier

FEATURES

- SAMPLE CURRENT/HOLD CURRENT RATIO: 10^6
- SLEW RATE: 5V/µs
- BANDWIDTH: 2MHz
- APERTURE TIME: 50ns
- LOW CHARGE TRANSFER: 10pC
- CONNECT IN ANY OP AMP CONFIGURATION
- ALSO USE AS GATED OP AMP
- DTL/TTL COMPATIBLE CONTROL INPUT

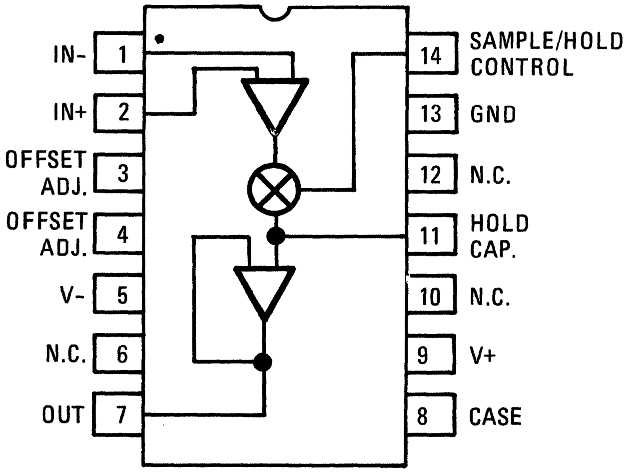
DESCRIPTION

The HA-2420/2425 is a monolithic circuit consisting of a high performance operational amplifier with its output in series with an ultra-low leakage analog switch and a MOSFET input unity gain amplifier.

With an external holding capacitor connected to the switch output, a versatile, high performance sample-and-hold or track-and-hold circuit is formed. When the switch is closed, the device behaves as an operational amplifier, and any of the standard op amp feedback networks may be connected around the device to control gain, frequency response, etc. When the switch is opened the output will remain at its last level.

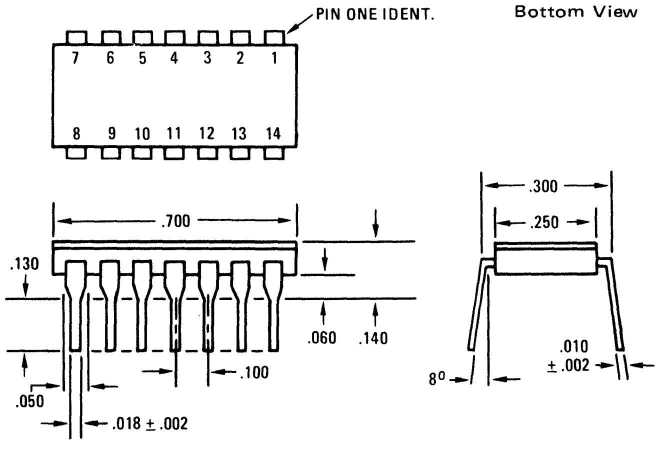
The device may also be used as a versatile operational amplifier with a gated output for applications such as analog switches, peak holding circuits, etc.

FUNCTIONAL DIAGRAM



PACKAGE

CODE 1S 14 LEAD BRAZED D.I.P.



ALL DIMENSIONS IN INCHES.

ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	40V
Differential Input Voltage	±30V
Digital Input Voltage (Pin 14)	+8V, -15V
Output Current	Short Circuit Protected

Internal Power Dissipation	300mW (note 8)
Operating Temperature Range	
HA-2420	$-55^oC \leq T_A \leq +125^oC$
HA-2425	$0^oC \leq T_A \leq +75^oC$
Storage Temperature Range	$-65^oC \leq T_A \leq +150^oC$

ELECTRICAL CHARACTERISTICS

Test Conditions V_{Supply} = ±15.0V
C_H = 1000pF

Unless Otherwise Specified

Digital Input (Pin 14) V_{IL} = +0.8V (Sample)
V_{IH} = +2.0V (Hold)

PARAMETER	TEMP.	HA-2420 LIMITS			HA-2425 LIMITS			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS								
Offset Voltage	+25°C		2	4		3	6	mV
	Full		3	6		4	8	mV
*Bias Current	+25°C		50	200		50	200	nA
	Full			400			400	nA
Offset Current	+25°C		10	50		10	50	nA
	Full			100			100	nA
Input Resistance	+25°C	5	10		5	10		MΩ
Common Mode Range	Full	±10			±10			V
TRANSFER CHARACTERISTICS								
* Large Signal Voltage Gain (Note 1, 4)	Full	25K	50K		25K	50K		V/V
*Common Mode Rejection (Note 2)	Full	80	90		74	90		dB
Gain Bandwidth Product (Note 3)	+25°C		2			2		MHz
OUTPUT CHARACTERISTICS								
* Output Voltage Swing (Note 1)	Full	±10			±10			V
* Output Current	+25°C	±10			±10			mA
Full Power Bandwidth (Note 3, 4)	+25°C		70			70		kHz
Output Resistance	+25°C		5			5		Ω
TRANSIENT RESPONSE								
Rise Time (Note 3, 5)	+25°C		100			100		ns
Overshoot (Note 3, 5)	+25°C		20			20		%
Slew Rate (Note 3, 6)	+25°C		5			5		V/µs
DIGITAL INPUT CHARACTERISTICS								
Digital Input Current (V_{IN} = 0V)	Full			0.8			0.8	mA
Digital Input Current (V_{IN} = +5.0V)	Full			20			20	µA
Digital Input Voltage (Low)	Full			0.8			0.8	V
Digital Input Voltage (High)	Full	2.0			2.0			V
SAMPLE/HOLD CHARACTERISTICS								
Acquisition Time (Note 3, 7)	+25°C		4			4		µs
Aperture Time	+25°C		50			50		ns
* Drift Current	+25°C		5	50		5	50	pA
	Full		0.5	10		.05	1.0	nA
* Charge Transfer	+25°C		10	20		10	20	pC
POWER SUPPLY CHARACTERISTICS								
* Supply Current	+25°C		2.5	5.0		2.5	5.0	mA
* Power Supply Rejection Ratio	Full	80	90		74	90		dB

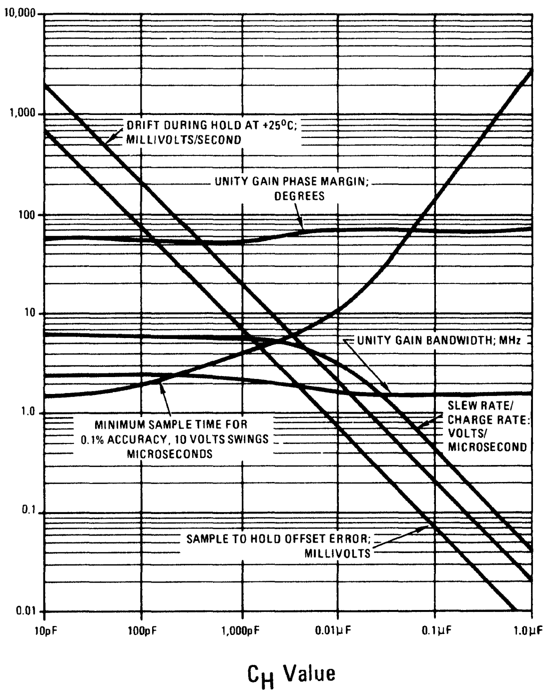
NOTES:
1. $R_L = 2K\Omega$
2. V_{CM} = +5 V.D.C.
3. $A_V = +1$, $R_L = 2K\Omega$, $C_L = 50pF$
4. V_{OUT} = 20V peak-to-peak
5. V_{OUT} = 400mV peak-to-peak
6. V_{OUT} = 10.0V peak-to-peak
7. To 0.1% of final value
8. Derate Power Dissipation by 4.3mW/°C Above +105°C Ambient Temperature.

*100% Tested For DASH 8

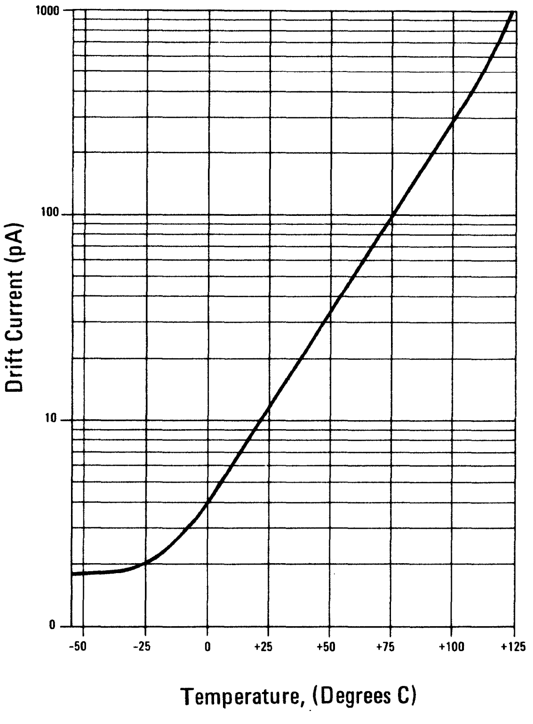
PERFORMANCE CURVES

V_{SUPPLY} = ±15VDC, T_A = +25°C, C_H = 1,000pF UNLESS OTHERWISE SPECIFIED

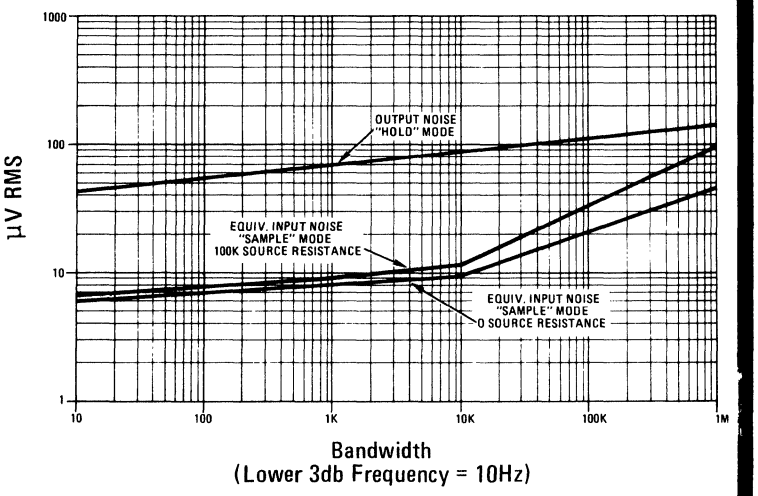
TYPICAL SAMPLE-AND-HOLD PERFORMANCE AS A FUNCTION OF HOLDING CAPACITANCE



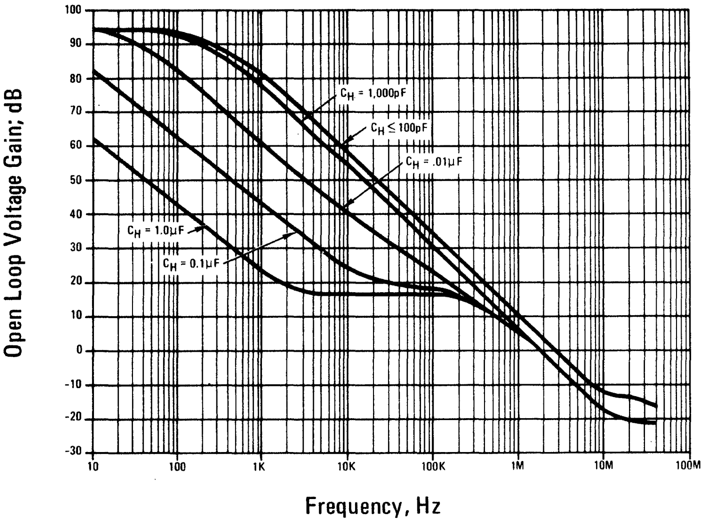
DRIFT CURRENT vs TEMPERATURE



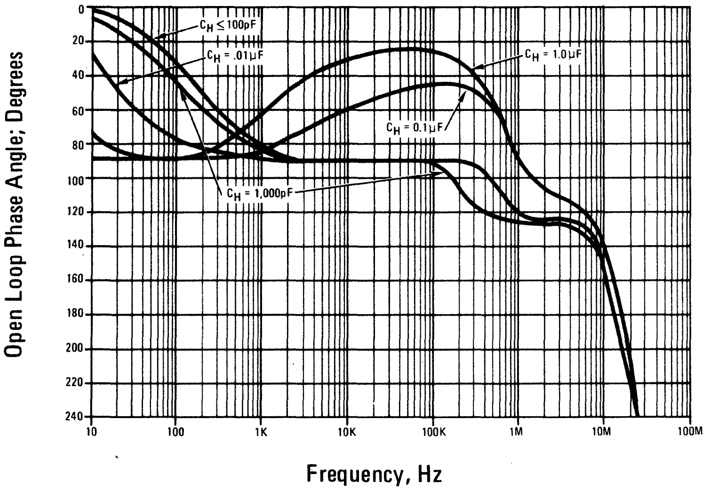
BROADBAND NOISE CHARACTERISTICS



OPEN LOOP FREQUENCY RESPONSE



OPEN LOOP PHASE RESPONSE



APPLICATIONS

BASIC TRACK-AND-HOLD/ SAMPLE-AND-HOLD

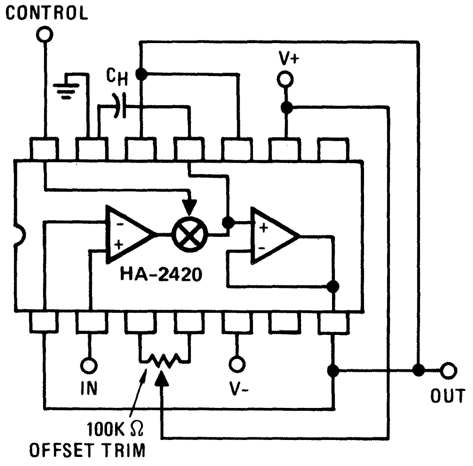


Figure 1

GUARD RING LAYOUT (BOTTOM VIEW)

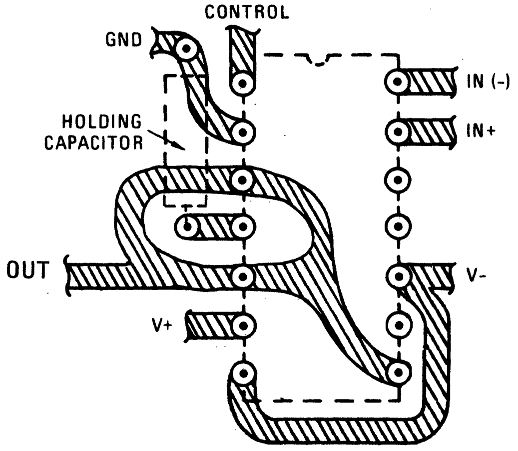


Figure 2

NOTES: 1) Figure 1 shows a typical unity gain circuit, with offset zeroing. All of the other normal op amp feedback configurations may be used with the HA-2420/2425. The input amplifier may be used as a gated amplifier by utilizing Pin 11 as the output. This amplifier has excellent drive capabilities along with exceptionally low switch leakage.

2) The method used to reduce leakage paths on the P.C. board and the device package is shown in Figure 2. This guard ring is recommended to minimize the drift during hold characteristic.

3) The holding capacitor should have extremely high insulation resistance and low dielectric absorption. Polystyrene (below +85°C), Teflon, or Mica types are recommended.

For more applications, consult Harris Application Note 517.

GLOSSARY OF TERMS

AQUISITION TIME:

The time required by the device after the "sample" command to reach its final value within ±0.1%. This time includes switch delay time, slewing time and settling time. This is the minimum sample time required to obtain a given accuracy.

CHARGE TRANSFER:

The small charge transferred to the holding capacitor from the inter-electrode capacitance of the switch when the unit is switched to the Hold mode. Sample-to-Hold offset error is directly proportional to this charge, where:

$$\text{Offset Error (V)} = \frac{\text{Charge (pC)}}{C_H\text{(pF)}}$$

APERTURE TIME:

The time required after the "hold" command until the switch is fully open. This delays the effective sample timing with rapidly changing input signals.

DRIFT CURRENT:

Leakage currents from the holding capacitor during the Hold mode which cause the output voltage to drift. Drift rate (droop rate) can be calculated from drift current values using the formula:

$$\frac{\Delta V}{\Delta T}\text{(Volts/Sec)} = \frac{\text{I(pA)}}{C_H\text{(pF)}}$$

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2500/2502/2505

High Slew Rate Operational Amplifiers

FEATURES

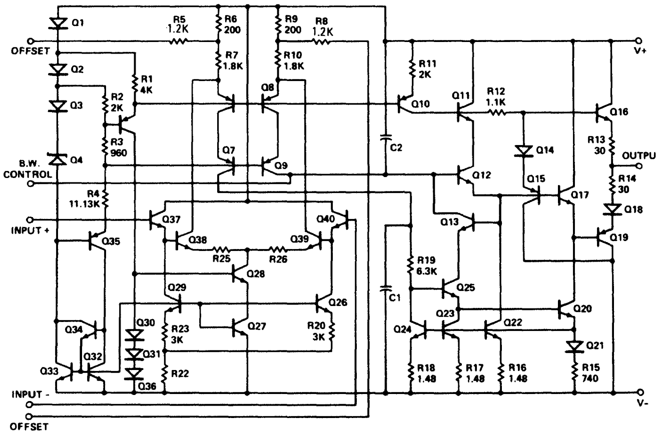
• HIGH SLEW RATE	30V/µs
• FAST SETTLING	330ns
• WIDE POWER BANDWIDTH	500kHz
• HIGH GAIN BANDWIDTH	12MHz
• HIGH INPUT IMPEDANCE	100mΩ
• LOW OFFSET CURRENT	10nA

- TRUE OP-AMP – CAN BE OPERATED NON-INVERTING OR INVERTING
- MEETS OR EXCEEDS MIL-STD-883 REQUIREMENTS

GENERAL DESCRIPTION

An operational amplifier with excellent D.C. characteristics, featuring high slew rate and fast settling time. Ideal for use in A/D, D/A, and sampled data systems; and for use in wide band R.F. or video systems where wide bandwidth at high output levels is required. The HA-2500/02/05 is internally compensated.

SCHEMATIC

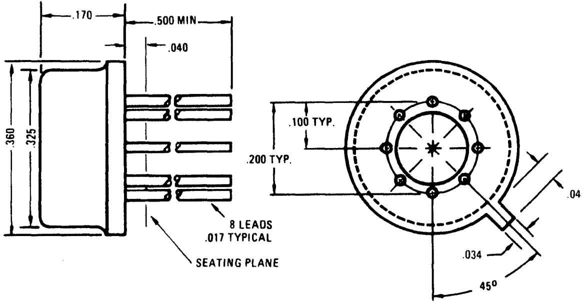


PACKAGES

CODE 2A

TO-99

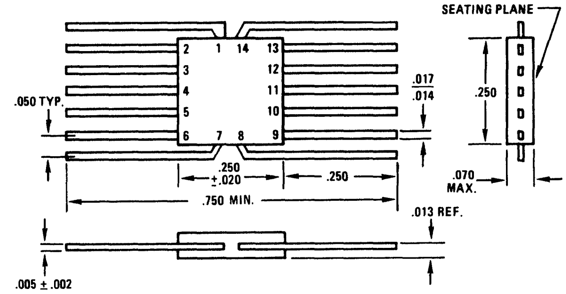
Bottom View



NOTES: 1. All leads gold plated KOVAR
2. All dimensions in inches

CODE 9V

(METAL BOTTOM) TO-86

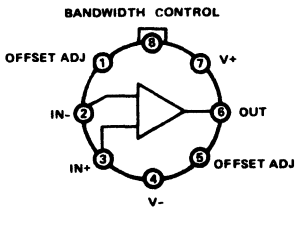


ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

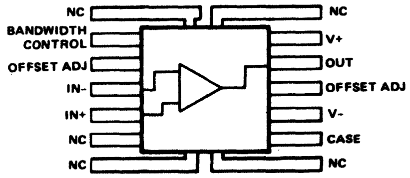
PIN OUT

TO-99

Top View



TO-86



LINEAR

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	40.0V	Operating Temperature Range –	HA-2500/HA-2502	$-55^oC \leq T_A \leq +125^oC$
Differential Input Voltage	±15.0V		HA-2505	$0^oC \leq T_A \leq +75^oC$
Peak Output Current	50mA	Storage Temperature Range		$-65^oC \leq T_A \leq +150^oC$
Internal Power Dissipation	300mW			

ELECTRICAL CHARACTERISTICS

V+ = +15V D.C., V- = -15V D.C.

		HA-2500 -55°C to +125°C			HA-2502 -55°C to +125°C			HA-2505 0°C to +75°C			
		LIMITS			LIMITS			LIMITS			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS											
* Offset Voltage	+25°C Full		2	5 8		4	8 10		4	8 10	mV mV
Offset Voltage Average Drift	Full		20			20			20		µV/°C
* Bias Current	+25°C Full		100	200 400		125	250 500		125	250 500	nA nA
* Offset Current	+25°C Full		10	25 50		20	50 100		20	50 100	nA nA
Input Resistance	+25°C	25	50		20	50		20	50		MΩ
Common Mode Range	Full	±10.0			±10.0			±10.0			V
TRANSFER CHARACTERISTICS											
* Large Signal Voltage Gain (Note 1,4)	+25°C Full	20K 15K	30K		15K 10K	25K		15K 10K	25K		V/V V/V
* Common Mode Rejection Ratio (Note 2)	Full	80	90		74	90		74	90		dB
Gain Bandwidth Product (Note 3)	+25°C		12			12			12		MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 1)	Full	±10.0	±12.0		±10.0	±12.0		±10.0	±12.0		V
* Output Current (Note 4)	+25°C	±10	±20		±10	±20		±10	±20		mA
Full Power Bandwidth (Note 4)	+25°C	350	500		300	500		300	500		kHz
TRANSIENT RESPONSE											
Rise Time (Notes 1, 5, 6 & 8)	+25°C		25	50		25	50		25	50	ns
Overshoot (Notes 1, 5, 7 & 8)	+25°C		25	40		25	50		25	50	%
* Slew Rate (Notes 1,4,5 & 8)	+25°C	±25	±30		±20	±30		±20	±30		V/µs
Settling Time to 0.1% (Notes 1,4,5 & 8)	+25°C		0.33			0.33			0.33		µs
POWER SUPPLY CHARACTERISTICS											
* Supply Current	+25°C		4	6		4	6		4	6	mA
* Power Supply Rejection Ratio (Note 9)	Full	80	90		74	90		74	90		dB

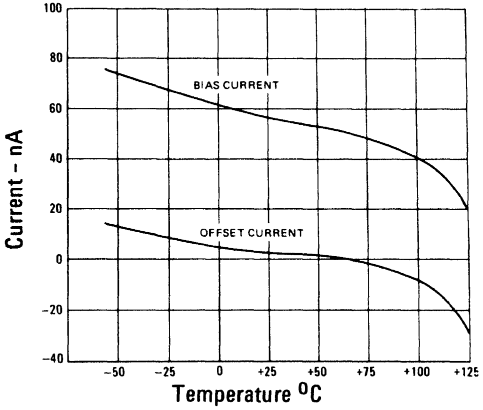
NOTES:
1. R_L = 2K
2. V_{CM} = ± 5.0V
3. A_V >10
4. V_O = ±10.0V
5. C_L = 50pF
6. V_O = ±400mV
7. V_O = ±600mV
8. See transient response test circuits and waveforms page four.
9. ΔV = ±5.0V

*100% Tested For DASH 8

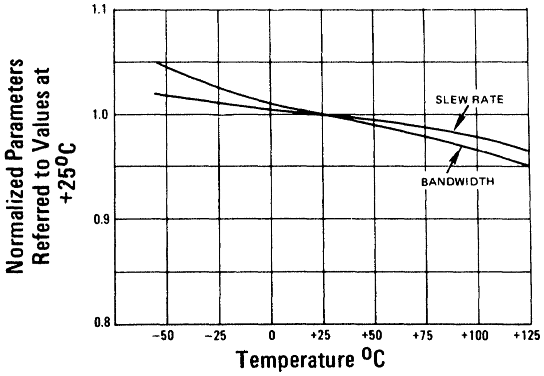
PERFORMANCE CURVES

V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED

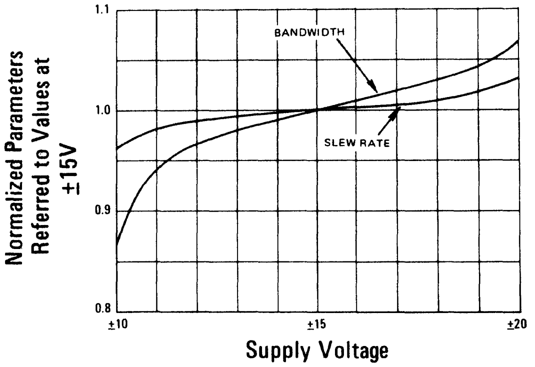
INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE



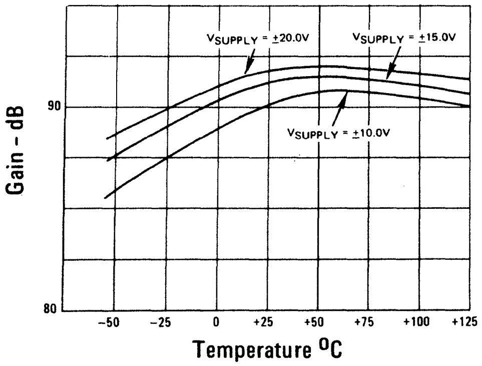
NORMALIZED AC PARAMETERS vs TEMPERATURE



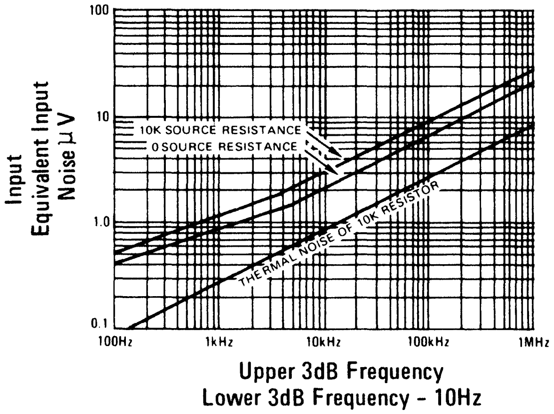
NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE AT +25°C



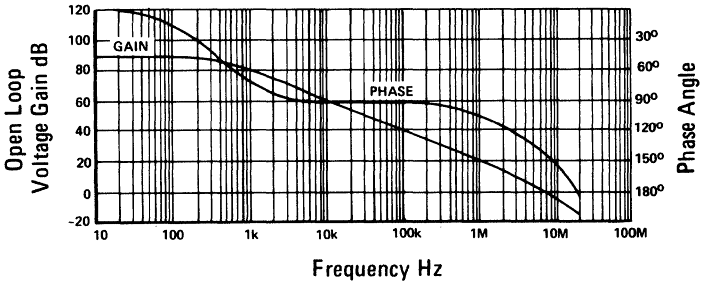
OPEN LOOP VOLTAGE GAIN vs TEMPERATURE



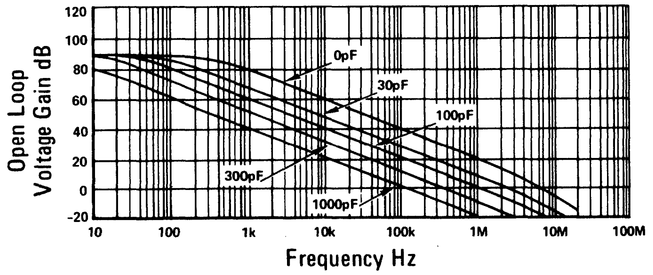
EQUIVALENT INPUT NOISE vs BANDWIDTH



OPEN-LOOP FREQUENCY AND PHASE RESPONSE

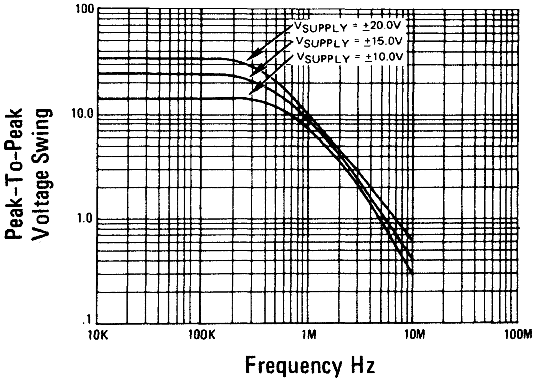


OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND



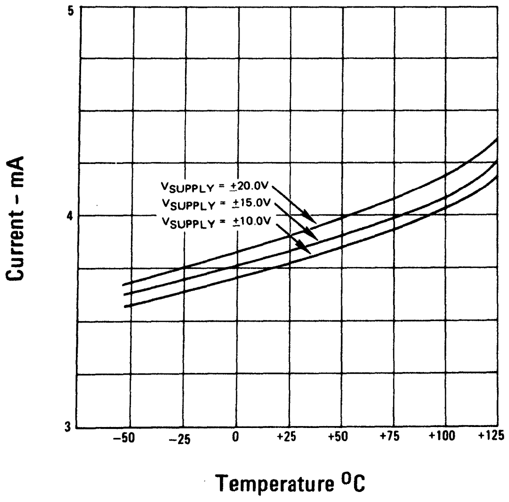
NOTE: External compensation components are not required for stability, but may be added to reduce bandwidth if desired.

OUTPUT VOLTAGE SWING vs FREQUENCY AT +25°C

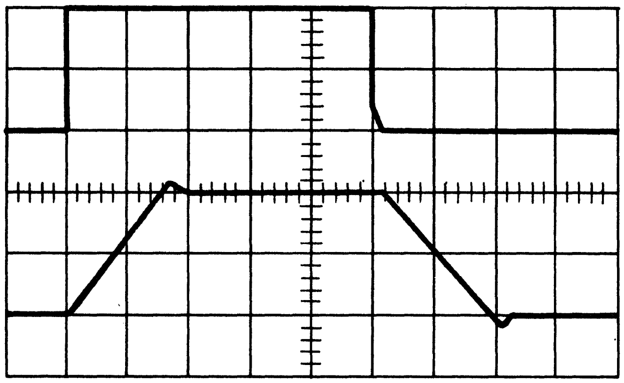


PERFORMANCE CURVES (continued)

POWER SUPPLY CURRENT
vs TEMPERATURE



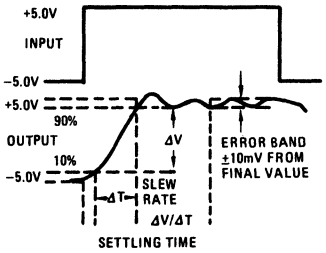
VOLTAGE FOLLOWER PULSE RESPONSE



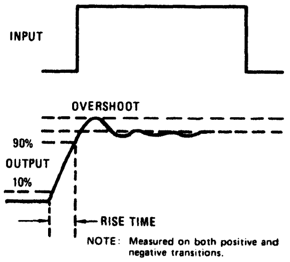
R_L = 2KΩ, C_L = 50pF
Upper Trace: Input
Lower Trace: Output

Vertical = 5V/Div.
Horizontal = 200ns/Div.
T_A = +25°C, V_S = ±15.0V

SLEW RATE AND
SETTLING TIME

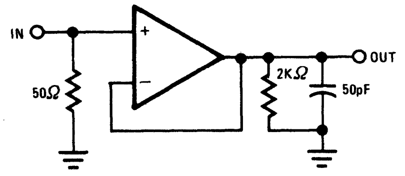


TRANSIENT RESPONSE

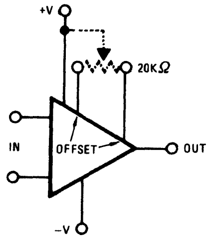


NOTE: Measured on both positive and negative transitions.

SLEW RATE AND
TRANSIENT RESPONSE



SUGGESTED
OFFSET ZERO
ADJUST HOOK-UP



DEFINITIONS

INPUT OFFSET VOLTAGE—That voltage which must be applied between the input terminals through two equal resistances to force the output voltage to zero.

INPUT OFFSET CURRENT—The difference in the currents into the two input terminals when the output is at zero voltage.

INPUT BIAS CURRENT—The average of the currents flowing into the input terminals when the output is at zero voltage.

INPUT COMMON MODE VOLTAGE—The average referred to ground of the voltages at the two input terminals.

COMMON MODE RANGE—The range of voltages which is exceeded at either input terminal will cause the amplifier to cease operating.

TRANSIENT RESPONSE—The closed loop step function response of the amplifier under small signal conditions.

GAIN BANDWIDTH PRODUCT—The product of the gain and the bandwidth at a given gain.

SLEW RATE (Rating Limiting)—The rate at which the output will move between full scale stops, measured in terms of volts per unit time. This limit to an ideal step function response is due to the non-linear behavior in an amplifier due to its limited ability to produce large, rapid changes in output voltage (slewing)...restricting it to rates of change of voltage lower than might be predicted by observing the small signal frequency response.

SETTLING TIME—Time required for output waveform to remain within 0.1 percent of final value.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2510/2512/2515

High Slew Rate Operational Amplifiers

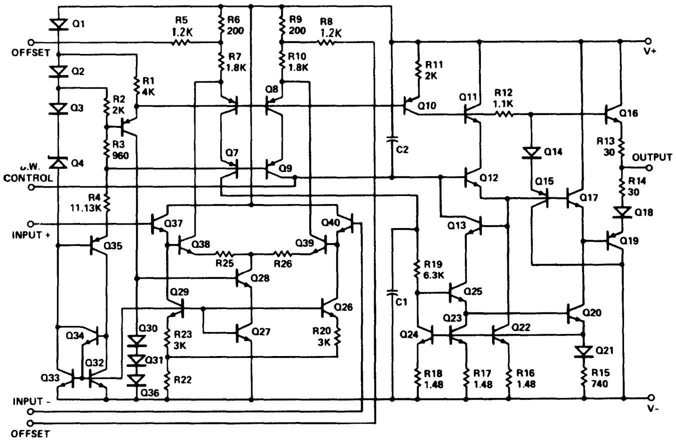
FEATURES

• HIGH SLEW RATE	60V/µs
• FAST SETTLING	250ns
• WIDE POWER BANDWIDTH	1,000 kHz
• HIGH GAIN BANDWIDTH	12 MHz
• HIGH INPUT IMPEDANCE	100m Ω
• LOW OFFSET CURRENT	10nA
• TRUE OP AMP – CAN BE OPERATED NON-INVERTING OR INVERTING	
• MEETS OR EXCEEDS MIL-STD-883 REQUIREMENTS	

GENERAL DESCRIPTION

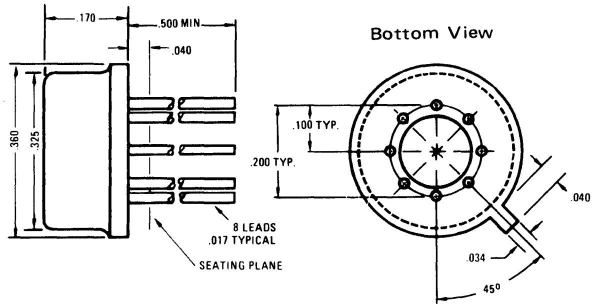
An operational amplifier with excellent D.C. characteristics, featuring high slew rate and fast settling time. Ideal for use in A/D, D/A and sampled data systems; and for use in wide band R.F. or video systems where wide bandwidth at high output levels is required. The HA-2510/12/15 is internally compensated.

SCHEMATIC



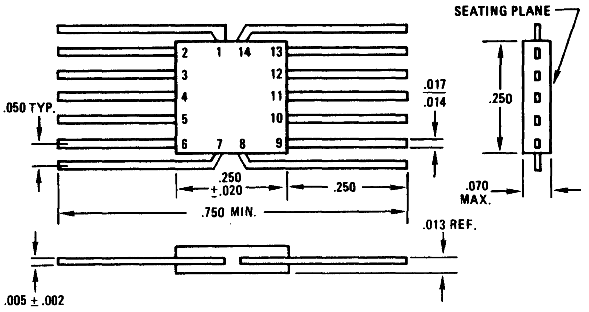
PACKAGES

CODE 2A TO-99



NOTES. 1. All leads gold plated KOVAR
2. All dimensions in inches

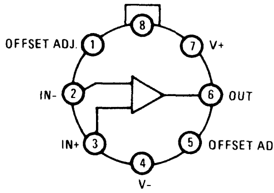
CODE 9V TO-86 (METAL BOTTOM)



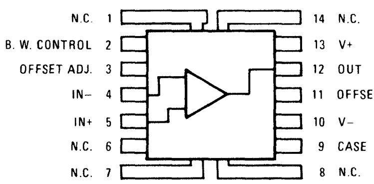
ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

PIN OUT

TO-99
Top View



TO-86



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	40.0V	Peak Output Current	50mA
Differential Input Voltage	±15.0V	Internal Power Dissipation	300mW
Operating Temperature Range		Storage Temperature Range	$-65^oC \leq T_A \leq +150^oC$
HA-2510/HA-2512	$-55^oC \leq T_A \leq +125^oC$		
HA-2515	$0^oC \leq T_A \leq +75^oC$		

ELECTRICAL CHARACTERISTICS

V+ = +15V D.C., V− = 15V D.C.

		HA-2510 -55°C to +125°C LIMITS			HA-2512 -55°C to +125°C LIMITS			HA-2515 0°C to +75°C LIMITS			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS											
* Offset Voltage	+25°C		4	8		5	10		5	10	mV
	Full			11			14			14	mV
Offset Voltage Average Drift	Full		20			25			30		µV/°C
* Bias Current	+25°C		100	200		125	250		125	250	nA
	Full			400			500			500	nA
* Offset Current	+25°C		10	25		20	50		20	50	nA
	Full			50			100			100	nA
Input Resistance	+25°C	50	100		40	100		40	100		MΩ
Common Mode Range	Full	±10.0			±10.0			±10.0			V
TRANSFER CHARACTERISTICS											
* Large Signal Voltage Gain (Note 1,4)	+25°C	10K	15K		7.5K	15K		7.5K	15K		V/V
	Full	7.5K			5K			5K			V/V
* Common Mode Rejection Ratio (Note 2)	Full	80	90		74	90		74	90		dB
Gain Bandwidth Product (Note 3)	+25°C		12			12			12		MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 1)	Full	±10.0	±12.0		±10.0	±12.0		±10.0	±12.0		V
* Output Current (Note 4)	+25°C	±10	±20		±10	±20		±10	±20		mA
Full Power Bandwidth (Note 4)	+25°C	750	1000		600	1000		600	1000		kHz
TRANSIENT RESPONSE											
Rise Time (Notes 1, 5, 6 & 8)	+25°C		25	50		25	50		25	50	ns
Overshoot (Notes 1, 5, 7 & 8)	+25°C		25	40		25	50		25	50	%
* Slew Rate (Notes 1, 4, 5 & 8)	+25°C	±50	±65		±40	±60		±40	±60		V/µs
Settling Time (Notes 1, 4, 5 & 8)	+25°C		0.25			0.25			0.25		µs
POWER SUPPLY CHARACTERISTICS											
* Supply Current	+25°C		4	6		4	6		4	6	mA
* Power Supply Rejection Ratio (Note 9)	Full	80	90		74	90		74	90		dB

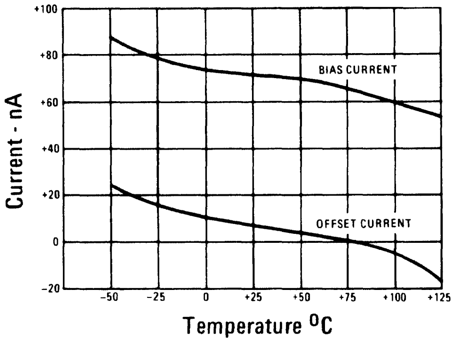
NOTES:
1. $R_L = 2K$
2. $V_{CM} = \pm 5.0V$
3. $A_V > 10$
4. $V_O = \pm 10.0V$
5. $C_L = 50pF$
6. $V_O = \pm 400mV$
7. $V_O = \pm 600mV$
8. See transient response test circuits and waveforms page four.
9. $\Delta V = \pm 5.0V$

*100% Tested For DASH 8

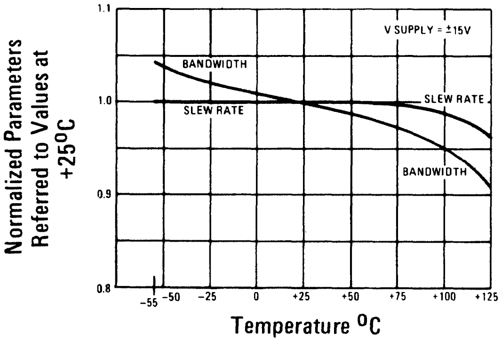
PERFORMANCE CURVES

V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED.

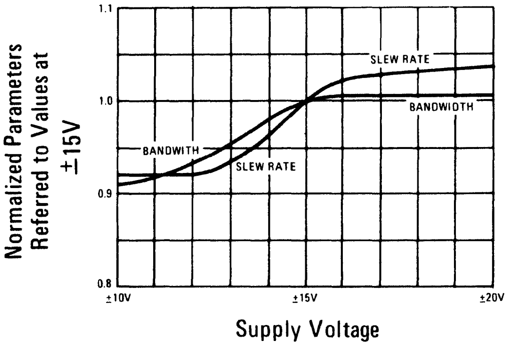
INPUT BIAS AND OFFSET CURRENT
vs TEMPERATURE



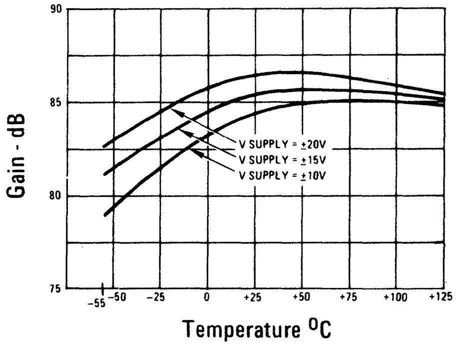
NORMALIZED AC PARAMETERS
vs TEMPERATURE



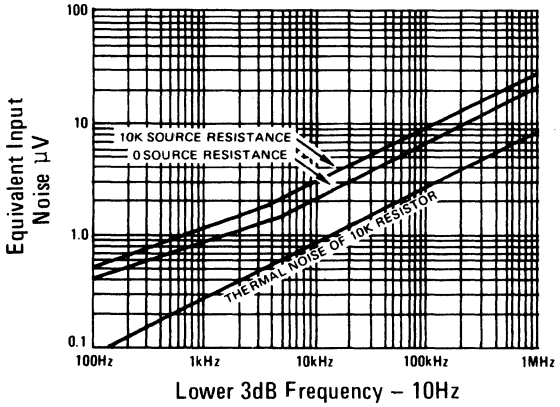
NORMALIZED AC PARAMETERS
vs SUPPLY VOLTAGE



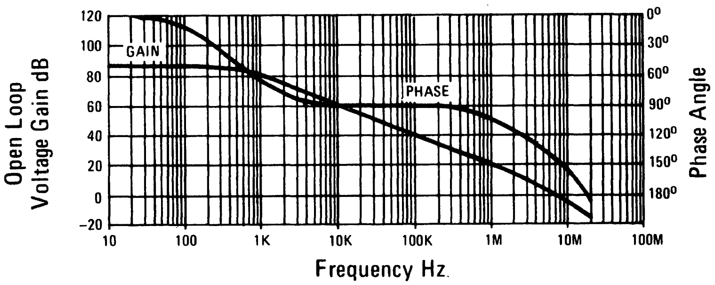
OPEN LOOP VOLTAGE GAIN
vs TEMPERATURE



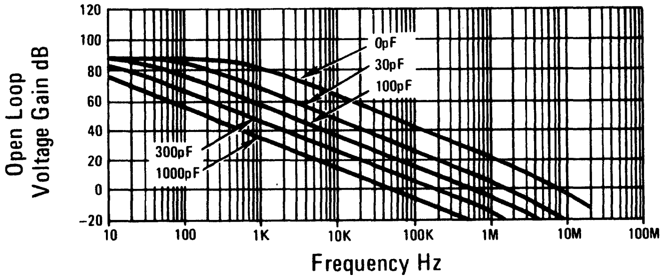
EQUIVALENT INPUT NOISE
vs BANDWIDTH



OPEN LOOP FREQUENCY AND PHASE RESPONSE

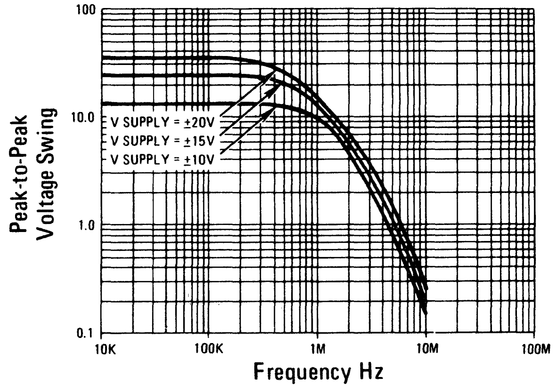


OPEN-LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND



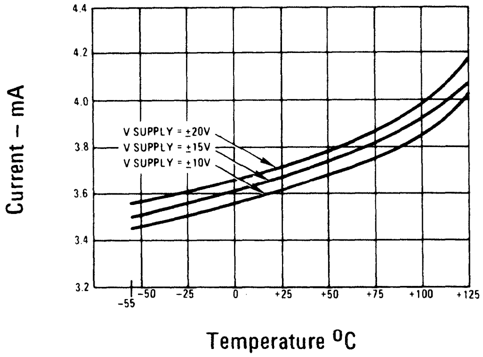
NOTE: External compensation components are not required for stability, but may be added to reduce bandwidth if desired.

OUTPUT VOLTAGE SWING
vs FREQUENCY AT +25°C

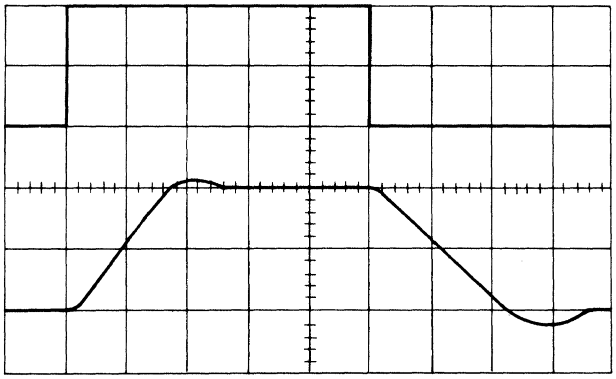


PERFORMANCE CURVES (continued)

POWER SUPPLY CURRENT
VS
TEMPERATURE



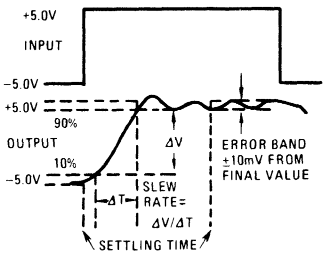
VOLTAGE FOLLOWER PULSE RESPONSE



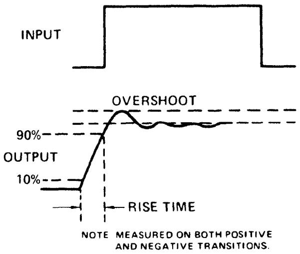
$R_L = 2K\Omega$, $C_L = 50pF$
Upper Trace: Input
Lower Trace: Output

Vertical = 5V/Div.
Horizontal = 100n/Div.
$T_A = +25^oC$, $V_S = \pm15.0V$

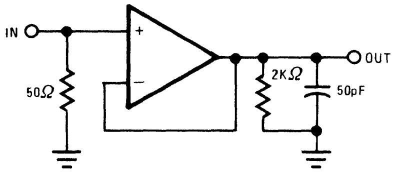
SLEW RATE AND SETTLING TIME



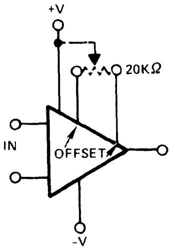
TRANSIENT RESPONSE



SLEW RATE AND TRANSIENT RESPONSE



SUGGESTED OFFSET ZERO ADJUST HOOK-UP



DEFINITIONS

INPUT OFFSET VOLTAGE—That voltage which must be applied between the input terminals through two equal resistances to force the output voltage to zero.

INPUT OFFSET CURRENT—The difference in the currents into the two input terminals when the output is at zero voltage.

INPUT BIAS CURRENT—The average of the currents flowing into the input terminals when the output is at zero voltage.

INPUT COMMON MODE VOLTAGE—The average referred to ground of the voltages at the two input terminals.

COMMON MODE RANGE—The range of voltages which is exceeded at either input terminal will cause the amplifier to cease operating.

COMMON MODE REJECTION RATIO—The ratio of a specified range of input common mode voltage to the peak-to-peak change in input offset voltage over this range.

OUTPUT VOLTAGE SWING—The peak symmetrical output voltage swing, referred to ground, that can be obtained without clipping.

INPUT RESISTANCE—The ratio of the change in input voltage to the change in input current.

OUTPUT RESISTANCE—The ratio of the change in output voltage to the change in output current.

VOLTAGE GAIN—The ratio of the change in output voltage to the change in input voltage producing it.

UNITY GAIN BANDWIDTH—The frequency at which the voltage gain of the amplifier is unity.

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2520/2522/2525

High Slew Rate Operational Amplifiers

FEATURES

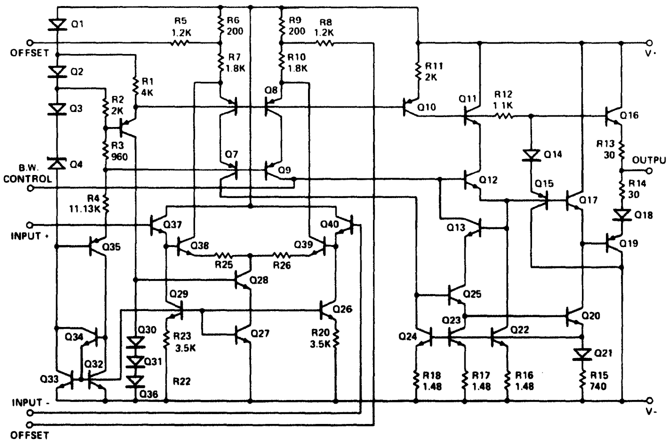
• HIGH SLEW RATE	120V/µs
• FAST SETTLING	200ns
• WIDE POWER BANDWIDTH	2,000 kHz
• HIGH GAIN BANDWIDTH	20 MHz
• HIGH INPUT IMPEDANCE	100mΩ
• LOW OFFSET CURRENT	10nA

- TRUE OP AMP – CAN BE OPERATED NON-INVERTING OR INVERTING
- MEETS OR EXCEEDS MIL-STD-883 REQUIREMENTS

GENERAL DESCRIPTION

An operational amplifier with excellent D.C. characteristics, featuring high slew rate and fast settling time. Ideal for use in A/D, D/A and sampled data systems; and for use in wide band R.F. or video systems where wide bandwidth at high output levels is required. The HA-2520/22/25 is stable for closed loop gains greater than 3 without external compensation.

SCHEMATIC

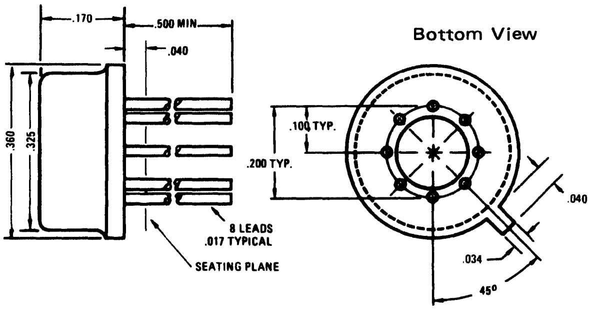


PACKAGES

CODE 2A

TO-99

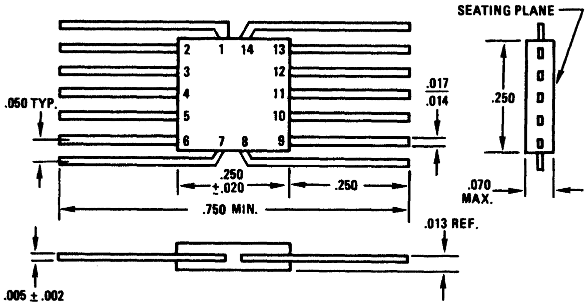
Bottom View



NOTES: 1. All leads gold plated KOVAR
2. All dimensions in inches

CODE 9V

TO-86 (METAL BOTTOM)

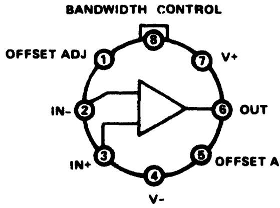


ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

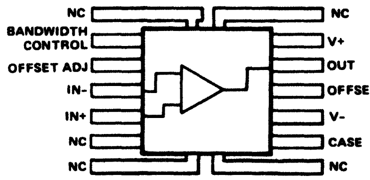
PIN OUT

TO-99

Top View



TO-86



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	40.0V	Peak Output Current	50mA
Differential Input Voltage	±15.0V	Internal Power Dissipation	300mW
Operating Temperature Range			
HA-2520/2522	$-55^\circ C \leq T_A \leq +125^\circ C$	Storage Temperature Range	$-65^\circ C \leq T_A \leq +150^\circ C$
HA-2525	$0^\circ C \leq T_A \leq +75^\circ C$		

ELECTRICAL CHARACTERISTICS

V+ = +15V D.C., V- = -15V D.C.

		HA-2520 -55°C to +125°C LIMITS			HA-2522 -55°C to +125°C LIMITS			HA-2525 0°C to +75°C LIMITS			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS											
* Offset Voltage	+25°C		4	8		5	10		5	10	mV
	Full			11			14			14	mV
Offset Voltage Average Drift	Full		20			25			30		μV/°C
* Bias Current	+25°C		100	200		125	250		125	250	nA
	Full			400			500			500	nA
* Offset Current	+25°C		10	25		20	50		20	50	nA
	Full			50			100			100	nA
Input Resistance	+25°C	50	100		40	100		40	100		MΩ
Common Mode Range	Full	±10.0			±10.0			±10.0			V
TRANSFER CHARACTERISTICS											
* Large Signal Voltage Gain (Note 1,4)	+25°C	10K	15K		7.5K	15K		7.5K	15K		V/V
	Full	7.5K			5K			5K			V/V
* Common Mode Rejection Ratio (Note 2)	Full	80	90		74	90		74	90		dB
Gain Bandwidth Product (Note 3)	+25°C		20			20			20		MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 1)	Full	±10.0	±12.0		±10.0	±12.0		±10.0	±12.0		V
* Output Current (Note 4)	+25°C	±10	±20		±10	±20		±10	±20		mA
Full Power Bandwidth (Note 4)	+25°C	1500	2000		1200	1600		1200	1600		kHz
TRANSIENT RESPONSE ($A_V = +3$)											
Rise Time (Notes 1, 5, 6 & 8)	+25°C		25	50		25	50		25	50	ns
Overshoot (Notes 1, 5, 6 & 8)	+25°C		25	40		25	50		25	50	%
* Slew Rate (Notes 1, 4, 5 & 8)	+25°C	±100	±120		±80	±120		±80	±120		V/μs
Settling Time (Notes 1, 4, 5 & 8)	+25°C		0.20			0.20			0.20		μs
POWER SUPPLY CHARACTERISTICS											
* Supply Current	+25°C		4	6		4	6		4	6	mA
* Power Supply Rejection Ratio (Note 7)	Full	80	90		74	90		74	90		dB

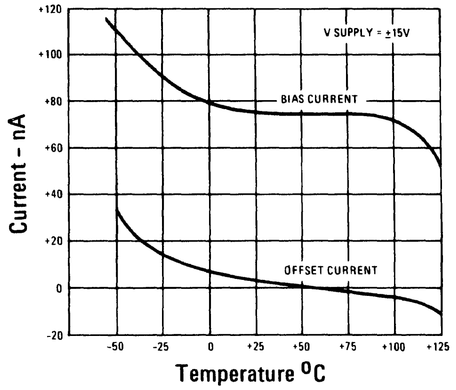
NOTES:
1. $R_L = 2K$
2. $V_{CM} = \pm 5.0V$
3. $A_V > 10$
4. $V_O = \pm 10.0V$
5. $C_L = 50pF$
6. $V_O = \pm 200mV$
7. $\Delta V = \pm 5.0V$
8. See transient response test circuits and waveforms page four.

*100% Tested For DASH 8

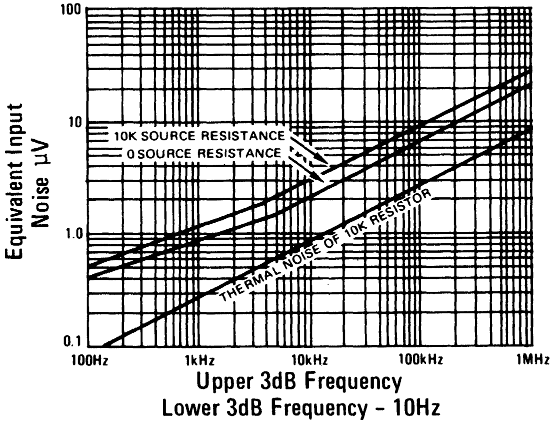
PERFORMANCE CURVES

V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED

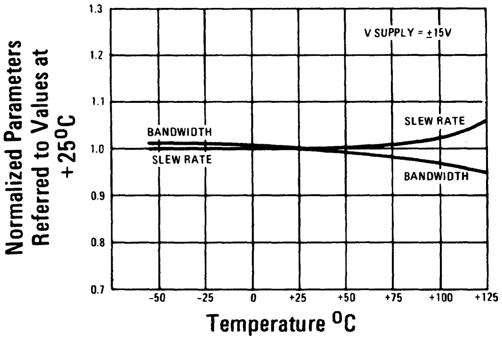
INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE



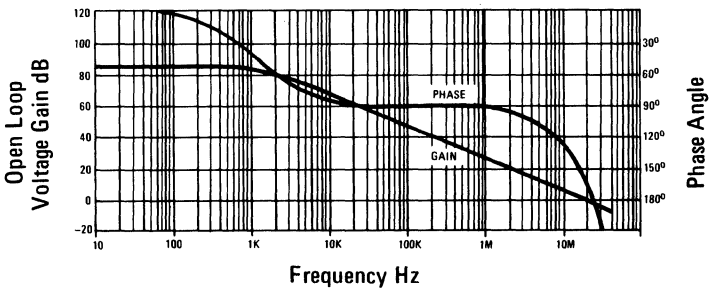
EQUIVALENT INPUT NOISE vs BANDWIDTH



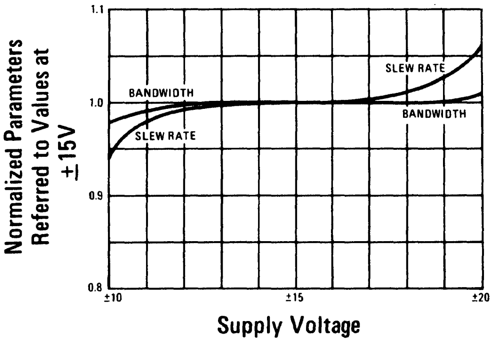
NORMALIZED AC PARAMETERS vs TEMPERATURE



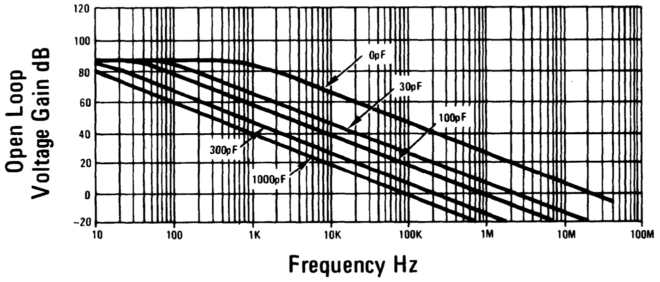
OPEN-LOOP FREQUENCY AND PHASE RESPONSE



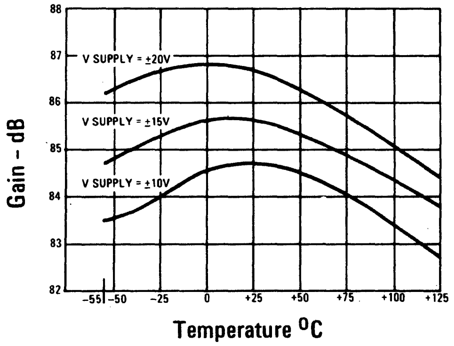
NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE AT +25°C



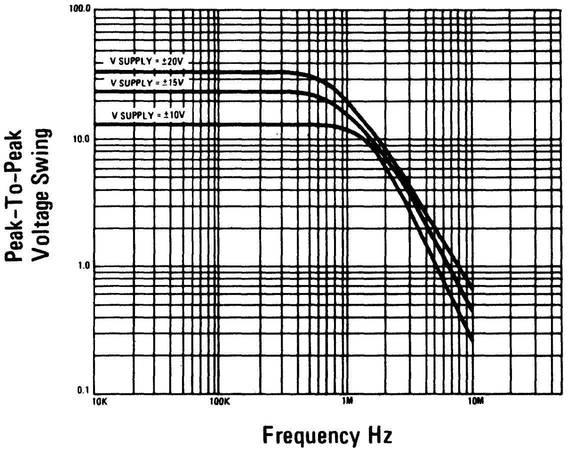
OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND



OPEN LOOP VOLTAGE GAIN vs TEMPERATURE

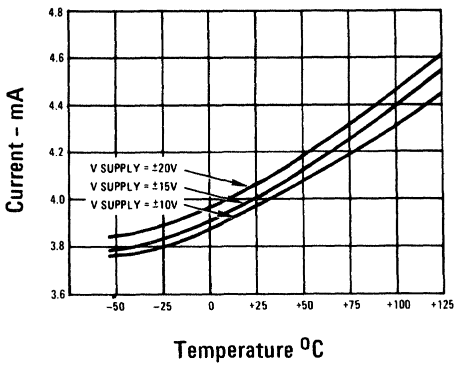


OUTPUT VOLTAGE SWING vs FREQUENCY AT +25°C

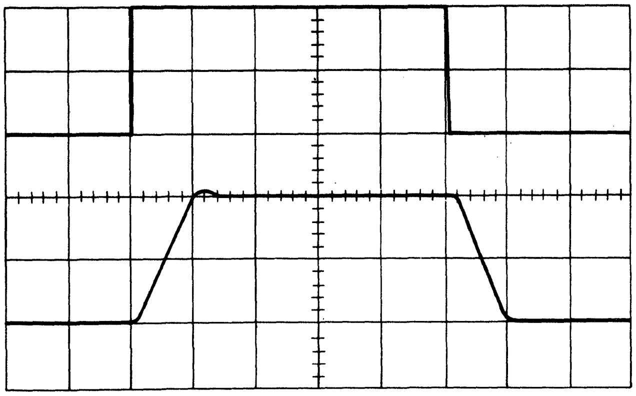


PERFORMANCE CURVES (continued)

POWER SUPPLY CURRENT vs TEMPERATURE



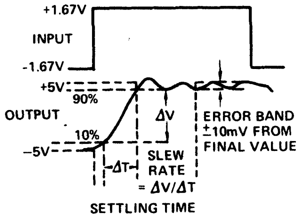
VOLTAGE FOLLOWER PULSE RESPONSE



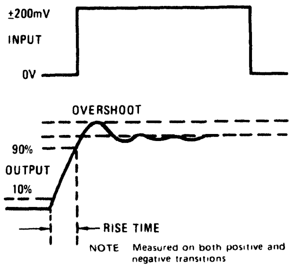
$R_L = 2K\Omega$, $C_L = 50pF$
Upper Trace: Input; 1.33V/Div.
Lower Trace: Output; 5V/Div.

Horizontal = 100ns/Div.
$T_A = +25°C$, $V_S = \pm15V$

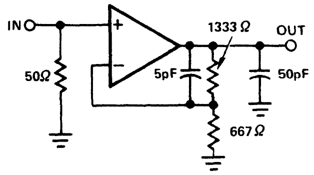
SLEW RATE AND SETTLING TIME



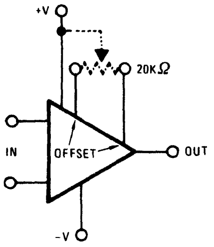
TRANSIENT RESPONSE



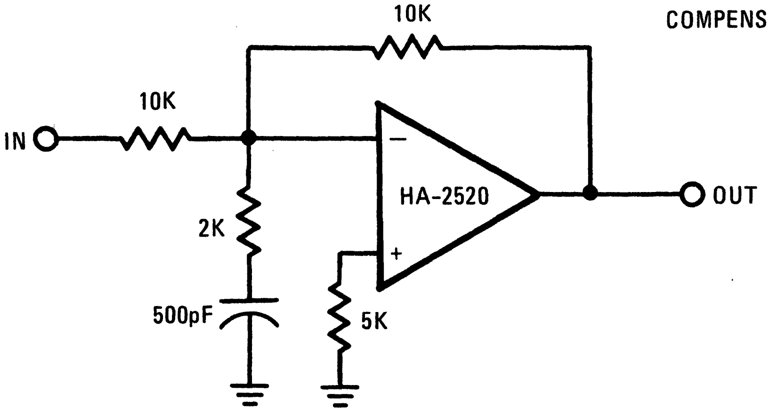
SLEW RATE AND TRANSIENT RESPONSE



SUGGESTED OFFSET ZERO ADJUST HOOK-UP



TYPICAL APPLICATIONS



COMPENSATION CIRCUIT FOR INVERTING UNITY GAIN

Slew Rate	≈	120V/µs
Bandwidth	≈	10MHz
Settling Time	≈	500ns

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2530/2535

High Slew Rate, Wideband Inverting Amplifier

FEATURES

● HIGH SLEW RATE	±320V/µs
● FAST SETTLING TIME	550ns
● WIDE POWER BANDWIDTH	5MHz
● HIGH GAIN BANDWIDTH PRODUCT	70MHz
● LOW OFFSET VOLTAGE	0.8mV
● LOW POWER SUPPLY CURRENT	3.5mA

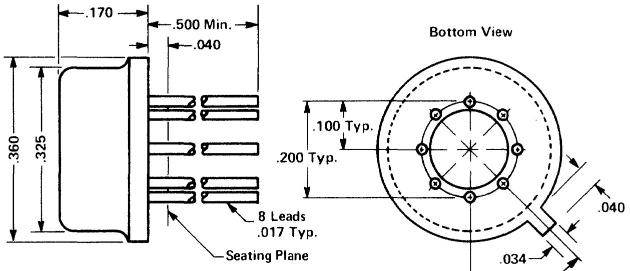
DESCRIPTION

The HA-2530/2535 is a monolithic wideband inverting amplifier whose performance characteristics are superior to any other monolithic in its class. The device uses a feedforward amplifier technique to achieve widepower bandwidth and high slew rate at no expense to noise or DC parameters. It is excellent for use in pulse circuits requiring high slew rate and fast settling, such as high speed integrators, A/D, D/A and sampled data systems. Also recommended for many video applications where wideband response at high output current levels are required. For gains less than 10 a small capacitor is required for stability.

PACKAGES

CODE 2A

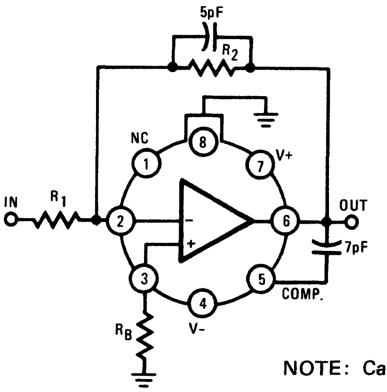
TO-99



NOTES: 1. All leads gold plated KOVAR
2. All dimensions in inches

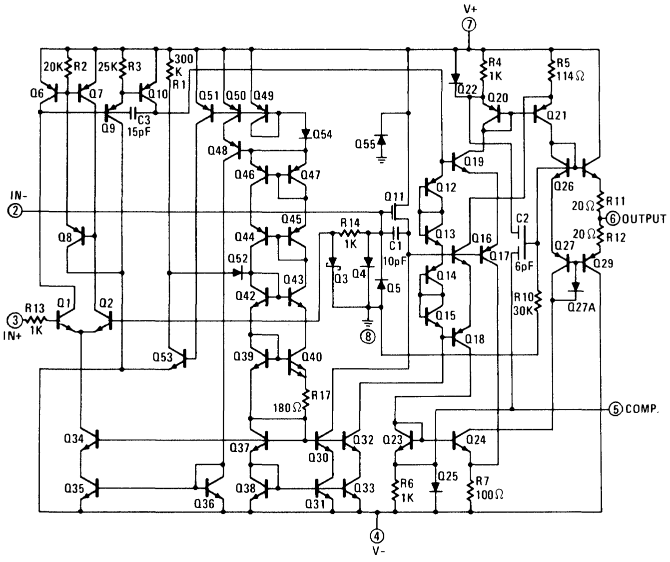
PIN-OUT AND TYPICAL HOOK-UP

Top View



NOTE: Case tied to V-

SCHEMATIC



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	40V	Internal Power Dissipation (Note 1)	550mW	
		Operating Temperature Range	$-55^oC \le T_A \le +125^oC$	(HA-2530)
Peak Output Current	±100mA		$0^oC \le T_A \le +75^oC$	(HA-2535)
		Storage Temperature Range	$-65^oC \le T_A \le +150^oC$	

ELECTRICAL CHARACTERISTICS

Test Conditions: $V_{Supply} = \pm 15.0V$ Unless Otherwise Specified.

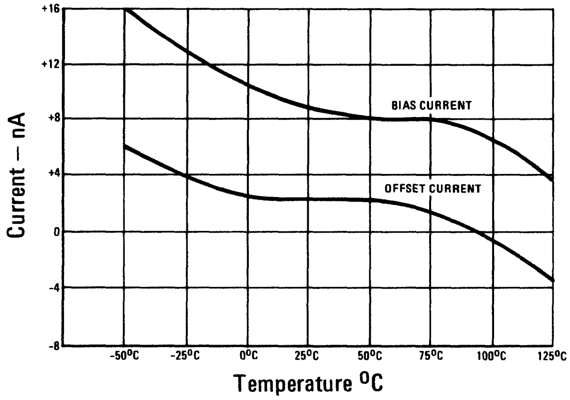
		HA-2530 -55°C to +125°C			HA-2535 0°C to +75°C			
		LIMITS			LIMITS			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS								
* Offset Voltage	+25°C		0.8			0.8		mV
	Full			3			5	mV
Average Offset Voltage Drift	Full		5			5		µV/°C
* Bias Current	+25°C		15			15		nA
	Full			100			200	nA
* Offset Current	+25°C		5			5		nA
	Full			20			20	nA
Input Resistance	+25°C		2			2		MΩ
Input Capacitance	+25°C		10			10		pF
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Notes 2,5)	+25°C		$2X10^6$			$2X10^6$		V/V
*	Full	10^5			10^5			V/V
* Common-Mode Rejection Ratio (Note 3)	Full	86	100		80	100		dB
Gain Bandwidth Product (Note 4)	+25°C		70			70		MHz
OUTPUT CHARACTERISTICS								
* Output Voltage Swing (Note 2)	Full	±10	±12		±10	±12		V
* Output Current (Note 5)	+25°C	±25	±50		±25	±50		mA
Full Power Bandwidth (Note 5)	+25°C	4	5		4	5		MHz
TRANSIENT RESPONSE (NOTES 6&7)								
* Rise Time	+25°C		20	40		20	40	ns
* Overshoot	+25°C		30	45		30	50	%
* Slew Rate	+25°C	±280	±320		±250	±320		V/µs
Settling Time	+25°C		500			500		ns
POWER SUPPLY CHARACTERISTICS								
* Supply Current	+25°C		3.5	6		3.5	6	mA
* Power Supply Rejection Ratio (Note 8)	Full	86	100		80	100		dB

NOTES:
1. Derate at 5.5mW/°C for Operation Ambient Temperature Above 105°C
2. $R_L = 2K$
3. $V_{CM} = \pm 5.0V$
4. $A_V > 10$
5. $V_O = \pm 10V$
6. $C_L = 50pF$
7. See Transient Response Test Circuit and Wave Forms, Page 4.
8. $\Delta V = \pm 5.0V$

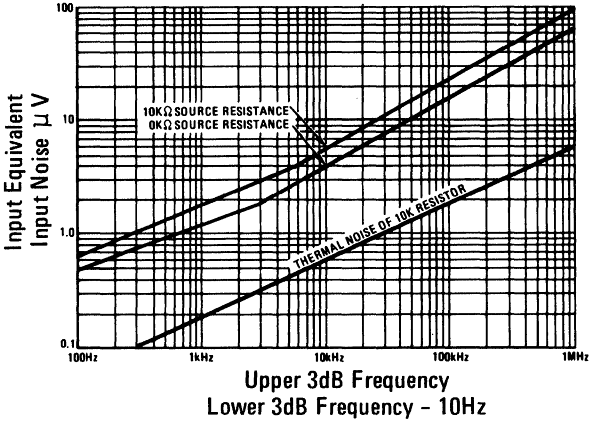
*100% Tested For DASH 8

PERFORMANCE CURVES

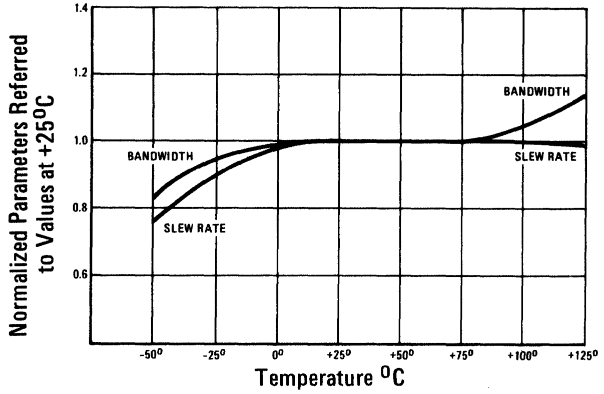
V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED



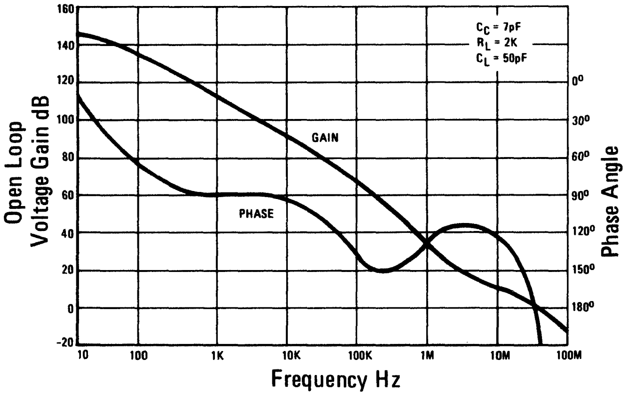
INPUT BIAS AND OFFSET CURRENT vs. TEMPERATURE



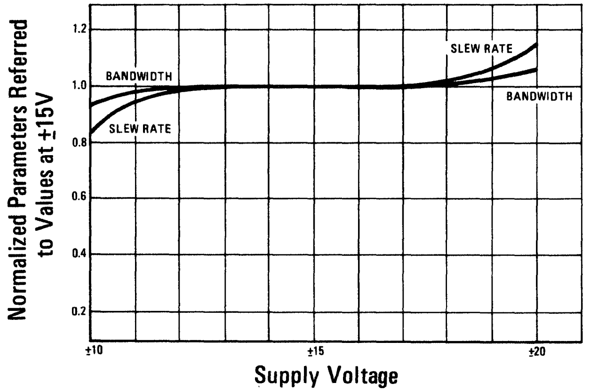
EQUIVALENT INPUT NOISE vs. BANDWIDTH



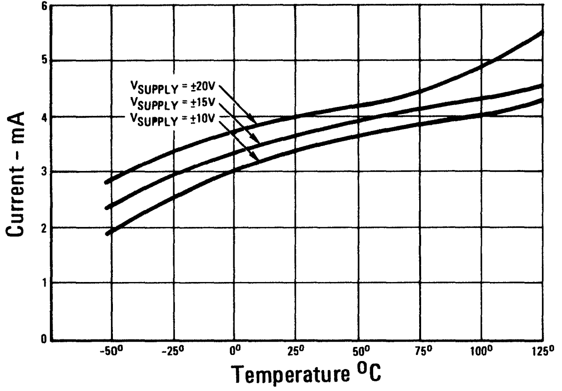
NORMALIZED AC PARAMETERS vs. TEMPERATURE



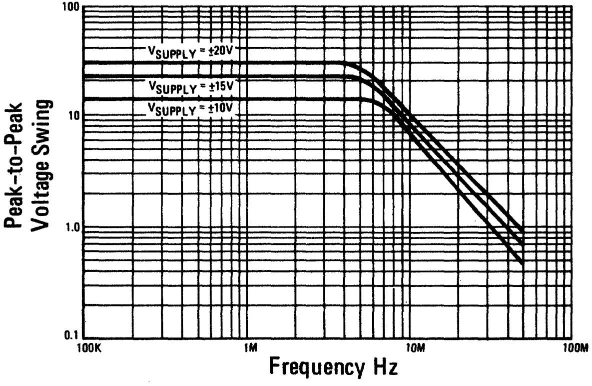
OPEN-LOOP FREQUENCY AND PHASE RESPONSE



NORMALIZED AC PARAMETERS vs. SUPPLY VOLTAGE AT +25°C



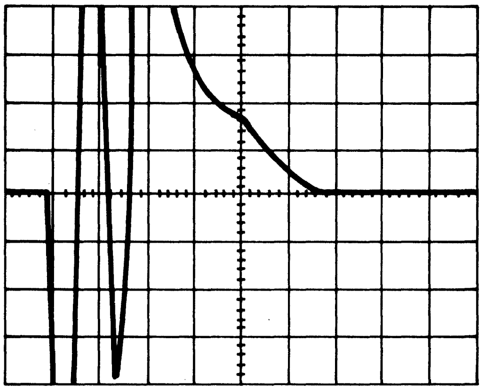
POWER SUPPLY CURRENT vs. TEMPERATURE



OUTPUT VOLTAGE SWING vs. FREQUENCY AT +25°C

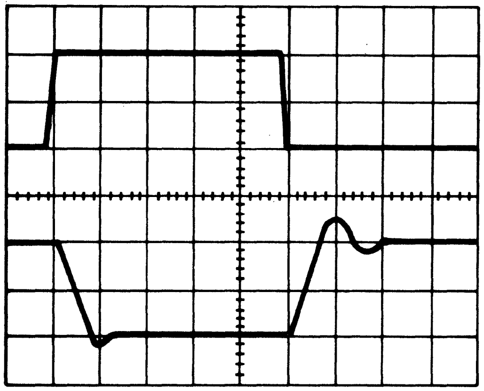
PERFORMANCE CURVES (continued)

SETTLING TIME MEASUREMENT *1



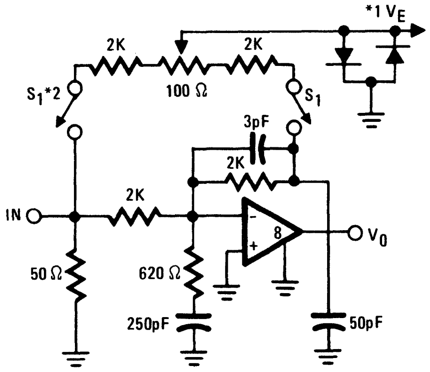
VERTICAL = 5mV/DIV.
HORIZONTAL = 100ns/DIV.
$T_A = +25^oC, V_S = \pm15V$

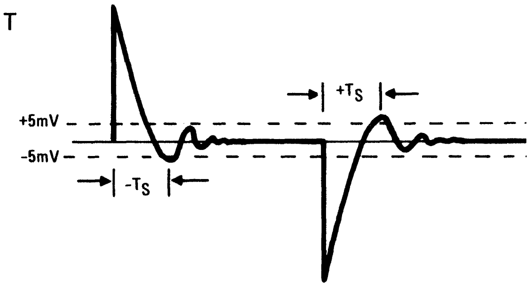
UNITY GAIN PULSE RESPONSE



UPPER TRACE: INPUT VERTICAL = 5V/DIV.
LOWER TRACE: OUTPUT HORIZONTAL = 50ns/DIV.
$T_A = +25^oC, V_S = \pm15V$

SLEW RATE/SETTLING TIME/TRANSIENT RESPONSE TEST CIRCUIT

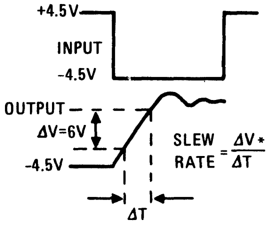




*1 Settling time (T_S) is measured using a high speed high recovery oscilloscope to display the error voltage V_E. When V_E is within $\pm$5mV of final value the output V_O will be within $\pm$10mV (0.1%).

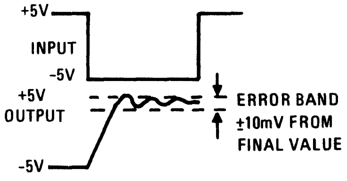
*2 S_1 closed for settling time.

SLEW RATE

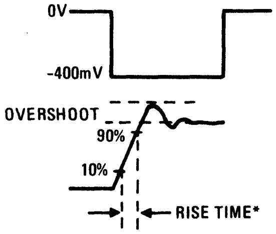


* MEASURED ON BOTH POSITIVE AND NEGATIVE EXCURSIONS.

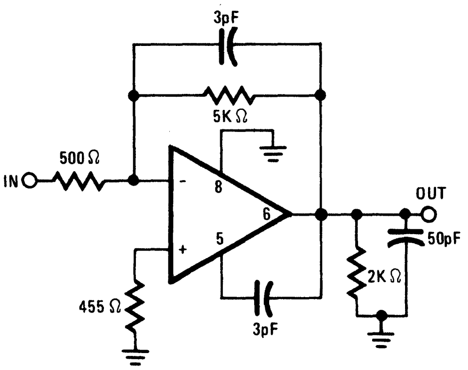
SETTLING TIME



TRANSIENT RESPONSE



5MHz VIDEO AMPLIFIER (A_V = 10)



HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2600/2602/2605

High Impedance Operational Amplifier

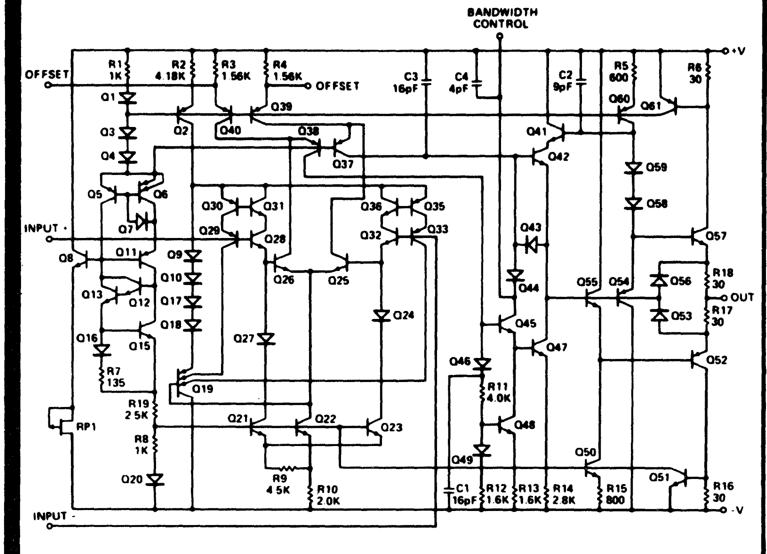
FEATURES

- HIGH INPUT IMPEDANCE
- LOW INPUT BIAS CURRENT
- LOW INPUT OFFSET CURRENT
- LOW INPUT OFFSET VOLTAGE
- HIGH GAIN
- HIGH SLEW RATE
- FAST RESPONSE TIME
- OUTPUT SHORT CIRCUIT PROTECTION
- MEETS OR EXCEEDS MIL-STD-883 REQUIREMENTS

GENERAL DESCRIPTION

Internally compensated high impedance, high performance monolithic operational amplifier intended for use as a general purpose operational amplifier in precision instrumentation and signal processing.

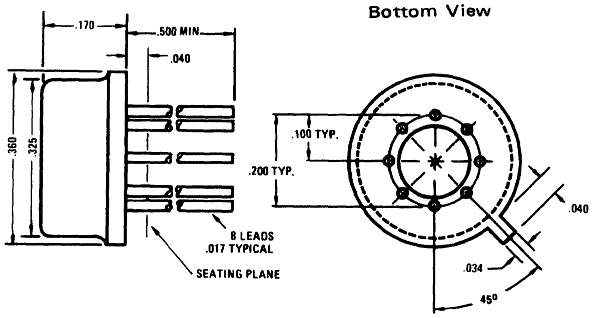
SCHEMATIC



PACKAGES

CODE 2A

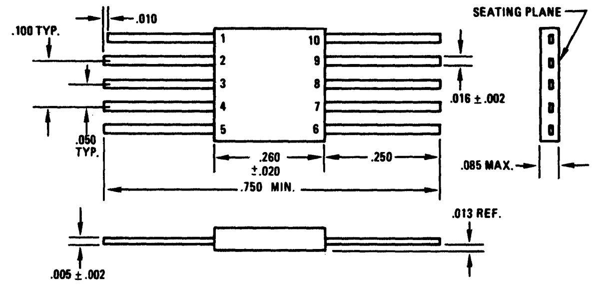
TO-99



NOTES: 1. All leads gold plated KOVAR
2. All dimensions in inches

CODE 9W

TO-91



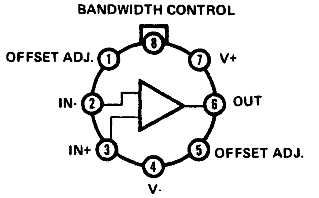
ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

PIN OUT

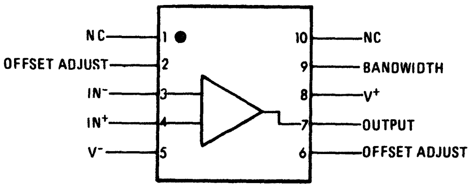
TO-99

Top View

Case Connected to V-



TO-91



Case Connected to V-

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	45.0V
Differential Input Voltage	±12.0V
Peak Output Current	Full Short Circuit Protection
Internal Power Dissipation	300mW
Operating Temperature Range – HA-2600/HA-2602	$-55^{0}C \leq T_A \leq +125^{0}C$
HA-2605	$0^{0} \leq T_A \leq +75^{0}C$
Storage Temperature Range	$-65^{0}C \leq T_A \leq +150^{0}C$

ELECTRICAL CHARACTERISTICS V+=+15VDC, V- = -15VDC

PARAMETER	TEMP.	HA-2600 $-55^{0}C$ to $+125^{0}C$			HA-2602 $-55^{0}C$ to $+125^{0}C$			HA-2605 $0^{0}C$ to $+75^{0}C$			UNITS
		LIMITS			LIMITS			LIMITS			
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS											
* Offset Voltage	+25°C		0.5	4		3	5		3	5	mV
	Full		2	6			7			7	mV
Offset Voltage Average Drift	Full		5								µV/°C
* Bias Current	+25°C		1	10		15	25		5	25	nA
	Full		10	30			60			40	nA
* Offset Current	+25°C		1	10		5	25		5	25	nA
	Full		5	30			60			40	nA
Input Resistance	+25°C	100	500		40	300		40	300		MΩ
Common Mode Range	Full	±11.0			±11.0			±11.0			V
TRANSFER CHARACTERISTICS											
* Large Signal Voltage Gain (Notes 1, 4)	+25°C	100K	150K		80K	150K		80K	150K		V/V
	Full	70K			60K			70K			V/V
* Common Mode Rejection Ratio (Note 2)	Full	80	100		74	100		74	100		dB
Unity Gain Bandwidth (Note 3)	+25°C		12			12			12		MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 1)	Full	±10.0	±12.0		±10.0	±12.0		±10.0	±12.0		V
* Output Current (Note 4)	+25°C	±15	±22		±10	±18		±10	±18		mA
Full Power Bandwidth (Note 4)	+25°C	50	75		50	75		50	75		kHz
TRANSIENT RESPONSE											
Rise Time (Notes 1, 5, 6 & 8)	+25°C		30	60		30	60		30	60	ns
Overshoot (Notes 1, 5, 7 & 8)	+25°C		25	40		25	40		25	40	%
* Slew Rate (Notes 1, 4, 5 & 8)	+25°C	±4	±7		±4	±7		±4	±7		V/µs
Settling Time (Notes 1, 4, 5 & 8)	+25°C		1.5			1.5			1.5		µs
POWER SUPPLY CHARACTERISTICS											
* Supply Current	+25°C		3.0	3.7		3.0	4.0		3.0	4.0	mA
* Power Supply Rejection Ratio (Note 9)	Full	80	90		74	90		74	90		dB

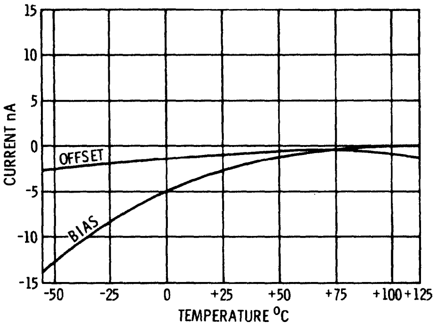
TEST CONDITIONS

NOTES:
1. $R_L = 2K$
2. $V_{CM} = \pm 5.0V$
3. $V_O < 90mV$
4. $V_O = \pm 10V$
5. $C_L = 100pF$
6. $V_O = \pm 200mV$
7. $V_O = \pm 400mV$
8. See Transient response test circuits and waveforms page three.
9. $V_S = \pm 9.0V$ to $\pm 15V$

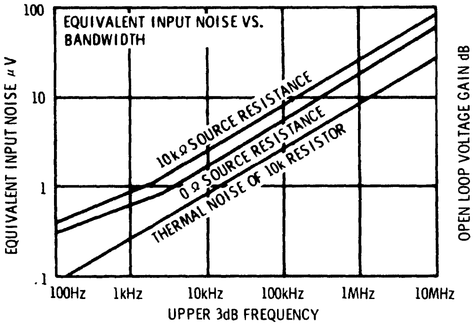
*100% Tested For DASH 8

PERFORMANCE CURVES

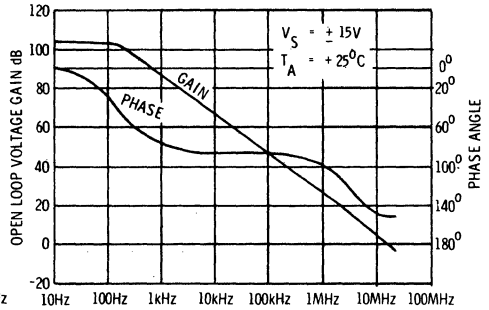
V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED.



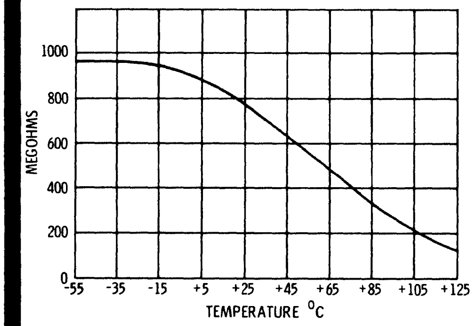
INPUT BIAS CURRENT AND OFFSET CURRENT AS A FUNCTION OF TEMPERATURE



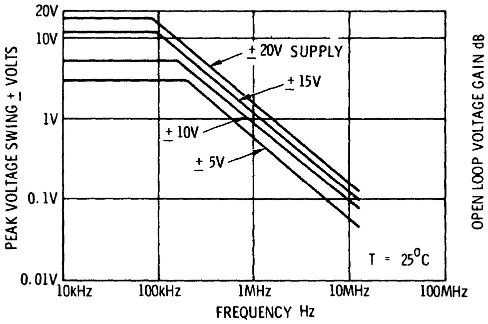
LOWER 3dB FREQUENCY - 10Hz
BROADBAND NOISE CHARACTERISTICS



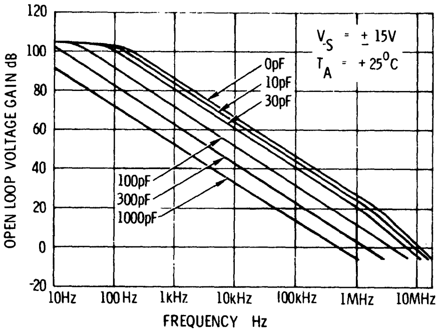
OPEN LOOP FREQUENCY AND PHASE RESPONSE



INPUT IMPEDANCE VS. TEMPERATURE, 100Hz

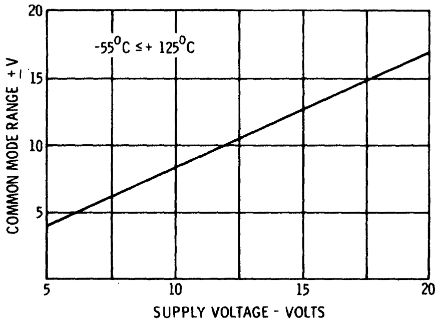


OUTPUT VOLTAGE SWING VS. FREQUENCY

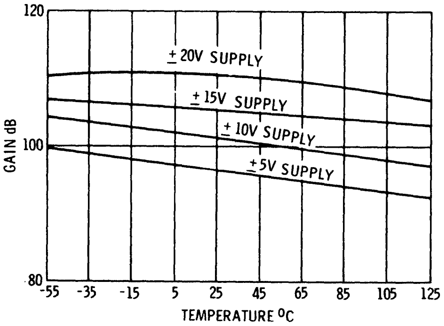


OPEN-LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND

Note: External Compensation Components are not Required for Stability, But May be Added to Reduce Bandwidth if Desired. If External Compensation is Used, Also Connect 100pF Capacitor From Output to Ground.

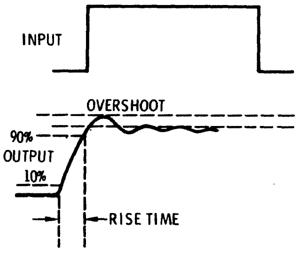


COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



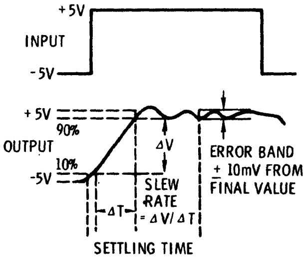
OPEN-LOOP VOLTAGE GAIN VS. TEMPERATURE

TRANSIENT RESPONSE

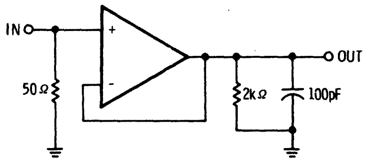


NOTE: MEASURED ON BOTH POSITIVE AND NEGATIVE TRANSITIONS.

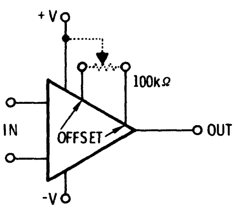
SLEW RATE AND SETTLING TIME



SLEW RATE AND TRANSIENT RESPONSE

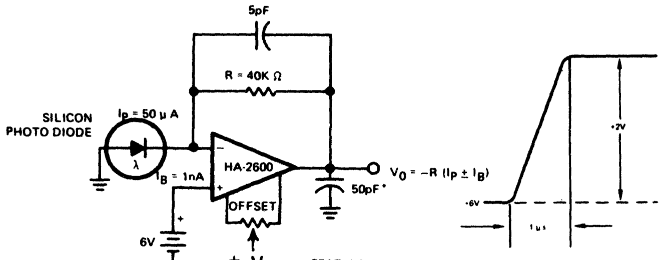


SUGGESTED OFFSET ZERO ADJUST HOOK-UP



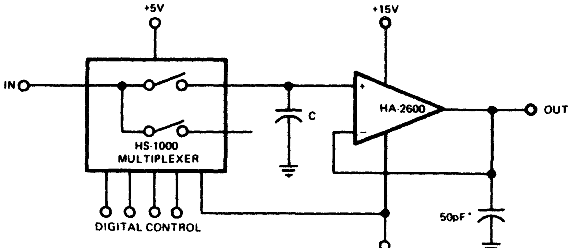
TYPICAL APPLICATIONS

PHOTO-CURRENT TO VOLTAGE CONVERTER



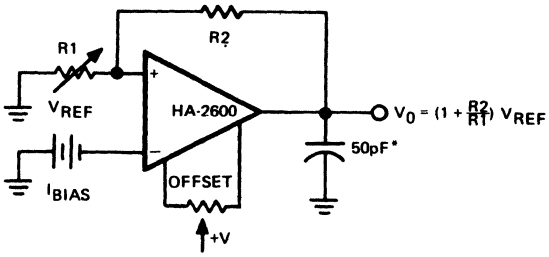
FEATURES:
1. CONSTANT CELL VOLTAGE
2. MINIMUM BIAS CURRENT ERROR

SAMPLE – AND – HOLD



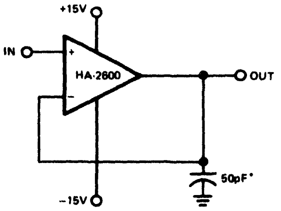
DRIFT RATE $\frac{I_{bias}}{C}$ IF C = 1000pF DRIFT = .01 V/ms MAX.

REFERENCE VOLTAGE AMPLIFIER



FEATURES:
1. MINIMUM BIAS CURRENT IN REFERENCE CELL
2. SHORT-CIRCUIT PROTECTION

VOLTAGE FOLLOWER



1.000 GAIN 0.9999
$Z_{in} = -10^{12}$ MIN.
$Z_{out} = .01$ MAX.
SLEW RATE = 4V/ μs MIN.
B. W. = 12MHz TYP.
OUTPUT SWING = ± 10V MIN. TO 50kHz

*A small load capacitance is recommended in all applications where practical to prevent possible high frequency oscillations resulting from external wiring parasitics. Capacitance up to 100pF has negligible effect on the bandwidth or slew rate.

DEFINITIONS

INPUT OFFSET VOLTAGE – That voltage which must be applied between the input terminals through two equal resistances to force the output voltage to zero.

INPUT OFFSET CURRENT – The difference in the currents into the two input terminals when the output is at zero voltage.

INPUT BIAS CURRENT – The average of the currents flowing into the input terminals when the output is at zero voltage.

INPUT COMMON MODE VOLTAGE – The average referred to ground of the voltages at the two input terminals.

COMMON MODE RANGE – The range of voltages which is exceeded at either input terminal will cause the amplifier to cease operating.

COMMON MODE REJECTION RATIO – The ratio of a specified range of input common mode voltage to the peak-to-peak change in input offset voltage over this range.

OUTPUT VOLTAGE SWING – The peak symmetrical output voltage swing, referred to ground, that can be obtained without clipping.

INPUT RESISTANCE – The ratio of the change in input voltage to the change in input current.

OUTPUT RESISTANCE – The ratio of the change in output voltage to the change in output current.

VOLTAGE GAIN – The ratio of the change in output voltage to the change in input voltage producing it.

BANDWIDTH – The frequency at which the voltage gain is 3 dB below its low frequency value.

UNITY GAIN BANDWIDTH – The frequency at which the voltage gain of the amplifier is unity.

POWER SUPPLY REJECTION RATIO – The ratio of the change in input offset voltage to the change in power supply voltage producing it.

TRANSIENT RESPONSE – The closed loop step function response of the amplifier under small signal conditions.

PHASE MARGIN – $[180^\circ - (\Phi_1 - \Phi_2)]$ where Φ_1 is the phase shift at the frequency where the absolute magnitude of gain is unity Φ_2 is the phase shift at a frequency much lower than the open-loop bandwidth.

SLEW RATE (Rate Limiting) – The rate at which the output will move between full scale stops, measured in terms of volts per unit time. This limit to an ideal step function response is due to the non-linear behavior in an amplifier due to its limited ability to produce large, rapid changes in output voltage (slewing) . . . restricting it to rates of change of voltage lower than might be predicted by observing the small signal frequency response.

SETTLING TIME – Time required for output waveform to remain within 0.1 percent of final value.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2620/2622/2625

Wide Band, High Impedance Operational Amplifiers

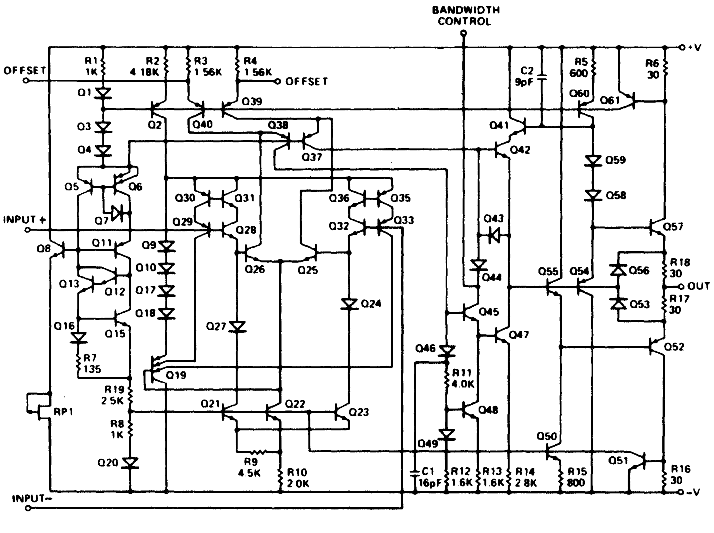
FEATURES

● GAIN BANDWIDTH PRODUCT	100MHz
● HIGH INPUT IMPEDANCE	500MΩ
● LOW INPUT BIAS CURRENT	1nA
● LOW INPUT OFFSET CURRENT	1nA
● LOW INPUT OFFSET VOLTAGE	1mV
● HIGH GAIN	150K
● HIGH SLEW RATE	35V/μs
● OUTPUT SHORT CIRCUIT PROTECTION	

GENERAL DESCRIPTION

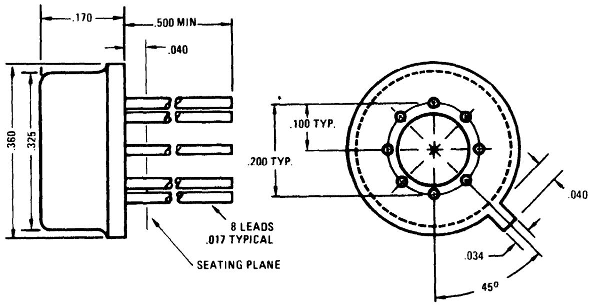
The HA-2620 family of operational amplifiers has very low input bias current and intended for use as high impedance comparators and wide band amplifiers. The HA-2620 family features very high gain, very high slew rate and output short circuit protection. The HA-2620 and HA-2622 operate over the full military temperature range from -55°C to +125°C. The HA-2625 operates over the temperature range of 0°C to +75°C.

SCHEMATIC

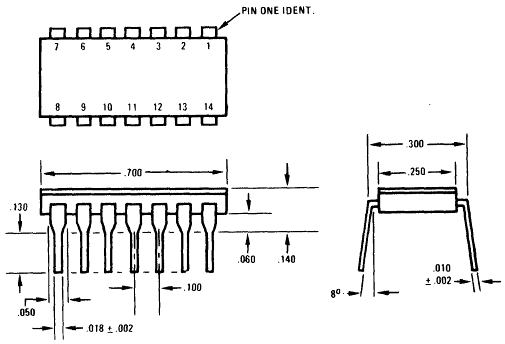


PACKAGES

CODE 2A Bottom View TO-99



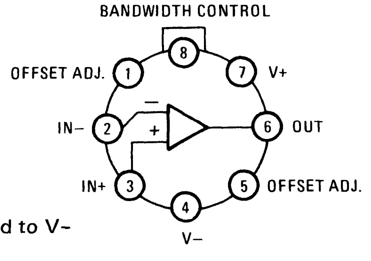
CODE 1S



ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

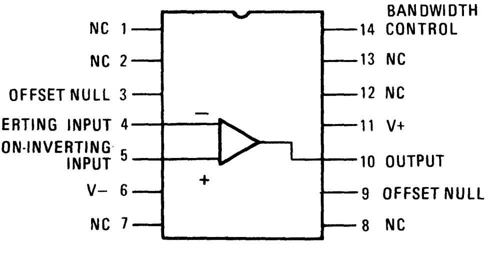
PIN OUT Top View

TO-99



Case Connected to V−

TO-116



Case Connected to V−

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	45.0V
Differential Input Voltage	±12.0V
Peak Output Current	Full Short Circuit Protection
Internal Power Dissipation	300mW
Storage Temperature Range	$-65^{o}C \leq T_A \leq +150^{o}C$

ELECTRICAL CHARACTERISTICS

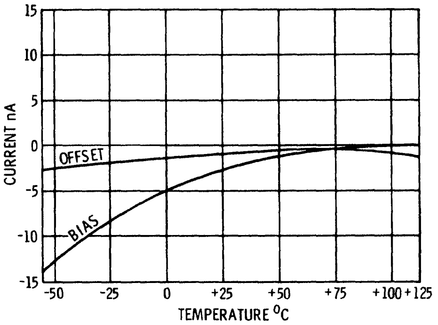
$V^+ = +15$ VDC, $V^- = -15$ VDC		HA-2620 −55°C to +125°C			HA-2622 −55°C to +125°C			HA-2625 0°C to +75°C			
PARAMETER	TEMPERATURE	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS											
* Offset Voltage (Note 1)	+25°C		0.5	4		3	5		3	5	mV
	Full			6			7			7	mV
* Bias Current	+25°C		1	15		5	25		5	25	nA
	Full		10	35			60			40	nA
* Offset Current	+25°C		1	15		5	25		5	25	nA
	Full		5	35			60			40	nA
Input Resistance	+25°C	65	500		40	300		40	300		MΩ
Common Mode Range	Full	±11.0			±11.0			±11.0			V
TRANSFER CHARACTERISTICS											
* Large Signal Voltage Gain (Notes 2 & 3)	+25°C	100K	150K		80K	150K		80K	150K		V/V
	Full	70K			60K			70K			V/V
* Common Mode Rejection Ratio (Note 4)	Full	80	100		74	100		74	100		dB
Gain Bandwidth Product (Notes 2, 5, &6)	+25°C		100			100			100		MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 2)	Full	±10.0	±12.0		±10.0	±12.0		±10.0	±12.0		V
* Output Current (Note 3)	+25°C	±15	±22		±10	±18		±10	±18		mA
Full Power Bandwidth (Notes 2, 3 & 7)	+25°C	400	600		320	600		320	600		kHz
TRANSIENT RESPONSE											
Rise Time (Notes 2, 5, 7 & 8)	+25°C		17	45		17	45		17	45	ns
* Slew Rate (Notes 2, 7, 8 & 10)	+25°C	±25	±35		± 20	±35		± 20	±35		V/µs
POWER SUPPLY CHARACTERISTICS											
* Supply Current	+25°C		3.0	3.7		3.0	4.0		3.0	4.0	mA
* Power Supply Rejection Ratio (Note 9)	Full	80	90		74	90		74	90		dB

NOTES:
1. Offset may be externally adjusted to zero.
2. $R_L = 2K\Omega$, $C_L = 50pF$
3. $V_O = \pm 10.0V$
4. $V_{CM} = \pm 5.0V$
5. $V_O < 90mV$
6. 40dB Gain
7. See transient response test circuits and waveforms page 3.
8. $A_V = 5.0V$ (The HA-2620 family is not stable at unity gain without external compensation.)
9. $V_{Sup} = \pm 9.0V$ to $\pm 15.0V$
10. $V_O = 5.0V$

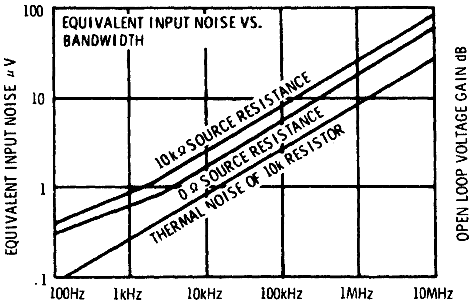
*100% Tested For DASH 8

TYPICAL PERFORMANCE CURVES

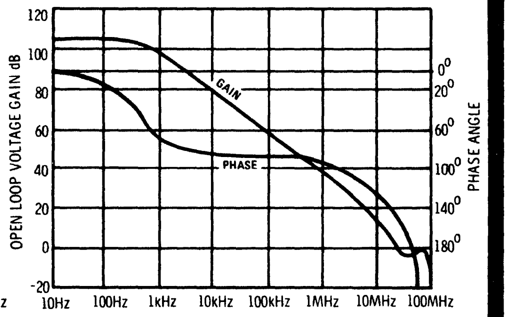
V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED.



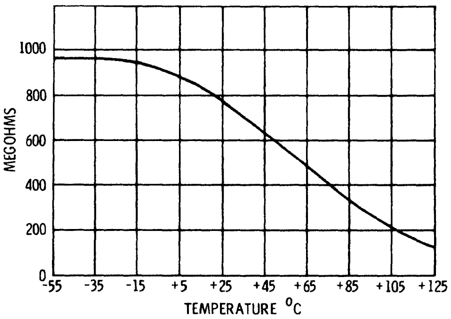
INPUT BIAS CURRENT AND OFFSET CURRENT-
AS A FUNCTION OF TEMPERATURE



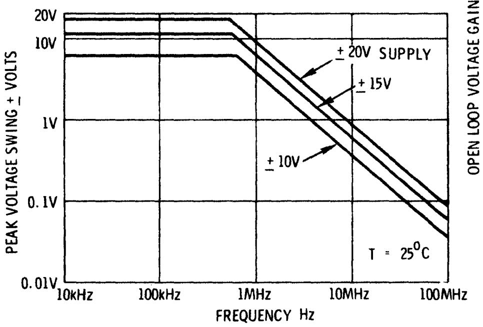
UPPER 3dB FREQUENCY
LOWER 3dB FREQUENCY - 10Hz
BROADBAND NOISE CHARACTERISTICS



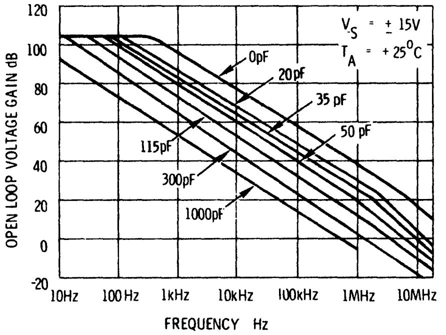
OPEN LOOP FREQUENCY AND PHASE RESPONSE



INPUT IMPEDANCE VS. TEMPERATURE, 100Hz

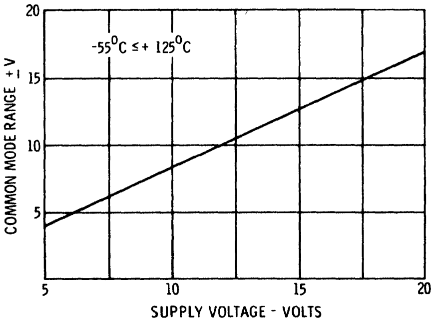


OUTPUT VOLTAGE SWING VS. FREQUENCY

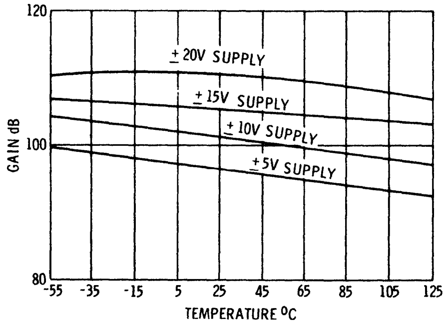


OPEN-LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND

Note: External Compensation is Required For Closed Loop Gain <5 . If External Compensation is Used, Also Connect 100 pF Capacitor From Output to Ground.

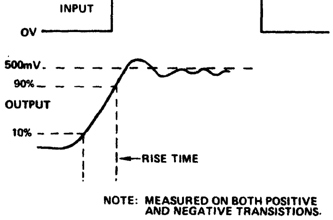


COMMON MODE VOLTAGE RANGE
AS A FUNCTION OF SUPPLY VOLTAGE



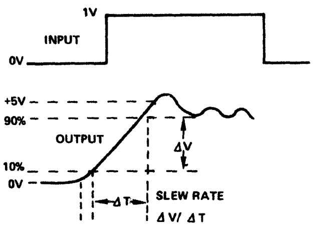
OPEN-LOOP VOLTAGE GAIN VS. TEMPERATURE

TRANSIENT RESPONSE

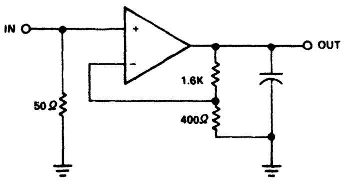


NOTE: MEASURED ON BOTH POSITIVE AND NEGATIVE TRANSITIONS.

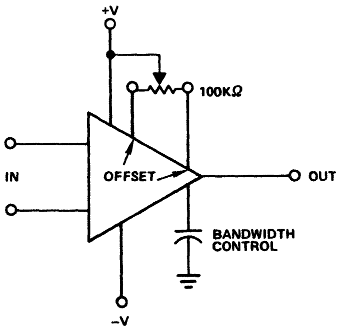
SLEW RATE



SLEW RATE AND TRANSIENT RESPONSE

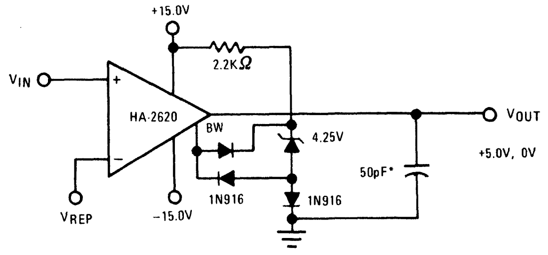


SUGGESTED OFFSET ZERO ADJUST AND BANDWIDTH CONTROL HOOK-UP

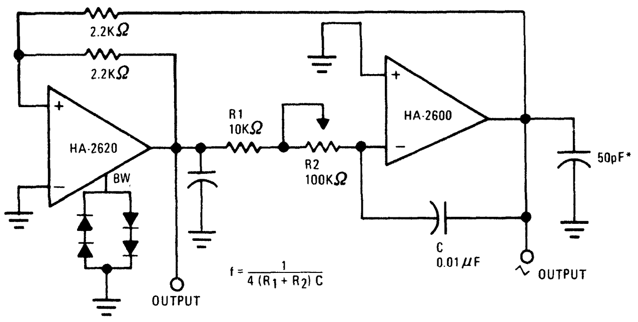


TYPICAL APPLICATIONS

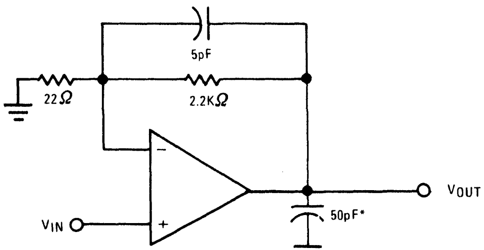
HIGH IMPEDANCE COMPARATOR



FUNCTION GENERATOR



VIDEO AMPLIFIER



BW = 1 MHz
GAIN = 40dB

*A small load capacitance of at least 30pF (including stray capacitance) is recommended to prevent possible high frequency oscillations.

DEFINITIONS

INPUT OFFSET VOLTAGE—That voltage which must be applied between the input terminals through two equal resistances to force the output voltage to zero.

INPUT OFFSET CURRENT—The difference in the currents into the two input terminals when the output is at zero voltage.

INPUT BIAS CURRENT—The average of the currents flowing into the input terminals when the output is at zero voltage.

INPUT COMMON MODE VOLTAGE—The average referred to ground of the voltages at the two input terminals.

COMMON MODE RANGE—The range of voltages which is exceeded at either input terminal will cause the amplifier to cease operating.

COMMON MODE REJECTION RATIO—The ratio of a specified range of input common mode voltage to the peak-to-peak change in input offset voltage over this range.

OUTPUT VOLTAGE SWING—The peak symmetrical output voltage swing, referred to ground, that can be obtained without clipping.

INPUT RESISTANCE—The ratio of the change in input voltage to the change in input current.

OUTPUT RESISTANCE—The ratio of the change in output voltage to the change in output current.

VOLTAGE GAIN—The ratio of the change in output voltage to the change in input voltage producing it.

UNITY GAIN BANDWIDTH—The frequency at which the voltage gain of the amplifier is unity.

POWER SUPPLY REJECTION RATIO—The ratio of the change in input offset voltage to the change in power supply voltage producing it.

TRANSIENT RESPONSE—The closed loop step function response of the amplifier under small signal conditions.

GAIN BANDWIDTH PRODUCT—The product of the gain and the bandwidth at a given gain.

SLEW RATE (Rate Limiting)—The rate at which the output will move between full scale stops, measured in terms of volts per unit time. This limit to an ideal step function response is due to the non-linear behavior in an amplifier due to its limited ability to produce large, rapid changes in output voltage (slewing)...restricting it to rates of change of voltage lower than might be predicted by observing the small signal frequency response.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2630/2635

High Performance Current Booster

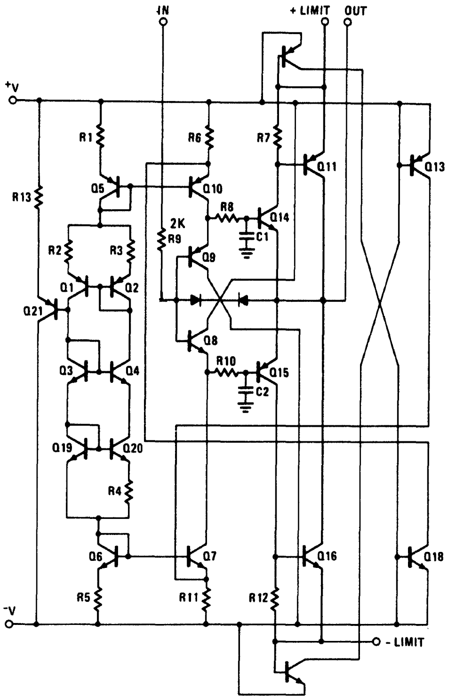
FEATURES

● OUTPUT CURRENT	± 600mA
● SLEW RATE	500V/ μs
● BANDWIDTH	8MHz
● FULL POWER BANDWIDTH	8MHz
● INPUT RESISTANCE	2.0 X $10^6\Omega$
● OUTPUT RESISTANCE	2.0Ω
● POWER SUPPLY RANGE	±5 TO ±20V
● PACKAGE IS ELECTRICALLY ISOLATED	

DESCRIPTION

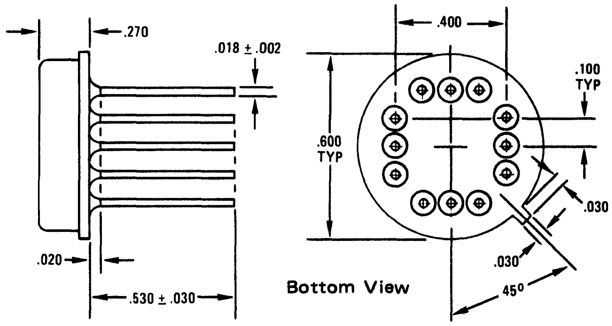
The HA-2630/2635 is a unity voltage gain, current amplifier intended to be used in series with an operational amplifier, inside the feedback loop, wherever additional output current capability is required. Wide bandwidth and exceptionally high slew rate allow it to be used with high performance op amps without producing instability or signal distortion. Current delivered to the load may be limited to a predetermined level by choice of two optional external limiting resistors. This device is packaged in an electrically isolated TO-8 type can allowing it to be conveniently mounted with or without a heat sink. The HA-2630 has guaranteed operation over -55°C to +125°C, while the HA-2635 is guaranteed over 0°C to +75°C.

SCHEMATIC DIAGRAM



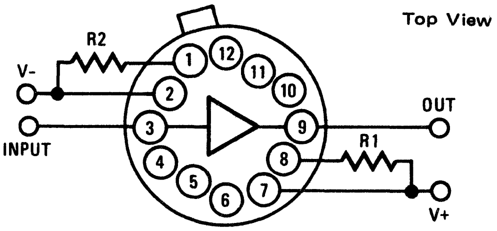
PACKAGE

CODE 2G TO-8



ALL DIMENSIONS ARE IN INCHES
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

PIN OUT



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	40V
Input Voltage Range	± V Supply
Output Current (Note 2)	±700mA
Internal Power Dissipation (Note 6) Free Air:	1W
In Heat Sink:	4W

Operating Temperature Range:
$-55^{\circ}C \leq T_A \leq +125^{\circ}C$ (HA-2630)
$0^{\circ}C \leq T_A \leq +75^{\circ}C$ (HA-2635)

Storage Temperature Range:
$-65^{\circ}C \leq T_A \leq +150^{\circ}C$

ELECTRICAL CHARACTERISTICS

$V_{Supply} = \pm 15$ Volts $R_L = 50$ Ohms $R_1 = R_2 = 0$ Ohms Unless otherwise specified.

		HA-2630 -55°C to +125°C			HA-2635 0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS								
*Bias Current	+25°C		30	150		30	150	µA
	Full			200			200	µA
Input Resistance	+25°C		2.0			2.0		MΩ
Input Capacitance	+25°C		5.0			5.0		pF
TRANSFER CHARACTERISTICS								
Voltage Gain (Note 1)	Full	.85	.95		.85	.95		V/V
*Offset Voltage ($V_{OUT} - V_{IN}$)	+25°C		70	±200		70	±200	mV
	Full			±300			±300	mV
Bandwidth (-3dB)	+25°C		8.0			8.0		MHz
OUTPUT CHARACTERISTICS								
*Output Voltage Swing	Full	±10			±10			V
*Output Current (Note 1)	+25°C	±400	±600		±400	±600		mA
	Full	±300			±300			mA
Output Resistance	+25°C		2.0			2.0		Ω
Full Power Bandwidth (Note 1)	+25°C		8.0			8.0		MHz
TRANSIENT RESPONSE								
Rise Time (Note 3)	+25°C		30			30		ns
Slew Rate (Note 4)	+25°C	200	500		200	500		V/µs
POWER SUPPLY CHARACTERISTICS								
*Supply Current	Full		15	20		15	23	mA
Supply Voltage Range	Full	±5		±20	±5		±20	V
Power Supply Rejection Ratio (Note 5)	Full		66			66		dB

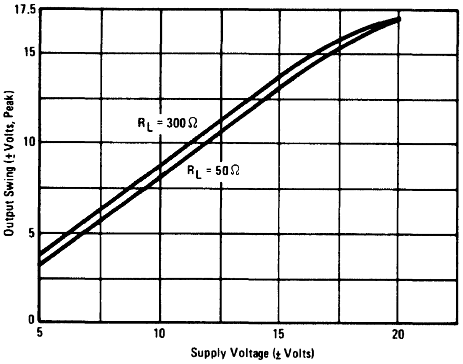
NOTES:
1. $V_O = \pm 10V$
2. Heat sink is required for continuous short circuit protection, regardless of current limit setting.
3. $V_O = 0.4V$ p-p.
4. $V_O = 10V$ p-p.
5. $\Delta V_{SUPPLY} = \pm 5V$.
6. Without heat sink, derate by 14mW/°C ambient temperature above 100°C ambient, with heat sink, derate by 67mW/°C case temperature above 115°C case.

*100% Tested For DASH 8

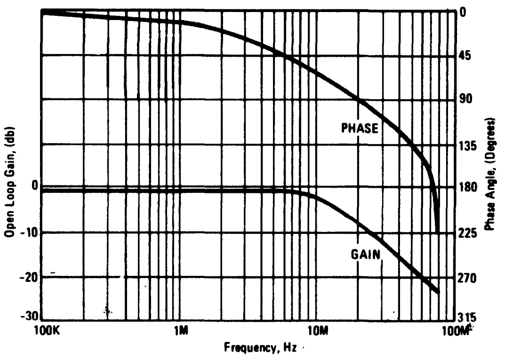
PERFORMANCE CURVES

V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED

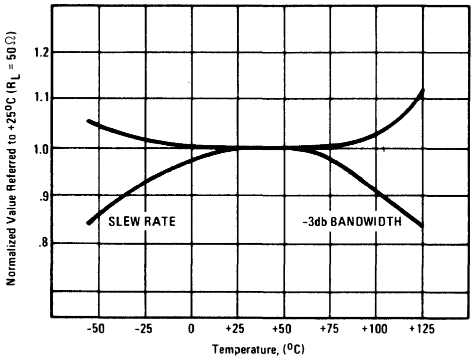
OUTPUT SWING (R_{LIMIT} = 0Ω)



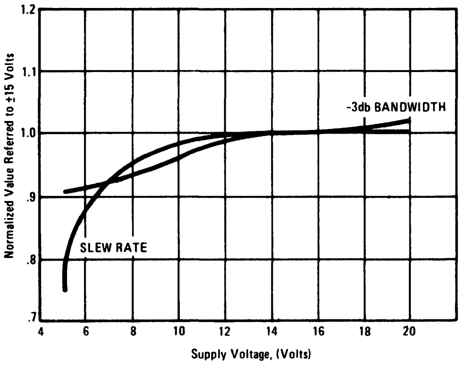
OPEN LOOP FREQUENCY AND PHASE RESPONSE (R_L = 50Ω, C_L ≈ 10pf)



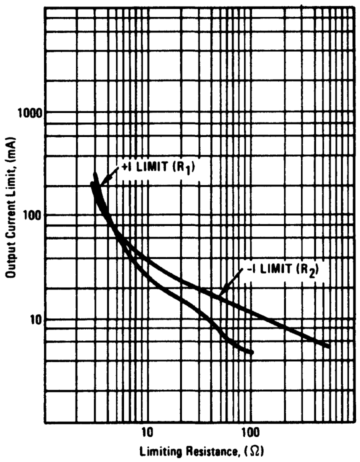
NORMALIZED AC PARAMETERS vs. TEMPERATURE (R_L = 50Ω)



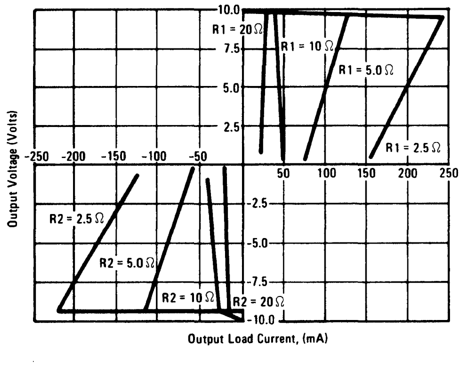
NORMALIZED AC PARAMETERS vs. SUPPLY VOLTAGE (R_L = 50Ω)



OUTPUT CURRENT LIMITING vs. LIMITING RESISTANCE

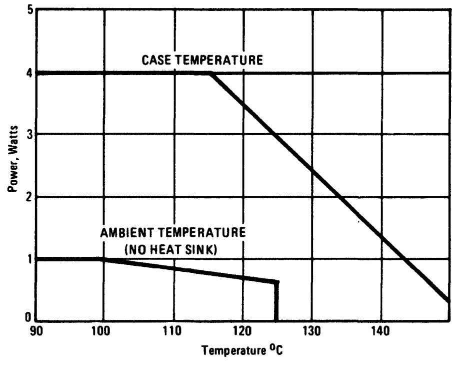


OUTPUT CURRENT CHARACTERISTIC



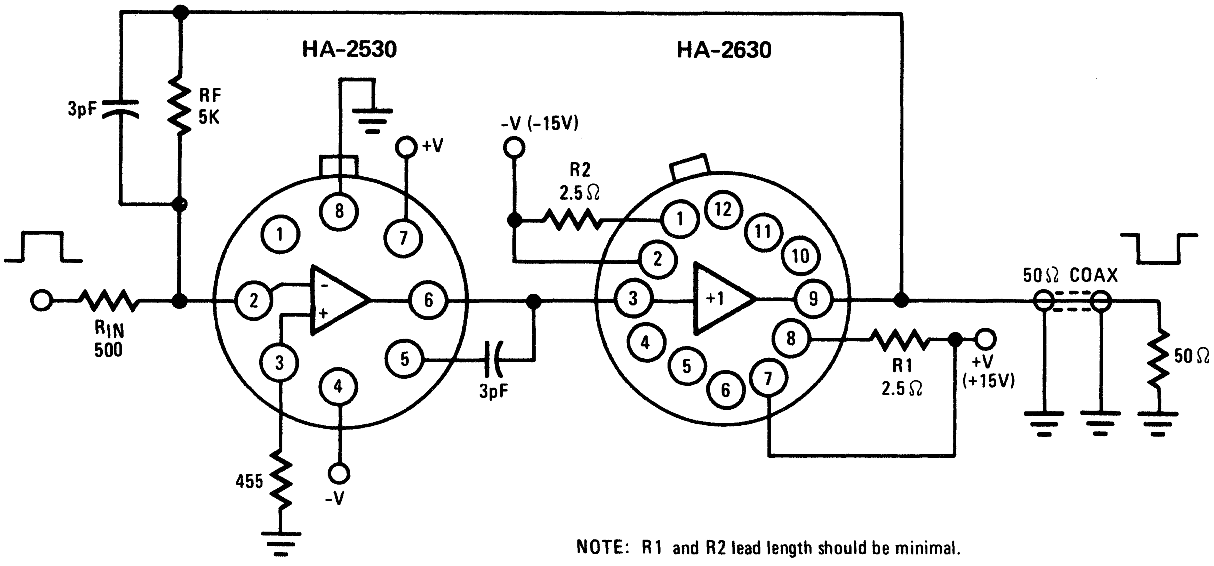
POWER DISSIPATION vs. LIMITING RESISTANCE WITH OUTPUT SHORTED TO GROUND; V_{IN} = +10V

MAXIMUM ALLOWABLE INTERNAL POWER DISSIPATION vs. TEMPERATURE



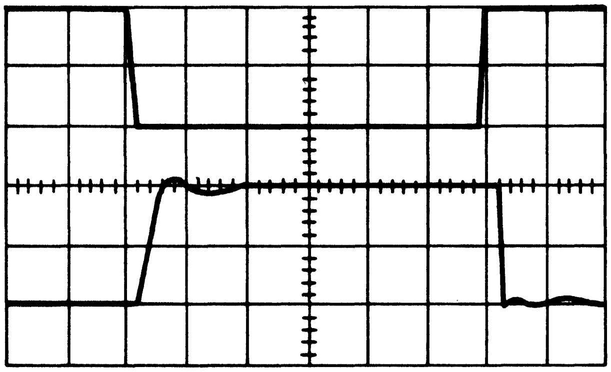
TYPICAL APPLICATION

20db, 5MHz VIDEO COAXIAL LINE DRIVER



NOTE: R1 and R2 lead length should be minimal.

LINE DRIVER PULSE RESPONSE



Horizontal Scale = 200ns/Div.
Upper Trace: Input, 200mV/Div.
Lower Trace: Output, 2V/Div.

SOME OTHER APPLICATIONS

- BIPOLAR POWER SUPPLY
- FUNCTION GENERATOR OUTPUT
- DEFLECTION COIL DRIVE
- AUDIO OUTPUT AMPLIFIER

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2640/2645

High Voltage Operational Amplifier

FEATURES

OUTPUT VOLTAGE SWING	±35V
SUPPLY VOLTAGE	±10V to ±40V
OFFSET CURRENT	5nA
BANDWIDTH	4MHz
SLEW RATE	5V/µs
COMMON MODE INPUT VOLTAGE SWING	±35V
OUTPUT OVERLOAD PROTECTION	

DESCRIPTION

The HA-2640/2645 is a high voltage, high performance, internally compensated monolithic operational amplifier.

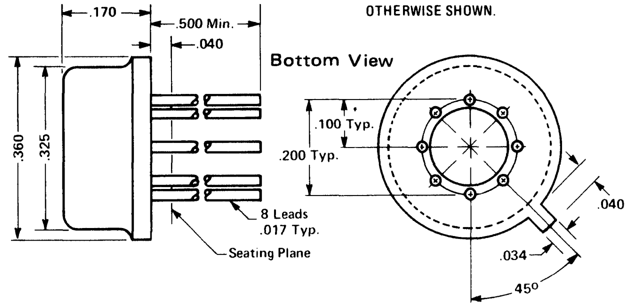
It is intended for use wherever a high output voltage range is required, or where high supply voltages (up to 80 Volts total) are encountered. Output current is limited by a chip temperature sensing circuit, providing positive protection against damage under any overload or output short circuit condition. The device may also be used as a pin for pin replacement for many general purpose op amps to achieve superior input current, bandwidth, and slew rate.

The HA-2640 has guaranteed operation over -55°C to +125°C, while the HA-2645 is guaranteed over 0°C to +75°C.

PACKAGE

CODE 2A TO-99

ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

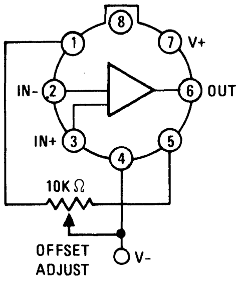


NOTE: 1. All leads gold plated KOVAR
2. All dimensions in inches

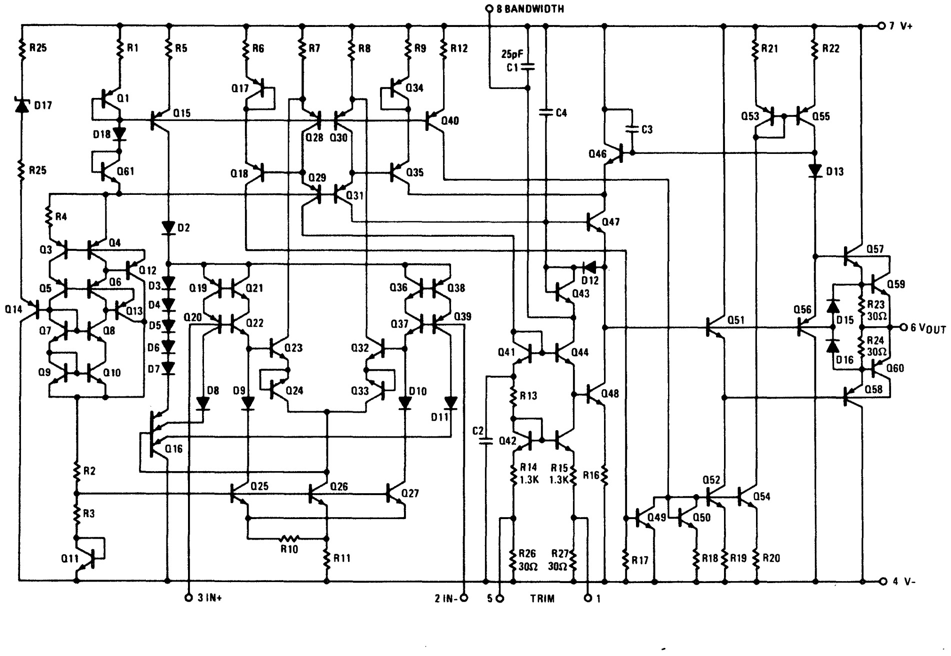
PIN OUT

Top View

TO-99



SCHEMATIC DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	100V
Input Voltage Range	±37V
Output Current/Full Short Circuit Protection	
Internal Power Dissipation	680mW*

*Derate by 4.6mW/°C above +25°C

Operating Temperature Range

$-55^{\circ}C \leq T_A \leq +125^{\circ}C$ (HA-2640)

$0^{\circ}C \leq T_A \leq +75^{\circ}C$ (HA-2645)

Storage Temperature Range

$-65^{\circ}C \leq T_A \leq +150^{\circ}C$

ELECTRICAL CHARACTERISTICS

$V_{Supply} = \pm 40V$, $R_L = 5K$, Unless Otherwise Specified.

		HA-2640 -55°C to +125°C			HA-2645 0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS								
* Offset Voltage	+25°C		2	4		2	6	mV
	Full			6			7	mV
Offset Voltage Average Drift	Full		15			15		µV/°C
* Bias Current	+25°C		10	25		12	30	nA
	Full			50			50	nA
* Offset Current	+25°C		5	12		15	30	nA
	Full			35			50	nA
Input Resistance	+25°C	50	250		40	200		MΩ
Common Mode Range	Full	±35			±35			V
TRANSFER CHARACTERISTICS								
* Large Signal Voltage Gain (Note 8)	+25°C	100K	200K		100K	200K		V/V
	Full	75K			75K			V/V
* Common Mode Rejection Ratio (Note 1)	Full	80	100		74	100		dB
Unity Gain Bandwidth (Note 2)	+25°C		4			4		MHz
OUTPUT CHARACTERISTICS								
* Output Voltage Swing	Full	±35			±35			V
* Output Current (Note 9)	+25°C	±12	±15		±10	±12		mA
Output Resistance	+25°C		500			500		Ω
Full Power Bandwidth (Note 3)	+25°C		23			23		kHz
TRANSIENT RESPONSE (Note 7)								
Rise Time (Notes 4, 6)	+25°C		60			60		ns
Overshoot (Notes 4, 6)	+25°C		15			15		%
Slew Rate (Note 6)	+25°C		5			5		V/µs
POWER SUPPLY CHARACTERISTICS								
* Supply Current	+25°C		3.2	3.8		3.2	4.5	mA
Supply Voltage Range	Full	±10		±40	±10		±40	V
* Power Supply Rejection Ratio (Note 5)	Full	80	90		74	90		dB

NOTES:

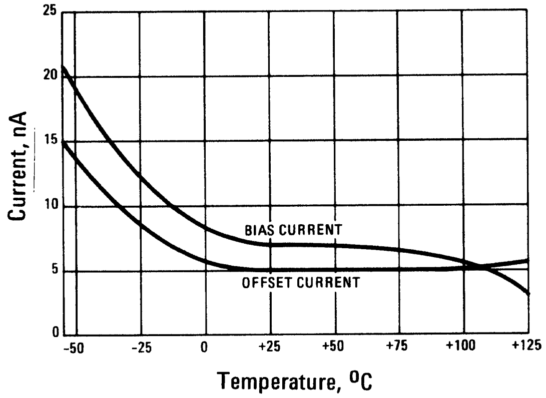
1. $V_{CM} = \pm 30V$
2. $V_O = 90mV$
3. $V_O = \pm 35V$
4. $V_O = \pm 200mV$
5. $V_S = \pm 10V$ to $\pm 40V$
6. $A_V = 1$
7. $C_L = 50pF$
8. $\Delta V_O = \pm 30.0V$
9. $R_L = 1K\Omega$

*100% Tested For DASH 8

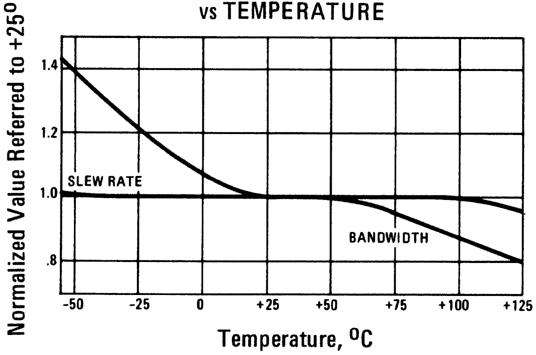
PERFORMANCE CURVES

V+ = V- = 40VDC, T_A = +25°C UNLESS OTHERWISE STATED

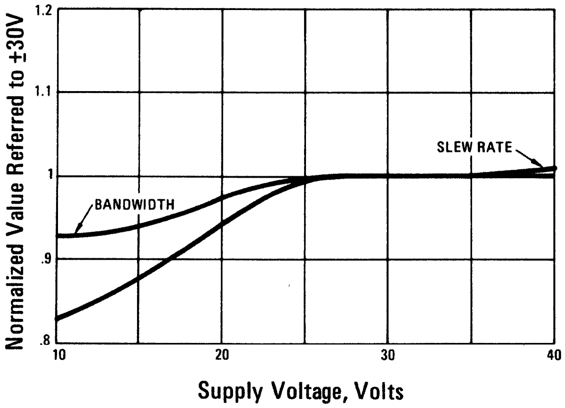
INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE



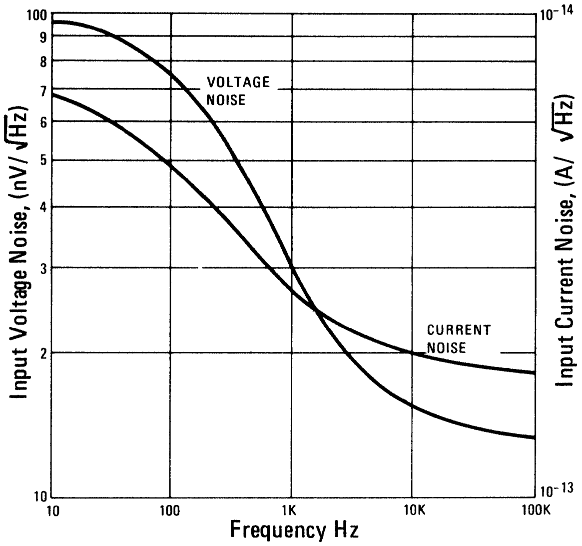
NORMALIZED AC PARAMETERS vs TEMPERATURE



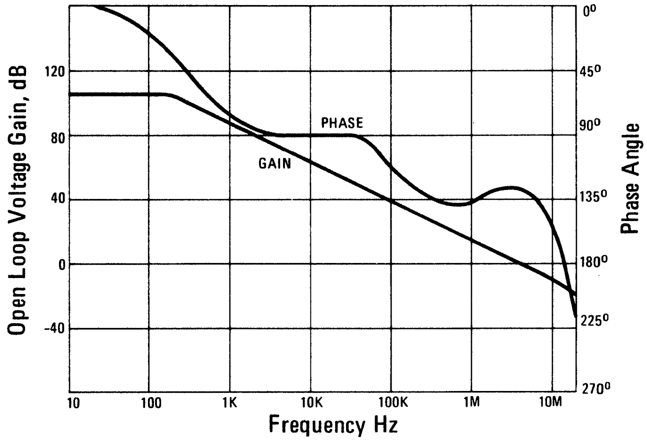
NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE AT +25°C



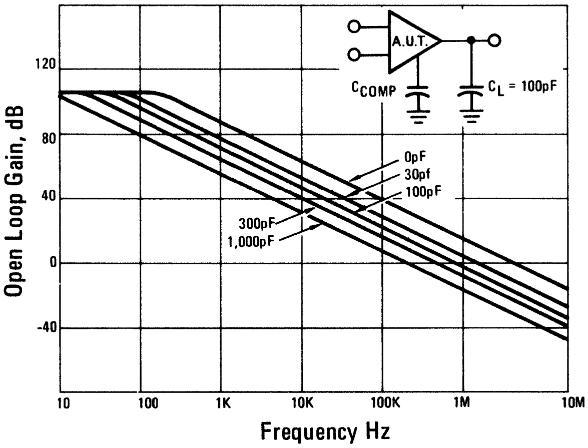
INPUT NOISE CHARACTERISTICS



OPEN LOOP FREQUENCY AND PHASE RESPONSE



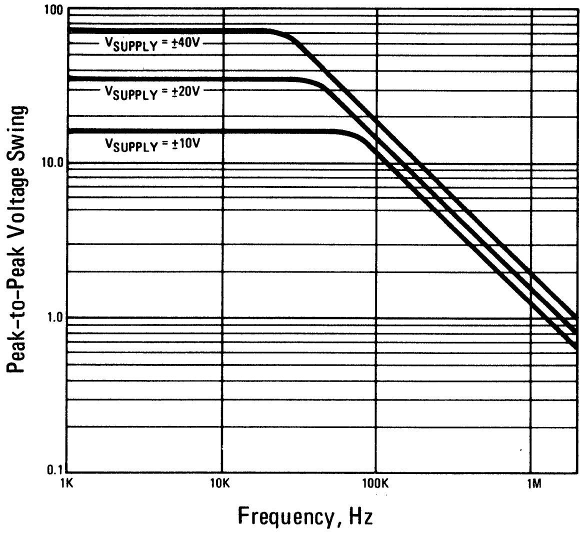
OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND



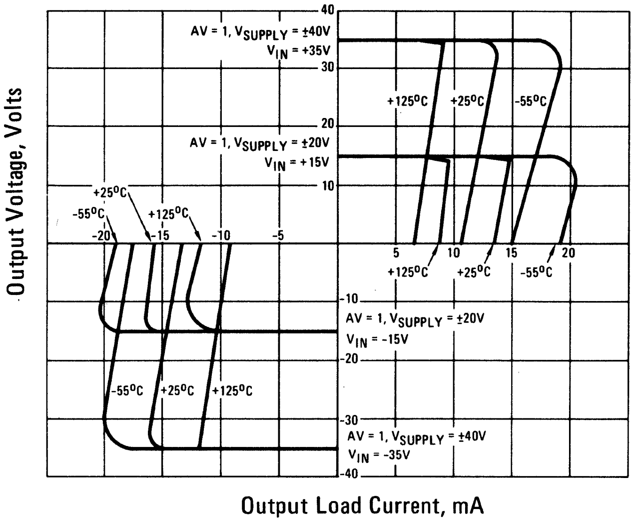
NOTE: External Compensation Components are not Required for Stability. But May be Added to Reduce Bandwidth if Desided. C_L = 100pF is Also Required for Stability Only if External Compensation Capacitor is Used.

PERFORMANCE CURVES (continued)

OUTPUT VOLTAGE SWING vs FREQUENCY AT +25°C

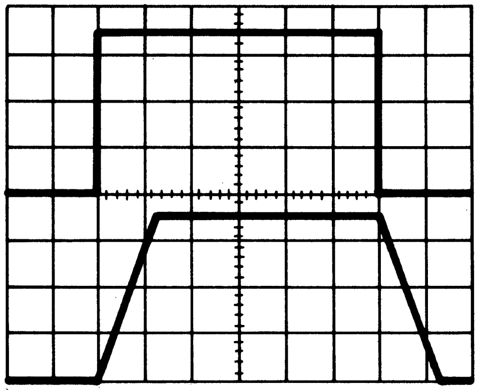


OUTPUT CURRENT CHARACTERISTIC



SWITCHING WAVEFORM AND TEST CIRCUIT

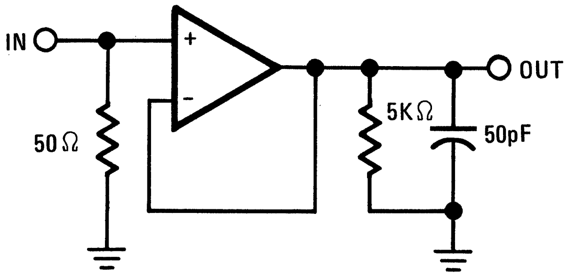
VOLTAGE FOLLOWER PULSE RESPONSE



R_L = 5K, C_L = 50pF
Vertical = 10V/Div.
Horizontal = 5 µs/Div.

T_A = +25°C
V_S = ±40V

SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2650/2655

Dual High Performance Operational Amplifier

FEATURES

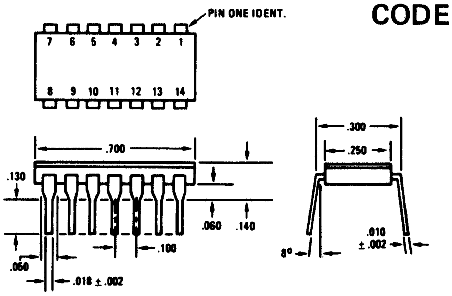
● Slew Rate	5V/μS
● Bandwidth	8 MHz
● Bias Current	35 nA
● Av. Offset Voltage Drift	8μV/°C
● Power Consumption	75mW
● Supply Voltage Range	±2V to ±20V

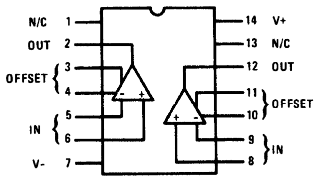
DESCRIPTION

The HA-2650/HA-2655 contains two internally compensated operational amplifiers on a single chip offering high slew rate and high frequency performance at no expense to DC performance. Applications of the device range from DC to high frequency video circuits; such as tone generators, active filters, integrators, high impedance buffers, etc. The device is available in the TO-116 DIP and the TO-99 metal can, in either the military or commercial temperature range.

PACKAGE/PINOUTS

CODE 1S

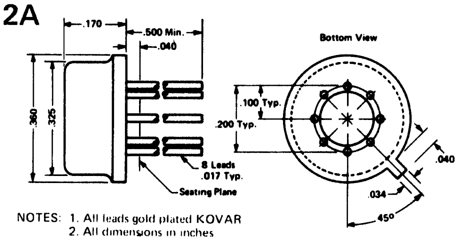




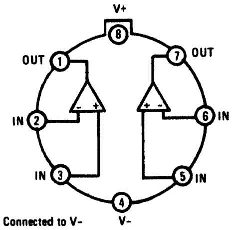
TO-116
(TOP VIEW)

NOTE: Bottom of package is connected to V-

CODE 2A



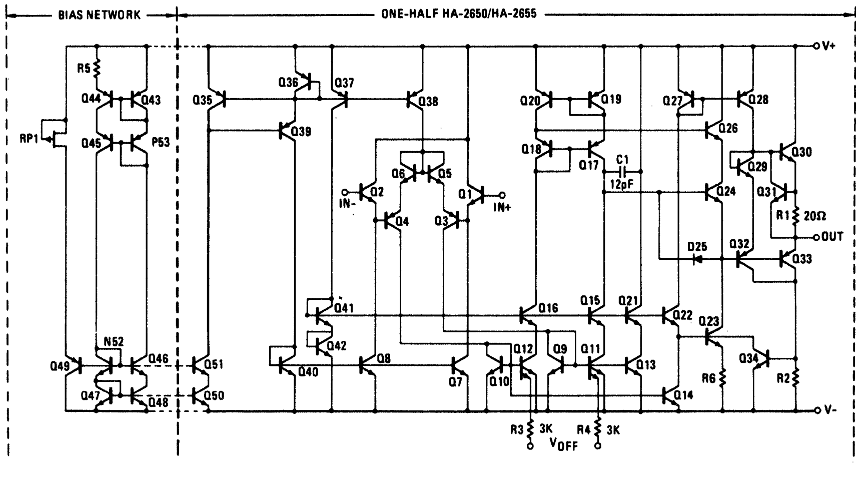
NOTES: 1. All leads gold plated KOVAR
2. All dimensions in inches



TO-99
(TOP VIEW)

NOTE: Case Connected to V-

SCHEMATIC DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

T_A = +25°C Unless Otherwise Stated

Voltage Between V+ and V- Terminals	40.0V
Differential Input Voltage	±30.0V
Input Voltage (Note 1)	±15.0V
Output Short Circuit Duration	Indefinite

Power Dissipation (Note 2)	TO-99	300 mW
	TO-116	300 mW

Operating Temperature Range:

HA-2650	$-55°C \leq T_A \leq +125°C$
HA-2655	$0°C \leq T_A \leq +75°C$
Storage Temperature Range	$-65°C \leq T_A \leq +150°C$

ELECTRICAL CHARACTERISTICS

V+ = 15V V- = -15V

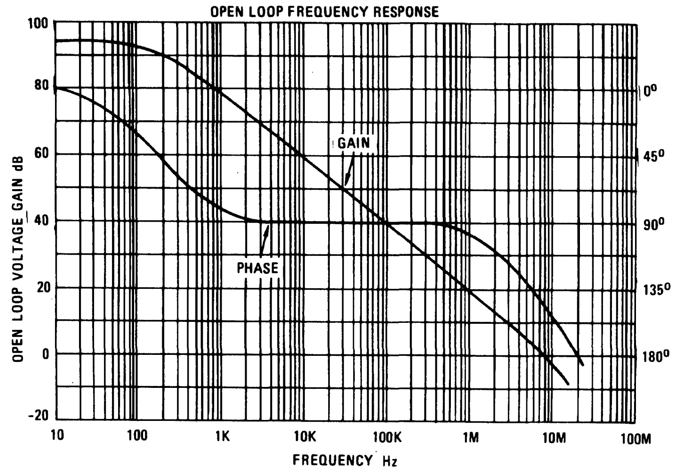
		HA-2650 -55°C to +125°C			HA-2655 0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS								
*Offset Voltage	+25°C		1.5	3		2	5	mV
	Full			5			7	mV
Av. Offset Voltage Drift	Full		8			8		μV/°C
*Bias Current	+25°C		35	100		50	200	nA
	Full			200			300	nA
*Offset Current	+25°C		1	30		2	60	nA
	Full			60			100	nA
Common Mode Range	Full	±13			±13			V
Differential Input Resistance	+25°C	5	20		5	20		MΩ
Common Mode Input Resistance	+25°C		500			500		MΩ
Input Capacitance	+25°C		5			5		pF
TRANSFER CHARACTERISTICS								
*Large Signal Voltage Gain (Note 3ab)	+25°C	25K	40K		20K	40K		V/V
	Full	20K			15K			V/V
*Common Mode Rejection Ratio (Note 4)	+25°C	80	100		74	100		dB
	Full	80			74			dB
OUTPUT CHARACTERISTICS								
*Output Voltage Swing (Note 3c)	+25°C	±13	±14		±13	±14		V
	Full	±13			±13			V
Full Power Bandwidth (Note 5)	+25°C	30	80		30	80		KHz
Output Current (Note 3a)	+25°C		±20			±18		mA
Output Resistance	+25°C		100			100		Ω
TRANSIENT RESPONSE (Note 6)								
Rise Time (Note 7)	+25°C		40			40		ns
Overshoot (Note 7)	+25°C		15			15		%
Slew Rate	+25°C	±2	±5		±2	±5		V/μs
POWER SUPPLY CHARACTERISTICS								
*Supply Current	+25°C		2.5	3		3	4	mA
*Power Supply Rejection Ratio (Note 8)	+25°C	80	100		74	100		dB
	Full	80			74			dB

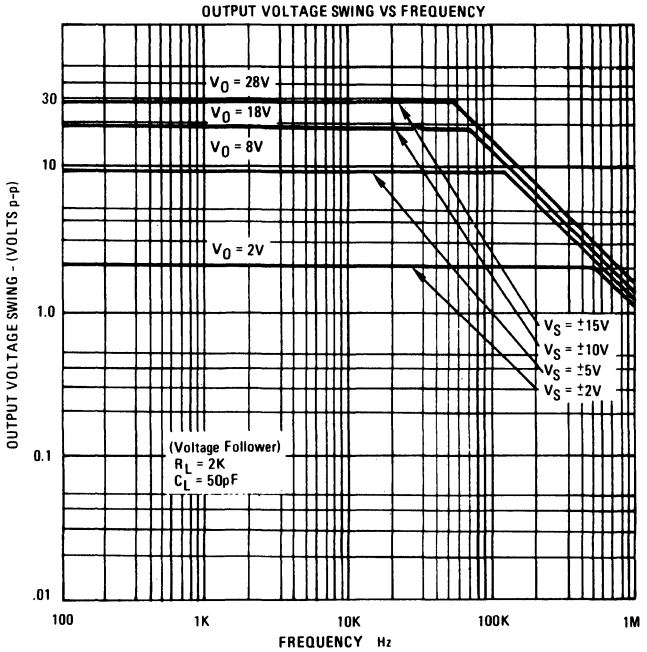
NOTES:
1. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
2. Derate at 4.7mW/°C at ambient temperatures above +110°C.
3. (a) $V_O = \pm 10V$ (b) $R_L = 2K$ (c) $R_L = 10K$
4. $V_{CM} = \pm 5.0V$
5. $A_V = 1, R_L = 2K, V_O = 20V_{pp}$
6. See transient response/slew rate circuit.
7. $V_{in} = 200mV$
8. $\Delta V = \pm 5.0V$

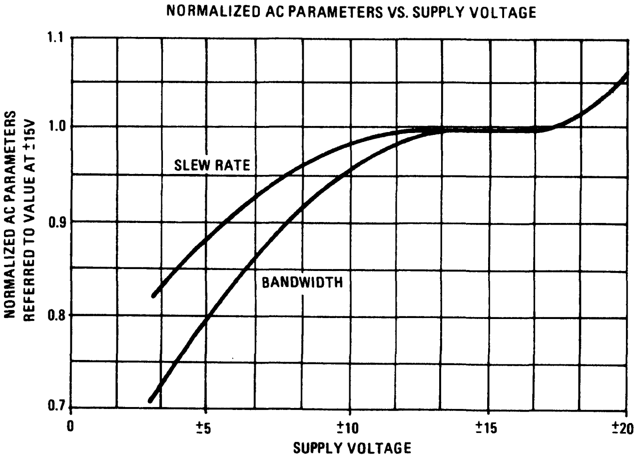
*100% Tested For DASH 8

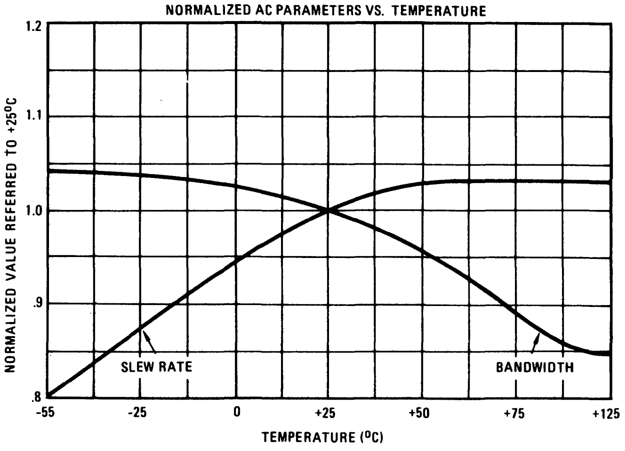
PERFORMANCE CURVES

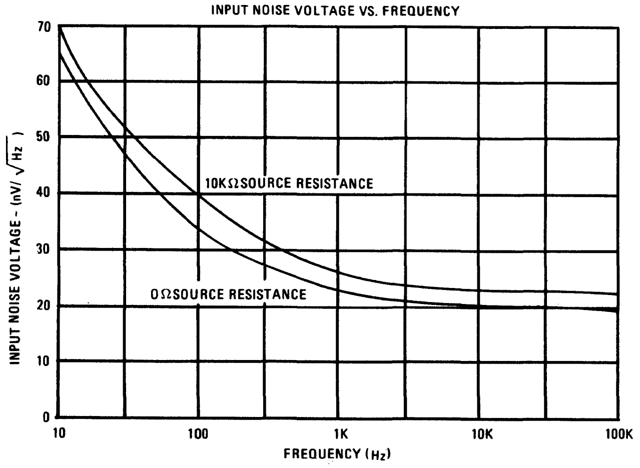
V+ = +15V, V- = -15V, T_A = +25°C Unless Otherwise Stated.

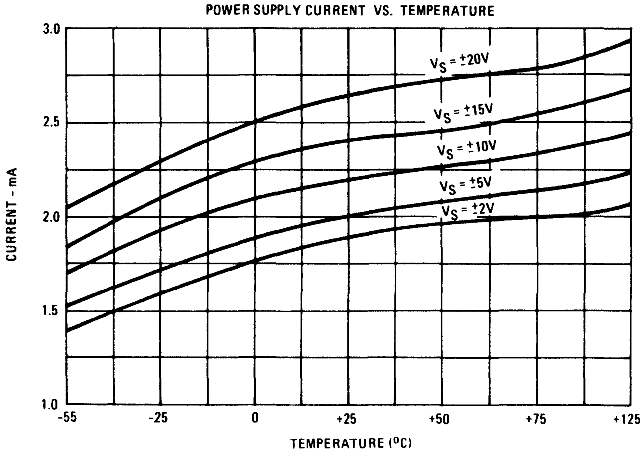






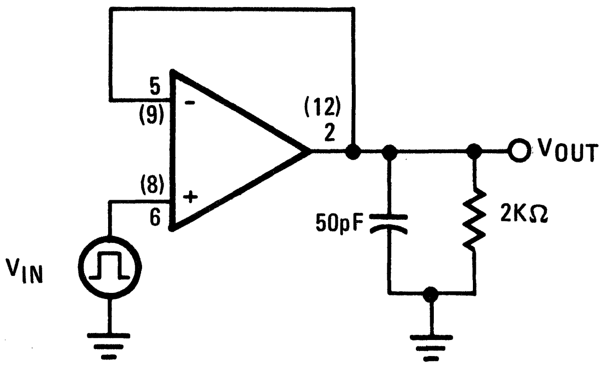






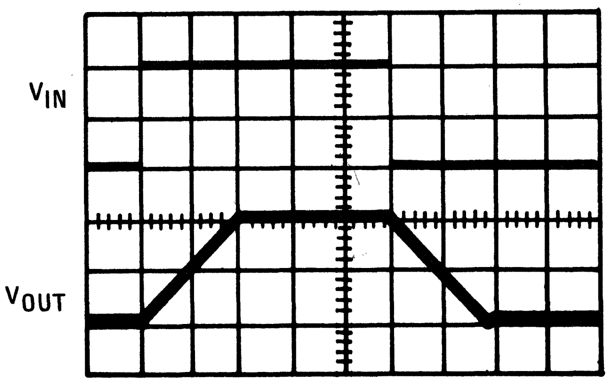
PERFORMANCE CHARACTERISTICS

TRANSIENT RESPONSE/SLEW RATE CIRCUIT



Note: Numbers in parentheses refer to the second half of TO-116 package.

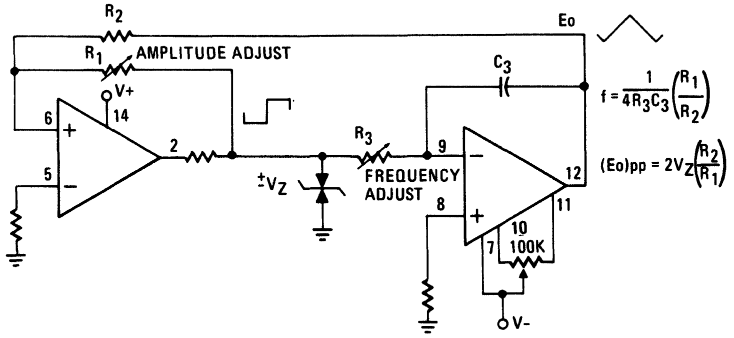
SLEWING WAVEFORM



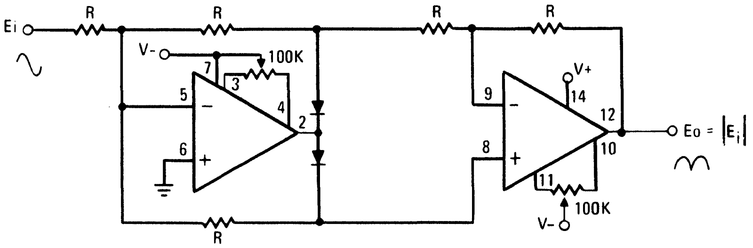
VERTICAL 5V/DIV. HORIZONTAL 1μs/DIV.

TYPICAL APPLICATIONS

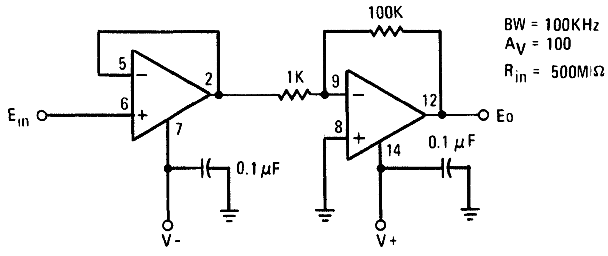
LOW COST HIGH FREQUENCY GENERATOR



ABSOLUTE-VALUE CIRCUIT



HIGH IMPEDANCE
HIGH GAIN
HIGH FREQUENCY INVERTING AMP



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2700/2704/2705

High Performance Operational Amplifiers

FEATURES

• HIGH SLEW RATE	20V/µs	• HIGH CM_{rr}	106dB
• LOW POWER DISSIPATION	2.25mW AT ±15.0V	• WIDE POWER SUPPLY RANGE	±5.5V TO ±20.0V
• HIGH OPEN LOOP GAIN	300K (R_L = 2KΩ)	• FULLY INTERNALLY COMPENSATED	
• LOW INPUT BIAS CURRENT	5nA	• OUTPUT SHORT CIRCUIT PROTECTED	
• LOW OFFSET VOLTAGE	0.5mV	• OFFSET NULL CAPABILITY	

GENERAL DESCRIPTION

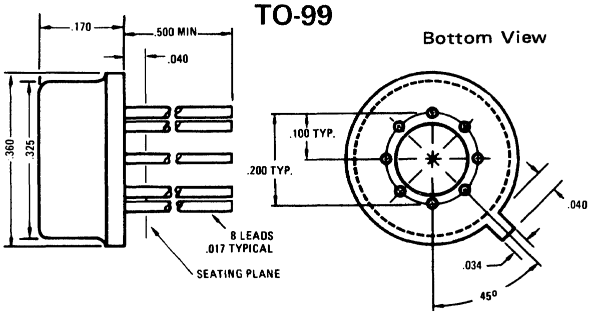
The HA-2700 is a general purpose amplifier which utilizes a revolutionary input circuit concept that makes possible operation at very low power levels without compromising large signal response characteristics or output drive capability. Advanced circuit design techniques and the use of vertical NPN and PNP transistors make possible the attainment of very high gain with a single stage of voltage amplification, thus ensuring closed loop stability even in the critical unity gain follower mode, without the use of external compensation components.

The circuit is intended for use in applications that require fast large signal response with low power dissipation and for instrumentation applications in which low offset voltage, current drift, large voltage gain and high common mode rejection are necessary. Full output short circuit protection and the large differential input breakdown enable the device to withstand a variety of fault conditions.

PACKAGES

CODE 2A

TO-99

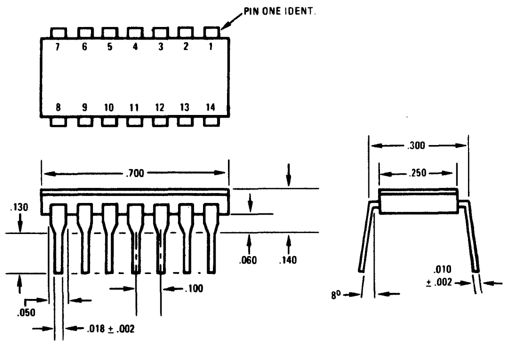


NOTES: 1. All leads gold plated KOVAR
2. All dimensions in inches

CODE 1S

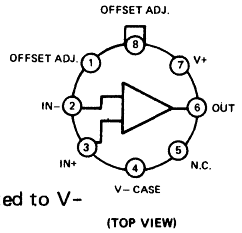
TO-116

ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.



PIN OUT

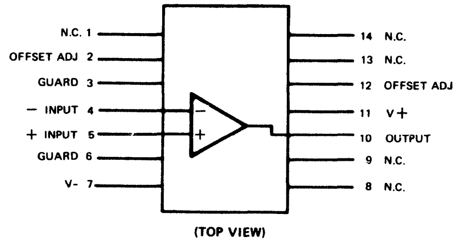
TO-99:
HA2-2700/HA2-2704/HA2-2705



Case Connected to V-

(TOP VIEW)

TO-116:
HA1-2700/HA1-2704/HA1-2705



(TOP VIEW)

Case Connected to V-

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	44.0V
Differential Input Voltage	±18.0V
Internal Power Dissipation (Note 7)	300mW
Storage Temperature	$-65^{\circ}C \leq T_A \leq +150^{\circ}C$

ELECTRICAL CHARACTERISTICS

$V^+ = +15.0$ V.D.C. $V^- = -15.0$ V.D.C.

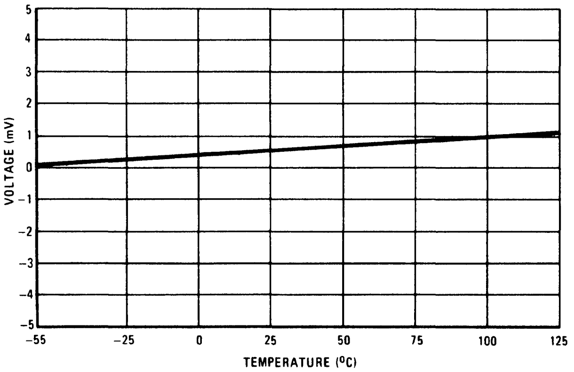
PARAMETER	TEMP.	HA-2700 −55°C to +125°C			HA-2704 −25°C to +85°C			HA-2705 0°C to +75°C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS											
* Offset Voltage (Note 1)	+25°C		0.5	3.0		0.5	3.0		1.0	5.0	mV
	Full			5.0			6.0			7.0	mV
* Bias Current	+25°C		5.0	20.0		5.0	20.0		5.0	40.0	nA
	Full			50.0			50.0			70.0	nA
* Offset Current	+25°C		2.5	10.0		2.5	10.0		2.5	15.0	nA
	Full			30.0			30.0			40.0	nA
Common Mode Range	Full	±11.0			±11.0			±11.0			V
TRANSFER CHARACTERISTICS											
* Large Signal Voltage Gain (Notes 2 & 3)	+25°C	200K	300K		200K	300K		200K	300K		V/V
	Full	100K			100K			100K			V/V
* Common Mode Rejection Ratio (Note 4)	Full	86	106		86	106		80	106		dB
Gain Bandwidth Product (Note 2)	+25°C		1.0			1.0			1.0		MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 2)	+25°C	±12.0	±13.0		±12.0	±13.0		±12.0	±13.0		V
	Full	±11.0			±11.0			±11.0			V
* Output Current (Note 3)	+25°C		10			10			10		mA
TRANSIENT RESPONSE CHARACTERISTICS											
* Slew Rate (Notes 2 & 6)	+25°C	10	20		10	20		10	20		V/µs
POWER SUPPLY CHARACTERISTICS											
* Supply Current	+25°C		75	150		75	150		75	150	µA
* Power Supply Rejection Ratio (Note 5)	Full	86	100		86	100		80	100		dB

NOTES:
1. Can be adjusted to zero with 1 megohm pot between Pins 1 and 8 with the tap to Pin 7.
2. $R_L = 2K$, $C_L = 100pF$
3. $V_O = \pm 10.0V$
4. $V_{CM} = \pm 5.0V$
5. $V_S = \pm 10.0V$ to $\pm 20.0V$
6. $A_V = 5$
7. Derate by 6.6 mW/°C above 105°C.

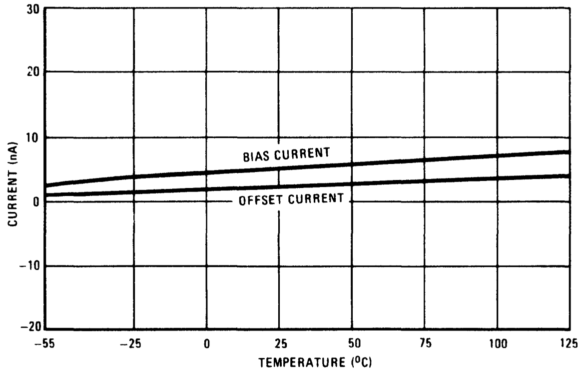
*100% Tested For DASH 8

TYPICAL PERFORMANCE CURVES

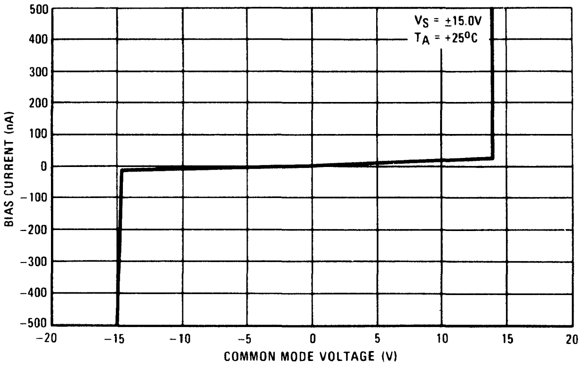
OFFSET VOLTAGE AS A FUNCTION OF TEMPERATURE



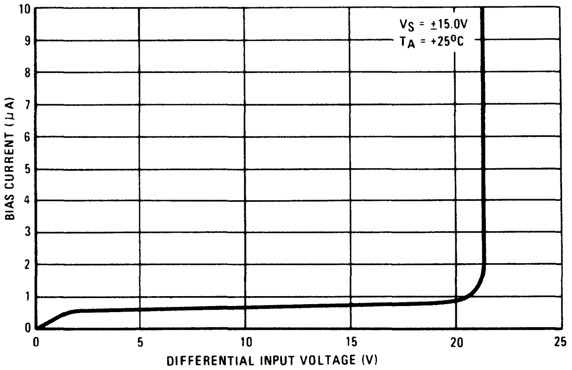
INPUT BIAS CURRENT AND OFFSET CURRENT AS A FUNCTION OF TEMPERATURE



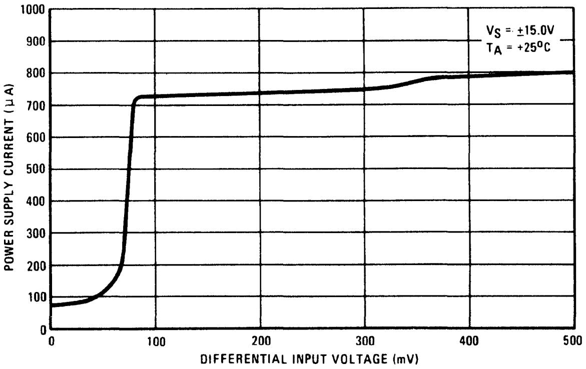
BIAS CURRENT AS A FUNCTION OF COMMON MODE VOLTAGE



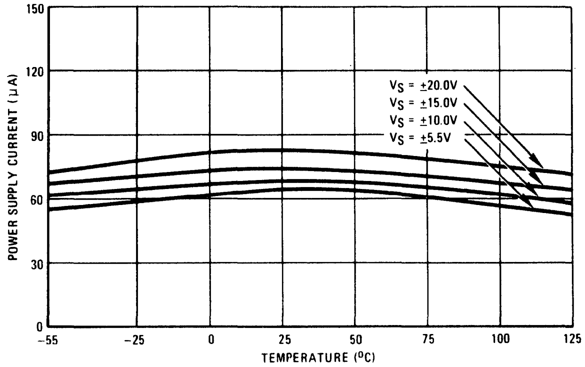
BIAS CURRENT AS A FUNCTION OF DIFFERENTIAL INPUT VOLTAGE



POWER SUPPLY CURRENT AS A FUNCTION OF DIFFERENTIAL INPUT VOLTAGE

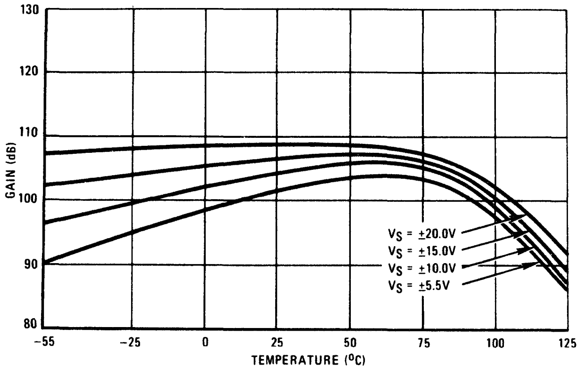


POWER SUPPLY CURRENT AS A FUNCTION OF TEMPERATURE



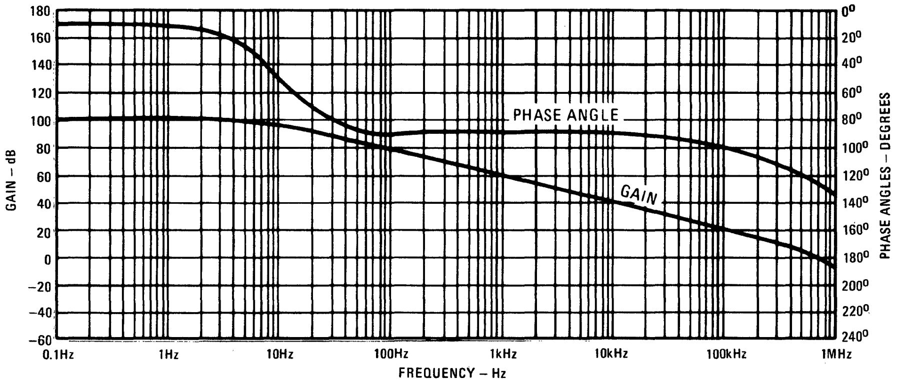
VOLTAGE GAIN AS A FUNCTION OF TEMPERATURE

NOTE: Open loop (comparator) applications are not recommended, because of the above characteristic.



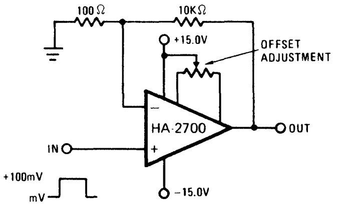
TYPICAL PERFORMANCE CURVES (continued)

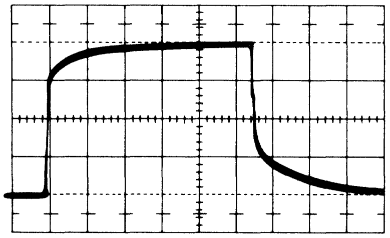
PHASE-FREQUENCY RESPONSE FOR THE HA-2700



TYPICAL APPLICATIONS

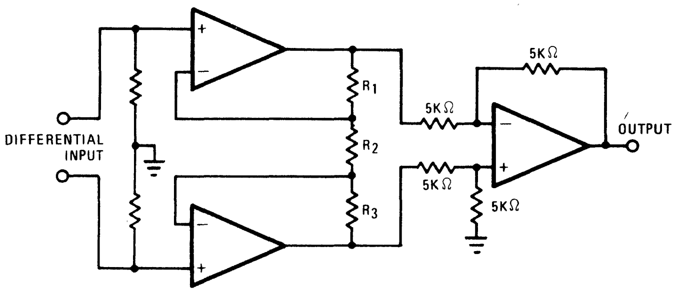
HIGH GAIN AMPLIFIER (100 V/V)





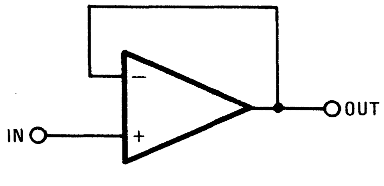
SCALE:
Horizontal – 20μs/division
Vertical – 5.0V/division

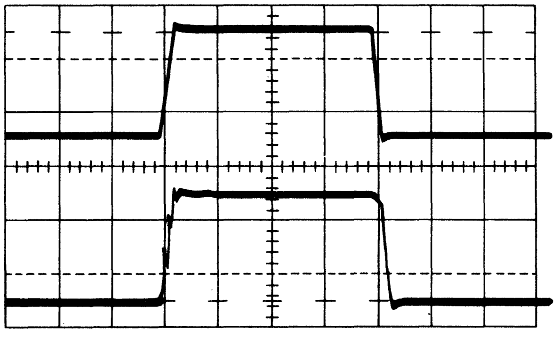
DIFFERENTIAL INPUT INSTRUMENTATION AMPLIFIER



THE GAIN IS GIVEN BY: $\frac{(R_1 + R_2 + R_3)}{R_2} = G$

UNITY GAIN VOLTAGE FOLLOWER





Non-inverting unity gain with a 2KΩand 100pF load
TOP: V_{IN} = 10.0V Peak to Peak
BOTTOM: V_{OUT}
SCALE: Horizontal -1 μs/division
Vertical -5.0V/division

NOTE: Faster increase rise and fall time and increase distortion on output wave form.

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2720/2725

Wide Range Programmable Operational Amplifier

FEATURES

- WIDE RANGE A.C. PROGRAMMING

SLEW RATE:	0.06 TO 6V/μS
GAIN X BANDWIDTH:	5KHz TO 10MHz

- WIDE RANGE D.C. PROGRAMMING

POWER SUPPLY RANGE:	±1.2V TO ±18V
SUPPLY CURRENT:	1μA TO 1.5mA
BIAS CURRENT:	0.4 TO 50nA

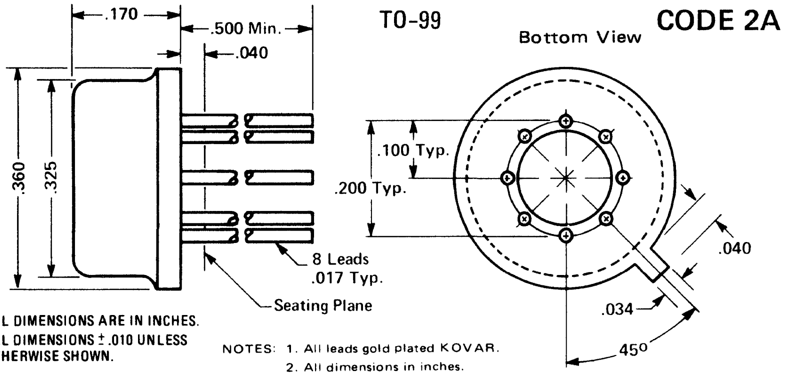
- LOW NOISE
- SHORT CIRCUIT PROTECTION

DESCRIPTION

The HA-2720/2725 Programmable Operational Amplifier is an internally compensated monolithic device offering wide range performance specifications. Parameters such as power dissipation, slew rate, bandwidth, noise and input DC parameters are programmed by selecting an external resistor or current source. Supply voltage as low as ± 3 volts may be used with little degradation of AC performance. Applications such as current controlled oscillators, active filters, modulators and sample and hold circuits can be derived easily by modulating the set current.

The HA-2720 is guaranteed for operation form -55°C to +125°C while the HA-2725 is guaranteed from 0°C to +75°C.

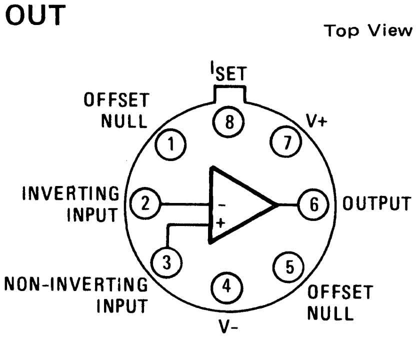
PACKAGE



ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

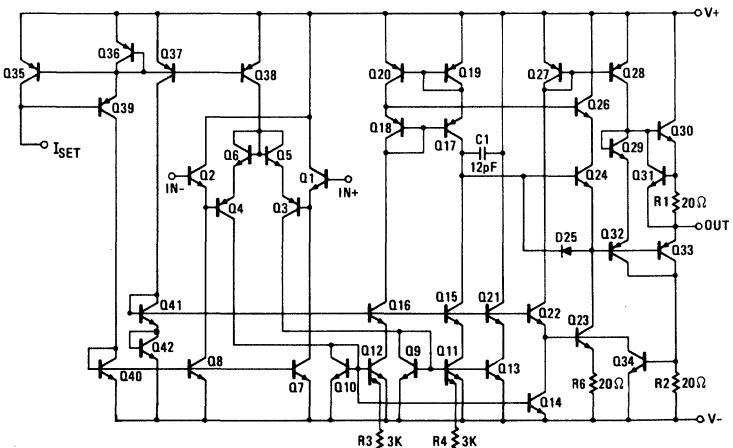
NOTES: 1. All leads gold plated KOVAR.
2. All dimensions in inches.

PIN OUT



NOTE: Case tied to V⁻

SCHEMATIC



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	45.0V
Differential Input Voltage	±30.0V
Input Voltage (Note 1)	±15.0V
I_{SET} (Current at I_{SET})	500μA
V_{SET} (Voltage to Gnd. at I_{SET})	$V+ - 2.0V \leq V_{SET} \leq V+$

Power Dissipation (Note 2)	300mW
Operating Temperature Range:	
HA-2720	$-55^{o}C \leq T_A \leq +125^{o}C$
HA-2725	$0^{o}C \leq T_A \leq +75^{o}C$
Storage Temperature Range	$-65^{o}C \leq T_A \leq +150^{o}C$

ELECTRICAL CHARACTERISTICS

V+ = +3.0V, V- = -3.0V

		HA-2720 -55°C to +125°C						HA-2725 0°C to +75°C						
		I_{SET} = 1.5μA			I_{SET} = 15μA			I_{SET} = 1.5μA			I_{SET} = 15μA			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS														
*Offset Voltage	25°C		2.0	3.0		2.0	3.0		2.0	5.0		2.0	5.0	mV
	Full			5.0			5.0			7.0			7.0	mV
Offset Current	25°C		0.5	3.0		1.0	10		0.5	5.0		1.0	10	nA
	Full			7.5			20			7.5			20	nA
Bias Current	25°C		2.0	5.0		8.0	20		2.0	10		8.0	30	nA
	Full			10			40			10			40	nA
Input Resistance	25°C		50			5			50			5		MΩ
Input Capacitance	25°C		3.0			3.0			3.0			3.0		pF
TRANSFER CHARACTERISTICS														
*Large Signal Voltage Gain (Note 9)	25°C	20K	40K		20K	40K		15K	40K		15K	40K		V/V
	Full	15K			15K			10K			10K			V/V
*Common Mode Rejection Ratio (Note 4)	Full	80			80			74			74			dB
OUTPUT CHARACTERISTICS														
*Output Voltage Swing (Note 3)	25°C	±2.0	±2.2		±2.0	±2.2		±2.0	±2.2		±2.0	±2.2		V
	Full	±2.0			±1.9			±2.0			±2.0			V
Output Current (Note 5)	25°C		±0.2			±2.0			±0.2			±2.0		mA
Output Resistance	25°C		2K			500			2K			500		Ω
Output Short-Circuit Current	25°C		2.8			14			2.8			14		mA
TRANSIENT RESPONSE														
Rise Time (Note 6)	25°C		2.5			0.25			2.5			0.25		μs
Overshoot (Note 6)	25°C		5			10			5			10		%
Slew Rate (Note 7)	25°C		0.07			0.70			0.07			0.70		V/μs
POWER SUPPLY CHARACTERISTICS														
Supply Current	25°C		15			170			15			170		μA
	Full			20			200			20			200	μA
*Power Supply Rejection Ratio (Note 8)	Full	100			100			150			150			μV/V

*100% Tested For DASH 8

ELECTRICAL CHARACTERISTICS

V+ = +15.0V, V- = -15.0V

PARAMETER	TEMP.	HA-2720 -55°C to +125°C						HA-2725 0°C to +75°C						UNITS
		I_{SET} = 1.5µA			I_{SET} = 15µA			I_{SET} = 1.5µA			I_{SET} = 15µA			
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS														
*Offset Voltage	25°C		2.0	3.0		2.0	3.0		2.0	5.0		2.0	5.0	mV
	Full			5.0			5.0			7.0			7.0	mV
*Offset Current	25°C		0.5	3.0		1.0	10		0.5	5.0		1.0	10	nA
	Full			7.5			20			7.5			20	nA
*Bias Current	25°C		2.0	5.0		8.0	20		2.0	10		8.0	30	nA
	Full			10			40			10			40	nA
Input Resistance	25°C		50			5			50			5		MΩ
Input Capacitance	25°C		3.0			3.0			3.0			3.0		pF
TRANSFER CHARACTERISTICS														
*Large Signal Voltage Gain (Notes 3 & 9)	25°C	40K	100K		40K	120K		25K	100K		25K	120K		V/V
	Full	25K			25K			20K			20K			V/V
*Common Mode Rejection Ratio (Note 4)	25°C		90			90			90			90		dB
	Full	80			80			74			74			dB
OUTPUT CHARACTERISTICS														
*Output Voltage Swing (Note 3)	25°C	±12	±13.5		±12	±13.5		±12	±13.5		±12	±13.5		V
	Full	±10			±10			±10			±10			V
Output Current (Note 5)	25°C		±0.5			±5.0			±0.5			±5.0		mA
Output Resistance	25°C		2K			500			2K			500		Ω
Output Short-Circuit Current	25°C		3.7			19			3.7			19		mA
TRANSIENT RESPONSE														
Rise Time (Note 6)	25°C		2.0			0.2			2.0			0.2		µs
Overshoot (Note 6)	25°C		5			15			5			15		%
Slew Rate (Note 7)	25°C		0.1			0.8			0.1			0.8		V/µs
POWER SUPPLY CHARACTERISTICS														
*Supply Current	25°C		20			210			20			210		µA
	Full			25			250			25			250	µA
*Power Supply Rejection Ratio (Note 8)	Full	100			100			150			150			µV/V

NOTES:
1. For supply voltages less than ±15.0V, the absolute maximum input voltage is equal to supply voltage.
2. Derate at 6.8mW/°C for operation ambient temperatures above 75°C.

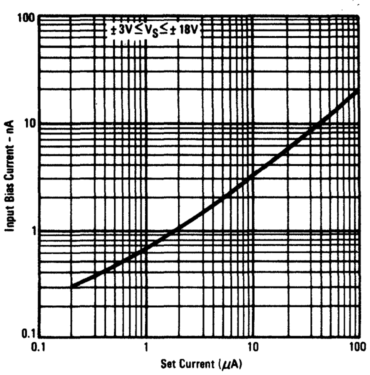
	V_{SUPPLY} = ±3.0V	V_{SUPPLY} = ±15.0V	I_{SET} = 1.5µA	I_{SET} = 15µA
3.	T = +25°C and Full	T = +25°C	R_L = 75KΩ	R_L = 5KΩ
	—	T = Full	R_L = 75KΩ	R_L = 75KΩ
4.	V_{CM} = ±1.5V	V_{CM} = ±5.0V		
5.	V_O = ±2.0V	V_O = ±10.0V		
6.	← A_V = +1, V_{IN} = 400mV, R_L = 5K, C_L = 100pF →			
7.	V_O = ±2.0V	V_O = ±10.0V	R R_L = 20K	R_L = 5K
8.	ΔV = ±1.5V	ΔV = ±5.0V		
9.	V_O = ±1.0V	V_O = ±10.0V		

*100% Tested For DASH 8

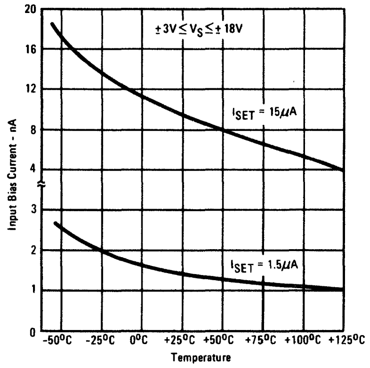
PERFORMANCE CURVES

UNLESS OTHERWISE NOTED: $T_A = +25^oC$, $V_S = \pm 15VDC$

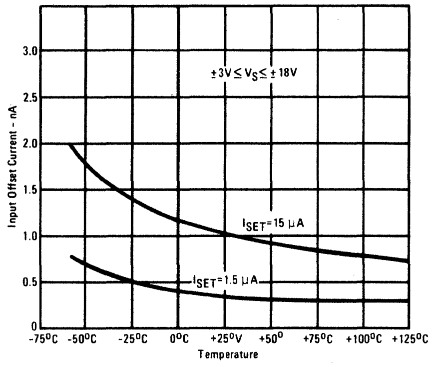
INPUT BIAS CURRENT
vs. SET CURRENT



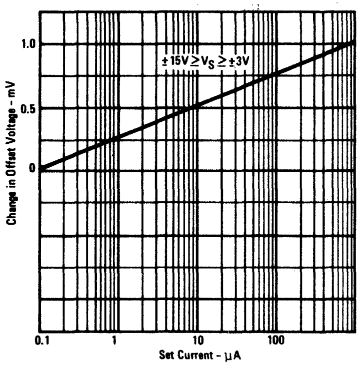
INPUT BIAS CURRENT
vs. TEMPERATURE



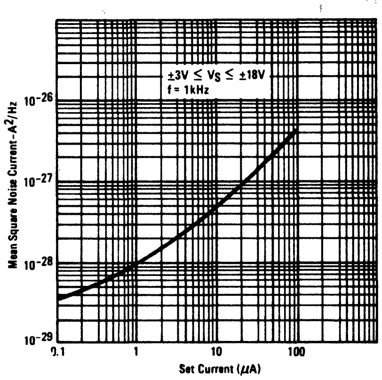
INPUT OFFSET CURRENT
vs. TEMPERATURE



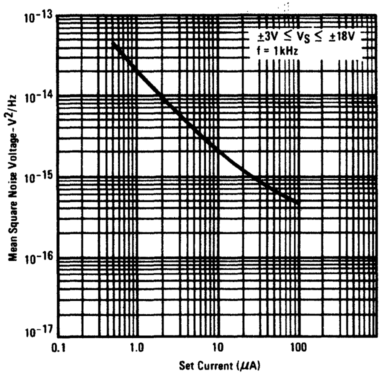
CHANGE IN OFFSET VOLTAGE
vs. I_{SET} (UNNULLED)



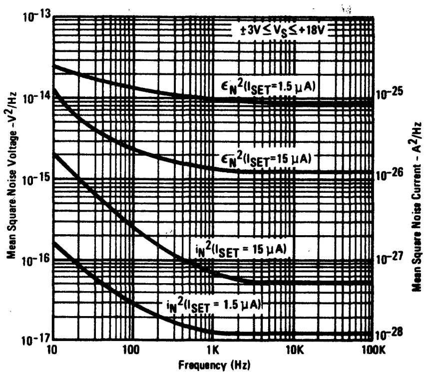
INPUT NOISE CURRENT
vs. I_{SET}



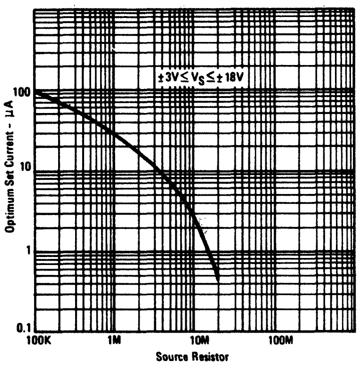
INPUT NOISE VOLTAGE
vs. I_{SET}



INPUT NOISE VOLTAGE AND CURRENT
vs. FREQUENCY



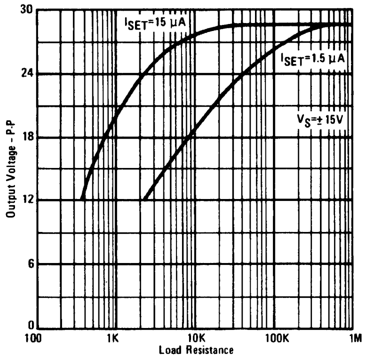
OPTIMUM SET CURRENT FOR MINIMUM
NOISE vs. SOURCE RESISTOR



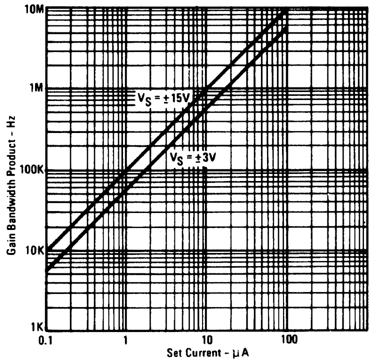
PERFORMANCE CURVES

UNLESS OTHERWISE NOTED: $T_A = +25^oC$, $V_S = \pm 15VDC$

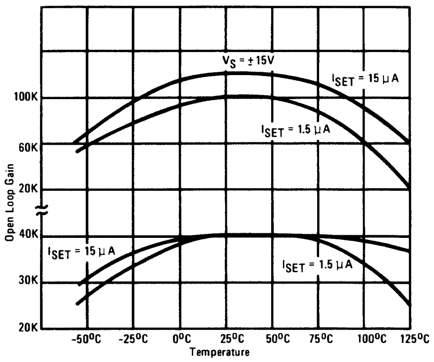
MAXIMUM OUTPUT VOLTAGE SWING vs. LOAD RESISTANCE



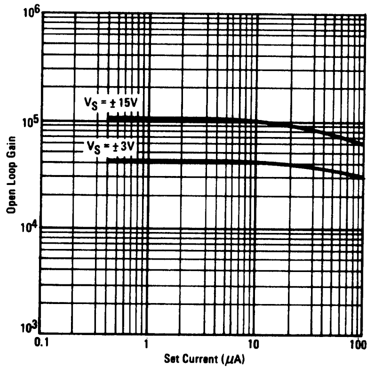
GAIN BANDWIDTH PRODUCT vs. I_{SET}



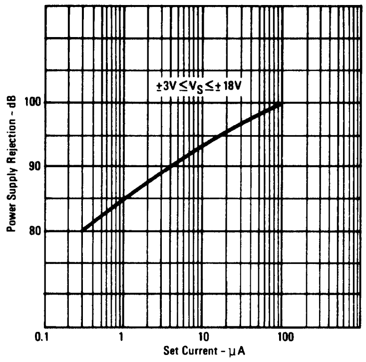
OPEN LOOP VOLTAGE GAIN vs. TEMPERATURE



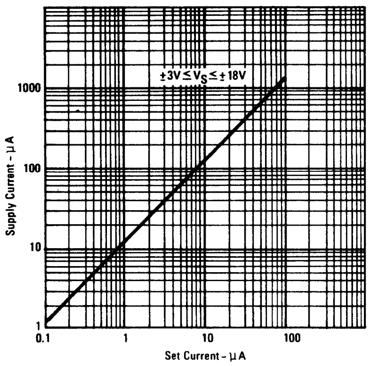
OPEN LOOP VOLTAGE GAIN vs. I_{SET}



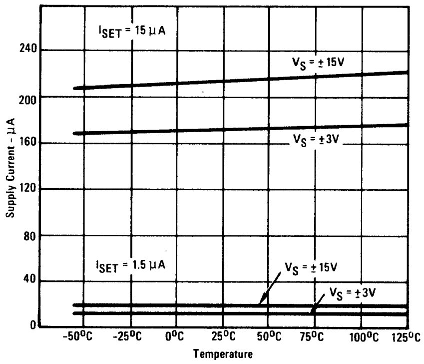
POWER SUPPLY REJECTION vs. I_{SET}



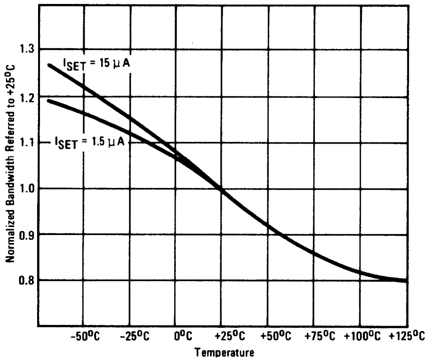
STANDBY SUPPLY CURRENT vs. I_{SET}



SUPPLY CURRENT vs. TEMPERATURE

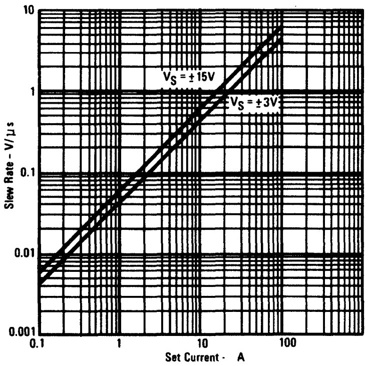


NORMALIZED BANDWIDTH vs. TEMPERATURE

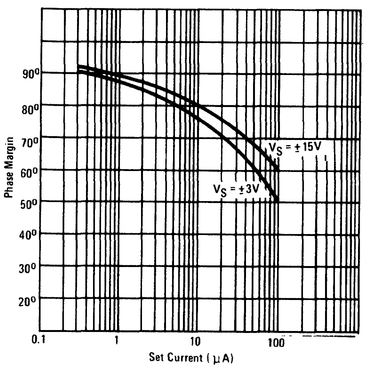


PERFORMANCE CURVES

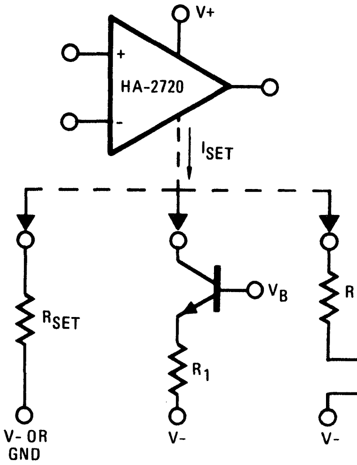
SLEW RATE vs. I_{SET}



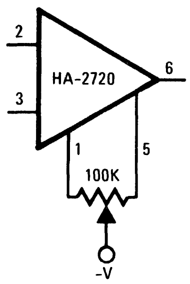
PHASE MARGIN vs. SET CURRENT



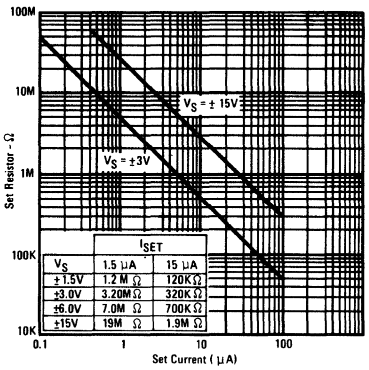
TYPICAL BIASING CIRCUITS



SUGGESTED OFFSET NULL

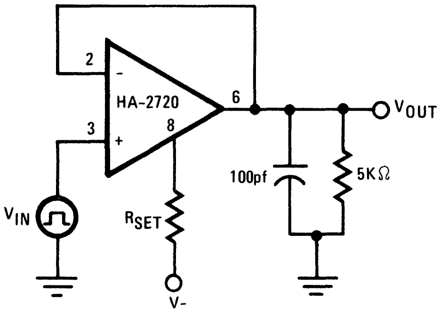


SET CURRENT VS. SET RESISTOR

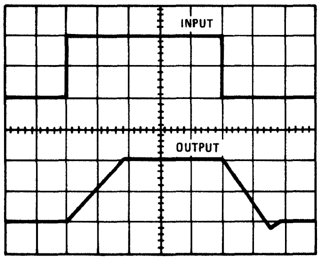


	I_{SET}	
V_S	1.5 µA	15 µA
±1.5V	1.2 M Ω	120K Ω
±3.0V	3.20M Ω	320K Ω
±6.0V	7.0M Ω	700K Ω
±15V	19M Ω	1.9M Ω

TRANSIENT RESPONSE/SLEW RATE CIRCUIT



SLEWING WAVEFORM



VERTICAL: 5V/DIV
HORIZONTAL: 1µS/DIV
I_{SET} = 100µA

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2730/2735

Wide Range Dual Programmable Operational Amplifier

FEATURES

- WIDE RANGE A.C. PROGRAMMING

SLEW RATE:	0.06 TO 6V/µs
GAIN X BANDWIDTH:	5kHz TO 10MHz

- WIDE RANGE D.C. PROGRAMMING

POWER SUPPLY RANGE:	±1.2V TO ±18V
SUPPLY CURRENT:	1µA TO 1.5mA
BIAS CURRENT;	0.4 TO 50nA

- LOW NOISE
- MONOLITHIC CONSTRUCTION
- SHORT CIRCUIT PROTECTION

DESCRIPTION

The HA-2730/2735 Dual Programmable Operational Amplifiers consist of two HA-2720 type op amps on a single monolithic chip. It features the same performance characteristics as the HA-2720/2725 and in addition offers closer thermal tracking, reduced size weight, and greater reliability than two single devices. The HA-2730/2735 is programmed by selecting two external bias resistors or current sources for independent control of each side. Applications such as current controlled oscillators, active filters, modulators and sample and hold circuits can be derived easily by modulating the set current.

The HA-2730 is guaranteed for operation from -55°C to +125°C while the HA-2735 is guaranteed form 0°C to +75°C.

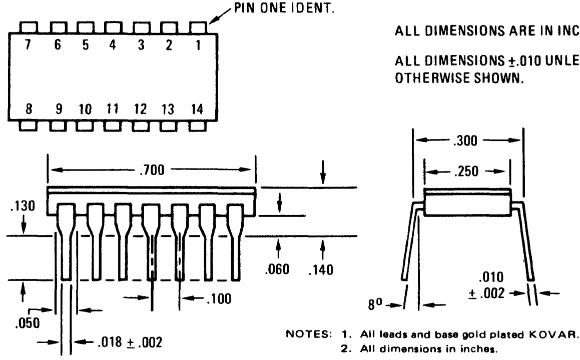
PACKAGE

CODE 1S

14 LEAD BRAZED D.I.P.

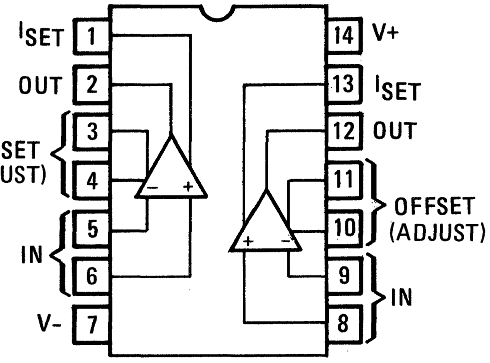
ALL DIMENSIONS ARE IN INCHES.

ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.



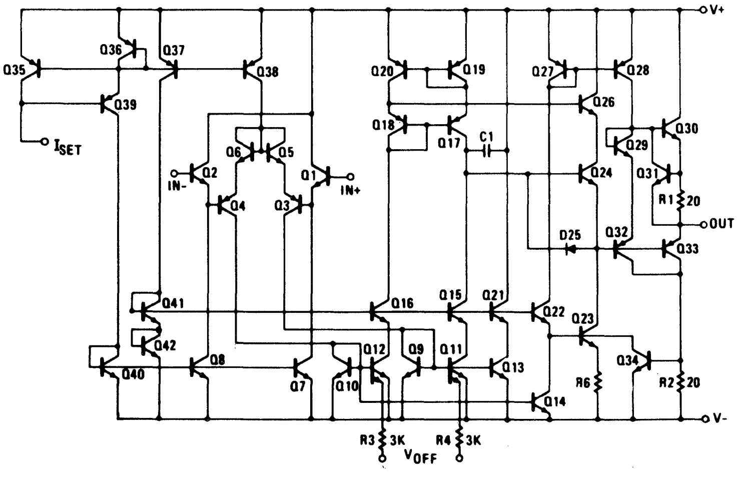
NOTES: 1. All leads and base gold plated KOVAR.
2. All dimensions in inches.

PIN OUT



NOTE: Bottom of package is connected to V-.

SCHEMATIC



(ONE HALF ONLY)
HA-2730/2735

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	45.0V
Differential Input Voltage	±30.0V
Input Voltage (Note 1)	±15.0V
I_{SET} (Current at I_{SET})	500µA
V_{SET} (Voltage to Gnd. at I_{SET})	$V+ - 2.0V \leq V_{SET} \leq V+$
Power Dissipation (Note 2)	500mW
Operating Temperature Range:	
HA-2730	$-55^{\circ}C \leq T_A \leq +125^{\circ}C$
HA-2735	$0^{\circ}C \leq T_A \leq +75^{\circ}C$
Storage Temperature Range	$-65^{\circ}C \leq T_A \leq +150^{\circ}C$

ELECTRICAL CHARACTERISTICS (Each Side)

V+ = +3.0V, V- = -3.0V

		HA-2730 -55°C to +125°C						HA-2735 0°C to +75°C						
		I_{SET} = 1.5µA			I_{SET} = 15µA			I_{SET} = 1.5µA			I_{SET} = 15µA			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS														
*Offset Voltage	25°C		2.0	3.0		2.0	3.0		2.0	5.0		2.0	5.0	mV
	Full			5.0			5.0			7.0			7.0	mV
Offset Current	25°C		0.5	3.0		1.0	10		0.5	5.0		1.0	10	nA
	Full			7.5			20			7.5			20	nA
Bias Current	25°C		2.0	5.0		8.0	20		2.0	10		8.0	30	nA
	Full			10			40			10			40	nA
Input Resistance	25°C		50			5			50			5		MΩ
Input Capacitance	25°C		3.0			3.0			3.0			3.0		pF
TRANSFER CHARACTERISTICS														
*Large Signal Voltage Gain (Notes 3 & 9)	25°C	20K	40K		20K	40K		15K	40K		15K	40K		V/V
	Full	15K			15K			10K			10K			V/V
*Common Mode Rejection Ratio (Note 4)	Full	80			80			74			74			dB
OUTPUT CHARACTERISTICS														
*Output Voltage Swing (Note 3)	25°C	±2.0	±2.2		±2.0	±2.2		±2.0	±2.2		±2.0	±2.2		V
	Full	±2.0			±1.9			±2.0			±2.0			V
Output Current (Note 5)	25°C		±0.2			±2.0			±0.2			±2.0		mA
Output Resistance	25°C		2K			500			2K			500		Ω
Output Short-Circuit Current	25°C		2.8			14			2.8			14		mA
TRANSIENT RESPONSE														
Rise Time (Note 6)	25°C		2.5			0.25			2.5			0.25		µs
Overshoot (Note 6)	25°C		5			10			5			10		%
Slew Rate (Note 7)	25°C		0.07			0.70			0.07			0.70		V/µs
POWER SUPPLY CHARACTERISTICS														
*Supply Current (Each Amp)	25°C		15			170			15			170		µA
	Full			20			200			20			200	µA
*Power Supply Rejection Ratio (Note 8)	Full	100			100			150			150			µV/V

*100% Tested For DASH 8

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (Each Side)

V+ = +15.0V, V- = -15.0V

		HA-2730 -55°C to +125°C						HA-2735 0°C to +75°C						
		I_{SET} = 1.5μA			I_{SET} = 15μA			I_{SET} = 1.5μA			I_{SET} = 15μA			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS														
*Offset Voltage	25°C		2.0	3.0		2.0	3.0		2.0	5.0		2.0	5.0	mV
	Full			5.0			5.0			7.0			7.0	mV
*Offset Current	25°C		0.5	3.0		1.0	10		0.5	5.0		1.0	10	nA
	Full			7.5			20			7.5			20	nA
*Bias Current	25°C		2.0	5.0		8.0	20		2.0	10		8.0	30	nA
	Full			10			40			10			40	nA
Input Resistance	25°C		50			5			50			5		MΩ
Input Capacitance	25°C		3.0			3.0			3.0			3.0		pF
TRANSFER CHARACTERISTICS														
*Large Signal Voltage Gain (Notes 3 & 9)	25°C	40K	100K		40K	120K		25K	100K		25K	120K		V/V
	Full	25K			25K			20K			20K			V/V
*Common Mode Rejection Ratio (Note 4)	25°C		90			90			90			90		dB
	Full	80			80			74			74			dB
OUTPUT CHARACTERISTICS														
*Output Voltage Swing (Note 3)	25°C	±12	±13.5		±12	±13.5		±12	±13.5		±12	±13.5		V
	Full	±10			±10			±10			±10			V
Output Current (Note 5)	25°C		±0.5			±5.0			±0.5			±5.0		mA
Output Resistance	25°C		2K			500			2K			500		Ω
Output Short-Circuit Current	25°C		3.7			19			3.7			19		mA
TRANSIENT RESPONSE														
Rise Time (Note 6)	25°C		2.0			0.2			2.0			0.2		μs
Overshoot (Note 6)	25°C		5			15			5			15		%
Slew Rate (Note 7)	25°C		0.1			0.8			0.1			0.8		V/μs
POWER SUPPLY CHARACTERISTICS														
*Supply Current (Each Amp)	25°C		20			210			20			210		μA
	Full			25			250			25			250	μA
*Power Supply Rejection Ratio (Note 8)	Full	100			100			150			150			μV/V

NOTES:
1. For supply voltages less than ±15.0V, the absolute maximum input voltage is equal to supply voltage.
2. Derate at 4.7mW/°C at ambient temperatures above 68°C.

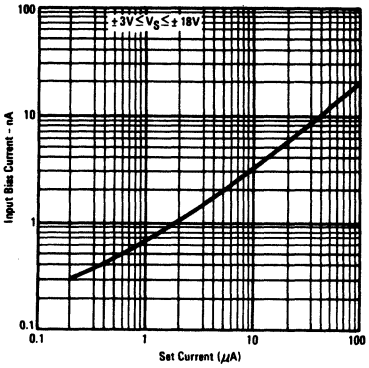
	V_{SUPPLY} = ±3.0V	V_{SUPPLY} = ±15.0V	I_{SET} = 1.5μA	I_{SET} = 15μA
3.	T = +25°C and Full	T = +25°C	R_L = 75KΩ	R_L = 5KΩ
	—	T = Full	R_L = 75KΩ	R_L = 75KΩ
4.	V_{CM} = ±1.5V	V_{CM} = ±5.0V		
5.	V_O = ±2.0V	V_O = ±10.0V		
6.	← A_V = +1, V_{IN} = 400mV, R_L = 5K, C_L = 100pF →			
7.	V_O = ±2.0V	V_O = ±10.0V	R R_L = 20K	R_L = 5K
8.	ΔV = ±1.5V	ΔV = ±5.0V		
9.	V_O = ±1.0V	V_O = ±10.0V		

*100% Tested For DASH 8

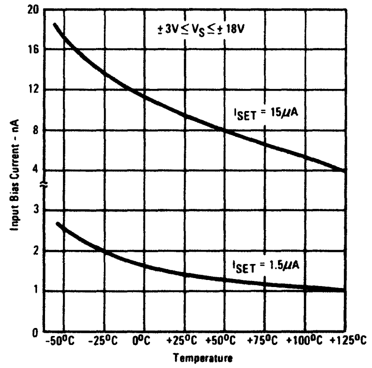
PERFORMANCE CURVES

UNLESS OTHERWISE NOTED: $T_A = 25^oC$, $V_S = \pm15VDC$

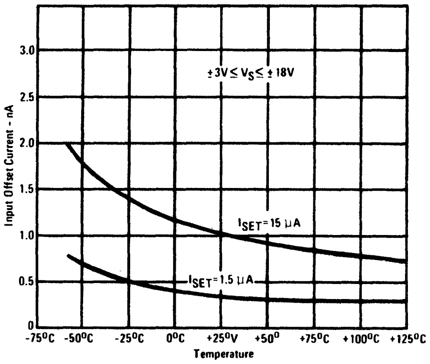
INPUT BIAS CURRENT vs. SET CURRENT



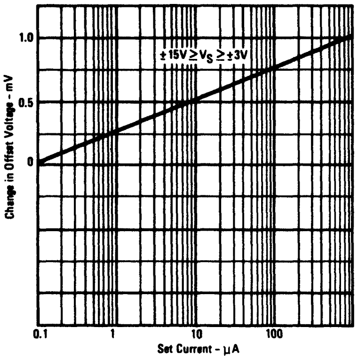
INPUT BIAS CURRENT vs. TEMPERATURE



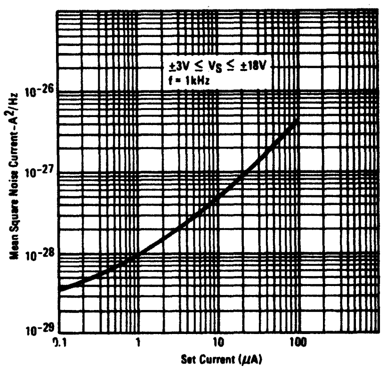
INPUT OFFSET CURRENT vs. TEMPERATURE



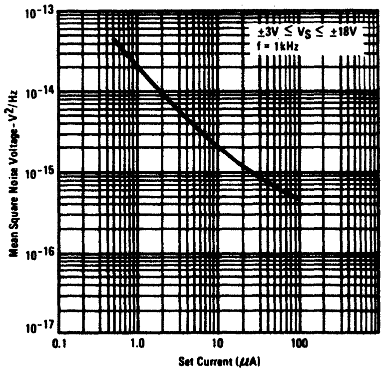
CHANGE IN OFFSET VOLTAGE vs. I_{SET} (UNNULLED)



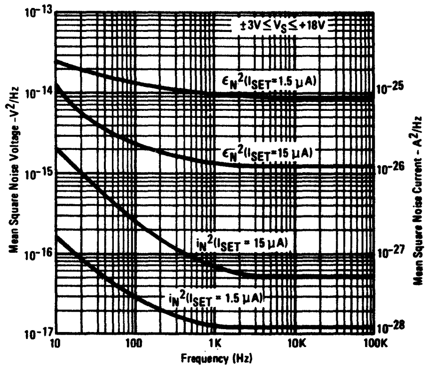
INPUT NOISE CURRENT vs. I_{SET}



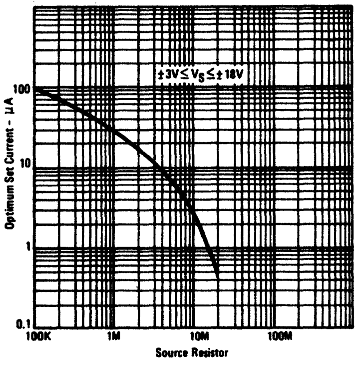
INPUT NOISE VOLTAGE vs. I_{SET}



INPUT NOISE VOLTAGE AND CURRENT vs. FREQUENCY



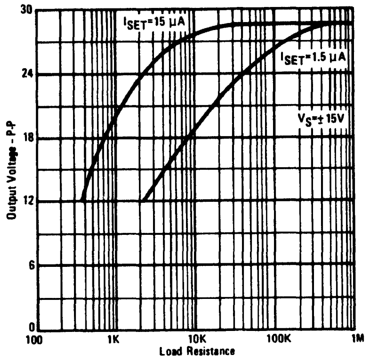
OPTIMUM SET CURRENT FOR MINIMUM NOISE vs. SOURCE RESISTOR



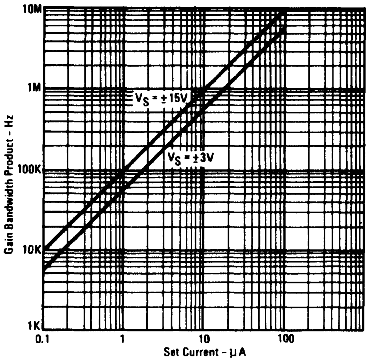
PERFORMANCE CURVES

UNLESS OTHERWISE NOTED: $T_A = 25^oC$, $V_S = \pm 15VDC$

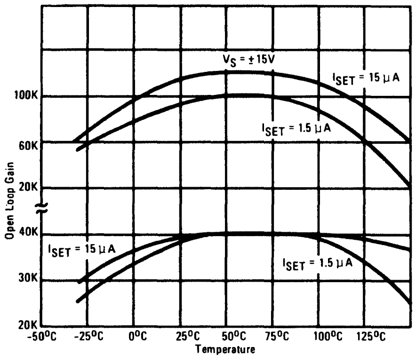
MAXIMUM OUTPUT VOLTAGE SWING vs. LOAD RESISTANCE



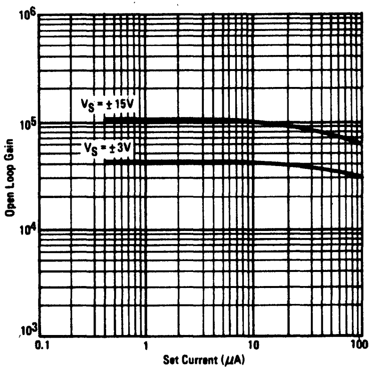
GAIN BANDWIDTH PRODUCT vs. I_{SET}



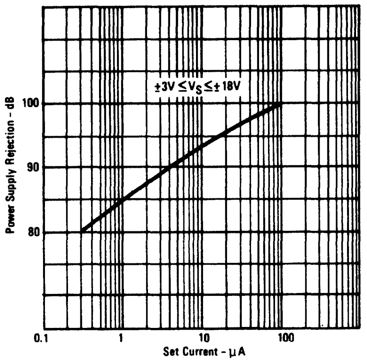
OPEN LOOP VOLTAGE GAIN vs. TEMPERATURE



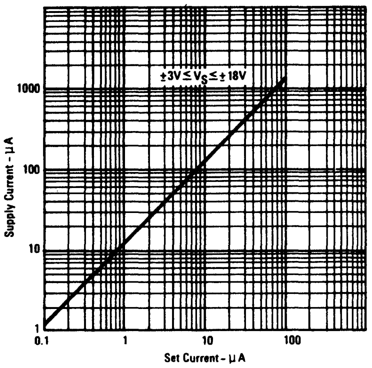
OPEN LOOP VOLTAGE GAIN vs. I_{SET}



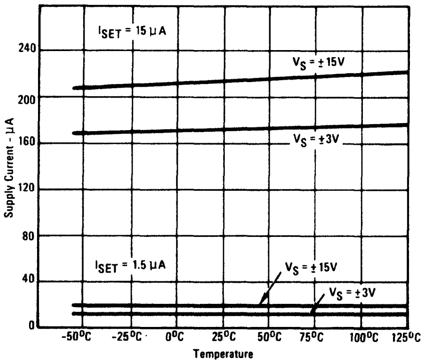
POWER SUPPLY REJECTION vs. I_{SET}



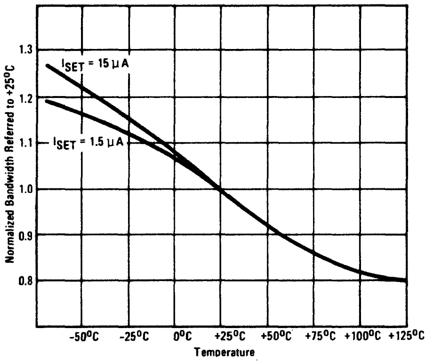
STANDBY SUPPLY CURRENT vs. I_{SET}



SUPPLY CURRENT vs. TEMPERATURE

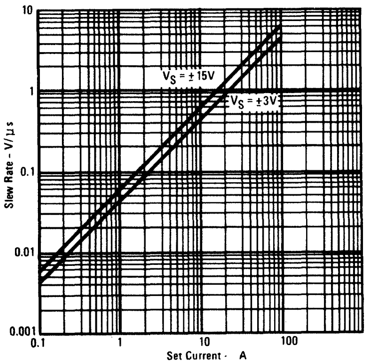


NORMALIZED BANDWIDTH vs. TEMPERATURE

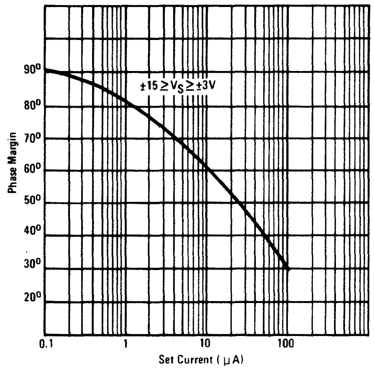


PERFORMANCE CURVES

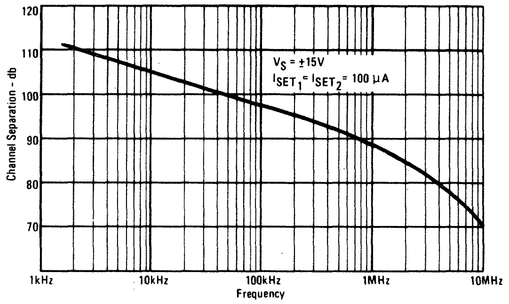
SLEW RATE vs. I_{SET}



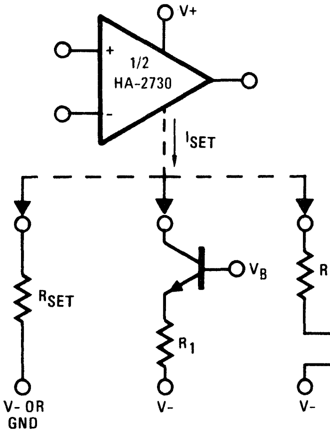
PHASE MARGIN vs. SET CURRENT



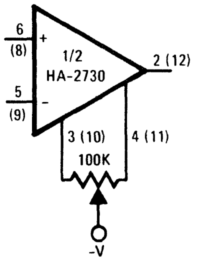
CHANNEL SEPARATION vs. FREQUENCY



TYPICAL BIASING CIRCUITS

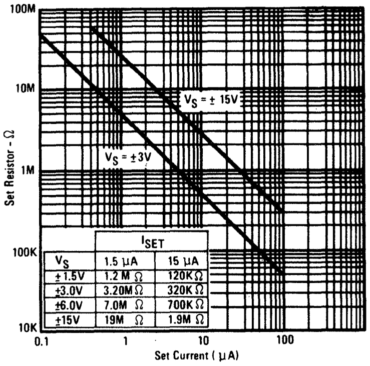


SUGGESTED OFFSET NULL



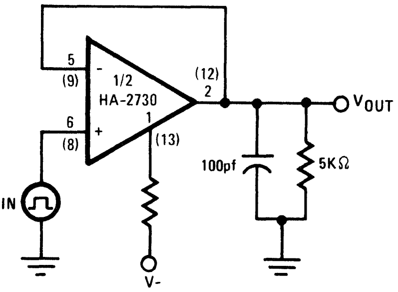
NOTE: Numbers in parenthsis refer to the second half.

SET CURRENT VS. SET RESISTOR



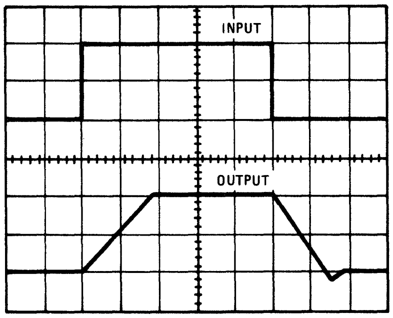
	I_{SET}	
V_S	1.5 µA	15 µA
±1.5V	1.2 M Ω	120K Ω
±3.0V	3.20M Ω	320K Ω
±6.0V	7.0M Ω	700K Ω
±15V	19M Ω	1.9M Ω

TRANSIENT RESPONSE/SLEW RATE CIRCUIT



NOTE: Numbers in parenthsis refer to the second half.

SLEWING WAVEFORM



VERTICAL: 5V/DIV
HORIZONTAL: 1µS/DIV
I_{SET} = 100µA

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2820/2825

Phase Locked Loop

FEATURES

- FREQUENCY RANGE 0.01 Hz TO 3 MHz
- INDEPENDENT PHASE DETECTOR AND OSCILLATOR FOR VERSATILITY
- TWO ISOLATED PHASE DETECTOR OUTPUTS
- DTL/TTL COMPATIBLE OSCILLATOR OUTPUT
- OSCILLATOR STABILITY: 100ppm/°C, .01%/VOLT

DESCRIPTION

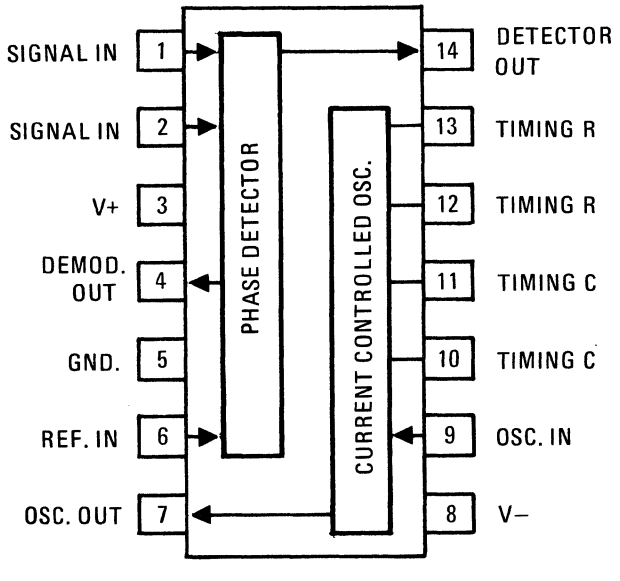
The HA-2820/2825 Phase Locked Loop is useful for many operations in the frequency domain in the sub-audio to low R.F. bands. It features a number of functional and parametric improvements over other similar monolithic circuits.

A major feature is a high impedance current source phase detector output with provisions for external connection to the oscillator input which is a low impedance current sink. This allows connection of complex passive or active filters, amplifiers, sweep circuits, etc. within the loop. Also, the two phase detector outputs are isolated from one another so that different filter functions can be connected at the two outputs without interaction. The capability of independently adjusting loop bandwidth and demodulated output bandwidth allows phase modulation detectors to be constructed.

Applications include modulators and demodulators for F.M., phase modulation, and F.S.K.; frequency multiplication; data synchronization; tracking filters; and speed controls.

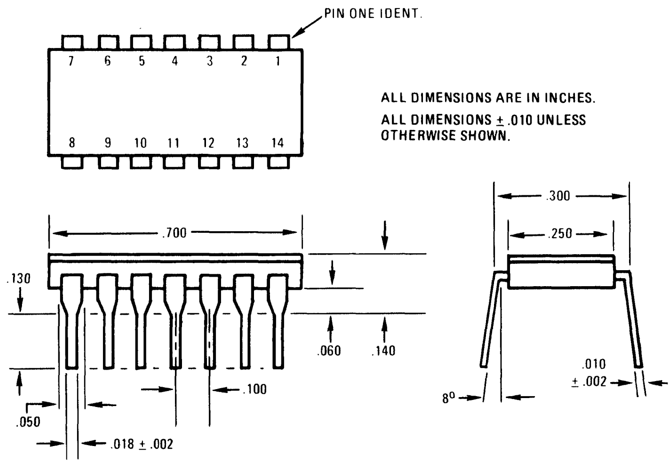
FUNCTIONAL DIAGRAM

(TOP VIEW)



PACKAGE

CODE 1S 14 LEAD BRAZED D.I.P.



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals	27.0V	Power Dissipation	300mW (Note 3)
Input Voltage	2 VRMS	Operating Temperature	
		HA-2820	$-55^{\circ}C > T_A > +125^{\circ}C$
		HA-2825	$0^{\circ}C > T_A > +75^{\circ}C$
Output Current, Pin 7	10mA	Storage Temperature	· $-65^{\circ}C > T_A > +150^{\circ}C$

ELECTRICAL CHARACTERISTICS

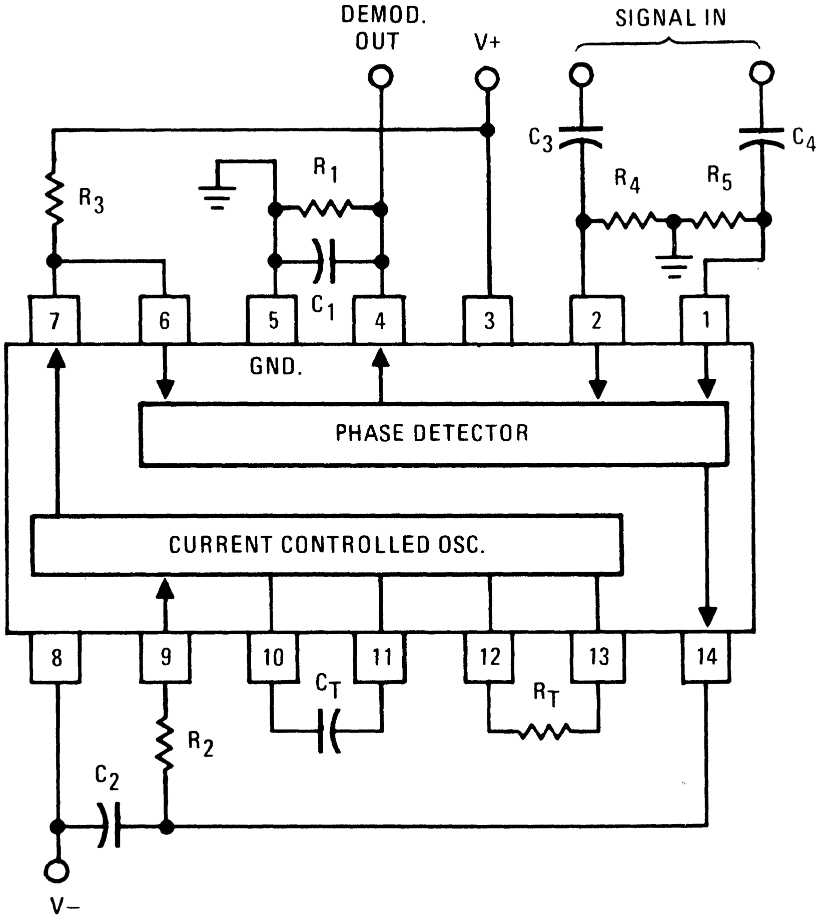
V+ = +6.0V V_{IN} = 100mV RMS
V- = -6.0V $F_0 \approx$ 50kHz
Pin 5 = Ground See Test Circuit, Page 3

Unless otherwise specified

PARAMETER	TEMP.	HA-2820 -55°C to +125°C LIMITS			HA-2825 0°C to +75°C LIMITS			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
PHASE DETECTOR								
Input Impedance, Pins 1 - 2	+25°C		100K			100K		Ω
Input Voltage Range, Pins 1 - 2 (Note 1)	Full	10	5		10	5		mV RMS
Output Impedance, Pins 4 & 14	+25°C		10			10		MΩ
Output Offset Current, Pins 4 & 14	+25°C		10	15		10	15	μA
Output Offset Current, Pins 4 & 14	Full			20			20	μA
Conversion Gain, Pins 4 & 14	+25°C		50			50		μA/Radian
CURRENT CONTROLLED OSCILLATOR								
Maximum Frequency	Full	3	5		3	5		MHz
Frequency Drift	Full		100			100		ppm/°C
Frequency Change with Supply Voltage (Note 4)	Full		.01			.01		%/V
Input Resistance, Pin 9	+25°C		500			500		Ω
Input Open Circuit Voltage, Pin 9	+25°C		-3.5			-3.5		V
Conversion Gain	+25°C		1.0			1.0		% Δf/μA
Output Voltage, High	+25°C	+1.9			+1.9			V
Output Voltage, Low	+25°C			+0.4			+0.4	V
Output Rise Time	+25°C		100			100		ns
Output Fall Time	+25°C		125			125		ns
CLOSED LOOP CHARACTERISTICS								
Loop Gain	+25°C		50			50		% Δf/Radian
Tracking Range	+25°C		50			50		%Δf
Demod. Output Swing, Pin 4	+25°C		±700			±700		mV
Frequency Drift	Full		100			100		ppm/°C
POWER SUPPLY CHARACTERISTICS								
Supply Current, V+	Full		3	5		3	5	mA
Supply Current, V-	Full		7	10		7	10	mA
Supply Voltage Range (Notes 2, 3)	Full	±6		±12	±6		±12	V

NOTES 1. For ± 10% tracking range.
2. +5.0V, -7.0V may be used alternatively.
3. Derate power dissipation by 6.6mW/°C above +105°C ambient temperature.
4. $\Delta V_S = \pm 2V$

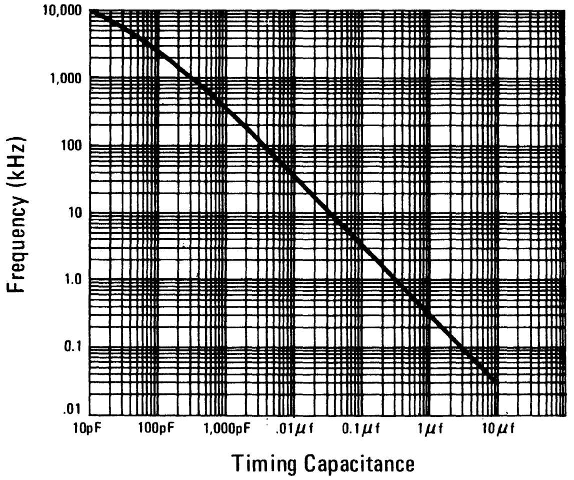
TEST CIRCUIT



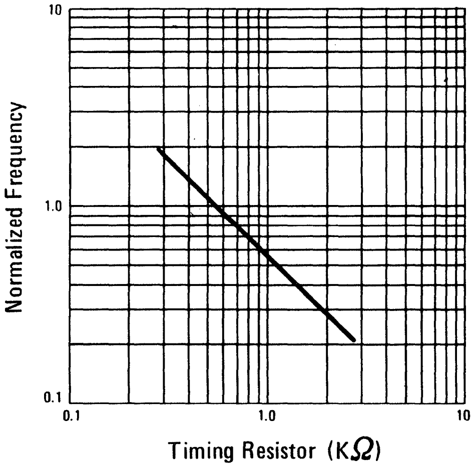
Unless otherwise specified: V+ = +6.0V; V– = -6.0V; $R_1 = R_3 = 10K\Omega$; $R_2 = 1K\Omega$; $R_4 = R_5 = 300\Omega$; $R_T = 540\Omega$; $C_1 = .015\mu f$; $C_2 = C_3 = C_4 = 0.1\mu f$; $C_T = 0.01\mu f$ ($f_0 \approx 50kHz$); V_{IN} = 100mV RMS; $T_A = +25^oC$

PERFORMANCE CURVES

CENTER FREQUENCY, f_0 vs.
TIMING CAPACITOR, C_T ($R_T = 540\Omega$)

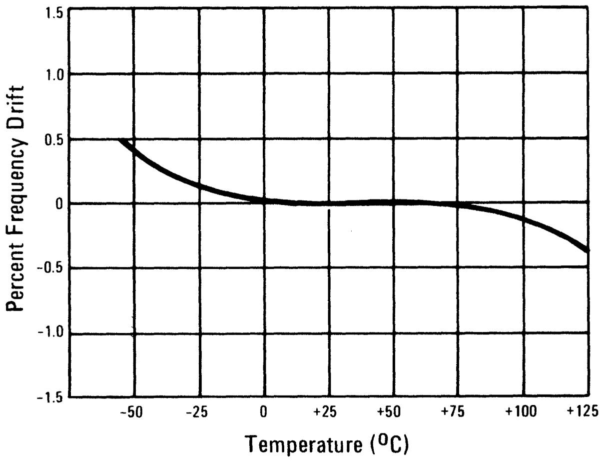


CENTER FREQUENCY, f_0 vs.
TIMING RESISTOR, R_T ($C_T = .01\mu f$)

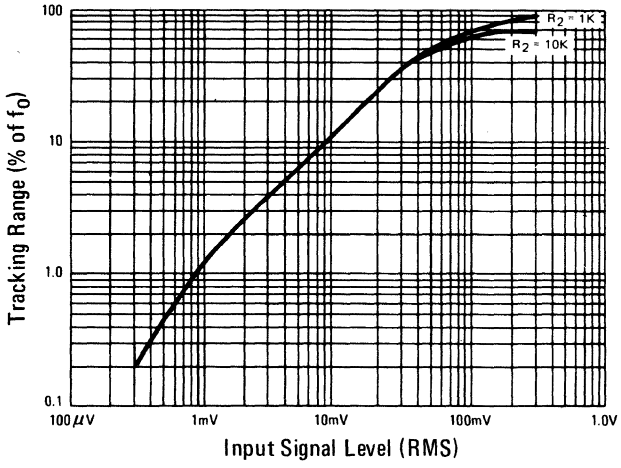


PERFORMANCE CURVES *(continued)*

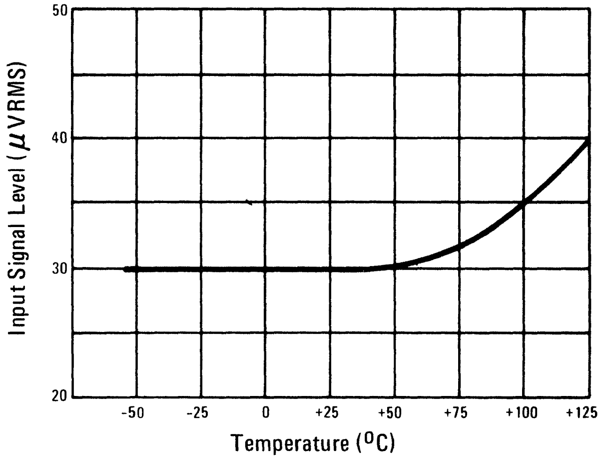
CENTER FREQUENCY DRIFT
vs. TEMPERATURE



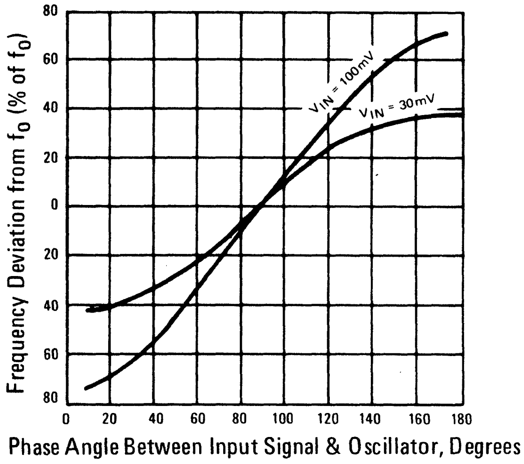
TRACKING RANGE vs. INPUT SIGNAL LEVEL



MINIMUM SIGNAL TO MAINTAIN LOCK

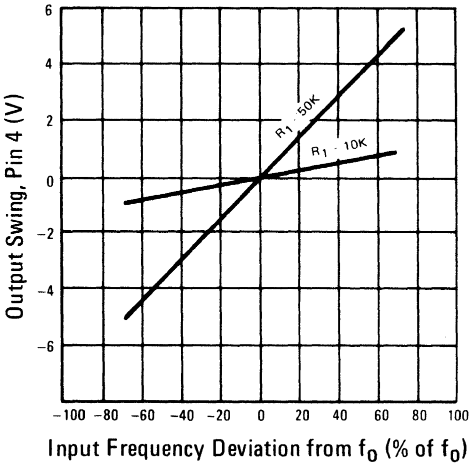


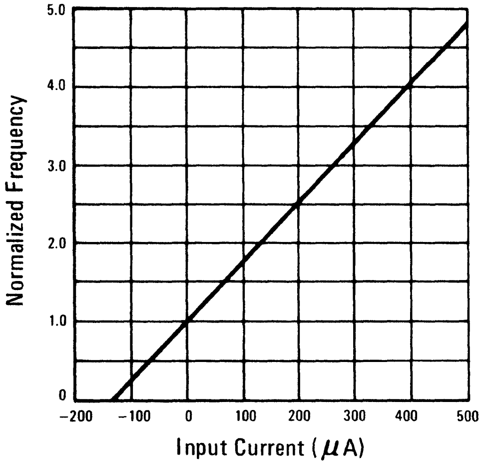
LOOP GAIN CHARACTERISTIC



DEMODULATED OUTPUT SWING

OSCILLATOR FREQUENCY
vs. INPUT CURRENT, PIN 9 (f_0 = 50kHz)





HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2900/2904/2905

Chopper Stabilized Operational Amplifier

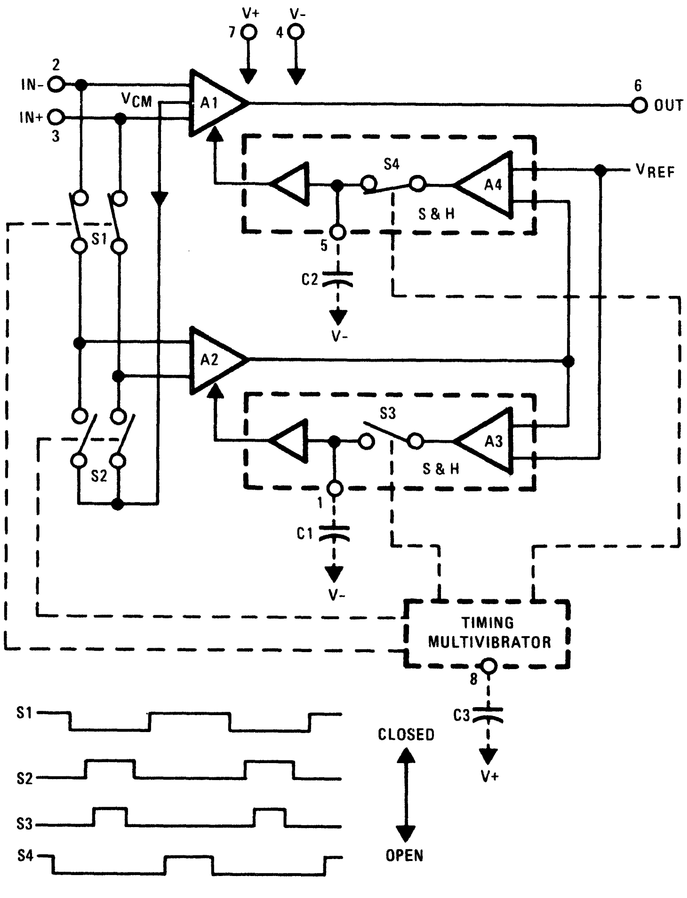
FEATURES

● OFFSET VOLTAGE DRIFT:	0.2μV/°C
● OFFSET CURRENT DRIFT:	1pA/°C
● OPEN LOOP GAIN:	5 X 10^8
● BANDWIDTH:	3MHz
● SLEW RATE:	2.5V/μS
● TRUE DIFFERENTIAL INPUTS	

DESCRIPTION

The HA-2900/2904/2905 is the first monolithic chopper stabilized operational amplifier. It features superior offset drift characteristics, extremely low input currents, and excellent AC performance. Its inputs are symmetrical and differential, meaning that the device may be operated in any op amp feedback configuration; inverting, non-inverting, or balanced. Applications include high gain DC instrumentation, precision integrators, and as a substitute for other op amps wherever much lower errors without external adjustments are required. The device is packaged in a hermetic can with standard pin out, and requires only three external capacitors for operation.

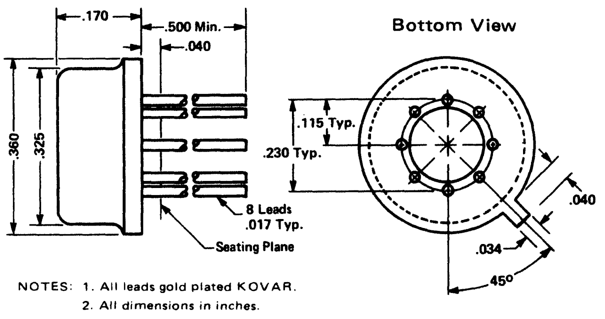
FUNCTIONAL DIAGRAM



PACKAGE

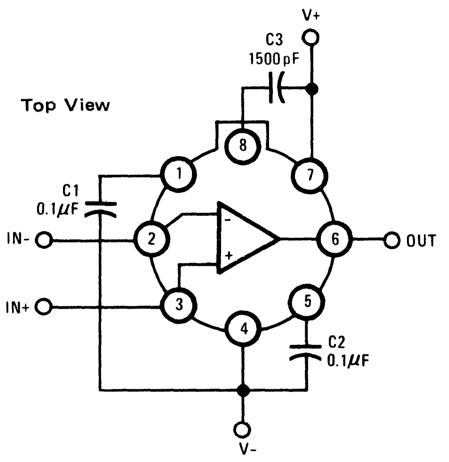
CODE 2A TO-99

ALL DIMENSIONS ARE IN INCHES
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.



NOTES: 1. All leads gold plated KOVAR.
2. All dimensions in inches.

PIN OUT AND SUGGESTED HOOKUP



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V+ and V- Terminals 42.0V
Differential Input Voltage (Note 1) ±15V
Output Current/Full Short Circuit Protection
Internal Power Dissipation 300mW*

Operating Temperature Range $-55^{\circ}C \leq T_A \leq +125^{\circ}C$ (HA-2900)
$-25^{\circ}C \leq T_A \leq +85^{\circ}C$ (HA-2904)
$0^{\circ}C \leq T_A \leq +75^{\circ}C$ (HA-2905)
Storage Temperature Range $-65^{\circ}C \leq T_A \leq +150^{\circ}C$

*Derate by 6.6mW/°C above +105°C

ELECTRICAL CHARACTERISTICS

Test Conditions: C1 = C2 = 0.1µF, C3 = 1500pF, V_{Supply} = ±15.0V unless otherwise specified.

		HA-2900 -55°C to +125°C			HA-2904 -25°C to +85°C			HA-2905 0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS											
*Offset Voltage	+25°C		20			20			20		µV
	Full			60			50			80	µV
Offset Voltage Average Drift	Full		0.3	0.6		0.2	0.4		0.2		µV/°C
*Bias Current	+25°C		150			150			150		pA
	Full			1,000			1,000			1,000	pA
*Offset Current	+25°C		50			50			50		pA
	Full			500			500			500	pA
Offset Current Average Drift	Full		1	4		1	3		1		pA/°C
Input Resistance	+25°C		100			100			100		MΩ
Input Capacitance	+25°C		10			10			10		pF
Common Mode Range	Full	±10			±10			±10			V
TRANSFER CHARACTERISTICS											
*Large Signal Voltage Gain (Note 2)	+25°C		5×10^8			5×10^8			5×10^8		V/V
	Full	10^6			10^7			10^6			V/V
Chopper Frequency	+25°C		750			750			750		Hz
*Common Mode Rejection Ratio (Note 3)	Full	120	160		130	160		120	160		dB
Gain Bandwidth Product (Note 4)	+25°C		3			3			3		MHz
OUTPUT CHARACTERISTICS											
*Output Voltage Swing (Note 2)	Full	±10	±12		±10	±12		±10	±12		V
*Output Current	+25°C	±10			±10			±7			mA
Output Resistance	Full		200			200			200		Ω
Full Power Bandwidth (Note 5)	+25°C		40			40			40		kHz
TRANSIENT RESPONSE (NOTES 2, 8, and 9)											
Rise Time (Note 6)	+25°C		200			200			200		ns
Overshoot (Note 6)	+25°C		20			20			20		%
Slew Rate (Note 5)	+25°C		2.5			2.5			2.5		V/µs
POWER SUPPLY CHARACTERISTICS											
*Supply Current	+25°C		3.5	5.0		3.5	5.0		3.5	5.0	mA
*Supply Voltage Range	Full	±12		±20	±10		±20	±12		±20	V
*Power Supply Rejection Ratio (Note 7)	Full	120	160		130	160		120	160		dB

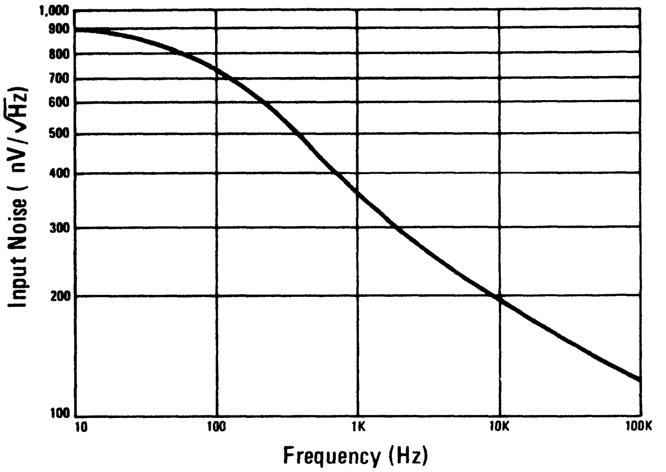
NOTES:
1. Input terminals should be protected against static discharge during handling and installation. Input voltage should never exceed supply voltages.
2. R_L = 2K
3. V_{CM} = ±5.0V
4. A_V = 10
5. V_O = ±10V
6. V_O = ±200mV
7. ΔV_S = ±5V
8. C_L = 50pF
9. A_V = +1 See transient response test circuits and waveforms, page 4.

*100% Tested For DASH 8

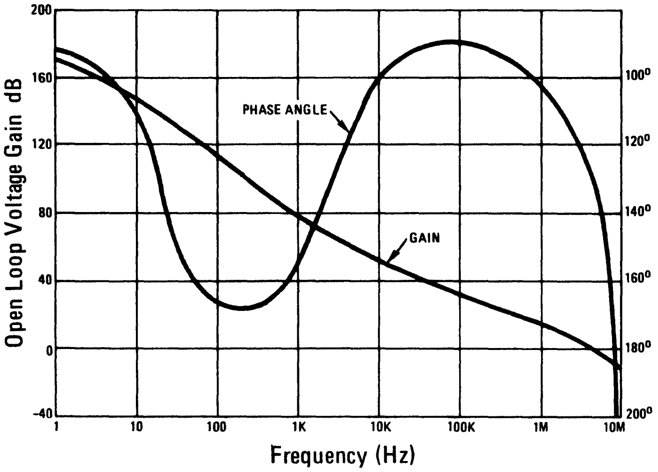
PERFORMANCE CURVES

V+ = V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED

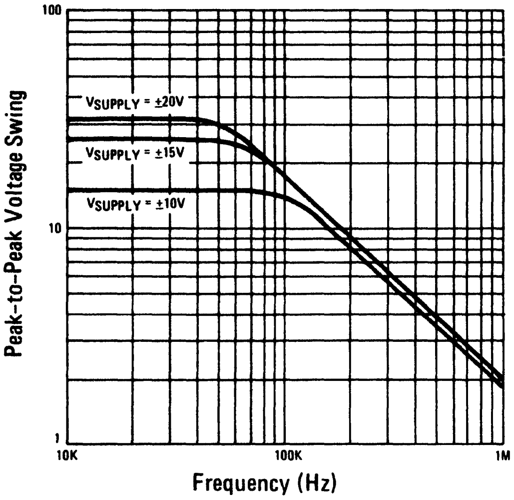
INPUT VOLTAGE NOISE



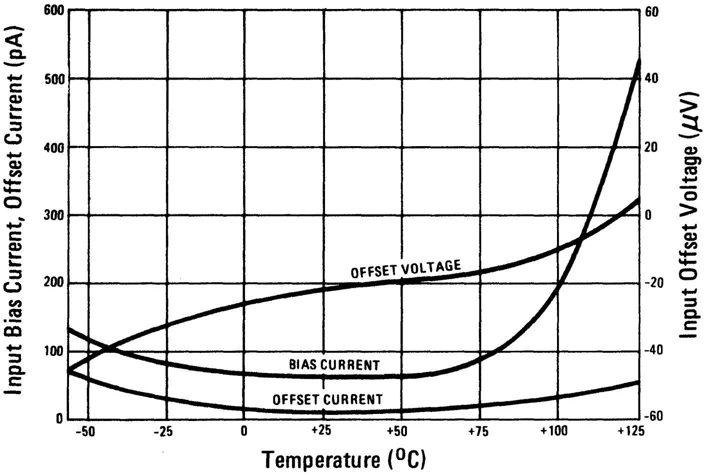
OPEN LOOP FREQUENCY AND PHASE RESPONSE



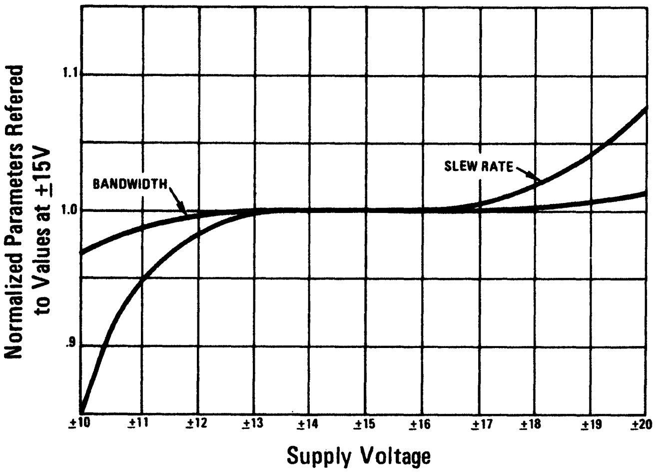
OUTPUT VOLTAGE SWING vs. FREQUENCY



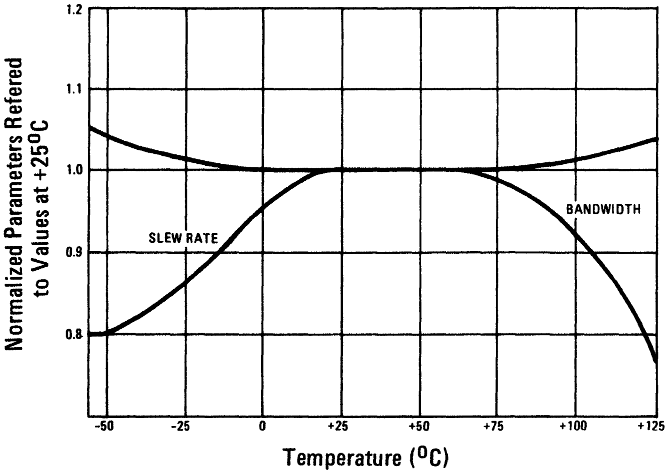
TYPICAL INPUT CHARACTERISTICS vs. TEMPERATURE



NORMALIZED A.C. PARAMETERS vs. SUPPLY VOLTAGE

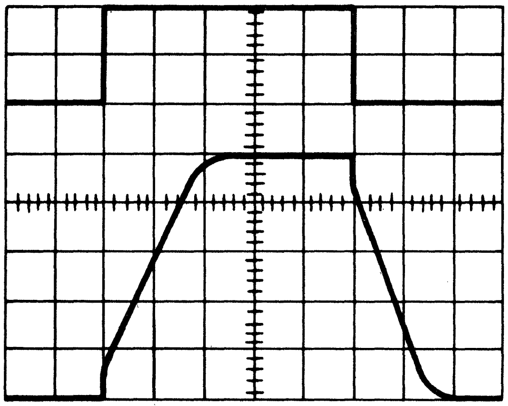


NORMALIZED A.C. PARAMETERS vs. TEMPERATURE



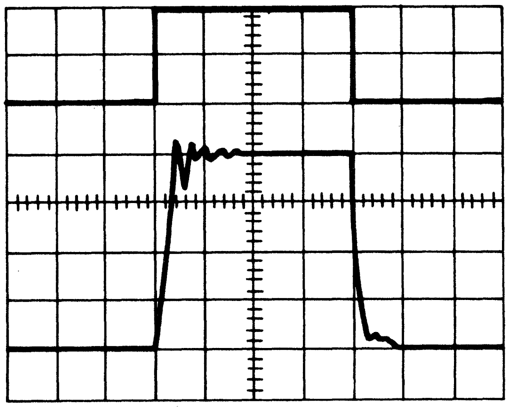
PERFORMANCE CURVES (continued)

VOLTAGE FOLLOWER
SLEWING WAVEFORM



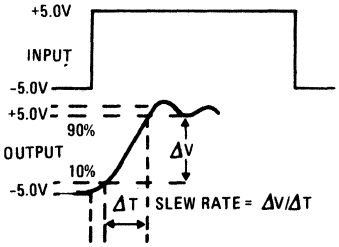
Upper Trace: Input: 5V/Div.
Lower Trace: Output; 2V/Div.
Horizontal: 2μS/Div.

VOLTAGE FOLLOWER
TRANSIENT RESPONSE WAVEFORM

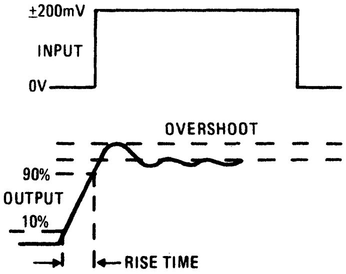


Upper Trace: Input; 100mV/Div.
Lower Trace: Output; 50mV/Div.
Horizontal: 500ns/Div.

SLEW RATE

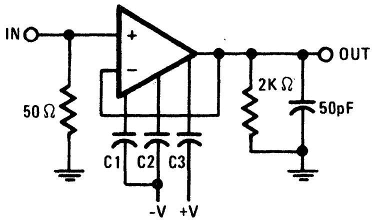


TRANSIENT RESPONSE



NOTE: Measured on both positive and negative transitions.

SLEW RATE AND
TRANSIENT RESPONSE



APPLICATION TIPS

(1) Device inputs should be protected against exceeding either supply voltage from static discharge or inadvertent connection, particularly when wired directly to a connector or instrument panel.

(2) External capacitors C1, C2, and C3 should have good temperature stability, low leakage, and low dielectric absorption. Polystyrene (below +85°C), teflon types or polycarbonate are recommended. C3 could also be silver mica.

(3) Particular care must be exercised in system layout and material and component selection to realize the full performance potential of the HA-2900/2904/2905. External sources of drift error may include the thermocouple and electrochemical EMF's generated at junctions of dissimilar metals, leakage across insulating materials, static charges created by moving air, and improper grounding and shielding practices.

(4) Chopper noise is present chiefly as a common mode input current signal, and may be minimized by matching the impedances at the two inputs. Random noise may be reduced at the expense of bandwidth using active or passive filtering.

(5) Input frequencies near the chopper frequency (750Hz) or its harmonics may result in small components of difference frequency in the output. This effect should be checked in the individual application, and if objectionable, a low pass filter may be added in series with the input.

(6) When operating at closed loop gains between 70dB and 140dB, compensation networks may be required, because of open loop phase shift in this gain region. In most cases, a capacitor placed in parallel with the feedback resistor to yield a gain-bandwidth product < 2MHz will be sufficient.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HD-0165

Keyboard Encoder

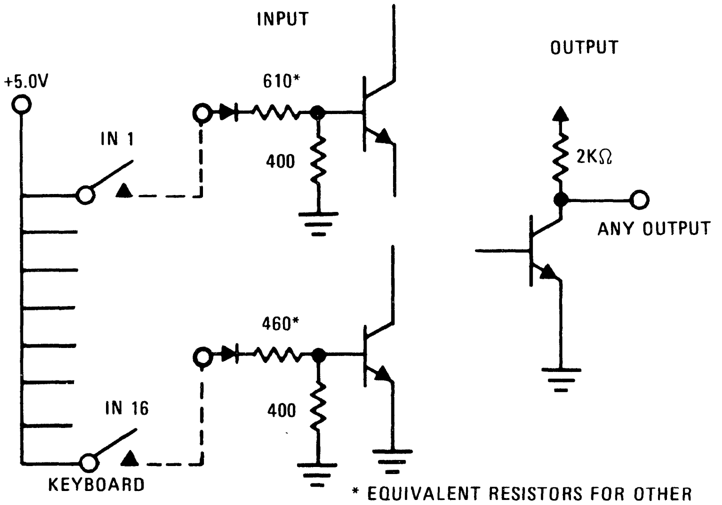
FEATURES

- STROBE OUTPUT
- KEY ROLLOVER OUTPUT
- EXPANDABLE: 2 PACKAGES REQUIRED FOR FULL TELETYPEWRITER, EIGHT-BIT ENCODING
- SINGLE +5.0V SUPPLY REQUIRED, DTL/TTL OUTPUTS
- MONOLITHIC RELIABILITY

GENERAL DESCRIPTION

The HD-0165 Keyboard Encoder is a 16 line to four-bit parallel encoder intended for use with manual data entry devices such as calculator or typewriter keyboards. In addition to the encoding function, there is a Strobe output and a Key Rollover output which energizes whenever two or more inputs are energized simultaneously. Any four-bit code can be implemented by proper wiring of the input lines. Inputs are normally wired through the key switches to the +5.0V power supply. Full typewriter keyboard encoding up to eight bits can be accomplished with two Encoder circuits by the use of double pole key switches or single pole switches with two isolation diodes per key. Outputs will interface with all popular DTL and TTL logic families. The circuit is packaged in a hermetic 24-pin dual in-line package and operates over the temperature range of 0°C to +75°C.

EQUIVALENT CIRCUITS

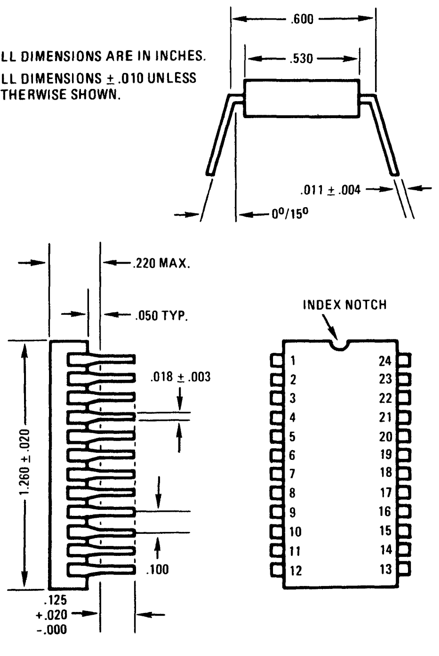


* EQUIVALENT RESISTORS FOR OTHER INPUTS ARE BETWEEN THESE TWO VALUES

PACKAGE

CODE 1J 24 LEAD CERAMIC D. I. P.

ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+7.0V	Output Current	30mA
Input Voltage	+5.5V	Storage Temperature	-65^{0} to $+150^{0}$C
Output Voltage	+5.5V	Operating Temperature (Case)	0^{0}C to $+75^{0}$C

ELECTRICAL CHARACTERISTICS

Test Conditions: $V_{CC} = +5.0V \pm 5\%$
$T_{Case} = 0^{0}C$ to $+75^{0}C$
Unless otherwise specified

	PARAMETER	SYM.	LIMITS			UNITS	TEST CONDITIONS
			MIN.	TYP.	MAX.		
	Input Current "1"	I_{IH}			17	mA	$V_{IN} = +5.0V$
D.C.	Output Voltage "0"	V_{OL}		+0.2	+0.4	V	$V_{IH} = +4.5V$ $I_{OL} = 10mA$
					+0.4		$V_{IH} = +3.5V$ $I_{OL} = 3.2mA$
	Output Voltage "1"	V_{OH}	+2.4	+4.0			V_{IL} = Open Circuit, $I_{OH} = -240\mu A$
	Power Supply Current Operating	I_{CC}			52	mA	One Input at +5.25V
	Power Supply Current Maximum	I_{CCM}			88	mA	All Inputs at +5.25V
A.C.	Skew Time (Note 1)	T_{SK}		80	200	ns	$T_{Case} = 25^{0}C$ $V_{CC} = V_{IN} = +5.0V$ $C_L < 50pF$

NOTE: (1) Skew time is the maximum time differential between propagation delay times of any outputs including strobe and $\overline{K_{RO}}$.

TRUTH TABLE

INPUTS																OUTPUTS					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	$\overline{St.}$	$\overline{K_{RO}}$
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H
H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	L	H
L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	H
L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	H	H	L	H
L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	H
L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	H	H	L	H	L	H
L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	H	L	H	L	H
L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	H	L	L	H	L	H
L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	H	L	H
L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	H	H	L	L	H
L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	H	L	L	H
L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	H	L	H	L	L	H
L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	H	L	L	H
L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	H	H	L	L	L	H
L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	H	L	L	L	H
L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	H	L	L	L	L	H
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	H
ANY TWO OR MORE HIGH																X	X	X	X	L	L

INPUTS: L = Open Circuit or < +1.0V H = > +4.5V Current Source
OUTPUTS: L = < +0.4V H = > +2.4V X = Erroneous Data

APPLICATIONS

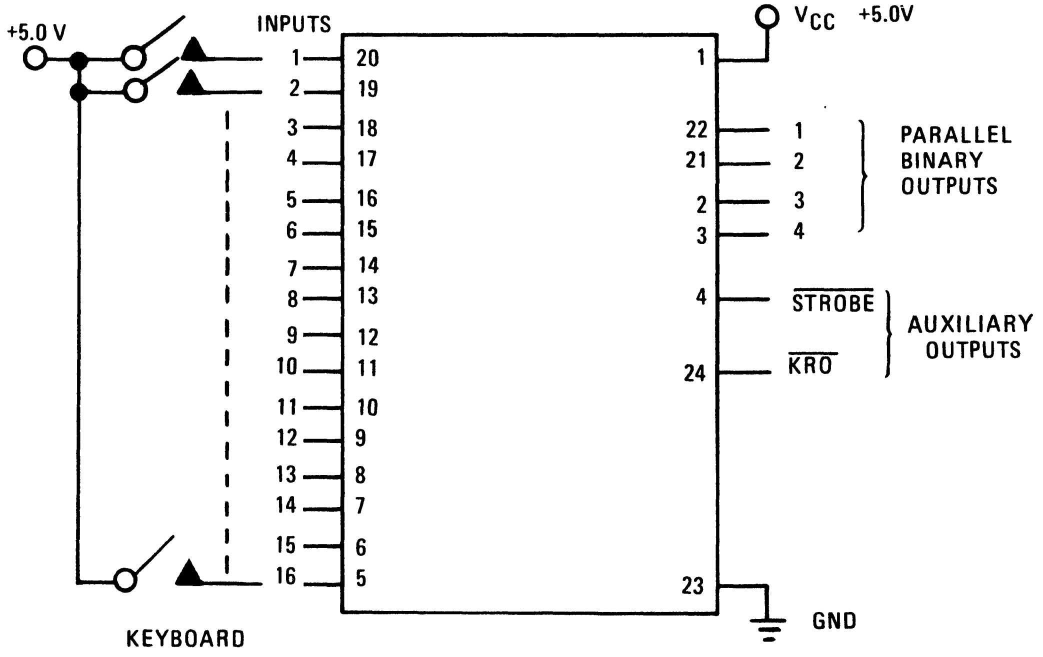


Figure 1. GENERAL CONFIGURATION FOR ENCODING TWO TO SIXTEEN KEYS

The Truth Table is used to determine wiring from the key switches to Encoder inputs to produce desired output codes.

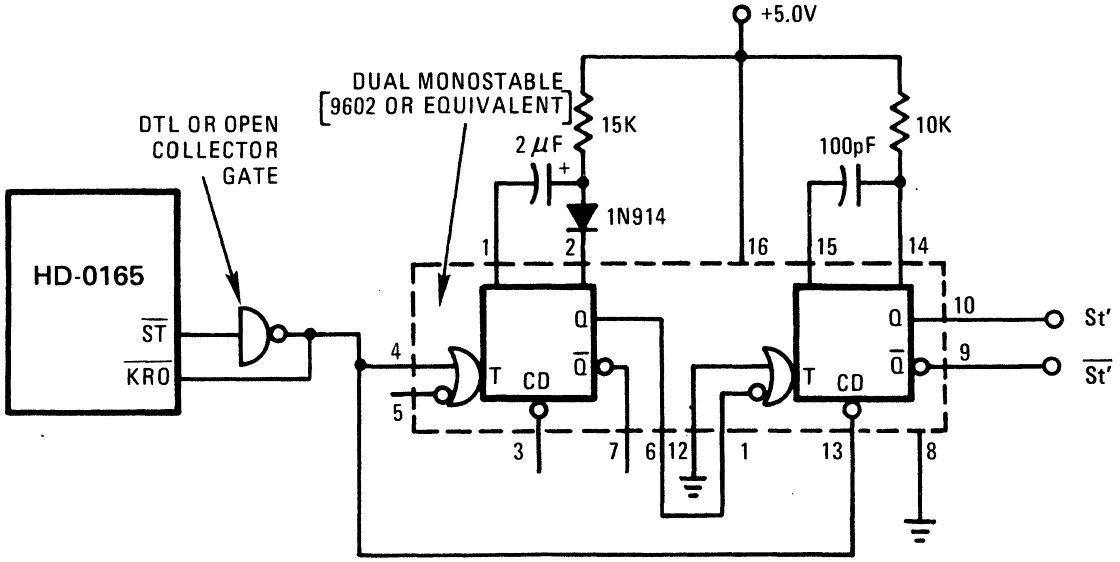


Figure 2. SWITCH BOUNCE ELIMINATION

This circuit generates a delayed Strobe pulse (St′). Delay time is determined by first monostable and should be about 10ms. Pulse width is determined by second monostable and should be set according to system requirements. Effect of switch bounce or arcing on make or break is positively eliminated and proper encoding will take place under two key rollover conditions.

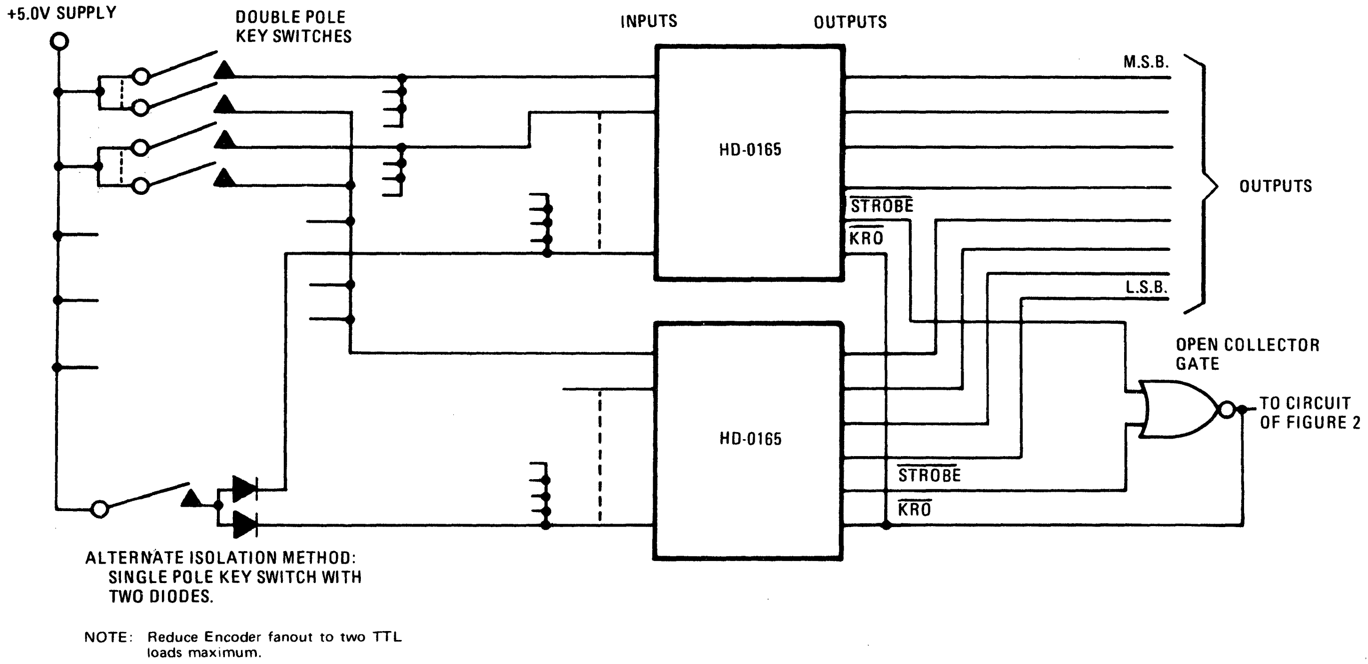


Figure 3. ENCODING UP TO 256 KEYS

Use upper Encoder to produce the four most significant output bits; the lower to produce the least significant bits. Use Truth Table and required output codes to determine wiring from each key to the two Encoders.

SHIFT and CONTROL functions can be implemented by logic gates in series with the output lines.

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HD-245/545 *Triple Line Transmitter*
HD-246/546/249/549 *Triple Line Receivers*
HD-248/548 *Triple Party Line Receiver*

FEATURES:

- CURRENT MODE OPERATION
- HIGH SPEED: 15MHz WITH 50FT. CABLE;
  2MHz WITH 1,000FT. CABLE
- HIGH NOISE IMMUNITY
- LOW EMI GENERATION
- LOW POWER DISSIPATION
- HIGH COMMON MODE REJECTION
- TRANSMITTER AND RECEIVER PARTY LINE CAPABILITY
- TOLERATES -2.0V TO +20.0V GROUND DIFFERENTIAL
  (Transmitter with respect to receiver)
- TRANSMITTER INPUT/RECEIVER OUTPUT TTL/DTL
  COMPATIBLE

GENERAL DESCRIPTION

Each transmitter-receiver combination provides a digital interface between systems linked by 100Ω twisted pair, shielded cable. Each device contains three circuits fabricated within a single monolithic chip. Data rates greater than 15MHz are possible depending on transmission line loss characteristics and length.

The transmitter employs constant current switching which provides high noise immunity along with high speeds, low power dissipation, low EMI generation and the ability to drive high capacitance loads. In addition, the transmitters can be turned "off", allowing several transmitters to time-share a single line.

Receiver input/output differences are shown in the following table:

	INPUT	OUTPUT
HD-246 / 546	100 Ω	OPEN COLLECTOR
HD-248 / 548	HI-Z	6K PULL-UP RES.
HD-249 / 549	100 Ω	6K PULL-UP RES.

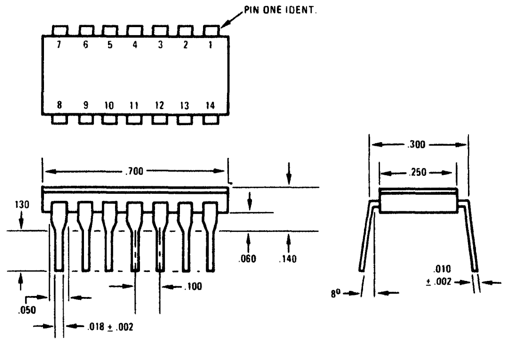
The internal 100 Ω cable termination consists of 50 Ω from each input to ground.

HD-248/548 "party line" receivers have a high-Z input such that as many as ten of these receivers can be used on a single transmission line.

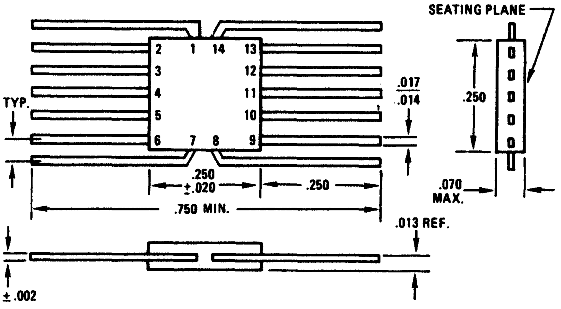
Each transmitter input and receiver output can be connected to TTL and DTL systems. When used with shielded transmission line, the transmitter-receiver system has very high immunity to capacitive and magnetic noise coupling from adjacent conductors. The system can tolerate ground differentials of -2.0 V to +20.0V (transmitter with respect to receiver).

PACKAGES

CODE 1S 14 LEAD BRAZED C.I.P.



CODE 9V TO-86 (METAL BOTTOM)



ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

SPECIFICATIONS HD-245/545 TRANSMITTERS

ABSOLUTE MAXIMUM RATINGS

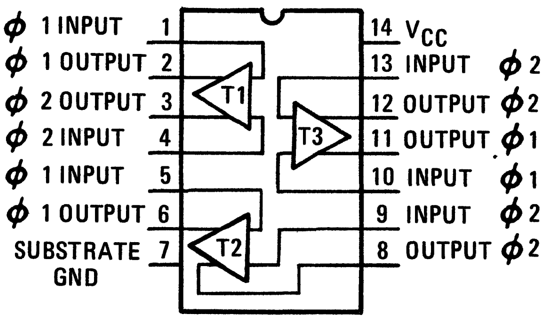
Input Voltage Range:	-0.5V to +10V	V_{CC} Range:	-0.5V to +10V
Output Voltage Range:	-30V to +0.5V with respect to V_{CC}	Storage Temperature Range:	-65°C to +150°C

ELECTRICAL CHARACTERISTICS

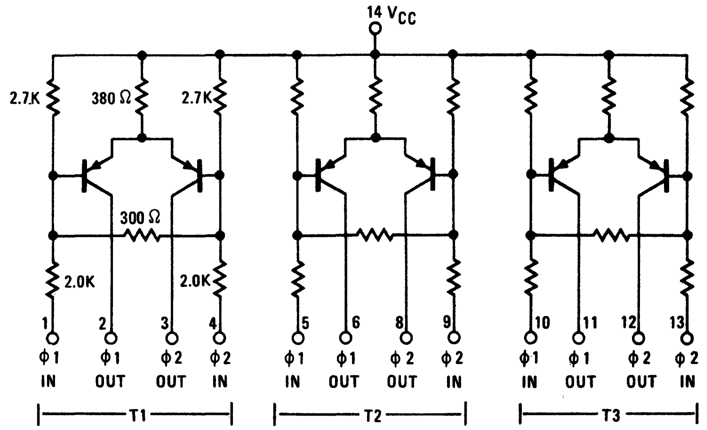
				HD-245 -55°C to +125°C			HD-545 0°C to +75°C				TEST CONDITION	
	PARAMETER	SYMBOL	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	V_{CC}	NOTES
DC	INPUT LOW CURRENT	I_{IL}	25°C Full		-1.5	-2.2 -2.5		-1.5	-2.3 -2.4	mA	5.5	1
	"ON" OUTPUT CURRENT	I_{OUT} "ON"	25°C Full Full	-2.3 -2.0 -1.6			-1.9 -1.8 -1.5			mA mA mA	4.5 4.5 4.5	1 1 2
			25°C Full		-4.1	-5.4 -5.6		-4.1	-6.3 -6.7	mA	5.5	1
	"ON" OUTPUT CURRENT UNBALANCE	ΔI_{OUT}	25°C Full		0.1	0.25 0.3		0.1	0.25 0.3	mA	5.5	3
	"OFF" OUTPUT CURRENT	I_{OUT} "OFF"	25°C Full		-30	-100 -100		-30	-100 -100	μA	4.5	1
	OUTPUT BREAKDOWN	BV_{CER}	25°C	-30	-50		-30	-50		V	GND	4
	POWER SUPPLY CURRENT-TOTAL		25°C 25°C		15	18.6 0.6		15	24 0.6	mA	5.0	5 6
AC	PROPAGATION DELAY	t_{PLH}	25°C Full		3	10 14		3	10 14	ns	5.0	
	TEST CIRCUIT 1, PAGE 4	t_{PHL}	25°C Full		3.2	10 14		3.2	10 14	ns	5.0	

NOTES:
1. One input at Gnd. one input open, each output at Gnd.
2. One input at 0.45V, one input open, each output at Gnd.
3. Difference between ϕ1 and ϕ2 "ON" output data current.
4. Each input at Gnd., one output at Gnd., $I_{Limit} \geq 100\mu A$ on output tested with -30V applied.
5. One input of each transmitter at Gnd and the other input open. All six output lines at Gnd.
6. All six input lines open, all six output lines at Gnd.

BLOCK DIAGRAM



SCHEMATIC



SPECIFICATIONS HD-246/546; HD-248/548; HD-249/549 RECEIVERS

ABSOLUTE MAXIMUM RATINGS

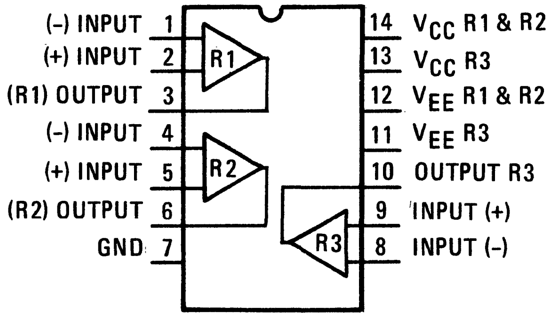
Input Voltage Range	-1.0V to +1.0V	Input Current	±25mA
Output Voltage Range	-0.5V to +6.0V	Output Current	+50mA
V_{CC} Range	-0.5V to +8.0V	Storage Temperature	-65°C to +150°C
V_{EE} Range	-8.0V to +0.5V		

ELECTRICAL CHARACTERISTICS

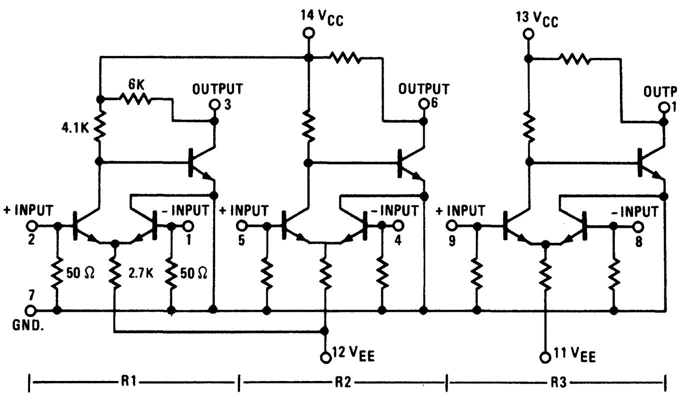
	PARAMETER	SYM.	TEMP.	HD-246 / 248 / 249 -55°C to +125°C			HD-546 / 548 / 549 0°C to +75°C			UNITS	TEST CONDITIONS V_{EE} = -5V	
				MIN.	TYP.	MAX	MIN.	TYP.	MAX.		V_{CC}	NOTES
DC	INPUT RESISTANCE (HD-246/546 & HD-249/549	R_{IN}	+25°C Full	40 39	47	61 68	35 33	47	65 70	Ohms		
	PULL-UP RESISTOR (HD-248/548 & HD-249/549)		+25°C Full	4.2 4.1	6	7.8 8.6	4.0 3.9	6	8.1 8.6	K Ohms		
	OUTPUT VOLTAGE (HIGH)	V_{OH}	+25°C Full	2.6 2.5			2.6 2.5			V	4.5	Note 1 I_{OH}=-120μA Ext. 6K Res. For HD-246/546
	OUTPUT VOLTAGE (LOW)	V_{OL}	+25°C Full			0.45 0.45			0.45 0.45	V	4.5	Note 2 I_{OL}=9.6mA 10mA For HD-246/546
	OUTPUT VOLTAGE (LOW) (INPUT SHORTCIRCUIT)	V_{OLSC}	+25°C		0.4			0.4		V	5.0	Note 3 I_{OL} = 3.2mA
	POWER SUPPLY CURRENT (TOTAL) HD-246 / 546	I_{CC} I_{EE}	+25°C		3.3 5.1	4.8 6.0		3.3 5.1	5.7 6.3	mA	5.0	Note 4
		I_{CC} I_{EE}	+25°C		3.9 5.1	6.6 6.0		3.9 5.1	7.5 6.3	mA	5.0	Note 5
	HD-248 / 548 & HD-249 / 549	I_{CC} I_{EE}	+25°C		6.3 5.1	7.8 6.0		6.3 5.1	8.7 6.3	mA	5.0	Note 4
		I_{CC} I_{EE}	+25°C		3.9 5.1	6.6 6.0		3.9 5.1	7.5 6.3	mA	5.0	Note 5
AC	PROPAGATION DELAY	t_{PLH}	+25°C Full		18	30 30		18	30 30	ns	5.0	
	TEST CIRCUIT 2 PAGE 4	t_{PHL}	+25°C Full		25	30 30		25	30 30	ns	5.0	

NOTES:
1. (+) I_{IN} = 1.5mA; (—) Input = open (For HD-248/548; Ext. 50Ω Res. or 75mV).
2. (+) Input = open; (—) I_{IN} = 1.5mA. (For HD-248/548; Ext. 50Ω Res. or 75mV)
3. Both inputs shorted to Gnd; or both inputs open such that 50 Ω termination resistors are in the circuit.
4. (+) Input = open; (—) I_{IN} = 3mA.
5. (+) I_{IN} = 3mA; (—) Input = open.

BLOCK DIAGRAM



SCHEMATIC



NOTES:
1. HD- 249/549 is as shown
2. HD- 246/546 does not have 6K output pull- up resistors.
3. HD- 248/548 does not have 50 Ω input termination resistors.
4. Resistor values are nominal

TEST CIRCUITS

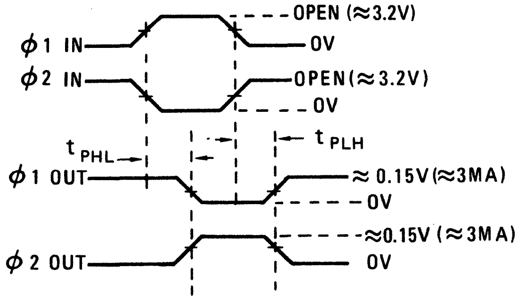
TEST CIRCUIT 1 - TRANSMITTER PROPAGATION DELAY

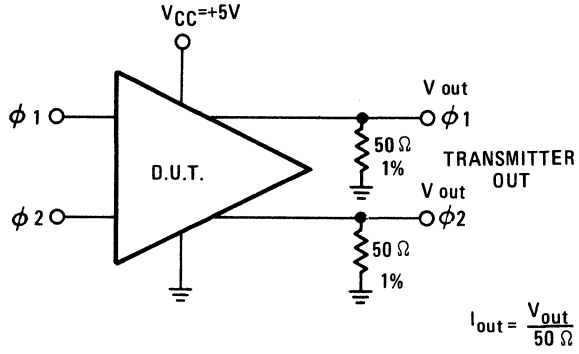
INPUT:

t_{TLH}, t_{THL} $\leq$ 10 ns

pw = 500 ns

f = 1 MHz





$I_{out} = \frac{V_{out}}{50\ \Omega}$

All measurements referenced to 50 % V points

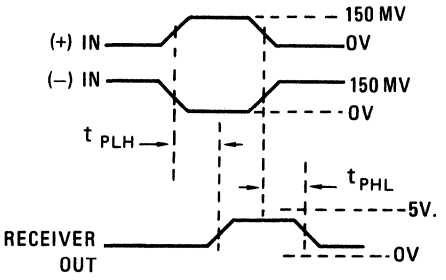
TEST CIRCUIT 2 - RECEIVER PROPAGATION DELAY

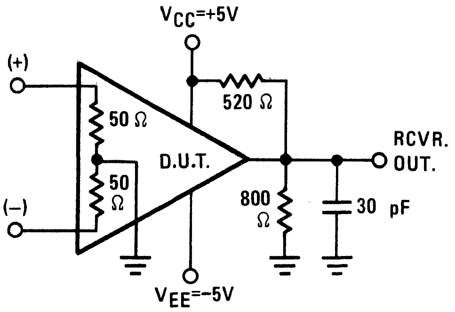
INPUT:

t_{TLH}, t_{THL} $\leq$ 10ns

pw = 500ns

f = 1 MHz



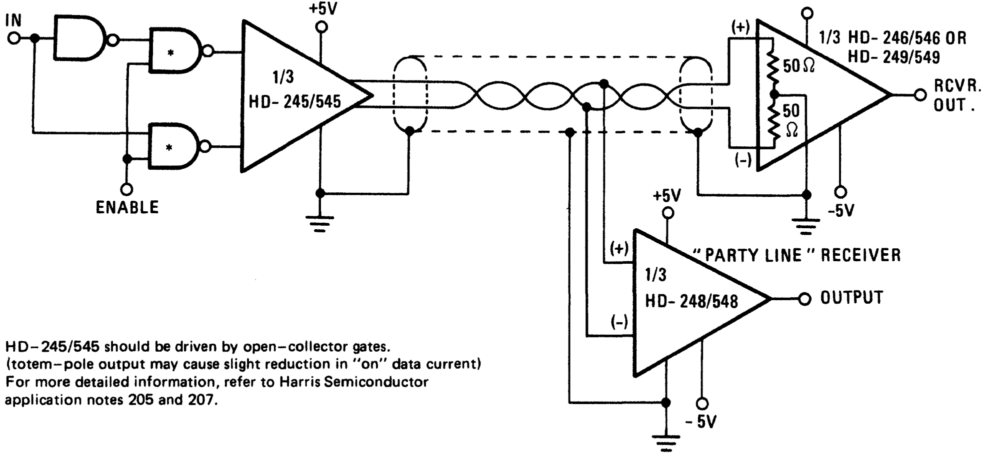


All measurements referenced to 50%V points.

NOTE: External 50Ω resistors needed for HD–248/548.

APPLICATIONS

TYPICAL APPLICATION



* HD–245/545 should be driven by open–collector gates. (totem–pole output may cause slight reduction in "on" data current) For more detailed information, refer to Harris Semiconductor application notes 205 and 207.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HD-1488

Quad Line Driver

FEATURES

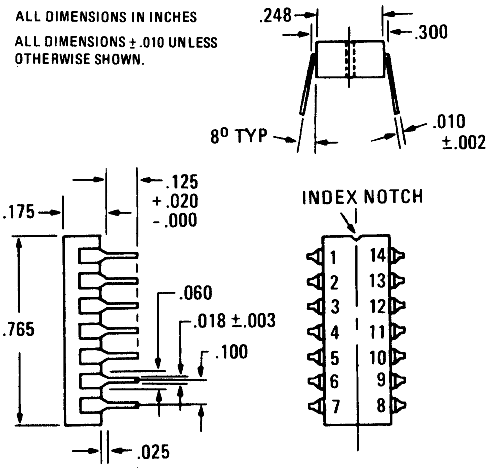
- ±6.0V OUTPUT LEVELS
- SHORT CIRCUIT PROTECTED
- USEFUL AS LOGIC LEVEL SHIFTER
- MONOLITHIC RELIABILITY

DESCRIPTION

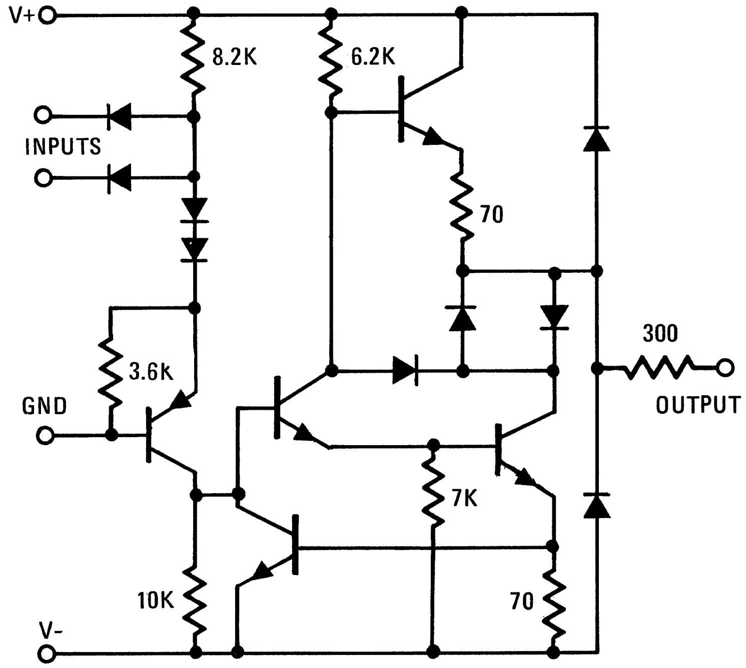
The Harris HD-1488 is a quadruple line driver monolithic integrated circuit meeting the electrical requirements of EIA standard RS-232-C for interface between data terminal equipment and data communication equipment. This standard assures electrical interface compatibility between data equipment made by different manufacturers. The driver circuit is useful in any application requiring transfer of digital signals up to 20K bits per second using common-return signal lines over relatively short distances. The circuit inputs can be driven from any of the popular DTL or TTL logic families. It is available in a 14-pin hermetic dual in-line package for operation from 0°C to +75°C. The companion quad line receiver circuit is the Harris HD-1489.

PACKAGE

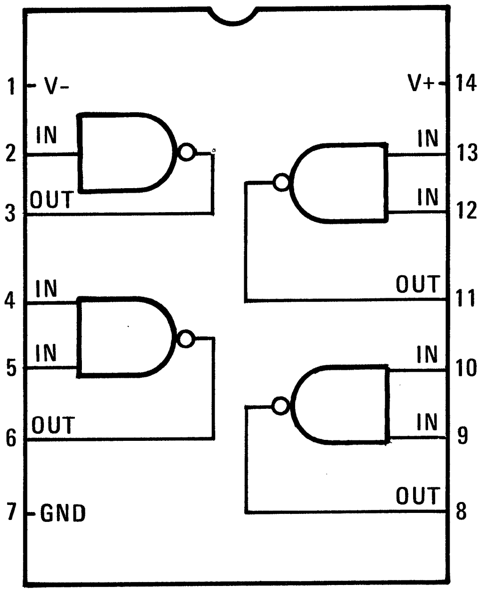
CODE 1A TO-116 (14 LEAD CERAMIC D.I.P.)



SCHEMATIC



CONNECTION DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V+, V- at +25°C Derate by 35mV/°C	±15.0V	Storage Temperature	-65°C to +150°C
Input Voltage	V- ≤ V_{IN} ≤ 7.0V	Operating Temperature, T_A	0°C to +75°C
Output Voltage	V_{OUT} ≥ V+ +5V ≤ V- -5V	Power Dissipation at +25°C Derate by 6.7mW/°C	1000mW

ELECTRICAL CHARACTERISTICS

Test Conditions: V+ = +9.0V, V- = -9.0V, T_A = 0°C to +75°C unless otherwise specified.

	PARAMETER		SYM.	LIMITS			UNITS	TEST CONDITIONS
				MIN.	TYP.	MAX.		
D.C.	Input Current	"0"	I_F		1.0	1.3	mA	V_{IN} = 0.0V
		"1"	I_R			10	µA	V_{IN} = +5.0V
	Output Voltage	"0"	V_{OL}	-6.0	-7.0		V	V_{IN} = +1.9V, R_L = 3K
		"1"	V_{OH}	+6.0	+7.0			V_{IN} = +0.8V, R_L = 3K
	Output Short Circuit Current		I_{SC+}	+6	+10	+12	mA	V_{IN} = 0.0V to +0.8V
			I_{SC-}	-6	-10	-12		V_{IN} = +1.9V to +5.0V
	Output Resistance		R_O	300			Ohms	V+ = V- = 0.0V V_O = ±2.0V
	Supply Current		I+		+15	+20	mA	V+ = +9.0V
			I-		-13	-17		V- = -9.0V
			I+		+19	+25	mA	V+ = +12.0V
			I-		-18	-23		V- = -12.0V
	Power Dissipation		P_D			333	mW	V+ = +9.0V, V- = -9.0V
			P_D			576		V+ = +12.0V, V- = -12.0V
A.C.	Propagation Delay		T_{PD+}		250	300	ns	R_L = 3KΩ
			T_{PD-}		30	120		
	Rise Time (Note 1)		T_r		50	100	ns	C_L = 15pF
	Fall Time (Note 1)		T_f		25	75	ns	T_A = +25°C

NOTES: 1. To maintain a maximum rate of voltage change of 30V/µs, the load capacitance, including transmission line, should be at least 330pF.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HD-1489

Quad Line Receiver

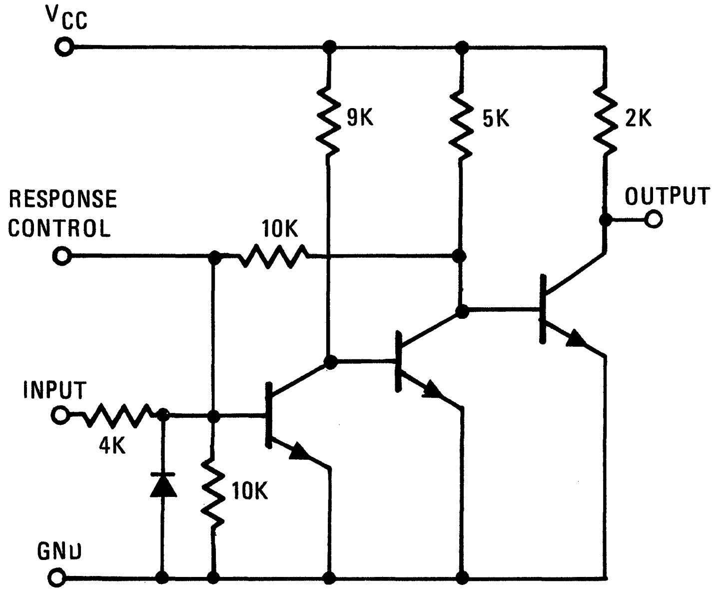
FEATURES

- INPUT LEVEL HYSTERESIS
- INPUTS WITHSTAND ±30.0V
- PROVISION FOR THRESHOLD ADJUSTMENT OR NOISE FILTERING
- MONOLITHIC RELIABILITY

GENERAL DESCRIPTION

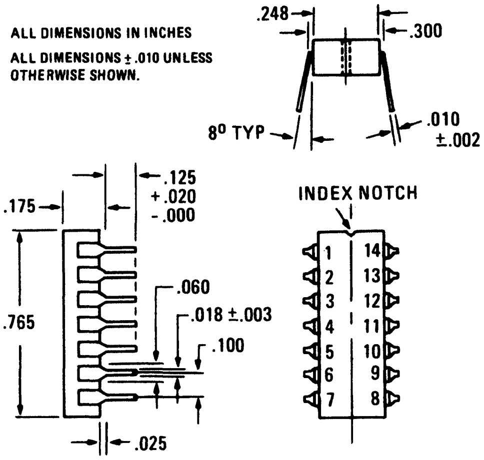
The Harris HD-1489 is a quadruple line receiver monolithic integrated circuit meeting the electrical requirements of EIA Standard RS-232-C for interface between data terminal equipment and data communication equipment. This standard assures electrical interface compatibility between data equipment made by different manufacturers. The receiver circuit is useful in any application requiring transfer of digital signals up to 20K bits per second using common-return signal lines over relatively short distances. The circuit outputs can drive any of the popular DTL or TTL logic families. It is available in a 14-pin hermetic dual in-line package for operation from 0°C to +75°C. The companion quad line driver circuit is the Harris HD-1488.

SCHEMATIC

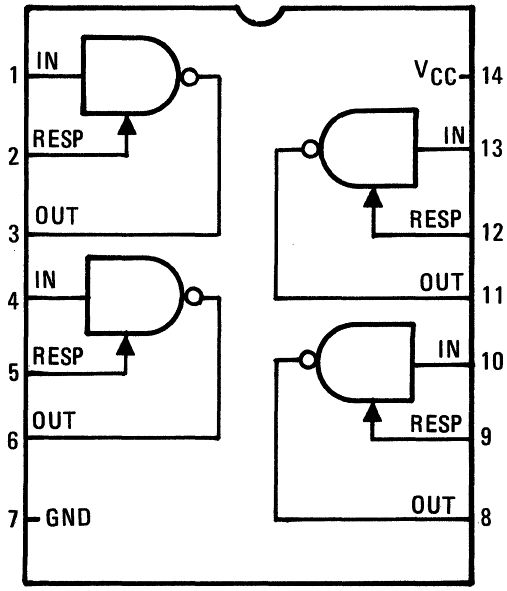


PACKAGE

CODE 1A TO-116 (14 LEAD CERAMIC D.I.P)



CONNECTION DIAGRAM



LINEAR

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+10.0V	Storage Temperature	-65°C to +150°C
Input Voltage	±30.0V	Operating Temperature	0°C to +75°C
Output Current	20mA	Power Dissipation at +25°C Derate by 5mW/°C	1000mW

ELECTRICAL CHARACTERISTICS

Test Conditions: V_{CC} = +5.0V, T_A = 0°C to +75°C,
Response control pin open unless otherwise specified.

	PARAMETER		SYM.	LIMITS			UNITS	TEST CONDITIONS	
				MIN.	TYP.	MAX.			
D.C.	Input Current	"0"	I_{IL}	-.43			mA	V_{IN} = -3.0V	
		"1"	I_{IH}	+.43				V_{IN} = +3.0V	
		"0"	I_{IL}	-3.6		-8.3	mA	V_{IN} = -25.0V	
		"1"	I_{IH}	+3.6		+8.3		V_{IN} = +25.0V	
	Input Threshold Voltage (Note 1)	"0"	V_{IL}	0.75		1.25	V	$V_{OH} \geq 2.5V$	T_A = +25°C
		"1"	V_{IH}	1.0		1.5		$V_{OL} \leq .45V$	
	Output Voltage (Note 2)	"0"	V_{OL}		0.2	0.45	V	V_{IN} = +1.5V, I_{OL} = 10mA	
		"1"	V_{OH}	2.6	4.0	5.0		V_{IN} = +0.75V, I_{OH} = -0.5mA	
		"1"	V_{OH}	2.6	4.0	5.0		V_{IN} = Open, I_{OH} = -0.5mA	
	Output Short Circuit Current		I_{SC}		3.0		mA	V_{IN} = +0.75V	
	Supply Current		I_{CC}		20	26	mA	V_{CC} = +5.0V	
	Power Dissipation		P_D		100	130	mW	V_{CC} = +5.0V	
A.C.	Propagation Delay		T_{PD+}		60	85	ns	R_L = 3.9KΩ	T_A = +25°C
			T_{PD-}		25	50		R_L = 390Ω	
	Rise Time		T_r		90	175	ns	R_L = 3.9KΩ	
	Fall Time		T_f		8.0	20		R_L = 390Ω	

NOTES:

(1) Hysteresis is typically 250mV to prevent output chatter as input signal passes through the threshold region. If desired, thresholds can be made more positive by connecting a resistor from the response control pin to a negative supply; or more negative by connecting the resistor to a positive supply. A capacitor up to 500pF may be connected from the response control pin to ground, making the circuit output less sensitive to narrow noise spikes.

(2) This assures that the output will be in the "1" state if the input line is open or shorted to ground.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HD-1489A

Quad Line Receiver

FEATURES

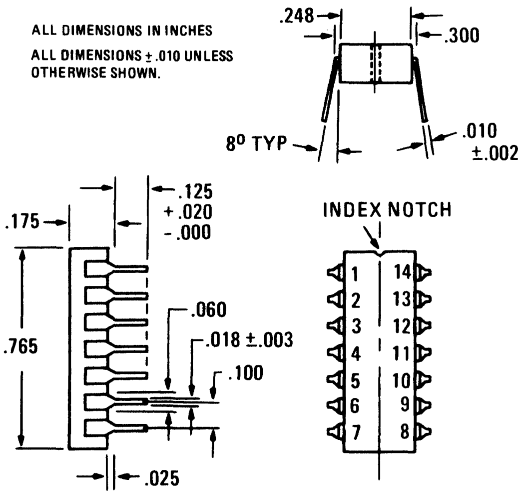
- INPUT HYSTERESIS 1.15V TYP.
- INPUTS WITHSTAND ±30.0V
- PROVISION FOR THRESHOLD ADJUSTMENT AND/OR NOISE FILTERING
- MONOLITHIC RELIABILITY

GENERAL DESCRIPTION

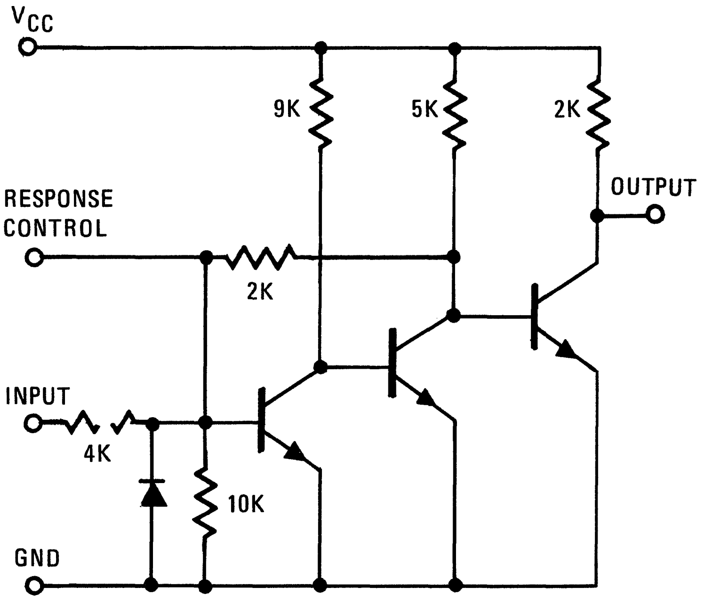
The Harris HD-1489A is a quadruple line receiver monolithic integrated circuit meeting the electrical requirements of EIA Standard RS-232-C for interface between data terminal equipment and data communication equipment. This standard assures electrical interface compatibility between data equipment made by different manufacturers. The receiver circuit is useful in any application requiring transfer of digital signals up to 20K bits per second using common-return signal lines over relatively short distances. The circuit outputs can drive any of the popular DTL or TTL logic families. It is available in a 14-pin hermetic dual in-line package for operation from 0°C to +75°C. The companion quad line driver circuit is the Harris HD-1488.

PACKAGE

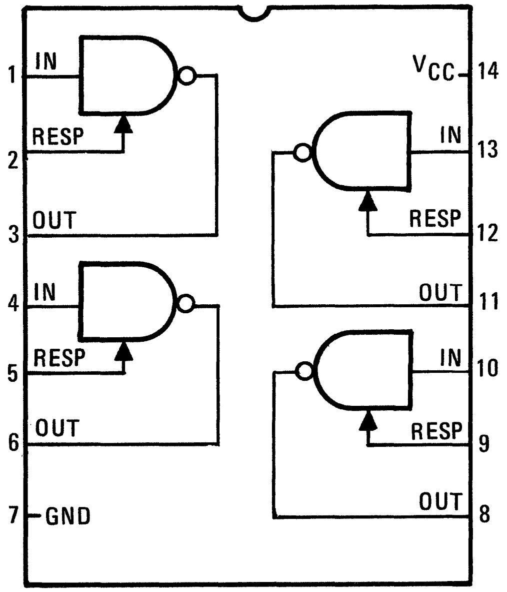
CODE 1A TO-116 (14 LEAD CERAMIC D.I.P)


ALL DIMENSIONS IN INCHES
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

SCHEMATIC



CONNECTION DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+10.0V	Storage Temperature	-65°C to +150°C
Input Voltage	±30.0V	Operating Temperature	0°C to +75°C
Output Current	20mA	Power Dissipation at +25°C	1000mW
		Derate by 5mW /°C	

ELECTRICAL CHARACTERISTICS

Test Conditions: V_{CC} = +5.0V, T_A = 0°C to +75°C,
Response control pin open unless otherwise specified.

	PARAMETER		SYM.	LIMITS			UNITS	TEST CONDITIONS	
				MIN.	TYP.	MAX.			
D.C.	Input Current	"0"	I_{IL}	-.43			mA	V_{IN} = -3.0V	
		"1"	I_{IH}	+.43				V_{IN} = +3.0V	
		"0"	I_{IL}	-3.6		-8.3	mA	V_{IN} = -25.0V	
		"1"	I_{IH}	+3.6		+8.3		V_{IN} = +25.0V	
	Input Threshold Voltage (Note 1)	"0"	V_{IL}	0.75		1.25	V	$V_{OH} \geq 2.5V$	T_A = +25°C
		"1"	V_{IH}	1.75		2.25		$V_{OL} \leq .45V$	
	Output Voltage (Note 2)	"0"	V_{OL}		0.2	0.45	V	V_{IN} = +1.5V, I_{OL} = 10mA	
		"1"	V_{OH}	2.6	4.0	5.0		V_{IN} = +0.75V, I_{OH} = -0.5mA	
		"1"	V_{OH}	2.6	4.0	5.0		V_{IN} = Open, I_{OH} = -0.5mA	
	Output Short Circuit Current		I_{SC}		3.0		mA	V_{IN} = +0.75V	
	Supply Current		I_{CC}		20	26	mA	V_{CC} = +5.0V	
	Power Dissipation		P_D		100	130	mW	V_{CC} = +5.0V	
A.C.	Propagation Delay		T_{PD+}		60	85	ns	R_L = 3.9KΩ	T_A = +25°C
			T_{PD-}		25	50		R_L = 390Ω	
	Rise Time		T_r		90	175	ns	R_L = 3.9KΩ	
	Fall Time		T_f		8.0	20		R_L = 390Ω	

NOTES:

(1) Hysteresis is typically 1,15V to prevent output chatter as input signal passes through the threshold region. If desired, thresholds can be made more positive by connecting a resistor from the response control pin to a negative supply; or more negative by connecting the resistor to a positive supply. A capacitor up to 500pF may be connected from the response control pin to ground, making the circuit output less sensitive to narrow noise spikes.

(2) This assures that the output will be in the "1" state if the input line is open or shorted to ground.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-200

Dual SPST CMOS Analog Switch

FEATURES

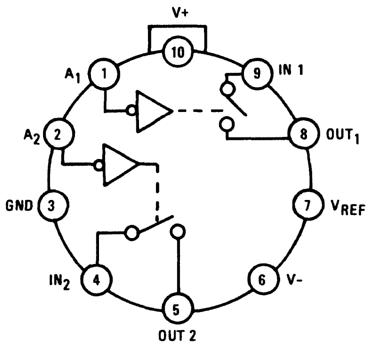
● ANALOG SIGNAL RANGE	±15V
● TURN-ON TIME (TYP)	240ns
● $R_{ON}<60\Omega$ (TYP) AT +25°C	
● SWITCH CURRENT AT +25°C	80mA
● LOW POWER DISSIPATION	15mW
● DTL/TTL AND CMOS COMPATIBLE	
● NO LATCH-UP	

DESCRIPTION

The HI-200 is a monolithic device consisting of two independently selectable SPST switches. High switching speeds at low power levels are simultaneously achieved using the Harris Dielectric Isolation, Complementary MOS process. Latch-up or SCR phenomenon is inherently non-existent with this process. The device is packaged in a 10 pin TO-100 hermetic can and is available in both military and commercial temperature ranges.

PIN OUT

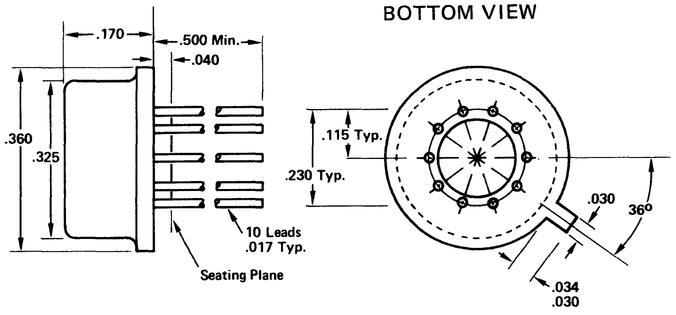
TOP VIEW



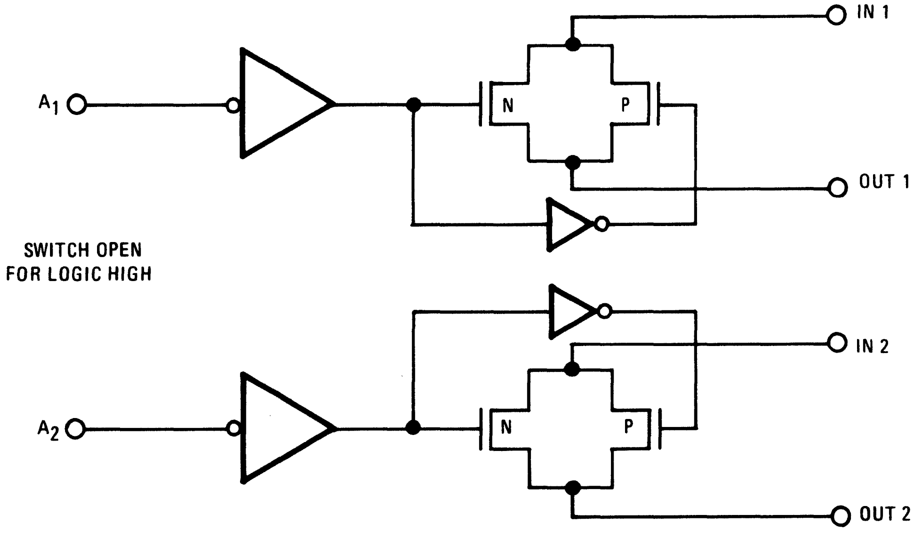
PACKAGE

CODE 2G

TO-100



FUNCTIONAL DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage Between Pins 6 and 10 40V
V_{REF} to Ground +20V, -5V
Digital Input Voltage: $+V_{Supply}$ +4V
$-V_{Supply}$ -4V
Analog Input Voltage (One Switch)
$+V_{Supply}$ +2.0V
$-V_{Supply}$ -2.0V

Total Power Dissipation* 450mW
Operating Temperature
HI-200-2 -55°C to +125°C
HI-200-5 0°C to +75°C
Storage Temperature -65°C to +150°C

*Derate 6 mW/°C above T_A = 75°C

ELECTRICAL CHARACTERISTICS

Unless Otherwise Specified
Supplies = +15V, -15V; V_{REF} (Pin 7) = Open; V_{AH} (Logic Level High) = 3.0V V_{AL} (Logic Level Low) = +0.8V
For Test Conditions, consult Performance Characteristics

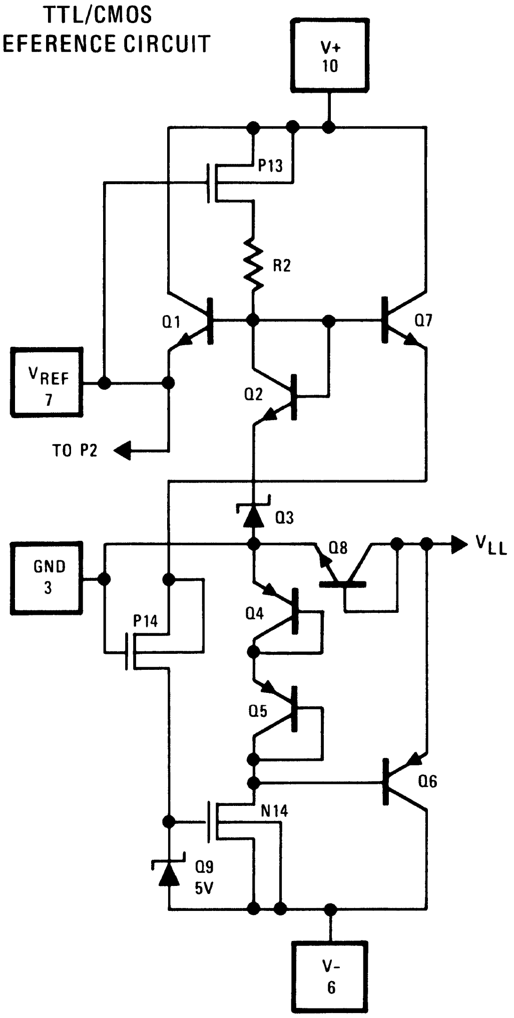
		-55°C to +125°C			0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
ANALOG SWITCH CHARACTERISTICS								
*V_S, Analog Signal Range	Full	-15		+15	-15		+15	V
*R_{ON}, On Resistance (Note 1)	+25°C		55	70		55	80	Ω
	Full		80	100		72	100	Ω
*$I_{S(OFF)}$, Off Input Leakage Current	+25°C		1			1		nA
	Full		100	500		10	500	nA
*$I_{D(OFF)}$, Off Output Leakage Current	+25°C		1			1		nA
	Full		100	500		10	500	nA
*$I_{D(ON)}$, On Leakage Current	+25°C		.02			.02		nA
	Full		6	500		6	500	nA
DIGITAL INPUT CHARACTERISTICS								
V_{AL}, Input Low Threshold	Full			0.8			0.8	V
V_{AH}, Input High Threshold	Full	3.0			3.0			V
*I_A, Input Leakage Current (High or Low) (Note 2)	Full			1.0			1.0	μA
SWITCHING CHARACTERISTICS								
t_{OPEN}, Break - Before Make Delay (Note 3)	+25°C		60			60		ns
t_{on}, Switch on Time	+25°C		240	500		240		ns
t_{off}, Switch off Time	+25°C		330	500		500		ns
"Off Isolation" (Note 4)	+25°C		70			70		dB
$C_{S(OFF)}$, Input Switch Capacitance	+25°C		5.5			5.5		pF
$C_{D(OFF)}$, Output Switch Capacitance	+25°C		5.5			5.5		pF
$C_{D(ON)}$, Output Switch Capacitance	+25°C		11			11		pF
C_A, Digital Input Capacitance	+25°C		5			5		pF
$C_{DS(OFF)}$, Drain-To-Source Capacitance	+25°C		0.5			0.5		pF
POWER REQUIREMENTS (Note 5)	+25°C		15			15		mW
P_D, Power Dissipation	Full			60			60	mW
* I^+, Current (Pin 10)	+25°C		0.5			0.5		mA
	Full			2.0			2.0	mA
* I^-, Current (Pin 6)	+25°C		0.5			0.5		mA
	Full			2.0			2.0	mA

NOTES:
1. V_{OUT} = +10V I_{OUT} = 1mA
2. Digital Inputs Are MOS Gates Typical Leakage is Less Than 1nA
3. V_{AH} = 4.0V
4. V_A = +3V, R_L = 1KΩ, C_L = 10pF, V_S = 3VRMS, f, 100 kHz
5. V_A = +3V or V_A = 0V For Both Switches

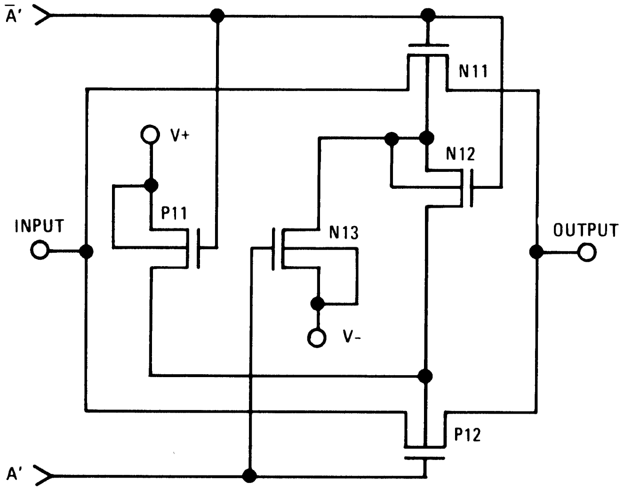
*100% Tested For DASH 8

SCHEMATIC DIAGRAMS

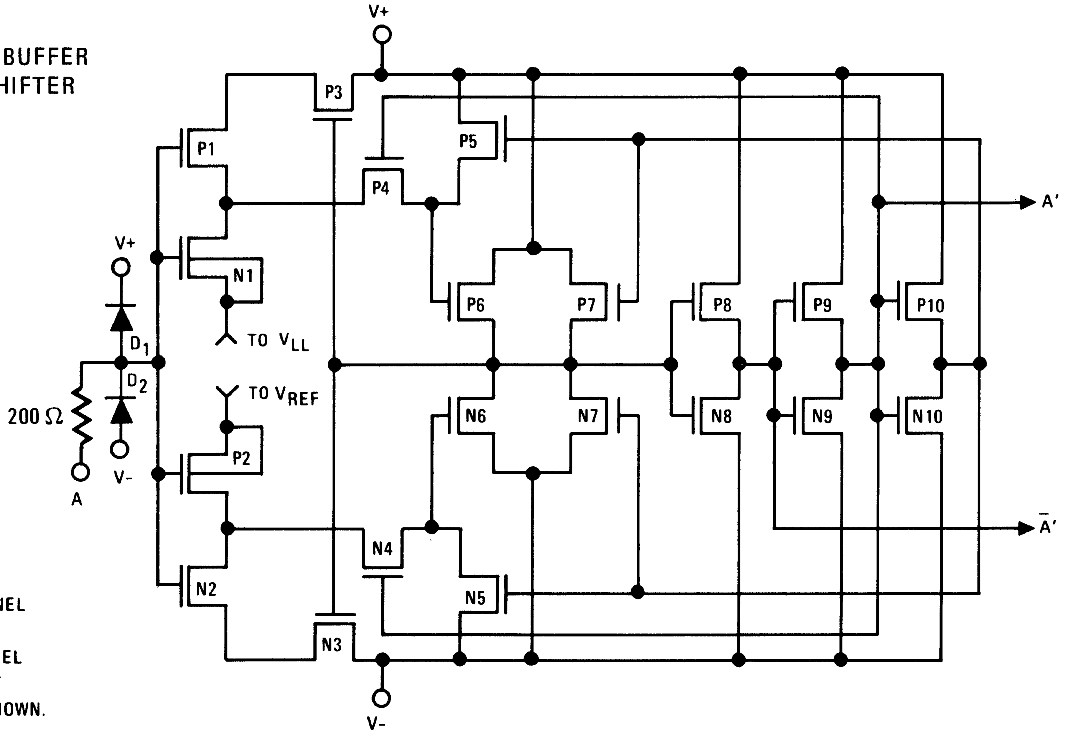
TTL/CMOS
REFERENCE CIRCUIT



SWITCH CELL



DIGITAL INPUT BUFFER
AND LEVEL SHIFTER



ALL N-CHANNEL
BODIES TO V-

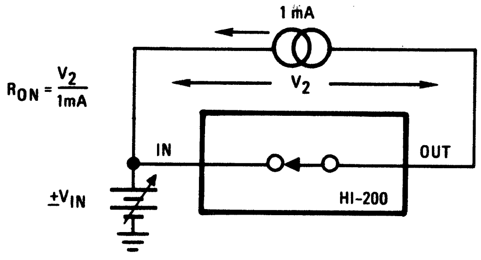
ALL P-CHANNEL
BODIES TO V+

EXCEPT AS SHOWN.

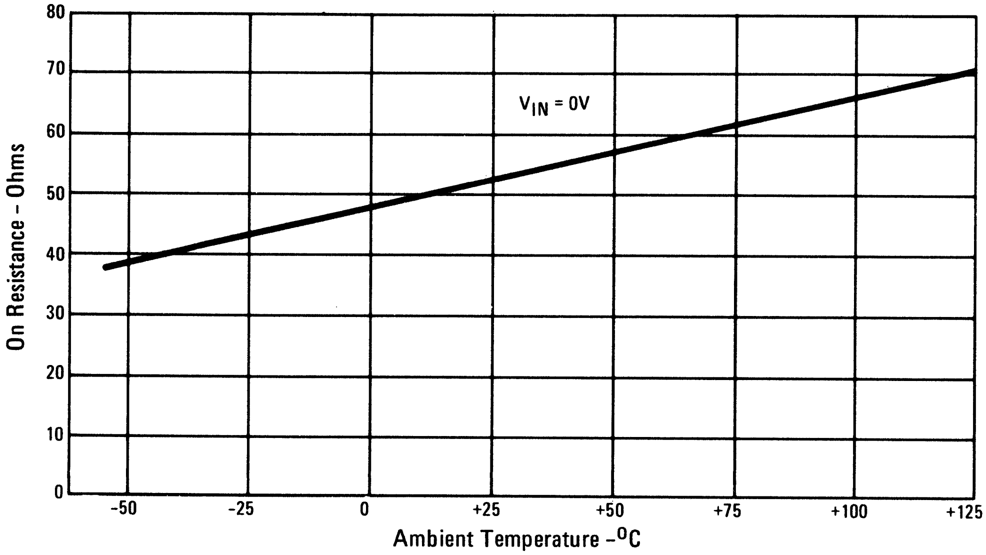
PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS

(UNLESS OTHERWISE SPECIFIED T_A = 25°C, V_{SUPPLY} = ± 15V, V_{AH} = 3.0V V_{AL} = 0.8V AND V_{REF} = OPEN).

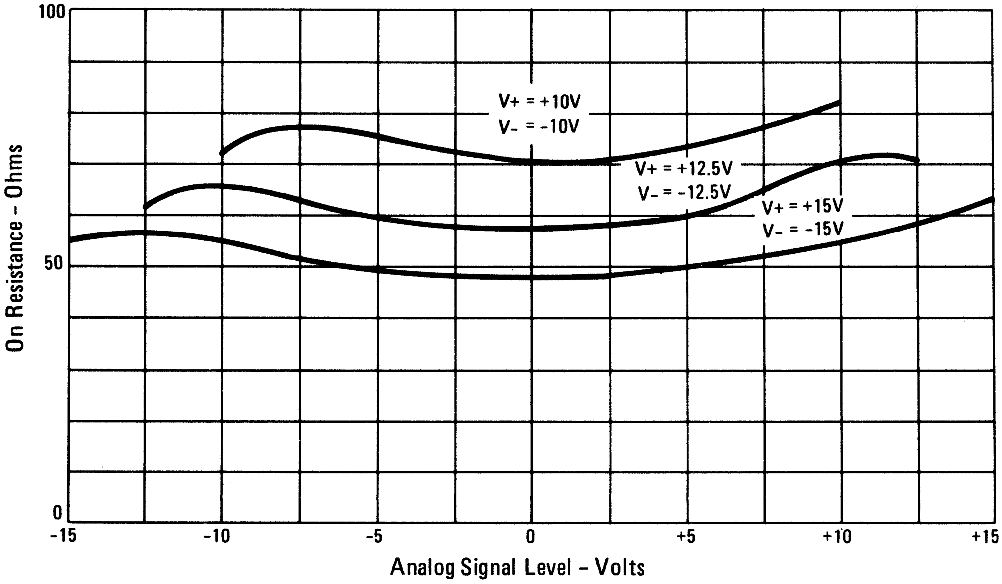
ON RESISTANCE vs. ANALOG SIGNAL LEVEL, SUPPLY VOLTAGE AND TEMPERATURE



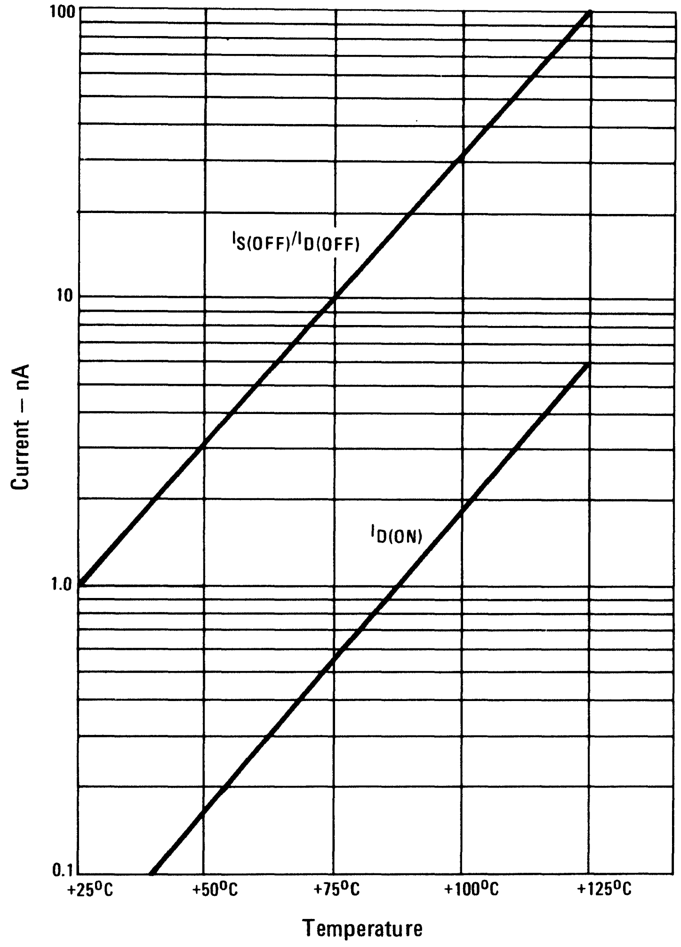
ON RESISTANCE vs. TEMPERATURE



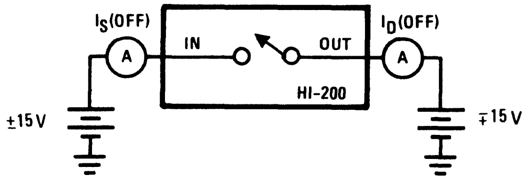
(HI-200)
ON RESISTANCE vs. ANALOG SIGNAL LEVEL AND POWER SUPPLY VOLTAGE



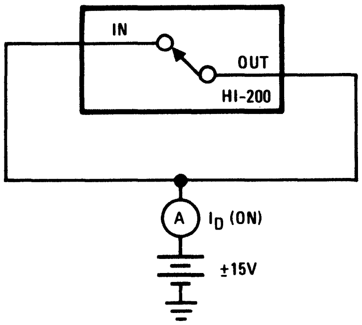
SWITCH LEAKAGE CURRENT vs. TEMPERATURE (HI-200)



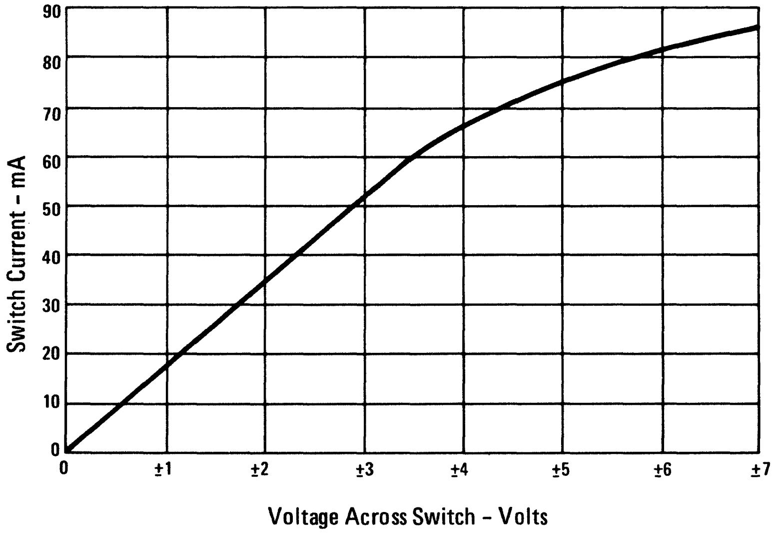
OFF LEAKAGE CURRENT vs. TEMPERATURE



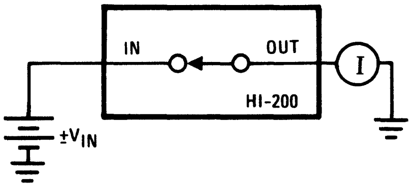
ON LEAKAGE CURRENT vs. TEMPERATURE



SWITCH CURRENT vs. VOLTAGE

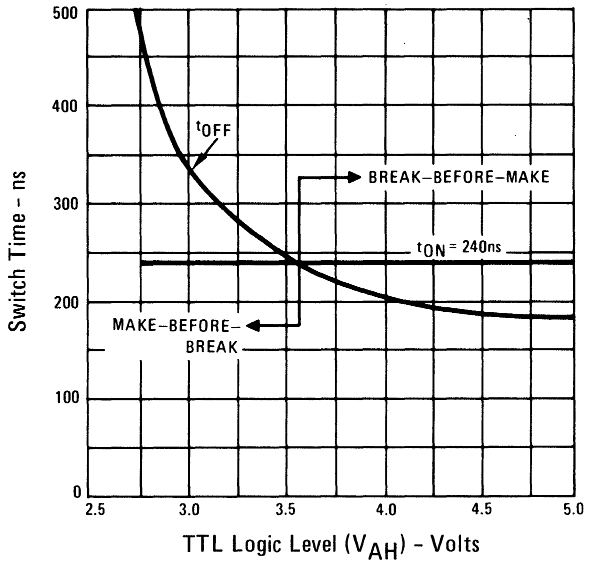


SWITCH CURRENT vs. VOLTAGE

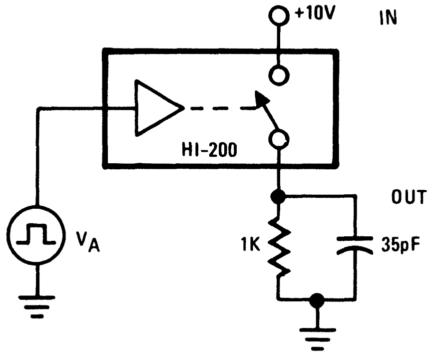


PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS (continued)

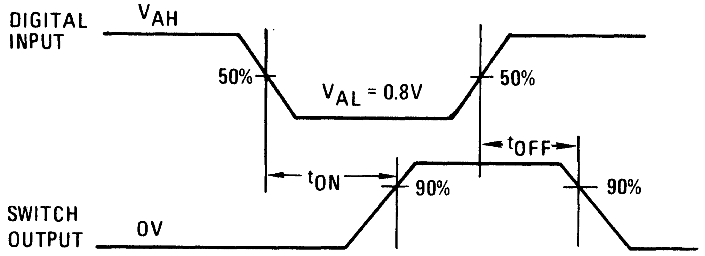
(HI-200)
SWITCH TIME vs. TTL LOGIC LEVEL



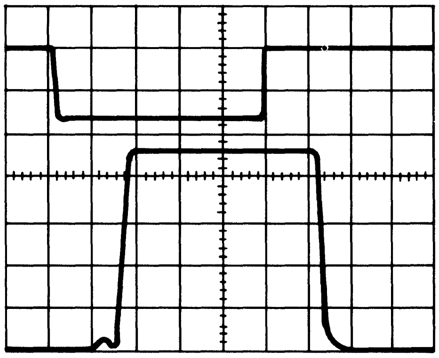
ON/OFF SWITCH TIME vs.
LOGIC LEVEL



SWITCHING WAVEFORMS

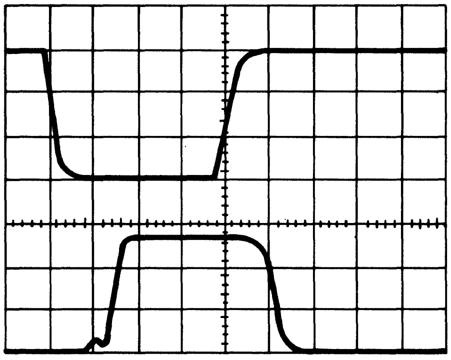


t_{ON}, t_{OFF} (TTL INPUT)
V_{AH} = +4.0V



Top: TTL Input Vertical: 2V/Div.
Bottom: Output Horizontal: 200ns/Div.

t_{ON}, t_{OFF}(CMOS INPUT)
V_{REF} = OPEN, V_{AH} = +15V



Top: CMOS Input Vertical: 5V/Div.
Bottom: Output Horizontal: 200ns/Div.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-201

Quad SPST CMOS Analog Switch

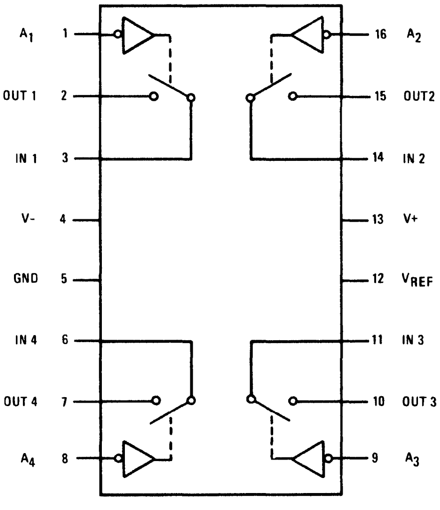
FEATURES

● ANALOG SIGNAL RANGE	±15V
● TURN-ON TIME (TYP)	185 ns
● ON RESISTANCE (TYP)	65Ω
● NO LATCH-UP	
● NO DIGITAL INPUT CURRENT SPIKE	
● DTL/TTL AND CMOS COMPATIBLE	

DESCRIPTION

The HI-201 is a monolithic device consisting of four independently selectable SPST switches. High switching speeds at low power levels are simultaneously achieved using the Harris Dielectric Isolation, Complementary MOS process. Latch-up or SCR phenomenon is inherently non-existent with this process. The device is packaged in a 16 pin hermetic Dual In-Line and is available in both military and commercial temperature ranges.

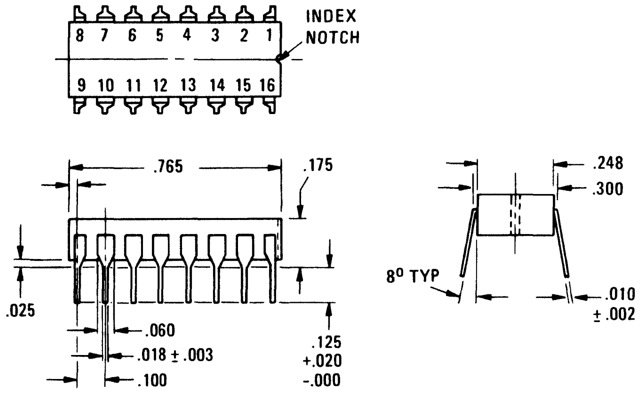
PIN OUT



PACKAGE

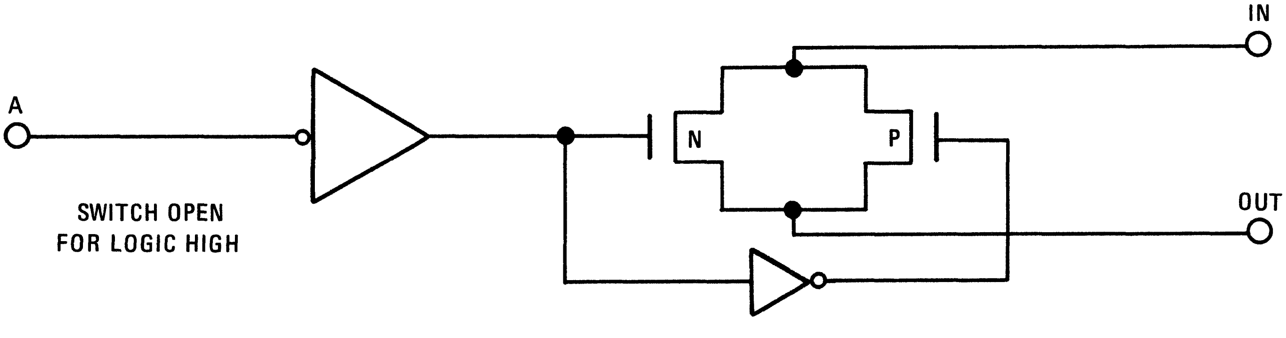
CODE 1W

16 LEAD D.I.P.



FUNCTIONAL DIAGRAM

TYPICAL SWITCH



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage Between Pins 4 and 13		40V
V_{REF} to Ground		+20V, -5V
Digital Input Voltage:	$V_{Supply}(+)$ +4V $V_{Supply}(-)$ -4V	
Analog Input Voltage (One Switch)	$+V_{Supply}$ +2.0V $-V_{Supply}$ -2.0V	

Total Power Dissipation*		750mW
Operating Temperature		
	HI-201-2	-55^oC to $+125^oC$
	HI-201-5	0^oC to $+75^oC$
Storage Temperature		-65^oC to $+150^oC$

*Derate 8 mW/^oC Above $T_A = +75^oC$

ELECTRICAL CHARACTERISTICS

Unless Otherwise Specified
Supplies = +15V, -15V; V_{REF} (Pin 7) = Open; V_{AH} (Logic Level High) = 3.0V V_{AL} (Logic Level Low) = +0.8V
For Test Conditions, consult Performance Characteristics

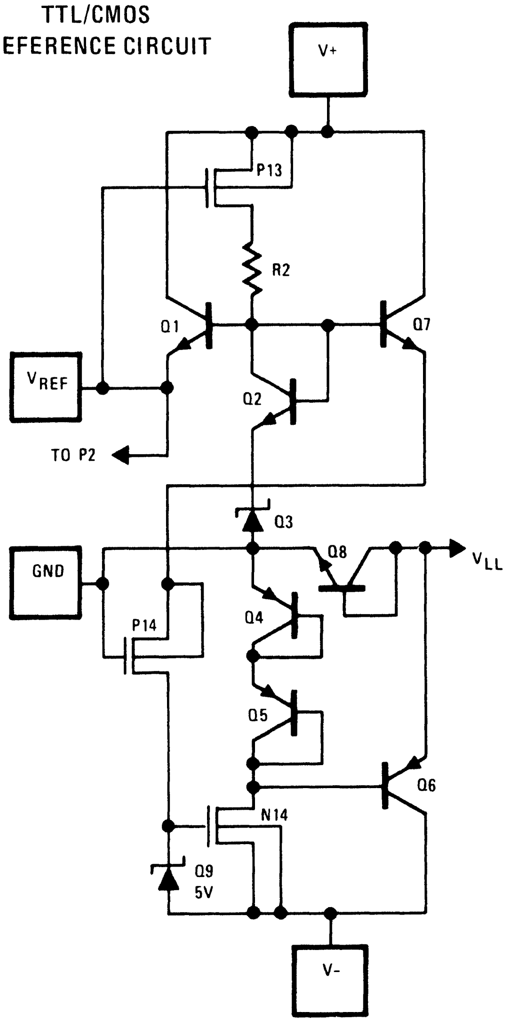
PARAMETER	TEMP.	HI-201-2 -55^oC to $+125^oC$ MIN.	TYP.	MAX.	HI-201-5 0^oC to $+75^oC$ MIN.	TYP.	MAX.	UNITS
ANALOG SWITCH CHARACTERISTICS								
*V_S, Analog Signal Range	Full	-15		+15	-15		+15	V
*R_{ON}, On Resistance (Note 1)	$+25^oC$		65	80		65	100	Ω
	Full		85	125		75	125	Ω
*$I_{S(OFF)}$, Off Input Leakage Current	$+25^oC$		2			2		nA
	Full			500			250	nA
*$I_{D(OFF)}$, Off Output Leakage Current	$+25^oC$		2			2		nA
	Full			500			250	nA
*$I_{D(ON)}$, On Leakage Current	$+25^oC$		2			2		nA
	Full			500			250	nA
DIGITAL INPUT CHARACTERISTICS								
V_{AL}, Input Low Threshold	Full			0.8			0.8	V
V_{AH}, Input High Threshold	Full	3.0			3.0			V
*I_A, Input Leakage Current (High or Low) (Note 2)	Full			1.0			1.0	μA
SWITCHING CHARACTERISTICS								
t_{OPEN}, Break - Before Make Delay (Note 3)	$+25^oC$		30			30		ns
t_{on}, Switch ON Time	$+25^oC$		185	500		185		ns
t_{off}, Switch OFF Time	$+25^oC$		220	500		220		ns
"Off Isolation" (Note 4)	$+25^oC$		80			80		dB
$C_{S\ (OFF)}$, Input Switch Capacitance	$+25^oC$		5.5			5.5		pF
$C_{D\ (OFF)}$, Output Switch Capacitance	$+25^oC$		5.5			5.5		pF
$C_{D(ON)}$ Output Switch Capacitance	$+25^oC$		11			11		pF
C_A, Digital Input Capacitance	$+25^oC$		5			5		pF
$C_{DS\ (OFF)}$, Drain-To-Source Capacitance	$+25^oC$		0.5			0.5		pF
POWER REQUIREMENTS (Note 5)	$+25^oC$		15			15		mW
P_D, Power Dissipation	Full			60			60	mW
*I+, Current (Pin 13)	$+25^oC$		0.5			0.5		mA
	Full			2.0			2.0	mA
*I– Current (Pin 4)	$+25^oC$		0.5			0.5		mA
	Full			2.0			2.0	mA

NOTES:
1. $V_{OUT} = \pm 10V$ $I_{OUT} = 1mA$
2. Digital Inputs Are MOS Gates - Typical Leakage is Less Than 1nA
3. $V_{AH} = 4.0V$
4. $V_A = 5V$, $R_L = 1K\Omega$, $C_L = 10pF$, $V_S = 3VRMS$, f = 100KHz
5. $V_A = +3V$ or $V_A = 0V$ For all Switches

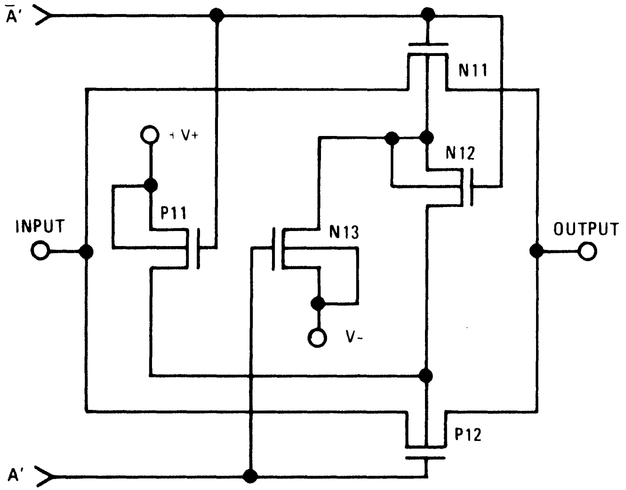
*100% Tested For DASH 8

SCHEMATIC DIAGRAMS

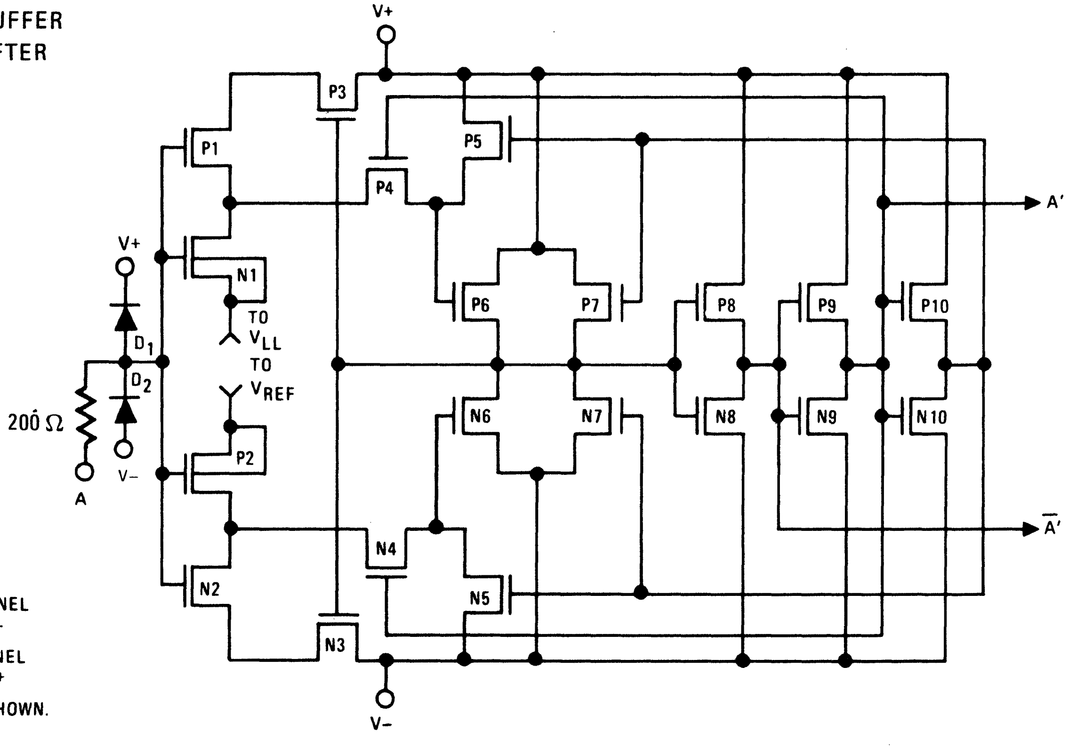
TTL/CMOS
REFERENCE CIRCUIT



SWITCH CELL



DIGITAL INPUT BUFFER
AND LEVEL SHIFTER



ALL N-CHANNEL
BODIES TO V-

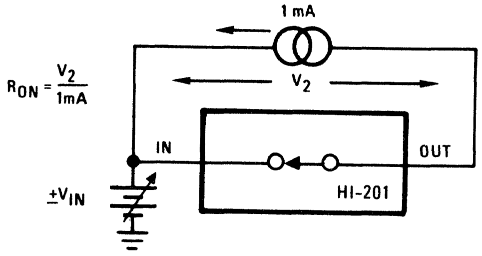
ALL P-CHANNEL
BODIES TO V+

EXCEPT AS SHOWN.

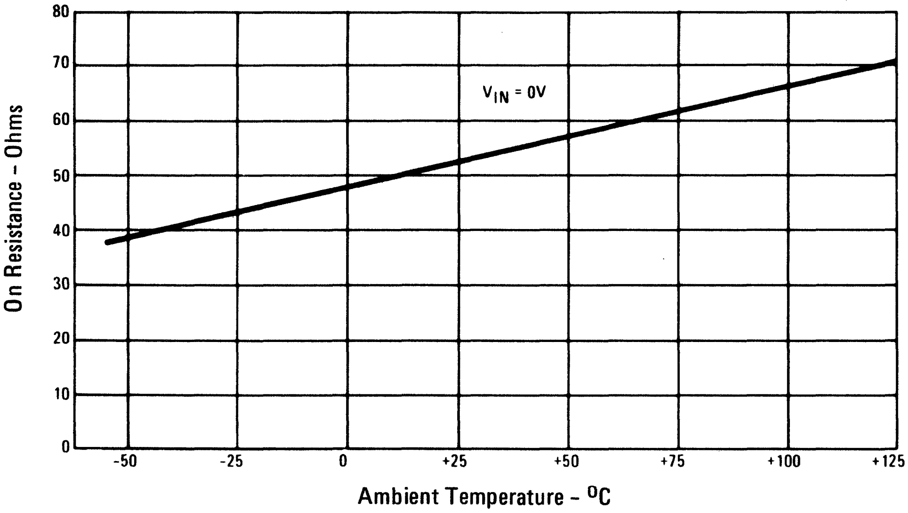
PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS

(UNLESS OTHERWISE SPECIFIED $T_A = 25^oC$, $V_{SUPPLY} = \pm 15V$, $V_{AH} = 3.0V$ $V_{AL} = 0.8V$ AND V_{REF} = OPEN).

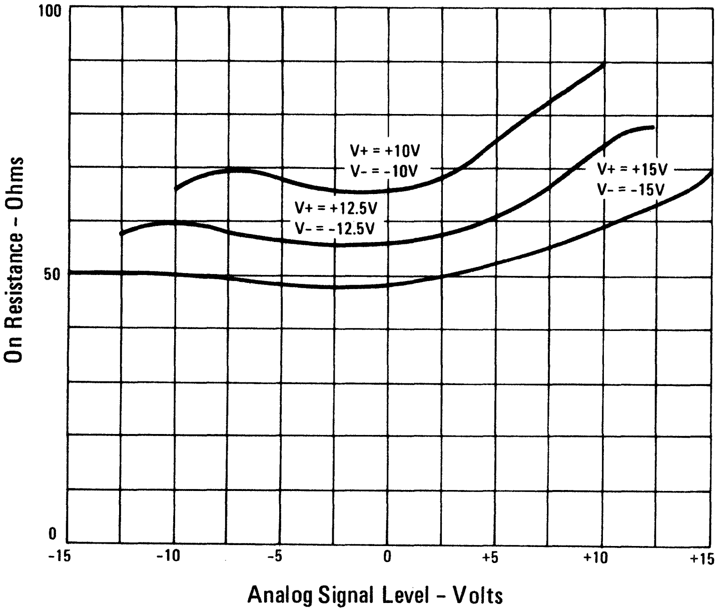
ON RESISTANCE vs. ANALOG SIGNAL LEVEL, SUPPLY VOLTAGE AND TEMPERATURE



ON RESISTANCE vs. TEMPERATURE

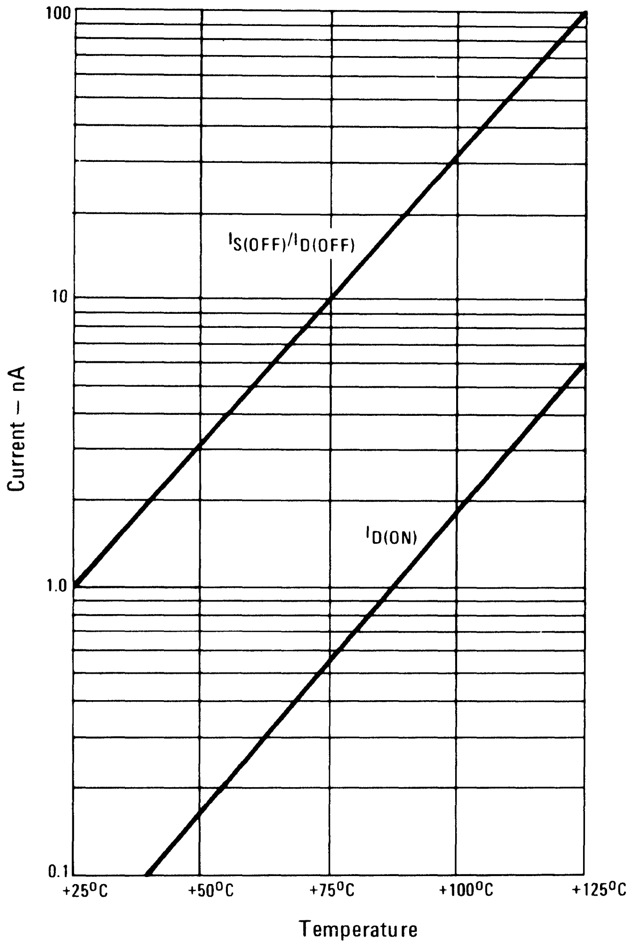


(HI-201)
ON RESISTANCE vs. ANALOG SIGNAL LEVEL AND POWER SUPPLY VOLTAGE

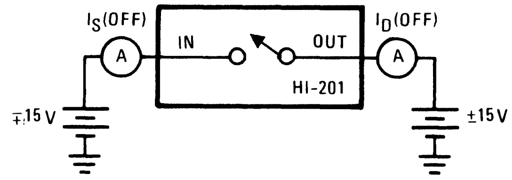


PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS (continued)

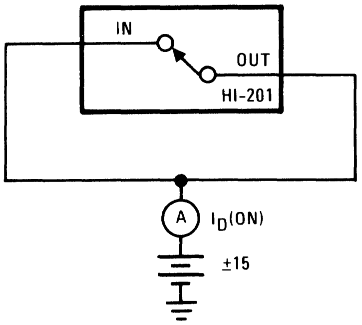
SWITCH LEAKAGE CURRENT vs.
TEMPERATURE (HI-201)



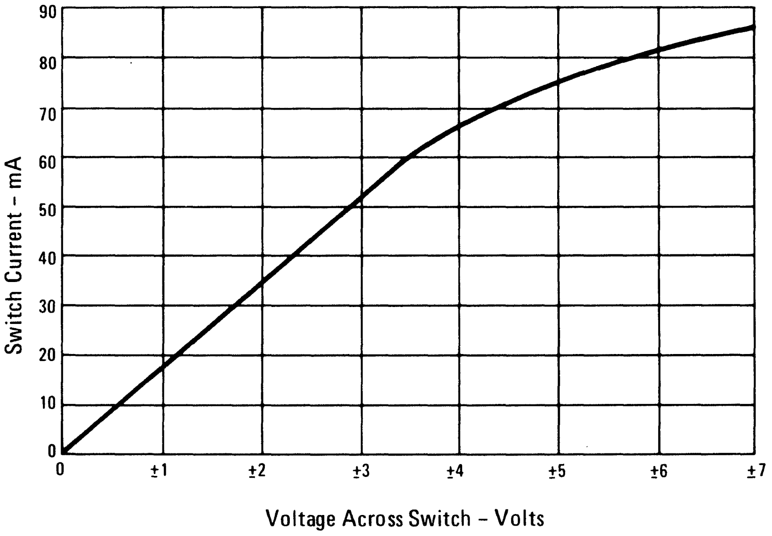
OFF LEAKAGE CURRENT
vs. TEMPERATURE



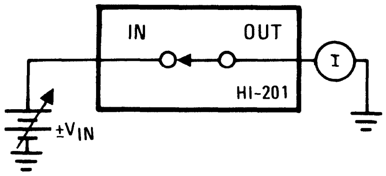
ON LEAKAGE CURRENT
vs. TEMPERATURE



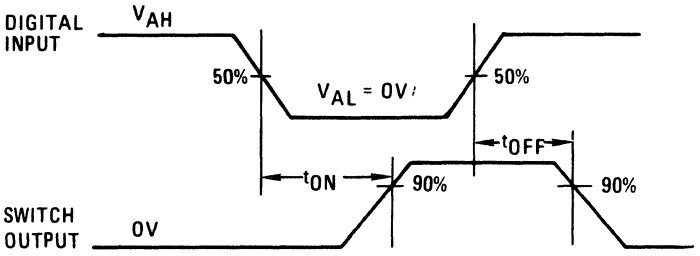
SWITCH CURRENT vs. VOLTAGE



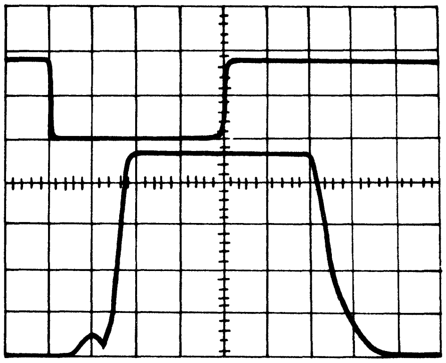
SWITCH CURRENT
vs. VOLTAGE



SWITCHING WAVEFORMS

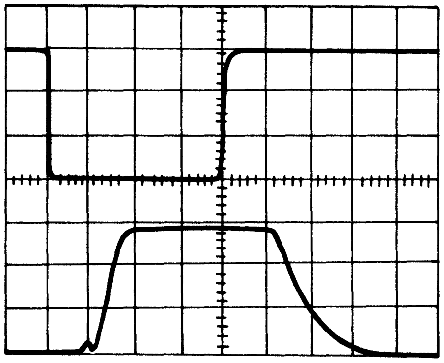


t_{ON}, t_{OFF}(TTL INPUT)
V_{IN} = 3.5V



Top: TTL Input Horizontal: 100ns/Div.
Bottom: Output Vertical: 2V/Div.

t_{ON}, t_{OFF}(CMOS INPUT)
V_{REF} = OPEN, V_{IN} = +15V



Top: CMOS Input Vertical: 5V/Div.
Bottom: Output Horizontal: 100ns/Div.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-506A/HI-507A

16 Channel Analog Multiplexer with Overvoltage Protection

FEATURES

- ANALOG/DIGITAL OVERVOLTAGE PROTECTION
- FAIL SAFE WITH POWER LOSS (NO LATCHUP)
- BREAK BEFORE MAKE SWITCHING
- DTL/TTL AND CMOS COMPATIBLE
- ANALOG SIGNAL RANGE ±15V
- ACCESS TIME 500ns TYP.
- SUPPLY CURRENT AT 1MHz ADDRESS TOGGLE 4mA TYP.
- STANDBY POWER 7.5mW TYP.

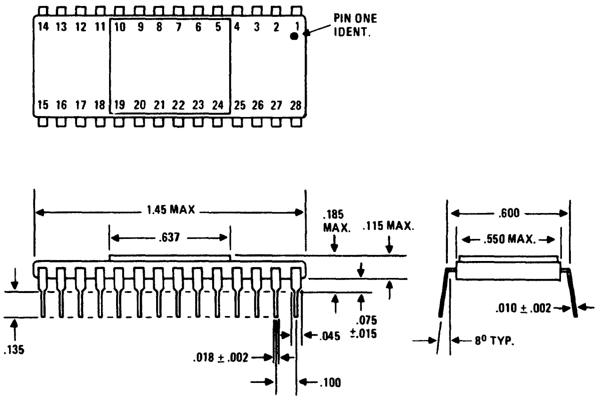
DESCRIPTION

The HI-506A and HI-507A analog multiplexers are constructed with the Harris Dielectric Isolation, Complementary MOS process. Digital and Analog inputs are protected from overvoltage inputs that exceed either supply voltage with no channel interaction. Channel interaction is also eliminated in the event of power loss. The HI-506A is a single-ended 16 channel multiplexer while the HI-507A is a differential 8 channel version. The devices are packaged in a 28 pin dual-in-line package and are available in both military and commercial temperature ranges.

PACKAGE

CODE 1L

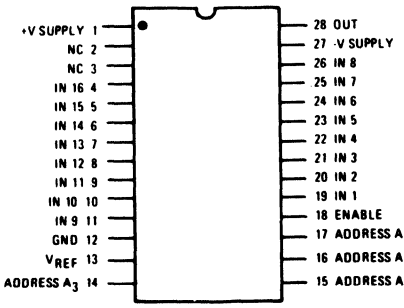
28 LEAD D.I.P.



PIN OUT/TRUTH TABLE

HI-506A

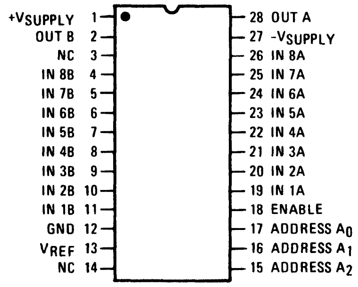
Top View



A_3	A_2	A_1	A_0	EN	"ON" CHANNEL
X	X	X	X	L	NONE
L	L	L	L	H	1
L	L	L	H	H	2
L	L	H	L	H	3
L	L	H	H	H	4
L	H	L	L	H	5
L	H	L	H	H	6
L	H	H	L	H	7
L	H	H	H	H	8
H	L	L	L	H	9
H	L	L	H	H	10
H	L	H	L	H	11
H	L	H	H	H	12
H	H	L	L	H	13
H	H	L	H	H	14
H	H	H	L	H	15
H	H	H	H	H	16

HI-507A

Top View



A_2	A_1	A_0	EN	"ON" SWITCH PAIR
X	X	X	L	NONE
L	L	L	H	1
L	L	H	H	2
L	H	L	H	3
L	H	H	H	4
H	L	L	H	5
H	L	H	H	6
H	H	L	H	7
H	H	H	H	8

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage Between Pins 1 and 27	40V
V_{REF} to Ground	+20V
V_{EN}, V_A, Digital Input Overvoltage:	

$$V_A \begin{cases} V_{Supply}(+) & +4V \\ V_{Supply}(-) & -4V \end{cases}$$

Analog Input Overvoltage:

$$V_S \begin{cases} V_{Supply}(+) & +20V \\ V_{Supply}(-) & -20V \end{cases}$$

Total Power Dissipation*	1200mW
Operating Temperature:	
HI-506A/HI-507A-2	-55°C to +125°C
HI-506A/HI-507A-5	0°C to +75°C
Storage Temperature	-65°C to +150°C

*Derate 8mW/°C above $T_A = +25°C$

ELECTRICAL CHARACTERISTICS

Unless Otherwise Specified.

Supplies = +15V, -15V; V_{REF} (Pin 13) = Open; V_{AH} (Logic Level High) = +4.0V; V_{AL} (Logic Level Low) = +0.8V

For Test Conditions, consult Performance Characterisitcs section.

		HI-506A/507A-2 -55°C to +125°C			HI-506A/507A-5 0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
ANALOG CHANNEL CHARACTERISTICS								
*V_S, Analog Signal Range	Full	-15		+15	-15		+15	V
*R_{ON}, On Resistance (Note 1)	+25°C		1.2	1.5		1.5	1.8	KΩ
	Full		1.5	2.0		1.8	2.0	KΩ
*$I_{S(OFF)}$, Off Input Leakage Current	+25°C		0.03			0.03		nA
	Full			±50			±50	nA
*$I_{D(OFF)}$, Off Output Leakage Current	+25°C		1.0			1.0		nA
HI-506A	Full			±500			±500	nA
HI-507A	Full			±250			±250	nA
*$I_{D(OFF)}$ with Input Overvoltage Applied (Note 2)	+25°C		4.0			4.0		nA
	Full			2.0				µA
*$I_{D(ON)}$, On Channel Leakage Current	+25°C		0.1			0.1		nA
HI-506A	Full			±500			±500	nA
HI-507A	Full			±250			±250	nA
DIGITAL INPUT CHARACTERISTICS								
V_{AL}, Input Low Threshold } TTL Drive (Note 7)	Full			0.8			0.8	V
V_{AH}, Input High Threshold } TTL Drive (Note 7)	Full	4.0			4.0			V
V_{AL} } MOS Drive (Note 3)	+25°C			0.8			0.8	V
V_{AH} } MOS Drive (Note 3)	+25°C	6.0			6.0			V
*I_A, Input Leakage Current (High or Low)	Full			1.0			5.0	µA
SWITCHING CHARACTERISTICS								
t_A, Access Time	+25°C		0.5	1.0		0.5		µs
t_{OPEN}, Break - Before Make Delay	+25°C		80			80		ns
$t_{ON\ (EN)}$, Enable Delay (ON)	+25°C		300			300		ns
$t_{OFF\ (EN)}$, Enable Delay (OFF)	+25°C		300			300		ns
"Off Isolation" (Note 4)	+25°C		65			65		dB
$C_{S\ (OFF)}$, Channel Input Capacitance	+25°C		5			5		pF
$C_{D\ (OFF)}$, Channel Output Capacitance HI-506A	+25°C		50			50		pF
HI-507A	+25°C		25			25		pF
C_A, Digital Input Capacitance	+25°C		5			5		pF
$C_{DS\ (OFF)}$, Input to Output Capacitance	+25°C		1			1		pF
POWER REQUIREMENTS								
P_D, Power Dissipation	Full		7.5			7.5		mW
*I+, Current Pin 1 (Note 5)	Full		0.5	2.0		0.5	5.0	mA
*I-, Current Pin 27 (Note 5)	Full		0.02	1.0		0.02	2.0	mA
*I+, Standby (Note 6)	Full		0.5	2.0		0.5	5.0	mA
*I-, Standby (Note 6)	Full		0.02	1.0		0.02	2.0	mA

NOTES

1. $V_{OUT} = \pm 10V$, $I_{OUT} = -100\mu A$
2. Analog Overvoltage = ± 33V
3. $V_{REF} = +10V$
4. $V_{EN} = 0.8V$, $R_L = 1K$, $C_L = 7pF$, $V_S = 3VRMS$, f = 500KHz
5. $V_{EN} = +4.0V$
6. $V_{EN} = 0.8V$
7. To drive from DTL/TTL circuits, 1KΩPull-up resistors to +5.0V supply are recommended

*100% Tested For DASH 8

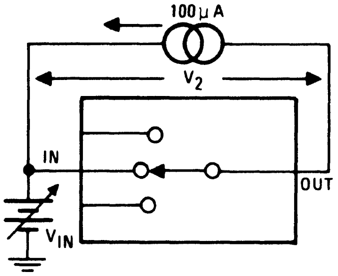
PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS

(UNLESS OTHERWISE SPECIFIED $T_A = 25^oC$, $V_{SUPPLY} = \pm15V$, $V_{AH} = +4V$, $V_{AL} = 0.8V$ AND V_{REF} = OPEN.)

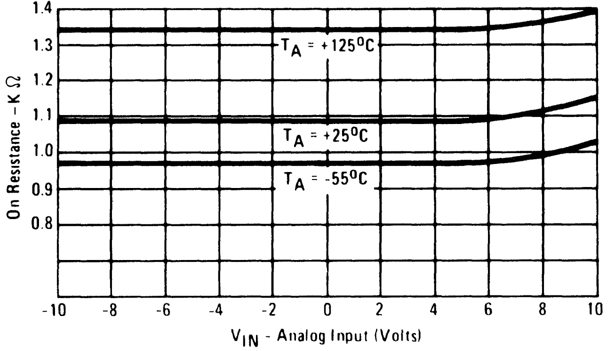
TEST CIRCUIT NO.1

ON RESISTANCE vs. INPUT SIGNAL LEVEL, SUPPLY VOLTAGE

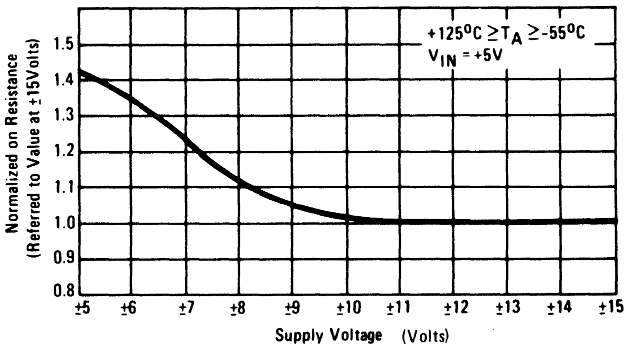
$$R_{ON} = \frac{V_2}{100\mu A}$$



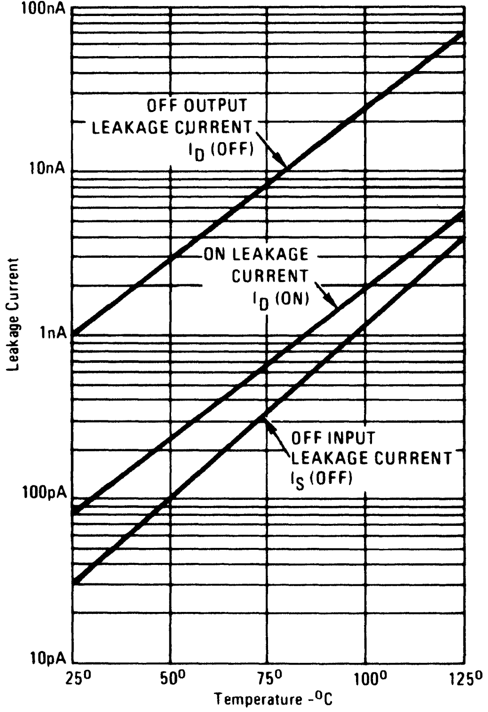
ON RESISTANCE vs. ANALOG INPUT VOLTAGE



NORMALIZED ON RESISTANCE vs. SUPPLY VOLTAGE

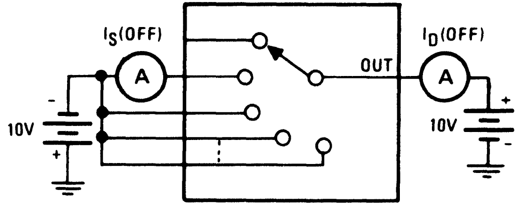


LEAKAGE CURRENT vs. TEMPERATURE



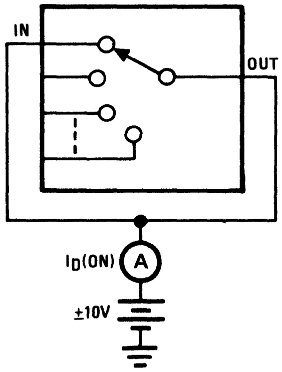
TEST CIRCUIT NO.2

OFF LEAKAGE CURRENT vs. TEMPERATURE

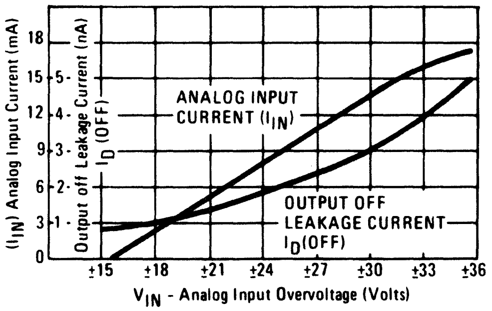


ON LEAKAGE CURRENT vs. TEMPERATURE

TEST CIRCUIT NO.3

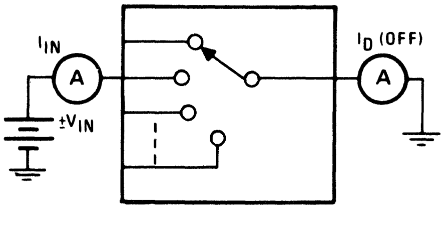


ANALOG INPUT OVERVOLTAGE CHARACTERISTICS

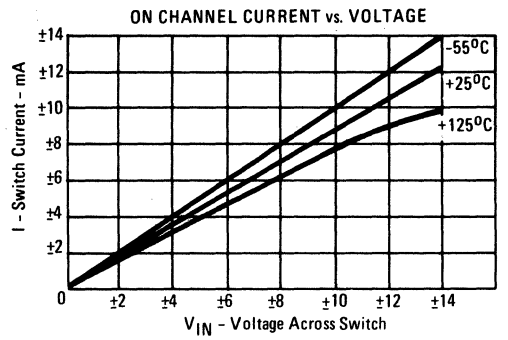


ANALOG INPUT OVERVOLTAGE CHARACTERISTICS

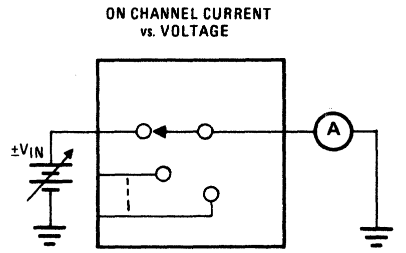
TEST CIRCUIT NO.4



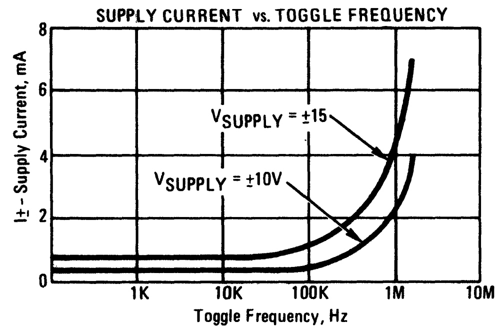
PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS (continued)

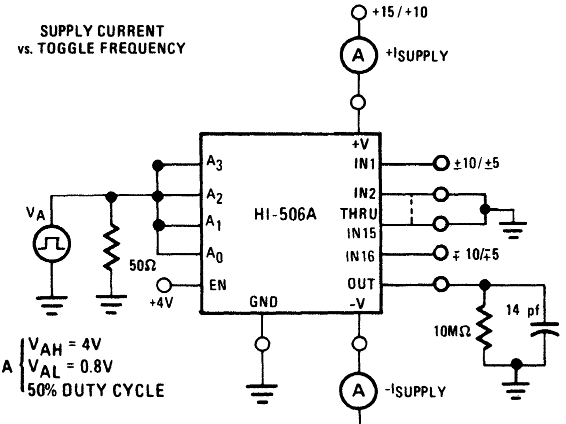


TEST CIRCUIT NO.5



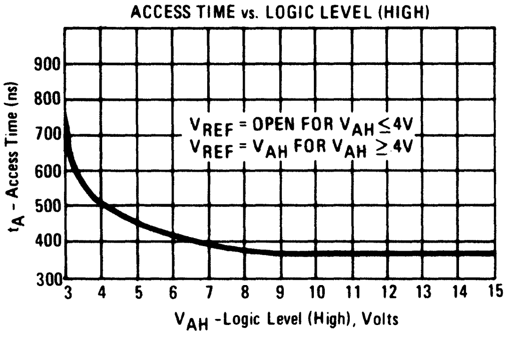
TEST CIRCUIT NO.6

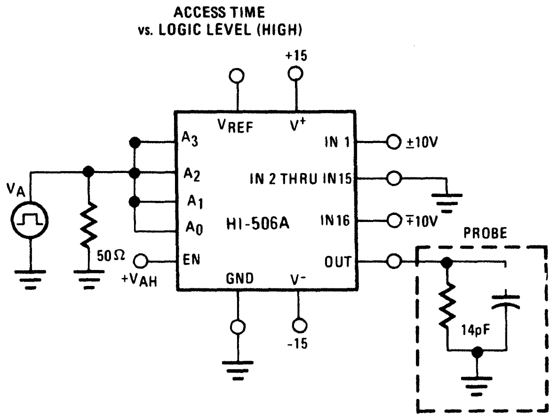




SIMILAR CONNECTION FOR HI-507A

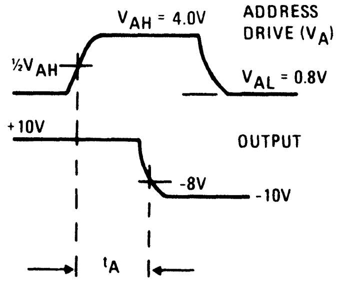
TEST CIRCUIT NO.7

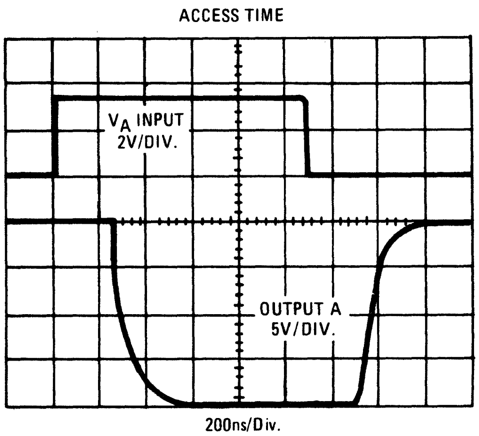




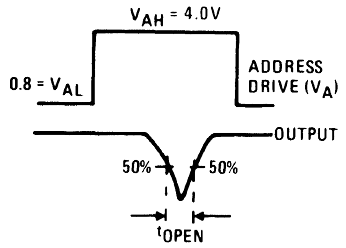
SIMILAR CONNECTION FOR HI-507A

SWITCHING WAVEFORMS



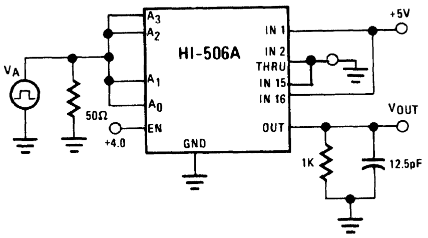


SWITCHING WAVEFORMS (continued)



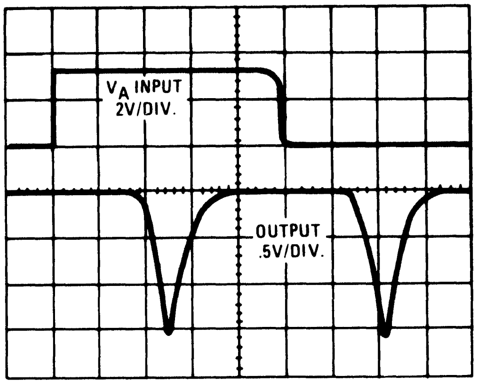
TEST CIRCUIT NO.8

BREAK BEFORE MAKE DELAY (t_{OPEN})

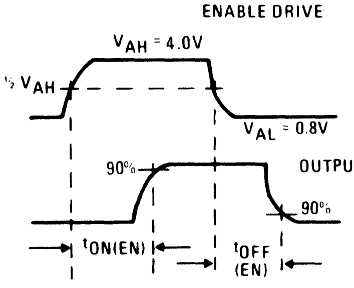


SIMILAR CONNECTION FOR HI-507A

BREAK BEFORE MAKE DELAY (t_{OPEN})

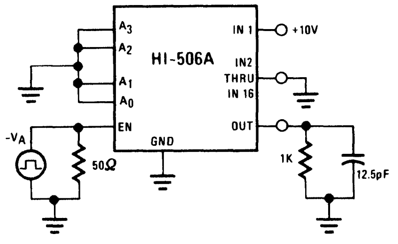


100ns/Div.



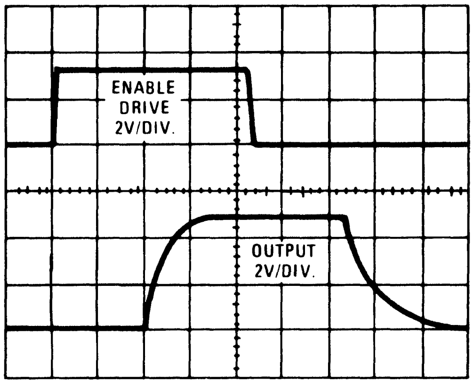
TEST CIRCUIT NO.9

ENABLE DELAY ($t_{ON(EN)}$, $t_{OFF(EN)}$)



SIMILAR CONNECTION FOR HI-507A

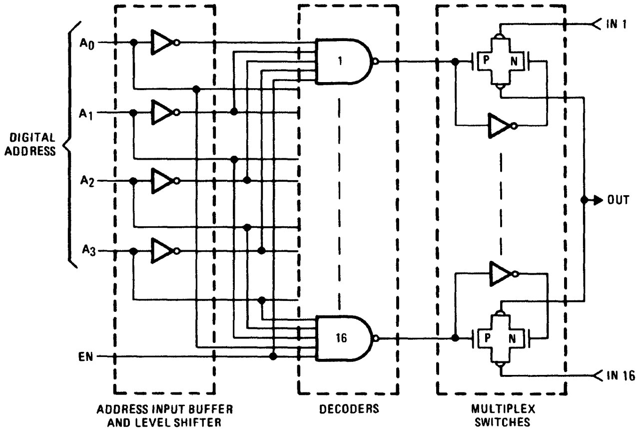
ENABLE DELAY ($t_{ON(EN)}$, $t_{OFF(EN)}$)



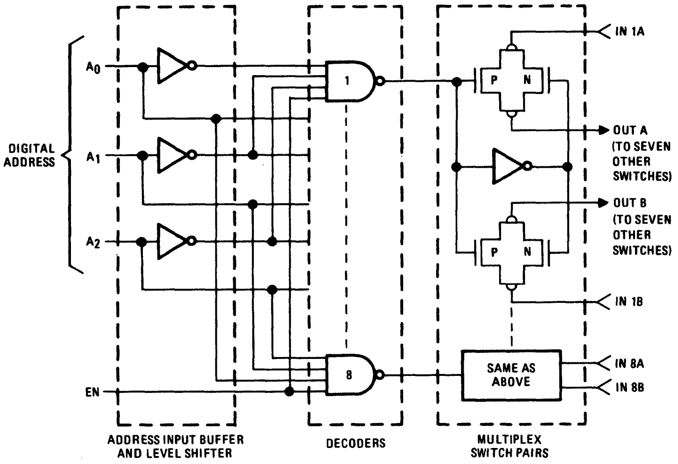
100ns/Div.

SCHEMATIC DIAGRAMS

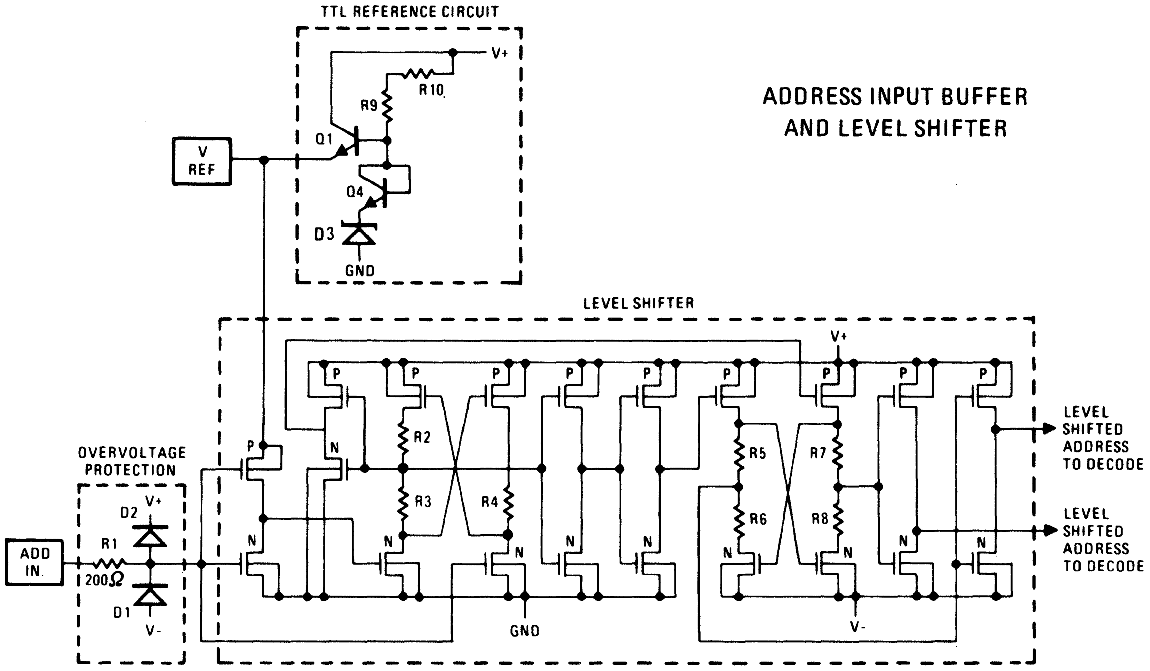
FUNCTIONAL BLOCK DIAGRAM HI-506A



FUNCTIONAL BLOCK DIAGRAM HI-507A

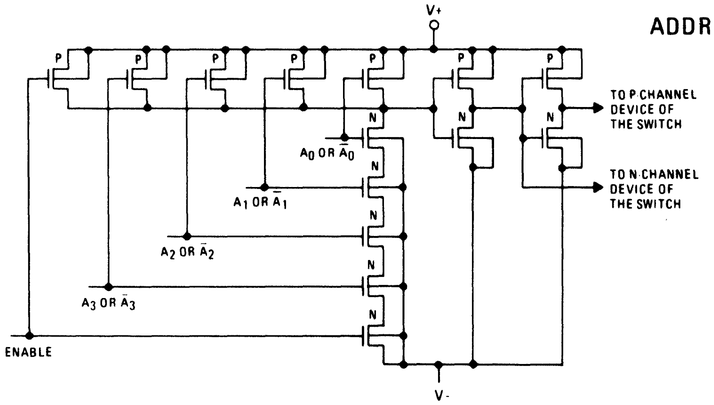


ADDRESS INPUT BUFFER AND LEVEL SHIFTER

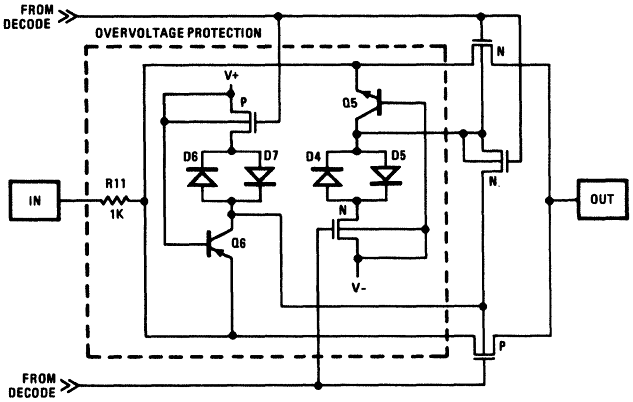


ADDRESS DECODER

DELETE A_3 or $\overline{A}_3$ INPUT FOR HI-507A



MULTIPLEX SWITCH



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-508A/509A

8 Channel Analog Multiplexers with Overvoltage Protection

FEATURES

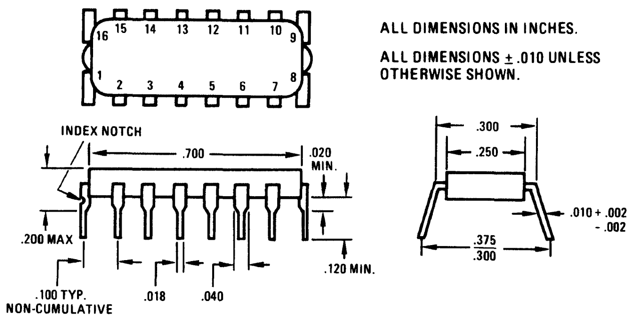
- ANALOG/DIGITAL OVERVOLTAGE PROTECTION
- FAIL SAFE WITH POWER LOSS
- BREAK BEFORE MAKE SWITCHING
- DTL / TTL AND CMOS COMPATIBLE
- ANALOG SIGNAL RANGE ±15V
- ACCESS TIME 500ns TYP.
- SUPPLY CURRENT AT 1MHz ADDRESS TOGGLE 4mA TYP.
- STANDBY POWER 7.5mW TYP.

DESCRIPTION

The HI-508A and HI-509A analog multiplexers are constructed with the Harris Dielectric Isolation, Complementary MOS process. Digital and Analog inputs are protected from overvoltage inputs that exceed either supply voltage with no channel interaction. Channel interaction is also eliminated in the event of power loss. The HI-508A is a single-ended 8 channel multiplexer while the HI-509A is a differential 4 channel version. The devices are packaged in a 16 pin dual-in-line package and are available in both military and commercial temperature ranges.

PACKAGE

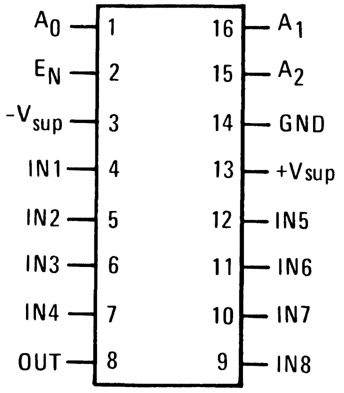
CODE 1F 16 LEAD D.I.P.



ALL DIMENSIONS IN INCHES.
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

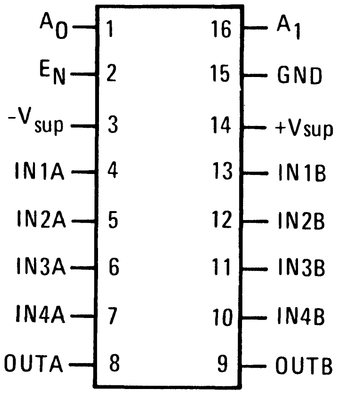
PIN OUT/TRUTH TABLE

HI-508A



A_2	A_1	A_0	E_N	"ON" CHANNEL
X	X	X	L	NONE
L	L	L	H	1
L	L	H	H	2
L	H	L	H	3
L	H	H	H	4
H	L	L	H	5
H	L	H	H	6
H	H	L	H	7
H	H	H	H	8

HI-509A



A_1	A_0	EN	ON SWITCH PAIR
X	X	L	NONE
L	L	H	1
L	H	H	2
H	L	H	3
H	H	H	4

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage between Supply Pins	40V

V_{EN}, V_A, Digital Input Overvoltage:

$$V_A \begin{cases} V_{Supply}(+) +4V \\ V_{Supply}(-) -4V \end{cases}$$

Analog Input Overvoltage:

$$V_S \begin{cases} V_{Supply}(+) +20V \\ V_{Supply}(-) -20V \end{cases}$$

Total Power Dissipation*	725 mW
Operating Temperature:	
HI-508A/HI-509A-2	-55°C to +125°C
HI-508A/HI-509A-5	0°C to +75°C
Storage Temperature	-65°C to +150°C

*Derate 8mW/°C above t_A = 75°C

ELECTRICAL CHARACTERISTICS

Unless Otherwise Specified.

Supplies = +15V, -15V; V_{REF} (Pin 13) = Open; V_{AH} (Logic Level High) = +4.0V; V_{AL} (Logic Level Low) = +0.8V

For Test Conditions, consult Performance Characterisitcs section.

		HI-508A/509A-2			HI-508A/509A-5			
		-55°C to +125°C			0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP	MAX.	UNITS
ANALOG CHANNEL CHARACTERISTICS								
*V_S, Analog Signal Range	Full	-15		+15	-15		+15	V
* R_{ON}, On Resistance (Note 1)	+25°C		1.2	1.5		1.5	1.8	K Ω
	Full		1.5	1.8		1.8	2.0	K Ω
* $I_{S(OFF)}$, Off Input Leakage Current	+25°C		0.03			0.03		nA
	Full			±50			±50	nA
*$I_{D(OFF)}$, Off Output Leakage Current	+25°C		1.0			1.0		nA
	Full			±250			±250	nA
*$I_{D(OFF)}$ with Input Overvoltage Applied (Note 2)	+25°C		4.0			4.0		nA
	Full			2.0				μA
*$I_{D(ON)}$, On Channel Leakage Current	+25°C		0.1			0.1		nA
	Full			±250			±250	nA
DIGITAL INPUT CHARACTERISTICS								
V_{AL}, Input Low Threshold (Note 6)	Full			0.8			0.8	V
V_{AH}, Input High Threshold (Note 6)	Full	4.0			4.0			V
*I_A, Input Leakage Current (High or Low)	Full			1.0			1.0	μA
SWITCHING CHARACTERISTICS								
t_A, Access Time	+25°C		0.5	1.0		0.5		μs
t_{OPEN}, Break - Before Make Delay	+25°C		80			80		ns
$t_{ON(EN)}$, Enable Delay (ON)	+25°C		300			300		ns
$t_{OFF (EN)}$, Enable Delay (OFF)	+25°C		300			300		ns
"OFF Isolation" (Note 3)	+25°C		65			65		dB
$C_{S (OFF)}$, Channel Input Capacitance	+25°C		5			5		pF
$C_{D (OFF)}$, Channel Output Capacitance								
HI-508A	+25°C		25			25		pF
HI-509A	+25°C		12			12		pF
C_A, Digital Input Capacitance	+25°C		5			5		pF
$C_{DS (OFF)}$, Input to Output Capacitance	+25°C		0.1			0.1		pF
POWER REQUIREMENTS								
P_D, Power Dissipation	Full		7.5			7.5		mW
* I+, Current (Note 4)	Full		0.5	2.0		0.5	5.0	mA
*I-, Current (Note 4)	Full		0.02	1.0		0.02	2.0	mA
*I+, Standby (Note 5)	Full		0.5	2.0		0.5	5.0	mA
* I-, Standby (Note 5)	Full		0.02	1.0		0.02	2.0	mA

NOTES:
1. $V_{OUT} = \pm 10V$, $I_{OUT} = -100\mu A$
2. Analog Overvoltage = ± 33V
3. V_{EN} = 0.8V, R_L = 1K, C_L = 7pF, V_S = 3V RMS, f = 500KHz
4. V_{EN} = +4.0V
5. V_{EN} = 0.8V
6. To drive from DTL/TTL Circuits, 1KΩ pull-up resistors to +5.0V supply are recommended

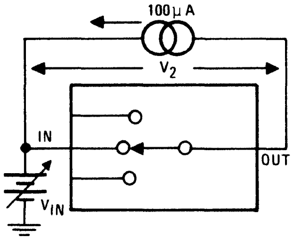
*100% Tested For DASH 8

PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS

(UNLESS OTHERWISE SPECIFIED $T_A = 25^oC$, $V_{SUPPLY} = \pm 15V$, $V_{AH} = +4V$, $V_{AL} = 0.8V$

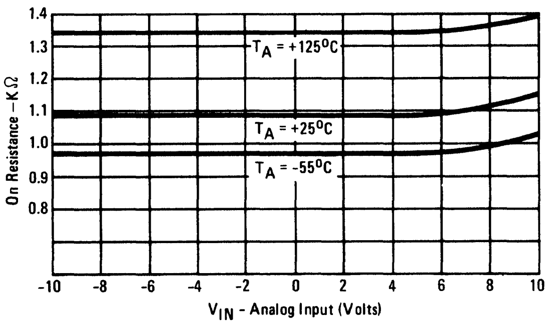
TEST CIRCUIT NO. 1

$R_{ON} = \frac{V_2}{100 \mu A}$

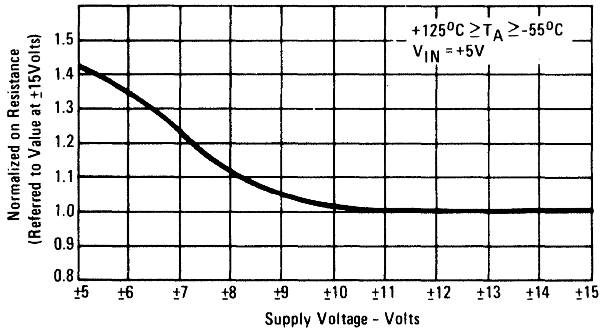


ON RESISTANCE vs. INPUT SIGNAL LEVEL, SUPPLY VOLTAGE

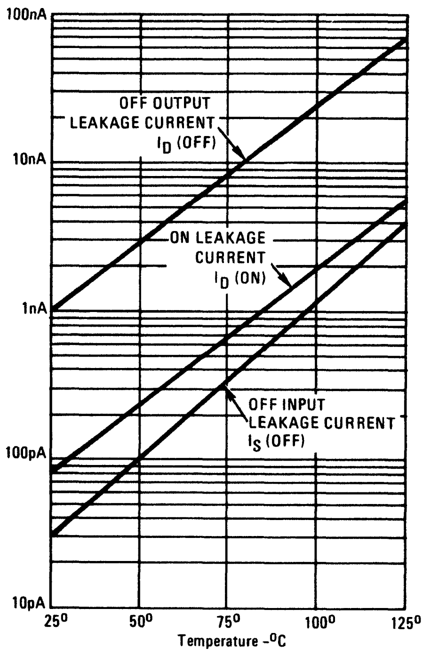
ON RESISTANCE vs. ANALOG INPUT VOLTAGE



NORMALIZED ON RESISTANCE vs. SUPPLY VOLTAGE

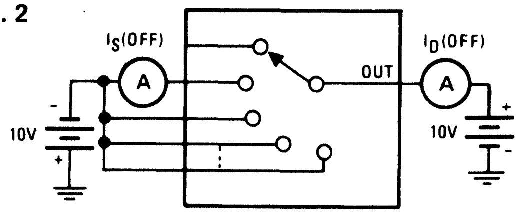


LEAKAGE CURRENT vs. TEMPERATURE



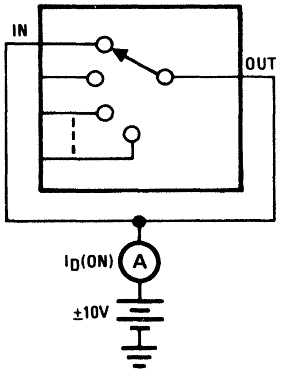
TEST CIRCUIT NO. 2

OFF LEAKAGE CURRENT vs. TEMPERATURE

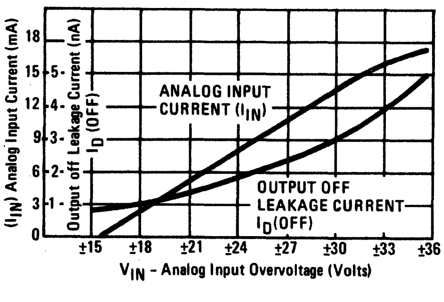


ON LEAKAGE CURRENT vs. TEMPERATURE

TEST CIRCUIT NO. 3

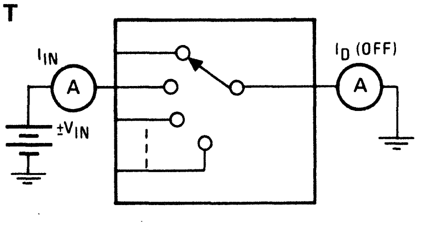


ANALOG INPUT OVERVOLTAGE CHARACTERISTICS



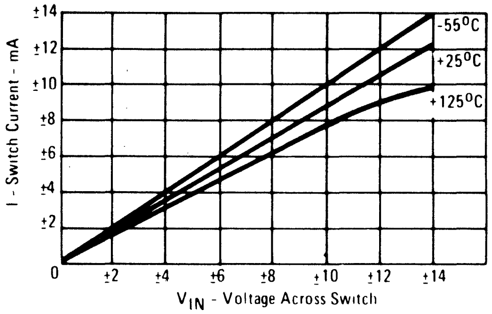
ANALOG INPUT OVERVOLTAGE CHARACTERISTICS

TEST CIRCUIT NO. 4



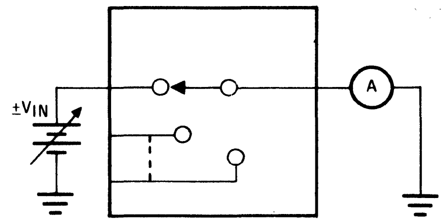
PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS (continued)

ON CHANNEL CURRENT vs. VOLTAGE



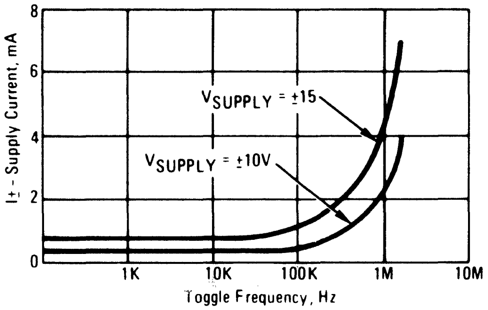
TEST CIRCUIT NO.5

ON CHANNEL CURRENT vs. VOLTAGE

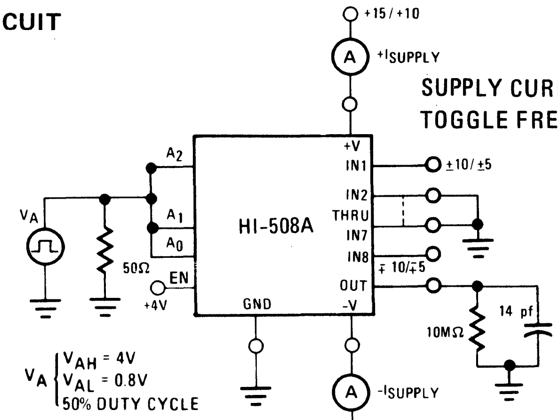


TEST CIRCUIT NO.6

SUPPLY CURRENT vs. TOGGLE FREQUENCY



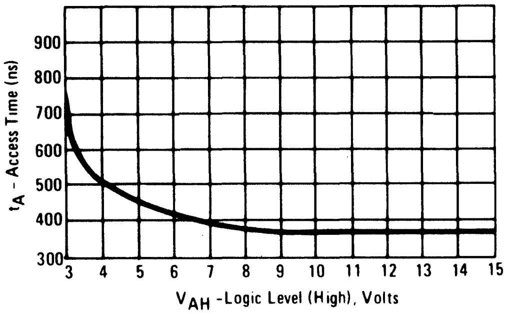
SUPPLY CURRENT vs. TOGGLE FREQUENCY



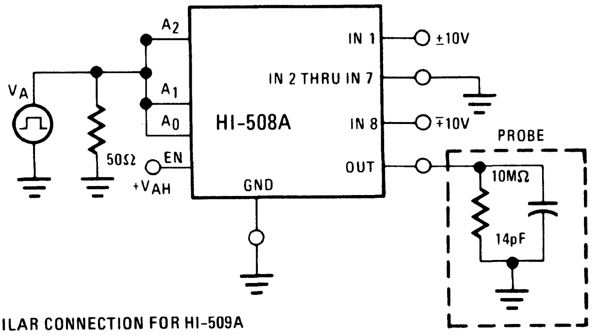
*SIMILAR CONNECTION FOR HI-509A

TEST CIRCUIT NO.7

ACCESS TIME vs. LOGIC LEVEL (HIGH)

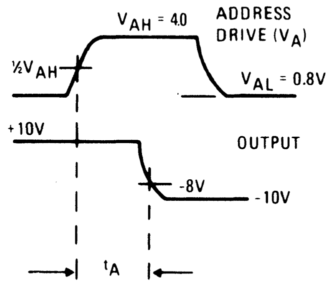


ACCESS TIME vs. LOGIC LEVEL(HIGH)

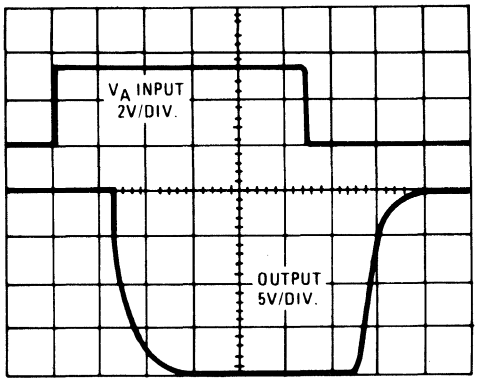


* SIMILAR CONNECTION FOR HI-509A

SWITCHING WAVEFORMS



ACCESS TIME

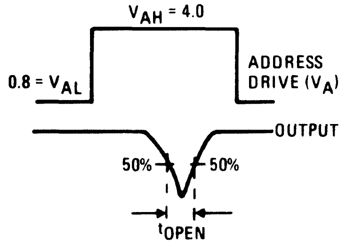


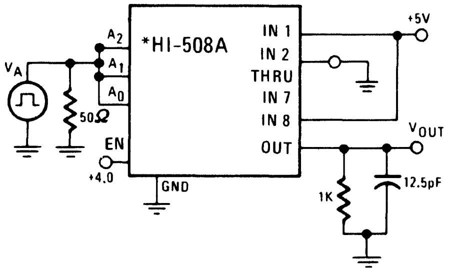
200ns/Div.

SWITCHING WAVEFORMS *(continued)*

TEST CIRCUIT NO. 8

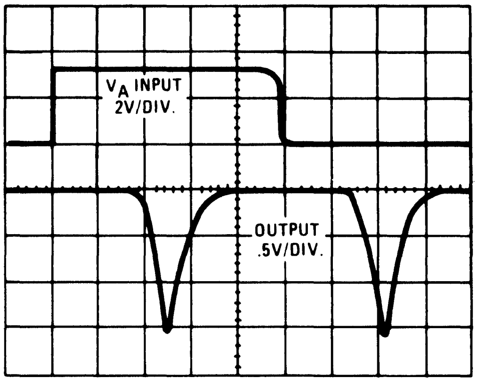
BREAK BEFORE MAKE DELAY (t_{OPEN})





*SIMILAR CONNECTION FOR HI-509A

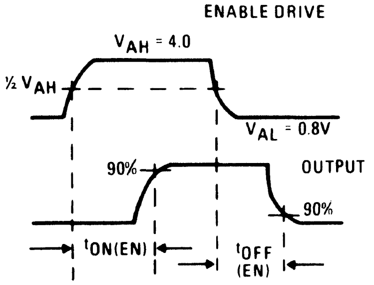
BREAK BEFORE MAKE DELAY (t_{OPEN})

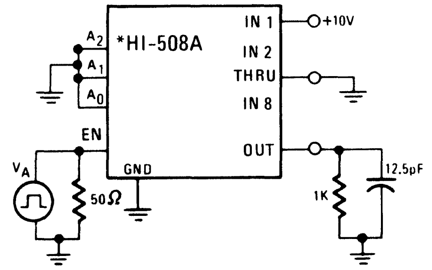


100ns/Div.

TEST CIRCUIT NO. 9

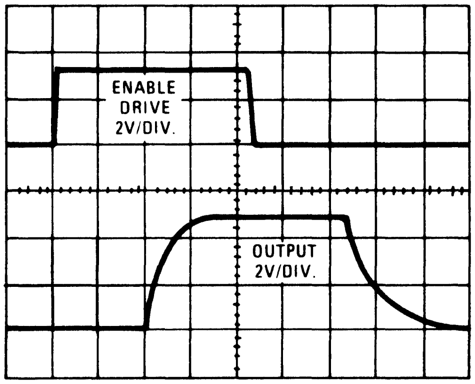
ENABLE DELAY ($t_{ON(EN)}$, $t_{OFF(EN)}$)





* SIMILAR CONNECTION FOR HI-509A

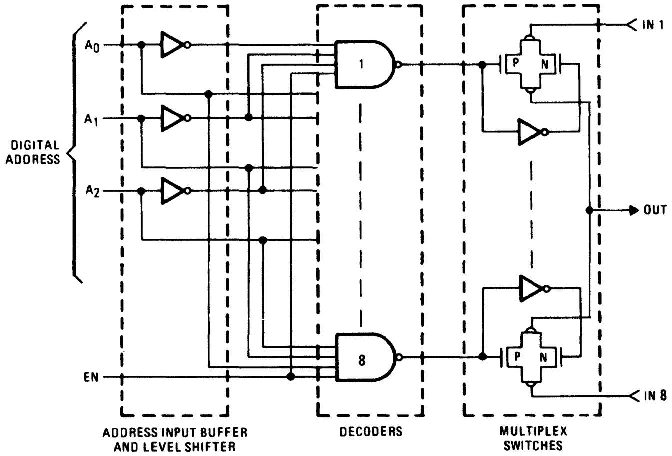
ENABLE DELAY ($t_{ON(EN)}$, $t_{OFF(EN)}$)



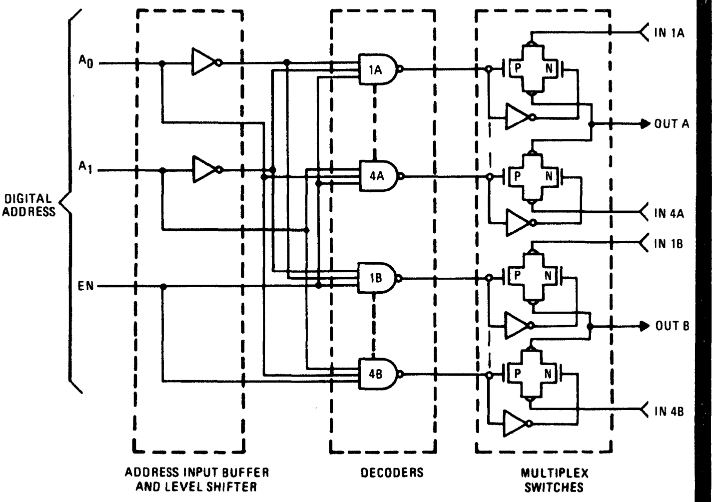
100ns/Div.

SCHEMATIC DIAGRAMS

FUNCTIONAL BLOCK DIAGRAM HI-508A

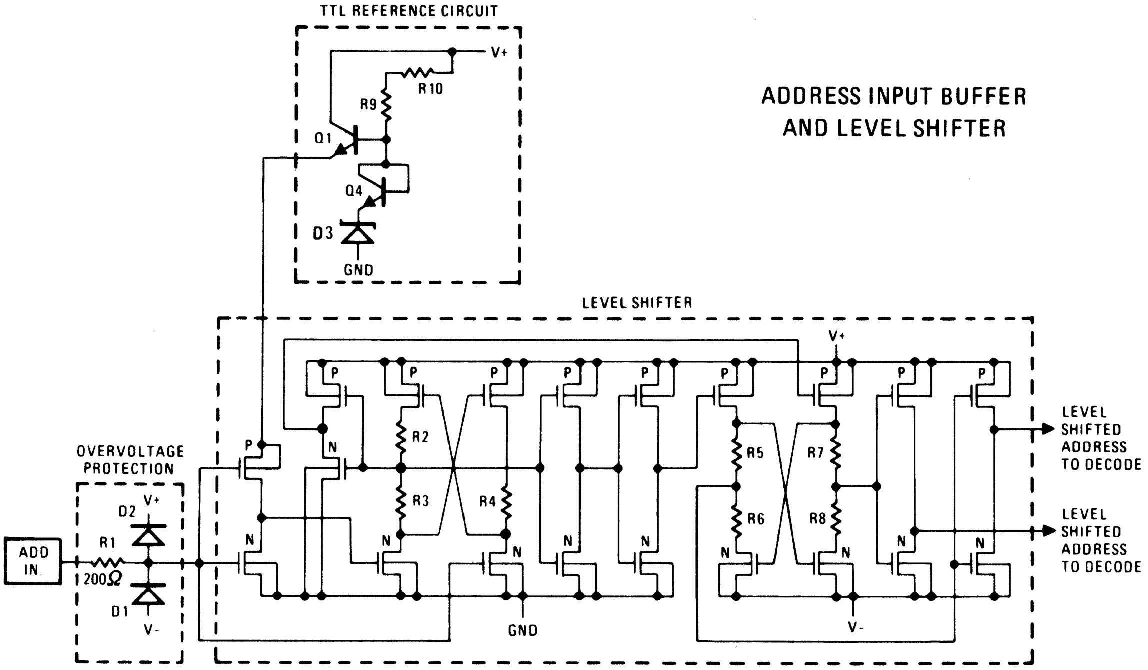


FUNCTIONAL BLOCK DIAGRAM HI-509A



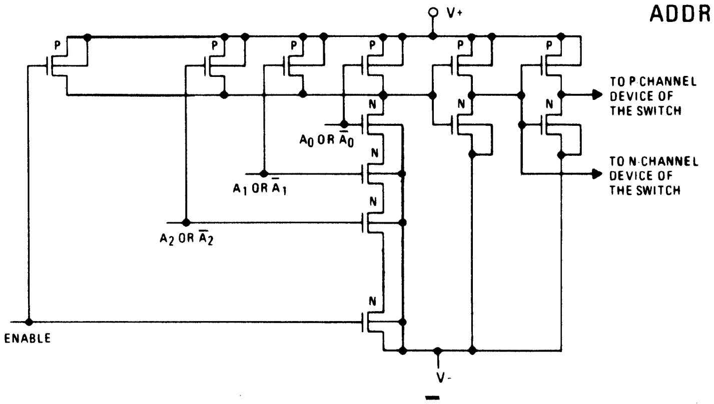
SCHEMATIC DIAGRAMS (continued)

ADDRESS INPUT BUFFER AND LEVEL SHIFTER

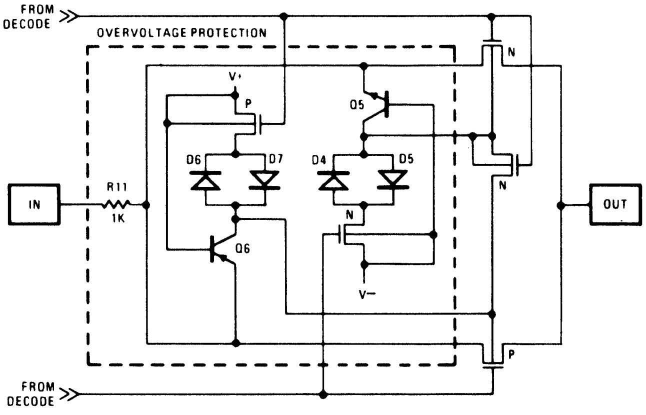


ADDRESS DECODER

DELETE A_2 OR $\overline{A}_2$ INPUT FOR HI-509A



MULTIPLEX SWITCH



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-1080/HI-1085

8-Bit D to A Converter
High Speed Monolithic

FEATURES

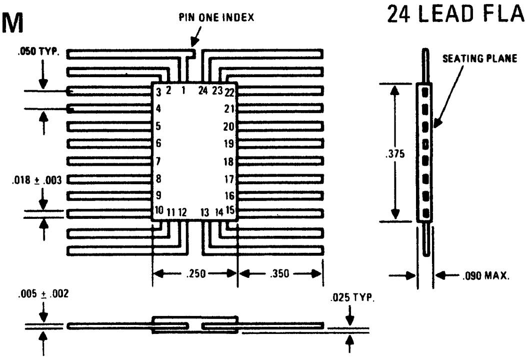
- ACCURACY – (HI-1080) } Guaranteed −55° to +125°C; (HI-1085) } or 0° to +75°C
- SPEED – 1.5 Microseconds settling to ½ L.S.B.
- VERSATILITY – Unipolar, Bipolar, Offset Operation
  - Positive or Negative External Reference
  - Taps Provided for Scale Factor Adjustment
  - Provision for Cascading Converters
  - Matched Amplifier Feedback Resistors
  - Inputs DTL/TTL Compatible
- RELIABILITY – Monolithic Construction
  - Meets Requirements of MIL-STD-883

GENERAL DESCRIPTION

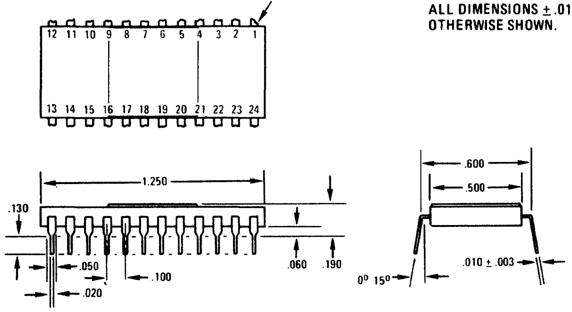
The HI-1080/1085 is a current switching converter complete with a precision thin film R-2R ladder resistor network on a single monolithic chip. It is ideal for general purpose high speed, moderate accuracy digital-analog interfaces. It is particularly suitable as part of a high speed successive approximation or up-down counter type A to D converter.

PACKAGES

CODE 9M 24 LEAD FLAT PACK

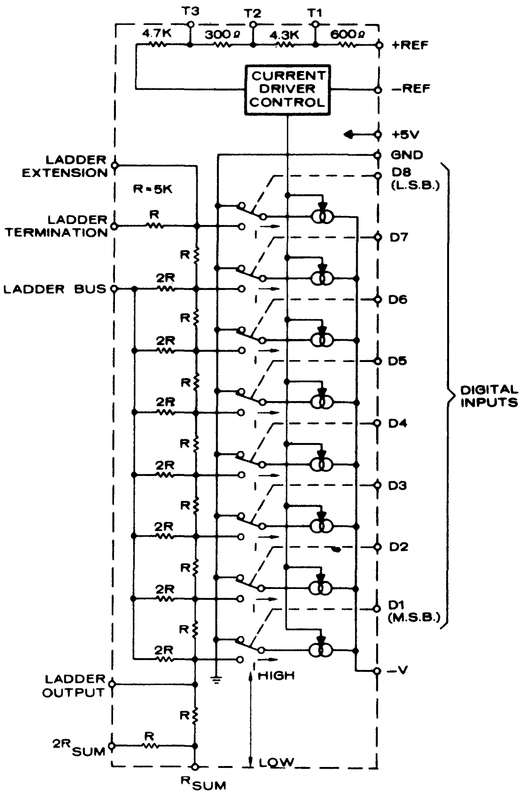


CODE 1H 24 LEAD D.I.P.

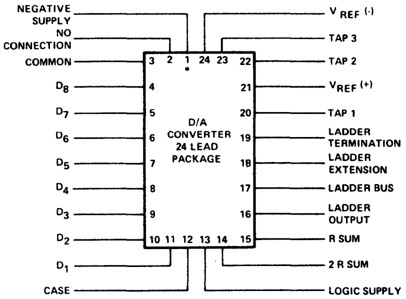


ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

FUNCTIONAL DIAGRAM



PIN CONFIGURATION



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Maximum ratings are limiting values above which permanent circuit damage may occur.

Voltage
  V +: +8.0V
  V - : -18.0V

Ladder Common:
  ±8.0V
  I_{REF}: 1.6 mA

Storage Temp:
  -65°C ≤ TA ≤ +150°C
Power Dissipation:
  450 mW *

Digital Inputs: +5.5V

*Derate at 4mW/°C above 85°C ambient.

ELECTRICAL CHARACTERISTICS

Unless otherwise stated all measurements taken at $V^+ = +5V$, $V^- = -15V$
$V_{REF} = +5V$, $V_{in}High = +2.4V$, $V_{in}Low = +0.4V$
Unipolar, zero reference connection (Figure 3)

	HI-1080 TEMP	LIMITS MIN	TYP	MAX	UNITS	HI-1085 TEMP	LIMITS MIN	TYP	MAX	UNITS
* Resolution		8			Bits		8			Bits
* Accuracy (Calibrated at 25°C) (Note 1)	+25°C -55°C to +125°C		1/4 1/2	1/2 1	L.S.B.	0°C to +75°C		1/2	1	L.S.B.
* $V_{Full\ Scale}$ (Note 2) (Uncalibrated)	+25°C	-4.5	-4.98	-5.5	Volts	+25°C	-4.5	-4.98	-5.5	Volts
Power Supply Rejection (Note 3)	-55°C to +125°C	.05	.001		L.S.B. per Volt	0°C to +75°C	.05	.001		L.S.B. per Volt
Settling Time (Note 4)	+25°C		1.5	3.0	µs	+25°C		1.5		µs
Digital Inputs: High Threshold				2.0	Volts				2.0	Volts
Low Threshold (Note 5)		0.8			Volts		0.8			Volts
I_{in}High	-55°C to +125°C		.01	1	µA	0°C to +75°C		.01	1	µA
I_{in}Low (Note 6)			-0.7	-1.0	mA			-0.7	-1.0	mA
Supply Current: * I^+	-55°C to +125°C		8	10	mA	0°C to +75°C		8	10	mA
* I^-			8	10	mA			8	10	mA
* I_{REF} (Note 7)			0.5	0.6	mA			0.5	0.6	mA

NOTES: Test Conditions –

1. Any Input Combination
2. Inputs all low
3. $\Delta V_{OUT}/\Delta V_{SUPPLY}$
   $V^+ = +5 \pm 0.5V$
   $V^- = -15 \pm 3V$
4. To ±0.2% of full scale after full scale input step
   $R_L > 10\ M\Omega$
   $C_L < 5pF$
5. $V^+ = 4.5V$
6. $V_{in} = 2.4$ Volts
   $V^+ = 5.5V$
   $V_{in} = 0.4$ Volts
   $V^+ = 5.5V$
7. $V^+ = +5.0V$
   $V^- = -15.0V$
   $V_{REF} = +5.0V$
   Inputs all low

*100% Tested For DASH 8

PERFORMANCE CURVES

TYPICAL OUTPUT ACCURACY VS. TEMPERATURE

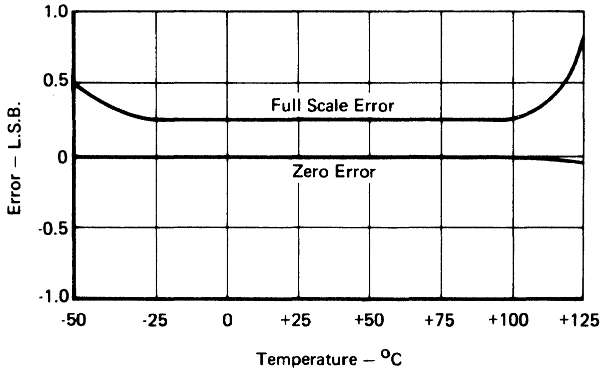


Figure 1

TYPICAL SETTLING TIME

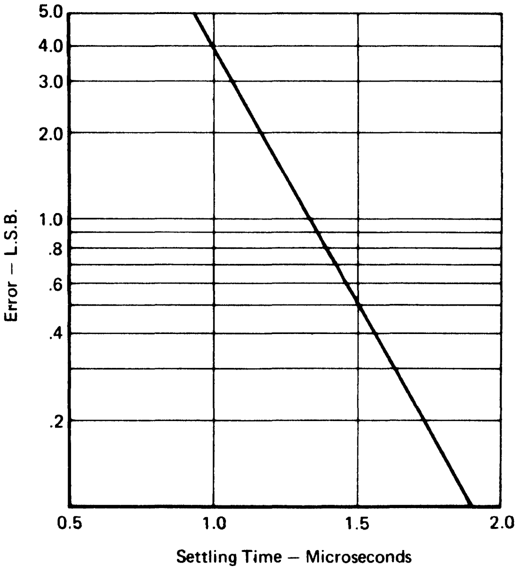
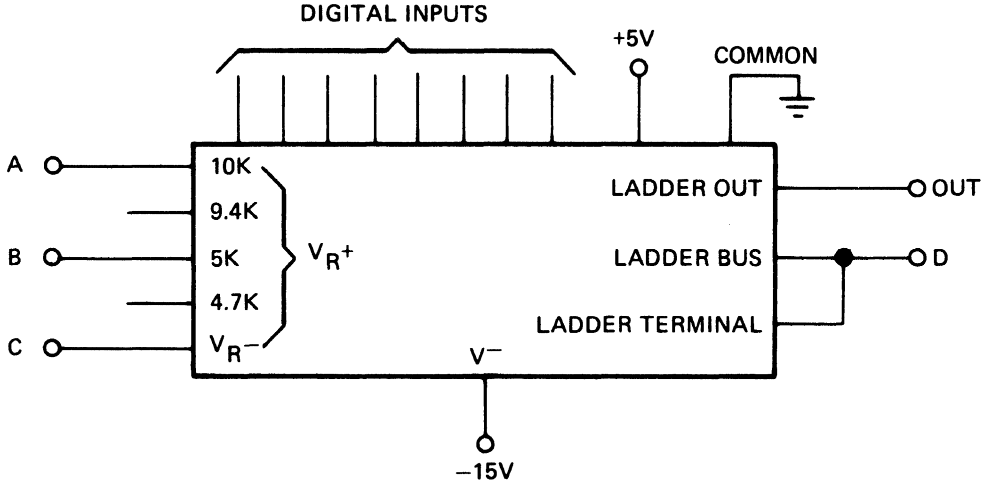


Figure 2

OPERATION MODES

D/A CONVERTER OPERATION MODES



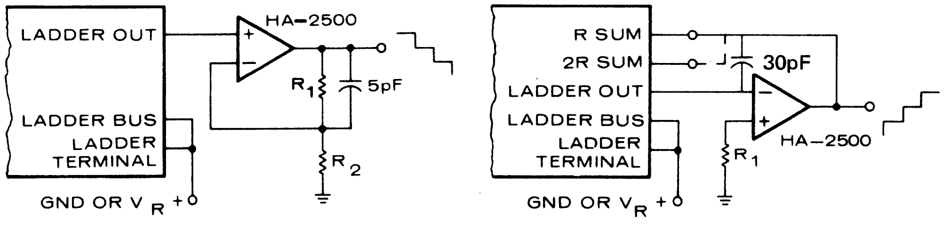
MODE	OUTPUT RANGE INPUTS: ALL HIGH TO ALL LOW	CONNECTIONS			
		A	B	C	D
UNIPOLAR ZERO REFERENCE	0 TO – V_R+ – 1 L.S.B.	V_R+	N.C.	GND	GND
UNIPOLAR ZERO F.S.	+ / V_R+/ TO 0 + 1 L.S.B.	V_R+	N.C.	GND	V_R
BIPOLAR	/V_R+/ TO –V_R + 1 L.S.B.	N.C.	V_R+	GND	V_R+

OPERATING MODES

Figure 3

* Tap 1 or Tap 3 with selected external series resistor may be sûbstituted for points A or B, respectively, for fine adjustment of output range.

BUFFER AMPLIFIER CONNECTION



NON–INVERTING OUTPUT
(MORE NEGATIVE WITH INCREASING
COMPLEMENT OF INPUT NUMBER)

OUTPUT RANGE: SAME AS SHOWN
ON 'CHART 'OPERATING MODE' CHART
MULTIPLIED BY $\frac{R2}{R_1 + R_2}$

INVERTING OUTPUT
(MORE POSITIVE WITH INCREASING
COMPLEMENT OF INPUT NUMBER)

FULL SCALE OUTPUT	OUTPUT FEEDBACK CONNECTED TO :	R_1
+4.98V	SUM	2.5K
+9.96V	$2R_{SUM}$	3.3K

Figure 4

CASCADED UNITS FOR 12 BIT RESOLUTION

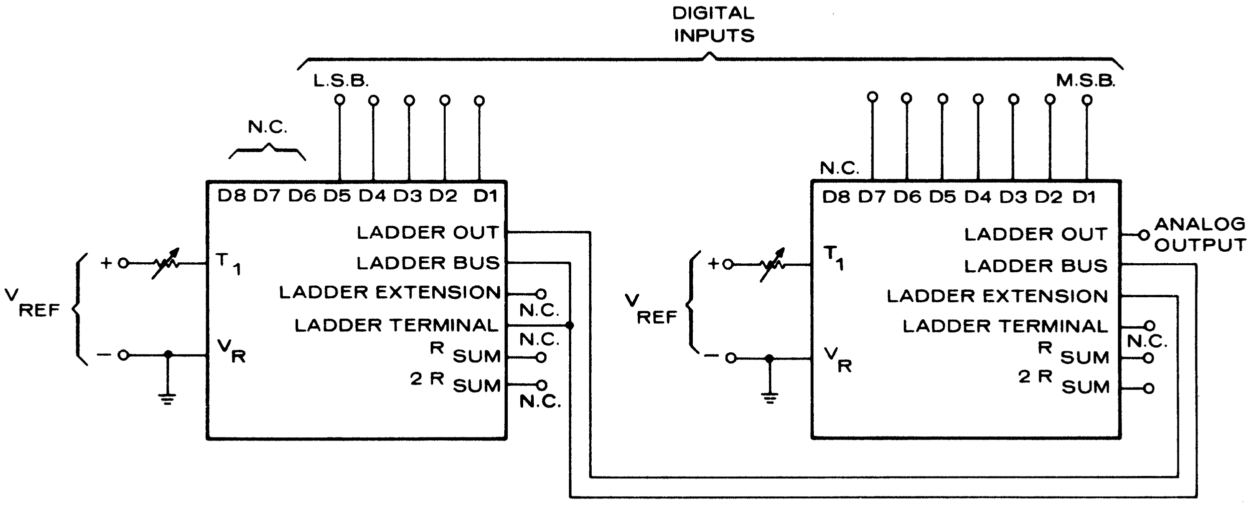


Figure 5

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-1800A

Analog Switch Four-Channel

FEATURES

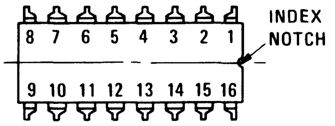
SIGNAL RANGE	±15V
"ON" RESISTANCE	125Ω TYP.
LEAKAGE AT +125°C	40 nA TYP.
ACCESS TIME	500 ns TYP.
DTL/TTL COMPATIBLE ADDRESS	
-55°C to +125°C OPERATION	

DESCRIPTION

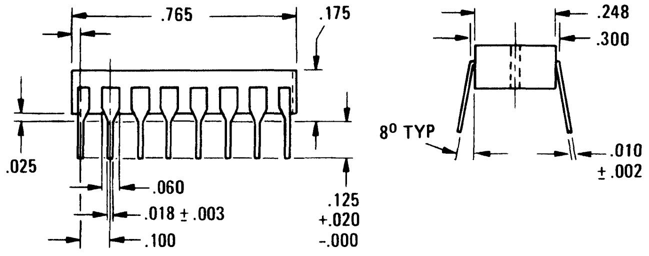
The HI-1800A is a general purpose analog switch which may be used as a signal selector, multiplexer, chopper, or cross-point switch for signals from D.C. to R.F. The configuration is two independent DPST switches with versatile TTL compatible addressing logic which allows connection as two SPDT, or a single DPDT, SPDT, or SPST switch by connection of external jumpers. ON resistance decreases correspondingly when switching elements are connected in parallel. The HI-1800A is fabricated on a single dielectrically isolated chip using complementary N and P channel MOS devices. This unique process produces exceptionally low leakage currents (even at +125°C), constant ON resistance, low power dissipation, and fast switching. The HI-1800A is available in a hermetic 16 pin dual-in-line package.

PACKAGE

CODE 1W 16 LEAD CERAMIC D.I.P.



ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

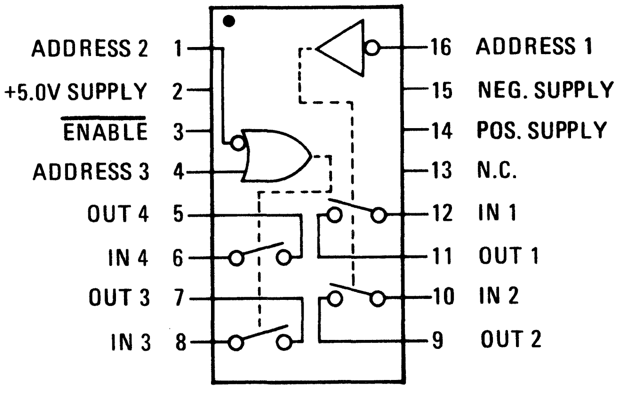


TRUTH TABLE

INPUT ADDRESS				SWITCH CHANNELS			
A1	A2	A3	$\overline{EN}$	1	2	3	4
L	X	X	L	ON	ON		
H	X	X	L	OFF	OFF		
X	L	X	L			ON	ON
X	X	H	L			ON	ON
X	H	L	L			OFF	OFF
X	X	X	H	OFF	OFF	OFF	OFF

H≥+4.0V L≤+0.4V

PIN FUNCTIONS



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage Between Pins 14 and 15	40.0V	Digital Input Voltage	V^-_{Supply}, V^+_{Supply}
Logic Supply Voltage, Pin 2	30.0V	Total Power Dissipation	780 mW (Note 2)
Analog Input Voltage: V^+_{Supply} +2V	V^-_{Supply} -2V	Storage Temperature Range	−65°C to +150°C

ELECTRICAL CHARACTERISTICS

Supplies = +15V, -15V, +5.0V

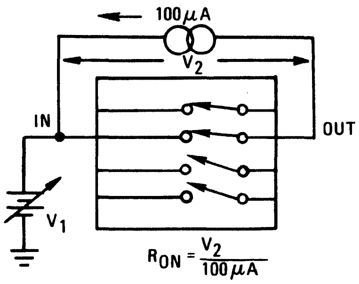
PARAMETER	TEMP.	HI-1800A-2 -55°C to +125°C			HI-1800A-5 0°C to +75°C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
ANALOG CHANNEL CHARACTERISTICS								
* V_{IN}, Analog Signal Range	Full	-15		+15	-15		+15	V
* R_{ON}, ON Resistance (Note 3)	+25°C Full		125	200 250		125	200 250	Ω Ω
* I_S (OFF), Input Leakage Current	Full		40	100		40	100	nA
* I_D (OFF), Output Leakage Current	Full		40	100		40	100	nA
* I_D (ON), On Channel Leakage Current	Full		40	100		40	100	nA
DIGITAL INPUT CHARACTERISTICS								
V_{IL}, Input Low Threshold	Full			0.4			0.4	V
V_{IH}, Input High Threshold (Note 4)	Full	4.0			4.0			V
* I_{IN}, Input Leakage Current	Full		.01	1		.01	1	µA
SWITCHING CHARACTERISTICS								
t_A, Access Time (Note 5)	+25°C		500			500		ns
Break-Before-Make Delay	+25°C		200			200		ns
C_{IN}, Channel Input Capacitance	+25°C		8			8		pF
C_{OUT}, Channel Output Capacitance	+25°C		8			8		pF
C_D, Digital Input Capacitance	+25°C		5			5		pF
POWER REQUIREMENTS								
P_D, Power Dissipation	Full		10			10		mW
P_{DS}, Standby Power (Note 6)	Full		10			10		mW
* I_+, Current Pin 14	Full		0.001	0.5		0.001	1	mA
* I_-, Current Pin 15	Full		0.5	1		0.5	2	mA
* I_L, Current Pin 2	Full		0.5	1		0.5	2	mA

NOTES:
1. Voltage ratings apply when voltages at all other pins are within their nominal operating ranges.
2. Derate 9.25 mW/°C above t_A = +75°C
3. $V_{OUT} = \pm 10V$ $I_{OUT} = -100\mu A$.
4. To drive from DTL/TTL circuits, 1K pullup resistors to +5.0V supply are recommended.
5. Time measured to 90% of final output level; V_{OUT} = -5.0V to +5.0V, Digital Inputs = 0.4V to +4.0V.
6. Voltage at Pin 3, $\overline{\text{ENABLE}} \geq +4.0V$.

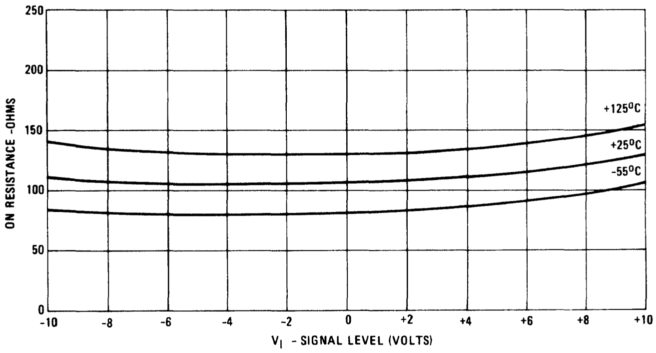
*100% Tested For DASH 8

PERFORMANCE CHARACTERISTICS

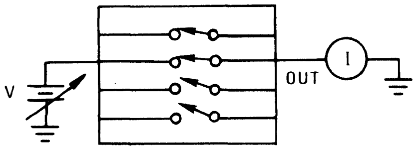
ON RESISTANCE vs ANALOG SIGNAL LEVEL



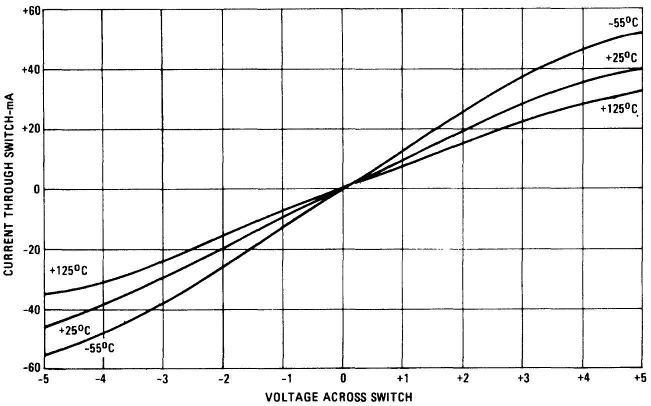
Test Circuit



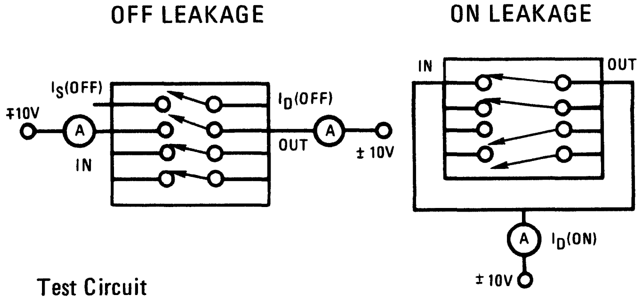
ON CHANNEL CURRENT vs VOLTAGE



Test Circuit

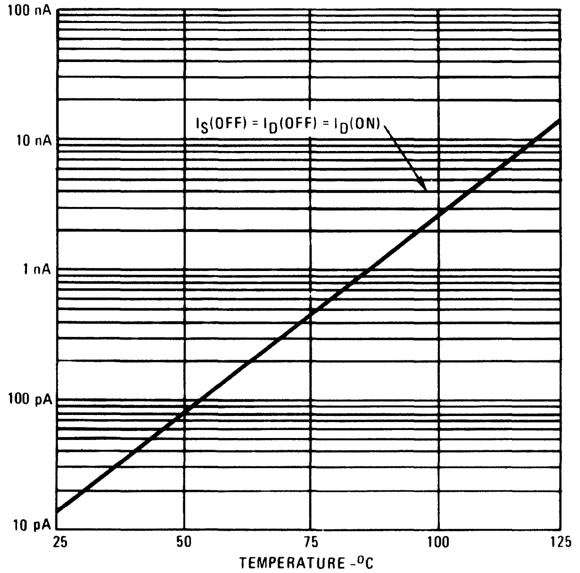


ON/OFF LEAKAGE CURRENTS vs TEMPERATURE

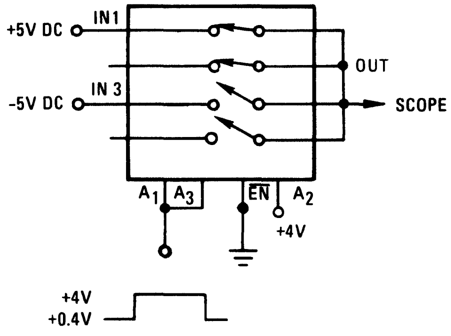

OFF LEAKAGE

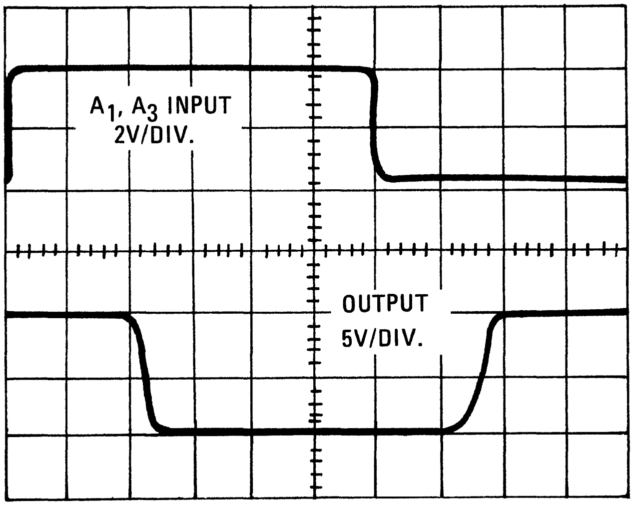
ON LEAKAGE

Test Circuit



ACCESS TIME

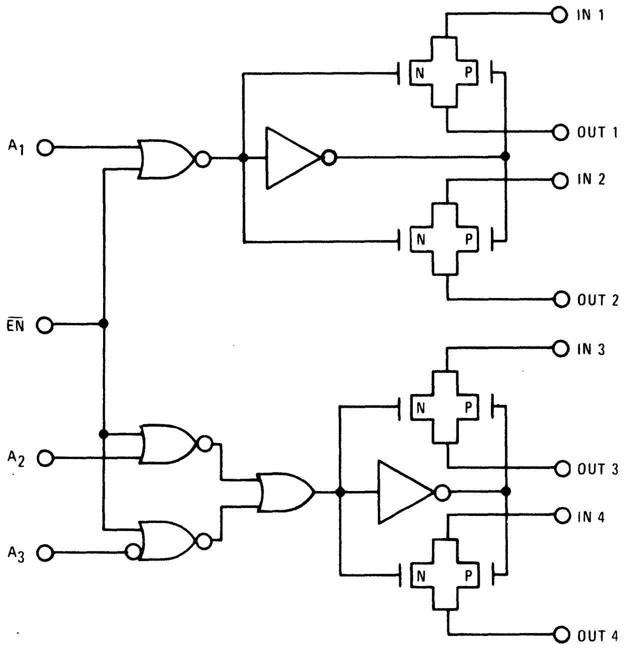




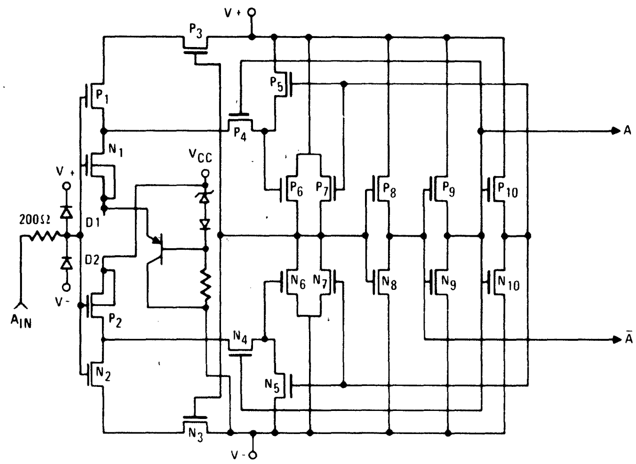
200ns/DIV.

SCHEMATIC DIAGRAM

BLOCK DIAGRAM HI-1800A



ADDRESS INPUT BUFFER

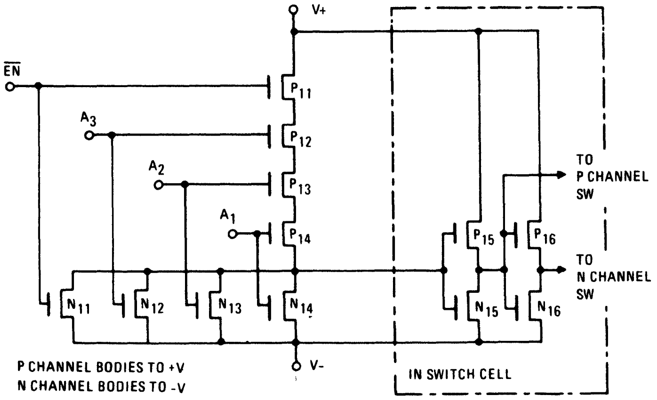


ALL N-CHANNEL
BODIES TO V-

ALL P-CHANNEL
BODIES TO V+

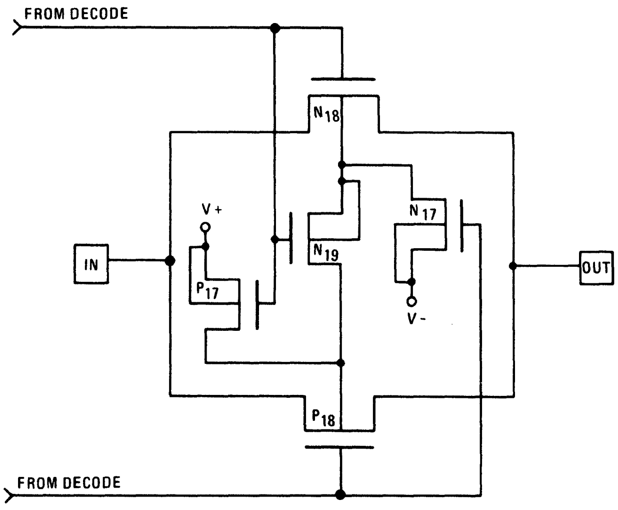
UNLESS OTHERWISE INDICATED

DECODER GATE



P CHANNEL BODIES TO +V
N CHANNEL BODIES TO -V

MULTIPLEX SWITCH



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-1818A/1828A

8 Channel Analog Multipexers

FEATURES

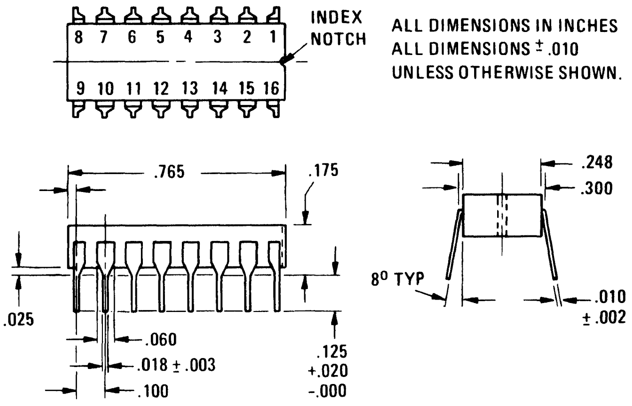
● SIGNAL RANGE	±15V
● "ON" RESISTANCE	250 Ω TYP.
● INPUT LEAKAGE AT +125°C	20nA TYP.
● ACCESS TIME	350ns TYP.
● POWER CONSUMPTION	5mW TYP.
● DTL/TTL COMPATIBLE ADDRESS	
● -55°C TO +125°C OPERATION	

GENERAL DESCRIPTION

The Harris HI-1818A and HI-1828A Analog Multiplexers represent a significant breakthrough in analog switch performance. Vastly superior characteristics are obtained through the unique process of forming complementary MOS transistors in a dielectrically isolated substrate. These devices are useful as multiplexers, signal selectors, and choppers over a wide range of signal levels and switching frequencies. The HI-1818A is a single 8 channel multiplexer while the HI-1828A is a differential 4 channel version. The devices are packaged in a standard 16 pin dual in-line hermetic case and are available in the full military or commercial temperature ranges.

PACKAGE

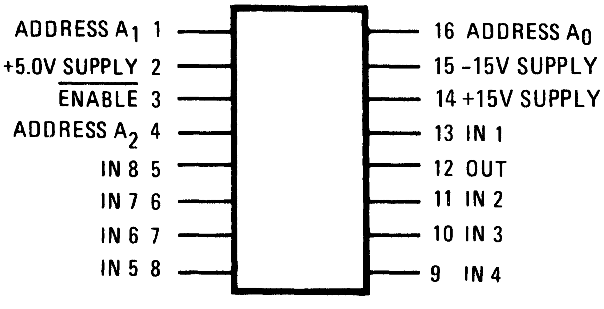
CODE 1W 16 LEAD CERAMIC D.I.P.



ALL DIMENSIONS IN INCHES
ALL DIMENSIONS ± .010
UNLESS OTHERWISE SHOWN.

PIN OUT/TRUTH TABLE

HI-1818A

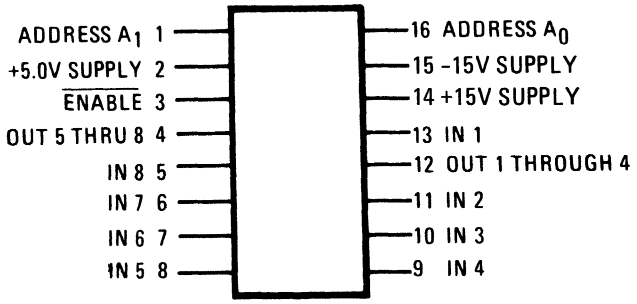


ADDRESS				"ON"
A_2	A_1	A_0	EN	CHANNEL
L	L	L	L	1
L	L	H	L	2
L	H	L	L	3
L	H	H	L	4
H	L	L	L	5
H	L	H	L	6
H	H	L	L	7
H	H	H	L	8
X	X	X	H	NONE

PIN OUT/TRUTH TABLE

HI-1828A

ADDRESS			"ON"
A_1	A_0	EN	CHANNELS
L	L	L	1 and 5
L	H	L	2 and 6
H	L	L	3 and 7
H	H	L	4 and 8
X	X	H	NONE



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Supply Voltage Between Pins 14 and 15	40.0V	Digital Input Voltage	V-Supply to V+ Supply
Logic Supply Voltage, Pin 2	30.0V	Total Power Dissipation (Note 2)	780mW
Analog Input Voltage: V^{+}_{Supply} +2V V^{-}_{Supply} -2V		Storage Temperature Range	-65°C to +150°C

ELECTRICAL CHARACTERISTICS

Supplies = +15V, -15V, +5V		HI-1818A-2/1828A-2 -55°C to +125°C			HI-1818A-5/1828A-5 0°C to +75°C			
PARAMETER	TEMP.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
ANALOG CHANNEL CHARACTERISTICS								
* V_{IN}, Analog Signal Range	Full	-15		+15	-15		+15	V
* R_{ON}, ON Resistance (Note 3)	+25°C		250	400		250	400	Ω
	Full		300	500		300	500	Ω
* I_S(OFF), Input Leakage Current	Full		20	50		20	50	nA
* I_D(ON), On Channel Leakage (HI-1818A)	Full		100	250		100	250	nA
Current (HI-1828A)	Full		50	125		50	125	nA
* I_D(OFF) Output Leakage Current (HI-1818A)	Full		100	250		100	250	nA
(HI-1828A)	Full		50	125		50	125	nA
DIGITAL INPUT CHARACTERISTICS								
V_{IL}, Input Low Threshold	Full			0.4			0.4	V
V_{IH}, Input High Threshold (Note 4)	Full	4.0			4.0			V
* I_{IN}, Input Leakage Current	Full		.01	1		.01	1	µA
SWITCHING CHARACTERISTICS								
T_S, Access Time (Note 5)	+25°C		350			350		ns
Break-Before-Make Delay	+25°C		100			100		ns
C_{IN}, Channel Input Capacitance	+25°C		4			4		pF
C_{OUT}, Channel Output Capacitance (HI-1818A)	+25°C		20			20		pF
(HI-1828A)	+25°C		10			10		pF
C_D, Digital Input Capacitance	+25°C		5			5		pF
POWER REQUIREMENTS								
P_D, Power Dissipation	Full		5			5		mW
P_{DS}, Standby Power (Note 6)	Full		5			5		mW
* I_+, Current Pin 14	Full		0.1	0.5		0.1	1	mA
* I_-, Current Pin 15	Full		0.3	1		0.3	2	mA
* I_L, Current Pin 2	Full		0.3	1		0.3	2	mA

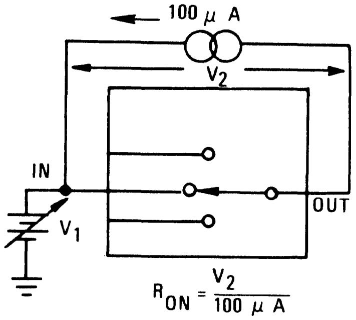
NOTES:

1. Voltage ratings apply when voltages at all other pines are within their nominal operating ranges.
2. Derate 9.25 mW/°C above 75°C
3. $V_{OUT} = \pm 10V$ $I_{OUT} = -100\mu A$
4. To drive from DTL/TTL circuits, 1KΩ pullup resistors to +5.0V supply are recommended.
5. Time measured to 90% of final output level; V_{OUT} = - 5.0V to +5.0V, Digital Inputs = 0V to +4.0V.
6. Voltage at Pin 3, $\overline{\text{ENABLE}}$ = +4.0V.

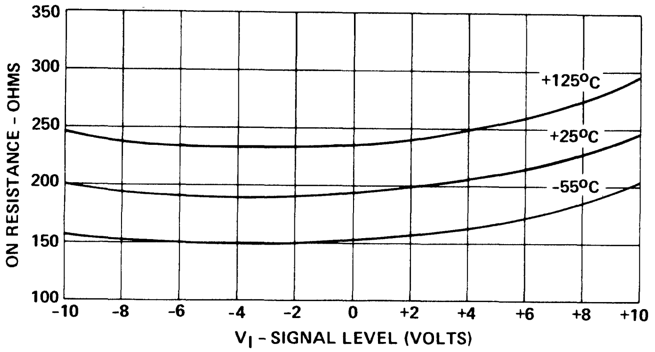
*100% Tested For DASH 8

PERFORMANCE CHARACTERISTIS

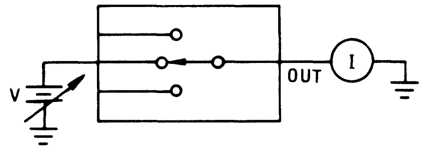
ON RESISTANCE vs ANALOG SIGNAL LEVEL



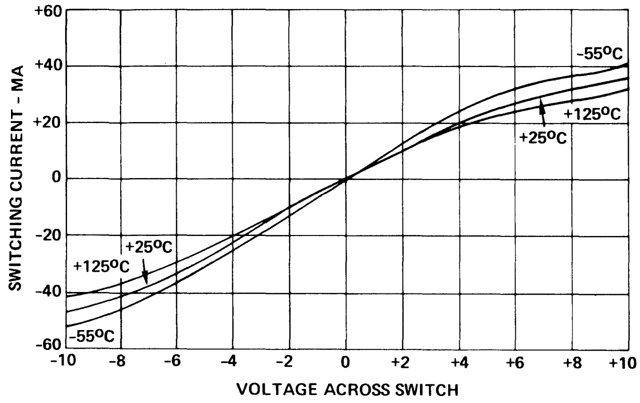
Test Circuit



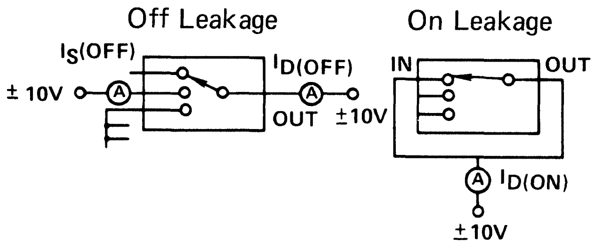
ON CHANNEL CURRENT vs VOLTAGE

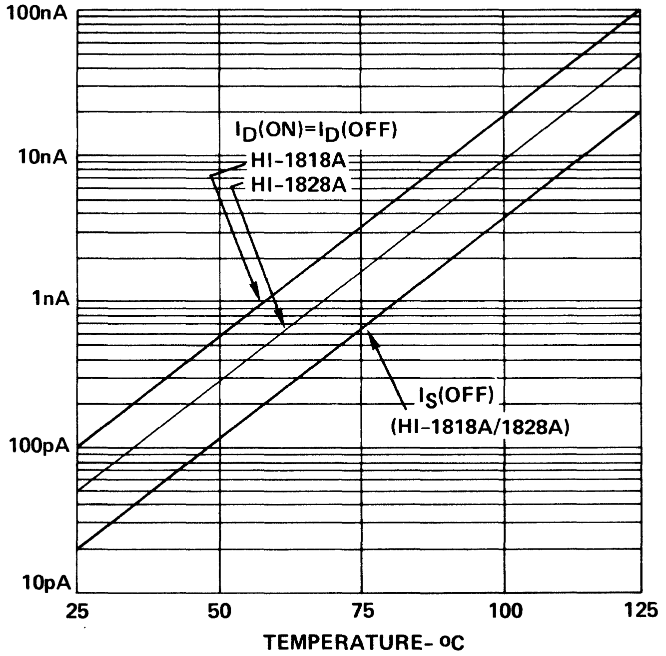


Test Circuit

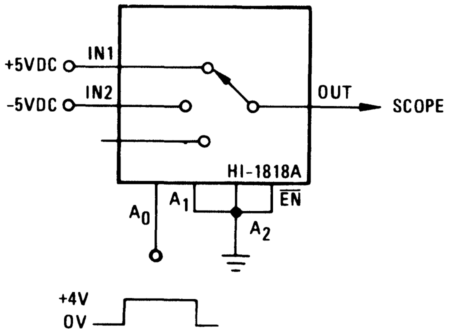


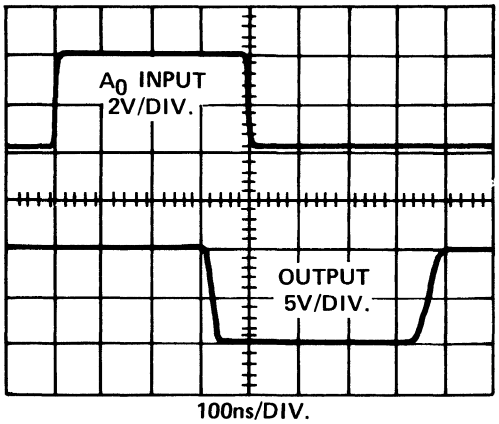
ON/OFF LEAKAGE CURRENTS vs TEMPERATURE





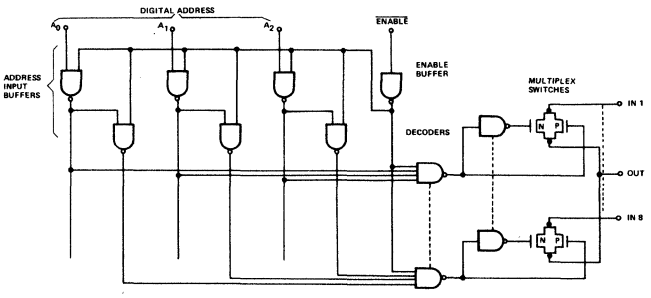
ACCESS TIME



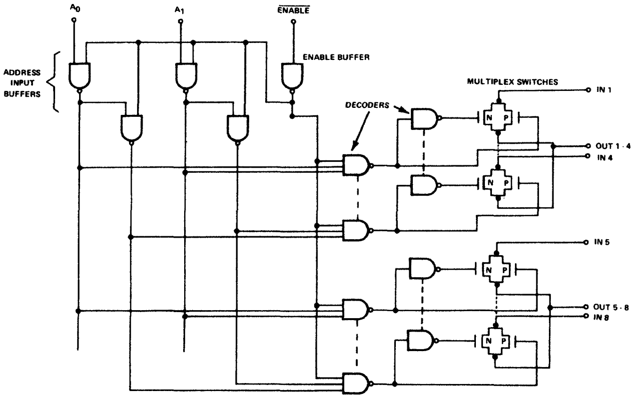


SCHEMATIC DIAGRAM

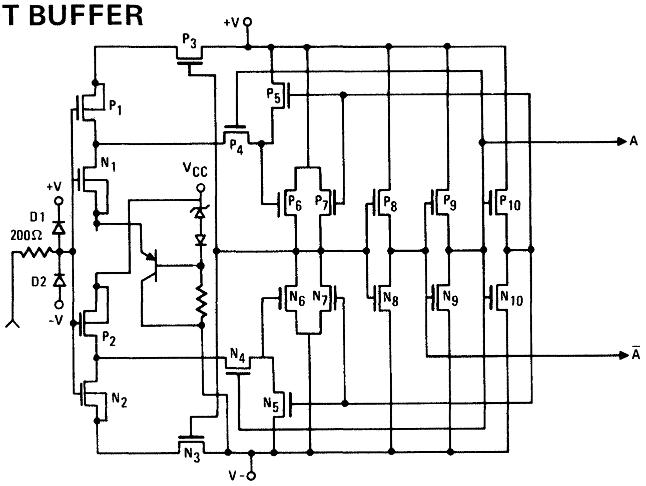
BLOCK DIAGRAM HI-1818A



BLOCK DIAGRAM HI-1828A



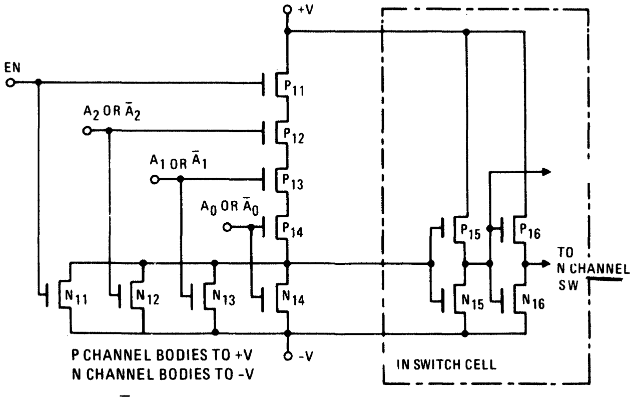
ADDRESS INPUT BUFFER



ALL N-CHANNEL BODIES TO V-

ALL P-CHANNEL BODIES TO V+ UNLESS OTHERWISE INDICATED.

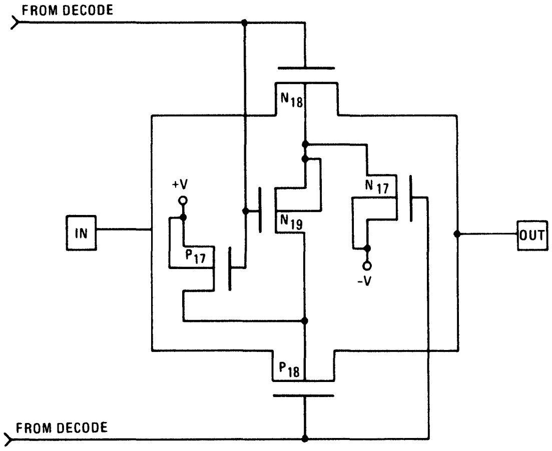
DECODER GATE



P CHANNEL BODIES TO +V
N CHANNEL BODIES TO -V

A_2 OR $\overline{A}_2$ NOT USED FOR HI-1828A

MULTIPLEX SWITCH



HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-5040 thru HI-5051
HI-5046A and HI-5047A
CMOS Analog Switches

FEATURES

• WIDE ANALOG SIGNAL RANGE	±15V
• LOW "ON" RESISTANCE (TYP)	25Ω
• HIGH CURRENT CAPABILITY (TYP)	80mA
• BREAK-BEFORE-MAKE SWITCHING	
TURN-ON TIME (TYP)	370nS
TURN-OFF TIME (TYP)	280nS
• NO LATCH-UP	
• INPUT MOS GATES ARE PROTECTED FROM ELECTROSTATIC DISCHARGE	
• DTL, TTL, CMOS, PMOS COMPATIBLE	

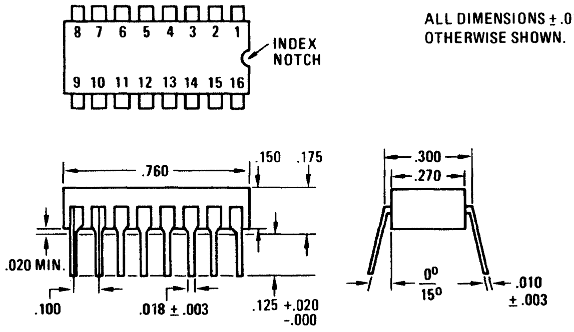
DESCRIPTION

This family of CMOS ANALOG SWITCHES offers high performance at analog levels up to the supply rails. Low leakages, low "ON" resistance and high "OFF ISOLATION" characteristics are achieved using the latch-free, high reliability, Harris Dielectric Isolation process. These monolithic chips incorporate bipolar with MOS devices for mininizing power consumption when CMOS logic levels are used. The HI-5040 series replaces the IH-5040 family and is functionally compatible to the DG 180/190 family. The HI-5046A/5047A are proprietary 30 ohm versions of the HI-5046/5047. All are available in both commercial and military temperature ranges.

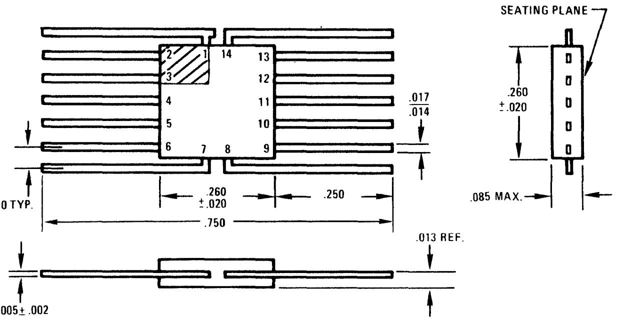
PACKAGES

CODE 1D 16 LEAD CERAMIC D.I.P.

ALL DIMENSIONS IN INCHES
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

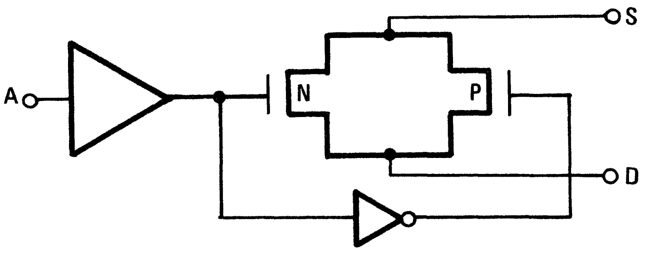


CODE 9H 14 LEAD FLAT PACK (TO–86)



FUNCTIONAL DIAGRAM

TYPICAL SWITCH



FUNCTIONAL DESCRIPTION

PART NUMBER	TYPE	RON
HI-5040	SPST	75Ω
HI-5041	DUAL SPST	75Ω
HI-5042	SPDT	75Ω
HI-5043	DUAL SPDT	75Ω
HI-5044	DPST	75Ω
HI-5045	DUAL DPST	75Ω
HI-5046	DPDT	75Ω
HI-5046A	DPDT	30Ω
HI-5047	4PST	75Ω
HI-5047A	4PST	30Ω
HI-5048	DUAL SPST	30Ω
HI-5049	DUAL DPST	30Ω
HI-5050	SPDT	30Ω
HI-5051	DUAL SPDT	30Ω

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V^+ -V^-)	36V
V_R to Ground	V^+, V^-
Digital and Analog Input Voltage	V^+ +4V V^- -4V

Analog Current (S to D)	80mA
Total Power Dissipation*	450mW
Operating Temperature	
HI-50XX-2	-55°C to +125°C
HI-50XX-5	0°C to +75°C
Storage Temperature	-65°C to +150°C

*Derate 6mW/°C above T_A = 75°C

ELECTRICAL CHARACTERISTICS

Unless Otherwise Specified
Supplies = +15V, -15V; V_R = 0V; V_{AH} (Logic Level High) = 3.0V; V_{AL} (Logic Level Low) = +0.8V, V_L = +5V
For Test Conditions, consult Performance Characteristics

		-55°C to +125°C			0°C to +75°C			
PARAMETER	TEMP	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
ANALOG SWITCH CHARACTERISTICS								
Analog Signal Range	Full	-15		+15	-15		+15	V
Ron, "ON" Resistance (Note 1a)	+25°C		50			50		Ω
	Full			75			75	Ω
Ron, "ON" Resistance (Note 1b)	+25°C		25			25		Ω
	Full			50			50	Ω
Ron, Channel-to-Channel Match (Note 1a)	+25°C		2	10		2	10	Ω
Ron, Channel-to-Channel Match (Note 1b)	+25°C		1	5		1	5	Ω
$I_{S(OFF)} = I_{D(OFF)}$, Off Input or Output	+25°C		0.8			0.8		nA
Leakage Current	Full		100	500		100	500	nA
$I_{D(ON)}$, On Leakage Current	+25°C		0 .01			0.01		nA
	Full		2	500		2	500	nA
DIGITAL INPUT CHARACTERISTICS								
V_{AL}, Input Low Threshold	Full			0.8			0.8	V
V_{AH}, Input High Threshold	Full	3.0			3.0			V
I_A, Input Leakage Current (High or Low)	Full		.01	1.0		.01	1.0	μA
SWITCHING CHARACTERISTICS								
t_{on}, Switch "ON" Time	+25°C		370	1000		370		ns
t_{off}, Switch "OFF" Time	+25°C		280	500		280		ns
Charge Injection (Note 2)	+25°C		5	20		5		mV
"OFF Isolation" (Note 3)	+25°C	75	80			80		dB
"Crosstalk" (Note 3)	+25°C	80	88			88		dB
$C_{S(OFF)}$, Input Switch Capacitance	+25°C		11			11		pF
$C_{D(OFF)}$, Output Switch Capacitance	+25°C		11			11		pF
$C_{D(ON)}$,	+25°C		22			22		pF
C_A, Digital Input Capacitance	+25°C		5			5		pF
$C_{DS(OFF)}$, Drain-To-Source Capacitance	+25°C		0.5			0.5		pF
POWER REQUIREMENTS								
P_D, Quiescent Power Dissipation	+25°C		1.5			1.5		mW
I^+, +15V Quiescent Current	Full			0.3			0.5	mA
I^-, -15V Quiescent Current	Full			0.3			0.5	mA
I_L, +5V Quiescent Current	Full			0.3			0.5	mA
I_R, Gnd Quiescent Current	Full			0.3			0.5	mA

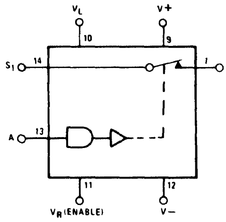
NOTES:
1. $V_{OUT} = \pm 10V$, I_{OUT} = 1mA
   a) For HI-5040 thru HI-5047
   b) For HI-5048 thru HI-5051, HI-5046A/5047A
2. V_{IN} = 0V, C_L = 10,000pF
3. R_L = 100Ω, f= 100 KHz, V_{IN} = 2 V_{PP}, C_L=5pF

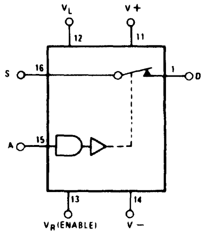
SWITCH FUNCTIONS

SWITCH STATES ARE FOR LOGIC "1" INPUT

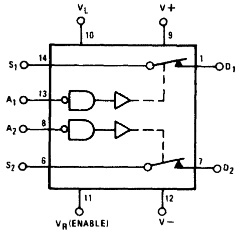
FLATPACK CERDIP

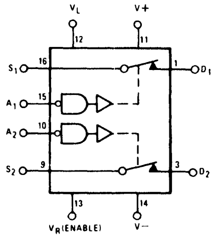
SPST
HI-5040 (75Ω)



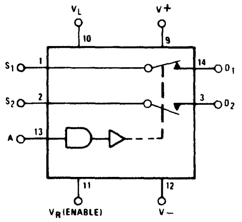


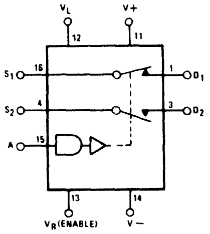
DUAL SPST
HI-5041 (75Ω)



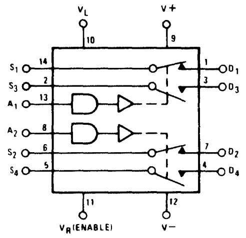


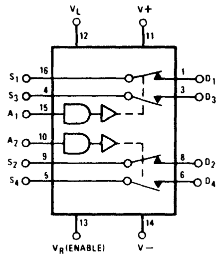
SPDT
HI-5042 (75Ω)



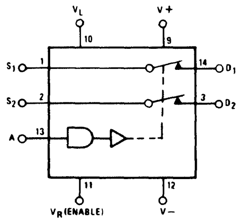


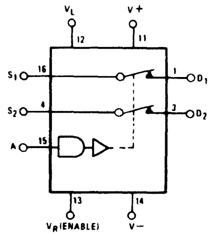
DUAL SPDT
HI-5043 (75Ω)



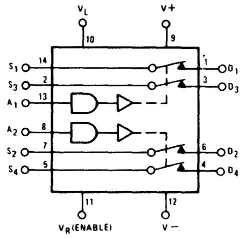


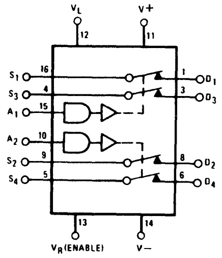
DPST
HI-5044 (75Ω)



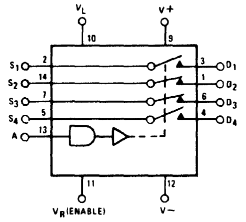


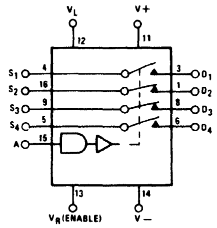
DUAL DPST
HI-5045 (75Ω)



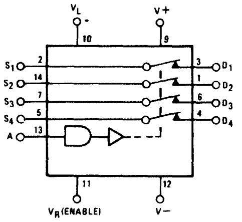


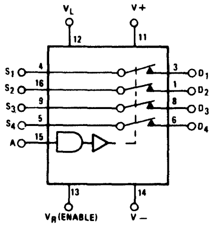
DPDT
HI-5046 (75Ω)
HI-5046A (30Ω)



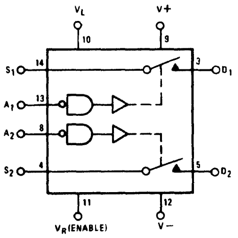


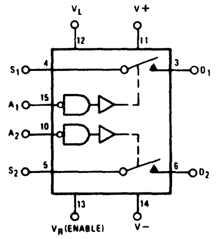
4PST
HI-5047 (75Ω)
HI-5047A (30Ω)



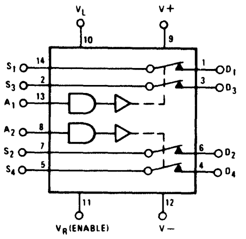


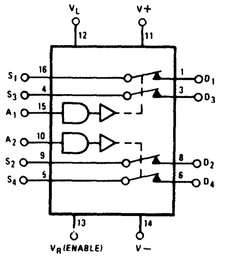
DUAL SPST
HI-5048 (30Ω)



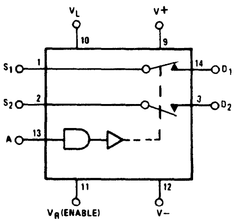


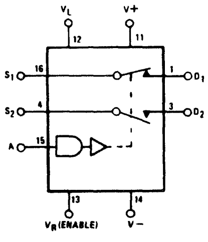
DUAL DPST
HI-5049 (30Ω)



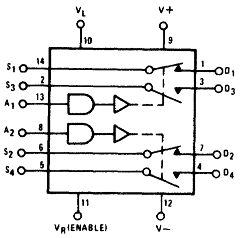


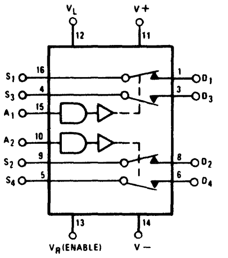
SPDT
HI-5050 (30Ω)





DUAL SPDT
HI-5051 (30Ω)

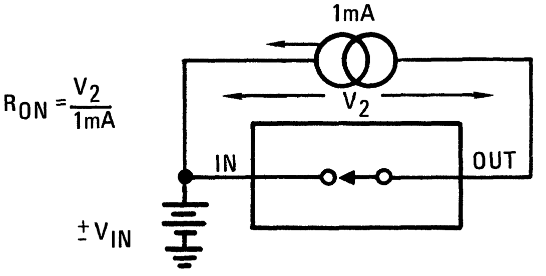




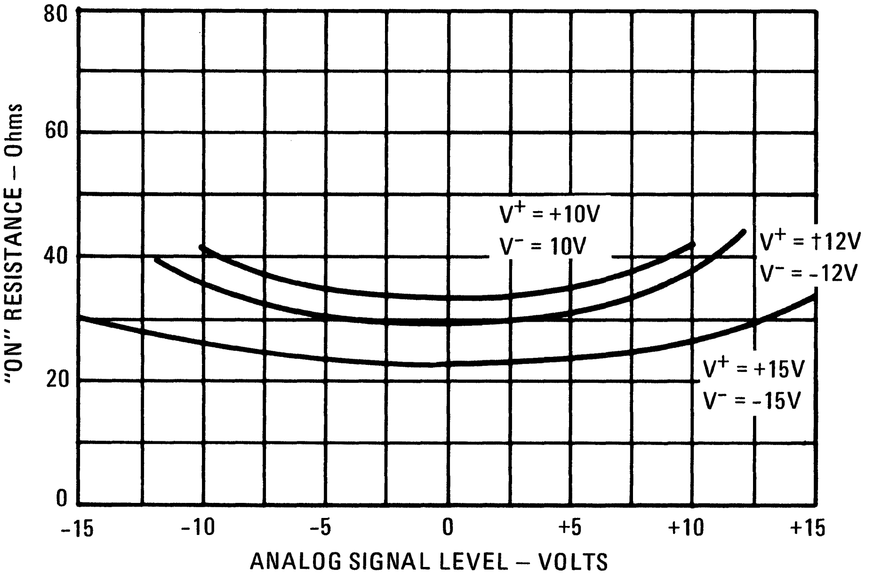
PERFORMANCE CHARACTERISTICS AND TEST CIRCUITS

(UNLESS OTHERWISE SPECIFIED $T_A = 25^oC$, $V^+ = +15V$, $V^- = -15V$, $V_L = +5V$, $V_R = 0V$, $V_{AH} = 3.0V$ and $V_{AL} = 0.8V$

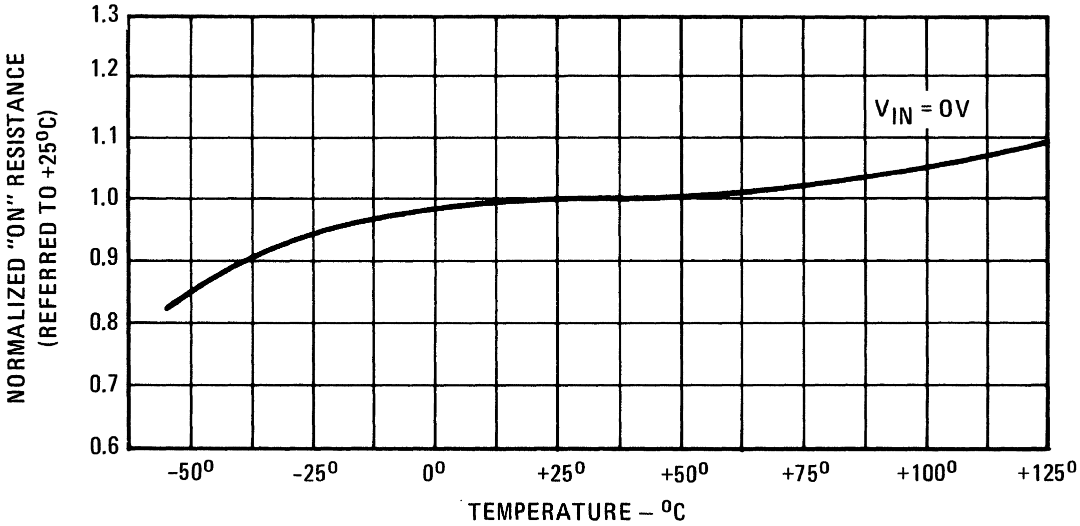
ON RESISTANCE vs. ANALOG SIGNAL LEVEL, SUPPLY VOLTAGE AND TEMPERATURE



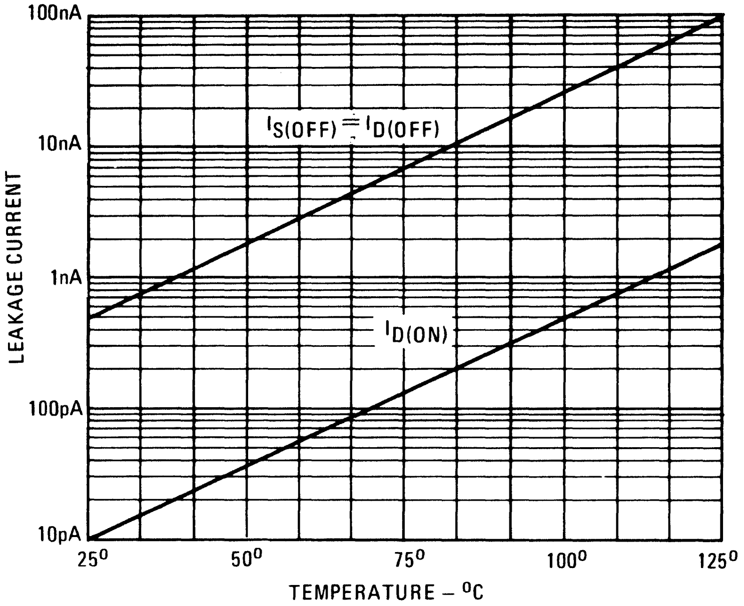
"ON"' RESISTANCE vs. ANALOG SIGNAL LEVEL AND POWER SUPPLY VOLTAGE



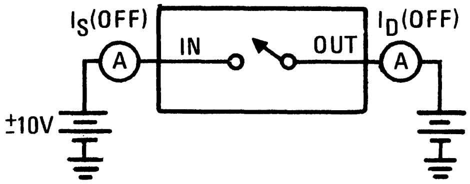
NORMALIZED "ON" RESISTANCE vs. TEMPERATURE



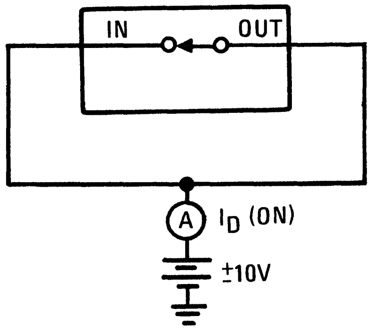
ON/OFF LEAKAGE CURRENT vs. TEMPERATURE



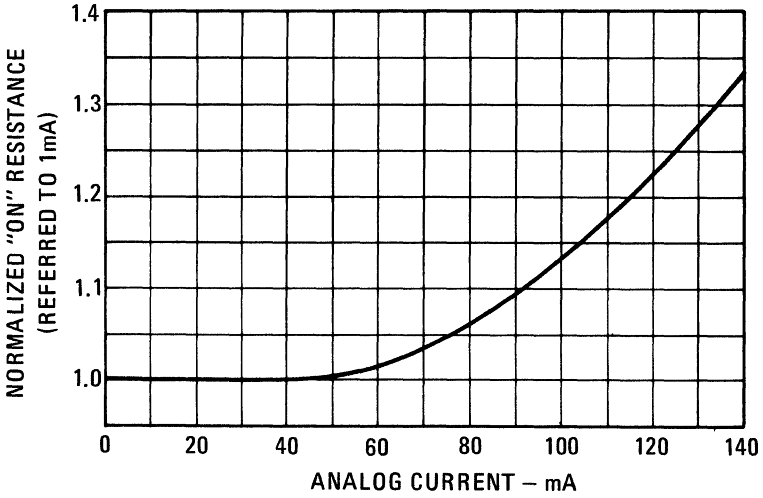
OFF LEAKAGE CURRENT vs. TEMPERATURE



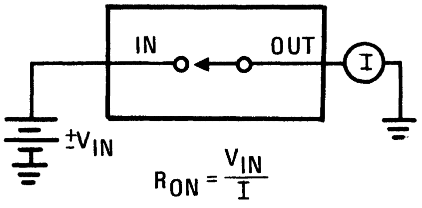
ON LEAKAGE CURRENT vs. TEMPERATURE



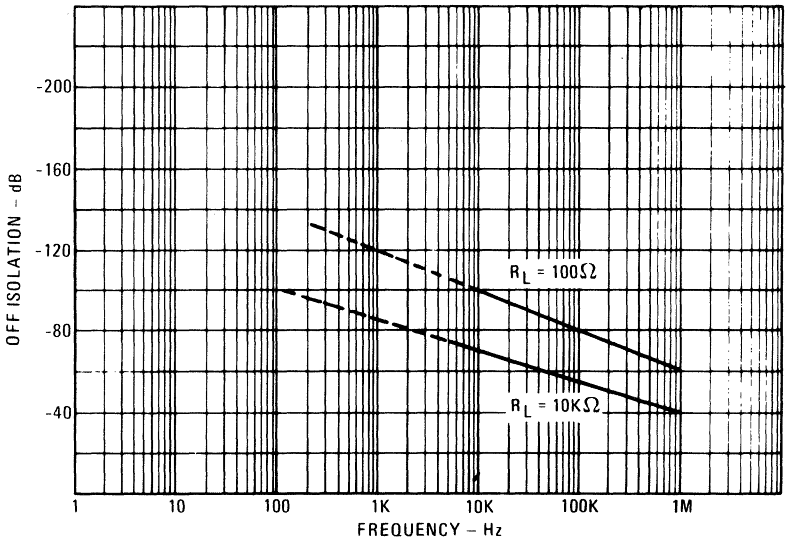
NORMALIZED "ON" RESISTANCE vs. ANALOG CURRENT

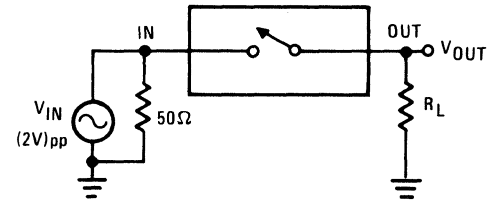


"ON" RESISTANCE vs. ANALOG CURRENT



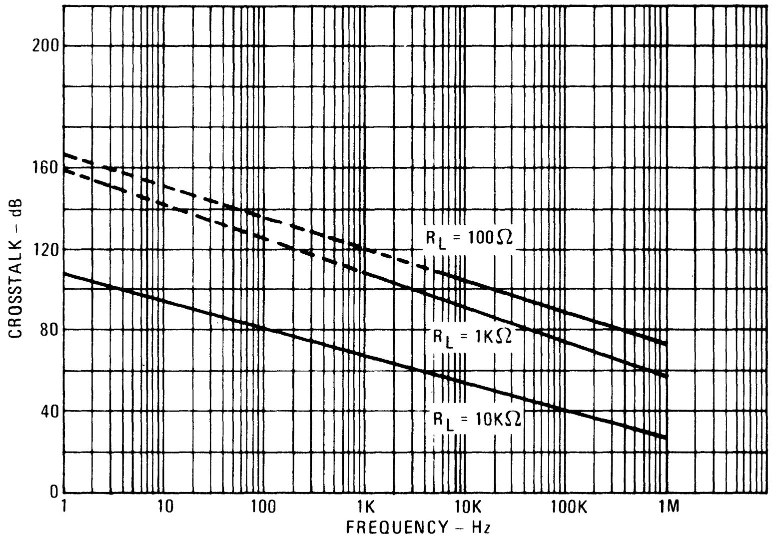
"OFF" ISOLATION vs. FREQUENCY

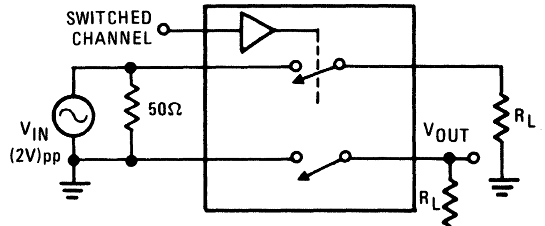




$$\text{"OFF" ISOLATION} = 20 \log\left(\frac{V_{IN}}{V_{OUT}}\right)$$

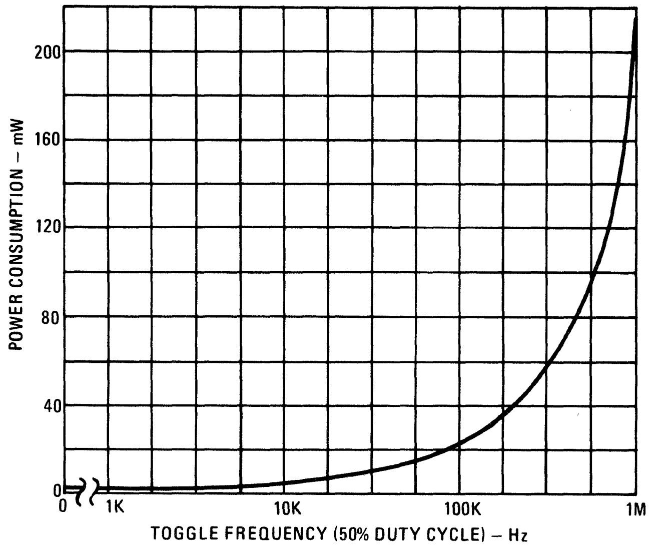
CROSSTALK vs. FREQUENCY

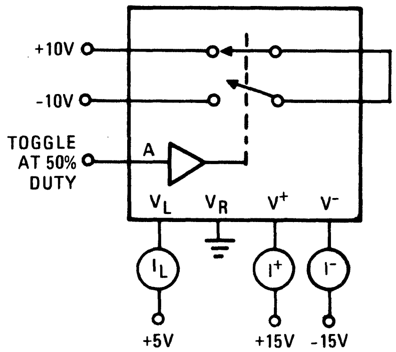




$$\text{"CROSSTALK"} = 20 \log\left(\frac{V_{IN}}{V_{OUT}}\right)$$

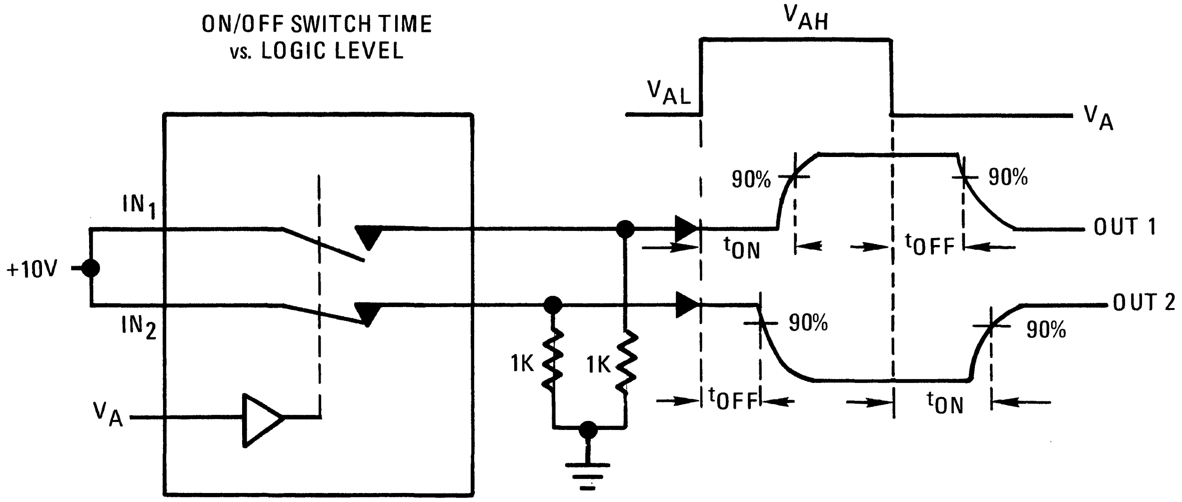
POWER CONSUMPTION vs. FREQUENCY

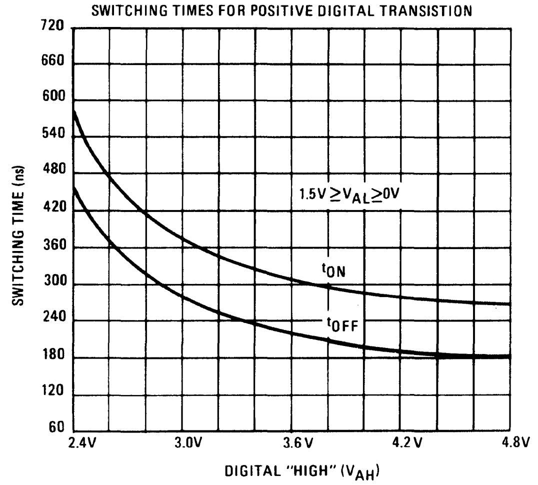


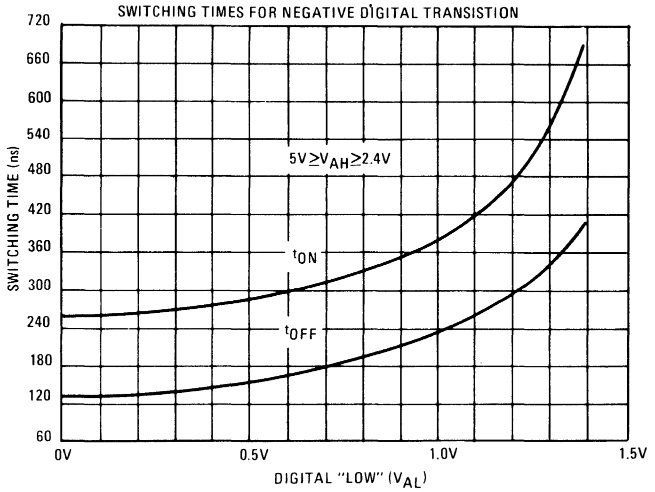


SWITCHING CHARACTERISTICS

ON/OFF SWITCH TIME
vs. LOGIC LEVEL

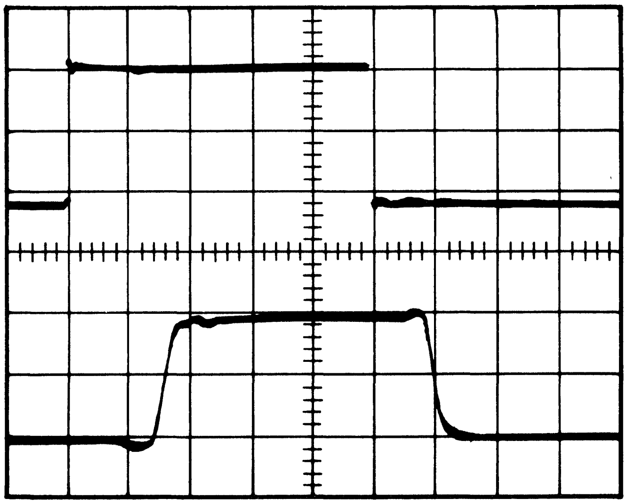






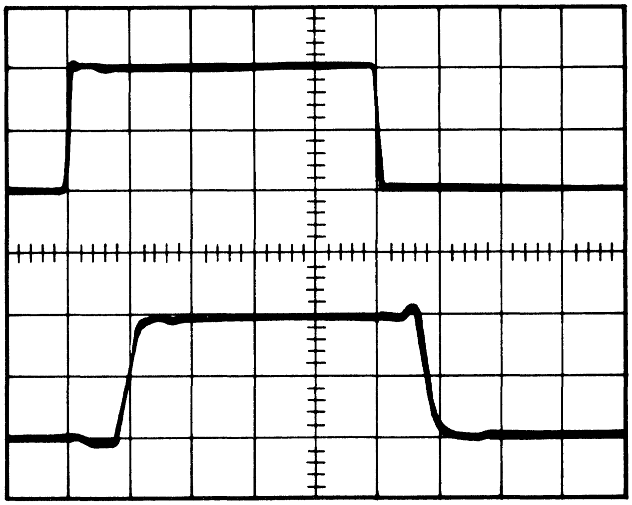
SWITCHING WAVEFORMS

TOP: TTL INPUT (IV/DIV)
V_{AH} = 3V, V_{AL} = 0.8V
BOTTOM: OUTPUT (5V/DIV)



200ns/DIV

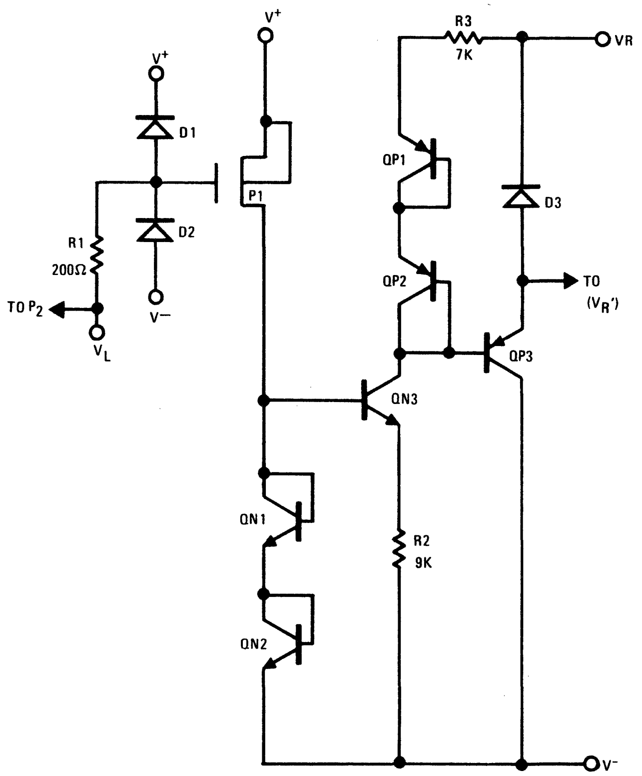
TOP: CMOS INPUT (5V/DIV)
V_{AH} = 10V, V_{AL} = 0V
BOTTOM: OUTPUT (5V/DIV



200ns/DIV

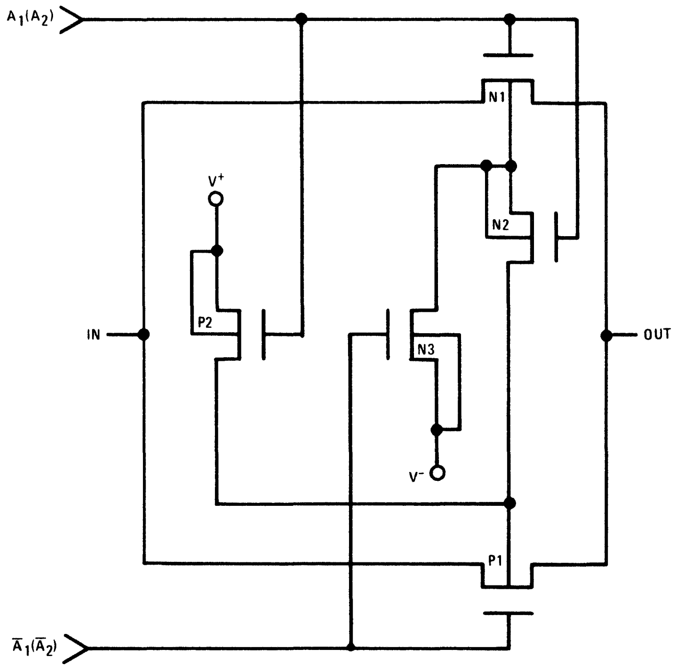
SCHEMATIC DIAGRAMS

TTL/CMOS REFERENCE CIRCUIT*

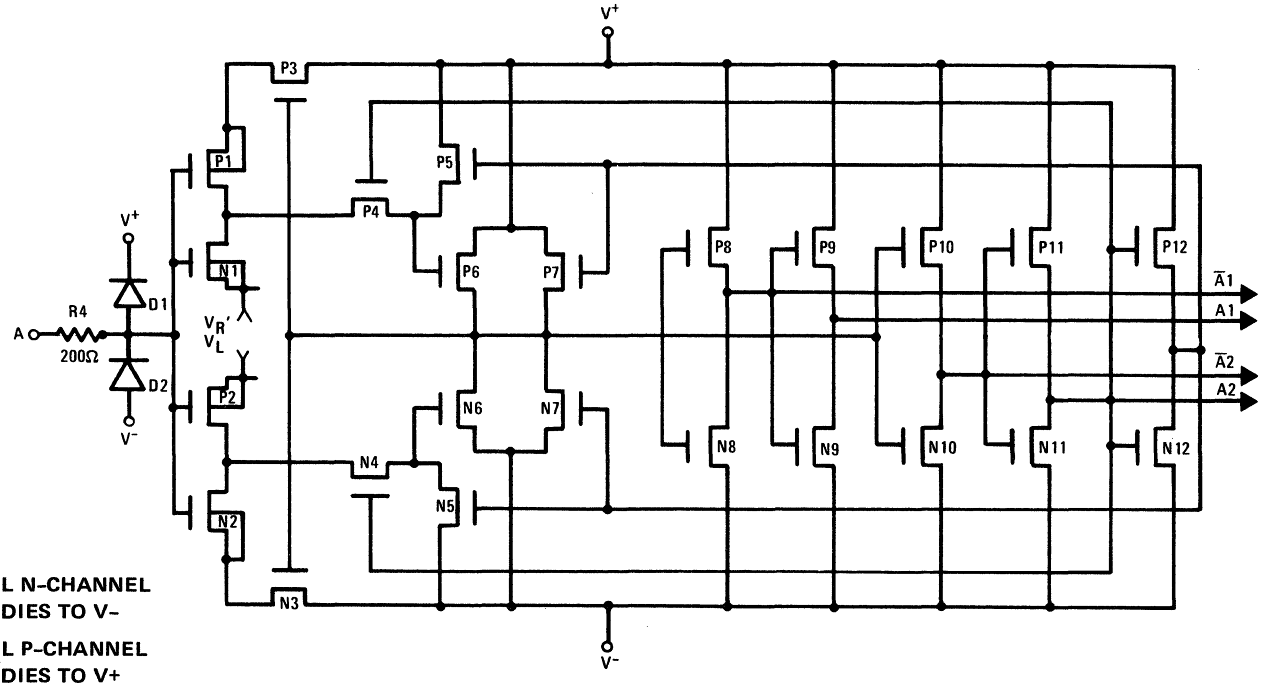


*Connect V^+ to V_L for minimizing power consumption when when driving from CMOS circuits

SWITCH CELL



DIGITAL INPUT BUFFER AND LEVEL SHIFTER



ALL N-CHANNEL BODIES TO V−

ALL P-CHANNEL BODIES TO V+

EXCEPT AS SHOWN

MEMORY DATA SHEETS

On the subject of field programmable read-only memories the words PROM and Harris Semiconductor are virtually inseparable. The first effort to produce user programmable logic was ushered in by Harris in 1967 with the introduction of the diode matrix family. Again, in 1969, the advent of the HPROM-0512 heralded the world's first monolithic field programmable read-only memory. This prototype, featuring nichrome fuse technology paved the way for future PROM generations establishing unprecedented reliability attested to by the fact that the HPROM-0512, as of the printing of this catalog, is still the only field programmable read-only memory to receive full JAN 38510 certification.

After six years of high volume PROM manufacturing Harris Semiconductor remains today the world's largest single manufacturer of PROMs. Now, this high volume experience, coupled with continuing reliability, introduces the next generation in PROM development, the "GENERIC" family of PROMs. With design controlled by a family concept, each GENERIC PROM features identical programming, improved AC performance guaranteed over full temperature and voltage ranges, common circuit design and process technology. We invite you to study our GENERIC data sheets. You will soon see that "to know one GENERIC PROM is to know them all". Simplified device qualification, simplified system redesign and upgrading, maximum standardization and minimum costs; they're all in the family with GENERIC PROMs.

MEMORY ALPHA-NUMERICAL INDEX

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HD-234/534
Hex Interface Inverters
HD-235/535
Hex Interface Drivers

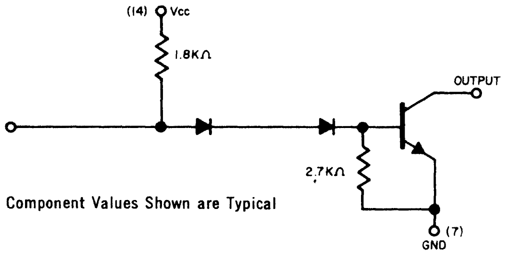
GENERAL DESCRIPTION

The integrated circuits covered by this data sheet form a part of Harris' family of Military and Industrial Monolithic Interface Circuits intended for use as universal inverters, translators between logic families, as logic drivers in Monolithic Diode Matrix logic and in high voltage applications. The interface circuit with the node-input is compatible with all logic families, RTL, DTL, T^2L and CML. The circuits are fabricated within a single monolithic silicon chip using passivated epitaxial techniques and Harris' Dielectric Isolation method. Each circuit type consists of six node-input inverters as shown in the circuit schematic. Use of Dielectric Isolation provides parasitic-free operation with electrical performance surpassing that of conventionally constructed integrated circuits. Harris' Interface Circuits are designed to meet or exceed the mechanical and environmental requirements of MIL-STD-883.

MILITARY	**200**	**SERIES**
INDUSTRIAL	**500**	**SERIES**

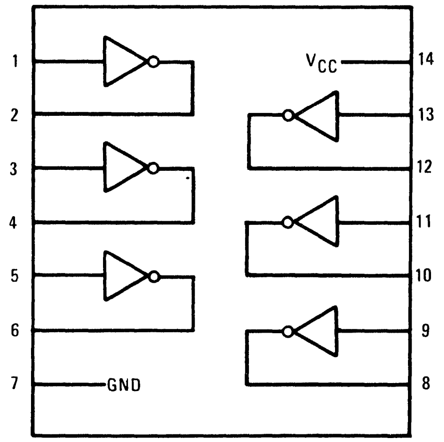
BASIC TYPES OF INTERFACE CIRCUITS

HEX INTERFACE INVERTER	
PROPAGATION DELAY	10ns
POWER DISSIPATION	10mW
OUTPUT BREAKDOWN VOLTAGE	6V
HIGH VOLTAGE HEX INTERFACE DRIVER	
PROPAGATION DELAY	35ns
POWER DISSIPATION	10mW
OUTPUT BREAKDOWN VOLTAGE	35V
HIGH VOLTAGE HEX INDICATOR DRIVER	
TURN-ON OR TURN-OFF DELAY	0.8µs
PROPAGATION DELAY	35ns
POWER DISSIPATION	12mW
OUTPUT BREAKDOWN VOLTAGE	55V



Component Values Shown are Typical

BASIC CIRCUIT SCHEMATIC
(one element)



SELECTION GUIDE

HEX INTERFACE INVERTER
200 SERIES . . . PAGES Di - 9, Di - 10
500 SERIES . . . PAGES Di - 9, Di - 12

HEX INTERFACE DRIVER
200 SERIES . . . PAGES Di - 9, Di - 11
500 SERIES . . . PAGES Di - 9, Di - 13

HEX INDICATOR DRIVER
500 SERIES . . . PAGES Di - 9, Di - 14

HEX INTERFACE INVERTER
HD-234

MILITARY 200 SERIES

ABSOLUTE MAXIMUM RATINGS

Input Voltage	: +6 Volts	Output Current	: +50mA
Output Voltage	: +6 Volts	Operating Temp.	: −55°C to +125°C
V_{cc}	: +8 Volts	Storage Temp.	: −65°C to +150°C

Maximum ratings are limiting values above which permanent circuit damage may occur.

STATIC ELECTRICAL CHARACTERISTICS (Notes 1, 4)

	LIMITS				TEST CONDITIONS				
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	TEMP.	V_{cc}	DRIVEN INPUT	OUTPUT	NOTES see page Di-11
"1" OUTPUT VOLTAGE									
node Input	4.0	4.5		V	−55°C	4.5V	2.2V	SEE	3
node Input	4.0	4.5		V	+25°C	4.5V	1.8V	NOTE	3
node Input	3.7	4.4		V	+125°C	4.5V	1.2V	2a	3
"0" OUTPUT VOLTAGE									
node Input		.25	.45	V	−55°C	4.5V		16.7mA	3
node Input		.25	.40	V	+25°C	5.0V		20.5mA	3
node Input		.25	.45	V	+125°C	5.5V		20.5mA	3
"0" INPUT CURRENT									
node Input		2.55	3.45	mA	−55°C	5.5V	.35V		3
node Input	1.80	2.70	3.45	mA	+25°C	5.5V	.35V		3
node Input		2.30	3.45	mA	+125°C	5.5V	.35V		3
"1" OUTPUT CURRENT									
			100	nA	+25°C	4.5V	GND	4.5V	3
			50	μA	+125°C	4.5V	GND	4.5V	3
POWER DISSIPATION									
		12	17.5	mW	+25°C	5.0V	GND		
		8	11.0	mW	+25°C	5.0V	OPEN		
OUTPUT CAPACITANCE									
		2.0		pF	+25°C	5.0V	GND	0.5VDC 25mVrms @ 1MHz	

SWITCHING (DYNAMIC) CHARACTERISTICS

	LIMITS				TEST CONDITIONS			
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	TEMP.	V_{cc}	TEST CIRCUIT	FAN-OUT
Turn On Delay		20	35	ns	−55°C	4.5V		8
t_{on}		13	20	ns	+25°C	4.5V	Circuit No. 1	8
		15	22	ns	+125°C	4.5V	$R_L = 220\Omega$	8
Turn Off Delay		10	25	ns	−55°C	5.5V	2	1
t_{off}		5	15	ns	+25°C	5.5V	2	1
		8	25	ns	+125°C	5.5V	2	1
Propagation Delay t_{pd}		8	12	ns	+25°C	5.0V	3	1

HIGH VOLTAGE HEX INTERFACE DRIVER
HD-235

ABSOLUTE MAXIMUM RATINGS

Input Voltage : +6 Volts
Output Voltage : +35 Volts
V_{cc} : +8 Volts
Output Current : +35mA
Operating Temp. : −55°C to +125°C
Storage Temp. : −65°C to +150°C

Maximum ratings are limiting values above which permanent circuit damage may occur.

STATIC ELECTRICAL CHARACTERISTICS (Notes 1, 4)

	LIMITS				TEST CONDITIONS				
CHARACTERISTIC	**MIN.**	**TYP.**	**MAX.**	**UNIT**	**TEMP.**	**V_{cc}**	**DRIVEN INPUT**	**OUTPUT**	**NOTES** see below
"1" OUTPUT VOLTAGE									
node Input	29			V	−55°C	4.5V	2.2V	SEE	3
node Input	29			V	+25°C	4.5V	1.8V	NOTE	3
node Input	28			V	+125°C	4.5V	1.2V	2b	3
"0" OUTPUT VOLTAGE									
node Input			1.0	V	−55°C	4.5V		5mA	3
node Input		.55	1.0	V	+25°C	5.0V		10mA	3
node Input			1.0	V	+125°C	5.5V		10mA	3
"0" INPUT CURRENT									
node Input		2.55	3.45	mA	−55°C	5.5V	.35V		3
node Input	1.80	2.70	3.45	mA	+25°C	5.5V	.35V		3
node Input		2.30	3.45	mA	+125°C	5.5V	.35V		3
"1" OUTPUT CURRENT									
		.025	1.0	μA	+25°C	4.5V	GND	30V	3
		1	50	μA	+125°C	4.5V	GND	30V	3
POWER DISSIPATION									
		12	17.5	mW	+25°C	5.0V	GND		
		8	11.0	mW	+25°C	5.0V	OPEN		
OUTPUT CAPACITANCE		5.0		pF	+25°C	5.0V	GND	0.5VDC 25mVrms @ 1MHz	

SWITCHING (DYNAMIC) CHARACTERISTICS

	LIMITS				TEST CONDITIONS		
CHARACTERISTIC	**MIN.**	**TYP.**	**MAX.**	**UNIT**	**TEMP.**	**V_{cc}**	**TEST CIRCUIT**
Propagation Delay			80	ns	−55°C	5.0V	
t_{pd}		35	70	ns	+25°C	5.0V	3
			80	ns	+125°C	5.0V	

NOTES:

1. This specification is written for one gate element. With multiple element packages, all elements within the package must qualify for the package to obtain "type" classification.

2a. The output is to be returned to V_{cc} through 5.6KΩ for these tests.

2b. The output is to be returned to +30V through 5.6KΩ for these tests.

3. "NAND" Logic Definitions: "UP" Level = "1" "DOWN" Level = "0".

4. All measurements made with Pin 7 at zero volts. All voltage and capacitance measurements are referenced to pin 7. Terminals not specifically mentioned are left electrically open.

5. These measurements must be made using current forcing, voltage measuring techniques.

HEX INTERFACE INVERTER
HD-534

ABSOLUTE MAXIMUM RATINGS

Input Voltage : +6 Volts
Output Voltage : +6 Volts
V_{cc} : +8 Volts
Output Current : +50mA
Operating Temp. : 0°C to +75°C
Storage Temp. : −65°C to +150°C

Maximum ratings are limiting values above which permanent circuit damage may occur.

STATIC ELECTRICAL CHARACTERISTICS (Notes 1, 4)

CHARACTERISTIC	LIMITS			UNIT	TEST CONDITIONS				NOTES see page Di-11
	MIN.	TYP.	MAX.		TEMP.	V_{cc}	DRIVEN INPUT	OUTPUT	
"1" OUTPUT VOLTAGE									
node Input	3.0	3.8		V	0°C	4.5V	1.6V	SEE	3
node Input	3.0	3.8		V	+25°C	4.5V	1.6V	NOTE	3
node Input	3.0	3.8		V	+75°C	4.5V	1.3V	2a	3
"0" OUTPUT VOLTAGE									
node Input		.30	.45	V	0°C	4.5V		12.0mA	3
node Input		.30	.45	V	+25°C	5.0V		13.3mA	3
node Input		.30	.45	V	+75°C	5.5V		14.4mA	3
"0" INPUT CURRENT									
node Input		2.70	3.45	mA	0°C	5.5V	.45V		3
node Input	1.80	2.70	3.45	mA	+25°C	5.5V	.45V		3
node Input		2.70	3.45	mA	+75°C	5.5V	.45V		3
"1" OUTPUT CURRENT									
		.05	1	μA	+25°C	4.5V	GND	4.5V	3
		.1	5	μA	+75°C	4.5V	GND	4.5V	3
POWER DISSIPATION									
		14.8	17.5	mW	+25°C	5.0V	GND		
		10.0	11.0	mW	+25°C	5.0V	OPEN		
OUTPUT CAPACITANCE		2.0		pF	+25°C	5.0V		0.5VDC 25mVrms @ 1 MHz	

SWITCHING (DYNAMIC) CHARACTERISTICS

CHARACTERISTIC	LIMITS				TEST CONDITIONS		
	MIN.	TYP.	MAX.	UNIT	TEMP.	V_{cc}	TEST CIRCUIT
Propagation Delay t_{pd}		18	25	ns	+25°C	5.0V	3

HIGH VOLTAGE HEX INTERFACE DRIVER
HD-535

ABSOLUTE MAXIMUM RATINGS

Input Voltage : +6 Volts Output Current : +35mA
Output Voltage : +35 Volts Operating Temp. : −0°C to +75°C
V_{cc} : +8 Volts Storage Temp. : −65°C to +150°C

Maximum ratings are limiting values above which permanent circuit damage may occur.

STATIC ELECTRICAL CHARACTERISTICS (Notes 1, 4)

	LIMITS				TEST CONDITIONS				
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	TEMP.	V_{cc}	DRIVEN INPUT	OUTPUT	NOTES see page Di-11
"1" OUTPUT VOLTAGE									
node Input	29			V	0°C	4.5V	1.6V	SEE NOTE 2b	3
node Input	29			V	+25°C	4.5V	1.6V		3
node Input	28			V	+75°C	4.5V	1.3V		3
"0" OUTPUT VOLTAGE									
node Input			1.0	V	0°C	4.5V		8.0mA	3
node Input		.65	1.0	V	+25°C	5.0V		8.0mA	3
node Input			1.0	V	+75°C	5.5V		8.0mA	3
"0" INPUT CURRENT									
node Input		2.95	3.45	mA	0°C	5.5V	.45V		3
node Input	1.80	2.95	3.45	mA	+25°C	5.5V	.45V		3
node Input		2.95	3.45	mA	+75°C	5.5V	.45V		3
"1" OUTPUT CURRENT									
		.1	1	μA	+25°C	4.5V	GND	30V	3
		1	50	μA	+75°C	4.5V	GND	30V	3
POWER DISSIPATION									
		14.8	17.5	mW	+25°C	5.0V	GND		
		10.0	11.0	mW	+25°C	5.0V	OPEN		
OUTPUT CAPACITANCE									
		5.0		pF	+25°C	5.0V	GND	0.5VDC 25mVrms @ 1 MHz	

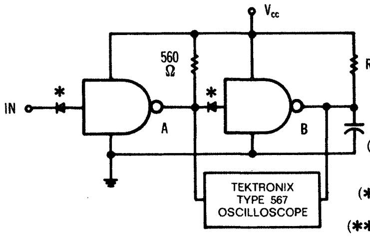
SWITCHING (DYNAMIC) CHARACTERISTICS

	LIMITS				TEST CONDITIONS		
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	TEMP.	V_{cc}	TEST CIRCUIT
Propagation Delay t_{pd}		35	70	ns	+25°C	5.0V	3

TEST CIRCUITS

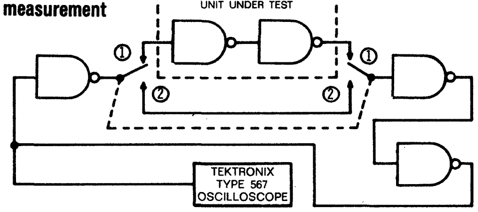
Test Circuit No. 1
t_{on} and t_{off} — measurements

INPUT PULSE
$t_r = t_f = 5ns$
f = 1MHz
pw = 100ns



(*) Diodes from Expander Gate RD-211
(**) Test Fixture and Probe Capacity

Test Circuit No. 3
t_{pd} measurement



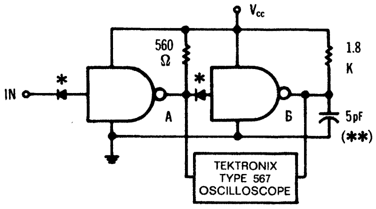
Propagation delay for one element based on pair delay measurement

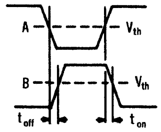
$t_{pd} = \frac{T_5 - T_3}{4}$ Where T_5 = Measured time for one cycle of oscillation with switch in position ① (5 elements)

And T_3 = Measured time for one cycle of oscillation with switch in position ② (3 elements standard)

Test Circuit No. 2
t_{on} and t_{off} — measurements

(*) Diodes from Expander Gate RD-211
(**) Test Fixture and Probe Capacity

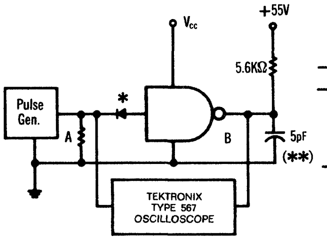


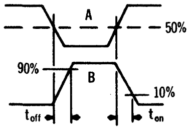


V_{TH}	−55°C	+25°C	+125°C
	1.9V	1.5V	1.2V

Test Circuit No. 4
t_{on} and t_{off} — measurements

INPUT PULSE
$t_r = t_f = 5ns$
f = 100KHz
pw = 5.0μs
Amp. = +3.5V



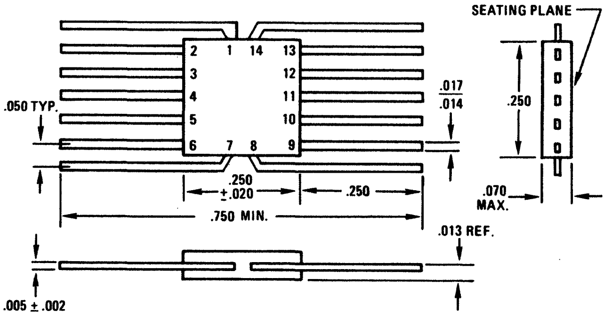


(*) Diodes from Expander Gate RD-211
(**) Test Fixture and Probe Capacity

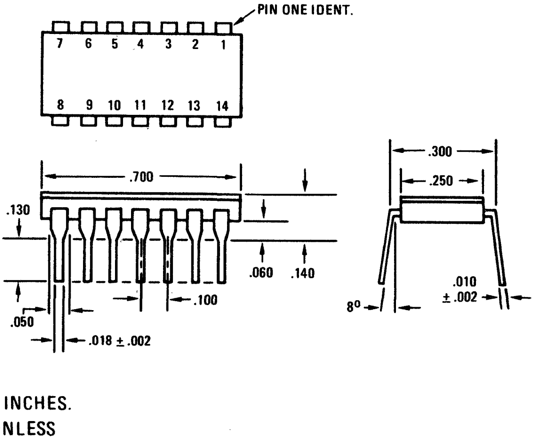
PACKAGING

Package outline drawings for Harris Integrated Circuits products are illustrated below. For each package, a particular Harris protective carrier is used in production, testing, and handling. If desired, this protective carrier may be specified for shipping purposes. Harris can also furnish custom designed packages from its inhouse facility. The package Carriers and their releationship to corresponding test contactors are shown.

CODE 9V TO-86 (METAL BOTTOM)



CODE 1S 14 LEAD BRAZED D.I.P.



ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HD-6600

Quad Power Strobe

HD-6605

Quad Logic Strobe

FEATURES

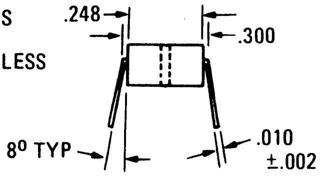
- HIGH DRIVE CURRENT – 200mA
- HIGH SPEED 50ns TYPICAL
- TTL COMPATIBLE INPUTS
- DIELECTRIC ISOLATION
- QUAD MONOLITHIC CONSTRUCTION
- POWER SUPPLY FLEXIBILITY
- LOW POWER STANDBY 30mW/CIRCUIT
  ACTIVE 95mW/CIRCUIT

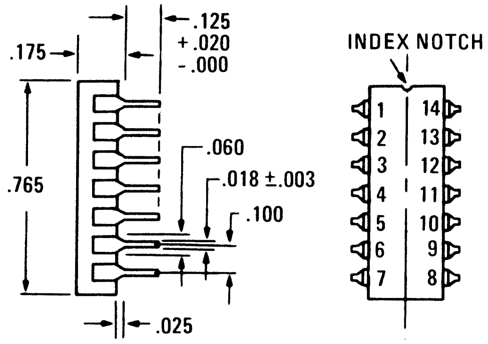
PACKAGE

CODE 1A TO-116(14 LEAD CERAMIC D.I.P.)

ALL DIMENSIONS IN INCHES

ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

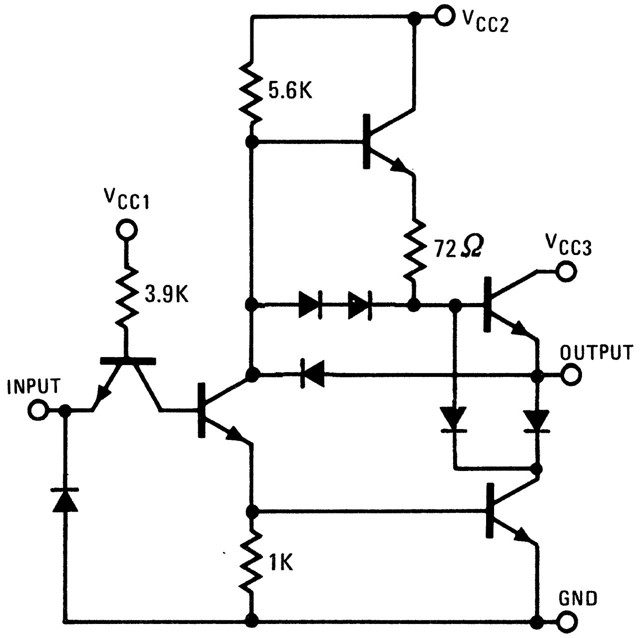




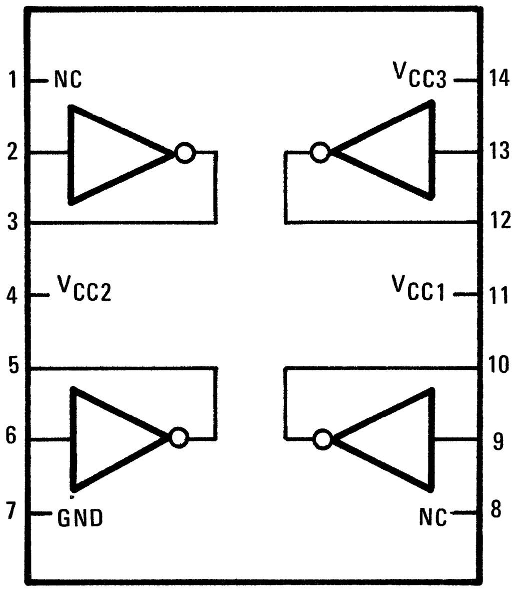
DESCRIPTION

The HD-6600 Quad Power Strobe and HD-6605 Quad Logic Strobe are constructed with Harris Dielectric Isolation Bipolar Monolithic Process. The design incorporates power supply flexibility with TTL compatible inputs and high current outputs.

CIRCUIT DIAGRAM



LOGIC DIAGRAM



NC: NO CONNECTION

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage V_{CC1}	+ 8 VDC
V_{CC2}	+18 VDC (HD-6600), +14 VDC (HD-6605)
V_{CC3}	+18 VDC (HD-6600), +8 VDC (HD-6605)
Input Voltage V_{IN}	-0.5 VDC to +5.5 VDC
Storage Temperature T_{STG}	-65°C to +150°C
Output Current I_L	-300mA
Power Dissipation at 25°C	1000mW (Derate 9mW/°C Above 60°C)

RECOMMENDED OPERATING CONDITIONS

Power Supplies: V_{CC1}	5 VDC	±10%
V_{CC2}	12 VDC	±15%
V_{CC3}	5 VDC	±20%

ELECTRICAL CHARACTERISTICS

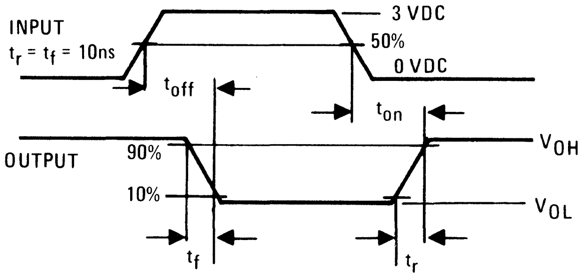
T_A = -55°C to +125°C HD1-6600-2/HD1-6605-2 V_{CC2} = 12.0 VDC
T_A = 0°C to + 75°C HD1-6600-5/HD1-6605-5 V_{CC3} = 5.0 VDC

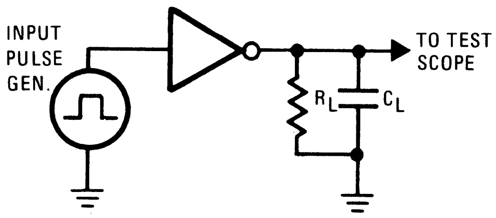
	PARAMETER	SYM.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC	Input Current	I_{IR} I_{IF}			60 -1.6	µA mA	V_{IN} = 2.4 VDC V_{IN} = 0.4 VDC V_{CC1} = 5.5 VDC
	Input Threshold Voltage	V_{IH}	2.0			V	V_{CC1} = 4.5 VDC
		V_{IL}			0.8	V	
	Output Voltage (Note 1)	V_{OH}	4.75	4.85		V	V_{CC1} = 5.0 VDC V_{IN} = 0.4 VDC I_L = -150mA DC
		V_{OL}			1.0	V	V_{CC1} = 5.0 VDC V_{IN} = 2.4 VDC I_L = 500 µA DC
	Supply Current (Note 2)	I_{CC1}		4	6.0	mA	V_{CC1} = 5.5 VDC V_{IN} = 2.4 VDC
		I_{CC1}		4	6.4	mA	V_{CC1} = 5.5 VDC V_{IN} = .4 VDC
		I_{CC2}		40	60	mA	V_{CC1} = 5.5 VDC V_{IN} = 0.4 VDC I_L = -150mA DC
		I_{CC2}		8	12	mA	V_{CC1} = 5.5 VDC V_{IN} = 2.4 VDC I_L = 0

	PARAMETER	SYM.	TYP.	MAX.	UNITS	CONDITIONS T_A = 25°C
AC	Turn On Delay	t_{on}	50	75	ns	V_{CC1} = 5.0 VDC V_{CC2} = 12 VDC V_{CC3} = 5.0 VDC R_L = 31.6 Ω C_L = 620 pf
	Turn Off Delay	t_{off}	50	75	ns	
	Rise Time	t_r	40	65	ns	
	Fall Time	t_f	40	65	ns	

NOTES: (1) One strobe enabled. (2) All strobes enabled.

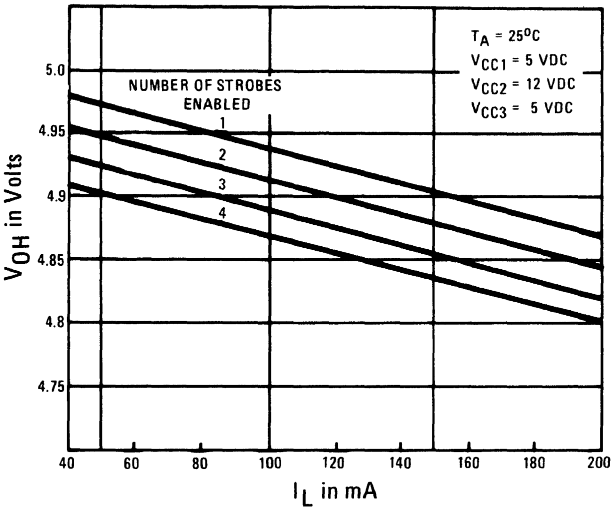
SWITCHING TIME DEFINITIONS



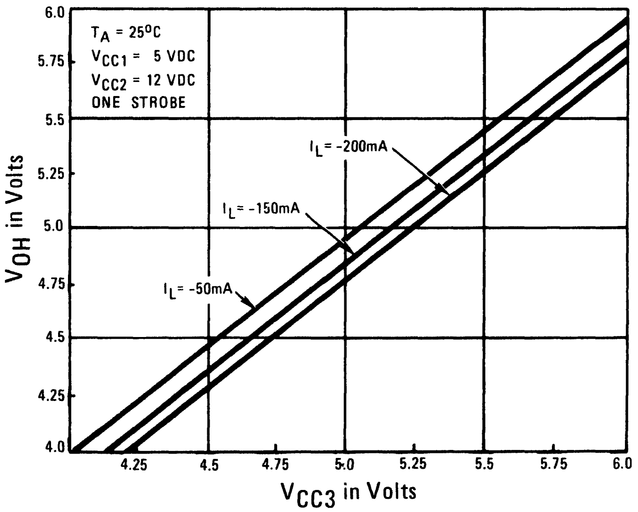


TYPICAL CHARACTERISTICS

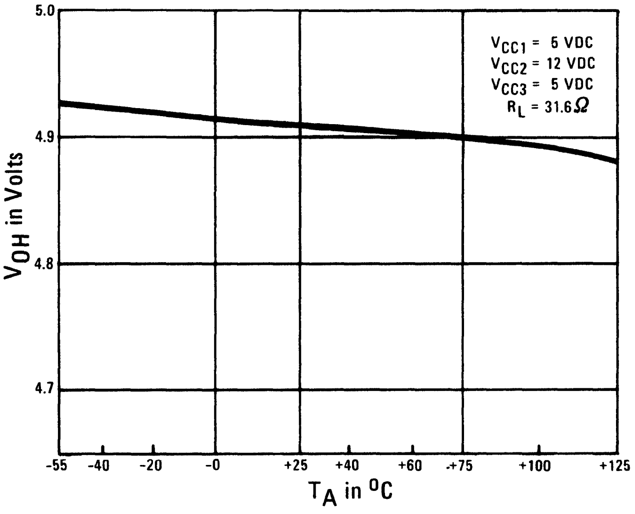
TYPICAL OUTPUT VOLTAGE vs.
LOAD CURRENT AND NUMBER OF STROBES ENABLED



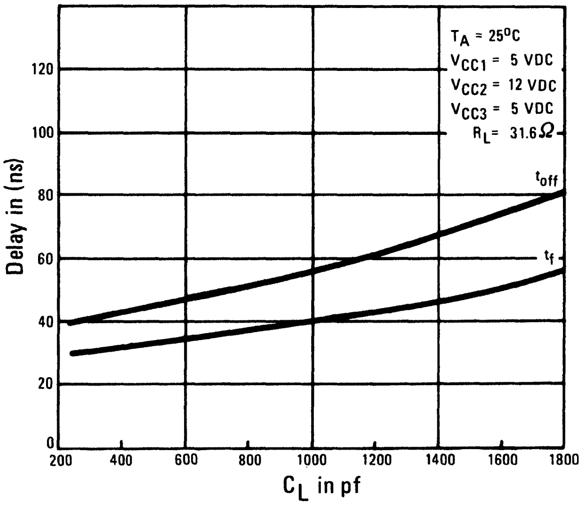
TYPICAL OUTPUT VOLTAGE vs.
V_{CC3} SUPPLY VOLTAGE



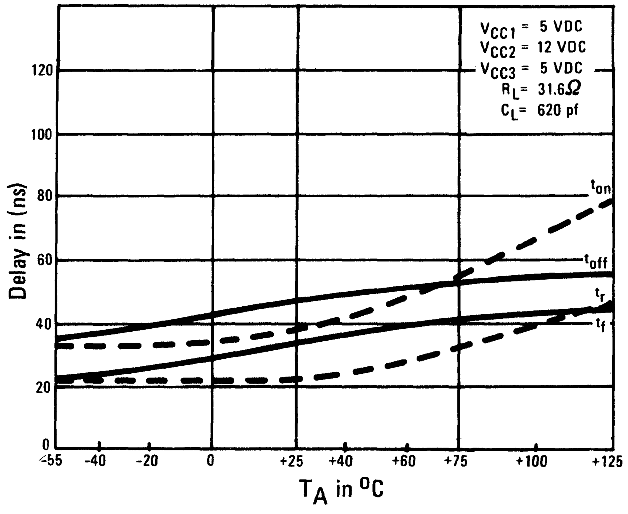
TYPICAL OUTPUT VOLTAGE vs.
AMBIENT TEMPERATURE



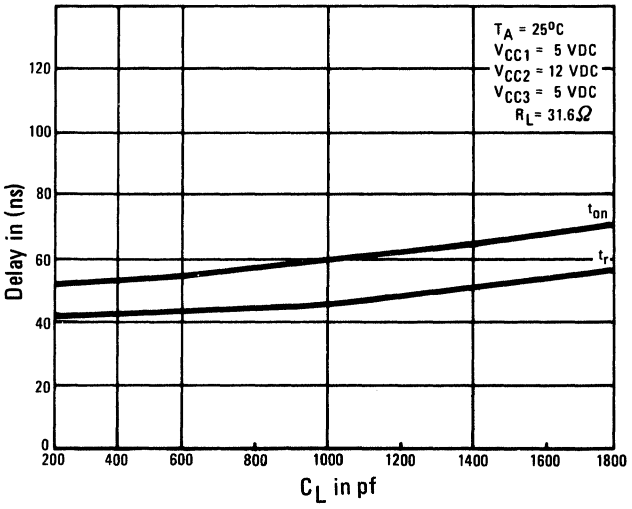
TYPICAL DELAY t_{off} AND t_f vs.
LOAD CAPACITANCE



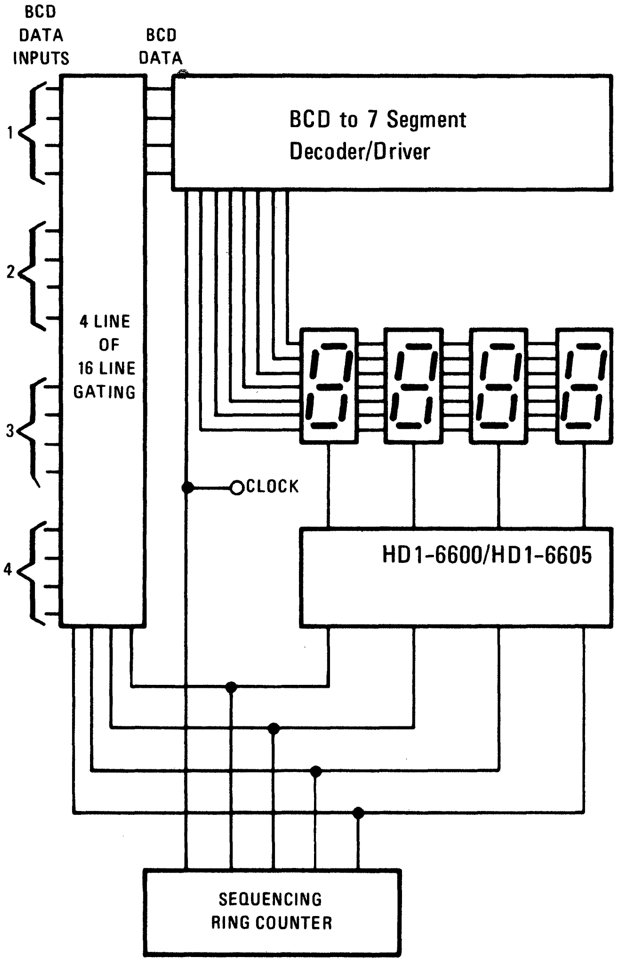
TYPICAL DELAY vs.
AMBIENT TEMPERATURE



TYPICAL DELAY t_{on} AND t_r vs.
LOAD CAPACITANCE

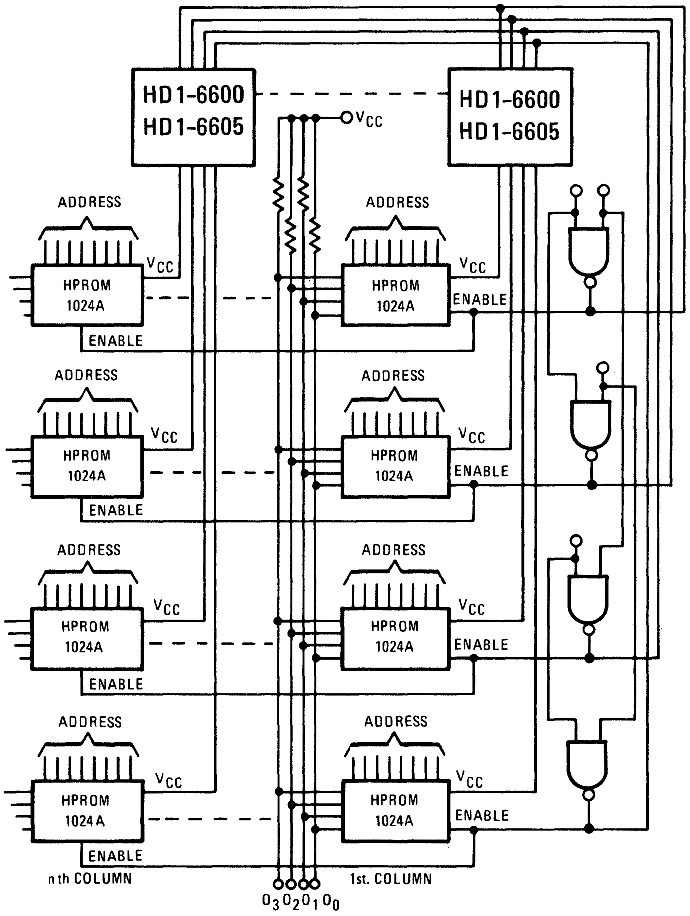


LED MULTIPLEXING



The HD-6600 Quad Power Strobe and HD-6605 Quad Logic Strobe, when used in conjunction with the HD-0140 Quad Latch/7 Segment Display Driver, provides a flexible multiplexed display system. The 150mA drive capability of the Power Strobe matches the current requirements of most 7 segment LED's presently available.

HD-6600 POWER STROBE
HD-6605 "PROM" LOGIC STROBE



The use of the HD-6600 Power Strobe or HD-6605 Quad Logic Strobe with the HPROM 1024A programmable memories allows expansion of a 256 word memory to a 1024 word memory with only a nominal increase in system power. Using the enable signal as the Power Strobe input optimizes the enable to output delay of the memory.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HM-010/030/040/050/ 074/080/090

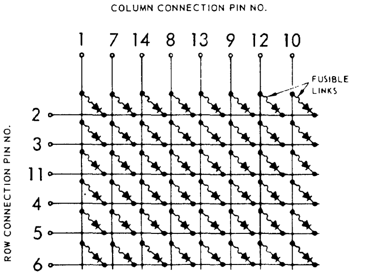
MIL Temperature Diode Matrices

Harris Monolithic Diode Matrices consist of arrays of passivated silicon diodes, fabricated in dielectrically isolated moats. Use of improved epitaxial techniques allow construction of arrays using the epitaxial layer as the common cathode connection for all diodes in a row. Column connection to the anode side of the diodes are made to metalized interconnect lines via fusible links. By selectively opening fuses, diodes are effectively removed from the circuit to form any desired matrix pattern. Harris automatic production test equipment provides instantaneous code pattern customizing from finished goods inventory.

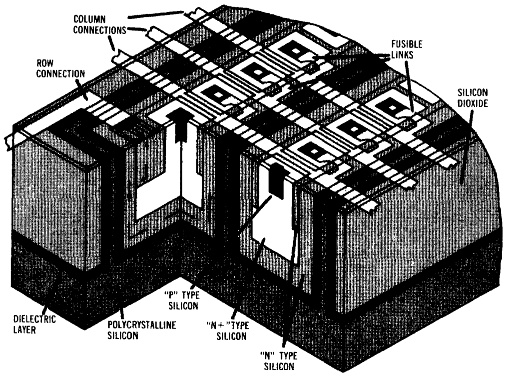
Combining the fusing technique with the availability of various matrix sizes and the possibility of assembling several matrices to form larger arrays, provides designers with the necessary flexibility in system design.

The matrices meet full military temperature range operation (-55°C to +125°C) and the circuits are designed to meet or exceed the mechanical and environmental requirements of MIL-STD-883.

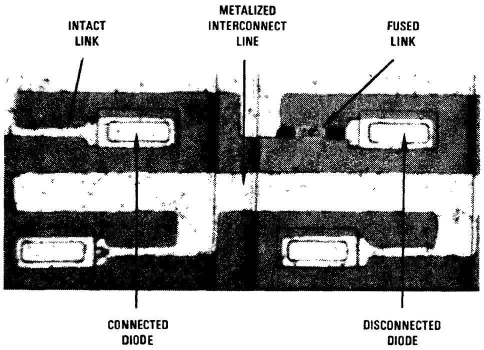
TYPICAL 6 x 8 CIRCUIT SCHEMATIC



Harris matrices are ideally suited for applications in logic generation, coding, decoding, and addressing type networks. For further information refer to Harris Diode Matrix Technical Information and Application Bulletin.



MONOLITHIC STRUCTURE



FUSIBLE LINK SYSTEM

MONOLITHIC INTERFACE CIRCUITS

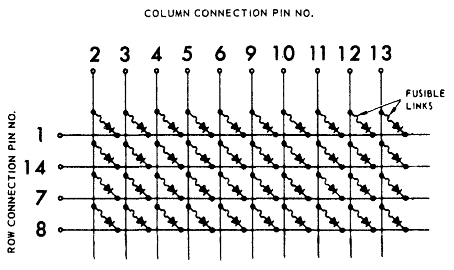
When the Harris family of Monolithic Diode Matrices are used with Harris Monolithic Interface circuits, complex logic generation is possible with simple diode-inverter logic. A product selection guide for the monolithic interface circuits is given to help designers select the best interface circuit and matrix for his application. The interface circuits can be used for input to or output from any diode matrix.

MONOLITHIC DIODE MATRICES

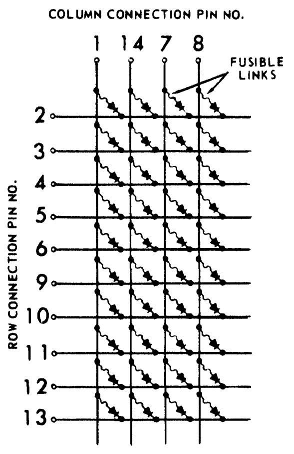
PRODUCT SELECTION GUIDE MILITARY

MATRIX SIZE	FAST RECOVERY	MEDIUM RECOVERY	GENERAL PURPOSE	PACKAGE OUTLINE
4 x 10	HM1-090	HM1-091	HM1-093	1A
4 x 10	HM9-090	HM9-091	HM9-093	9H
10 x 4	HM1-050	HM1-051	HM1-055	1A
10 x 4	HM9-050	HM9-051	HM9-055	9H
5 x 5	HM1-074	HM1-075	HM1-077	1A
5 x 5	HM9-074	HM9-075	HM9-077	9H
5 x 8	HM1-010	HM1-012	HM1-013	1A
5 x 8	HM9-010	HM9-012	HM9-013	9H
8 x 5	HM1-080	HM1-081	HM1-084	1A
8 x 5	HM9-080	HM9-081	HM9-084	9H
6 x 8	HM1-030	HM1-031	HM1-034	1A
6 x 8	HM9-030	HM9-031	HM9-034	9H
8 x 6	HM1-040	HM1-041	HM1-044	1A
8 x 6	HM9-040	HM9-041	HM9-044	9H

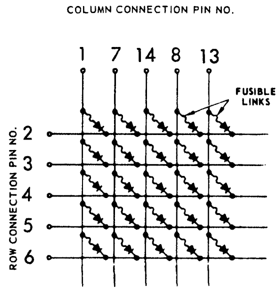
DIODE PIN OUT CONFIGURATION



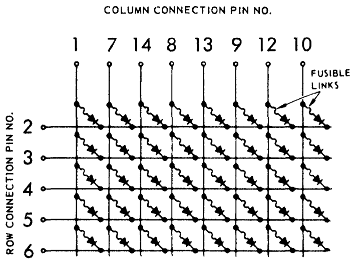
4 x 10



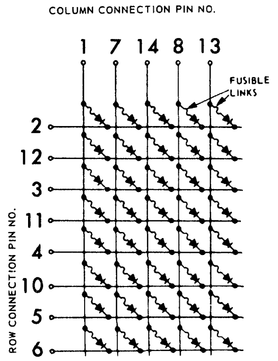
10 x 4



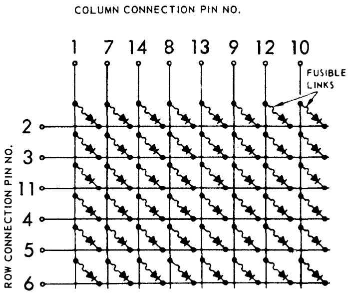
5 x 5



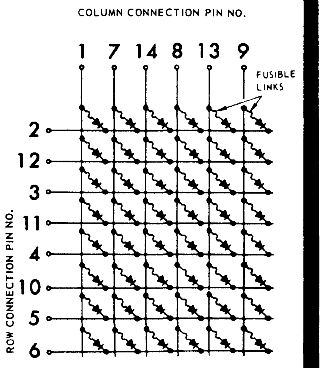
5 x 8



8 x 5



6 x 8



8 x 6

When ordering a matrix with a custom pattern take a matrix pattern and circle out those diodes to be removed from the matrix. Another method to clerly identify pattern is to call out row and column pins for each diode to be removed.

FAST RECOVERY MATRICES

HM-074	5 x 5	HM-050	10 x 4
HM-010	5 x 8	HM-080	8 x 5
HM-030	6 x 8	HM-090	4 x 10
HM-040	8 x 6		

ABSOLUTE MAXIMUM RATINGS

Forward Current : 100 mA
Surge Current (100 μs max.) : 200 mA
Total Ckt. Dissipation (still air) : 450 mW
Operating Temp. (ambient) : −55°C to +125°C
Storage Temp. (ambient) : −65°C to +150°C

Maximum ratings are limiting values above which permanent circuit damage may occur.

ELECTRICAL CHARACTERISTICS

HM-010 HM-050 HM-080
HM-030 HM-074 HM-090
HM-040

CHARACTERISTIC	LIMITS			UNIT	TEST CONDITIONS	
	MIN.	TYP.	MAX.		TEMP.	ELECTRICAL
FORWARD DROP						
$V_{F\,20}$			1.5	V	−55°C	$I_F = 20$ mA
		1.0	1.3	V	+25°C	$I_F = 20$ mA
$V_{F\,1}$			.95	V	−55°C	$I_F = 1$ mA
		0.7	.75	V	+25°C	$I_F = 1$ mA
REVERSE BREAKDOWN						
BV_R	40			V	−55°C	$I_R = 100$ μA
	45	60		V	+25°C	$I_R = 100$ μA
REVERSE CURRENT						
I_R		7	25	nA	+25°C	$V_R = 25$V
			10	μA	+125°C	$V_R = 25$V
REVERSE RECOVERY						
t_{rr}		7	10	ns	+25°C	$I_F = 10$ mA to $I_R = 10$ mA Recovery to 1 mA
CROSSPOINT CAPACITANCE C_{cp}		1.9	4.0	pF	+25°C	$V_R = 5$V, f = 1MHz
COUPLING COEFFICIENT I_{CL}		20	50	μA	+25°C	$I_{ADJ} = 20$ mA $V_{REV} = -5$V

PERFORMANCE CURVES

(See Page Me-18 for Performance Characteristic Curves)

V_F	Figure 1
I_R	Figure 2
C_{cp}	Figure 5

MEMORY

MEDIUM RECOVERY MATRICES

HM-075	5 x 5	HM-051	10 x 4
HM-012	5 x 8	HM-081	8 x 5
HM-031	6 x 8	HM-091	4 x 10
HM-041	8 x 6		

ABSOLUTE MAXIMUM RATINGS

Forward Current	: 100 mA		
Surge Current (100 µs max.)	: 200 mA	Operating Temp. (ambient)	: −55°C to +125°C
Total Ckt. Dissipation (still air)	: 450 mW	Storage Temp. (ambient)	: −65°C to +150°C

Maximum ratings are limiting values above which permanent circuit damage may occur.

ELECTRICAL CHARACTERISTICS

HM-012 HM-051 HM-081
HM-031 HM-075 HM-091
HM-041

CHARACTERISTIC	LIMITS			UNIT	TEST CONDITIONS	
	MIN.	TYP.	MAX.		TEMP.	ELECTRICAL
FORWARD DROP						
$V_{F\,20}$			1.7	V	−55°C	$I_F = 20$ mA
		1.2	1.5	V	+25°C	$I_F = 20$ mA
$V_{F\,1}$			1.0	V	−55°C	$I_F = 1$ mA
		0.75	0.8	V	+25°C	$I_F = 1$ mA
REVERSE BREAKDOWN BV_R	35			V	−55°C	$I_R = 100\ \mu A$
	40	60		V	+25°C	$I_R = 100\ \mu A$
REVERSE CURRENT I_R		25	50	nA	+25°C	$V_R = 25V$
			25	µA	+125°C	$V_R = 25V$
REVERSE RECOVERY t_{rr}		11	25	ns	+25°C	$I_F = 10$ mA to $I_R = 10$ mA Recovery to 1 mA
CROSSPOINT CAPACITANCE C_{cp}		1.9	4.0	pF	+25°C	$V_R = 5V$, $f = 1MHz$
COUPLING COEFFICIENT I_{CL}		20	50	µA	+25°C	$I_{ADJ} = 20$ mA $V_{REV} = -5V$

PERFORMANCE CURVES

(See Page Me-18 for Performance Characteristic Curves)

V_F	Figure 1
I_R	Figure 3
C_{cp}	Figure 5

GENERAL PURPOSE MATRICES

HM-077	5 x 5	HM-055	10 x 4
HM-013	5 x 8	HM-084	8 x 5
HM-034	6 x 8	HM-093	4 x 10
HM-044	8 x 6		

ABSOLUTE MAXIMUM RATINGS

Forward Current : 100 mA

Surge Current (100 μs max.) : 200 mA

Total Ckt. Dissipation (still air) : 450 mW

Operating Temp. (ambient) : −55°C to +125°C

Storage Temp. (ambient) : −65°C to +150°C

Maximum ratings are limiting values above which permanent circuit damage may occur.

ELECTRICAL CHARACTERISTICS

HM-013	**HM-055**	**HM-084**
HM-034	**HM-077**	**HM-093**
HM-044		

CHARACTERISTIC	LIMITS			UNIT	TEST CONDITIONS	
	MIN.	TYP.	MAX.		TEMP.	ELECTRICAL
FORWARD DROP						
$V_{F\,20}$			1.5	V	−55°C	$I_F = 20$ mA
		0.95	1.3	V	+25°C	$I_F = 20$ mA
$V_{F\,1}$			.95	V	−55°C	$I_F = 1$ mA
		0.7	.75	V	+25°C	$I_F = 1$ mA
REVERSE BREAKDOWN						
BV_R	30			V	−55°C	$I_R = 100\ \mu A$
	35	50		V	+25°C	$I_R = 100\ \mu A$
REVERSE CURRENT						
I_R		70	250	nA	+25°C	$V_R = 25V$
			50	μA	+125°C	$V_R = 25V$
REVERSE RECOVERY						
t_{rr}		20	50	ns	+25°C	$I_F = 10$ mA to $I_R = 10$ mA Recovery to 1 mA
CROSSPOINT CAPACITANCE C_{cp}		2.0	4.0	pF	+25°C	$V_R = 5V$, f = 1MHz
COUPLING COEFFICIENT I_{CL}		20	50	μA	+25°C	$I_{ADJ} = 20$ mA $V_{REV} = -5V$

PERFORMANCE CURVES

(See Page Me-18 for Performance Characteristic Curves)

V_F	Figure 1
I_R	Figure 4
C_{cp}	Figure 5

TYPICAL PERFORMANCE CHARACTERISTICS

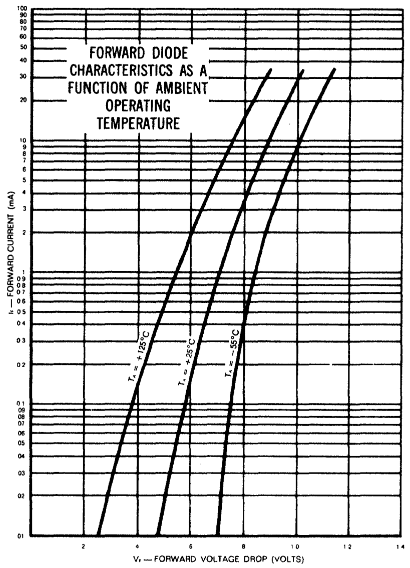


FIGURE 1

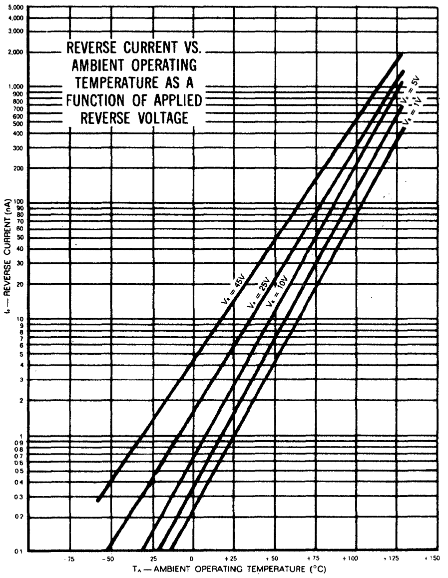


FIGURE 2

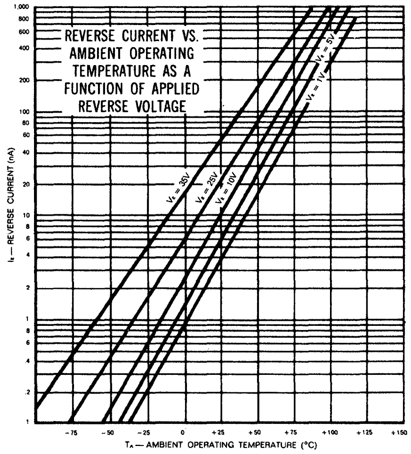


FIGURE 3

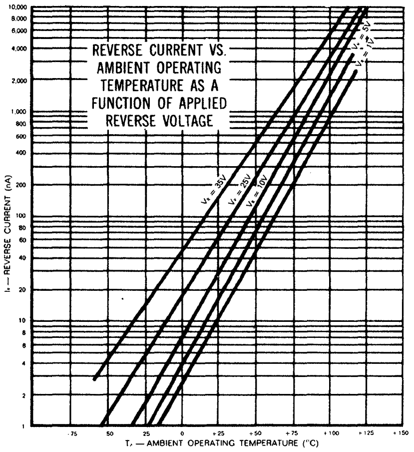


FIGURE 4

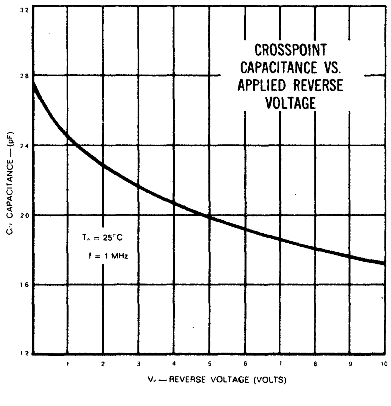
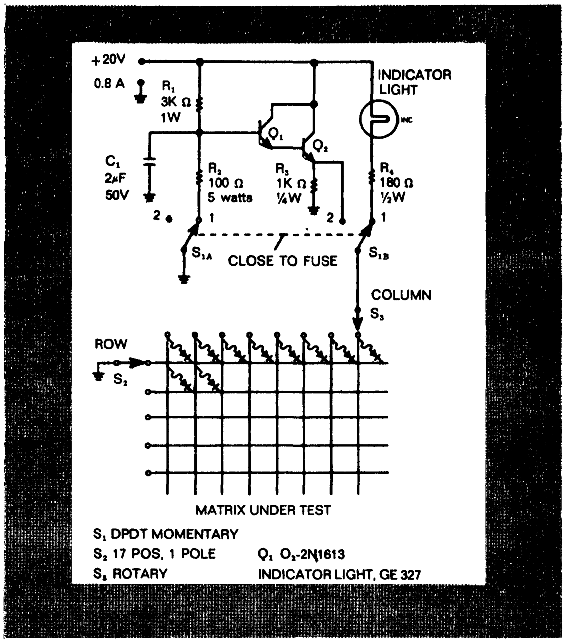


FIGURE 5

DIODE MATRIX FUSING

A simple ramp current generator is used to provide the fusing current. With switch S_{1A} in the position shown the capacitor C_1 is discharged to ground through R_2. The diode to be eliminated is selected by setting the row and column switches S_2 and S_3 respectively as required. When switch S_{1A} is activated to position 2, capacitor C_1 charges up through R_1 forming a ramp voltage that drives the base of Q_1. The darlington transistor pair of Q_1 and Q_2 transforms the voltage ramp to a current ramp that provides current to the column contacts on the matrix. This current, through the fuse, opens the fusible link in series with the selected diode. The peak fusing current required to open a fusible link, is approximately 750 milliamperes. As the temperature of the fuse is raised, the aluminum begins to melt. This melting continues until the fuse link separates. The cohesive forces of the melting aluminum retracts the remaining portions of the metal, thereby preventing formation of loose aluminum residues. The melting temperature of aluminum at approximately 650°C will not affect the passivating layer of silicon dioxide whose melting temperature is about 1350°C. Test verification is obtained by an indicating device placed in series with the column and row switches through the contacts S_{1B} to give visual indication of the condition of each diode in the matrix before and after fusing.



MONOLITHIC INTERFACE CIRCUITS

Harris interface circuits and monolithic diode matrices form a compatible family of intergrated circuits to complement any logic design. These circuits in combination can perform AND, OR, INVERT, AND-OR, NAND/NOR logic functions. The versatility of these circuits is unsurpassed when control, coding and decoding logic functions are performed.

PRODUCT SELECTION GUIDE FOR INTERFACE CIRCUITS

200/300 SERIES MILITARY -55°C to +125°C

TYPICAL CHARACTERISTICS AT V_{CC} = 5.0V and T_A = +25°C

TYPE NUMBER	DESCRIPTION	FAN-OUT	t_{pd} (ns)	POWER DISSIPATION (mW)	NOTES
HD-234	Hex Interface Inverter	8	8	10	1
HD-235	Hex Interface Driver	35V	35	10	2

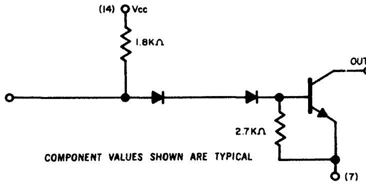
NOTE: Parts available in flat pack and dips

500 SERIES INDUSTRIAL 0°C to +75°C

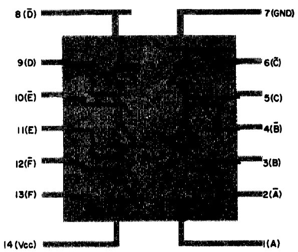
TYPICAL CHARACTERISTICS AT V_{CC} = 5.0V and T_A = +25°C

TYPE NUMBER	DESCRIPTION	FAN-OUT	t_{pd} (ns)	POWER DISSIPATION (mW)	NOTES
HD-534	Hex Inferface Inverter	5	18	12	1
HD-535	Hex Interface Driver	35V	35	12	2

NOTE: Parts available in flat pack and dips



BASIC CIRCUIT SCHEMATIC
(one element)



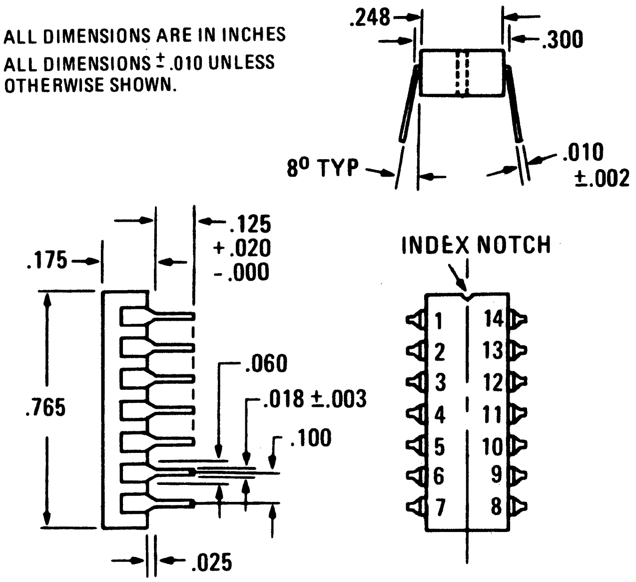
LOGIC DIAGRAM
(top view)

NOTES:

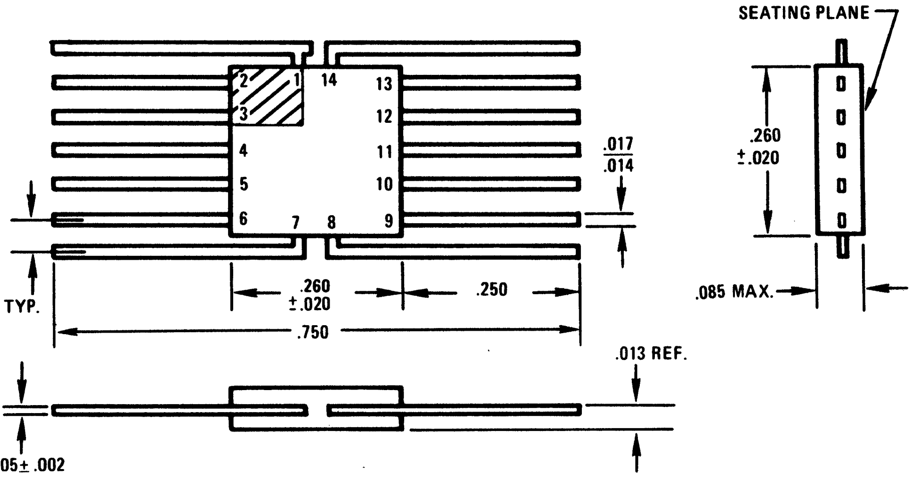
1.0 Fan-out is defined for Harris DTL logic of the same series number.

2.0 Voltage given in fan-out column is the minimum output breakdown voltage for this gate element.

CODE 1A TO-116(14 LEAD CERAMIC D.I.P.)


ALL DIMENSIONS ARE IN INCHES
ALL DIMENSIONS ± .010 UNLESS
OTHERWISE SHOWN.

CODE 9H TO-86 (CERAMIC)



ALL DIMENSIONS IN INCHES

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

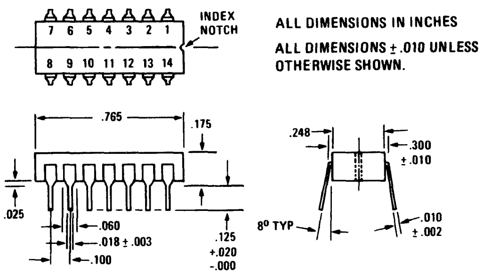
HM-0110 (4x10)
HM-0168 (6x 8)
HM-0104 (10x 4)
HM-0186 (8x 6)
Commercial Diode Matrices

DESCRIPTION

The commercial diode matrices are arrays of passivated silicon diodes, fabricated in dielectrically isolated moats. An epitaxial layer is used as the common cathode connection for all diodes in a row. Column connections to the anode side of the diodes are made through metal interconnect lines via fusible links. By selectively opening the links, diodes can be removed from the circuit to form any desired matrix pattern. This device is available in a 14-lead dual in-line CERDIP package. These parts are also available in a Mil-Temperature performance range.

PACKAGE

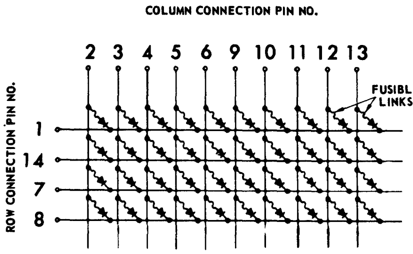
CODE 1A TO-116(14 LEAD CERAMIC D.I.P)



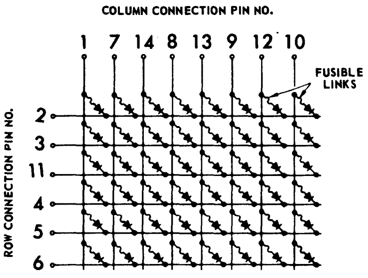
ALL DIMENSIONS IN INCHES
ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

MATRIX PATTERNS

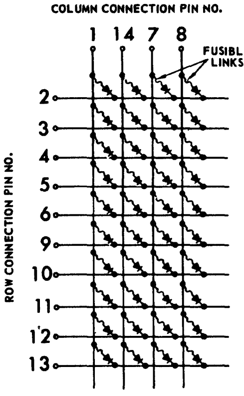
HM-0110
(4 x 10)



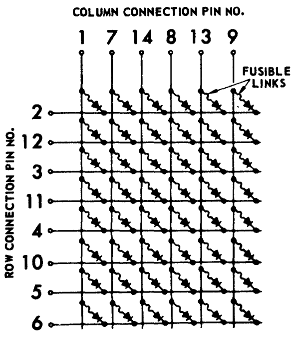
HM-0168
(6 x 8)



HM-0104
(10 x 4)



HM-0186
(8 x 6)



When ordering a matrix with a custom pattern take a matrix pattern and circle out those diodes to be removed from the matrix. Another method to clerly identify pattern is to call out row and column pins for each diode to be removed.

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Forward Current	100mA
Surge Current (100 µs Max.)	200mA
Total Circuit Dissipation (Still Air)	450mW
Operating Temperature (Ambient)	0°C to 70°C

ELECTRICAL CHARACTERISTICS AT 25°C

CHARACTERISTIC		HM1-0104 (10 x 4) HM1-0168 (6 x 8) HM1-0186 (8 x 6) LIMITS		HM1-0110 (4 x 10) LIMITS		CONDITIONS
		MIN.	MAX.	MIN.	MAX.	
Forward Drop	V_{F20}		1.5V		1.8V	I_F = 20mA
Forward Drop	V_{F1}		0.9V		1.0V	I_F = 1mA
Rev. Breakdown Volt.	BV_R	20V		20V		I_R = 100µA
Rev. Current	I_R		1µA		1µA	V_R = 15V
Rev. Rec. Time			100ns		100ns	I_F = 10mA I_R = 10mA to 1mA
Coupling Capacitance	C_{CP}		8pF		8pF	V_R = 5V f = 1MHz

NOTE: When ordering a matrix with a custom pattern either obtain copies of Harris patternizing forms from your local sales representative or contact headquarters, Marketing, Melbourne, Florida.

On all orders less than 100 units there will be a one time charge for each special pattern formed by Harris.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HM-7202

1024 x 1 N-Channel MOS RAM

FEATURES

- MIL And Commercial Versions
- Access Times From 350 TO 1000 NS
- Static - Easy To Use
- 1024 x 1 Organization
- Pinout Compatible With Industry Standard 2102
- Single +5V Power Supply
- TTL Compatible I/O
- No Clocks, No Refresh
- Two TTL Loads
- Three-State Output
- Output Can Be Or -Tied
- Inputs Protected From Static Change

DESCRIPTION

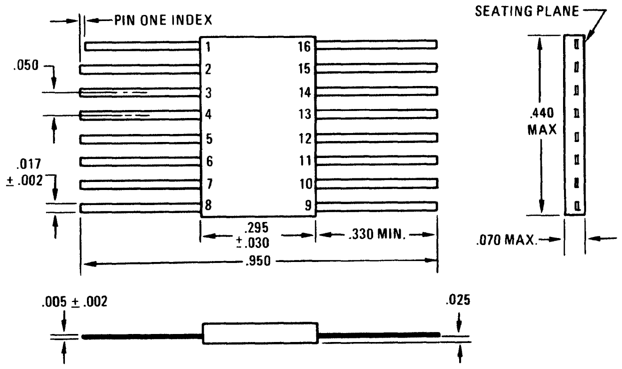
The HM-7202 is a 1024 Word X 1-Bit static N-Channel Random Access Read/Write Memory. Its TTL-Compatible I/O, single +5V supply, and static circuitry allow ease of operation without refresh or clocking.

Data Out is non-inverted from Data In.

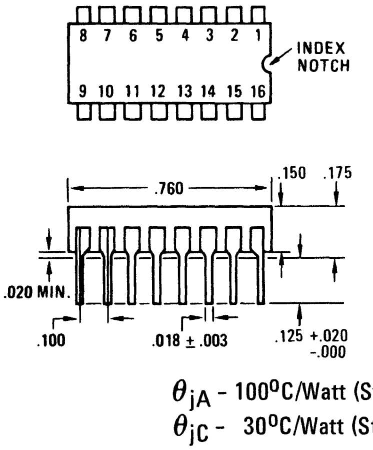
A chip select and three-state output allow easy memory array expansion. Input protection and 2 full TTL load drive capability round out the features of this easy-to-use-device.

The HM-7202 is compatible with the industry standard 2102-type devices, and is available in commercial and military temperature range, in a number of speed categories.

PACKAGING



θ_{jA} - 195°C/Watt (Still Air)
θ_{jC} - 55°C/Watt (Still Air)

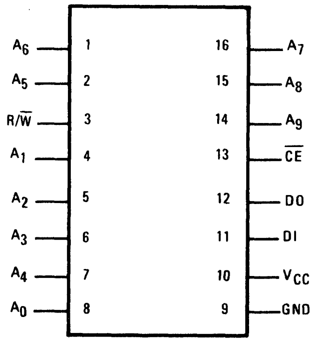


ALL DIMENSIONS IN INCHES.

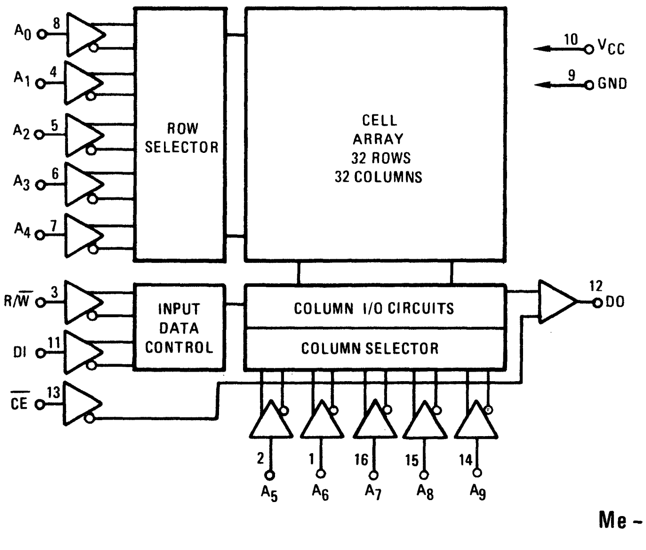
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

θ_{jA} - 100°C/Watt (Still Air)
θ_{jC} - 30°C/Watt (Still Air)

PINOUT



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Storage Temperature:	-65°C to +150°C	V_{CC} To Ground (Continuous):	-0.5V to +7.0V
Ambient Operating Temperature:	0°C to +70°C (7202-5) -55°C to +125°C (7202-2)	Voltage To Ground On Any Input Or Output:	-0.5V to +7.0V
Maximum Power Dissipation:	500mW	Maximum Current Into Output	±50mA

ELECTRICAL CHARACTERISTICS:

NOTE: V_{CC} = +5.0V ±5% (7202-5)
V_{CC} = +5.0V ±10% (7202-2)

D.C.

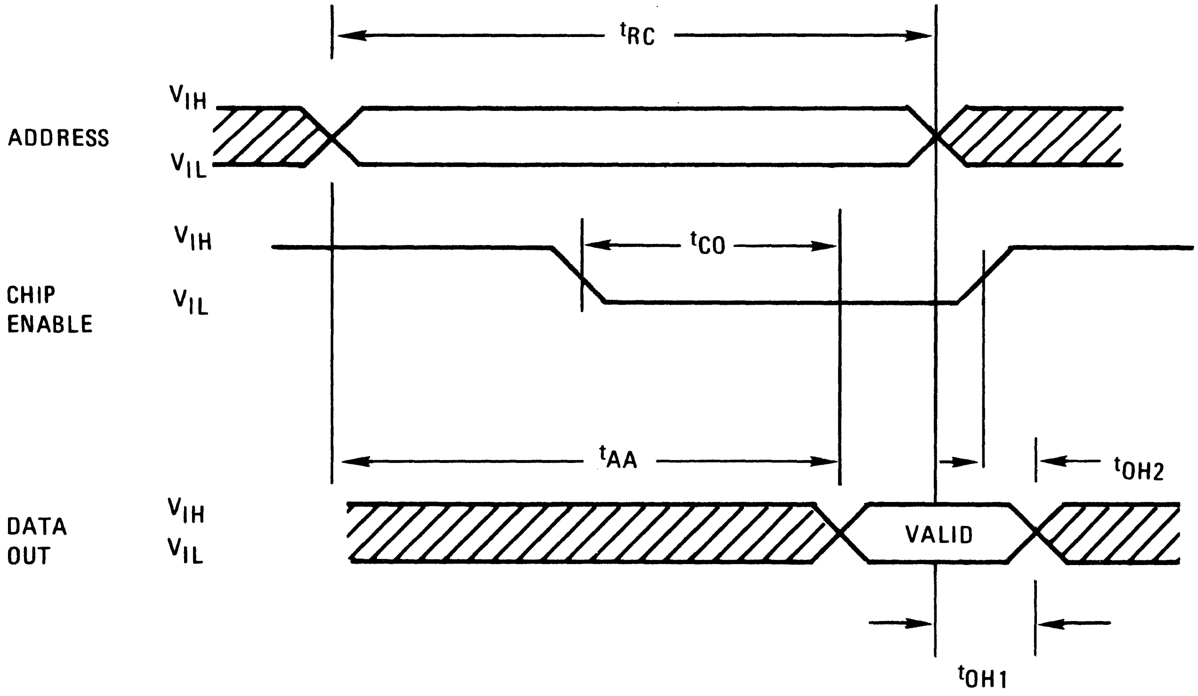
PARAMETER	SYMBOL	HM-7202-5 T_A = 0°C To +70°C			HM-7202-2 T_A = -55°C To +125°C			UNITS	CONDITIONS
		MIN	TYP	MAX	MIN	TYP	MAX		
Address/Enable "1"	I_{FA}			10			10	μA	$V_{in} = V_{CC} + 0.5V$
Forward Current "1"	I_{FE}			10			10	μA	
Address/Enable "0"	I_{RA}			-10			-10	μA	$V_{in} = 0$
Reverse Current "0"	I_{RE}			-10			-10	μA	
Input Threshold "1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$ Min
Voltage "0"	V_{IL}			0.65			0.65		$V_{CC} = V_{CC}$ Max
Output Voltage "1"	V_{OH}	2.4			2.4			V	I_{OH} = -0.2ma
(Three-State) "0"	V_{OL}			0.45			0.45		I_{OL} = 3.2ma
Output Leakage "1"	I_{OHL}			10			10	μA	$V_{\overline{CE}}$ = +2.0V $V_{OUT} = V_{CC} + 0.5V$
Current, Deselected "0"	I_{OLL}			-10			-10	μA	$V_{\overline{CE}}$ = +2.0V $V_{OUT} = 0$
Power Supply Current	I_{CC}			50			50	mA	All Inputs = V_{CC} Max $V_{CC} = V_{CC}$ Max Static: Output = high impedance

A.C.

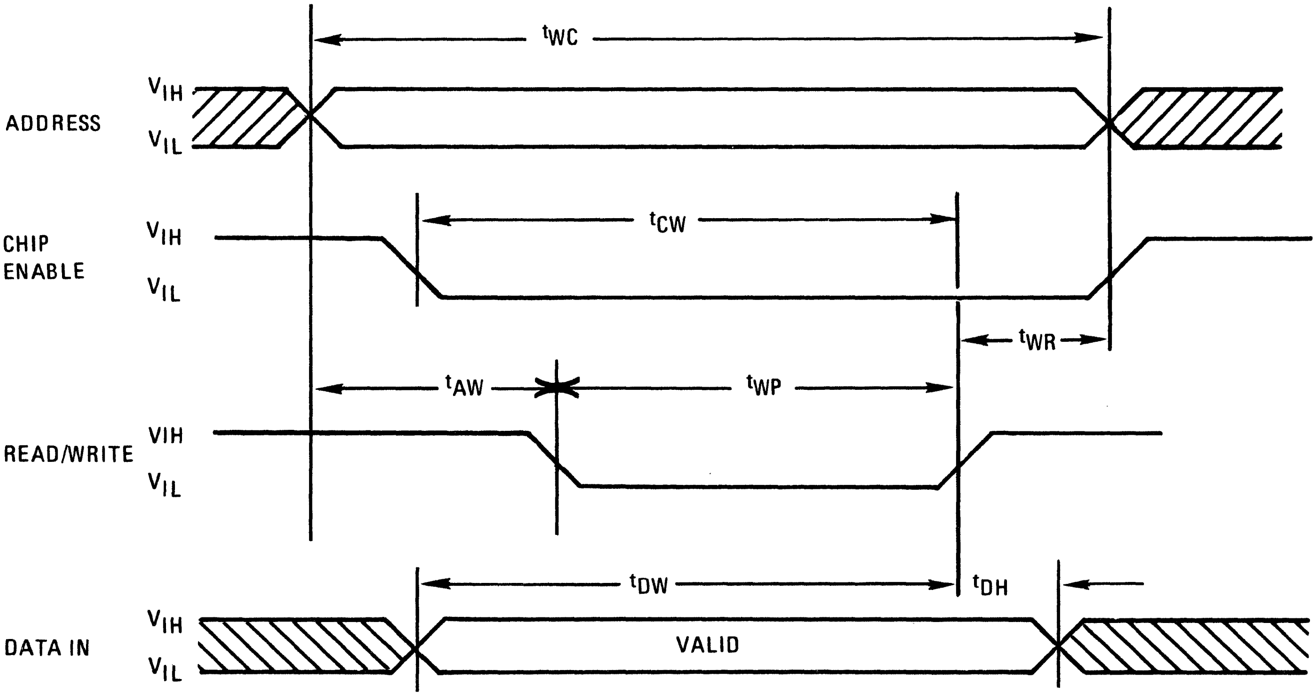
PARAMETER	SYMBOL	MIL/COMM HM-7202		MIL/COMM HM-7202A		MIL/COMM HM-7202B		MIL HM-7202C		COMM HM-7202C		UNITS	CONDITIONS
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
READ CYCLE:													
Address Access Time	t_{AA}		1000		650		500		400		350	NS	C_L = 50pF
Chip Enable Access Time	t_{CO}		500		400		350		300		180	NS	
Address-Output Hold Time	t_{OH1}	50		50		50		50		40		NS	Reference = 1.5V
CE-Output Hold Time	t_{OH2}	0		0		0		0		0		NS	
Read Cycle Time	t_{RC}	1000		650		500		400		350		NS	Input Pulse Levels +0.65V to +2.2V
WRITE CYCLE:													
Address Write Setup Time	t_{AW}	200		200		150		120		20		NS	$t_R = t_F$ = 20NS
Write Pulse Width Time	t_{WP}	750		400		300		220		200		NS	
Write Recovery Time	t_{WR}	50		50		50		50		50		NS	
Data Setup Time	t_{DW}	800		450		330		250		250		NS	
Data Hold Time	t_{DH}	100		100		100		100		50		NS	
CE-Write Setup Time	t_{CW}	900		550		400		300		250		NS	
Write Cycle Time	t_{WC}	1000		650		500		400		350		NS	

TEST CHARACTERISTICS

READ CYCLE



WRITE CYCLE

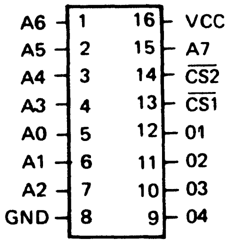
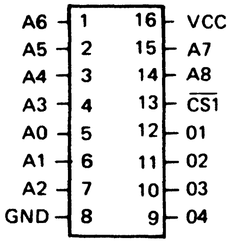
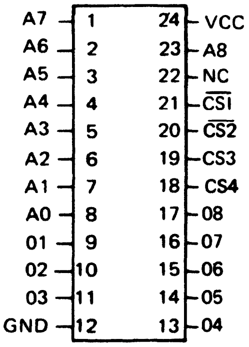
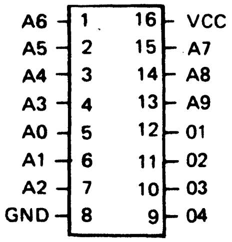
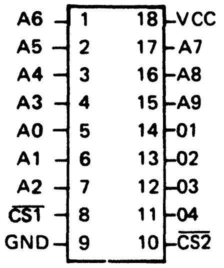
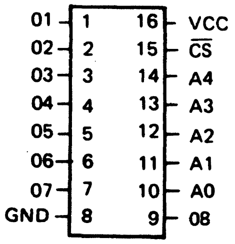


CAPACITANCE

FUNCTION	SYMBOL	CONDITIONS	TYP	MAX	LIMITS (1)
Address Input	C_A		3	5	pF
Read/Write	$C_{R/W}$	$V_{CC} = +5.0V$; $T_A = +25^oC$	7	10	pF
Input/Output	$C_{I/O}$	$V_T = 0V$; $f = 1MHz$	7	10	pF

NOTE 1. Capacitance is guaranteed, and sampled, but is not 100% tested.

HARRIS GENERIC PROM PRODUCT CHART

ORGANIZATION	PART NUMBER	OUTPUT TYPE	PINOUT	MAXIMUM ACCESS OVER VOLTAGE AND TEMP.	TYPICAL PROGRAMMING TIME (ALL BITS)
256 X 4	HM-7610 HM-7611	(OC) (TS)	 A6 1 16 VCC A5 2 15 A7 A4 3 14 $\overline{CS2}$ A3 4 13 $\overline{CS1}$ A0 5 12 01 A1 6 11 02 A2 7 10 03 GND 8 9 04	60ns	1 SECOND
512 X 4	HM-7620 HM-7621	(OC) (TS)	 A6 1 16 VCC A5 2 15 A7 A4 3 14 A8 A3 4 13 $\overline{CS1}$ A0 5 12 01 A1 6 11 02 A2 7 10 03 GND 8 9 04	70ns	2 SECONDS
512 X 8	HM-7640 HM-7641	(OC) (TS)	 A7 1 24 VCC A6 2 23 A8 A5 3 22 NC A4 4 21 $\overline{CS1}$ A3 5 20 $\overline{CS2}$ A2 6 19 CS3 A1 7 18 CS4 A0 8 17 08 01 9 16 07 02 10 15 06 03 11 14 05 GND 12 13 04	70ns	4 SECONDS
1024 X 4	HM-7644	ACTIVE PULLUP	 A6 1 16 VCC A5 2 15 A7 A4 3 14 A8 A3 4 13 A9 A0 5 12 01 A1 6 11 02 A2 7 10 03 GND 8 9 04	70ns	4 SECONDS
1024 X 4	HM-7642 HM-7643	(OC) (TS)	 A6 1 18 VCC A5 2 17 A7 A4 3 16 A8 A3 4 15 A9 A0 5 14 01 A1 6 13 02 A2 7 12 03 $\overline{CS1}$ 8 11 04 GND 9 10 $\overline{CS2}$	70ns	4 SECONDS
32 X 8	HM-7602 HM-7603	(OC) (TS)	 01 1 16 VCC 02 2 15 $\overline{CS}$ 03 3 14 A4 04 4 13 A3 05 5 12 A2 06 6 11 A1 07 7 10 A0 GND 8 9 08	40nsec	<1 SECOND

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HM-7602/7603

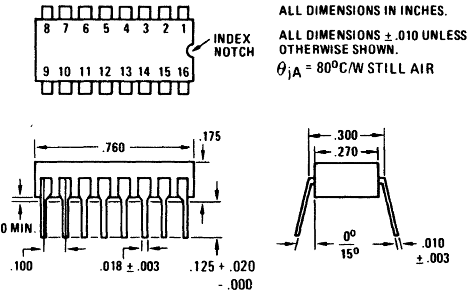
256–Bit Field Programmable Bipolar PROM

FEATURES

- 32 Words, 8-Bits per Word
- Simple, High Speed Programming Procedure (less than 1 second Typical)
- Inputs and Outputs TTL Compatible
  - ▶ Low Input Current – 400µA Logic "0", 40µA "1"
  - ▶ Full Output Drive – 15mA Sink/2mA Source
- Fast Access Time – 40ns Over Commercial Temperature and Voltage; 50ns Over Military Temperature and Voltage
- Expandable – "Wired-Or" Outputs with Chip Select

PACKAGE

CODE 1D



ALL DIMENSIONS IN INCHES.

ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

θ_{jA} = 80°C/W STILL AIR

DESCRIPTION

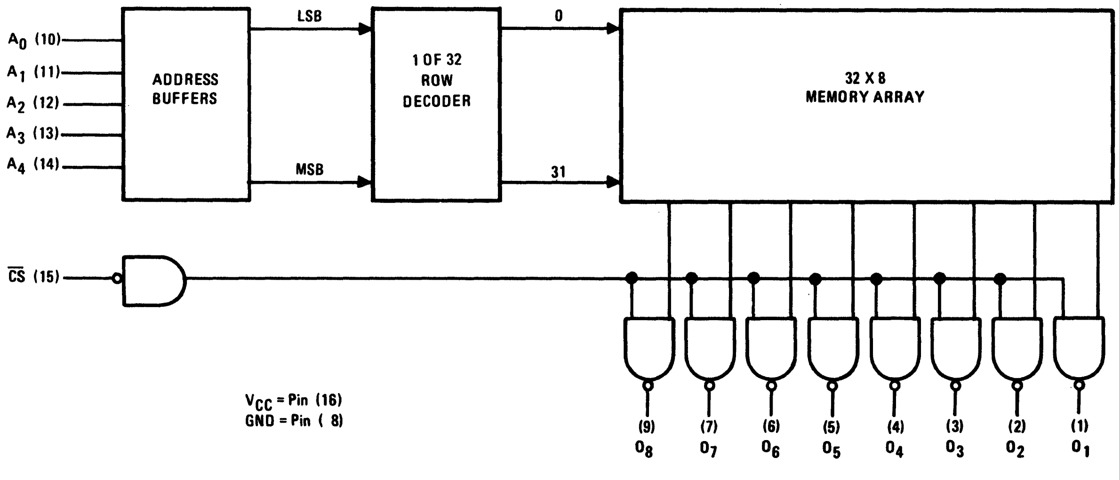
The HM-7602 (open collector) and HM-7603 (three-state) are fully decoded, high speed, 256-bit programmable ROM'S organized as 32 words by 8-bits per word. They are supplied with all bits storing a logical "1" (outputs high), and can be selectively programmed for a logical "0" (outputs low).

The nichrome fuse technology is the same as is used in the JAN approved MIL 38510/201 PROM, and in all other Harris PROMS.

The field programmable PROM can be custom programmed to any pattern using a simple programming procedure. Schottky Bipolar circuitry provides extremely fast access time, and features temperature and voltage compensation to minimize variations in access time.

In addition to the conventional storage array, two test rows and one test column are included to assure high programmability, and guarantee parametric and A.C. performance. Fuses in these test rows and columns are blown prior to shipment.

BLOCK DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Output or Supply Voltage (Operating)	7.0V
Address/Enable Input Voltage	5.5V
Address/Enable Input Current	-20mA
Output Sink Current	70mA
Storage Temperature	+150°C
Operating Temperature (Ambient)	+125°C
Maximum Junction Temperature	+175°C

Stresses above those listed under the "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress only rating and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. (While programming, follow the programming specifications.)

ELECTRICAL CHARACTERISTICS (OPERATING)

				HM-7602-5			HM-7603-5				
			V_{CC}	5V ±5%			5V ±5%				
			TA	0°C to +70°C			0°C to +70°C				
	PARAMETER		SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
D.C.	Address/Enable Input Current	"1"	I_{RA}, I_{RE}		0	40		0	40	μA	$V_{IH} = V_{CC}$ Max
		"0"	I_{FA}, I_{FE}		-0.1	-0.4		-0.1	-0.4	mA	$V_{IL} = 0.45V$
	Input Threshold Voltage	"1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$Min
		"0"	V_{IL}			0.8			0.8	V	$V_{CC} = V_{CC}$Max
	Output Voltage	"1"	V_{OH}	N/A			2.4	3.4		V	I_{OH} =-2.0mA ,$V_{CC} = V_{CC}$Min
		"0"	V_{OL}		0.35	0.45		0.35	0.45	V	I_{OL} = +15mA, $V_{CC} = V_{CC}$Min $V = V_{CS} = 0.8V$
	Output Disabled Current	"1"	$I_{OH\overline{E}}$			100			100	μA	V_{OH}, $V_{CC} = V_{CC}$ max
		"0"	$I_{OL\overline{E}}$			N/A			-100	μA	V_{OL} = +0.3V, $V_{CC} = V_{CC}$ Max $V = V_{CS} = 2.0V$
	Output Leakage	"1"	I_{OH}			100			N/A	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Power Supply Current		I_{CC}		90	130		90	130	mA	$V_{CC} = V_{CC}$ Max All Inputs Grounded
	Input Clamp Voltage		V_{CL}			-1.5			-1.5	V	I_{in} = -10ma
	Output Short Circuit Current		I_{OS}	N/A		N/A	15	23	30	mA	$V_{CC} = V_{CC}$ Max, V_{OUT} = 0.0V One output only for a Max of 1 sec
A.C.	Address Acces Time		t_{AA}		25	40		25	40	ns	V_{CC} and T_A Over Full Range
	Enable Access Time		t_{EA}		20	30		20	30	ns	V_{CC} and T_A Over Full Range

Typical Measurements are at $T_A = 25°C$, $V_{CC} = +5V$

				HM-7602-2			HM-7603-2				
			V_{CC}	5V ±10%			5V ±10%				
			TA	-55°C to +125°C			-55°C to +125°C				
	PARAMETER		SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
D.C.	Address/Enable Input Current	"1"	I_{RA}, I_{RE}		0	40		0	40	μA	$V_{IH} = V_{CC}$ Max
		"0"	I_{FA}, I_{FE}		-0.1	-0.4		-0.1	-0.4	mA	$V_{IL} = 0.45V$
	Input Threshold Voltage	"1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$ Min
		"0"	V_{IL}			0.8			0.8	V	$V_{CC} = V_{CC}$ Max
	Output Voltage	"1"	V_{OH}	N/A			2.4	3.4		V	I_{OH} = -2.0mA; $V_{CC} = V_{CC}$ Min
		"0"	V_{OL}		0.35	0.45		0.35	0.45	V	I_{OL} = +15mA; $V_{CC} = V_{CC}$ Min $V = V_{CS} = 0.8V$
	Output Disabled Current	"1"	$I_{OH\overline{E}}$			100			100	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
		"0"	$I_{OL\overline{E}}$			N/A			-100	μA	V_{OL} = +0.3V, $V_{CC} = V_{CC}$ Max $V = V_{CS} = 2.0V$
	Output Leakage	"1"	I_{OH}			100			N/A	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Power Supply Current		I_{CC}		90	130		90	130	mA	$V_{CC} = V_{CC}$ Max All Inputs Grounded
	Input Clamp Voltage		V_{CL}			-1.5			-1.5	V	I_{in} = -10ma
	Output Short Circuit Current		I_{OS}	N/A		N/A	15	23	30	mA	$V_{CC} = V_{CC}$ Max, V_{OUT} = 0.0V One output only for a Max of 1 sec
A.C.	Address Access Time		t_{AA}		25	50		25	50	ns	V_{CC} and T_A Over Full Range
	Enable Access Time		t_{EA}		20	35		20	35	ns	V_{CC} and T_A Over Full Range

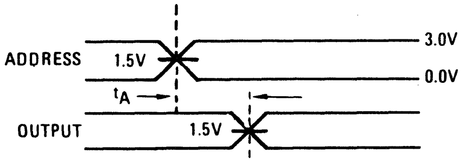
Typical Measurements are at $T_A = 25°C$, $V_{CC} = +5V$

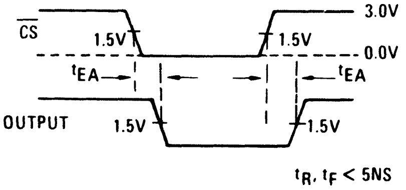
CAPACITANCE (1): $T_A = 25°C$

PARAMETER	SYMBOL	TYP.	UNITS	TEST CONDITION
Add. Input Cap.	C_{IN} A, CS	8	pF	V_{CC} = 5V, V_{IN} = 2.0V ,f = 1MHz
Output Cap.	C_{OUT}	8	pF	V_{CC} = 5V, V_{OUT} = 2.0V ,f = 1MHz

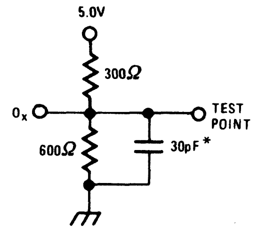
NOTE: (1) These parameters are only periodically sampled and are not 100% tested.

SWITCHING TIME DEFINITIONS





A.C. TEST LOAD



*Includes jig & probe total capacitance

PROGRAMMING

The HM-7602/7603 is manufactured with all bits/outputs Logical "1" (Output High). Any desired bit/output can be programmed to a Logical "0" (Output Low) by following the simple procedure shown below. One may build his own programmer to satisfy the specifications described in Table 1, or buy any of the commercially available programmers which meet these specifications. The HM-7602/7603 can be programmed automatically or by the manual procedure shown below.

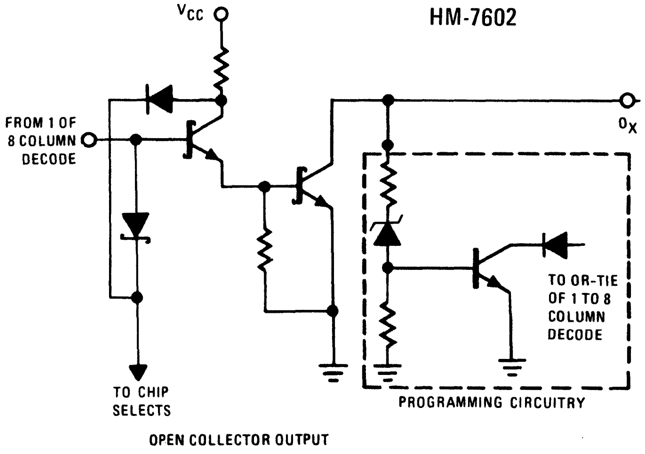
PROGRAMMING SPECIFICATIONS

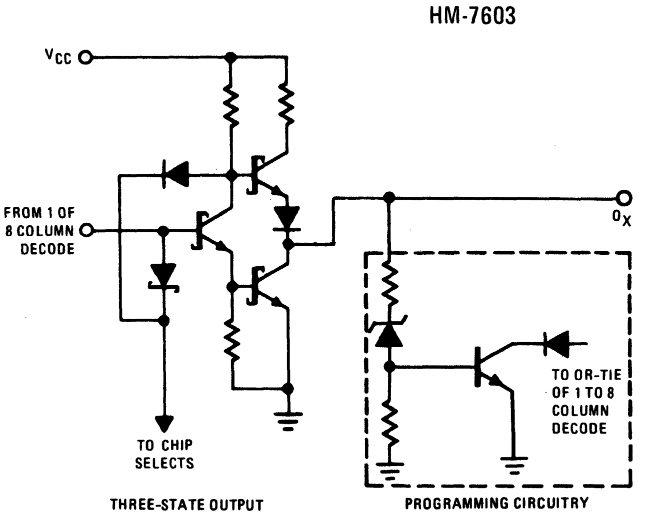
TABLE 1

PARAMETER	SYMBOL	MIN.	RECOM-MEND VALUE	MAX.	UNITS
Address Input Voltage (1)	V_{IH} V_{IL}	2.4 0.0	5.0 0.4	5.0 0.8	V V
Programming/Verify Voltage to V_{CC} (2)	V_{PH} V_{PL}	11.5 3.75	12.0 4.0	12.5 4.25	V
Programming Voltage Current Limit	I_{CCP}			600	mA
Programming (V_{CC}) Voltage Rise and Fall Time	t_r t_f	1 1	1 1	10 10	μs μs
Programming Delay	t_d	10	10	100	μs
Programming Pulse Width – First Attempts	t_{p1}	100	100	200	μs
Programming Pulse Width – Subsequent	t_{p2}	10	10	20	ms
Programming Duty Cycle	D.C.	–	10	10	%
Output Voltage Enable Disable (3)	V_{OPE} V_{OPD}	9.5 0	10.0 .45	10.5 5.5	V V
Output Voltage Enable Current Limit	I_{OPE}			10	mA
Case Temp	T_C			75	°C

1. **Address and chip select should not be left open for V_{IH}.**
2. **Verification at V_{CC} = 4.0 ± .25 Volts, T_A = 25°C is recommended to guardband performance over full temperature and voltage range.**
3. **Disable condition will be met with output open circuit.**

SCHEMATIC DIAGRAMS





PROGRAMMING PROCEDURE

1. Address the PROM with the binary address of the selected word to be programmed Address inputs are TTL compatible. An open circuit should not be used to address the PROM.
2. Disable the chip by applying input highs (V_{IH}) to the chip select input. The chip select input is TTL compatible. An open circuit should not be used to disable the chip.
3. Disable the programming circuitry by applying an Output Voltage Disable of less than V_{OPD} to the output of the PROM. The output may be left open circuit to achieve the disable.
4. Raise V_{CC} to V_{PH} with rise time equal to t_r.
5. After a delay equal to or greater than t_d, apply a pulse with amplitude equal to V_{OPE} and duration of t_{p1} to the output selected for programming. Note that the PROM is supplied with fuses intact generating an output high. Programming a fuse will cause the output to go low in the verify mode.
6. Other bits in the same word may be programmed while the V_{CC} input is raised to V_{PH} by applying output enable pulses to each output which is to be programmed. The output enable pulses must be separated by a minimum interval of t_d.
7. Lower V_{CC} to 4.0 ±.25 Volts following a delay to t_d from the last programming enable pulse applied to an output.
8. Enable the PROM for verification by applying a logic "0" (V_{IL}) to the $\overline{CS}$ input.
9. If any bit does not verify as programmed, repeat steps 2 through 8 using an output pulse enable width of t_{p1} for up to 15 additional pulses to enhance programming speed. If the bit is still unprogrammed, follow with at least 16 repetitive pulses of t_{p2} in width, to achieve high programming yield. In the event that the bit is still unprogrammed, the part is considered a programming reject and should be returned to the factory. The address and incorrect and desired contents of a location in which a programming failure has occured in any returned device must be included with that return.
10. Repeat steps 1 thru 9 for all other bits to be programmed in the PROM.

RECOMMENDED PROGRAMMING CIRCUIT

The circuit and timing diagram shown in Figures 1 and 2 will establish the proper programming condition for the output enable pulse. This allows the use of standard TTL parts for all logic inputs to the PROM. Note the gate which senses the output must be input protected to withstand input up to 12.5 Volts during programming.

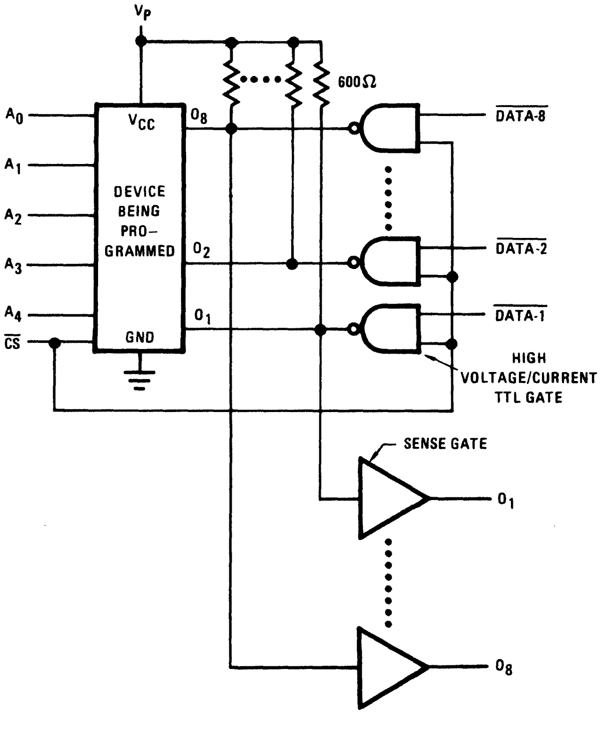


FIGURE 1

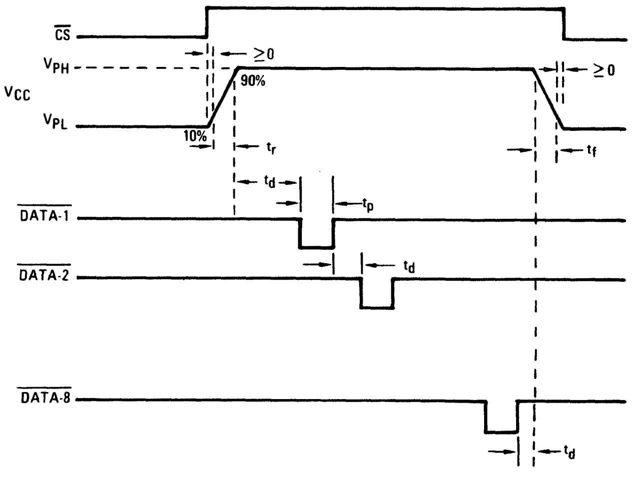


FIGURE 2

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HM-7610/7611

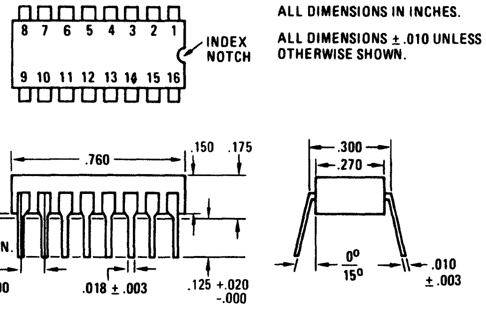
1024-Bit Field Programmable Bipolar PROM

FEATURES

- 256 Words, 4-Bits per Word
- Simple, High Speed Programming Procedure (less Than 1 Second Typical)
- Inputs and Outputs TTL Compatible
  - ▶ Low Input Current -400 μA Logic "0", 40 μA Logic "1"
  - ▶ Full Output Drive -15mA Sink/2mA Source
- Fast Access Time—60NS Over Commercial Temperature & Voltage, 75NS Over Military Temperature & Voltage
- Expandable – "Wired-Or" Outputs With Chip Select
- Pin Compatible With Industry Standard 256 X 4 Proms

PACKAGE

CODE 1D



ALL DIMENSIONS IN INCHES.

ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

DESCRIPTION

The HM-7610 (open collector) and HM-7611 (three-state) are fully decoded, high speed, 1024-bit programmable ROM'S organized as 256 words by 4 bits per word. They are supplied with all bits storing a logical "1" (outputs high), and can be selectively programmed for a logical "0" (outputs low).

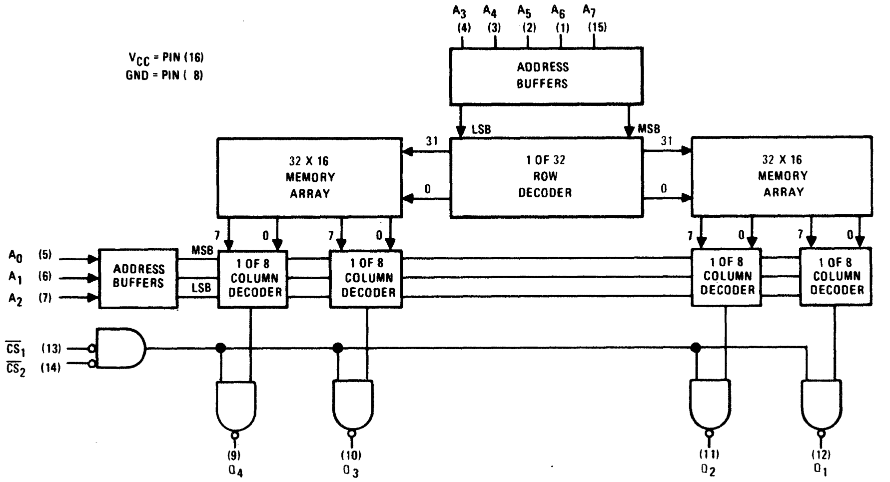
The nichrome fuse technology is the same as is used in the JAN approved MIL 38510/201 PROM, and in all other Harris PROMS.

The field programmable PROM can be custom programmed to any pattern using a simple programming procedure. Schottky Bipolar circuitry provides extremely fast access time, and features temperature and voltage compensation to minimize variations in access time.

The pinout is compatible with the industry standard 256X4 PROM.

In addition to the conventional storage array, two test rows and two test columns are included to assure high programmability, and guarantee parametric and A.C. performance. Fuses in these test rows and columns are blown prior to shipment.

BLOCK DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Output or Supply Voltage (Operating)	7.0V
Address/Enable Input Voltage	5.5V
Address/Enable Input Current	-20mA
Output Sink Current	70mA
Storage Temperature	+150°C
Operating Temperature (Ambient)	+125°C
Maximum Junction Temperature	+175°C

Stresses above those listed under the "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress only rating and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. (While programming, follow the programming specifications.)

ELECTRICAL CHARACTERISTICS (OPERATING)

				HM-7610-5			HM-7611-5				
			V_{CC}	5V ±5%			5V ±5%				
			TA	0°C to +70°C			0°C to +70°C				TEST
	PARAMETER		SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	CONDITIONS
D.C.	Address/Enable Input Current	"1"	I_{RA}, I_{RE}		0	40		0	40	μA	$V_{IH} = V_{CC}$ Max
		"0"	I_{FA}, I_{FE}		-0.1	-0.4		-0.1	-0.4	mA	$V_{IL} = 0.45V$
	Input Threshold Voltage	"1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$Min
		"0"	V_{IL}			0.8			0.8	V	$V_{CC} = V_{CC}$Max
	Output Voltage	"1"	V_{OH}	N/A			2.4	3.4		V	I_{OH} =-2.0mA ,$V_{CC} = V_{CC}$Min
		"0"	V_{OL}		0.35	0.45		0.35	0.45	V	I_{OL} = +15mA, $V_{CC} = V_{CC}$Min $V_{CS_1} = V_{CS_2} = 0.8V$
	Output Disabled Current	"1"	$I_{OH\overline{E}}$			100			100	μA	V_{OH}, $V_{CC} = V_{CC}$ max
		"0"	$I_{OL\overline{E}}$			N/A			-100	μA	V_{OL} = +0.3V, $V_{CC} = V_{CC}$ Max $V_{CS_1} = V_{CS_2} = 2.0V$
	Output Leakage	"1"	I_{OH}			100			N/A	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Power Supply Current		I_{CC}		90	130		90	130	mA	$V_{CC} = V_{CC}$ Max All Inputs Grounded
	Input Clamp Voltage		V_{CL}			-1.5			-1.5	V	I_{in} = -10ma
	Output Short Circuit Current		I_{OS}	N/A		N/A	15	23	30	mA	$V_{CC} = V_{CC}$ Max, V_{OUT} = 0.0V One output only for a Max of 1 sec
A.C.	Address Acces Time		t_{AA}		40	60		40	60	ns	V_{CC} and T_A Over Full Range
	Enable Access Time		t_{EA}		15	25		15	25	ns	V_{CC} and T_A Over Full Range

Typical Measurements are at $T_A = 25°C$, $V_{CC} = +5V$

				HM-7610-2			HM-7611-2				
			V_{CC}	5V ±10%			5V ±10%				
			TA	-55°C to +125°C			-55°C to +125°C				TEST
	PARAMETER		SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	CONDITIONS
D.C.	Address/Enable Input Current	"1"	I_{RA}, I_{RE}		0	40		0	40	μA	$V_{IH} = V_{CC}$ Max
		"0"	I_{FA}, I_{FE}		-0.1	-0.4		-0.1	-0.4	mA	$V_{IL} = 0.45V$
	Input Threshold Voltage	"1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$ Min
		"0"	V_{IL}			0.8			0.8	V	$V_{CC} = V_{CC}$ Max
	Output Voltage	"1"	V_{OH}	N/A			2.4	3.4		V	I_{OH} = -2.0mA; $V_{CC} = V_{CC}$ Min
		"0"	V_{OL}		0.35	0.45		0.35	0.45	V	I_{OL} = +15mA; $V_{CC} = V_{CC}$ Min $V_{CS_1} = V_{CS_2} = 0.8V$
	Output Disabled Current	"1"	$I_{OH\overline{E}}$			100			100	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
		"0"	$I_{OL\overline{E}}$			N/A			-100	μA	V_{OL} = +0.3V, $V_{CC} = V_{CC}$ Max $V_{CS_1} = V_{CS_2} = 2.0V$
	Output Leakage	"1"	I_{OH}			100			N/A	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Power Supply Current		I_{CC}		90	130		90	130	mA	$V_{CC} = V_{CC}$ Max All Inputs Grounded
	Input Clamp Voltage		V_{CL}			-1.5			-1.5	V	I_{in} = -10ma
	Output Short Circuit Current		I_{OS}	N/A		N/A	15	23	30	mA	$V_{CC} = V_{CC}$ Max, V_{OUT} = 0.0V One output only for a Max of 1 sec
A.C.	Address Access Time		t_{AA}		40	75		40	75	ns	V_{CC} and T_A Over Full Range
	Enable Access Time		t_{EA}		15	30		15	30	ns	V_{CC} and T_A Over Full Range

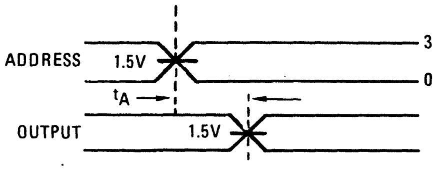
Typical Measurements are at $T_A = 25°C$, $V_{CC} = +5V$

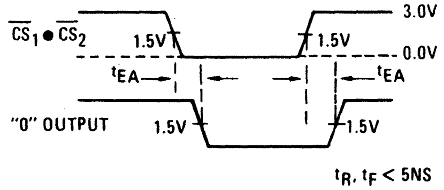
CAPACITANCE (1): $T_A = 25°C$

PARAMETER	SYMBOL	TYP.	UNITS	TEST CONDITION
Add. Input Cap.	$C_{IN\ A,\ CS}$	8	pF	V_{CC} = 5V, V_{IN} = 2.0V ,f = 1MHz
Output Cap.	C_{OUT}	8	pF	V_{CC} = 5V, V_{OUT} = 2.0V ,f = 1MHz

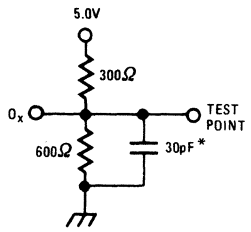
NOTE: (1) These parameters are only periodically sampled and are not 100% tested.

SWITCHING TIME DEFINITIONS





A.C. TEST LOAD



*Includes jig & probe total capacitance

PROGRAMMING

The HM-7610/7611 is manufactured with all bits/outputs Logical "1" (Output High). Any desired bit/output can be programmed to a Logical "0" (Output Low) by following the simple procedure shown below. One may build his own programmer to satisfy the specifications described in Table 1, or buy any of the commercially available programmers which meet these specifications. The HM-7610/7611 can be programmed automatically or by the manual procedure shown below.

PROGRAMMING SPECIFICATIONS

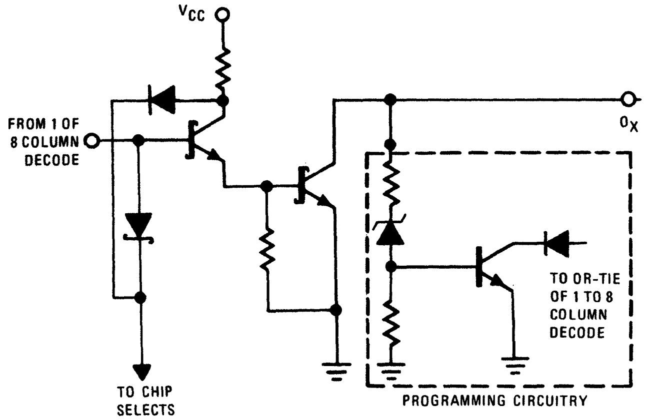
TABLE 1

PARAMETER	SYMBOL	MIN.	RECOMMEND VALUE	MAX.	UNITS
Address Input Voltage (1)	V_{IH} V_{IL}	2.4 0.0	5.0 0.4	5.0 0.8	V V
Programming/Verify Voltage to V_{CC} (2)	V_{PH} V_{PL}	11.5 3.75	12.0 4.0	12.5 4.25	V
Programming Voltage Current Limit	I_{CCP}			600	mA
Programming (V_{CC}) Voltage Rise and Fall Time	t_r t_f	1 1	1 1	10 10	µs µs
Programming Delay	t_d	10	10	100	µs
Programming Pulse Width – First Attempts	t_{p1}	100	100	200	µs
Programming Pulse Width – Subsequent	t_{p2}	10	10	20	ms
Programming Duty Cycle	D.C.	–	10	10	%
Output Voltage Enable Disable (3)	V_{OPE} V_{OPD}	9.5 0	10.0 .45	10.5 5.5	V V
Output Voltage Enable Current Limit	I_{OPE}			10	mA
Case Temp	T_C			75	°C

1. **Address and chip select should not be left open for V_{IH}.**
2. **Verification at $V_{CC} = 4.0 \pm .25$ Volts, $T_A = 25^\circ C$ is recommended to guardband performance over full temperature and voltage range.**
3. **Disable condition will be met with output open circuit.**

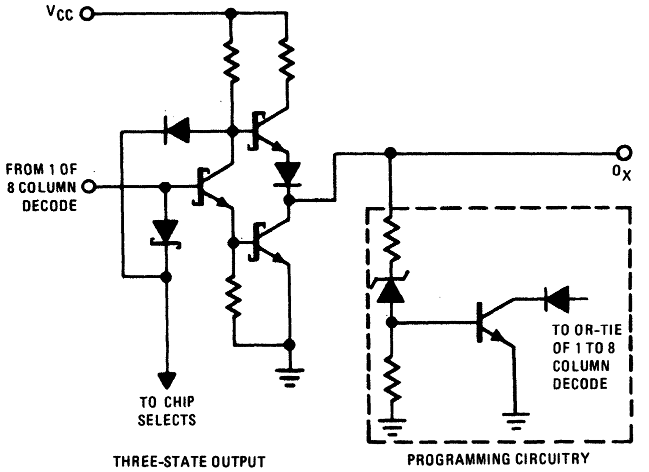
SCHEMATIC DIAGRAMS

HM-7610



OPEN COLLECTOR OUTPUT

HM-7611



THREE-STATE OUTPUT

PROGRAMMING PROCEDURE

1. Address the PROM with the binary address of the selected word to be programmed Address inputs are TTL compatible. An open circuit should not be used to address the PROM.
2. Disable the chip by applying input highs (V_{IH}) to both chip select inputs. The chip select inputs are TTL compatible. An open circuit should not be used to disable the chip.
3. Disable the programming circuitry by applying an Output Voltage Disable of less than V_{OPD} to the output of the PROM. The output may be left open circuit to achieve the disable.
4. Raise V_{CC} to V_{PH} with rise time equal to t_r.
5. After a delay equal to or greater than t_d, apply a pulse with amplitude equal to V_{OPE} and duration of t_{p1} to the output selected for programming. Note that the PROM is supplied with fuses intact generating an output high. Programming a fuse will cause the output to go low in the verify mode.
6. Other bits in the same word may be programmed while the V_{CC} input is raised to V_{PH} by applying output enable pulses to each output which is to be programmed. The output enable pulses must be separated by a minimum interval of t_d.
7. Lower V_{CC} to 4.0 ±.25 Volts following a delay to t_d from the last programming enable pulse applied to an output.
8. Enable the PROM for verification by applying a logic "0" (V_{IL}) to the $\overline{CS}_1$ and $\overline{CS}_2$ inputs.
9. If any bit does not verify as programmed, repeat steps 2 through 8 using an output pulse enable width of t_{p1} for up to 15 additional pulses to enhance programming speed. If the bit is still unprogrammed, follow with at least 16 repetitive pulses of t_{p2} in width, to achieve high programming yield. In the event that the bit is still unprogrammed, the part is considered a programming reject and should be returned to the factory. The address and incorrect and desired contents of a location in which a programming failure has occured in any returned device must be included with that return.
10. Repeat steps 1 thru 9 for all other bits to be programmed in the PROM.

RECOMMENDED PROGRAMMING CIRCUIT

The circuit and timing diagram shown in Figures 1 and 2 will establish the proper programming condition for the output enable pulse. This allows the use of standard TTL parts for all logic inputs to the PROM. Note the gate which senses the output must be input protected to withstand input up to 12.5 Volts during programming.

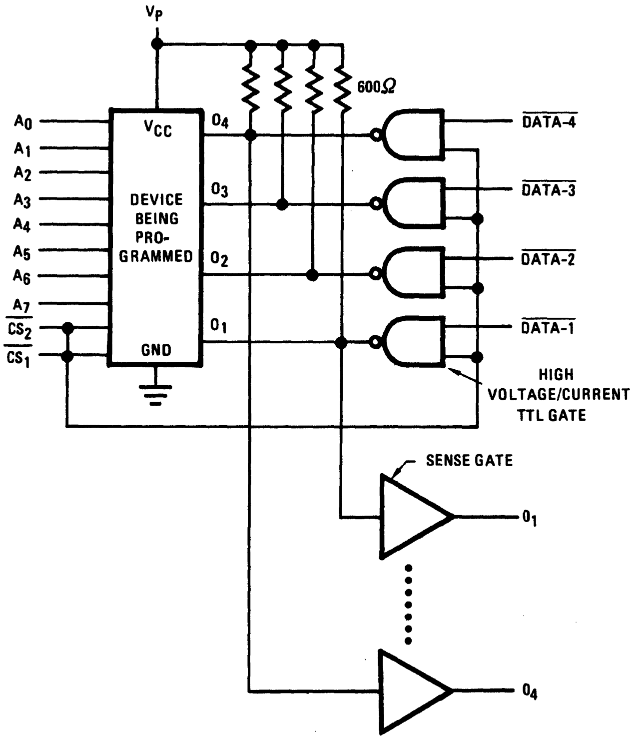


FIGURE 1

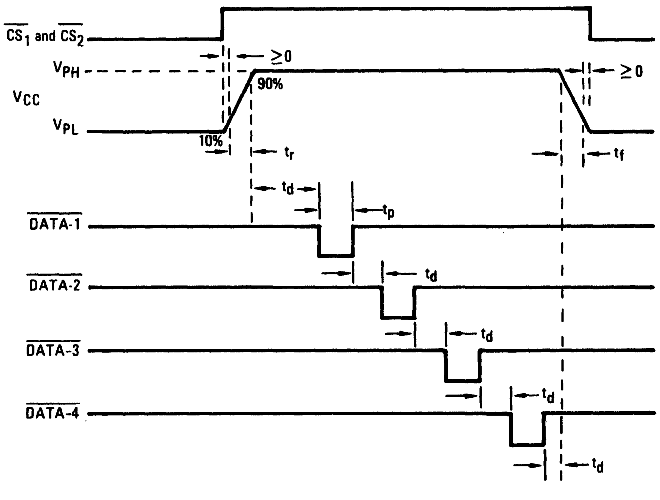


FIGURE 2

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HM-7620/7621

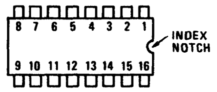
2048-Bit Field Programmable Bipolar PROM

FEATURES

- 512 Words, 4 Bits per Word
- Simple, High Speed Programming Procedure (2 Seconds)
- Inputs and Outputs TTL Compatible
  - ▶Low Input Current - 400μA Logic "0", 40μA Logic "1"
  - ▶Full Output Drive - 15mA Sink/2mA Source
- Fast Access Time - 70ns Over Commercial Temperature & Voltage, 85ns Over Military Temperature & Voltage
- Expandable - "Wired-Or" Outputs With Chip Select
- Upward Pin Compatibility With 256 x 4 Proms

PACKAGE

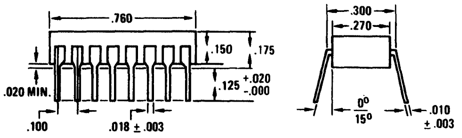
CODE 1D 16 LEAD CERAMIC D.I.P.



ALL DIMENSIONS IN INCHES.

ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

θ_{jA} = 80°C/W STILL AIR



DESCRIPTION

The HM-7620 (open collector) and HM-7621 (three-state) are fully decoded, high speed, 2048-bit programmable ROM'S organized as 512 words by 4 bits per word. They are supplied with all bits storing a logical "1" (outputs high), and can be selectively programmed for a logical "0" (outputs low).

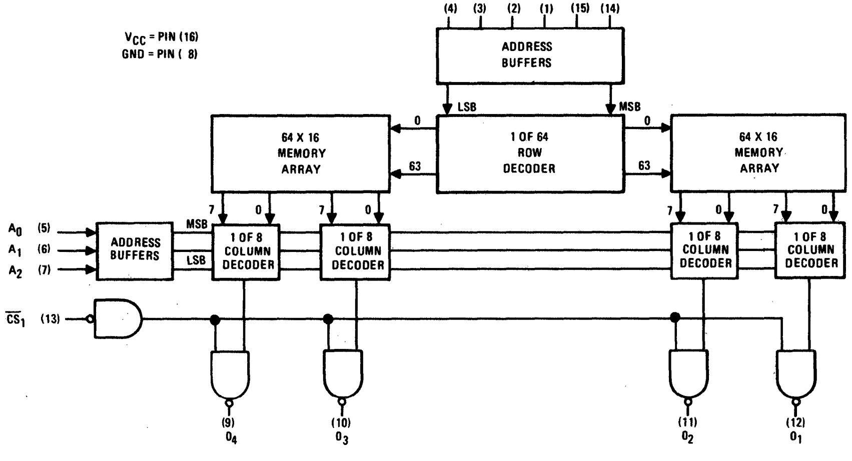
The nichrome fuse technology is the same as is used in the JAN approved MIL 38510/201 PROM, and in all other Harris PROMS.

The field programmable PROM can be custom programmed to any pattern using a simple programming procedure. Schottky Bipolar circuitry provides extremely fast access time, and features temperature and voltage compensation to minimize variations in access time.

The pinout is compatible with the industry standard 256 x 4 PROM with the exception that the $\overline{CS}_2$ input on pin 14 is replaced by Address Input A8. Systems using 256 x 4 PROMS can be upgraded to store twice the number of bits within the same board area, while maintaining the same system power requirements. Alternatively, both the package count and the system power can be halved by using the HM-7620/HM-7621 in place of the 256 x 4 PROM.

In addition to the conventional storage array, two test rows and two test columns are included to assure high programmability, and guarantee parametric and A.C. performance. These fuses are blown prior to shipment.

BLOCK DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Output or Supply Voltage (Operating)	7.0V
Address/Enable Input Voltage	5.5V
Address/Enable Input Current	-20mA
Output Sink Current	70mA
Storage Temperature	+150°C
Operating Temperature (Ambient)	+125°C
Maximum Junction Temperature	+175°C

Stresses above those listed under the "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress only rating and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. (While programming, follow the programming specifications.)

ELECTRICAL CHARACTERISTICS (OPERATING)

			V_{CC}	HM-7620-5 5V ±5%			HM-7621-5 5V ±5%				
			TA	0°C to +70°C			0°C to +70°C				TEST
	PARAMETER		SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	CONDITIONS
	Address/Enable	"1"	I_{RA}, I_{RE}		0	40		0	40	µA	$V_{IH} = V_{CC}$ Max
	Input Current	"0"	I_{FA}, I_{FE}		-0.1	-0.4		-0.1	-0.4	mA	$V_{IL} = 0.45V$
	Input Threshold	"1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$Min
	Voltage	"0"	V_{IL}			0.8			0.8	V	$V_{CC} = V_{CC}$Max
	Output Voltage	"1"	V_{OH}	N/A			2.4	3.4		V	I_{OH} =-2.0mA ,$V_{CC} = V_{CC}$Min
		"0"	V_{OL}		0.35	0.45		0.35	0.45	V	I_{OL} = +15mA, $V_{CC} = V_{CC}$Min
D.C.	Output Disabled	"1"	$I_{OH\overline{E}}$			100			100	µA	V_{OH}, $V_{CC} = V_{CC}$ max
	Current	"0"	$I_{OL\overline{E}}$			N/A			-100	µA	V_{OL} = +0.3V, $V_{CC} = V_{CC}$ Max
	Output Leakage	"1"	I_{OH}			100			N/A	µA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Power Supply Current		I_{CC}		90	130		90	130	mA	$V_{CC} = V_{CC}$ Max All Inputs Grounded
	Input Clamp Voltage		V_{CL}			-1.5			-1.5	V	I_{in} = -10ma
	Output Short Circuit Current		I_{OS}	N/A		N/A	15	23	30	mA	$V_{CC} = V_{CC}$ Max, V_{OUT} = 0.0V One output only for a Max of 1 sec
A.C.	Address Acces Time		t_{AA}		40	70		40	70	ns	V_{CC} and T_A Over Full Range
	Enable Access Time		t_{EA}		15	25		15	25	ns	V_{CC} and T_A Over Full Range

Typical Measurements are at T_A = 25°C, V_{CC} = +5V

			V_{CC}	HM-7620-2 5V ±10%			HM-7621-2 5V ±10%				
			TA	-55°C to +125°C			-55°C to +125°C				TEST
	PARAMETER		SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	CONDITIONS
	Address/Enable	"1"	I_{RA}, I_{RE}		0	*40		0	*40	µA	$V_{IH} = V_{CC}$ Max
	Input Current	"0"	I_{FA}, I_{FE}		-0.1	*-0.4		-0.1	*-0.4	mA	$V_{IL} = 0.45V$
	Input Threshold	"1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$ Min
	Voltage	"0"	V_{IL}			0.8			0.8	V	$V_{CC} = V_{CC}$ Max
	Output Voltage	"1"	V_{OH}	N/A			*2.4	3.4		V	I_{OH} = -2.0mA; V_{CC} =V_{CC} Min
		"0"	V_{OL}		0.35	*0.45		0.35	*0.45	V	I_{OL} = +15mA; V_{CC} =V_{CC} Min
D.C.	Output Disabled	"1"	$I_{OH\overline{E}}$			*100			*100	µA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Current	"0"	$I_{OL\overline{E}}$			N/A			*-100	µA	V_{OL} = +0.3V, $V_{CC} = V_{CC}$ Max
	Output Leakage	"1"	I_{OH}			*100			N/A	µA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Power Supply Current		I_{CC}		90	*130		90	*130	mA	$V_{CC} = V_{CC}$ Max All Inputs Grounded
	Input Clamp Voltage		V_{CL}			*-1.5			*-1.5	V	I_{in} = -10ma
	Output Short Circuit Current		I_{OS}	N/A		N/A	*15	23	*30	mA	$V_{CC} = V_{CC}$ Max, V_{OUT} = 0.0V One output only for a Max of 1 sec
A.C.	Address Access Time		t_{AA}		40	*85		40	*85	ns	V_{CC} and T_A Over Full Range
	Enable Access Time		t_{EA}		15	*30		15	*30	ns	V_{CC} and T_A Over Full Range

Typical Measurements are at T_A = 25°C, V_{CC} = +5V

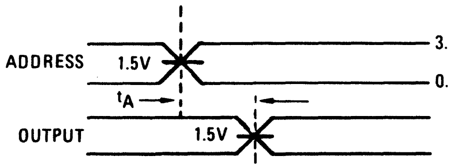
***100% Tested For DASH 8**

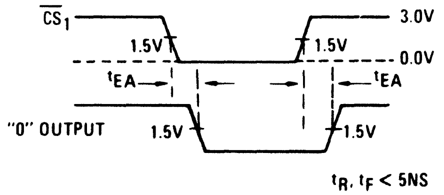
CAPACITANCE (1): T_A = 25°C

PARAMETER	SYMBOL	TYP.	UNITS	TEST CONDITIONS
Add. Input Cap.	C_{IN} A, CS	8	pF	V_{CC} = 5V, V_{IN} = 2.0V, f = 1MHz
Output Cap.	COUT	8	pF	V_{CC} = 5V, V_{OUT} = 2.0V, f = 1MHz

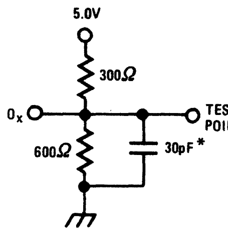
NOTE: (1) These parameters are only periodically sampled and are not 100% tested.

SWITCHING TIME DEFINITIONS





A.C. TEST LOAD



*Includes jig & probe total capacitance

PROGRAMMING

The HM-7620/7621 is manufactured with all bits/outputs Logical "1" (Output High). Any desired bit/output can be programmed to a Logical "0" (Output Low) by following the simple procedure shown below. One may build his own programmer to satisfy the specifications described in Table 1, or buy any of the commercially available programmers which meet these specifications. The HM-7620/7621 can be programmed automatically or by the manual procedure shown below.

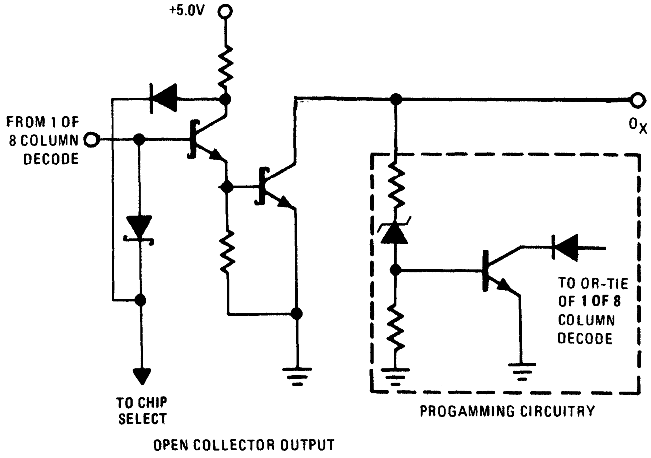
PROGRAMMING SPECIFICATIONS

PARAMETER	SYMBOL	MIN.	RECOM-MEND VALUE	MAX.	UNITS
Address Input Voltage (1)	V_{IH}	2.4	5.0	5.0	V
	V_{IL}	0.0	0.4	0.8	V
Programming/Verify Voltage to V_{CC}	V_{PH}	11.5	12.0	12.5	V
	V_{PL}	3.75	4.0	4.25	
Programming Voltage Current Limit (2)	I_{CCP}			600	mA
Programming (V_{CC}) Voltage Rise and Fall Time	t_r	1	1	10	µs
	t_f	1	1	10	µs
Programming Delay	t_d	10	10	100	µs
Programming Pulse Width – First Attempts	t_{p1}	100	100	200	µs
Programming Pulse Width – Subsequent	t_{p2}	10	10	20	ms
Programming Duty Cycle	D.C.	–	10	10	%
Output Voltage Enable	V_{OPE}	9.5	10.0	10.5	V
Disable (3)	V_{OPD}	0	.45	5.5	V
Output Voltage Enable Current Limit	I_{OPE}			10	mA
Case Temp	T_C			75	°C

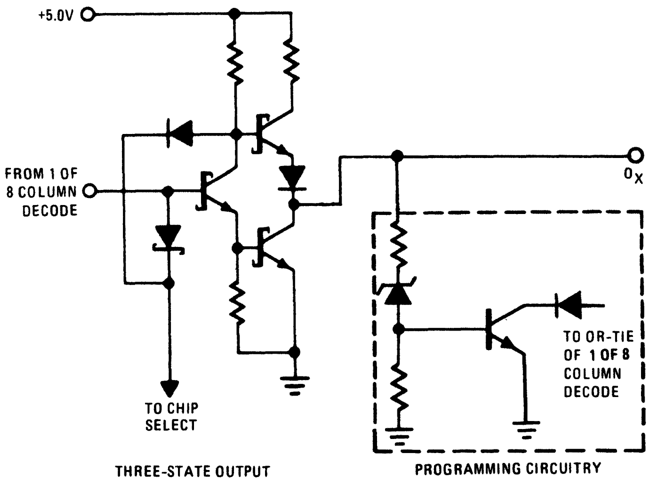
1. **Address and chip select should not be left open for V_{IH}.**
2. **Verification at $V_{CC} = 4.0 \pm .25$ Volts, $T_A = 25^{\circ}C$ is recommended to guardband performance over full temperature and voltage range.**
3. **Disable condition will be met with output open circuit.**

SCHEMATIC DIAGRAMS

HM-7620



HM-7621



PROGRAMMING PROCEDURE

1. Address the PROM with the binary address of the selected word to be programmed. Address inputs are TTL compatible. An open circuit should not be used to address the PROM.
2. Disable the chip by applying an input high (V_{IH}) to the chip select input. The chip select input is TTL compatible. An open circuit should not be used to disable the chip.
3. Disable the programming circuitry by applying an Output Voltage Disable of less than V_{OPD} to the output of the PROM. The output may be left open circuit to achieve the disable.
4. Raise V_{CC} to V_{PH} with rise time equal to t_r.
5. After a delay equal to or greater than t_d, apply a pulse with amplitude equal to V_{OPE} and duration of t_{p1} to the output selected for programming. Note that the PROM is supplied with fuses intact generating an output high. Programming a fuse will cause the output to go low in the verify mode.
6. Other bits in the same word may be programmed while the V_{CC} input is raised to V_{PH} by applying output enable pulses to each output which is to be programmed. The output enable pulses must be separated by a minimum interval of t_d.
7. Return VCC to 4.0 ±.25 V following a delay of t_d from the last programming enable pulse applied to an output.
8. Enable the PROM for verification by applying a logic "0" (V_{IL}) to the CS_1 input.
9. If any bit does not verify as programmed, repeat steps 2 through 8 using an output pulse enable width of t_{p1} for up to 15 additional pulses to enhance programming speed. If the bit is still unprogrammed, follow with at least 16 repetitive pulses of t_{p2} in width, to achieve high programming yield. In the event that the bit is still unprogrammed, the part is considered a programming reject and should be returned to the factory. The address and incorrect and desired contents of a location in which a programming failure has occured in any returned device must be included with that return.
10. Repeat steps 1 thru 9 for all other bits to be programmed in the PROM.

RECOMMENDED PROGRAMMING CIRCUIT

The circuit and timing diagram shown in Figures 1 and 2 will establish the proper programming condition for the output enable pulse. This allows the use of standard TTL parts for all logic inputs to the PROM. Note the gate which senses the output must be input protected to withstand input up to 12.5 Volts during programming.

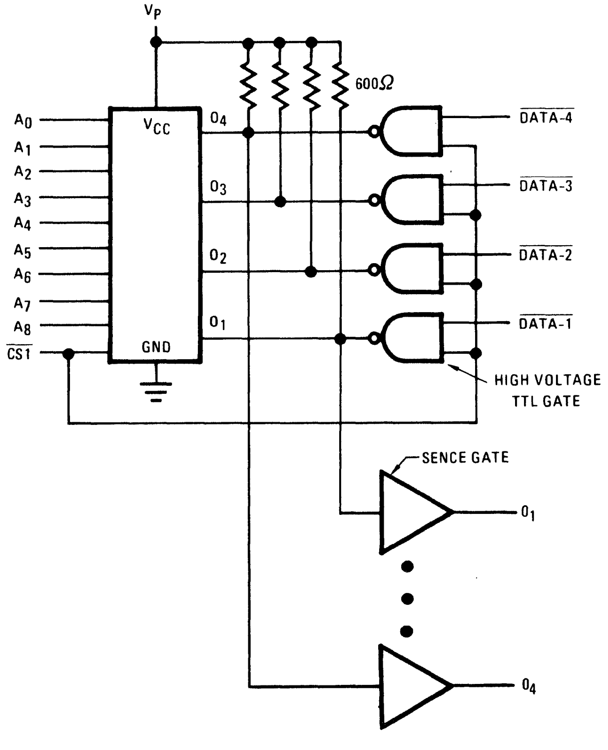


FIGURE 1

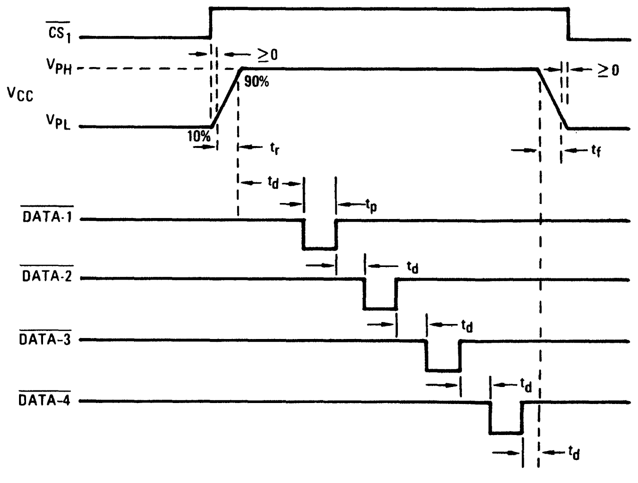


FIGURE 2

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HM-7640/7641

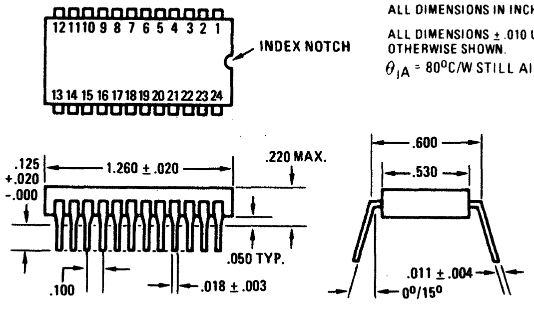
4096–Bit Field Programmable Bipolar PROM

FEATURES

- 512 Words, 8-Bits per Word
- Simple, High Speed Programming Procedure (less than 4 Seconds typical)
- Inputs and Outputs TTL Compatible
  - ►Low Input Current – 400 μA Logic "0", 40 μA Logic "1"
  - ►Full Output Drive – 15mA Sink/2mA Source
- Fast Access Time – 70ns Over Commercial Temperature and Voltage; 85ns Over Military Temperature and
- Voltage
- Expandable – "Wired-Or" Outputs with Chip Select
- Pin Compatible with Industry Standard ROMS

PACKAGE

CODE 1J



ALL DIMENSIONS IN INCHES.

ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

θ_{JA} = 80°C/W STILL AIR

DESCRIPTION

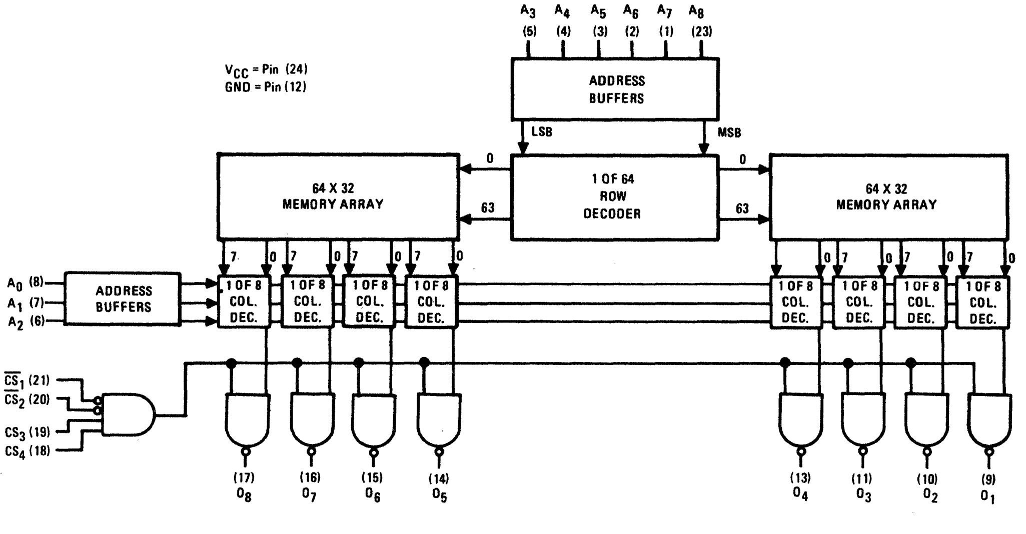
The HM-7640 (open collector) and HM-7641 (three-state) are fully decoded, high speed, 4096-bit programmable ROM's organized as 512 words by 8 bits per word. They are supplied with all bits storing a logical "1" (outputs high), and can be selectively programmed for a logical "0" (outputs low).

The nichrome fuse technology is the same as is used in the JAN approved MIL 38510/201 PROM, and in all other Harris PROMS.

The field programmable PROM can be custom programmed to any pattern using a simple programming procedure. Schottky Bipolar circuitry provides extremely fast access time, and features temperature and voltage compensation to minimize variations in access time.

In addition to the conventional storage array, two test rows and four test columns are included to assure high programmability, and guarantee parametric and A.C. performance Fuses in these test rows and columns are blown prior to shipment.

BLOCK DIAGRAM



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Output or Supply Voltage (Operating)	7.0V
Address/Enable Input Voltage	5.5V
Address/Enable Input Current	-20mA
Output Sink Current	70mA
Storage Temperature	+150°C
Operating Temperature (Ambient)	+125°C
Maximum Junction Temperature	+175°C

Stresses above those listed under the "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress only rating and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. (While programming, follow the programming specifications.)

ELECTRICAL CHARACTERISTICS (OPERATING)

				HM-7640-5			HM-7641-5				
			V_{CC}	5V ±5%			5V ±5%				
			TA	0°C to +70°C			0°C to +70°C				TEST
	PARAMETER		SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	CONDITIONS
D.C.	Address/Enable Input Current	"1"	I_{RA}, I_{RE}		0	40		0	40	μA	$V_{IH} = V_{CC}$ Max
		"0"	I_{FA}, I_{FE}		-0.1	-0.4		-0.1	-0.4	mA	$V_{IL} = 0.45V$
	Input Threshold Voltage	"1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$Min
		"0"	V_{IL}			0.8			0.8	V	$V_{CC} = V_{CC}$Max
	Output Voltage	"1"	V_{OH}	N/A			2.4	3.4		V	I_{OH} =-2.0mA, $V_{CC} = V_{CC}$Min
		"0"	V_{OL}		0.35	0.45		0.35	0.45	V	I_{OL} = +15mA, $V_{CC} = V_{CC}$Min $V_{CS_1} = V_{CS_2} = 0.8V$
	Output Disabled Current	"1"	$I_{OH\overline{E}}$			100			100	μA	V_{OH}, $V_{CC} = V_{CC}$ max
		"0"	$I_{OL\overline{E}}$			N/A			-100	μA	V_{OL} = +0.3V, $V_{CC} = V_{CC}$ Max $V_{CS_1} = V_{CS_2} = 2.0V$
	Output Leakage	"1"	I_{OH}			100			N/A	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Power Supply Current		I_{CC}		125	170		125	170	mA	$V_{CC} = V_{CC}$ Max All Inputs Grounded
	Input Clamp Voltage		V_{CL}			-1.5			-1.5	V	I_{in} = -10ma
	Output Short Circuit Current		I_{OS}	N/A		N/A	15	23	30	mA	$V_{CC} = V_{CC}$ Max, V_{OUT} = 0.0V One output only for a Max of 1 sec
A.C.	Address Acces Time		t_{AA}		40	70		40	70	ns	V_{CC} and T_A Over Full Range
	Enable Access Time		t_{EA}		15	25		15	25	ns	V_{CC} and T_A Over Full Range

Typical Measurements are at T_A = 25°C, V_{CC} = +5V

				HM-7640-2			HM-7641-2				
			V_{CC}	5V ±10%			5V ±10%				
			TA	-55°C to +125°C			-55°C to +125°C				TEST
	PARAMETER		SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	CONDITIONS
D.C.	Address/Enable Input Current	"1"	I_{RA}, I_{RE}		0	40		0	40	μA	$V_{IH} = V_{CC}$ Max
		"0"	I_{FA}, I_{FE}		-0.1	-0.4		-0.1	-0.4	mA	$V_{IL} = 0.45V$
	Input Threshold Voltage	"1"	V_{IH}	2.0			2.0			V	$V_{CC} = V_{CC}$ Min
		"0"	V_{IL}			0.8			0.8	V	$V_{CC} = V_{CC}$ Max
	Output Voltage	"1"	V_{OH}	N/A			2.4	3.4		V	I_{OH} = -2.0mA; $V_{CC} = V_{CC}$ Min
		"0"	V_{OL}		0.35	0.45		0.35	0.45	V	I_{OL} = +15mA; $V_{CC} = V_{CC}$ Min $V_{CS_1} = V_{CS_2} = 0.8V$
	Output Disabled Current	"1"	$I_{OH\overline{E}}$			100			100	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
		"0"	$I_{OL\overline{E}}$			N/A			-100	μA	V_{OL} = +0.3V, $V_{CC} = V_{CC}$ Max $V_{CS_1} = V_{CS_2} = 2.0V$
	Output Leakage	"1"	I_{OH}			100			N/A	μA	V_{OH}, $V_{CC} = V_{CC}$ Max
	Power Supply Current		I_{CC}		125	170		125	170	mA	$V_{CC} = V_{CC}$ Max All Inputs Grounded
	Input Clamp Voltage		V_{CL}			-1.5			-1.5	V	I_{in} = -10ma
	Output Short Circuit Current		I_{OS}	N/A		N/A	15	23	30	mA	$V_{CC} = V_{CC}$ Max, V_{OUT} = 0.0V One output only for a Max of 1 sec
A.C.	Address Access Time		t_{AA}		40	85		40	85	ns	V_{CC} and T_A Over Full Range
	Enable Access Time		t_{EA}		15	30		15	30	ns	V_{CC} and T_A Over Full Range

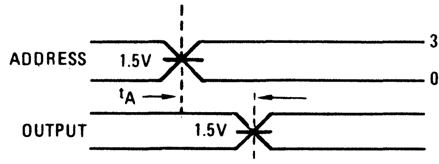
Typical Measurements are at T_A = 25°C, V_{CC} = +5V

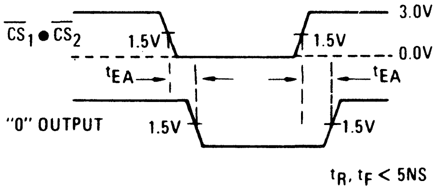
CAPACITANCE (1): T_A = 25°C

PARAMETER	SYMBOL	TYP.	UNITS	TEST CONDITION
Add. Input Cap.	$C_{IN\ A,\ CS}$	8	pF	V_{CC} = 5V, V_{IN} = 2.0V, f = 1MHz
Output Cap.	C_{OUT}	8	pF	V_{CC} = 5V, V_{OUT} = 2.0V, f = 1MHz

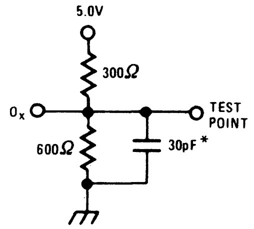
NOTE: (1) These parameters are only periodically sampled and are not 100% tested.

SWITCHING TIME DEFINITIONS





A.C. TEST LOAD



*Includes jig & probe total capacitance

PROGRAMMING

The HM-7640/7641 is manufactured with all bits/outputs Logical "1" (Output High). Any desired bit/output can be programmed to a Logical "0" (Output Low) by following the simple procedure shown below. One may build his own programmer to satisfy the specifications described in Table 1, or buy any of the commercially available programmers which meet these specifications. The HM-7640/7641 can be programmed automatically or by the manual procedure shown below.

PROGRAMMING SPECIFICATIONS

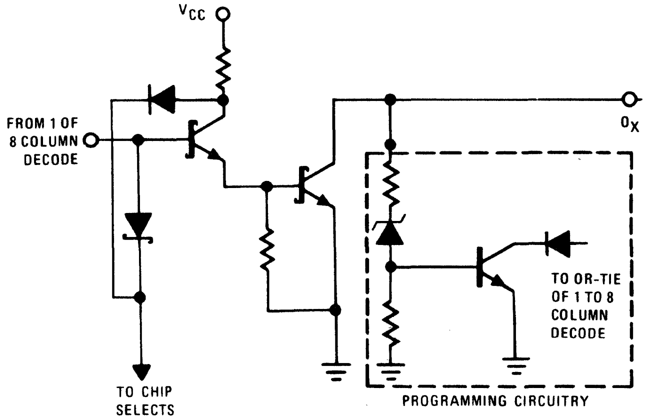
TABLE 1

PARAMETER	SYMBOL	MIN.	RECOMMEND VALUE	MAX.	UNITS
Address Input Voltage (1)	V_{IH} V_{IL}	2.4 0.0	5.0 0.4	5.0 0.8	V V
Programming/Verify Voltage to V_{CC} (2)	V_{PH} V_{PL}	11.5 3.75	12.0 4.0	12.5 4.25	V
Programming Voltage Current Limit	I_{CCP}			600	mA
Programming (V_{CC}) Voltage Rise and Fall Time	t_r t_f	1 1	1 1	10 10	µs µs
Programming Delay	t_d	10	10	100	µs
Programming Pulse Width – First Attempts	t_{p1}	100	100	200	µs
Programming Pulse Width – Subsequent	t_{p2}	10	10	20	ms
Programming Duty Cycle	D.C.	–	10	10	%
Output Voltage Enable Disable (3)	V_{OPE} V_{OPD}	9.5 0	10.0 .45	10.5 5.5	V V
Output Voltage Enable Current Limit	I_{OPE}			10	mA
Case Temp	T_C			75	°C

1. Address and chip select should not be left open for V_{IH}.
2. Verification at $V_{CC} = 4.0 \pm .25$ Volts, $T_A = 25°C$ is recommended to guardband performance over full temperature and voltage range.
3. Disable condition will be met with output open circuit.

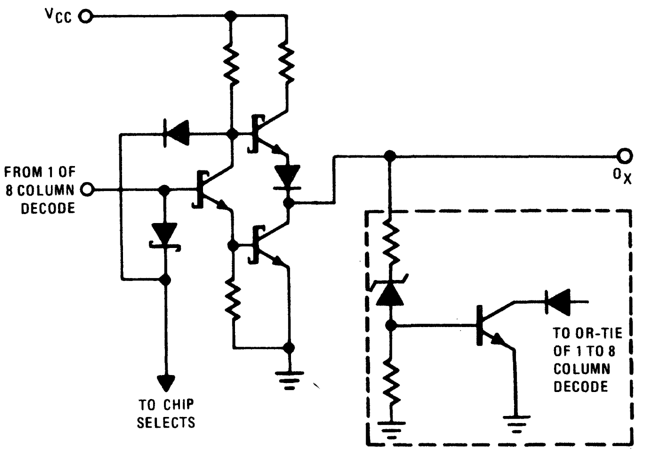
SCHEMATIC DIAGRAMS

HM-7640



OPEN COLLECTOR OUTPUT

HM-7641



THREE-STATE OUTPUT

PROGRAMMING PROCEDURE

1. Address the PROM with the binary address of the selected word to be programmed Address inputs are TTL compatible. An open circuit should not be used to address the PROM.
2. Disable the chip by applying input highs (V_{IH}) to both $\overline{CS_1}$ and $\overline{CS_2}$ chip select inputs. The chip select inputs are TTL compatible. An open circuit should not be used to disable the chip.
3. Disable the programming circuitry by applying an Output Voltage Disable of less than V_{OPD} to the output of the PROM. The output may be left open circuit to achieve the disable.
4. Raise V_{CC} to V_{PH} with rise time equal to t_r.
5. After a delay equal to or greater than t_d, apply a pulse with amplitude equal to V_{OPE} and duration of t_{p1} to the output selected for programming. Note that the PROM is supplied with fuses intact generating an output high. Programming a fuse will cause the output to go low in the verify mode..
6. Other bits in the same word may be programmed while the V_{CC} input is raised to V_{PH} by applying output enable pulses to each output which is to be programmed. The output enable pulses must be separated by a minimum interval of t_d.
7. Lower V_{CC} to 4.0 ±.25 Volts following a delay to t_d from the last programming enable pulse applied to an output.
8. Enable the PROM for verification by applying a logic "0" (V_{IL}) to the $\overline{CS_1}$ and $\overline{CS_2}$ inputs.
9. If any bit does not verify as programmed, repeat steps 2 through 8 using an output pulse enable width of t_{p1} for up to 15 additional pulses to enhance programming speed. If the bit is still unprogrammed, follow with at least 16 repetitive pulses of t_{p2} in width, to achieve high programming yield. In the event that the bit is still unprogrammed, the part is considered a programming reject and should be returned to the factory. The address and incorrect and desired contents of a location in which a programming failure has occured in any returned device must be included with that return.
10. Repeat steps 1 thru 9 for all other bits to be programmed in the PROM.

RECOMMENDED PROGRAMMING CIRCUIT

The circuit and timing diagram shown in Figures 1 and 2 will establish the proper programming condition for the output enable pulse. This allows the use of standard TTL parts for all logic inputs to the PROM. Note the gate which senses the output must be input protected to withstand input up to 12.5 Volts during programming.

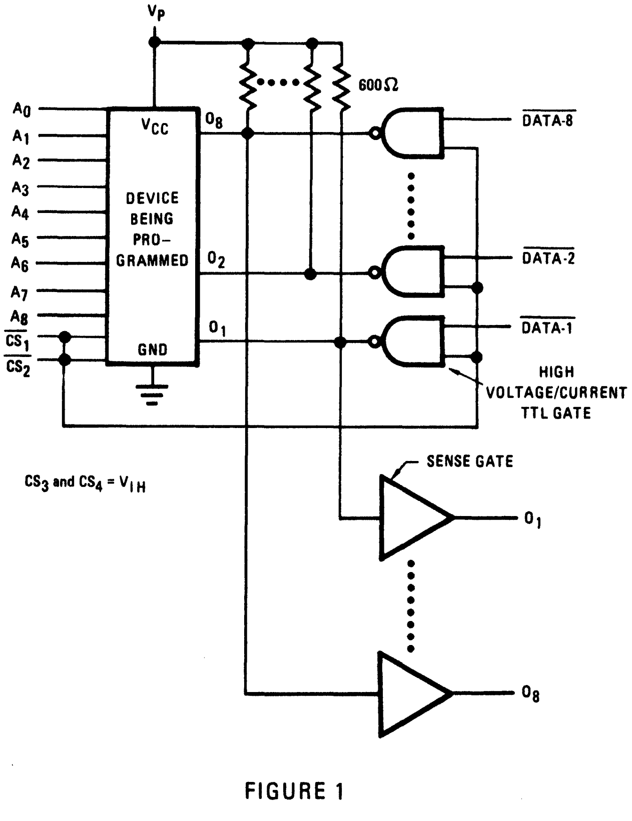


FIGURE 1

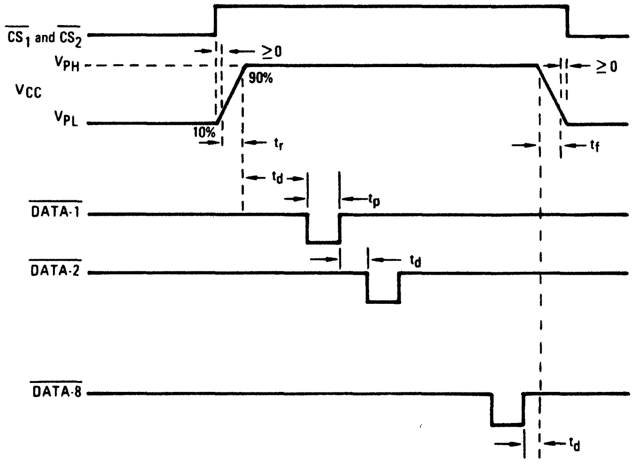


FIGURE 2

HARRIS BIPOLAR PROM CROSS-REFERENCE

NO. OF BITS	ORGANIZATION AND NO. OF OUTPUTS	HARRIS	AMD	FAIRCHILD	INTEL	INTERSIL	MMI	MOTOROLA	NATIONAL	SIGNETICS	TI
256	32X8 OPEN COLLECTOR	HPROM-8256-2				IM5600M	MM5330			S8223	54188A
		HPROM-8256-5				IM6500C	MM6330			N8223	74188A
		*HM7602-2							DM7577	S82S23	54S188
		*HM7602-5	AM27S08						DM8577	N82S23	74S188
	32X8 3-STATE	*HM7603-2				IM5610M	MM5331		DM7578	S82S123	54S288
		*HM7603-5	AM27S09			IM5610C	MM6331		DM8578	S82S123	74S288
512	64X8 OPEN COLLECTOR	HPROM-0512-2						MCM5303A			54186
		HPROM-0512-5						MCM5003A			74186
	64X8 PULL UP RESISTOR							MCM5304			
								MCM5004			
1024	256X4 OPEN COLLECTOR	HPROM-1024A-2		93416DM		IM5603M	MM5300		DM7573	S82S126	54S387
		HPROM-1024A-5		93416DC	3601	IM5603C	MM6300	MCM5005L	DM8573	N82S126	74S387
		HM7610-2									
		HM7610-5									
	256X4 3-STATE	HPROM-1024-2		93426DM		IM5623M	MM5301		DM7574	S82S129	54S287
		HPROM-1024-5		93426DC		IM5623C	MM6301		DM8574	N82S129	74S287
		HM7611-2									
		HM7611-5									
2048	512X4 OPEN COLLECTOR	HM7602-2				IM5604M	MM5305				54S370
		HM7620-5				IM5604C	MM6305				74S370
	512X4 3-STATE	HM7621-2			3602	IM5624M	MM5306			82S130	54S270
		HM7621-5		93436	3622	IM5624C	MM6306			82S131	74S270

NOTE: Compatibile pin-for-pin in read mode, but require different programming conditions for entering data into the memory.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HPROM-0512

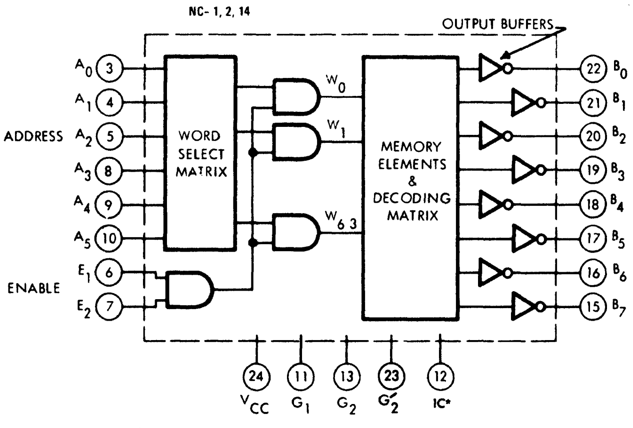
*512-Bit, Bipolar PROM™**

FEATURES

- FIELD PROGRAMMABLE
- 64 WORDS/8 BITS PER WORD
- FULLY DECODED
- DTL/TTL COMPATIBLE
- 55 NS ACCESS TIME
- SINGLE 5 VOLT POWER SUPPLY
- STATIC OUTPUT WITH FANOUT OF 10
- AVAILABLE IN EITHER MILITARY OR COMMERCIAL TEMPERATURE RANGE
- EXPANDABLE – "WIRED-OR" OUTPUTS
  "AND" ENABLE INPUTS

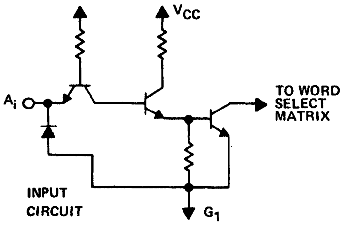
BLOCK DIAGRAM

HPROM-0512

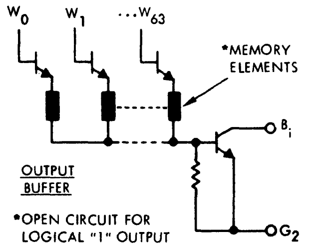


Note: For operational condition, return pins 11, 13 and 23 to system ground.

*IC - INTERNAL CONNECTION MUST BE LEFT OPEN



INPUT CIRCUIT



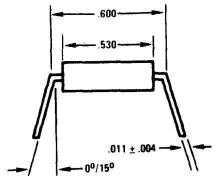
OUTPUT BUFFER

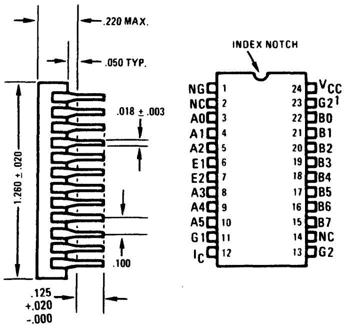
*OPEN CIRCUIT FOR LOGICAL "1" OUTPUT

PACKAGE

CODE 1J

24 LEAD CERAMIC D.I.P.





ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

TRUTH TABLE

Word Number	INPUTS							OUTPUTS							
	(1)E	A_5	A_4	A_3	A_2	A_1	A_0	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
(2)X	0	X	X	X	X	X	X	1	1	1	1	1	1	1	1
0	1	0	0	0	0	0	0	*	*	*	*	*	*	*	*
1	1	0	0	0	0	0	1	*	*	*	*	*	*	*	*
2	1	0	0	0	0	1	0	*	*	*	*	*	*	*	*
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
63	1	1	1	1	1	1	1	*	*	*	*	*	*	*	*

NOTE: (1) $E = E_1 \cdot E_2$ (2) X = "Don't Care"

FIELD PROGRAMMING

The HPROM-0512 is the first read-only memory which can be programmed electronically after manufacture and packaging. Most semiconductor read-only memories are programmed during manufacturing by designing the final metallization to correspond to the desired memory configuration. This process requires a different mask for each unique design and once the device is packaged, no further changes can be made. In contrast, the technique for programming the HPROM-0512(see page 5) is straightforward and can be implemented at the user's facility with little difficulty.

Referring to the block diagram above, the status of any bit is determined by the condition of the 512 "Memory Elements" which connect the input word lines to each of eight (8) output bit buffers. In an unprogrammed memory, all "Memory Elements" are short circuits so that logical "zeros" appear at each output bit position for any address input. "Electronic Programming" involves the alteration of specific "Memory Elements" to create logical "ones" in selected bit positions. This alteration is irreverisible and cannot be accomplished under normal operating conditions – thus, the HPROM-0512 is a true permanent memory when inserted in a system.

***PROM is a trademark of Harris Semiconductor for its family of field programmable read-only memories.**

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC}	7.0V	Storage Temperature	–65°C to +150°C
Address/Enable Input Voltage, V_A, V_E	-1.5V to +5.5V	Operating Temperature (Case)	–55°C to +125°C
Output Supply Voltage, V_{BS}	-0.5V to +7.0V	θ_{JC} = 15°C/W	
Output Sink Current, I_{OL}	-30mA	θ_{JA} = 50°C/W	
Input Current	-30mA		

ELECTRICAL CHARACTERISTICS

Test Conditions: $V_{CC} = 5.0 \pm 5\%$, $G_1 = G_2 = G_2' =$ Ground
T_{CASE} = –55°C to +125°C for HPROM-0512-2
0°C to +75°C for HPROM-0512-5
unless otherwise specified.

	PARAMETER		SYM	LIMITS			UNITS	TEST CONDITION	
				MIN	TYP	MAX			
	Enable Current	"1"	I_{RE}		10	* 60	µA	V_E = 2.4V	V_{CC} = 5.25V
					30	* 100		V_E = 5.25V	
		"0"	I_{FE}		–1.0	*–1.6	mA	V_E = 0.4V	V_{CC} = 5.25V
	Address Current	"1"	I_{RA}		10	* 60	µA	V_A = 2.4V	V_{CC} = 5.25V
					30	*100		V_A = 5.25V	
		"0"	I_{FA}		–1.0	*–1.6	mA	V_A = 0.4V	V_{CC} = 5.25V
	Input Threshold Voltage (1)	"1"	V_{IH}	2.0			V	V_{CC} = 4.75V	
		"0"	V_{IL}			0.8	V	V_{CC} = 5.25V	
D.C.	Output "0" Voltage		V_{OL}		0.25	*0.45	V	V_{CC} = 4.75V I_{OL} = 10mA	V_{IH} = 2.0V
	Output "1" Leakage Current		I_{OH}			*100	µA	V_{OH} = 2.4V	V_{IL} = 0.8V
						*200		V_{OH} = 5.25V	
	Power Supply Current (3)	(Quiescent)	I_{CC}		70	* 95	mA	V_{CC} = 5.25V; $V_E = V_A$ = 0V	
		(Operating)	I_{CC}		80		mA	V_{CC} = 5.25V; f = 4MB/s (2)	
	Output Capacity		C_{OUT}		5		pF	V_{OUT} = 2.0V	
A.C.	Address or Enable to Output Fall Delay (4)		t–	25	55	75	ns	R_1 = 470Ω R_2 = 1KΩ C_L = 30pF	
	Address or Enable to Output Rise Delay (4)		t+	25	55	75	ns	T_A = 25°C V_{CC} = 5.0V	

NOTES: (1) Threshold voltages are defined as the limits on the input levels which ensure that the desired input state is achieved.

(2) A typical device is one programmed to output 50% "ones".

(3) Output terminals left open —see Test Circuit 1.

(4) See Test Circuit 2.

100% Tested For DASH 8

TEST CIRCUITS

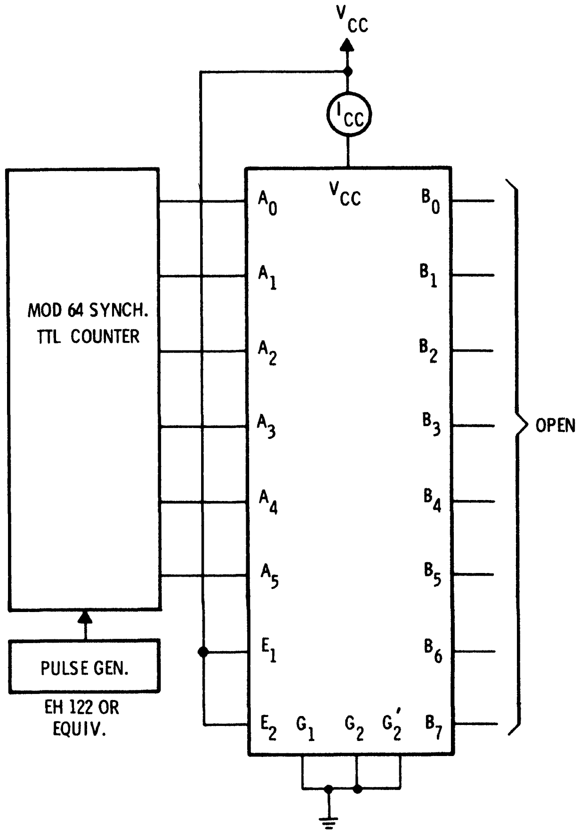


Figure 1.
OPERATING POWER SUPPLY CURRENT

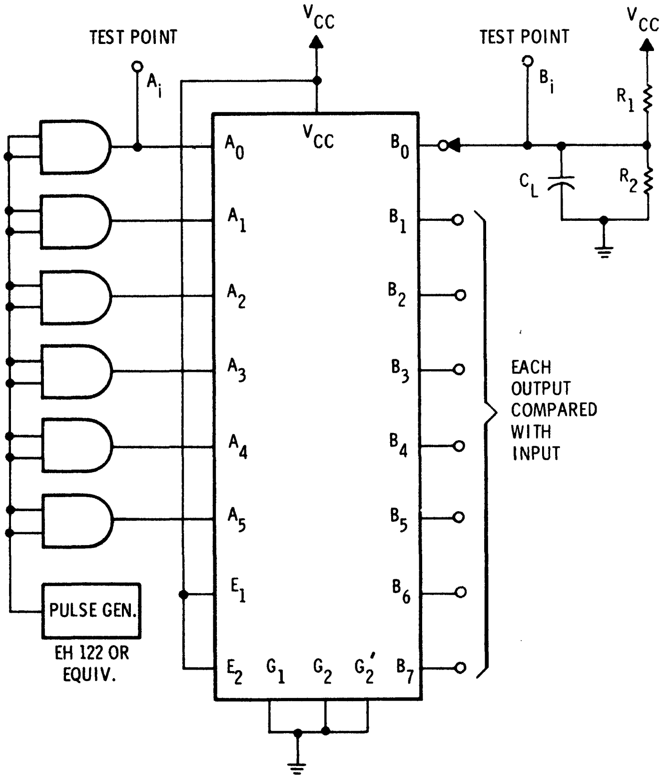
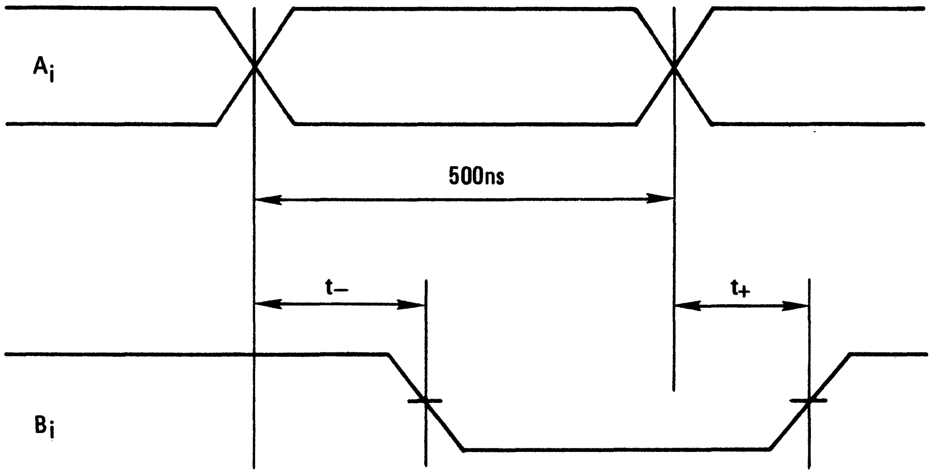


Figure 2.
PROPAGATION DELAYS

NOTE: Applies only to programmed units.

SWITCHING TIME DEFINITIONS



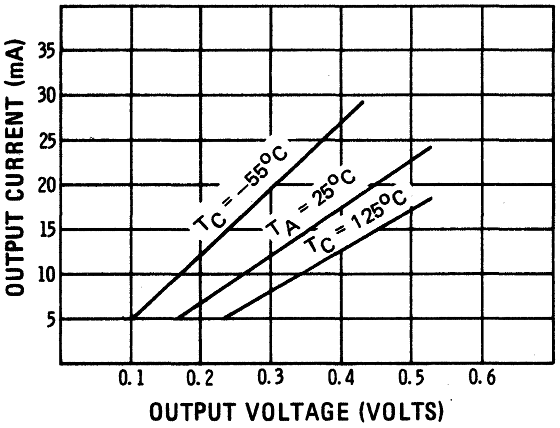
NOTES: (1) $E_1 = E_2 =$ "1"

(2) All measurements referenced to +1.5V level.

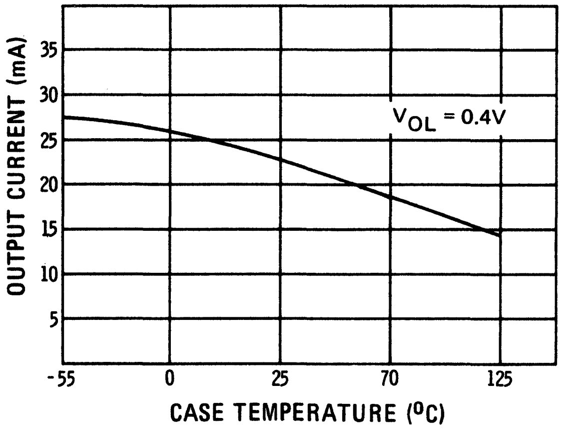
(3) Address rise and fall times ≤10ns.

CHARACTERISTIC CURVES

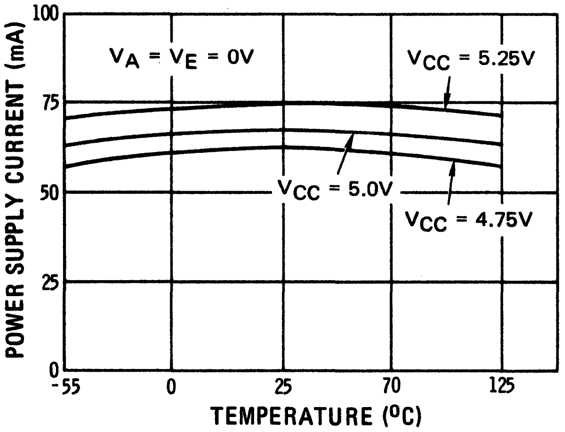
OUTPUT CHARACTERISTICS



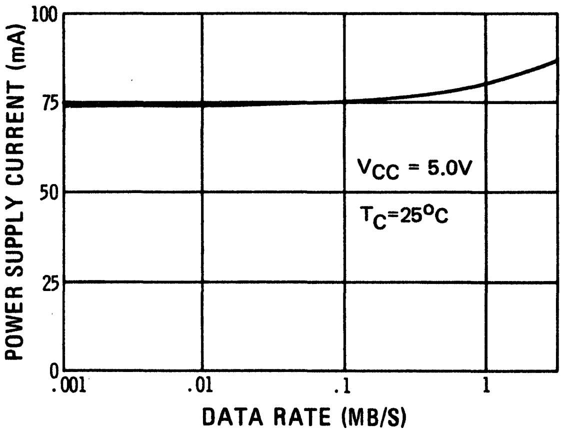
OUTPUT CURRENT VS. TEMPERATURE



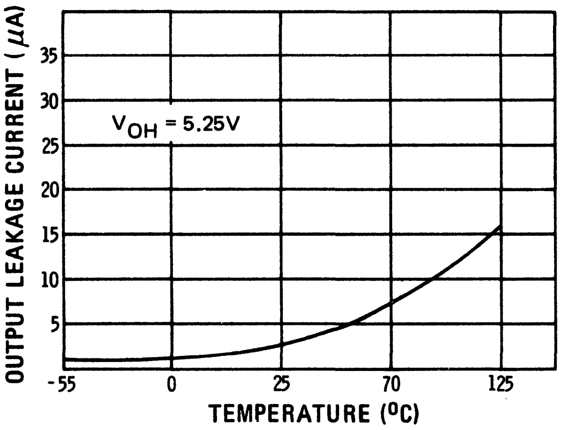
POWER SUPPLY CURRENT VS. TEMPERATURE



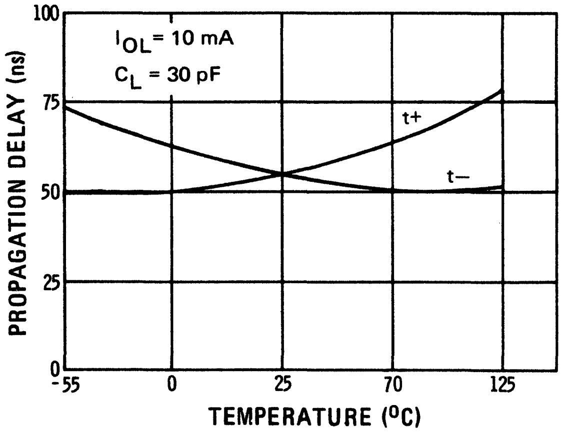
POWER SUPPLY CURRENT VS. DATA RATE



OUTPUT LEAKAGE CURRENT VS. TEMPERATURE



PROPAGATION DELAY VS. TEMPERATURE



TEST CONDITIONS: V_{CC} = 5.0V UNLESS OTHERWISE SPECIFIED.

PROGRAMMING SPECIFICATIONS

PARAMETER	SYM.	RECOMMENDED VALUE
Address Input Voltage "1"	V_{AH}	(1)Open Circuit
"0"	V_{AL}	-5.0V
Address Input low Current	IAL	-3.0mA
Power Supply Voltage	V_{CC}	5.0V +5%-0% $@I_{CC} \leq 250mA$
G_1 Voltage (2)	V_{G1}	-5.0V
G_2 Voltage	V_{G2}	0V
Programming Voltage (MAX)	$\overline{V}_{BP}$	-7.0V
Programming Current (MAX)	$\overline{I}_P$	100mA
Maximum Programming T_{CASE}	$\overline{T}_{CASE}$	75°C
Programming Pulse widths	PW	400 ms
Duty Cycle T_A 25°C	DC	20%

(1) An open collector TTL gate meets this specification.

(2) G_1 must be connected to -5.0V prior to applying V_{CC} or programming voltage.

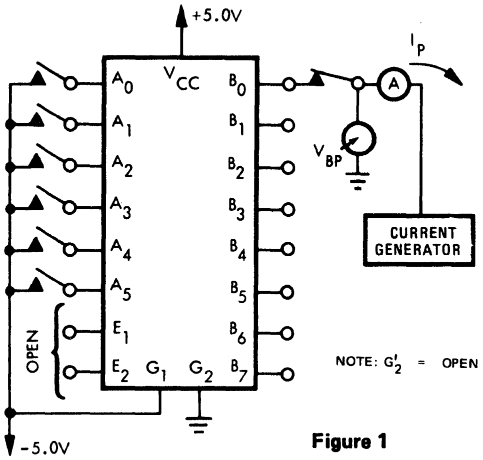


Figure 1
PROGRAMMING CONNECTIONS

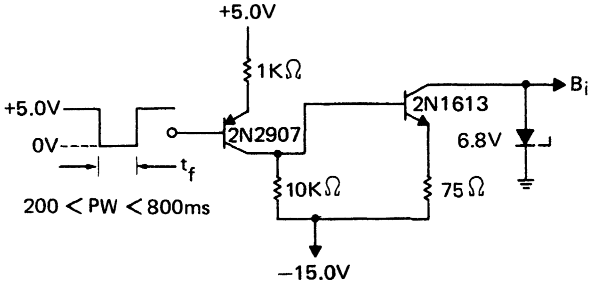


Figure 2
PROGRAMMING CIRCUIT

PROGRAMMING

Programming the HPROM-0512 is a simple operation which can be accomplished with a minimum of equipment. A negative going voltage pulse is applied to each output terminal where the initial logic "zero" is to be changed to a logic "one." The power supply and ground connections described below ensure that alteration of a specific logic element will not occure under normal operating conditions.

The following is the recommended procedure for reliably programming the HPROM-0512.

1. Connect the HPROM-0512 as shown in Figure 1. To address a particular word in memory, set the input switches to the binary equivalent of that word, where a logic "zero" is -5.0V and a logic "one" is an open circuit. (Do not return to supply.) All output bits (B_0, B_1 .... B_7) of this word are now available for programming.
2. With the output of the current generator limited to 100mA, apply a negative going pulse to the pin associated with the first bit to be changed from a "zero" to a "one". This is most easily accomplished by connecting the negative terminal of a variable power supply to the proper output pin and manually increasing the voltage to approximately 6.0V.

   (The circuit shown in Figure 2 can be used in more automated programming systems. This circuit generates a fusing pulse which is at the proper voltage and current levels for fast, reliable programming. Most devices will program with input pulse widths (PW) as low as 200ms.)

   Verify the bit programed by returning the device to the read mode and connecting a load resistor to +5V.
3. Skipping any bit which is to remain a "zero," repeat Step 2 for each "one" in the word being addressed. (For maximum reliability, program only one bit at a time.)
4. Set the next input address and repeat Steps 2 and 3. This procedure repeated for each input address for which a specific output word pattern is desired. Note that all addresses do not have to be programmed at the same time, nor do all output bits for a given address. A "zero" can always be changed to a "one" simply by repeating Steps1 and 2. A "zero" once programmed to "one" cannot be reprogrammed to "zero."

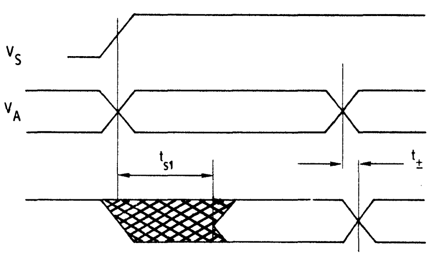
The procedure given above is intended merely to convey the mechanics of programming the HPROM-0512. Obviously, more sophisticated electronic methods can be devised to automate the process and minimize the time required for programming. Such a system is used by Harris to custom-program ROM's for customers whose memory configurations are already established and also for certain standard patterns. This particular system operates with punched card inputs which convey the programming information and also provide the test conditions for each programmed ROM.

APPLICATION INFORMATION

POWER STROBE

Since the HPROM-0512 is a permanent memory, V_{CC} may be removed from the chip during periods when the memory is not being accessed thus reducing the average power consumption. A circuit which performs this function is shown in Figure 1. Using the components shown, the propagation delay from the power strobe to the first output word (t_{s1}) becomes ~140ns. Figure 2 shows the variation in t_{s1} as a function of temperature.

TIMING DIAGRAM



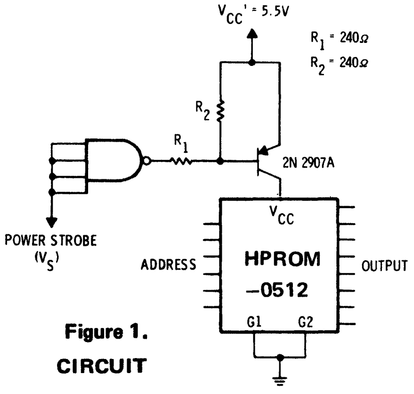


Figure 1.
CIRCUIT

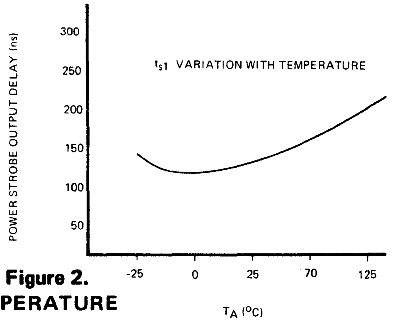
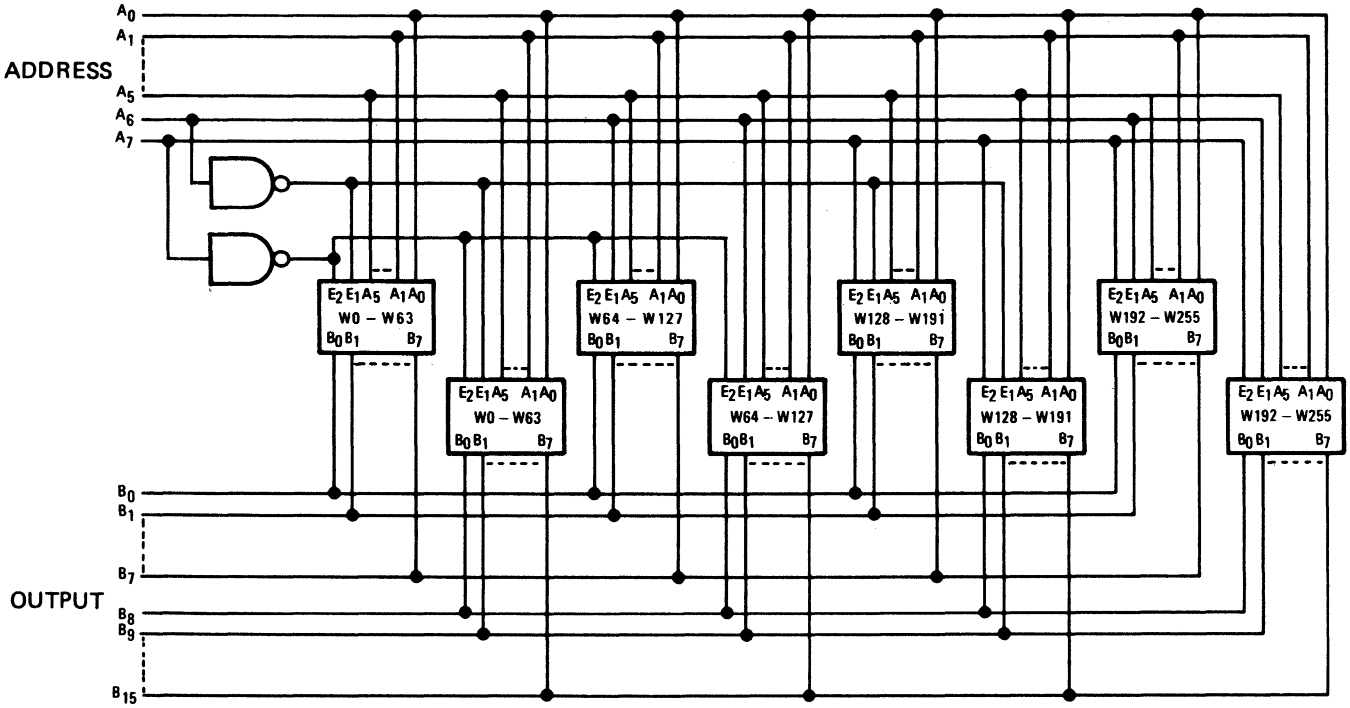


Figure 2.
TEMPERATURE VARIATIONS

EXPANDABILITY



The HPROM-0512 is easily expanded in both bit and word dimensions. Expanding in the word dimension is accomplished by using the E_1 and E_2 Enable Inputs as further decoding elements for the input address and wiring together (WIRE-OR) two or more output pins from corresponding bits of different words. The "WIRE-OR" connection results in increased capacitance and leakage at the output node as each additional package is connected. Expansion in the bit dimension is accomplished by paralleling corresponding address pins on two or more units. The Block Diagram above depicts a 256 word by 16-bit system.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

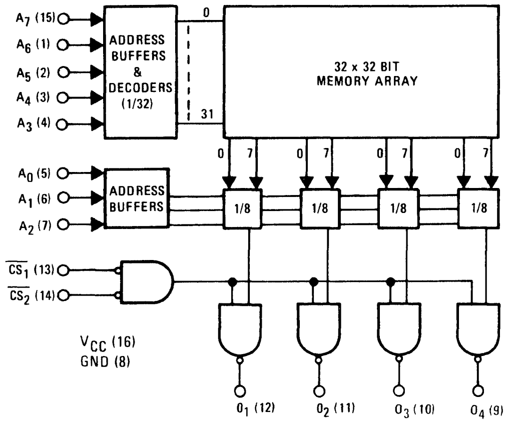
HPROM-1024/1024A

1024-Bit Field Programmable Bipolar PROM™

FEATURES

- FIELD PROGRAMMABLE
- 256/4 BITS PER WORD
- FULLY DECODED
- DTL/TTL COMPATIBLE
- 50ns ACCESS TIME
- PROVEN RELIABLE NICHROME FUSES
- LOW INPUT CURRENT ≤ 0.25mA
- SINGLE 5.0V POWER SUPPLY
- EXPANDABLE – "WIRED-OR" OUTPUTS WITH CHIP SELECT INPUT
- AVAILABLE IN MILITARY AND COMMERCIAL TEMPERATURE RANGES

BLOCK DIAGRAM



DESCRIPTION

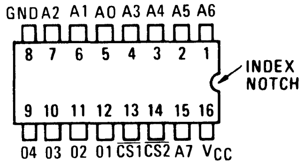
The HPROM-1024 (3-State) and the HPROM-1024A (Open Collector) are fully decoded, high speed, 1024-bit, field programmable ROM's organized as 256 words by 4 bits per word. Field programmable implies that, by following a simple programming procedure, users are able to program the PROM to any custom pattern to satisfy their system requirements.

The HPROM-1024 and the HPROM-1024A are identical except for the output stage. The HPROM-1024A has an Open Collector output while the HPROM-1024 has a third high impedance state output, allowing the device to work in a "Wire – OR" configuration. The third state is activated by disabling the device ($\overline{CS}_1$ or $\overline{CS}_2$ High).

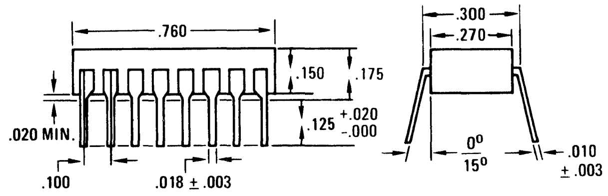
The HPROM-1024/1024A are supplied with all bits storing a Logical "1" (Output High) and can be selectively programmed for a Logical "0" (Output Low). The addressing scheme for programming and reading the information in the system is the same.

PACKAGE

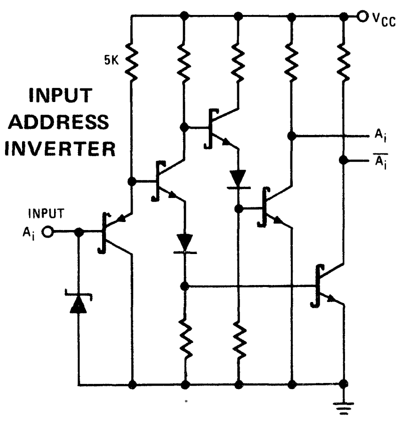
CODE 1D 16 LEAD CERAMIC D.I.P.

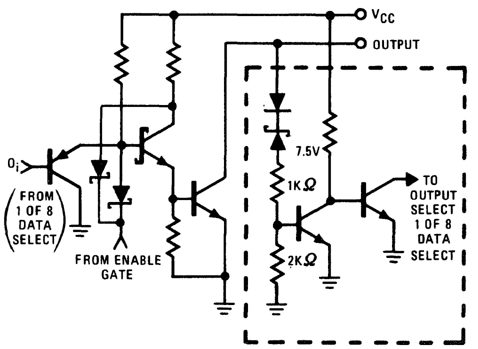


ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

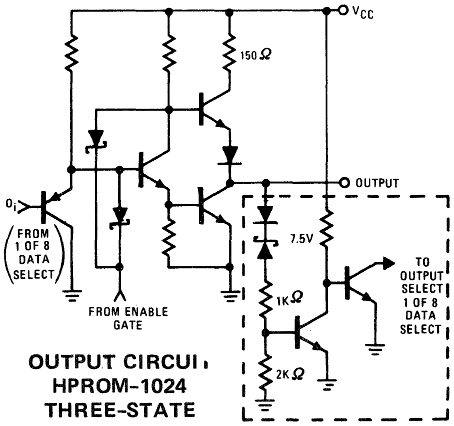


INPUT/OUTPUT SCHEMATICS





OUTPUT CIRCUIT
HPROM-1024A
OPEN COLLECTOR



OUTPUT CIRCUIT
HPROM-1024
THREE-STATE

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS:

Output or Supply Voltage	7.0V
Address/Enable Input Voltage	5.5V
Address/Enable Input Current	-20mA
Output Sink Current	70mA
Storage Temperature	+150°C
Operating Temperature (Case)	+125°C
Maximum Junction Temperature	+175°C

θ_{jC}= 25° C/W (Cerdip); θ_{jA}=80° C/W (Cerdip)

Note:

Stresses above those listed under the "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress only rating and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. (While programming, follow the programming specifications.)

ELECTRICAL CHARACTERISTICS (Operating Mode)

TEST CONDITION: V_{CC} = 5.0± 5%, T_A = -55°C to + 125°C (HPROM-1024-2, HPROM-1024A-2)
V_{CC} = 5.0± 5%, T_A = 0°C to +75°C (HPROM-1024-5, HPROM-1024A-5) unless otherwise specified.

	PARAMETER	SYMBOL	HPROM-1024			HPROM-1024A			UNITS	TEST CONDITIONS
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.		
D.C.	Address/Chip Select "1" Input Current "0"	I_{RA}, I_{RE} I_{FA}, I_{FE}			*40 *-0.25			*40 *-0.25	μA mA	$V_{IH} = V_{CC}$ Max. V_{IL} = 0.45V
	Input Clamp Voltage	V_{Clamp}		-0.7	*-1.0		-0.7	*-1.5		$V_{CC} = V_{CC}$ Min. I_{Clamp} = -10mA
	Input Threshold "1" Voltage "0"	V_{IH} V_{IL}	2.0		 0.8	2.0		 0.8	V V	
	Output Voltage "1" "0"	V_{OH} V_{OL}	*2.4		 *0.45	 N.A.	 N.A.	N.A. *0.45	V V	 I_{OL} = 15mA
	Output Leakage "1"	I_{OH}	N.A.	N.A.	N.A.			*100	μA	$V_{OH} = V_{CC}$ Max.
	Output Disabled Current	$I_{O\overline{E}}$			*100			*100	μA	V_{OH} = 2.4V, V_{E1}/V_{E2} = 2.0V
	Power Supply Current	I_{CC}			*130			*130	mA	All Inputs Grounded. $V_{CC} = V_{CC}$ Max.
A.C.	Address to Output	t_{A+} t_{A-}		50 50	*70 *70		50 50	*70 *70	ns ns	T_A = +25°C
	Enable Access Time	t_{E-} t_{off+}		20 20	*35 *35		20 20	*35 *35	ns ns	V_{CC} = 5.0V

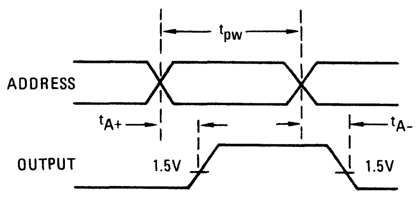
*100% Tested For DASH 8

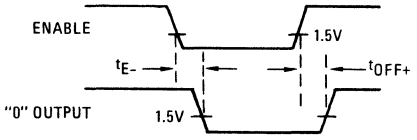
CAPACITANCE (1): T_A = 25°C

PARAMETER	SYMBOL	LIMITS		UNIT	TEST CONDITION	
		TYP.	MAX.			
Add. Input Cap.	$C_{IN\ A, CS2}$	7	15	pf	V_{CC} = 5V V_{IN} = 2.0V	T_A = 25°C
Chip Select Input Cap.	C_{CS1}	10	20	pf	V_{CC} = 5V V_{IN} = 2.0V	
Output Cap.	C_{OUT}	6	12	pf	V_{CC} = 5V V_{OUT} = 2.0V	

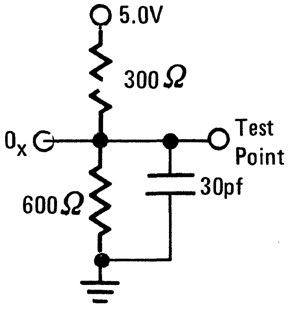
NOTE (1): These parameters are only periodically sampled and are not 100% tested.

SWITCHING TIME DEFINITIONS



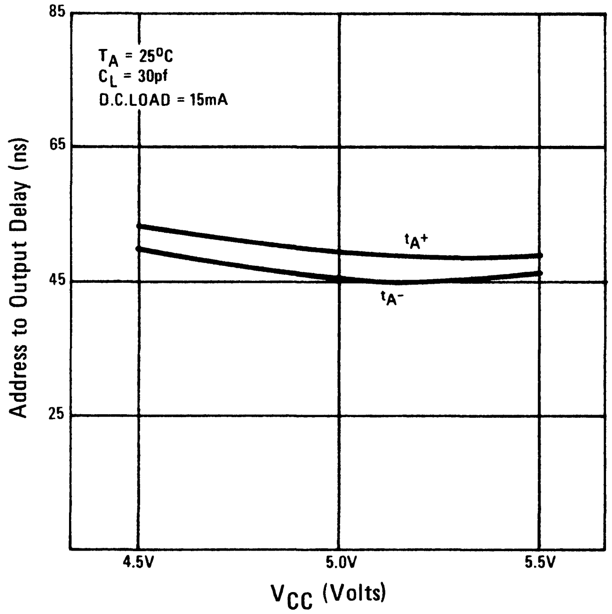


A.C. TEST LOADS

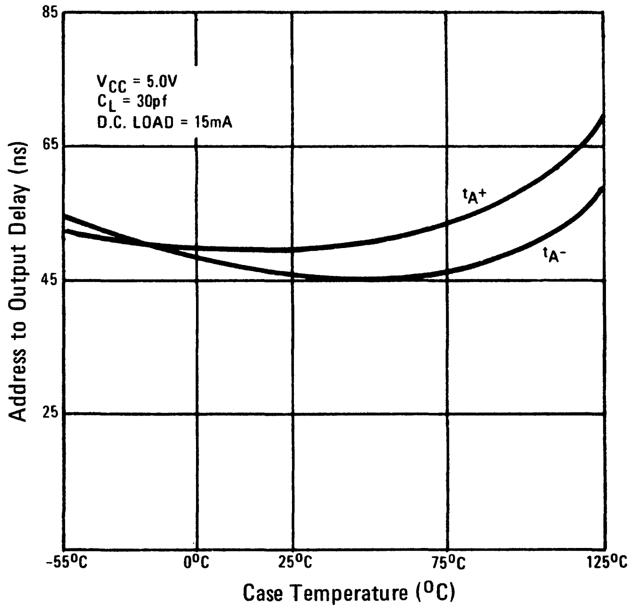


TYPICAL A.C. CHARACTERISTICS

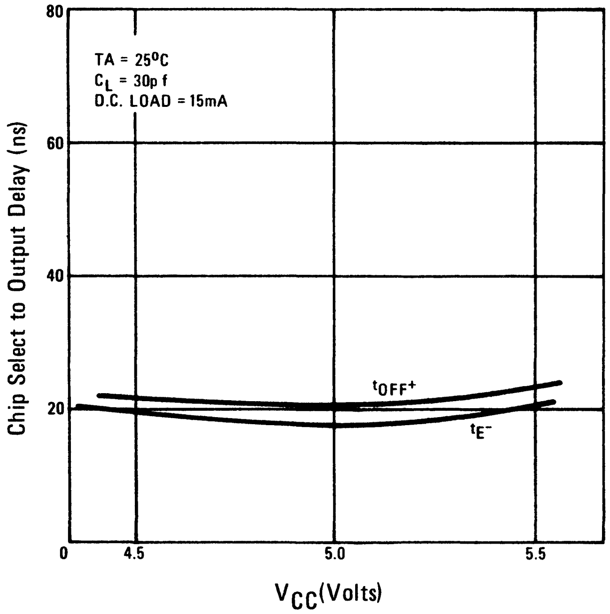
ADDRESS TO OUTPUT DELAY VS. SUPPLY VOLTAGE



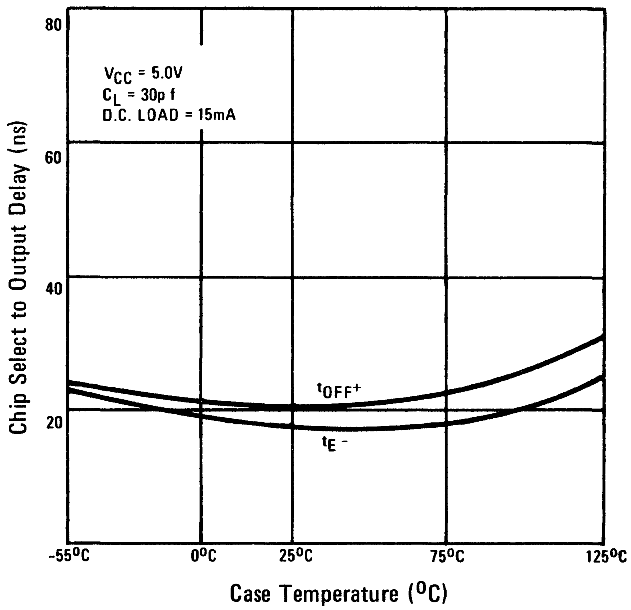
ADDRESS TO OUTPUT DELAY VS. CASE TEMPERATURE



CHIP SELECT TO OUTPUT DELAY VS. SUPPLY VOLTAGE



CHIP SELECT TO OUTPUT DELAY VS. CASE TEMPERATURE



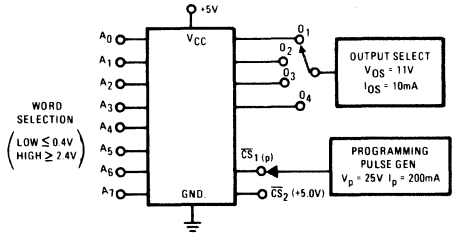
PROGRAMMING

The HPROM-1024/1024A is manufactured with all bits/outputs Logical "1" (Output High). Any desired bit/output can be programmed to a Logical "0" (Output Low) by following the simple procedure shown below. One may build his own programmer to satisfy the specifications described in Table 1, or buy any of the commercially available programmers which meet these specifications. The HPROM-1024/1024A can be programmed automatically or by the manual procedure shown below.

PROGRAMMING SPECIFICATIONS

PARAMETER	SYMBOL	MIN.	RECOMMENDED VALUE	MAX.	UNITS.	NOTES
Address Input Voltage	V_{IH}	2.4	5.0	5.0	V	Address inputs should not be left open for V_{IH}.
	V_{IL}	0.0	0.0	0.4	V	
Chip Select 2 Voltage (Pin 14)	$V_{\overline{CS2}}$	2.4	5.0	5.0	V	
Programming Voltage $\overline{CS}_1$ (Pin 13)	$V_{\overline{CS1}}$ (P)	24.0	25	25.5*	V	*Including overshoot
Programming Current Limit $\overline{CS}_1$ (Pin 13)	$I_{\overline{CS1}}$ (P)		200	300	mA	125mA is the typical programming current requirement.
Programming Pulse Width	T_{PW}	1	10	100	mS	t_{RISE} = 200 SEC ±20%
Output Select Voltage	V_{OS}	10.5	11	11.5	V	
Output Select Current limit	I_{OS}		10	20	mA	2mA is the typical current requirement.
Power Supply Voltage	V_{CC}	5.0	5.0	5.25	V	
Case Temperature	T_C	-25	25	75*	°C	*20% duty cycle with T_A = 25°C

MANUAL PROGRAMMING



The HPROM-1024/1024A may be programmed using the method shown in the figure on the left.

(1) Select the word to be programmed by applying the appropriate voltages to the address pins A_0 through A_7.

(2) Apply 11.0 volts to the output associated with the bit to be programmed. The other outputs may be left open or connected to any normal circuity which does not apply more than 5 volts to these outputs. Only one output is programmed at a time.

(3) Apply the 25 volt programming pulse to the Input Pin CS_1(Pin 13). The recommended programming pulse width is 10ms. However, programming speed may be enhanced by making initial attempts at 1msec. Bits which do not program with these pulse widths may be programmed either by repeating with 10ms pulses or by increasing the programming pulse width to 100ms. The multiple application of the programming pulse or the increased pulse width in no way affects the reliablity of the device. The case temperature of the device being programmed, however, must not exceed 75°C. The 20% duty cycle (at T_A = 25°C) generally maintains a T_{CASE} of 75°C. Bits which do not program when subjected to multiple pulses totaling 500 msec may be returned for replacement. Returned units should be accompanied with word and bit location of fuse which did not program.

(4) To verify that the output has been programmed following each application of the programming pulse, being Pin 13 and Pin 14 to 0.4 volts or less. V_{CC} should be reduced to 4.0 + .2 volts to guardband full temperature and volume range operations.

(5) The above procedure is repeated to program other bits on the chip.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HPROM-8256

256-Bit, Bipolar PROM

FEATURES

- FIELD PROGRAMMABLE
- 32 WORDS/8BITS PER WORD
- FULLY DECODED
- DTL/TTL COMPATIBLE
- 40NS ACCESS TIME
- PROVEN RELIABLE NICHROME FUSES
- SINGLE 5V POWER SUPPLY
- STATIC OUTPUT WITH FANOUT OF 10
- AVAILABLE IN MILITARY AND COMMERCIAL TEMPERATURE RANGES
- EXPANDABLE – "WIRED-OR" OUTPUTS – CHIP ENABLE INPUT

TRUTH TABLE

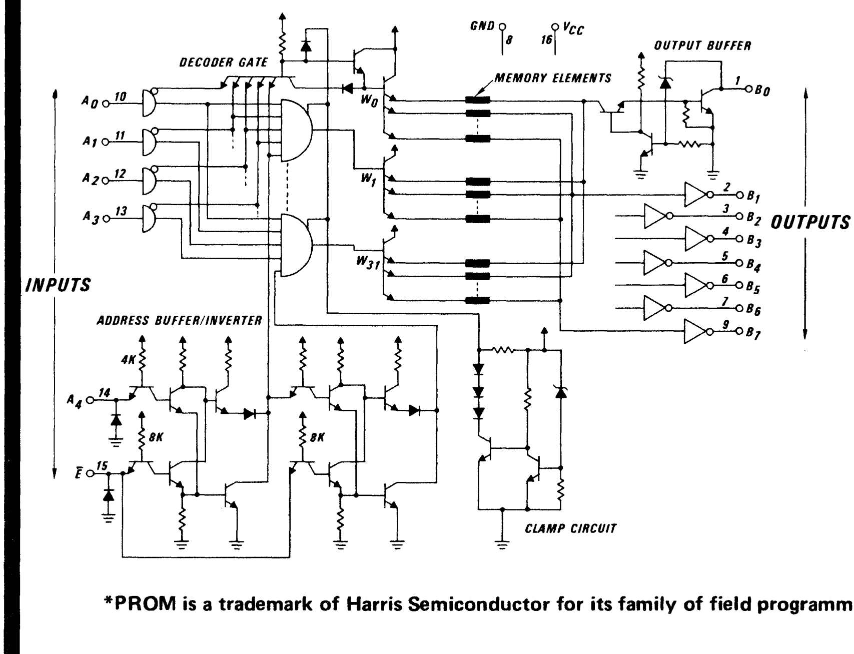
The HPROM-8256 is another in a series of field programmable read-only memories from Harris Semiconductor. Field programming implies that the device (packaged with logical "0's" in all 256 memory locations) can be programmed electronically by the user to any specific pattern using the simple procedure shown on page 4.

Referring to the circuit diagram below, the status of any bit is determined by the condition of the "memory element" in that bit location. For a logical "0" output, the memory element is in the conducting state and the output transistor is turned "on". Programming, then, involves opening selected memory elements to prevent current flow to the output transistor, creating a logical "1" in each programmed bit location.

WORD	INPUTS						OUTPUTS							
NUMBER	$\bar{E}$	A_4	A_3	A_2	A_1	A_0	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
X	1	X	X	X	X	X	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	*	*	*	*	*	*	*	*
1	0	0	0	0	0	1	*	*	*	*	*	*	*	*
2	0	0	0	0	1	0	*	*	*	*	*	*	*	*
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
31	0	1	1	1	1	1	*	*	*	*	*	*	*	*

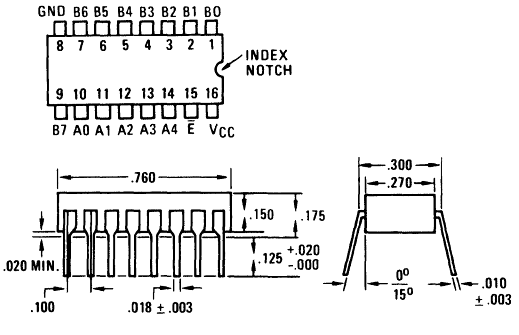
NOTE: X = DON'T CARE

CIRCUIT DIAGRAM



PACKAGE

CODE 1D 16 LEAD CERAMIC D.I.P.



ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

***PROM is a trademark of Harris Semiconductor for its family of field programmable read-only memories.**

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (Operating), V_{CC}	7.0V
Address/Enable Input Voltage, V_A, V_E	−1.5V to +5.5V
Output Supply Voltage (Operating), V_{BS}	−1.5V to +7.0V
Output Sink Current, I_{OL}	−30mA
Input Current	−30mA
Storage Temperature	−65°C to +150°C
Operating Temperature	−55°C to +125°C

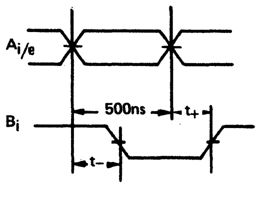
ELECTRICAL CHARACTERISTICS

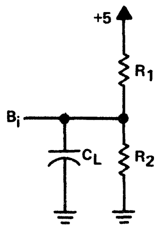
TEST CONDITIONS
HPROM-8256-2 (V_{CC}= +5.0V ±10%, T_A= -55°C to +125°C)
HPROM-8256-5 (V_{CC}= +5.0V ± 5%, T_A= 0°C to +75°C)

PARAMETER		SYM	HPROM-8256-2 (-55°C to +125°C)			HPROM-8256-5 (0°C to +75°C)			UNITS	TEST CONDITIONS
			MIN	TYP	MAX	MIN	TYP	MAX		
$\overline{\text{ENABLE}}$ Current	"1"	I_{RE}			*100			100	μA	V_{IN} = 4.5V
	"0"	I_{FE}			*-1.6			-1.6	mA	V_{IN} = 0.4V
Address Current	"1"	I_{RA}			*100			100	μA	V_{IN} = 4.5V
	"0"	I_{FA}			*-1.6			-1.6	mA	V_{IN} = 0.4V
Input Threshold Voltage	"1"	V_{IH}	2.0			1.9			V	
	"0"	V_{IL}			0.8			0.85	V	
Output "0" Voltage		V_{OL}			* 0.45			0.45	V	V_{CC}=V_{MIN}, I_{OL} = 10mA
Output "1" Leakage		I_{OH}			*200			200	μA	V_{OH} = 5.25V
Input Clamp Voltage		V_C			*-1.5V			-1.5V	V	I_{IN} = -5.0mA
Power Supply Current	(Quiescent)	I_{CC}			*80			80	mA	V_E = V_{IH}, Outputs open
	(Operating)				*100			110	mA	V_E = V_{IL}, Outputs open
Address/Enable to Output Fall Delay		t-		40	50		40	50	ns	R_1 = 470Ω, R_2 = 1KΩ, C_L = 30pF
Address/Enable to Output Rise Delay		t+		40	50		40	50	ns	T = 25°C V_{CC} = 5.0V

*100% Tested For DASH 8

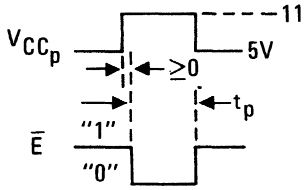
SWITCHING TIME DEFINITIONS





1. All measurements referenced to +1.5V.
2. Address rise and fall times ≤ 10ns.

PROGRAMMING



NOTE:
See Procedure No. 4 below.

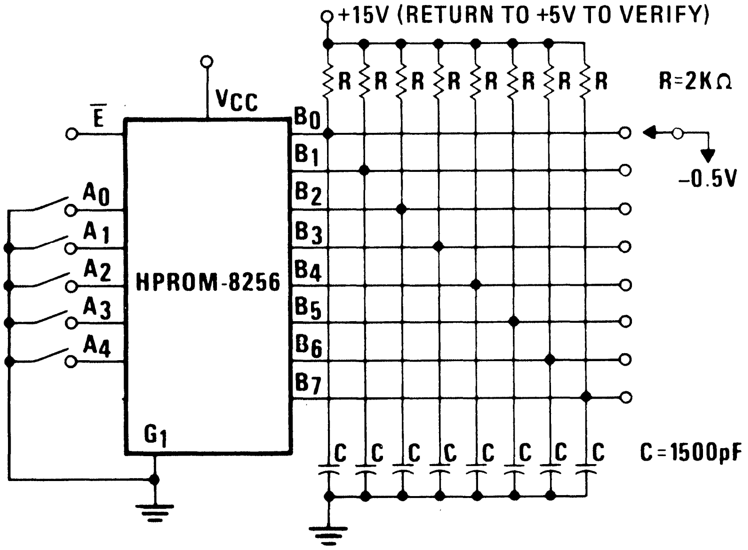


FIGURE 1

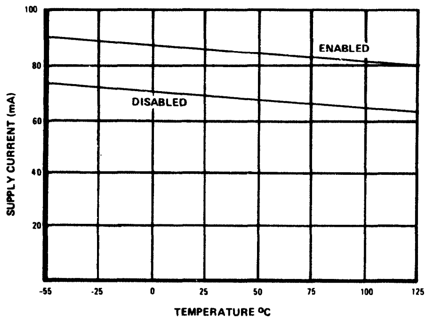
REQUIREMENTS

	RECOMMENDED VALUE	LIMITS		UNITS	NOTES
		MIN.	MAX.		
Enable/Address Input Low Current			-6.0	mA	V_{IN} = 0.4V
Enable/Address Input Voltage low	GND	—	0.4	V	
Enable/Address Input Voltage high	OPEN		–	V	
Programming Voltage (V_{CC_p})	11		11.5	V	I_{Limit} = 250mA
Programming Pulse Width (t_p)	20	0.5	800*	ms	*All devices should program with $t_p \leq$ 800ms.
Programming Output Voltage	-0.5	-1.0	0.0	V	
Non–Programming Output Current	4.0	2.0	8.0	mA	Output voltage nominally 8.3V.
T_{CASE}			75	°C	
Duty Cycle (T_A = 25°C)	60		80	%	

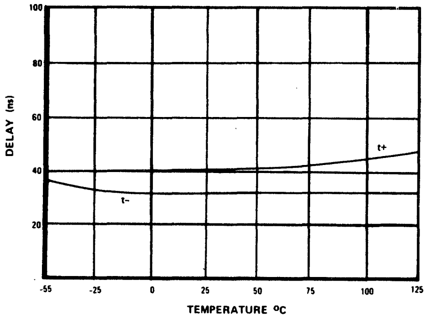
PROCEDURE

1. Connect the PROM as shown in figure 1.
2. Address the desired word by applying an open circuit for Logic "1" and ground for Logic "0". (High voltage open collector TTL inputs may also be used.)
3. Select first output bit to be programmed by taking that output to a negative 0.5V.
4. Disable device (E≥2.5V). (Nonprogramming outputs will rise to approximately 8.3V) Raise supply to +11V and enable device (E≤0.4V) to program the selected memory element. (Enable signal must not be applied prior to raising V_{CC} to +11V.) Device should be enabled for tp milliseconds. For fastest programming results the first attempts should be one millisecond with subsequent attempts greater than 10 milliseconds to maximize programmability.
5. Verify the bit programmed by lowering the +15V to +4.5V and then enabling the device.
6. In the event the device does not verify , repeat steps 2 – 5. Bits which do not program with a total of 800 msec of programming time are considered unprogrammable and may be returned for replacement. Devices returned must contain word and bit numbers of bits which did not program.
7. Repeat steps 3 through 6 to complete programming the remaining bits in the selected word.
8. Repeat steps 2 through 7 to complete programming the remaing words in the device.

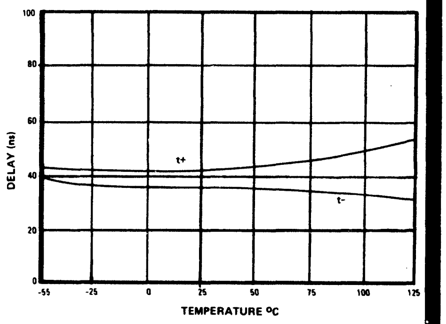
CHARACTERISTIC CURVES



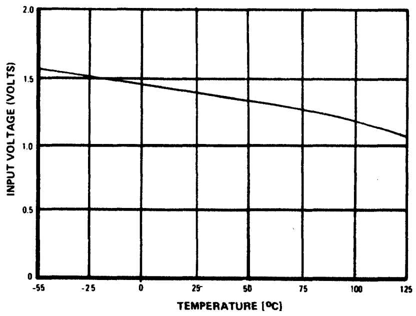
POWER SUPPLY CURRENT vs TEMPERATURE



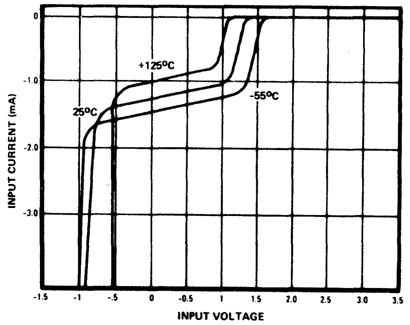
ADDRESS TO OUTPUT PROPAGATION DELAY vs TEMPERATURE



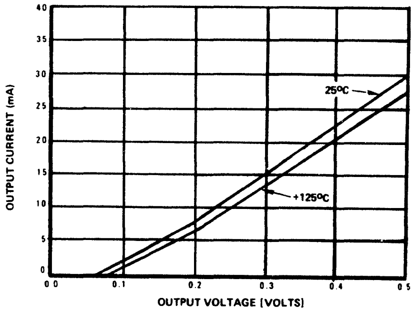
ENABLE TO OUTPUT PROPAGATION DELAY vs TEMPERATURE



INPUT THRESHOLD vs TEMPERATURE

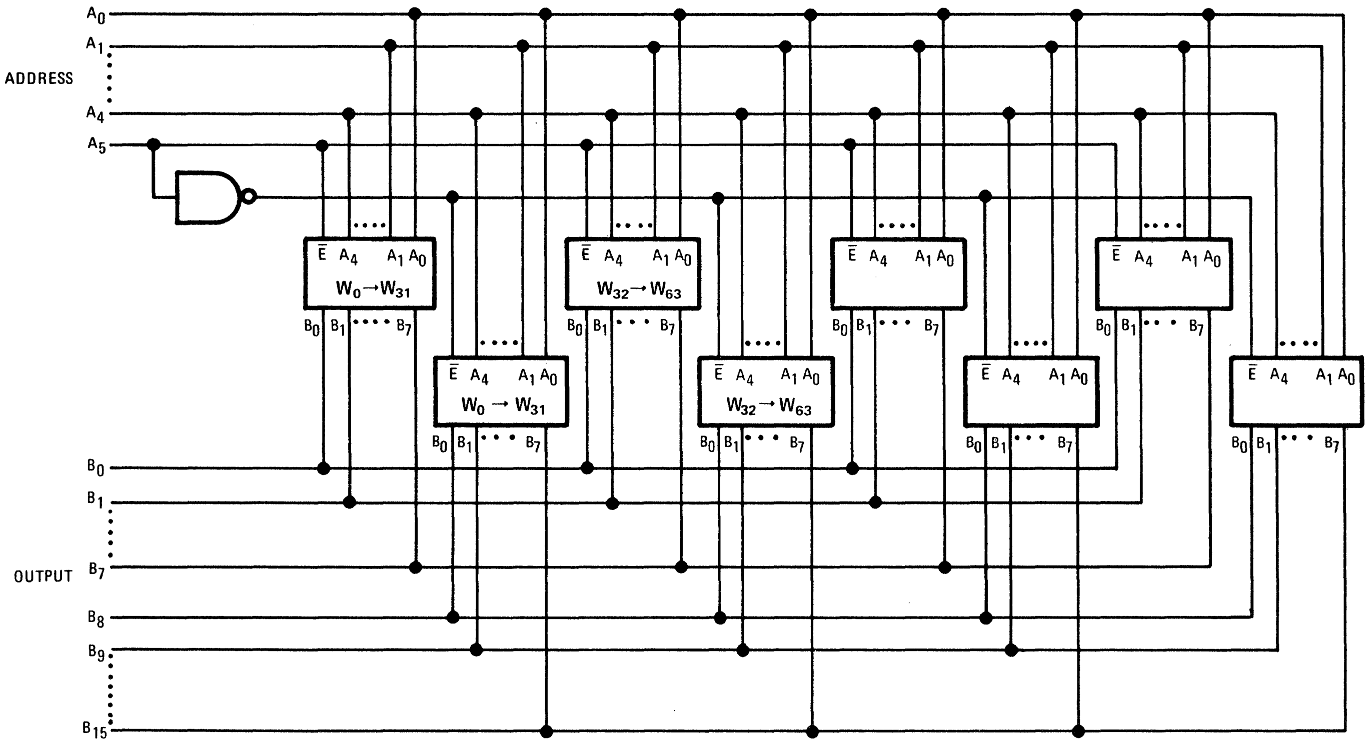


INPUT CURRENT vs INPUT VOLTAGE



OUTPUT LOW V-I CHARACTERISTICS

EXPANDABILITY



DASH 8

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

DASH 8

MIL-STD-883

OFF-THE-SHELF DELIVERY

MIL-STD-883/MIL-M-38510 Reliability Assurance Program

INTRODUCTION

STATEMENT OF SCOPE

This section establishes the detail requirements for Harris' Circuits screened and tested under the DASH 8 Program.

The Harris DASH 8 Devices pass the screening requirements of the latest issue of MIL-STD-883, Method 5004, Class B, and the requirements as specified in this document.

APPLICABLE DOCUMENTS
The following documents form a part of this section to the extent referenced herein:

MIL-M-38510	"Microcircuit Quality and Reliability Assurance, General Specification for."
MIL-Q-9858A	"Quality Program Requirements"
MIL-STD-883	"Test Methods and Procedures for Microelectronics"
NASA Publication 200-3	"Inspection System Provisions"

Harris maintains a product assurance program (PAP) using MIL-M-38510 as a guide. Harris Product Assurance Program assures compliance with the requirements and quality standards of control drawings and the requirements of this specification.

Systems and procedures used are in accordance with NASA Publication 200-3, MIL-Q-9858A and MIL-M-38510.

The DASH 8 Program will also be found useful by those Harris customers who must generate their own procurement specifications. Use of the enclosed Harris Standard Test Tables, Test Parameters, and Burn-In Circuits will aid in reducing specification negotiation time. CMOS is also avalable in DASH 8, for further information on CMOS DASH 8 see our CMOS Catalog or contact your local sales representative.

HARRIS SEMICONDUCTOR DASH 8 FLOW

MIL-STD-883, METHOD 5004, CLASS B,
100% SCREENING PRODEDURE

	SCREEN	METHOD
1	Internal Visual (Precap)	2010 Condition B
2	Stabilization Bake	1008, Condition C, 24 Hours minimum
3	Temperature Cycling	1010, Condition C
4	Constant Acceleration	2001, Condition G Y_1 Plane, 30K G's minimum
5	Seal, Fine Leak	1014, Condition (As applicable)
6	Seal, Gross Leak	1014, Omit Step 1, No vacuum Preconditioning Step 2
7	Initial Electrical	Harris Specifications
8	Burn-In	Method 1015, 168 hours @ 125°C (Burn-In Circuits Enclosed. See page Da-8.)
9	Final Electrical 9.1 D. C. Tests at 25°C Maximum and minimum operating temperatures 9.2 A. C. Tests at 25°C	Per appropriate Harris DASH 8 Data Sheet only those items identified by * are tested 100%.
10	External Visual	Method 2009
11	Lot Acceptance	Group A, Table 1, Subgroup 1, 2, 3 & 4

NOTE:

LOT DEFINITION: Production Lot and Inspection Lot shall be as defined in MIL-M-38510.

TRACEABILITY: All devices are assigned date code identification that provides traceability back to the inspection lot.

BRANDING: All devices are branded with the HX-XXX-8 and EIA data code.

AGED PRODUCT: Product that has been held for more than twelve months will be rescreened prior to shipment.

ADDITIONAL REQUIREMENTS: Attributes data will be supplied on Group A Lot Acceptance upon request.

Generic data from Harris' Reliability Add-On Program is available upon request; The objective of Harris Reliability Add-On Program is to provide a continuous life and environmental monitor for all product families in manufacturing. This program provides life test performance results to fulfill customer reliability data requirements and to verify package integrity. The Reliability Add-On Program is supplemental to customer funded Lot Qualification.

For customers desiring Lot Qualification, Harris Semiconductor will perform the Group A, Group B and Group C test to MIL-STD-883, Method 5005 as defined herein for an additional charge.

HARRIS RELIABILITY ADD-ON PROGRAM

Generic data from Harris' Reliability Add-On Program is available upon request; The objective of Harris Reliability Add-On Program is to provide a continuous life and environmental monitor for all product families in manufacturing. This program provides life test performance results to fulfill customer reliability data requirements and to verify package integrity. The Reliability Add-On Program is supplemental to customer funded Lot Qualification.

The Harris Reliability Add-On Program is an on-going program that provides generic product and package testing data that can be equated to MIL-STD-883 Group B and Group C tests. The data derived from the Add-On Program forms the basis for the Harris Reliability Bulletins published under the cognizance of the Harris Reliability Manager.

The Reliability Add-On Program section that is applicable to the DASH 8 program is listed below.

PRODUCT TYPE	SCHEDULE WITH SAMPLE SIZE	STRESS CONDITIONS	COMMENTS
GENERIC STANDARD	a) 1,000 hours sample of each generic type per quarter. b) Extend to 5,000 hours - 1 sample per quarter. c) Extend to 10,000 hours - 1 sample per half year. d) Sample size - 10 per stress medium for PROMs; 14/36 per stress medium for linears. e) Variables data points at 0, 168, 500, 1000, 2000, 5000, and 10,000 hours.	a) $T_A = +125^oC$ operating life b) $T_A = +175^oC$ storage life	
PACKAGE QUALIFICATION	a) One generic type per quarter per package type. b) Sample size - 50 good and 50 reject devices per package type for package qual;	a) Reference Reliability Standard Operating Procedure (RSOP) -002 and -003	Reason: Verify continued package integrity.
SPECIAL TESTS Al step coverage	a) One generic type, per month as a minimum	SEM Analysis	Reason: To verify aluminum coverage over oxide steps.

DASH 8

MIL-STD-883, METHOD 5005, GROUP B (NOTE 1)

TEST	METHOD	CONDITION	QUALITY CONFORMANCE INSPECTION (NOTE 2)	QUALIFICATION INSPECTION
			CLASS B LTPD	CLASS B LTPD
SUBGROUP 1				
Physical Dimensions	2016		15	10
SUBGROUP 2				
(a) Resistance to solvents	2015		3 devices (no failures)	3 devices (no failures)
(b) Internal Visual and mechanical	2014	Failure criteria from design and construction requirements of applicable procurement document	1 device (no failures)	1 device (no failures)
(c) Bond strength (NOTE 3) Ultrasonic or wedge	2011 (see 3.8)	Test condition C or D	15	10
SUBGROUP 3				
Solderability (NOTE 4)	2003	Soldering temperature of 260 ±10°C.	15	10
SUBGROUP 4				
Lead integrity	2004	Test condition B_2	15	10
Seal (NOTE 5)	1014	As applicable.		
(a) Fine				
(b) Gross				

NOTES:

1. Electrical reject devices from the same inspection lot may be used for all subgroups when end point measurements are not required.
2. Generic data from Harris Reliability Add-On Program available upon request.
3. Unless otherwise specified, at the manufacturers option, test samples for bond strength may be selected randomly immediately following internal visual (method 5004) prior to sealing.
4. The LTPD applies to the number of leads inspected except in no case shall less than three devices be used to provide the number of leads required.
5. Omit step 1 and vacuum preconditioning of step 2.

MIL-STD-883, METHOD 5005, GROUP C

TEST	METHOD	CONDITION	QUALITY CONFORMANCE INSPECTION (NOTE 6)	QUALIFICATION INSPECTION
			CLASS B LTPD	CLASS B LPTD
SUBGROUP 1 (NOTE 1)				
Thermal shock	1011	Test condition B as a minimum.	15	10
Temperature cycling	1010	Test condition C.		
Moisture resistance	1004			
Seal (NOTE 5) (a) Fine (b) Gross	1014	As applicable.		
Visual Examination (NOTE 2)				
End point elec. parameters		As specified in the applicable procurement document.		
SUBGROUP 2 (NOTE 1)				
Mechanical shock	2002	Test condition B	15	10
Vibration, variable frequency	2007	Test condition A		
Constant acceleration	2001	Test condition E		
Seal (NOTE 5) (a) Fine (b) Gross	1014	As applicable.		
Visual Examination (NOTE 3)				
End point elec. parameters		As specified in the applicable procurement document.		
SUBGROUP 3				
High temperature storage (NOTE 4)	1008	150^{+50}_{-25} °C storage, 1000 hours.	7	5
End point elec. parameters		As specified in the applicable procurement document.		
SUBGROUP 4				
Operating life test (NOTE 4)	1005	Test condition to be specified in the applicable procurement document (1000 hours).	5	3
End point elec. parameters		As specified in the applicable procurement document.		

NOTES:
1. Devices used for enviromental tests in subgroup 1 may be used for mechanical tests in subgroup 2.
2. Visual examination shall be in accordance with method 1010 or 1011 at a magnification of 5X to 10X.
3. Visual examination shall be performed at a magnification of 5X to 10X for evidence of defects or damage to case, leads, or seals resulting from testing (not fixturing). Such damage shall constitute a failure.
4. See applicable life test circuit enclosed herein.
5. Omit step 1 and vacuum preconditioning of step 2.
6. Generic data from Harris Reliability Add-On Program available upon request.

BURN-IN/LIFE TEST CIRCUIT INDEX

LINEAR

ANALOG MULTIPLEXERS AND SWITCHES

MULTIPLEXERS

		DRAWING NO.
HI-506	CMOS 16 Channel Analog Multiplexer	21
HI-506A	CMOS 16 Channel Analog Multiplexer	21
HI-507	Dual-8 CMOS Multiplexer	21
HI-507A	Dual-8 CMOS Multiplexer	21
HI-508A	8 Channel Analog Multiplexer	22
HI-509A	Dual 4-Channel Analog Multiplexer	23
HI-1818A	8 Channel Multiplexer	26
HI-1828A	Dual 4-Channel Multiplexer	27

SWITCHES

HI-200	Dual SPST Analog Switch	19
HI-201	Quad SPST Analog Switch	20
HI-1800A	DPDT-Low Leakage 4-Channel Analog Switch	25

OPERATIONAL AMPLIFIERS

F. E. T. INPUT

HA-2000	F. E. T. Input Preamplifier	3
HA-2050	High Slew Rate F. E. T. Input Operational Amplifier	2
HA-2050A	High Slew Rate F. E. T. Input Operational Amplifier	2
HA-2060	Wide Band F. E. T. Input Operational Amplifier	2
HA-2060A	Wide Band F. E. T. Input Operational Amplifier	2

HIGH SLEW RATE

HA-2500	High Slew Rate Operational Amplifier	2, 8
HA-2502	High Slew Rate Operational Amplifier	2, 8
HA-2510	High Slew Rate Operational Amplifier	2, 8
HA-2512	High Slew Rate Operational Amplifier	2, 8
HA-2520	High Slew Rate Operational Amplifier	2,8
HA-2522	High Slew Rate Operational Amplifier	2, 8
HA-2530	Wide Band High Slew Inverting Amplifiers	9

LOW NOISE WIDE BAND

HA-909	Low Noise, Operational Amplifier	1, 2

LOW POWER

HA-2700	Low Power, High Performance Operational Amplifiers	13, 14
HA-2720	Low Power, Current Programmable Operational Amplifiers	15
HA-2730	Low Power, Dual, Current Programmable Operational Amplifiers	16

PRECISION HIGH ZIN WIDE BAND

HA-2600	High Impedance Operational Amplifiers	2, 10
HA-2602	High Impedance Operational Amplifiers	2, 10
HA-2620	Wide Band, High Impedance Operational Amplifiers	2, 10, 11
HA-2622	Wide Band, High Impedance Operational Amplifiers	2, 10, 11
HA-2650	Dual High Performance Operational Amplifiers	2

SPECIAL FUNCTION

HA-2400	PRAM Four Channel Operational Amplifiers	6
HA-2420	Sample and Hold, Gated Operational Amplifiers	7
HA-2630	High Performance Current Booster	12

ULTRA HIGH PRECISION

HA-2900	Chopper Stabilized Operational Amplifiers	18

PHASE LOCKED LOOP

HA-2820	Phase Locked Loop	17

SPECIAL INTERFACE CIRCUITS

HI-1080	8-Bit, D to A Convertor High Speed Monolithic	24

VOLTAGE COMPARATOR

HA-2111	Precision Voltage Comparator	4, 5

MEMORY

BIPOLAR MEMORY

GENERIC PROMS

HM-7610	1024-Bit, Bipolar Generic PROM (open collector)	29
HM-7611	1024-Bit, Bipolar Generic PROM (three state)	29
HM-7620	2048-Bit, Bipolar Generic PROM (open collector)	33
HM-7621	2048-Bit, Bipolar Generic PROM (three state)	33

HPROM

HPROM-0512	512-Bit, Bipolar PROM	30
HPROM-1024	1024-Bit, Bipolar PROM (three state)	32
HPROM-1024A	1024-Bit, Bipolar PROM (open collector)	32
HPROM-8256	256-Bit, Bipolar PROM	31

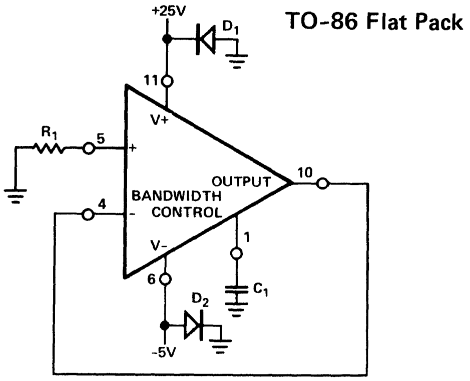
POWER/LOGIC STROBE

HD-6600	Quad Power Strobe	28
HD-6605	Quad Logic Strobe	28

BURN-IN CIRCUITS

1

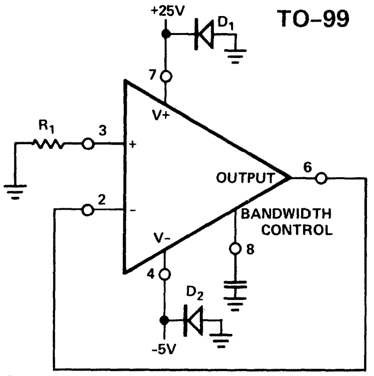
HA-909



NOTES:
T_A = +125°C
R_1 = 1Megohm
C_1 = 0.01 μF, 100V

2

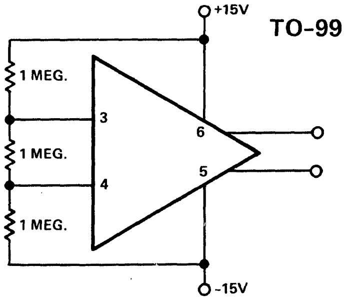
HA-909, HA-2500, HA-2502, HA-2510, HA-2512, HA-2520, HA-2522, HA-2600, HA-2602, HA-2620, HA-2622, HA-2050, HA-2050A, HA-2060, HA-2060A



NOTES:
T_A = +125°C
R_1 = 1Megohm
C_1 = 0.01 μF, 100V

3

HA-2000



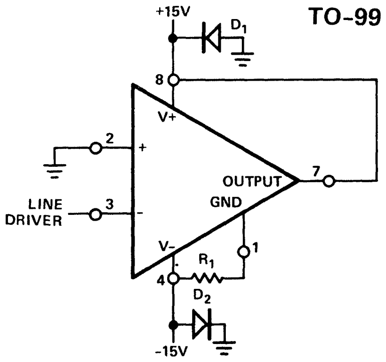
CIRCUIT TYPE:
FET Front End

DESIGNATION:
HA-2000

OPERATING LIFE TEST CONDITION:
1) TEMPERATURE: +125°C
2) VOLTAGE: ±15 Volts

4

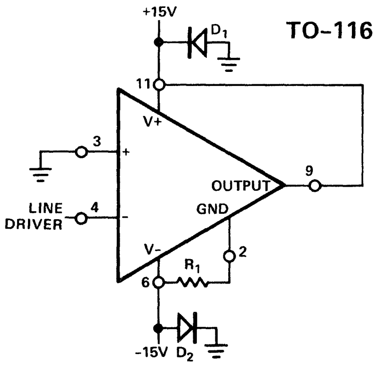
HA-2111



NOTES:
T_A = +125°C
R_1 = 300Ω
$D_{1,2}$ = IN4002
Freq: 50 KHz @ 12V peak to peak

5

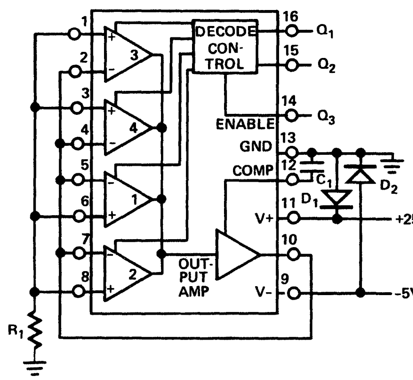
HA-2111



NOTES:
T_A = +125°C
R_1 = 300Ω
$D_{1,2,}$ = IN4002
Freq: = 50KHz @ 12V peak to peak

6

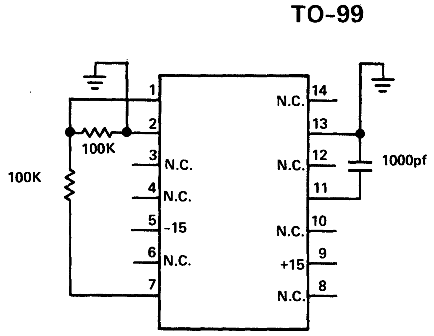
HA-2400



NOTES:
T_A = +125°C
R_1 = 100KΩ
C_1 = 910pF, 50V
$D_{1,2}$ = IN4002
Freq: Q_1 = 100KHz; Q_2 = 50KHz; Q_3 = 25KHz

7

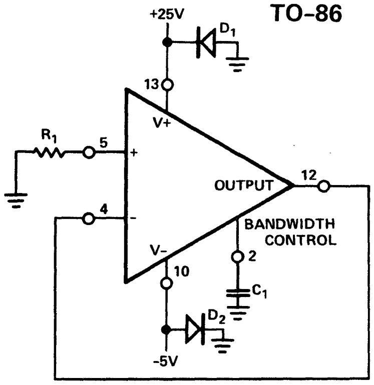
HA-2420



NOTE:
T_A = +125°C

8

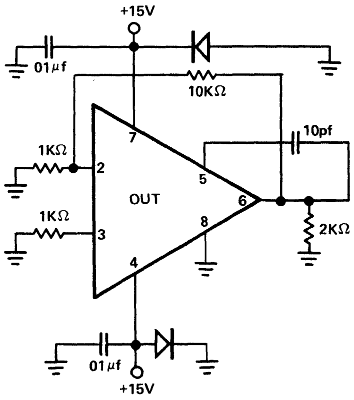
HA-2500, HA-2502, HA-2510, HA-2512, HA-2520, HA-2522



NOTES:
T_A = +125°C
R_1 = 1Megohm
C_1 = 0.01 μF, 50V

9

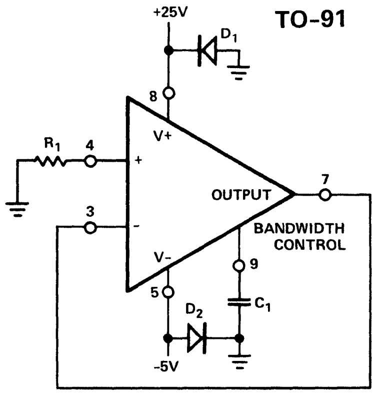
HA-2530



NOTE: T_A = +125°C

10

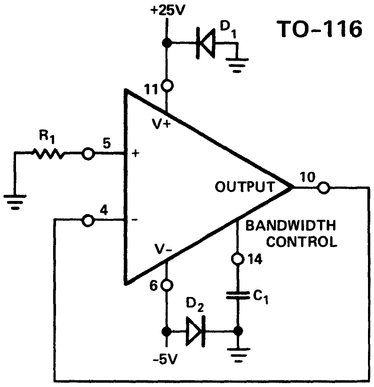
HA-2600, HA-2602, HA-2620, HA-2622



NOTES:
T_A = +125°C
R_1 = 1Megohm
C_1 = 0.01 μF, 100V

11

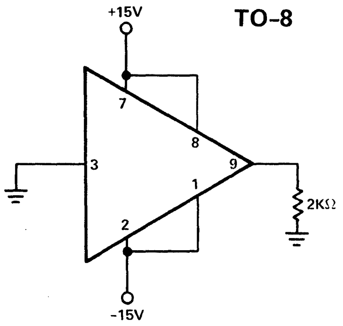
HA-2620/2622



NOTES:
T_A = +125°C
R_1 = 1 Megohm
C_1 = 0.01 μF, 100V

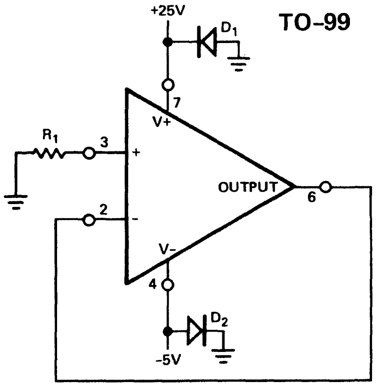
12

HA-2630



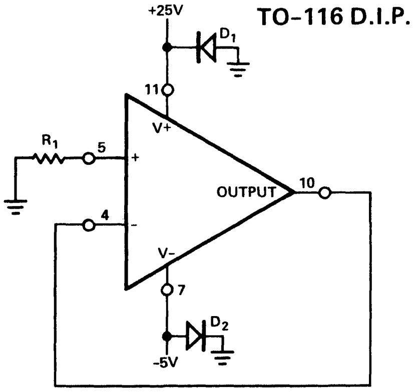
NOTE:
T_A = +125°C

13 HA-2700



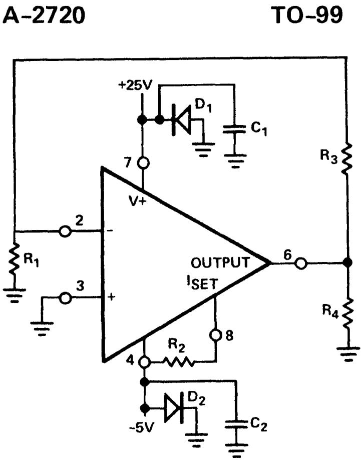
NOTES:
TA = +125oC
R1 = 1 Megohm

14 HA-2700



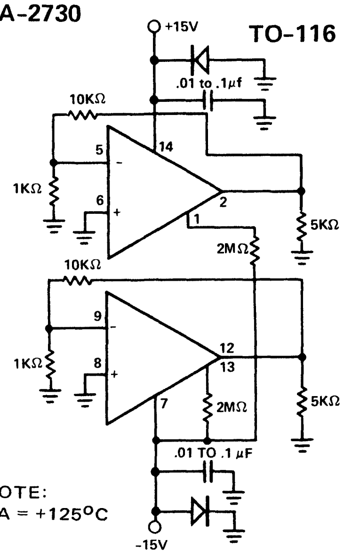
NOTES:
T_A = +125°C
R_1 = 1 Megohm

15 HA-2720



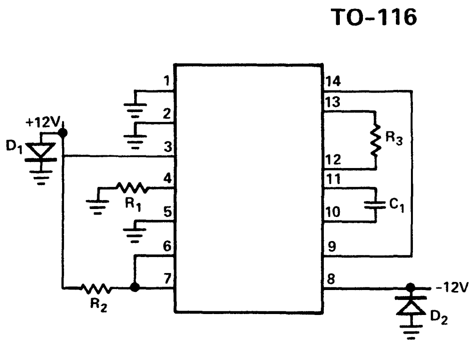
NOTES:
T_A = +125°
C_1C_2 = 0.01 to 0.1 μF
R_1 = 1KΩ
R_2 = 2MΩ
R_3 = 10KΩ
R_4 = 5KΩ

16 HA-2730



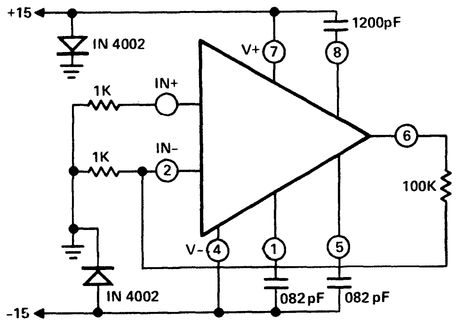
NOTE:
TA = +125°C

17 HA-2820



NOTES:
T_A = +125°C
R_1 = 10KΩ
R_2 = 4.7KΩ
R_3 = 560Ω
C_1 = 01 μF

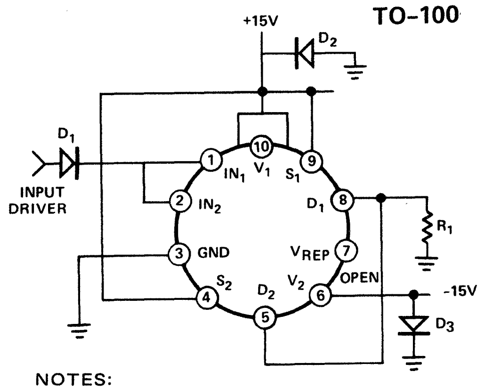
18 HA-2900



NOTE:
T_A = +125°C

19

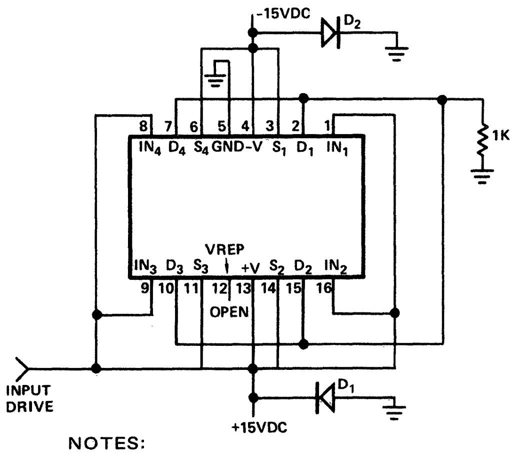
HI-200



NOTES:
$T_A = +125^oC$
$R_1 = 10K\Omega$
$D_1D_2D_3$ = IN4002
Freq: = 100KHz

20

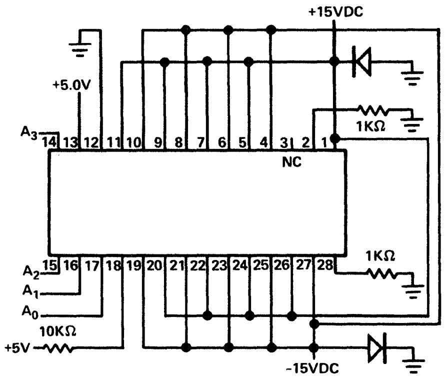
HI-201



NOTES:
$T_A = +125^oC$
D_1D_2 = IN4002
Freq: = 100KHz

21

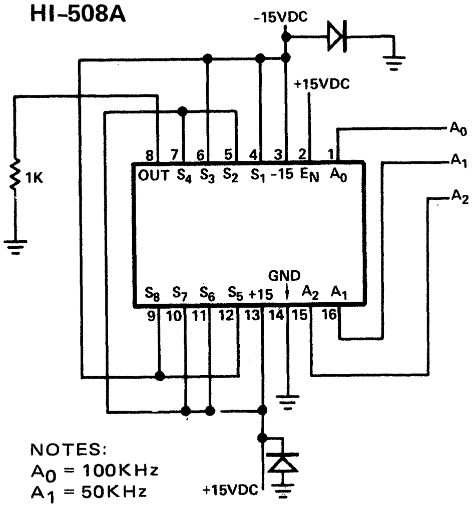
HI-506/507/506A/507A



NOTES:
A_0 = 100KHz
A_1 = 50KHz
A_2 = 25KHz
A_3 = 12.5KHz

22

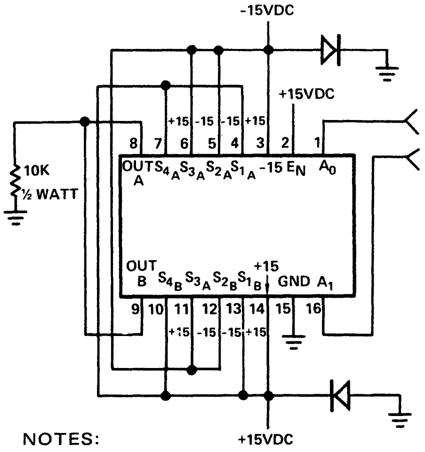
HI-508A



NOTES:
A_0 = 100KHz
A_1 = 50KHz
A_2 = 25KHz
TEMP: $+125^oC$
PACKAGE: 16 PIN DIP

23

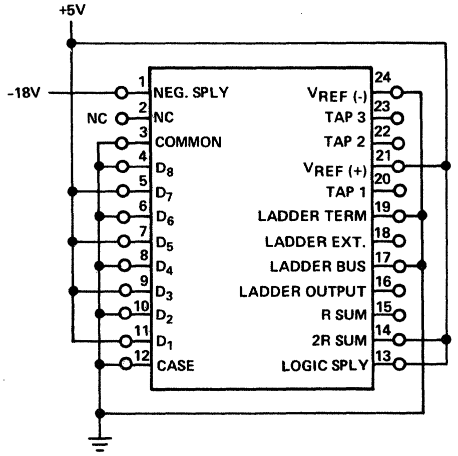
HI-509A



NOTES:
A_0 = 100KHz
A_1 = 50KHz
TEMP: $+125^oC$
PACKAGE: 16 PIN DIP

24

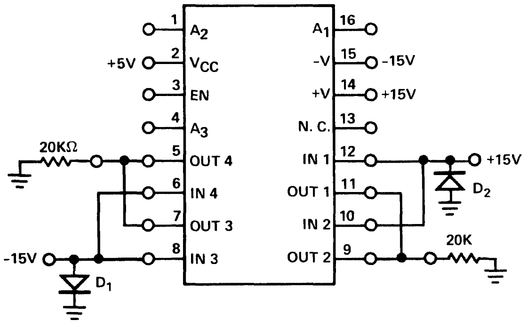
HI-1080



NOTE:
$T_A = +125^oC$

25

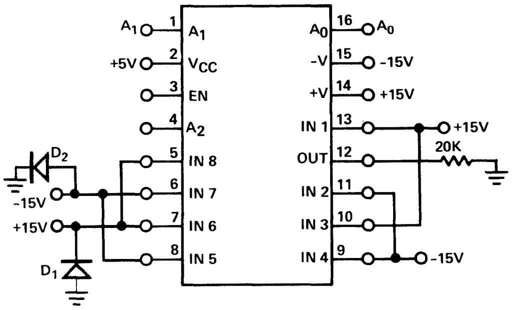
HI-1800A



NOTES:
T_A = +125°C
A_1 = 100KHz
A_2 = 50KHz
A_3 = 25KHz
EN = 12.5KHz

26

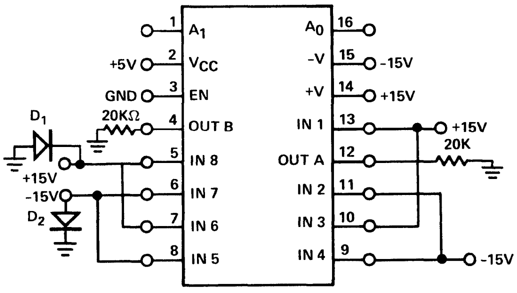
HI-1818A



NOTES:
T_A = +125°C
A_0 = 100KHz
A_1 = 50KHz
A_2 = 25KHz
EN = 12.5KHz

27

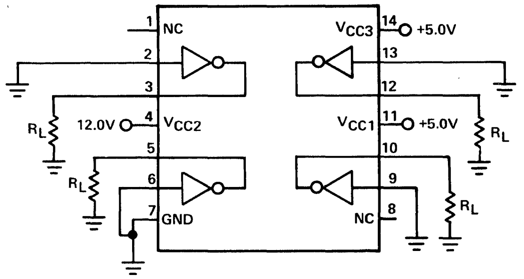
HI-1828A



NOTES:
T_A = +125°C
A_0 = 100KHz
A_1 = 50KHz
EN = 25KHz

28

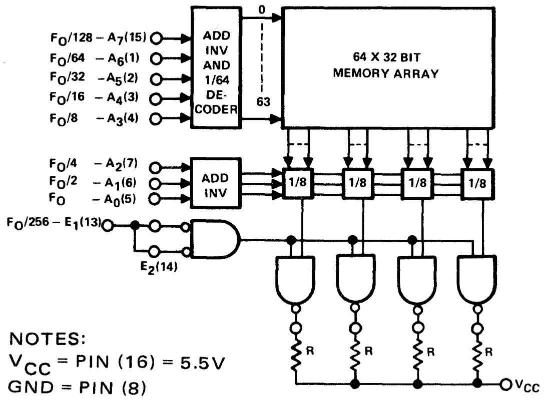
HD-6600/6605



NOTES:
T_A = +125°C
R_L = 39Ω
All V_{CC} = ± 10%

29

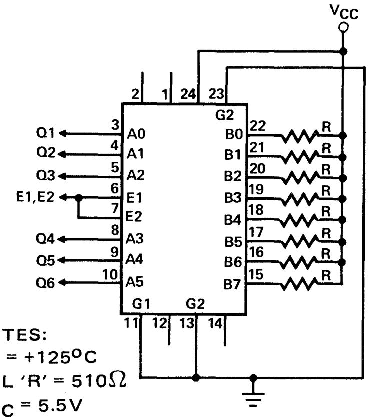
HM-7610/7611



NOTES:
V_{CC} = PIN (16) = 5.5V
GND = PIN (8)
R = 300Ω
F_O = 100KHz Square Wave
T_A = +125°C

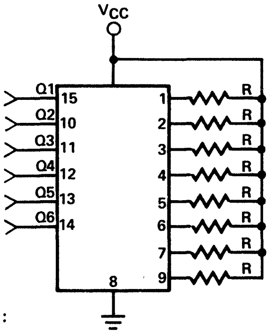
30

HPROM-0512



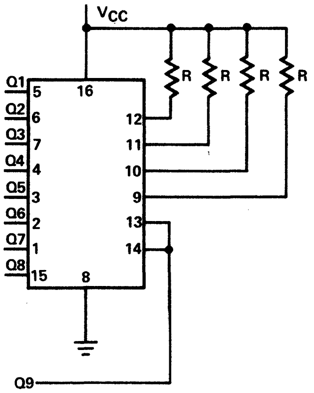
NOTES:
T_A = +125°C
ALL ‘R’ = 510Ω
V_{CC} = 5.5V
FREQ:
Q_1 = 100KHz, Q_2 = 50KHz
Q_3 = 25KHz, Q_4 = 12.5KHz
Q_5 = 6.15KHz, Q_6 = 3.12KHz
E1 = E2 = 1.5625KHz

31 HPROM-8256



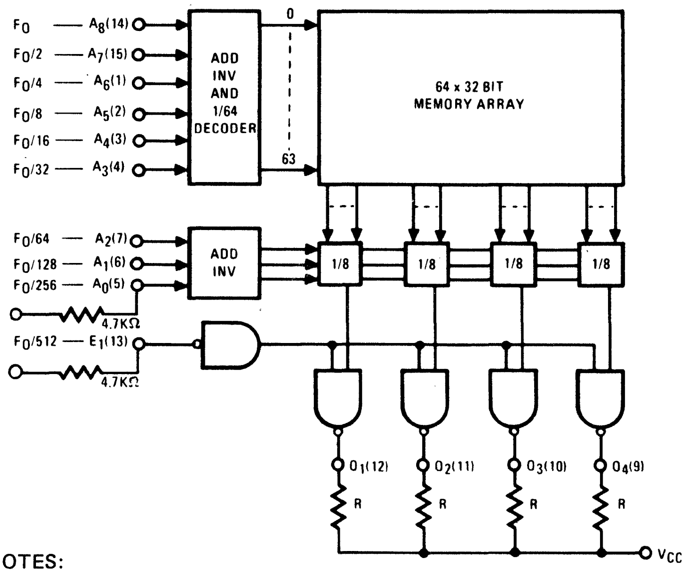
NOTES:
$T_A = +125^oC$
$V_{CC} = 5.5V$
ALL 'R' = 510Ω
FREQ:
Q_1 = 100KHz, Q_2 = 50KHz
Q_3 = 25KHz, Q_4 = 12.5KHz
Q_5 = 6.25KHz, Q_6 = 3.125KHz

32 HPROM-1024/1024A



NOTES:
$T_A = +125^oC$
ALL 'R' = 300Ω
$V_{CC} = 5.5V$
REEQ:
Q_1 = 100KHz, Q_2 = 50KHz
Q_3 = 25KHz, Q_4 = 12.5KHz
Q_5 = 6.15KHz, Q_6 = 3.125KHz
Q_7 = 1.5625KHz, Q_8 = 781.25Hz
Q_9 = 390.625Hz

33 HM-7620/7621



NOTES:
V_{CC} = PIN (16) = 5.0V
GND = PIN (8)
R = 300Ω

F_O = 100kHz SQUARE WAVE

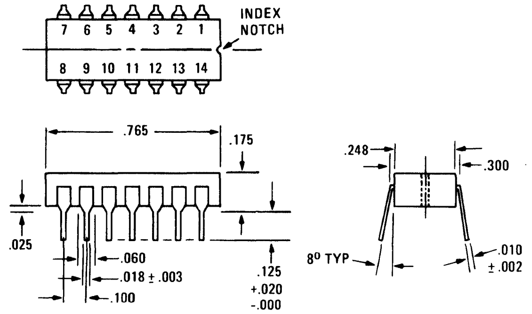
PACKAGING

PACKAGE DIMENSIONS

1. ALL DIMENSIONS IN INCHES.
2. ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

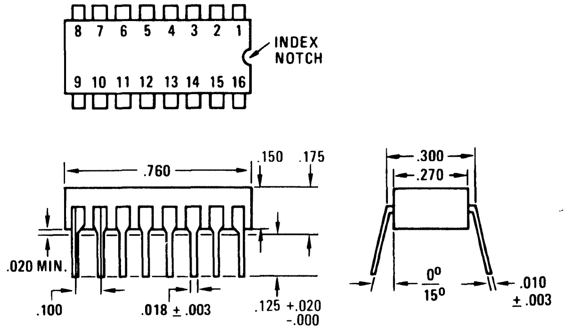
CODES 1A & 1U

TO-116 (14 LEAD CERAMIC D.I.P.)



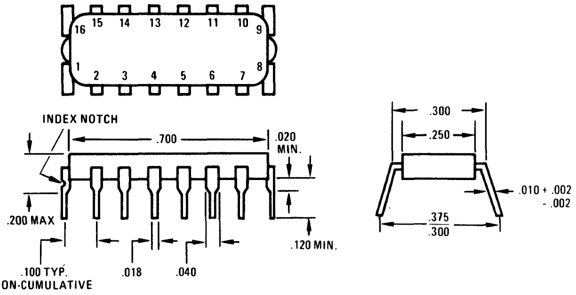
CODES 1B & 1D

16 LEAD CERAMIC D.I.P.



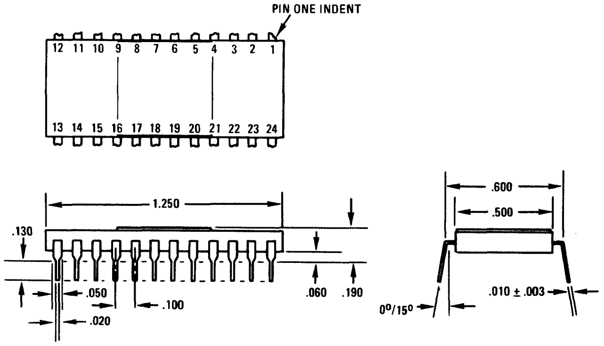
CODE 1F

16 LEAD D.I.P.



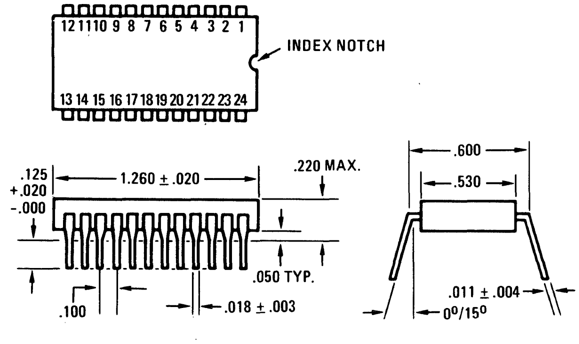
CODE 1H

24 LEAD D.I.P.



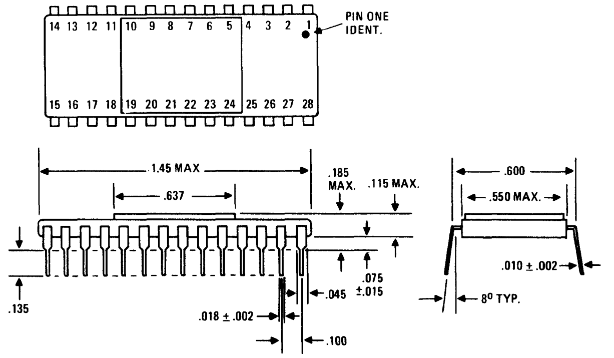
CODE 1J

24 LEAD CERAMIC D.I.P.



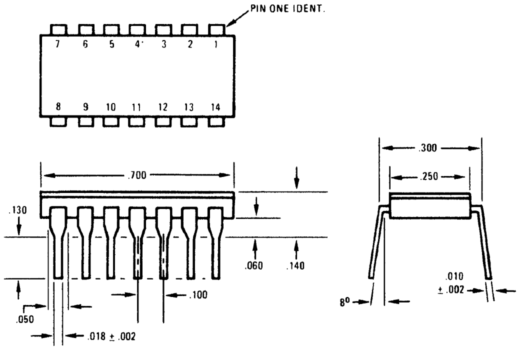
CODE 1L

28 LEAD D.I.P.

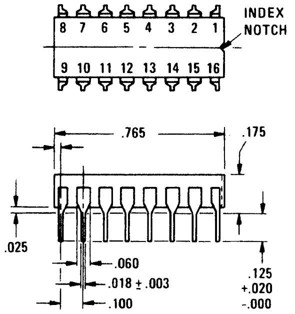


PACKAGE DIMENSIONS

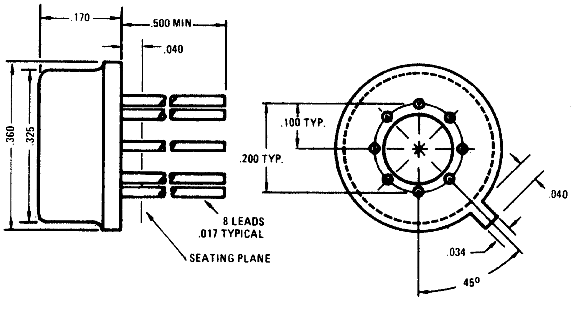
CODE 1S 14 LEAD BRAZED D.I.P.



CODE 1W 16 LEAD CERAMIC D.I.P.

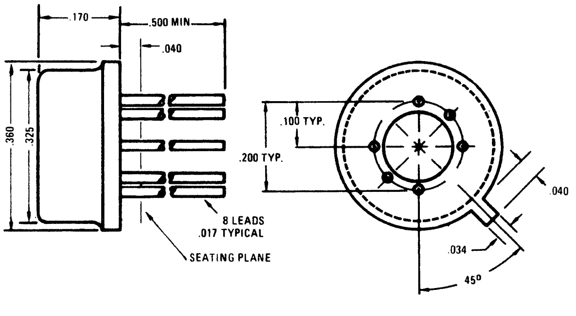


CODE 2A TO-99



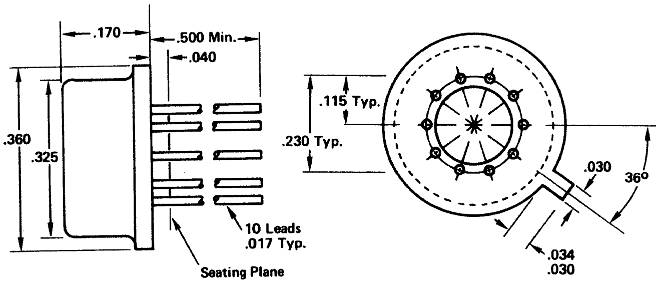
Bottom View

CODE 2B TO-78



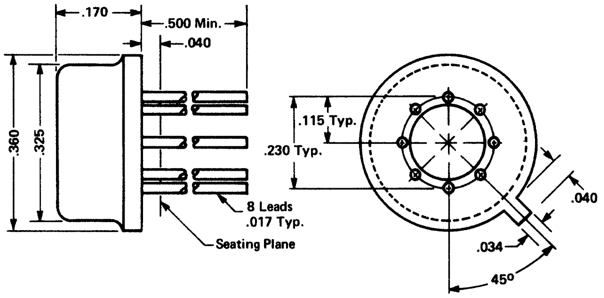
Bottom View

CODE 2D TO-100



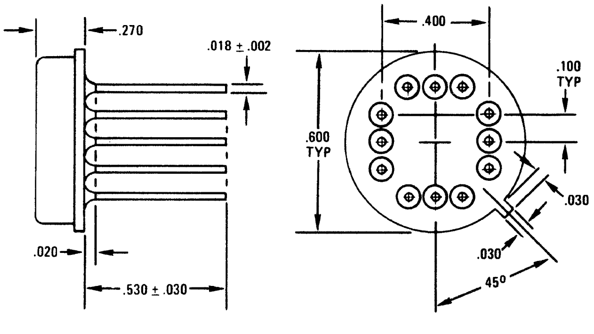
Bottom View

CODE 2E TO-99 (.230 PC)



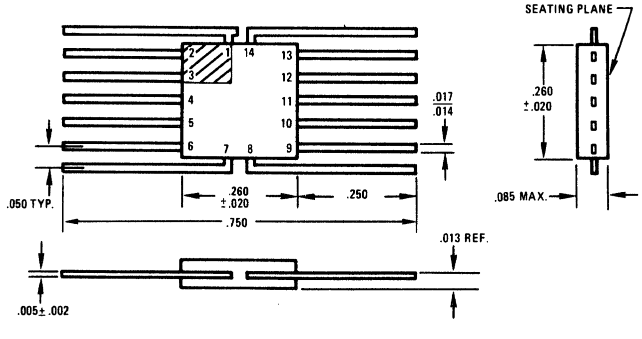
Bottom View

CODE 2G TO-8



Bottom View

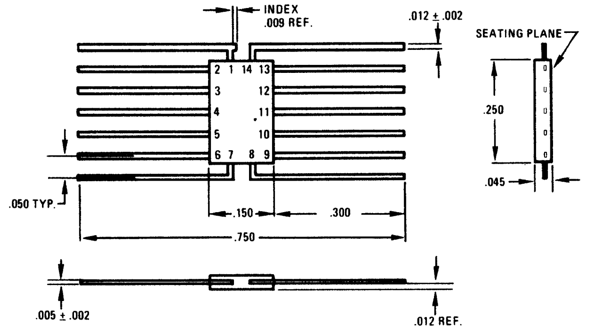
CODE 9H TO-86



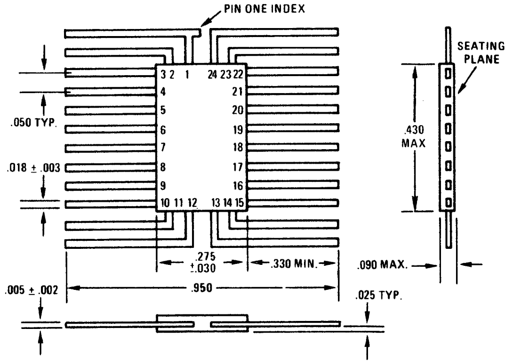
Package bottom – ceramic

PACKAGE DIMENSIONS

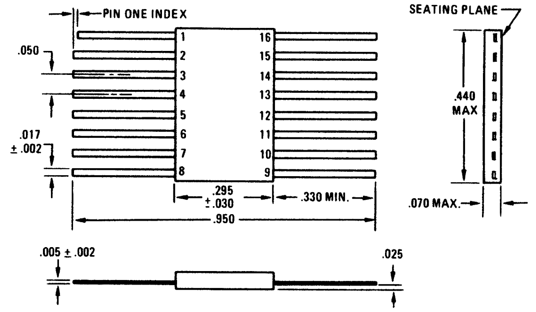
CODE 9J TO-84



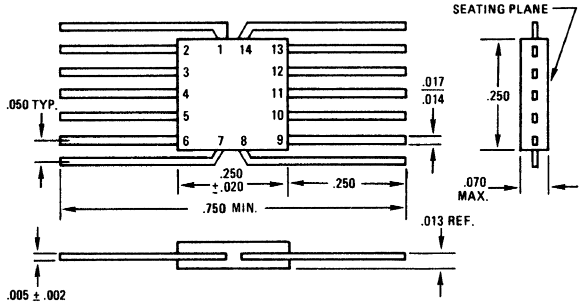
CODE 9M 24 LEAD FLAT PACK



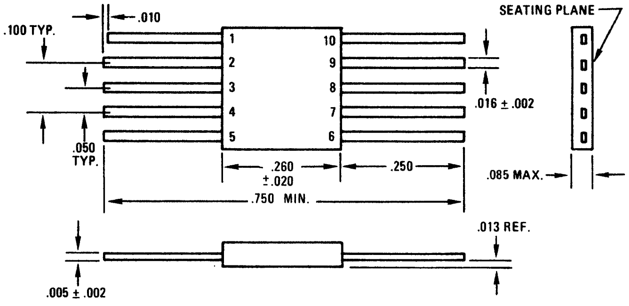
CODE 9S 16 LEAD FLAT PACK



CODE 9V TO-86



CODE 9W TO-91



LITERATURE GUIDE

Harris Product Literature Guide

CATALOGS

CONDENSED FORM (Integrated Circuits Catalog)
CMOS

DATA SHEETS

LINEAR

HA-909/911	Low Noise, Operational Amplifiers (See application notes 501,502)
HA-2000/2005/2000A 2005A	F.E.T. Input Preamplifier
HA-2050/2055/2050A 2055A	High Slew Rate F.E.T. Input Op Amp
HA-2060/2065/2060A 2065A	Wide Band F.E.T. Input Op Amp
HA-2111/2211	Precision Voltage Comparator
HA-2311	Precision Voltage Comparator
HA-2400/2404/2405	PRAM, Four Channel Op Amp (See application note 514)
HA-2420/2425	Sample & Hold, Gated Op Amp (See application note 517)
HA-2500/2502/2505	High Slew Rate Op Amp
HA-2510/2512/2515	High Slew Rate Op Amp
HA-2520/2522/2525	High Slew Rate Op Amp
HA-2530/2535	Wide Band High Slew Inverting Amp (See application note 506)
HA-2600/2602/2605	High Impedance Op Amp
HA-2620/2622/2625	Wide Band, High Impedance Op Amp (See application note 509)
HA-2630/2635	High Performance Current Booster
HA-2640/2645	High Voltage Op Amp
HA-2650/2655	Dual High Performance Op Amp
HA-2700/2704/2705	Low Power, High Performance Op Amp
HA-2720/2725	Low Power, Current Programmable Op Amp
HA-2730/2735	Low Power, Dual, Current Programmable Op Amp
HA-2820/2825	Phase Locked Loop (See application notes 601,602,605)
HA-2900/2904/2905	Chopper Stabilized Op Amp (See application note 518)
HD-0165	Key Board Encoder (See application note 204)
HD-245/545 to 249/549	Line Transmitter Receivers (See application notes 205,207)
HD-1488/1489/1489A	Line Transmitter Receivers (See application note 205)
HI-1080/1085	8 Bit, D to A Convertor High Speed Monolithic (See application notes 511, 512)

MULTIPLEXERS

HI-506A/507A	16 Channel/Differential - 8
HI-508A/509A	8 Channel/Differential - 4
HI-1818A/1828A	8 Channel/Differential - 4

SWITCHES

HI-200	Dual SPST	(70Ω)
HI-201	Quad SPST	(80Ω)
HI-1800A	DPDT-Low Leakage	
HI-5040	SPST	(75Ω)
HI-5041	Dual SPST	(75Ω)
HI-5042	SPDT	(75Ω)
HI-5043	Dual SPDT	(75Ω)
HI-5044	DPST	(75Ω)
HI-5045	Dual DPST	(75Ω)
HI-5046	DPDT	(75Ω)
HI-5046A	DPDT	(30Ω)
HI-5047	4PST	(75Ω)
HI-5047A	4PST	(30Ω)
HI-5048	Dual SPST	(30Ω)
HI-5049	Dual DPST	(30Ω)
HI-5050	SPDT	(30Ω)
HI-5051	Dual SPDT	(30Ω)
HI-1846	DPDT	(30Ω)
HI-1847	4PST	(30Ω)

DIGITAL

DIGITAL DATA SHEETS
(Refer to CMOS REFERENCE GUIDE in Digital Section this Catalog)

BIPOLAR MEMORY

HD-234/534	Hex Interface Inverters
HD-235/535	Hex Interface Inverters
HD-536	Hex Interface Driver
HD-6600	Quad Power Strobe
HD-6605	Quad Logic Strobe
HM-010/030/040/050 074/080/090	MIL-TEMP Range Diode Matrices
HM-0110/0168/0104 0186	Commercial Diode Matrices
HM-7220	4096 X 1 Dynamic N-Channel RAM
HM-7602/7603	32 X 8 Field Programmable Bipolar Generic PROM
HM-7610/7611	256 X 4 Field Programmable Bipolar Generic PROM
HM-7620/7621	512 X 4 Field Programmable Bipolar Generic PROM
HM-7640/7641/7642	1024 X 4 Field Programmable Bipolar Generic PROM
HM-7643/7644	512 X 8 Field Programmable Bipolar Generic PROM
HPROM-8256	256-Bit, Bipolar PROM
HPROM-0512	512-Bit, Bipolar PROM
HPROM-1024/1024A	1024-Bit, Field Programmable Bipolar PROM

MOS MEMORY

HM-7202	1024 X 1 Static N-Channel RAM

APPLICATION NOTES

NOTE 201	
NOTE 202	HPROM-0512 Bipolar PROM
NOTE 203	Programming the HPROM-0512 in an Expanded Configuration
NOTE 204	Designing with the HD-0165 Keyboard Encoder
NOTE 205	High Speed Digital Communications
NOTE 206	Monolithic Diode Matrices
NOTE 207	Receiver/Transmitter Noise Immunity
NOTE 208	Minimizing Gate Oxide Failures Due to Handling
NOTE 209	CMOS: Some Application Guidelines
NOTE 210	Using Junction Isolated CMOS
NOTE 501	HA-909 Operational Amplifiers
NOTE 502	HA-909 Operational Amplifiers Performance Tailoring
NOTE 504	Automatic Phase Margin Testing
NOTE 505	A High Impedance Hysteresis Circuit
NOTE 506	Equivalent Input Noise Measurements on High Gain Monolithic Operational Amplifiers
NOTE 507	A Simple Function Generator Using Operational Amplifiers
NOTE 508	Test Procedures for Operational Amplifiers
NOTE 509	A Simple Comparator Using the HA-2620
NOTE 510	A Simple Square-Trinagle Wave-form Generator
NOTE 511	Digital to Analog Converter Applications
NOTE 512	Counter Type A to D Converter
NOTE 514	The HA-2400 PRAM, 4 Channel Operational Amplifier
NOTE 515	Operational Amplifier Stability: Input Capacitance Considerations
NOTE 516	The HA-2530/2535 Wideband High Slew Inverting Amplifier
NOTE 517	Applications of a Monolithic Sample-and-Hold/Gated Operational Amplifier
NOTE 518	The HA-2900 Monolithic Chopper Stabilized Amplifier
NOTE 519	Operational Amplifier noise prediction
NOTE 520	CMOS Analog Multiplexers and Switches
NOTE 601	Introduction to the Phase Locked Loop
NOTE 602	A General Analysis of the Phase Locked Loop
NOTE 605	The HA-2820/2825 Low Frequency Phase Locked Loops

CHIP SHEETS

Diode Matrices (4 x 10, 10 x 4)

CF-1085	8-Bit D to A Converter Monolithic Chip
CF-1800A	4 Channel CMOS Analog Switch Monolthic Chip
CF-1818A	8 Channel CMOS Analog Multiplexer Monolithic Chip
CF-1828A	8 Channel CMOS Analog Multiplexer Monolithic Chip
CF-2005	F.E.T. Input Preamplifier Monolithic Chip
CF-2311	Precision Voltage Comparator
CF-2405	PRAM ™ 4 Channel Programmable Amplifier Monolithic Chip
CF-2425	Sample & Hold Gated Operational Amplifier Monolithic Chip
CF-2505	High Slew Rate Operational Amplifier Monolithic Chip
CF-2515	High Slew Rate Operational Amplifier Monolithic Chip
CF-2525	High Slew Rate Operational Amplifier Monolithic Chip
CF-2535	High Slew Rate, Wide Band Inverting Amplifier Monolithic Chip
CF-2605	High Input Impedance Operational Amplifier Monolithic Chip
CF-2625	Wide Band Operational Amplifier Monolithic Chip
CF-2635	Current Booster
CF-911	Low Noise, Operational Amplifier
CF-2645	High Voltage Operational Amplifier
CF-2655	Dual High Performance Operational Amplifier
CF-2705	Low Power, High Performance Operational Amplifier Monolithic Chip
CF-2725	Low Power, Current Programmable Operational Amplifier
CF-2735	Low Power, Dual Current Programmable Operational Amplifier
CF-2825	Phase Locked Loop Monolithic Chip
CF-2905	Chopper Stablized Operational Amplifier Monolithic Chip
CF-200	Dual SPST CMOS Analog Switch
CF-201	Quad SPST CMOS Analog Switch
CF-506A	16 Channel Analog Multiplexer with Over Voltage Protection Monolithic Chip
CF-507A	Differential 8 Channel Analog Multiplexer with Over Voltage Protection Monolithic Chip
CF-508A	8 Channel Analog Multiplexer with Over Voltage Protection
CF-509A	Differential 4 Channel Analog Multiplexer with Over Voltage Protection
CF-5040 to CF-5051	CMOS Analog Switches
CF-1846	
CF-1847	

SPECIAL LITERATURE

RELIABILITY REPORTS

Issue 3	Low Power Monolithic Op Amp
Issue 6	HA-2500 High Slew Rate Monolithic Op Amp
Issue 7	Complementary MOS Process
Issue 8	Field Programmable Read-Only Memory Devices HPROM-0512, HPROM-1024, HPROM-8256

MEMORY PRODUCTS TECHNICAL DATA BOOKLET
OEM PRICE SCHEDULE
NEW LINEAR PRODUCTS BOOKLET
OPERATIONAL AMPLIFIERS GUIDE
TECH BRIEF HM-7620/7621
TECH BRIEF 4096 BIT RAM
TECH BRIEF HM-7220

Sales

SALES OFFICES –

SUITE 103
4014 LONG BEACH BLVD.
LONG BEACH, CALIF. 90807
(213) 426-7687

SUITE 230
1032 ELWELL COURT
PALO ALTO, CALIF. 94303
(415) 964-6443

SUITE 100
15 SPINNING WHEEL ROAD
HINSDALE, ILL. 60521
(312) 325-4242

SUITE 301
177 WORCHESTER STREET
WELLESLEY HILLS, MASS. 02181
(617) 237-5430

SUITE 132
7710 COMPUTER AVENUE
MINNEAPOLIS, MINN. 55435
(612) 835-2505

3215 E. MAIN STREET
ENDWELL, N. Y. 13760
(607) 754-5464

535 BROADHOLLOW ROAD
MELVILLE, L. I., N. Y. 11746
(516) 249-4500

SUITE 220
333 WEST FIRST STREET
DAYTON, OHIO 45402
(513) 226-0636

SUITE 325
650 E. SWEDESFORD ROAD
WAYNE, PENN. 19087
(215) 687-6680

SUITE 7G
777 S. CENTRAL EXPRESSWAY
RICHARDSON, TEXAS 75080
(214) 231-9031

P. O. BOX 883
MELBOURNE, FL. 32901
(305) 724-7430
TWX-510-959-6259

NATIONAL REPRESENTATIVES –

ADDEM GROUP
37 PIONEER BLVD.
HUNTINGTON STA.
N. Y. 11746
(516) 567-5900
121 CRAWFORD RD.
MIDDLETOWN, N. J. 07740

BEACON NORTH, INC.
7115 LEESBURG PIKE
FALLS CHURCH, VA. 22043
(703) 534-1673
8513 LUCERNE RD.
RANDALLSTOWN, MD. 21133
(301) 922-1248
309 BEDFORD SPRINGS RD.
LYNCHBURG, VA.
(804) 237-4740

CHECKMATE SALES, INC.
6911 SOUTH YOSEMITE
SUITE 205
ENGLEWOOD, CO. 80110
(303) 771-4920

CONLEY & ASSOC.
W. BROADWAY
P. O. BOX 668
OVIEDO, FL. 32765
(305) 365-3283
P. O. BOX 700
BOCA RATON, FL. 33432
(305) 395-6108
2821 KIMBERLY LANE
TAMPA, FL.33618
(813) 933-3183

HADDEN ASSOC., INC.
7138 CONVOY COURT
SAN DIEGO, CA. 92111
(714) 565-9444

KW ELECTRONIC SALES, INC.
8415 N. MAIN STREET
DAYTON, OHIO 45415
3439 W. BRAINARD RD.
CLEVELAND, OHIO 44122
(216) 231-8292
4025 WILLIAM FLYNN HWY.
ALLISON PARK, PA. 15101

MONTIERIO ASSOC.
600 LEWIS RD.
KING OF PRUSSIA,
PENN. 19406
(215) 265-0634

R. W. MITSCHER CO.
P. O. BOX 10541
RALEIGH, N. C. 27316
(919) 828-0575
RT. 5, SINGLETON RD.
SHELBYVILLE, TN. 37160
(615) 684-2223
(615) 684-4544

RT. 3, BOX 362
TROUTVILLE, VA. 24175
(703) 345-3283
3100 BASIN COURT
VIRGINIA BEACH, VA. 23451

N. R. SCHULTZ CO.
P. O. BOX 159
BELLVUE, WA. 98009
(206) 454-0300
4175 SW CEDARHILL BLVD.
BEAVERTON, OR. 97005
(503) 643-1644

REAGAN/COMPAR ALBANY, INC.
6 HIGHLAND AVE.
ALBANY, N. Y. 12205
(518) 489-7408/4777

T. R. I.
801 CLAIRBORNE
OLATHE, KS. 66061
(913) 782-1177
TRADE CENTER BLDG.
300 BROOKES DR.
SUITE 108
HAZELWOOD, MO. 63042
(314) 731-5200

Q. T. WILES & ASSOC.
10427 NORTH SCOTTSDALE RD.
SCOTTSDALE, ARIZ. 85253
(602) 948-5590

CANADA

MUNRO ELECTRONIC COMPONENTS, INC.
2684 SLOUGH ST.
MISSISSAUGA, ONTARIO, CANADA
(416) 676-1042

INTERNATIONAL REPRESENTATIVES –

EUROPEAN HEADQUARTERS

HARRIS SEMICONDUCTOR INC.
53 BD. DE WATERLOO
B-1000 BRUSSELS
BELGIUM
TEL (02) 428 36 02
TX 26382

FAR EAST HEADQUARTERS

HARRIS SEMICONDUCTOR INC.
TIME-LIFE BUILDING
2-3-6 OTEMACHI
CHIYODAKU, TOKYO, JAPAN
279-1691

JAPAN

MITSUBISHI CORP.
6-3, MARUNOUCHI 2-CHOME,
CHIYODA-KU
TOKYO. 100-91
(03) 210-3023

HAKUTO CO., LTD.
FOREIGN DIVISION
C. P. O. BOX 25
TOKYO, 100-91
(03) 503-3711

AUSTRALIA

CEMA (DISTRIBUTORS) PTY. LTD.
21 CHANDOS ST.
CROWS NEST, N. S. W. 2065
439-4655

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION