3N98, 3N99

Silicon Insulated-Gate Field-Effect Transistors

N-CHANNEL "MOS"[a] DEPLETION TYPE

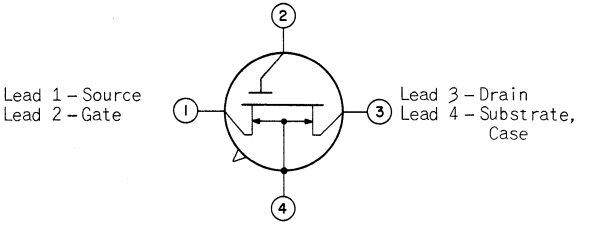
HIGH-INPUT RESISTANCE (10^{15} ohms)

4-LEAD "TO-18" TYPE CASE

For Low-Power Service at Frequencies Up to 60 Mc— Especially Useful in Applications Requiring High-Input Impedance

Mechanical:

Dimensions. . . . . .See accompanying *Dimensional Outline*
Terminal Diagram: BOTTOM VIEW



Maximum Ratings, *Absolute-Maximum Values:*

Drain-to-Source Voltage.	V_{DS}	32	volts
DC Gate-to-Source Voltage. . . .	V_{GS}	-6 to 2	volts
Peak Gate-to-Source Voltage. . .	v_{GS}	±15	volts
DC Gate-to-Substrate Voltage . .	V_{GB}	-1 to 2	volts
Peak Gate-to-Substrate Voltage .	v_{GB}	±15	volts
Drain-to-Substrate Voltage . . .	V_{DB}	-0.3 to 32	volts
Drain Current.	I_D	15	ma
Transistor Dissipation . . . . . At free-air temperatures up to 85° C	P_T	150	mw
Free-Air Temperature Range:			
Operating.	T_{opr}	-65 to 85	°C
Storage.	T_{stg}	-65 to 125	°C
Lead-Soldering Temperature[b]. . . (For 10 sec. max.)	T_L	230	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, electrode-voltage and electrode-current values for given test conditions are dc, circuit is common-source, and substrate is connected to source. Free-air temperature = 25° C.

		3N98	3N99		
Gate-to-Source Cutoff Voltage. V_{DS} = 12 volts, I_D = 50 μa	$V_{GS}(OFF)$	6	6	max.	volts
Gate Leakage Current	I_{GSS}	0.1	0.1	typ.	pa
V_{DS} = 0, V_{GS} = −6 to 2 volts	I_{GSS}	50	50	max.	pa
Drain-to-Source OFF Current. . V_{DS} = 6, V_{GS} = −9 volts	$I_{DS}(OFF)$	50	50	typ.	pa
Drain Current.	I_D	3.5	5	min.	ma
V_{DS} = 12 volts, V_{GS} = 0	I_D	5.5	7.5	typ.	ma
	I_D	7.7	10.5	max.	ma
Drain-to-Source ON Resistance. V_{DS} = 6 volts, V_{GS} = 9 volts	$r_{DS}(ON)$	900	800	typ.	ohms
Forward Transconductance . . .	g_{fs}	1000	1000	min.	μmhos
f = 1 kc, V_{DS} = 12 volts,	g_{fs}	1500	2000	typ.	μmhos
V_{GS} = 0	g_{fs}	3000	4000	max.	μmhos
Forward Transadmittance. . . . f = 60 Mc, V_{DS} = 12 volts, V_{GS} = 0	Y_{fs}	1000	1000	min.	μmhos
Input Conductance. . . . . f = 60 Mc, V_{DS} = 12 volts, V_{GS} = 0	g_{is}	80	80	typ.	μmhos
Output Conductance . . . . . f = 60 Mc, V_{DS} = 12 volts, V_{GS} = 0	g_{os}	200	200	typ.	μmhos
Small-Signal, Short Circuit, Reverse Transfer Capacitance f = 1 kc, V_{DS} = 12 volts, V_{GS} = 0	C_{rss}	0.5[c]	0.5[c]	max.	pf
Small-Signal, Short-Circuit, Input Capacitance. . . . . f = 1 kc, V_{DS} = 12 volts, V_{GS} = 0	C_{iss}	7[c]	7[c]	max.	pf
Spot Noise Figure. . . . . R_g[d] = 1 Megohm, f = 1 kc, V_{DS} = 12 volts, V_{GS} = 0	NF	7	7	typ.	db

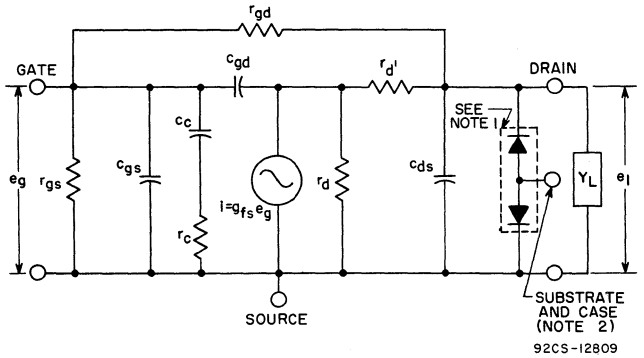
[a] Metal Oxide Semiconductor.

[b] Measured along lead at distances equal to or greater than 1/32" from seating surface.

[c] Maximum values shown for C_{rss} and C_{iss} are for devices with 5/16-inch leads.

[d] Generator resistance.

EQUIVALENT CIRCUIT FOR TYPES 3N98 AND 3N99 OVER THEIR USEFUL FREQUENCY RANGE (0 TO 60 Mc)



Note 1: The shunt effect of these back-to-back substrate diodes is included in the Output Conductance, g_{os}, and Drain-to-Source (output) Capacitance, c_{ds}.

Note 2: The gate effect of the substrate is included in the Forward Transconductance, g_{fs}.

SYMBOL	CHARACTERISTIC	TYPICAL VALUE 3N98	TYPICAL VALUE 3N99	UNIT
c_c	Intrinsic channel capacitance	4	4	pf
c_{ds}	Drain-to-source capacitance (includes approx. 1-pf drain-to-case and interlead capacitance)	2	2	pf
c_{gd}	Gate-to-drain capacitance (includes 0.1-pf interlead capacitance)	0.3	0.3	pf
c_{gs}	Gate-to-source interlead and case capacitance	0.9	0.9	pf
g_{fs}	Forward Transconductance	1500	2000	μmhos
g_{os}	Output conductance	200	200	μmhos
r_c	Effective gate series resistance	100	100	ohms
r_d	Active channel resistance	See *Typical Drain-to-Source-Resistance Characteristic*		
$r_{d'}$	Unmodulated channel resistance	300	300	ohms
r_{gd}	Gate-to-drain leakage resistance	2×10^{16}	2×10^{16}	ohms
r_{gs}	Gate-to-source leakage resistance	1×10^{15}	1×10^{15}	ohms

Relationships useful in the design of circuits using RCA-3N98 and 3N99 insulated-gate, field-effect transistors:

(1) Voltage Amplification, $A = Y_{fs}/Y_{os} + Y_L$
where Y_{fs} = forward transadmittance $\approx g_{fs}$
Y_{os} = output admittance = $g_{os} + jB_{os}$
Y_L = load admittance = $gL + jB_L$
$B_{os} = \omega c_{ds}$

(2) Effective input capacitance, $C_{in} = C_{iss} + c_{gd}$ (A+1)
where C_{iss} small-signal, short-circuit input capacitance

(3) Power output, $P_o = \frac{(I_d max - I_d min)(V_d max - V_d min)}{8}$

HANDLING AND OPERATING CONSIDERATIONS

RCA-3N98 and 3N99 insulated-gate, field-effect transistors have extremely high input resistance (10^{15} ohms), and consequently can accumulate substantial electrostatic charges if their gate electrodes are allowed to "float" during handling, testing, and other operations. It is particularly important to note that detrimentally high electrostatic voltages can be generated by inserting the leads of these devices in plastic "foam" or "snow" materials of the types frequently used for storage and shipment of small electronic devices — particularly in polystyrene "foam" or "snow".

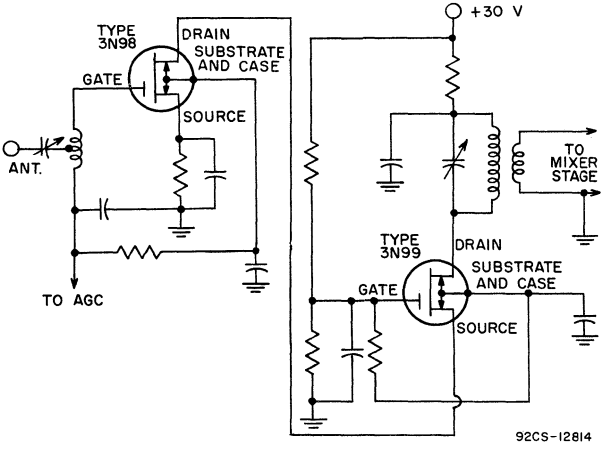
Consequently, adequate precautions should be taken to assure that no maximum voltage rating for these devices is ever exceeded during handling or testing, as well as during operation.

It is recommended that the substrate and case (Lead No.4) be operated at the same or approximately the same dc potential as the gate electrode (Lead No.2). Although the substrate may be used as the signal-input electrode, the 3N98 and 3N99 are not controlled for this method of operation.

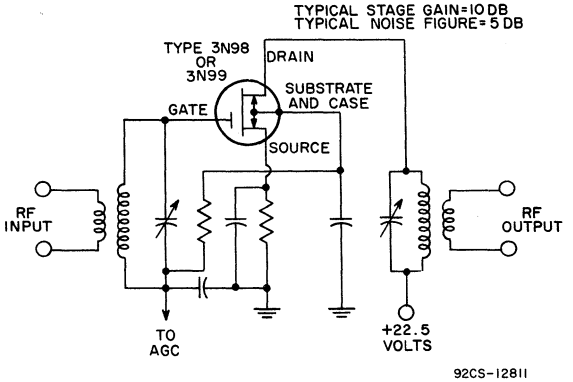
RCA 3N98 and 3N99 should never be inserted in or removed from circuits with the power on because transient voltages may permanently damage the devices.

For rf-amplifier applications, RCA 3N98 and 3N99 may be used in "cascode"-type circuits to minimize the effects of device feedback capacitance (see accompanying circuit). A cascode-type circuit arrangement may also be used for frequency conversion (with the oscillator signal injected at the gate of the driven unit), and as a self-oscillating mixer.

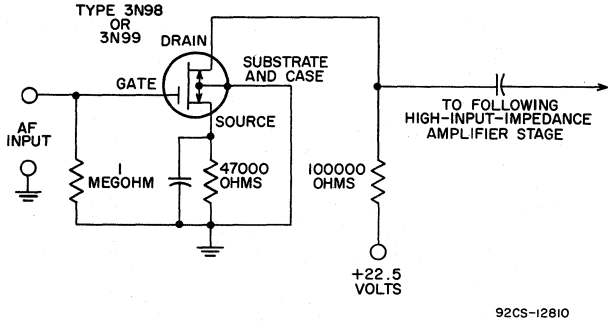
"CASCODE"-TYPE RF AMPLIFIER-STAGE CIRCUIT
3N98 AND 3N99



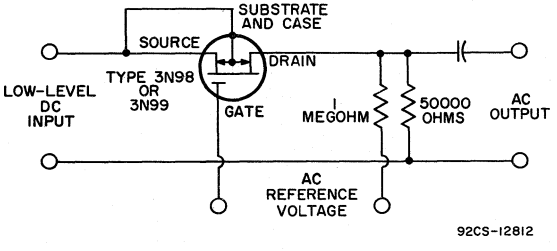
TYPICAL 60-Mc AMPLIFIER-STAGE CIRCUIT
3N98 OR 3N99



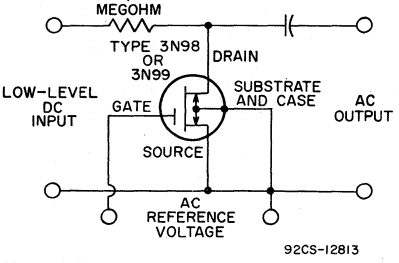
TYPICAL AF AMPLIFIER-STAGE CIRCUIT
3N98 OR 3N99



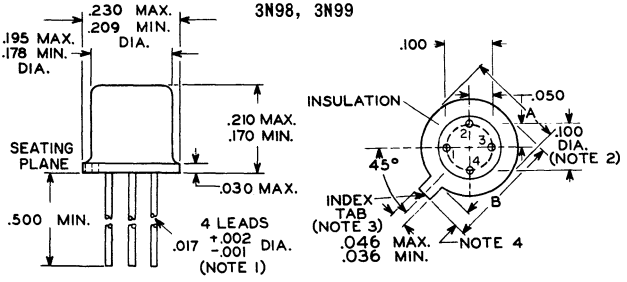
TYPICAL SERIES CHOPPER CIRCUIT
3N98 OR 3N99



TYPICAL SHUNT CHOPPER CIRCUIT
3N98 OR 3N99



DIMENSIONAL OUTLINE
3N98, 3N99



DIMENSIONS IN INCHES

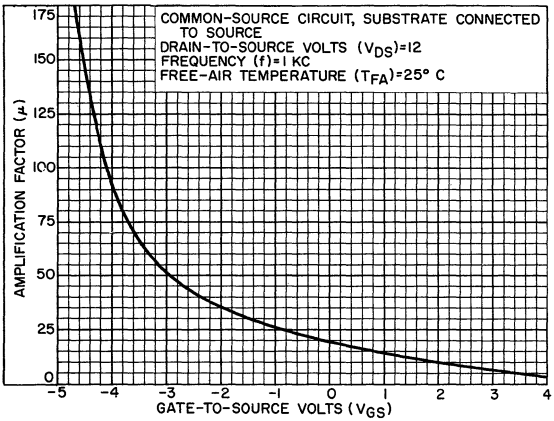
Note 1: The specified lead diameter applies in the zone between 0.050" and 0.250" from the seating plane. From 0.250" to the end of the lead, a maximum diameter of 0.021" is held. Outside of these zones, the lead diameter is not controlled.

Note 2: Maximum diameter leads at a gauging plane 0.054" + 0.001" - 0.000" below seating plane to be within 0.007" of their true location relative to max. width tab and to the maximum 0.230" diameter measured with a suitable gauge. If gauge is not used, measurement is made at seating plane.

Note 3: For visual orientation only.

Note 4: Tab length 0.280" minimum — 0.048" maximum and is determined by subtracting diameter A from dimension B.

Typical Amplification-Factor (μ) Characteristic
3N98



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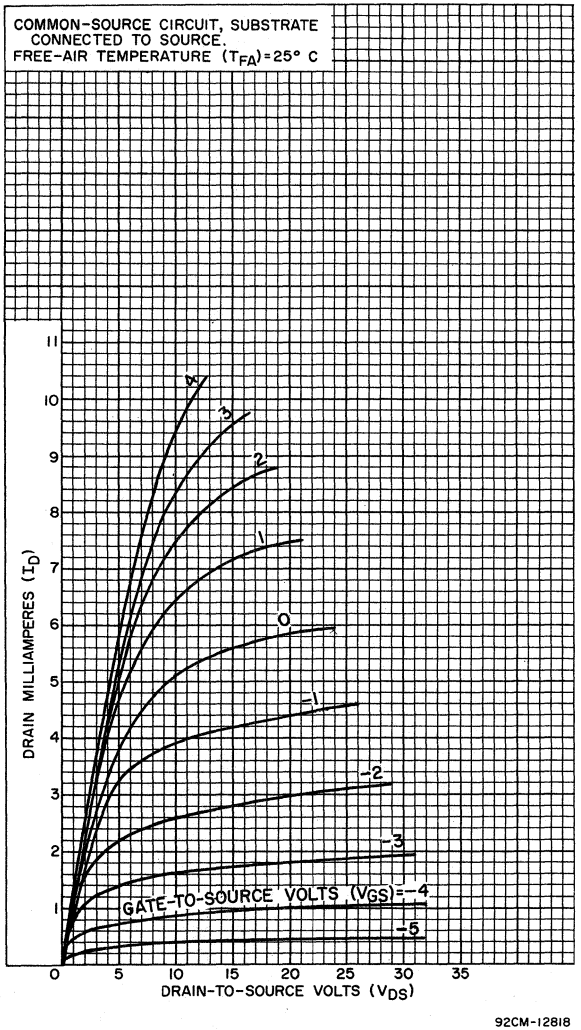
Typical Drain Characteristics

3N98



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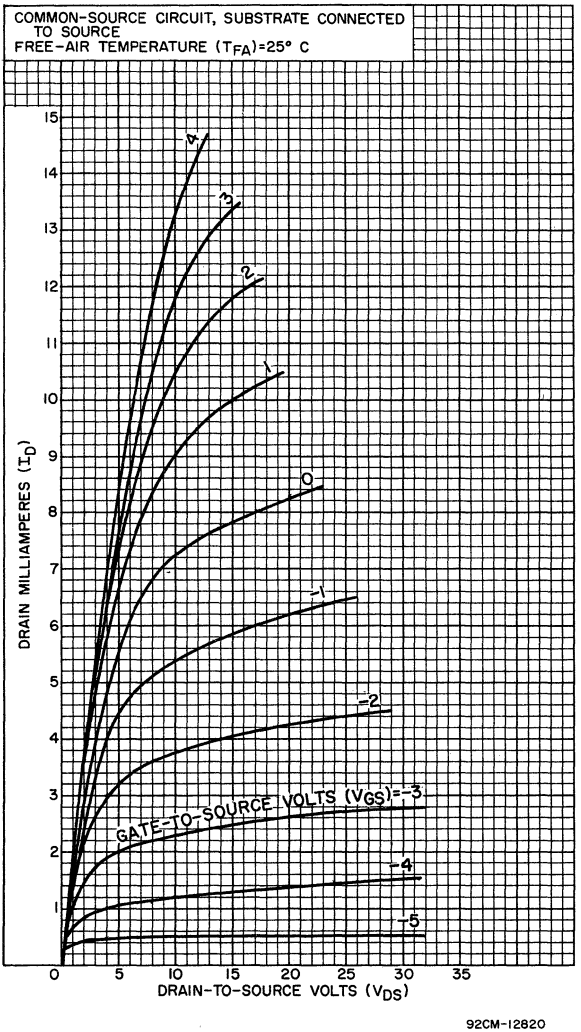
Typical Drain Characteristics

3N99



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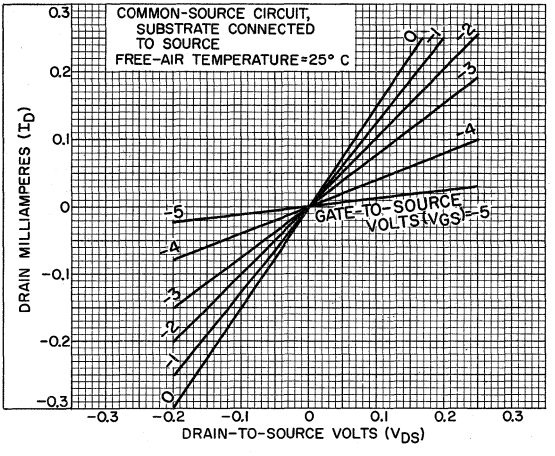
Typical Low-Level Bidirectional Output Characteristics

3N98



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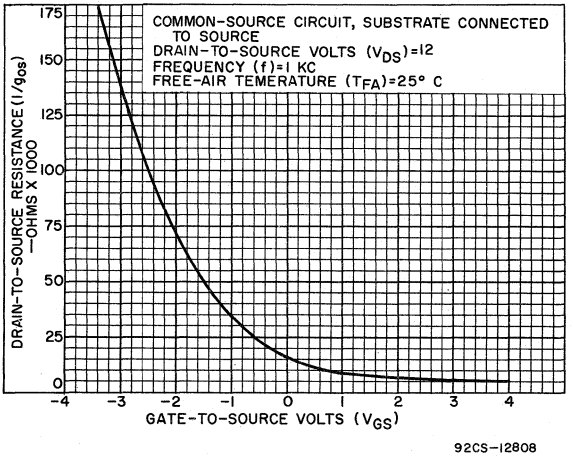
Typical Drain-to-Source-Resistance Characteristic

3N98



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