

3N204, 3N205, 3N206

Silicon Dual Insulated-Gate Field-Effect Transistors

With Integrated Gate-Protection Circuits for VHF TV
Applications

3N204 — RF Amplifier 3N205 — Mixer
3N206 — TV IF Amplifier

Features:

- Low C_{rss} — 0.03 pF max.
- High $|Y_{fs}|$ — 14 mmho typ. for 3N204 and 3N205
- Integrated gate-protection diodes

The RCA-3N204, 3N205, and 3N206 are n-channel silicon, depletion type, dual-insulated gate, field-effect transistors intended for vhf TV applications. Integrated back-to-back diodes protect the gates from excessive input voltages.

The 3N204 is intended for use in vhf rf amplifiers and delivers linear, low-noise amplification. Its extremely low feedback

capacitance allows high-gain stable operation without neutralization. The 3N205 is specified for low noise vhf mixer applications. The 3N206 is intended for use in tuned high-frequency amplifiers such as TV if strips.

Maximum Ratings, Absolute-Maximum Values at $T_A = 25^\circ$:

* DRAIN-TO-GATE No. 1 VOLTAGE	30 V
* DRAIN-TO-GATE No. 2 VOLTAGE	30 V
* DRAIN-TO-SOURCE VOLTAGE	25 V
* GATE No.1-TERMINAL FORWARD CURRENT [▲]	10 mA
* GATE No.2-TERMINAL FORWARD CURRENT [▲]	10 mA
* GATE No.1-TERMINAL REVERSE CURRENT	-10 mA
* GATE No.2-TERMINAL REVERSE CURRENT	-10 mA
* CONTINUOUS DRAIN CURRENT	50 mA
* DEVICE DISSIPATION:	
Up to $T_A = 25^\circ\text{C}$.	360 mW
Above $T_A = 25^\circ\text{C}$ derate linearly	2.4 mW/ $^\circ\text{C}$
Up to $T_C = 25^\circ\text{C}$.	1.2 W
Above $T_C = 25^\circ\text{C}$ derate linearly	8 mW/ $^\circ\text{C}$
* AMBIENT TEMPERATURE RANGE:	
Operating	-65 to +175 $^\circ\text{C}$
Storage	-65 to +200 $^\circ\text{C}$
* LEAD TEMPERATURE (During Soldering):	
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10 seconds max.	+300 $^\circ\text{C}$

[▲] Forward gate-terminal current is the current into a gate terminal with a forward-gate-to-source voltage applied. This voltage is of such polarity that an increase in its magnitude causes the channel resistance to decrease.

* In accordance with JEDEC registration data format (JS-9 RDF-19B).

ELECTRICAL CHARACTERISTICS, At $T_A = 25^\circ\text{C}$ (unless otherwise specified)

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS	
		MIN.	MAX.		
* Drain-to-Source Breakdown Voltage, $V_{(BR)DS}$	$I_D = 10\mu\text{A}$, $V_{G1S} = V_{G2S} = -5\text{V}$	25	-	V	
* Gate No.1-to-Source Forward Breakdown Voltage, $V_{(BR)G1SSF1}$	$I_{G1} = 10\text{mA}$, $V_{G2S} = V_{DS} = 0$	6	30	V	
* Gate No.1-to-Source Reverse Breakdown Voltage, $V_{(BR)G1SSR1}$	$I_{G1} = -10\text{mA}$, $V_{G2S} = V_{DS} = 0$	-6	-30	V	
* Gate No.2-to-Source Forward Breakdown Voltage, $V_{(BR)G2SSF1}$	$I_{G2} = 10\text{mA}$, $V_{G1S} = V_{DS} = 0$	6	30	V	
* Gate No.2-to-Source Reverse Breakdown Voltage, $V_{(BR)G2SSR1}$	$I_{G2} = -10\text{mA}$, $V_{G1S} = V_{DS} = 0$	-6	-30	V	
* Gate No.1-Terminal Forward Current, I_{G1SSF}	$V_{G1S} = 5\text{V}$, $V_{G2S} = V_{DS} = 0$	-	10	nA	
* Gate No.1-Terminal Reverse Current, I_{G1SSR}	$V_{G1S} = -5\text{V}$, $V_{G2S} = V_{DS} = 0$	$T_A = 25^\circ\text{C}$	-	-10	nA
		$T_A = 150^\circ\text{C}$	-	-10	μA
* Gate No.2-Terminal Forward Current, I_{G2SSF}	$V_{G2S} = 5\text{V}$, $V_{G1S} = V_{DS} = 0$	-	10	nA	
* Gate No.2-Terminal Reverse Current, I_{G2SSR}	$V_{G2S} = -5\text{V}$, $V_{G1S} = V_{DS} = 0$	$T_A = 25^\circ\text{C}$	-	-10	nA
		$T_A = 150^\circ\text{C}$	-	-10	μA
* Zero-Gate No.1-Voltage Drain Current, I_{DS}^2	$V_{DS} = 15\text{V}$, $V_{G1S} = 0$, $V_{G2S} = 4\text{V}$	3N204	6	30	mA
		3N205	6	30	
		3N206	3	15	
* Gate No.1-to-Source Cutoff Voltage, $V_{G1S(\text{off})}$	$V_{DS} = 15\text{V}$, $V_{G2S} = 4\text{V}$, $I_D = 20\mu\text{A}$	-0.5	-4	V	
* Gate No.2-to-Source Cutoff Voltage, $V_{G2S(\text{off})}$	$V_{DS} = 15\text{V}$, $V_{G1S} = 0$, $I_D = 20\mu\text{A}$	-0.2	-4	V	
* Small-Signal Common-Source Forward Transfer Admittance, $ y_{fs} ^3$	$V_{DS} = 15\text{V}$, $V_{G1S} = 0$, $V_{G2S} = 4\text{V}$, $f = 1\text{ kHz}$	3N204	10	22	mmho
		3N205	10	22	
		3N206	7	17	
* Small-Signal Common-Source Reverse Transfer Capacitance, C_{rss}	$V_{DS} = 15\text{V}$, $V_{G2S} = 4\text{V}$, $I_D = 10\text{ mA}$, $f = 1\text{ MHz}$	0.005	0.03	pF	

*In accordance with JEDEC registration data format (JS-9 RDF-19B).

- All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage-limiting network is functioning properly.
- This characteristic must be measured using pulse techniques ($t_W = 300\mu\text{s}$, duty cycle $\leq 2\%$).
- This characteristic must be measured with bias voltages applied for less than 5 seconds to avoid overheating. The signal is applied to gate No.1 with gate No.2 at ac ground.

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OPERATING CHARACTERISTICS at $T_A = 25^\circ\text{C}$

CHARACTERISTIC	TEST CONDITIONS	LIMITS			UNITS
		Min.	Typ.	Max.	
3N204					
* Common-Source Spot Noise Figure, NF	$V_{DD}=18\text{ V}, V_{GG}=7\text{ V},$ $f = 200\text{ MHz},$ See Fig.13	-	-	3.5	dB
* Small-Signal Common-Source Insertion Power Gain, G_{ps}		20	-	28	dB
* Bandwidth, BW		7	-	12	MHz
* Gain-Control Gate-Supply Voltage, $V_{GG}(GC)$	$V_{DD}=18\text{ V}, \Delta G_{ps}=-30\text{dB},$ ¹ $f=200\text{ MHz},$ See Fig. 13	0	-	-2	V
* Common-Source Spot Noise Figure, NF	$V_D=15\text{ V}, V_{G2S} = 4\text{ V},$ $f = 450\text{ MHz}, I_D = 10\text{ mA},$ See Figs. 15 and 16	-	-	5	dB
* Small-Signal Common Source Insertion Power Gain, G_{ps}		14	-	-	dB
3N205					
* Small-Signal Conversion Power Gain, $G_{ps}(\text{conv})$	$V_{DD}=18\text{ V}, f_{LO}=245\text{ MHz},$ ³	17	-	28	dB
* Bandwidth, BW	$f_{RF}=200\text{ MHz},$ See Fig.17	4	-	7	MHz
3N206					
* Common-Source Spot Noise Figure, NF	$V_{DD}=24\text{ V}, V_{GG}=6\text{ V},$ $f=45\text{ MHz},$ See Fig. 14	-	-	4	dB
* Small-Signal Common-Source Insertion Power Gain, G_{ps}		25	-	35	dB
* Bandwidth, BW		3	-	6	MHz
* Gain-Control Gate-Supply Voltage, $V_{GG}(GC)$		$V_{DD}=24\text{ V}, \Delta G_{ps}=-30\text{dB},$ ² $f=45\text{ MHz},$ See Fig. 14	-1.6	-	0.6

*In accordance with JEDEC registration data format (JS-9 RFD-19B).

- ΔG_{ps} is defined as the change in G_{ps} from the value at $V_{GG} = 7\text{ V}$.
- ΔG_{ps} is defined as the change in G_{ps} from the value at $V_{GG} = 6\text{ V}$.
- Amplitude at input from local oscillator is 3 V RMS.

TYPICAL CHARACTERISTICS

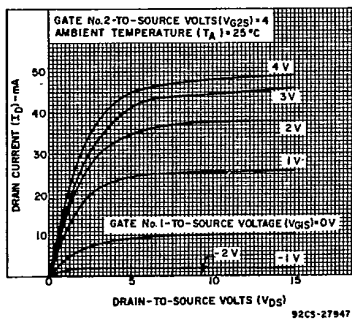


Fig.1 — Drain current vs. drain-to-source volts (pulse-tested with pulse duration = 300 μs , duty cycle $\leq 2\%$).

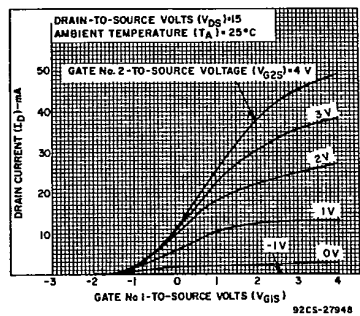


Fig.2 — Drain current vs. gate-No.1-to-source volts (pulse-tested with pulse duration = 300 μs , duty cycle $\leq 2\%$).

TYPICAL Y-PARAMETER CHARACTERISTICS

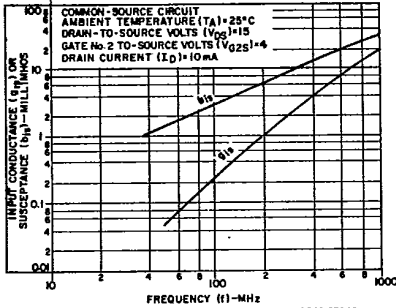


Fig. 3 - Y_{12} vs. f

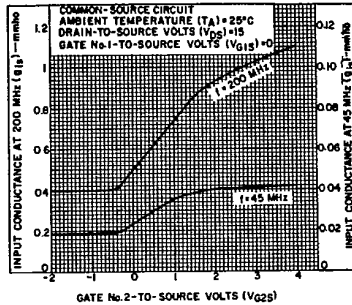


Fig. 4 - Y_{12} vs. V_{G2S}

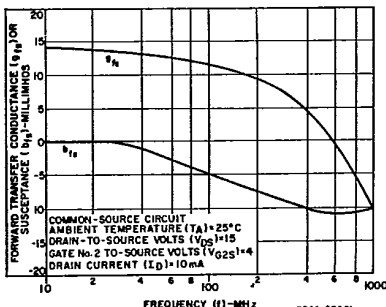


Fig. 5 - Y_{13} vs. f

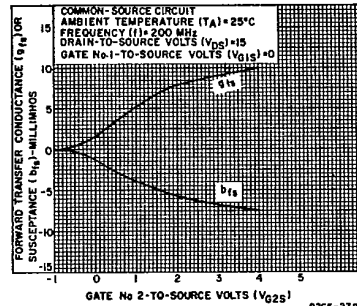


Fig. 6 - Y_{13} vs. V_{G2S}

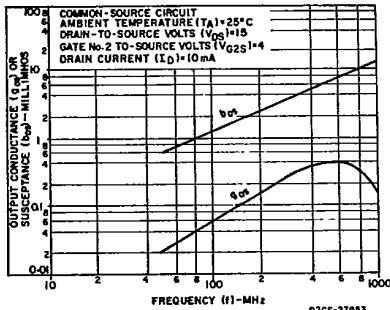


Fig. 7 - Y_{05} vs. f

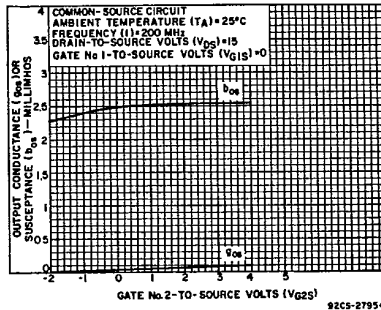


Fig. 8 - Y_{05} vs. V_{G2S}

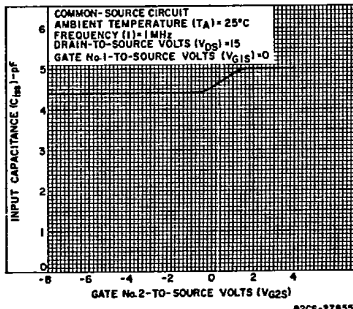


Fig. 9 - C_{iss} vs. V_{G2S}

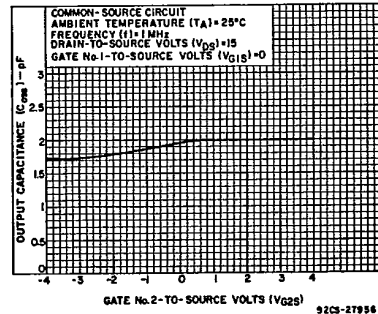


Fig. 10 - C_{oss} vs. V_{G2S}

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TYPICAL OPERATING CHARACTERISTICS: FOR 3N204

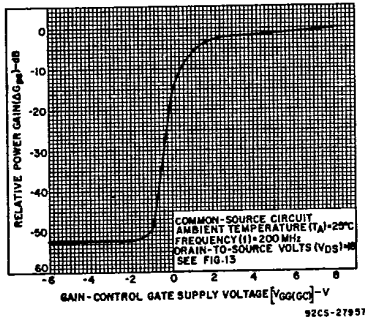


Fig. 11 - ΔG_{ps} vs. $V_{GG}(GC)$

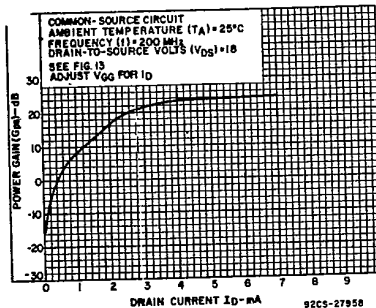
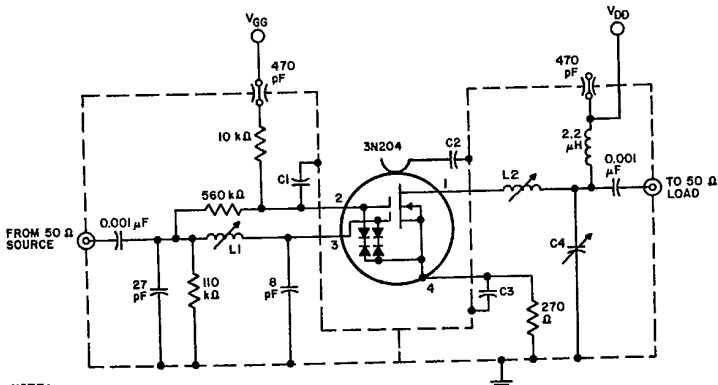


Fig. 12 - G_{ps} vs. I_D

TEST CIRCUITS

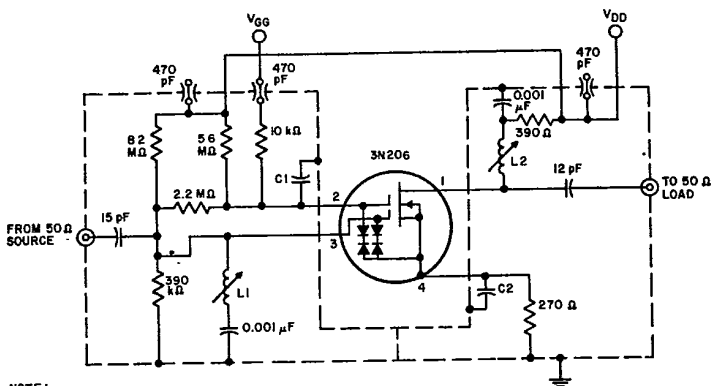


NOTE:
 C1, C2, & C3: LEADLESS DISC CERAMIC, 0.001 μ F
 C4: ARCO 462, 5-80 pF, OR EQUIVALENT
 L1: 3 TURNS No. 18 WIRE, 3/16 INCH-DIA ALUMINUM SLUG
 L2: 9 TURNS No. 20 WIRE, 3/16 INCH-DIA. ALUMINUM SLUG

92CS-27860

Fig. 13 - 200-MHz power gain, gain-control voltage, and noise-figure test circuit for 3N204*.

* In accordance with JEDEC registration data format (JS-9 RDF-19B).



NOTE:

C1: LEADLESS DISC CERAMIC, 0.001 μ F

C2: LEADLESS DISC CERAMIC, 0.01 μ F

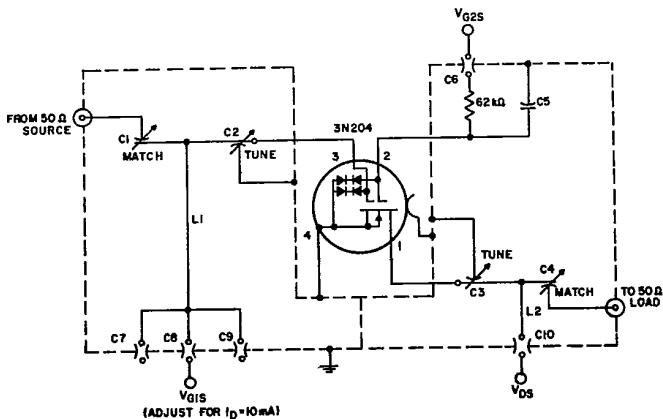
L1: 8 TURNS No. 28 WIRE, 5/32 INCH-DIA. FORM, TYPE "J" SLUG

L2: 9 TURNS No. 28 WIRE, 5/32 INCH-DIA. FORM, TYPE "J" SLUG

92CM-27959

Fig. 14 — -45-MHz power-gain and noise-figure test circuit for 3N206*.

* In accordance with JEDEC registration data format (JS-9 RDF-19B).



NOTE:

FOR TEST FIXTURE, SEE PICTORIAL DRAWING IN FIGURE 16

C1 THRU C4: SEE FIGURE 16, NOTE D

C5: 0.001 μ F LEADLESS DISC CAPACITOR

C6 THRU C10: ALLEN-BRADLEY F5AU 0.001 μ F FEED-THROUGH CAPACITORS, OR EQUIVALENT

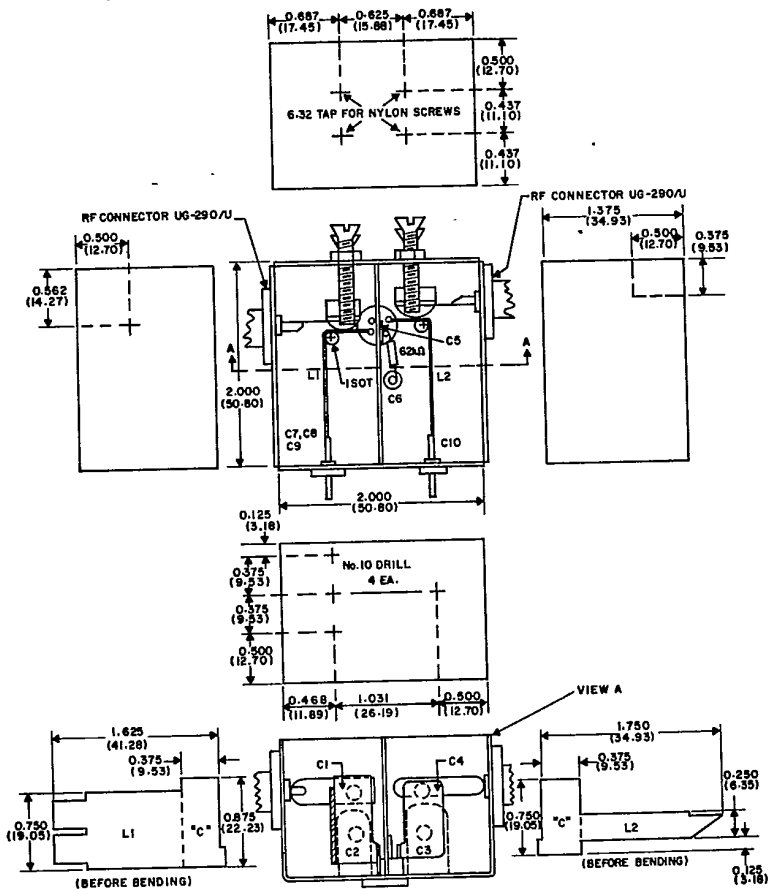
L1 & L2: SEE FIGURE 16

92CM-27961

Fig. 15 — -450-MHz power-gain and noise-figure test circuit for 3N204*.

* In accordance with JEDEC registration data format (JS-9 RDF-19B).

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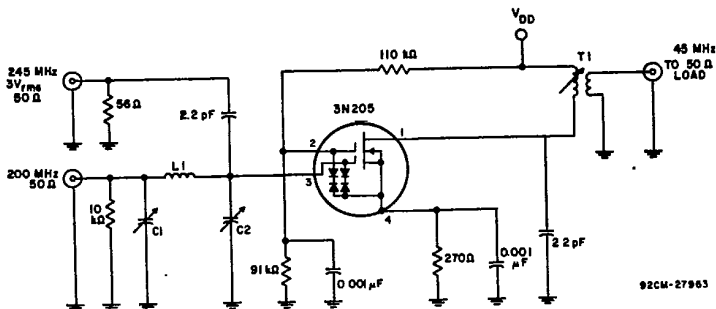
92CL-27962

NOTES:

- A. Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions, as indicated.
- B. The removable top of test fixture is not shown.
- C. For clarity, the $62\text{ k}\Omega$ resistor, the source and gate-2 socket pins, and insulating stand-off terminals (ISOT) soldered into the fold of L1 and L2 respectively for mechanical support, are not shown in view A.
- D. C1 and C2 (C3 and C4) consist of shim brass and the "C" portion of L1 (L2) separated by air and the mylar tape covering the "C" portion of L1 (L2).
- E. The four views surrounding the center view are as they would appear before the metal is bent up to form the sides.

Fig. 16 — 450 MHz power-gain and noise-figure test fixture*.

* In accordance with JEDEC registration data format (JS-9 RDF-19B).



92CM-27963

NOTE:

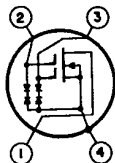
- C1: ARCO 462, 5-80 pF, or EQUIVALENT
 C2: ARCO 460, 1.5-15 pF, OR EQUIVALENT
 L1: 4 TURNS No.14 WIRE, 1/4 INCH INSIDE DIA.

- T1: PRI: 16 TURNS No.30 WIRE CLOSE WOUND
 ON 1/4 INCH DIA. FORM, TYPE "J" SLUG
 SEC: 5 TURNS No.30 WIRE CENTERED
 OVER PRIMARY

Fig.17 -- 200 MHz-to-45-MHz circuit for conversion power gain for 3N205.*

* In accordance with JEDEC registration data format (JS-9 RDF-19B).

TERMINAL DIAGRAM
Bottom View



- LEAD 1 - DRAIN
 LEAD 2 - GATE No.2
 LEAD 3 - GATE No.1
 LEAD 4 - SOURCE,
 SUBSTRATE AND CASE

OPERATING CONSIDERATIONS

The flexible leads of these devices are usually soldered to the circuit elements. As is the case with any high-frequency semiconductor device, the tips of soldering irons **MUST** be grounded.