

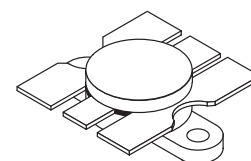
The RF Line
NPN Silicon
RF Power Transistor

Designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 520 MHz.

- Guaranteed 440, 470, 512 MHz 12.5 Volt Characteristics
Output Power = 50 Watts
Minimum Gain = 5.2 dB @ 440, 470 MHz
Efficiency = 55% @ 440, 470 MHz
IRL = 10 dB
- Characterized with Series Equivalent Large-Signal Impedance Parameters from 400 to 520 MHz
- Built-In Matching Network for Broadband Operation
- Triple Ion Implanted for More Consistent Characteristics
- Implanted Emitter Ballast Resistors
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 15.5 Vdc, 2.0 dB Overdrive
- Circuit board photomaster available upon request by contacting RF Tactical Marketing in Phoenix, AZ.

MRF650

50 W, 512 MHz
RF POWER
TRANSISTOR
NPN SILICON



CASE 316-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Emitter Voltage	V_{CES}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	12	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	135 0.77	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.3	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	5.0	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1.0 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	20	70	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	135	170	pF
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(continued)

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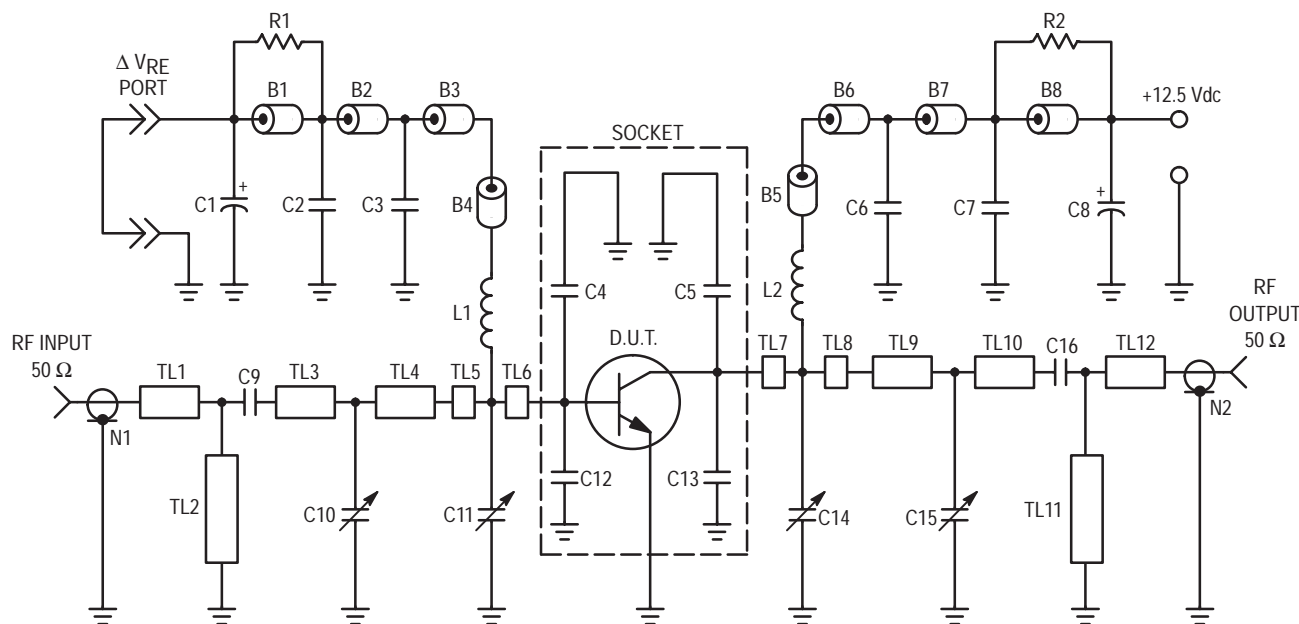
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ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (In Motorola Test Fixture. See Figure 1.)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 440, 470\text{ MHz}$)	G_{pe}	5.2	6.1	—	dB
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 512\text{ MHz}$)	G_{pe}	5.0	5.9	—	dB
Input Return Loss ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 440, 470, 512\text{ MHz}$)	IRL	10	15	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 440, 470\text{ MHz}$)	η	55	65	—	%
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 512\text{ MHz}$)	—	50	60	—	%
Output Mismatch Stress ($V_{CC} = 15.5\text{ V}$, 2.0 dB Overdrive, $f = 470\text{ MHz}$, VSWR = 20:1, All Phase Angles) (1)	ψ (2)	No Degradation in Output Power			

NOTES:

- $P_{in} = 2.0\text{ dB}$ above drive requirement for 50 W output at 12.5 Vdc.
- ψ = Mismatch stress factor — the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.



- B1, B8 — Ferrite Bead Ferroxcube VK200 20-4B
- B2, B3, B4, B5, B6, B7 — Ferrite Bead Ferroxcube #56-590-3B
- C1, C8 — 10 μF , 25 V, 25%, Electrolytic, ECS TE-1204
- C2, C7 — 1000 pF, Chip Cap, 5%, ATC 100B102JC50
- C3, C6 — 91 pF, 5%, Mica, SAHA 3HS0006-91
- C4, C5, C12, C13 — 36 pF, 5%, SAHA 3HS0006-36
- C9, C16 — 220 pF, Chip Cap, 5%, ATC 100B221JC200
- C10, C11, C15 — 0.8-10 pF, Variable, Johanson JMC501 PG26J200
- C14 — 1.0-20 pF, Variable, Johanson JMC5501 PG26J200
- L1, L2 — 3 Turns, 18 AWG, 0.19" ID — Total Length 3.5"
- N1, N2 — N Coaxial Conn., Omni-Spectra 3052-1648-10
- R1, R2 — 10 Ohm, 10%, 1.0 W, Carbon, RCA 831010

- TL1, TL12 — $Z_0 = 50\text{ Ohm}$
- TL2 — See Photomaster
- TL3 — See Photomaster
- TL4 — See Photomaster
- TL5 — See Photomaster
- TL6 — See Photomaster
- TL7 — See Photomaster
- TL8 — See Photomaster
- TL9 — See Photomaster
- TL10 — See Photomaster
- TL11 — See Photomaster

Transmission Line Boards: 1/16" Glass-Teflon
Keene GX-0600-55-22
2 oz. Cu Clad Both Sides
 $\epsilon_r = 2.55$

Bias Boards: 1/16" G10 or Equivalent
2 oz. Cu Clad Double Sided

Figure 1. 440 to 512 MHz Broadband Test Circuit Schematic

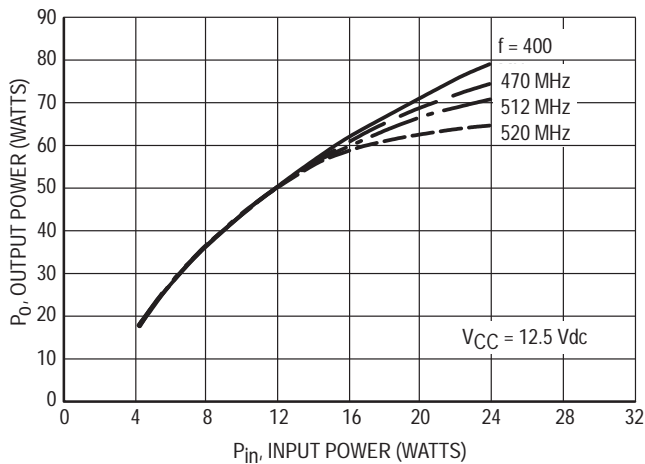


Figure 2. Output Power versus Input Power

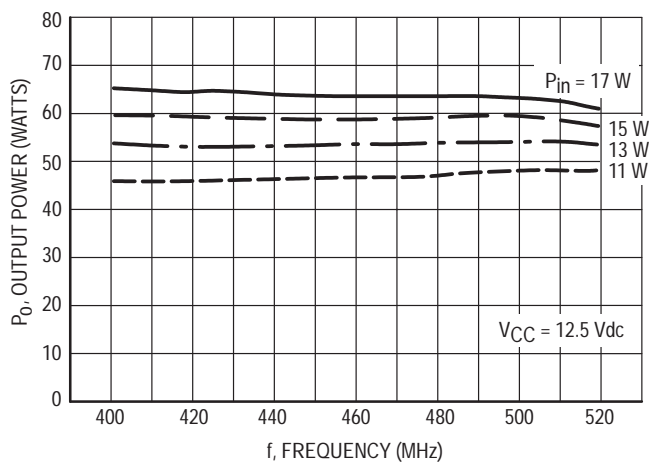


Figure 3. Output Power versus Frequency

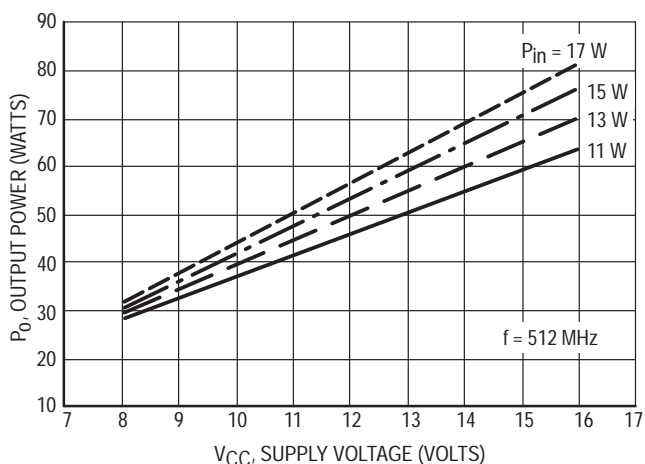


Figure 4. Output Power versus Supply Voltage

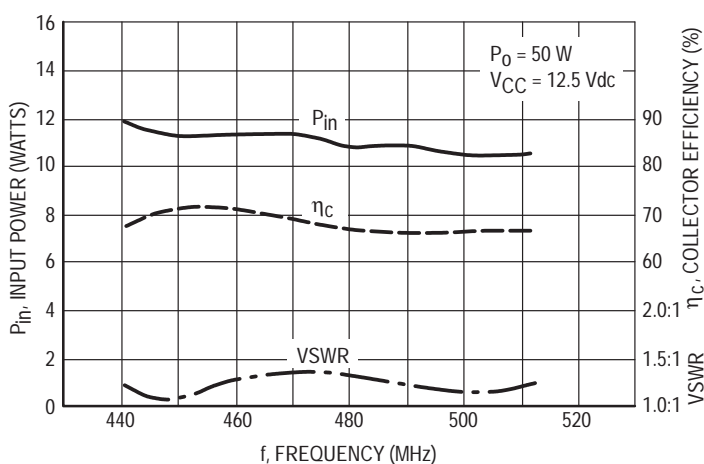
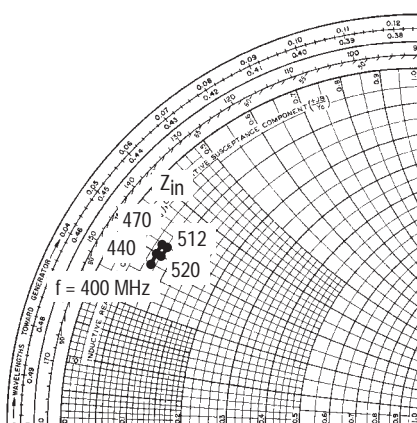


Figure 5. Broadband Performance for $P_o = 50$ W

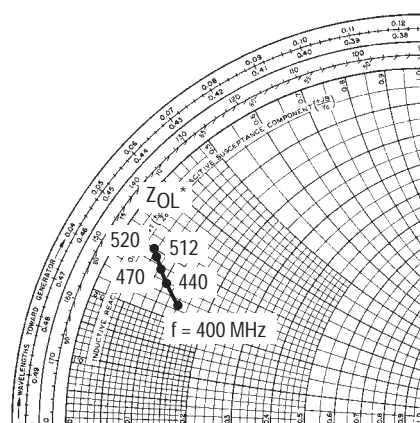


$P_{out} = 50$ W, $V_{CC} = 12.5$ Vdc

TUNED FOR MAXIMUM GAIN AT $P_o = 50$ W

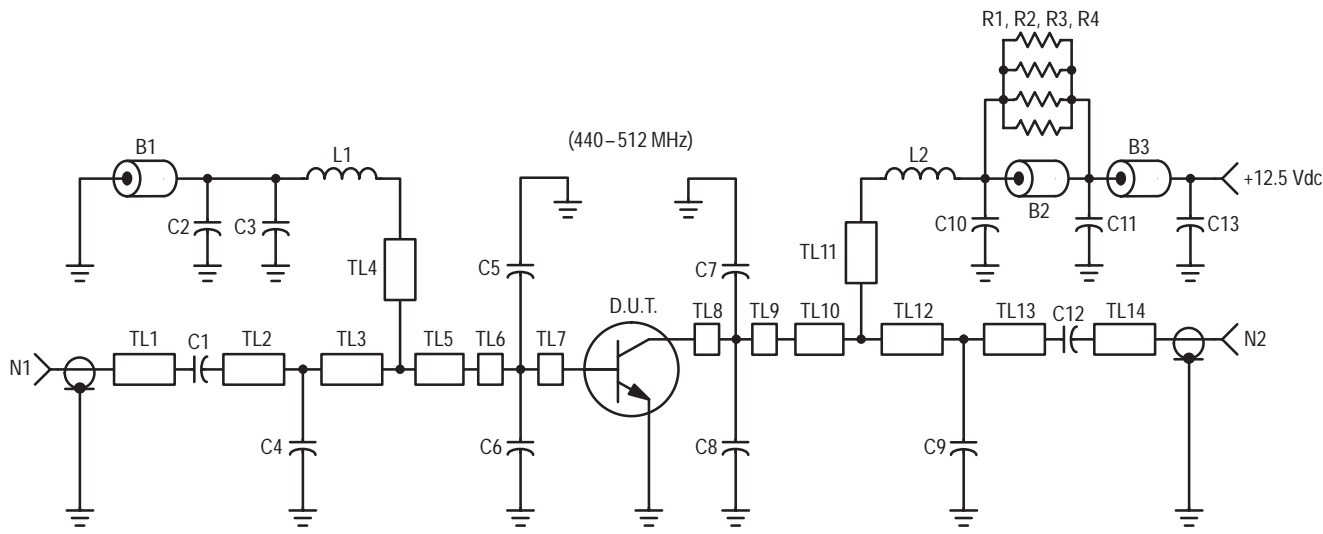
f (MHz)	Z_{in} Ω	Z_{OL}^* Ω
400	$0.7 + j2.8$	$1.4 + j2.3$
440	$0.7 + j3.2$	$1.1 + j2.6$
470	$0.8 + j3.3$	$0.8 + j2.7$
512	$0.8 + j3.2$	$0.7 + j2.9$
520	$0.7 + j3.0$	$0.6 + j3.0$

NOTE: Z_{in} & Z_{OL}^* are given from base-to-base and collector-to-collector respectively.



Z_{OL}^* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 6. Input and Output Impedance Normalized to 10 Ohms
Circuit Tuned for Maximum Gain @ $P_o = 50$ W



- B1, B2 — Ferrite Bead Fair Rite Products Corp.
 - B3 — Ferrite Bead Fair Rite Products Corp.
 - C2, C11 — 820 pF, 5%
 - C3, C10 — 91 pF, 5%, Mica, SAHA 3HS0006-91
 - C1, C12 — 220 pF, 5%, Murata Erie
 - C4 — 9.1 pF, 5%, Murata Erie
 - C5, C6, C7, C8 — 43 pF, 5%, Mica SAHA 3HS0006-43
 - C9 — 10 pF, 5%, Murata Erie
 - C13 — 10 μ F, Electrolytic, 50 V, Panasonic
 - L1 — 7 Turns, 24 AWG, ID Dia. 0.116"
 - L2 — 5 Turns, 18 AWG, ID Dia. 0.165"
 - N1, N2 — SMA Flange Mount, Omni-Spectra 2052-1618-02
 - R1, R2, R3, R4 — 39 Ohm 1/8 W 5% Rohm
 - TL1 — $Z_0 = 50$ Ohm
 - TL2 — $Z_0 = 50$ Ohm
 - TL3 — $Z_0 = 50$ Ohm
 - TL4 — See Photomaster
 - TL5 — $Z_0 = 50$ Ohm
 - TL6 — See Photomaster
 - TL7 — See Photomaster
 - TL8 — See Photomaster
 - TL9 — See Photomaster
 - TL10 — $Z_0 = 50$ Ohm
 - TL11 — See Photomaster
 - TL12 — $Z_0 = 50$ Ohm
 - TL13 — $Z_0 = 50$ Ohm
 - TL14 — $Z_0 = 50$ Ohm
- Board Material: 1/16" G10, $\epsilon_r = 4.5$
2 oz. Cu Clad Both Sides

Figure 7. Schematic of Broadband Demonstration Amplifier (3)

PERFORMANCE CHARACTERISTICS OF BROADBAND DEMONSTRATION AMPLIFIER

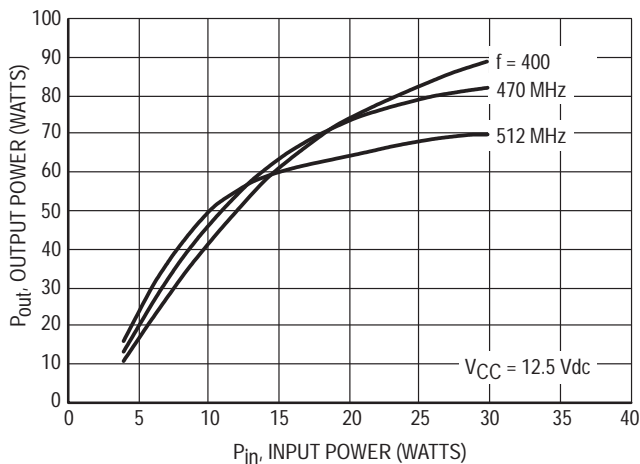


Figure 8. Output Power versus Input Power

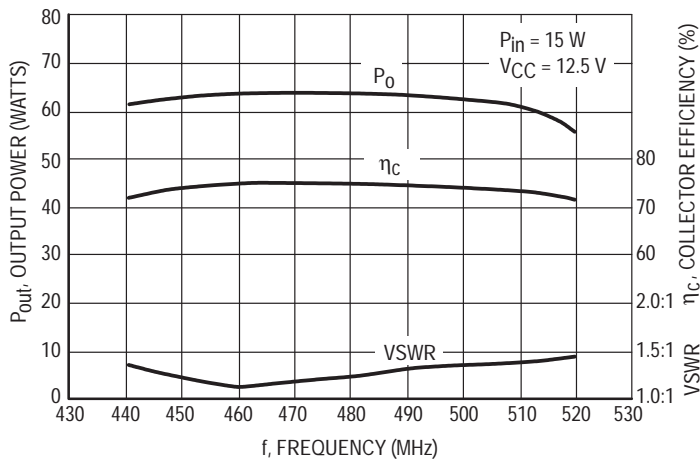


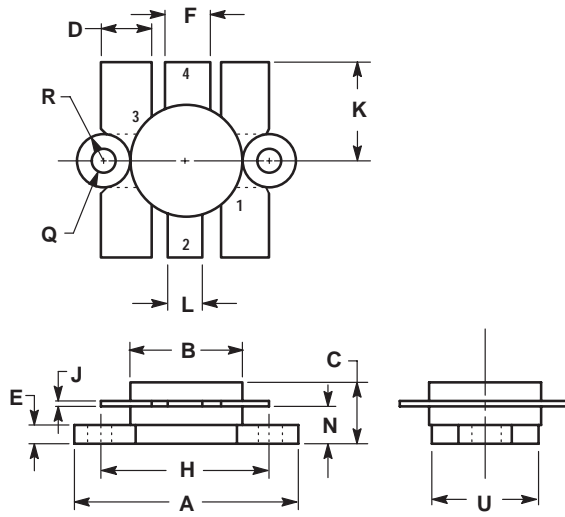
Figure 9. P_0 , η_c and VSWR versus Frequency

(3) Detailed design and performance information available from Motorola upon request.

PACKAGE DIMENSIONS

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NOTES:
1. FLANGE IS ISOLATED IN ALL STYLES.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

CASE 316-01
ISSUE D

NOTES


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