MARKING CODES FOR RF POWER TRANSISTORS

For the purposes of matched pair applications, RF power MOS transistors are marked with a code that indicates their gate-source voltage range (see Table 8).

Table 8 Marking codes for RF power transistors

CODE	V_{GS}	CODE	V_{GS}
0	1.00 to 1.10	J	2.80 to 2.90
1	1.10 to 1.20	K	2.90 to 3.00
2	1.20 to 1.30	L	3.00 to 3.10
3	1.30 to 1.40	M	3.10 to 3.20
4	1.40 to 1.50	N	3.20 to 3.30
5	1.50 to 1.60	O	3.30 to 3.40
6	1.60 to 1.70	P	3.40 to 3.50
7	1.70 to 1.80	Q	3.50 to 3.60
8	1.80 to 1.90	R	3.60 to 3.70
9	1.90 to 2.00	S	3.70 to 3.80
A	2.00 to 2.10	T	3.80 to 3.90
B	2.10 to 2.20	U	3.90 to 4.00
C	2.20 to 2.30	V	4.00 to 4.10
D	2.30 to 2.40	W	4.10 to 4.20
E	2.40 to 2.50	X	4.20 to 4.30
F	2.50 to 2.60	Y	4.30 to 4.40
G	2.60 to 2.70	Z	4.40 to 4.50
H	2.70 to 2.80		

MARKING CODES FOR MICROWAVE TRANSISTORS

The microwave transistors in this book are normally marked with manufacturer's name or trademark, type designation and lot identification code. If space on the transistor package is insufficient for full type designation, the following marking codes may be used for identification (see Table 9).

Table 9 Marking codes for microwave transistors

TYPE NUMBER	MARKING CODE
LBE2003S	407
LBE2009S	409
LTE21009R	435
LTE21025R	439
LTE42005S	502
LTE42012R	198
LV1721E50R	1721E50R
LV2024E45R	2024E45R
LV2327E40R	2327E40R
MTB10010U	10010U
MX1011B430W	MX1011B430W
PTB23003X	2303X
PTB32001X	3201X
PTB32003X	3203X
PTB32005X	3205X

RELIABILITY GRADES

Microwave transistors are available from different quality levels which are listed as follows:

- **Standard grade**

  This applies to devices following the designation rules as listed in the chapters “Type Designation Code For Microwave Transistors”and “Pro Electron Type Numbering System”.

- **Grade “X” and “Y”**

  These grades correspond respectively to the equivalent MIL-STD 19500 grades JANTX and JANTXV.

  They have been subject to additional screening tests than those normally applied to the standard grade. The local sales organization can confirm whether they are available for the type you have selected.

  The majority of the devices included in this book may also be available in accordance with a space screening file similar to JANS or ESA/SCC5010.

Reliability grades (only for brazed cap devices and orders in excess of 50 parts)

OPERATION	MIL STD 750 METHOD	CONDITIONS	REQUIREMENTS (%)		
			STD GRADE	GRADE “X”(1)	GRADE “Y”(2)
Assembly			100	100	100
Internal visual inspection		note 3	100	100	100
Capping			100	100	100
Stabilization bake	1032	T = 200 °C; duration 48 hours	100	100	100
Temperature cycling	1051	condition C; 20 cycles; no dwell at 25 °C	–	100	100
Constant acceleration	2006	20000 g axis Y1; P_{tot} ≤5 W	–	–	100
		10000 g axis Y1; P_{tot} >5 W	–	–	100
Hermetic seal (brazed cap)	1071	condition H - FC43			
fine			100	100	100
gross			100	100	100
Serialisation			–	–	100
Initial electrical parameters		note 4	–	100 GO/NOGO	100 GO/NOGO

OPERATION	MIL STD 750 METHOD	CONDITIONS	REQUIREMENTS (%)		
			STD GRADE	GRADE "X"(1)	GRADE "Y"(2)
High temperature reverse bias (HTRB)	1039	T_{amb} = 150 °C; V_{CBmin} = 80% of published V_{CB}; duration 48 hours	–	100	100
Interim electrical parameters		note 5	–	–	100 read and record
Power burn-in	1039	T_{amb} = 125 °C; V_{CB} = 10 V; I_C reached when T_j average = 175 °C; duration 160 hours	–	–	100
Delta calculation		note 6	–	–	100
Other electrical parameters		note 4	100	100 GO/NOGO	read and record
Marking		as specified	100	100	100
External visual inspection	2071		100	100	100
Packing			100	100	100
Check for delivery		note 3			

Notes

1. Grade "X" is equivalent to JANTX.
2. Grade "Y" is equivalent to JANTXV.
3. As per Philips component specification.
4. Published DC, R_{th} and RF parameters.
5. Interim electrical parameters are published.
6. Published collector cut off current and forward current ratio. Delta limits are: Delta h_{FE} max = ±20% of initial value; Delta cut off current max = ±100% of initial value or ±10% of published parameter limit (whichever is greater).

BATCH RELEASE TESTS FOR GRADE “X” AND “Y” EQUIVALENTS

Group B; note 1.

INSPECTIONS	MIL STD 750 METHOD	CONDITIONS	SAMPLING PLAN LTPD(2)	SMALL LOT QUALITY CONFORMANCE INSPECTION	
				NO. OF DEVICES	NO. OF FAILURES
Subgroup 1					
Solderability	2026	the sampling plan applies to the number of leads inspected. A minimum of 3 devices shall be tested.	15	4	0
Resistance to solvents	1022				
Subgroup 2					
Temperature cycling (air to air)	1051	no dwell at 25 °C; test condition C, except step 3 at 175 °C; 45 cycles including screening	10	6	0
Thermal shock	1056	10 cycles; condition A			
Hermetic seal fine leak gross leak	1071	 test condition H; max. leak rate = 5 x 10^{-7} atm cc/s test condition C			
Electrical measurements		DC parameters of the relevant data sheet			
Subgroup 3					
Steady-state operation life	1027	as power burn-in except T_{mb} = 150 °C; duration 340 hours	10	12	0
Electrical measurements		DC parameters of the relevant data sheet			
Bond strength	2037	the sample shall include a minimum of 3 devices and shall include all wire sizes	20 (wires)	20 (wires)	0
Subgroup 4					
Decap internal visual (design criteria)	2075	visual criteria in accordance with qualified design		1	0
Subgroup 5 (not applicable)					
Subgroup 6					
High temperature life (non operating)	1032	340 hours at T_{amb} = 200 °C (brazed cap)	10	12	0
Electrical measurements		DC parameters of the relevant data sheet			

Notes

1. Optional for grades “X” and “Y” (minimum order quantity = 50 devices).
2. Sampling according to MIL-STD 19500. Small lot sampling applies for batches up to 500 devices.

TYPE DESIGNATION CODE FOR MICROWAVE TRANSISTORS

Code structure

The standard structures of type designation code for microwave transistors can be shown as follows, where X represents a letter and 0 represents a numeral:

XXX0000X	for transistors without matching cell
XXX00000X	for transistors with input matching cell and specified for narrowband applications
XXX0000X00X or XXX0000X000X	for transistors specified for wideband applications

Letters

FIRST LETTER

The first letter shows the mode of operation:

L linear

M short pulse

P CW class B

R long pulse.

SECOND LETTER

The second letter shows the encapsulation:

A SOT100

B SOT441A (FO-45)

C SOT442A (FO-46)

E SOT122A

F SOT448A (FO-231)

L SOT437A (FO-229)

P SOT447A (FO-102)

T SOT440A (FO-41B)

V SOT445A (FO-83A and FO-83B)

W SOT446A (FO-93)

X SOT439A (FO-91B)

Z SOT443A (FO-57C).

THIRD LETTER

The third letter indicates the common potential:

E common emitter

B common base

C common collector.

FOURTH LETTER (SUFFIX LETTER)

The fourth letter indicates the supply voltage:

Q 10 to 12 V

R 15 to 16 V

S 18 V

T 20 V or 18 to 21 V

U 28 to 30 V

W 40 to 45 V

X 24 V

Y 50 V

Z 48 V.

Numbers

TRANSISTORS WITHOUT MATCHING CELL (XXX0000X)

1st digit indicates frequency of measurement (GHz).

2nd, 3rd and 4th digits indicate power:

in watts for P, M and R modes of operation

in multiples of 100 mW for L mode of operation.

TRANSISTORS SPECIFIED FOR NARROWBAND APPLICATIONS (XXX00000X)

1st and 2nd digits indicate frequency of measurement ($\times$ 0.1 GHz).

3rd, 4th and 5th digits give the power:

in watts for P, M and R modes of operation

in multiples of 100 mW for L mode of operation.

TRANSISTORS SPECIFIED FOR WIDEBAND APPLICATIONS

1st and 2nd digits indicate the lower frequency of use (in 0.1 GHz).

3rd and 4th digits indicate the higher frequency of use (in 0.1 GHz).

Last digit indicates the power:

in watts for P, M and R modes of operation

in multiples of 100 mW for L mode of operation.

SUMMARY OF SYMBOLS FOR MICROWAVE TRANSISTORS

C_{cb}	collector-base capacitance
C_{ce}	collector-emitter capacitance
C_{eb}	emitter-base capacitance
d_{im}	intermodulation distortion
δ	duty factor
F_{min}	noise factor
f	signal frequency
G_a	associated gain (for a low-noise transistor)
G_{ma}	maximum available gain
G_{ms}	maximum stable gain
G_p	power gain under specified conditions
G_{po}	low level power gain associated with P_{L1}
h_{FE}	DC current gain
I_C	DC collector current
I_{CBO}	collector cut-off current, open emitter
I_{CER}	collector cut-off current, with specified R_{BE}
I_{CES}	collector cut-off current, base connected to emitter
I_{CQ}	quiescent current
I_{EBO}	emitter cut-off current, open collector
η_C	collector efficiency $P_L / (I_C \times V_{CC})$
η_{add}	power added efficiency $(P_{out} - P_{in}) / (I_C \times V_{CC})$
P_{in}	input power
P_L	load power under specified conditions
P_{L1}	load power for 1 dB compressed power gain
P_{out}	output power
P_{tot}	total power dissipation
$R_{th\ j\text{-}c}$	thermal resistance from junction to case
$R_{th\ j\text{-}mb}$	thermal resistance from junction to mounting base
$R_{th\ mb\text{-}j}$	thermal resistance from mounting base to heatsink
T_j	junction temperature
t_p	pulse width
T_{sld}	lead soldering temperature
T_{stg}	storage temperature
V_{CBO}	collector-base voltage, open emitter
V_{CC}	collector supply voltage
V_{CE}	collector-emitter voltage
V_{CEO}	collector-emitter voltage, open base
V_{CER}	collector-emitter voltage with specified R_{BE}
V_{CES}	collector-emitter voltage, base connected to emitter
V_{EBO}	emitter-base voltage, open collector
VSWR	voltage standing wave ratio
z_i	complex transistor impedance as seen by the generator
Z_L	complex transistor load impedance as seen by the transistor
Z_{th}	thermal impedance from junction to heatsink.

OPERATING RECOMMENDATIONS

These recommendations are included for the avoidance of damage or destruction of silicon bipolar transistors operating at high frequencies and high power during testing, setting-up procedures and final operation.

Polarization

A current-limiting power supply should be used when testing transistors in a new circuit.

Initial testing at reduced supply voltage is discouraged because the resulting change in output impedance could cause oscillation due to mismatch.

The RF blocking 1in the supply line, together with the DC blocking capacitor of the internal output prematching circuit of the transistor, could sometimes cause oscillations at very low frequencies. The oscillations can often be removed by bypassing the choke with a low value resistor.

Operation

INPUT POWER

When the circuit has not been optimized, the average power input should be kept a lower level than specified. Initial testing of CW amplifiers is best performed in pulsed operation at 50% duty factor. For pulsed amplifiers, the duty factor should be reduced.

OUTPUT WAVEFORM

The output waveform should be checked with a spectrum analyser or similar equipment to ensure that no parasitic effects causing unwanted modulation are present.

FREQUENCY

Microwave performance is published in the data sheet at a single frequency or for a range of frequencies. Devices whose data is published for narrow band application can normally be used at frequencies other than that specified. However, for high power types in particular, broadband operation may be difficult to obtain and the gain of transistors with an internal input prematching network may decrease sharply at higher frequencies.

Broadband transistors (generally those with type numbers starting with two letters followed by four digits) also have an output prematching network. This is essentially a high-pass filter with a resonance frequency below the lowest operating frequency. The transistor could be damaged if operated at this resonance frequency, therefore the manufacturer should be consulted if extended frequency operation is required.

Thermal considerations

The junction temperature is of paramount importance in the reliability of transistors and every effort should be made to keep this temperature as low as possible. This is affected by mechanical aspects of the fitting, therefore mounting recommendations given by the manufacturer should be followed.

Values of thermal resistance given in the data sheets are for a specific junction temperature. Note that thermal resistance from junction to mounting base increases with junction temperature at approximately 0.3%/K.

For transistors required for pulsed operation, an equivalent thermal impedance is given for a specified pulse format (pulse width and duty factor). This allows for calculation of peak junction temperature (at the end of a pulse). For widely differing pulse formats the manufacturer should be consulted.

The maximum power dissipation is defined as $P_{tot} = V_{CE} \times I_C - P_o + P_i$ at $T_j = 200\ °C$.

APPLICATION INFORMATION

COMPONENT	DESCRIPTION	VALUE	DIMENSIONS	TYPE NUMBER
A	amplifier			1/4 MC3403 or equivalent
D.U.T.	microwave transistor			
TR	transistor			2N2219 or equivalent
D	diode			1N4148 or equivalent
C1, C2	tantalum capacitor	22 μF, 50 V		
R1	resistor	2.2 kΩ ±5%		
R2, R3, R5, R6	resistor	10 kΩ ±5%		
R4	resistor	4.7 kΩ ±5%		
R_p	resistor	10 kΩ ±5%	10 turns	
R_b, R_c, R_e, R_x	resistor	note 1		

Note

1. Values to be adapted to I_c of the D.U.T.

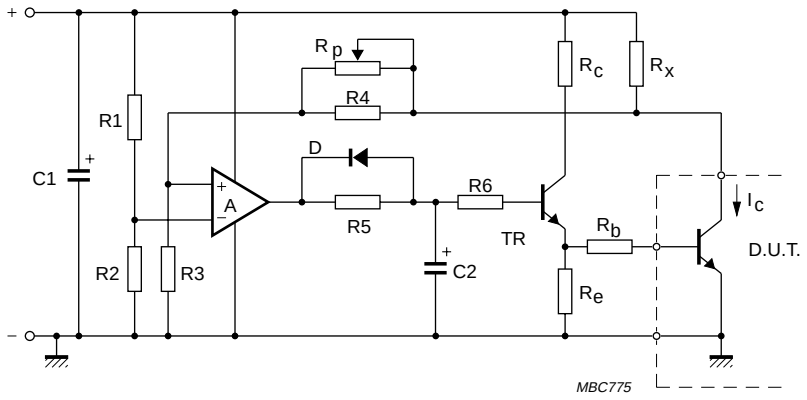

Fig.22 Bias circuit for a class-A linear microwave transistor.

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