

## S-Band Radar Transistor

The high power pulsed radar transistor device part number IB2731MH25 is designed for S-Band radar systems operating over the instantaneous bandwidth of 2.7-3.1 GHz. While operating in class C mode this common base device supplies a minimum of 25 watts of peak pulse power under the conditions of 200 $\mu$ s pulse width and 10% duty cycle. All devices are 100% screened for large signal RF parameters, including power gain compression. Excellent spectral stability into output mismatch over a broad input power range make it ideal for use in reliable high power solid state transmitters.



Silicon Bipolar  
– Ultra-high  $f_T$

Class C Operation  
– High Efficiency

Common Base Configuration  
– Single Power Supply

Gold Metal  
– Maximum Reliability

Emitter Ballasting  
– Optimum Thermal Distribution

Internal Impedance Matching  
– Ease of Use  
– Ultra-low Loss Design

BeO Package  
– Unmatched Thermal Reliability  
– Solder Seal Hermeticity

RF Test Fixture  
– Broadband  
– Matched to 50 $\Omega$   
– Long-term Correlation  
– 100% Device RF Screening  
– No External Tuning Allowed

Insertion Phase Marking  
– 5° Increment Marking

Patents Issued  
– US 6181200 B1  
– US 6331931 B1

| TYPICAL DATA       |            |         |          | TYPICAL DATA |                     |          |                      | TYPICAL DATA        |          |          |                    | TYPICAL DATA       |            |            |          |
|--------------------|------------|---------|----------|--------------|---------------------|----------|----------------------|---------------------|----------|----------|--------------------|--------------------|------------|------------|----------|
| Test Sequence Name | Freq (GHz) | PW (us) | Duty (%) | Vcc (V)      | P <sub>IN</sub> (W) | IRL (dB) | P <sub>OUT</sub> (W) | G <sub>p</sub> (dB) | OPC (dB) | OPF (dB) | I <sub>c</sub> (A) | n <sub>c</sub> (%) | Droop (dB) | VSWR 1.5:1 | VSWR 3:1 |
| OPC                | 2.700      | 200     | 10       | 36.0         | 3.1                 | --       | 36                   | --                  | 0.25     | --       | --                 | --                 | --         | --         | --       |
| Nominal            | 2.700      | 200     | 10       | 36.0         | 2.8                 | -10      | 34                   | 10.9                | --       | 0.55     | 1.85               | 51                 | -0.070     | --         | P        |
| 1.5:1 Stability/OD | 2.700      | 200     | 10       | 36.0         | 3.3                 | --       | --                   | --                  | --       | --       | --                 | --                 | --         | S          | --       |
| OPC                | 2.900      | 200     | 10       | 36.0         | 3.1                 | --       | 33                   | --                  | 0.43     | --       | --                 | --                 | --         | --         | --       |
| Nominal            | 2.900      | 200     | 10       | 36.0         | 2.8                 | -12      | 30                   | 10.3                | --       | --       | 1.79               | 47                 | -0.010     | --         | P        |
| 1.5:1 Stability/OD | 2.900      | 200     | 10       | 36.0         | 3.3                 | --       | --                   | --                  | --       | --       | --                 | --                 | --         | S          | --       |
| OPC                | 3.100      | 200     | 10       | 36.0         | 3.1                 | --       | 33                   | --                  | 0.15     | --       | --                 | --                 | --         | --         | --       |
| Nominal            | 3.100      | 200     | 10       | 36.0         | 2.8                 | -14      | 32                   | 10.5                | --       | --       | 1.83               | 48                 | -0.430     | --         | P        |
| 1.5:1 Stability/OD | 3.100      | 200     | 10       | 36.0         | 3.3                 | --       | --                   | --                  | --       | --       | --                 | --                 | --         | S          | --       |

**MAXIMUM RATINGS**

| Screen | Parameter                                    | Symbol    | Min | Max  | Units | Test Conditions |
|--------|----------------------------------------------|-----------|-----|------|-------|-----------------|
| BD     | Collector-Emitter Voltage                    | $V_{CES}$ | --  | 70   | V     | $V_{BE}=0V$ .   |
| BD     | Emitter-Base Voltage                         | $V_{EBO}$ | --  | 2.5  | V     | --              |
| BD     | Storage Temperature Range                    | $T_{STG}$ | -65 | +200 | °C    | --              |
| BD     | Operating Junction Temperature Range         | $T_J$     | -55 | +200 | °C    | --              |
| Note   | Screen 'BD' = parameter qualified By Design. |           |     |      |       |                 |

**THERMAL CHARACTERISTICS**

| Screen | Parameter                                    | Symbol       | Min | Max  | Units | Test Conditions                                                            |
|--------|----------------------------------------------|--------------|-----|------|-------|----------------------------------------------------------------------------|
| BD     | Thermal Resistance                           | $R_{TH(JC)}$ | --  | 1.20 | °C/W  | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ C$ , $P_{OUT}=25W$ . |
| Note   | Screen 'BD' = parameter qualified By Design. |              |     |      |       |                                                                            |

**PROCESSING SPECIFICATIONS**

| Screen | Parameter                                                                                | Symbol | Min | Max | Units | Test Conditions                                |
|--------|------------------------------------------------------------------------------------------|--------|-----|-----|-------|------------------------------------------------|
| 100%   | DC Wafer Probe                                                                           | --     | --  | --  | --    | Per Integra specification.                     |
| Q1     | Wafer DC and RF Qualification                                                            | --     | --  | --  | --    | Per Integra specification.                     |
| LM     | Wire Bond Strength                                                                       | --     | --  | --  | --    | Line monitor per Integra specification.        |
| 100%   | Pre-cap visual inspection                                                                | --     | --  | --  | --    | Per Integra specification.                     |
| 100%   | Gross leak test                                                                          | --     | --  | --  | --    | MIL-STD-750D, Method 1071.6, Test Condition C. |
| Note   | Screen 'Q1' = parameter is qualified by assembly and test of 3 pieces minimum per wafer. |        |     |     |       |                                                |
| Note   | Screen 'LM' = parameter is qualified by assembly line monitor.                           |        |     |     |       |                                                |

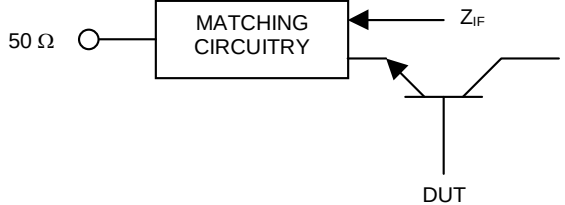
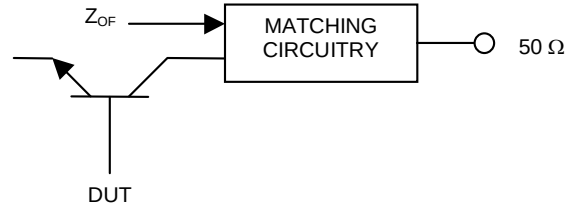
**DC ELECTRICAL CHARACTERISTICS**

| Screen | Parameter                                   | Symbol     | Min | Max | Units | Test Conditions                                     |
|--------|---------------------------------------------|------------|-----|-----|-------|-----------------------------------------------------|
| 100%   | Collector-Emitter Breakdown Voltage         | $BV_{CES}$ | 70  | --  | V     | $I_C=10mA$ , $V_{BE}=0V$ , $T_F=25\pm5^\circ C$ .   |
| 100%   | Zero Base Voltage Collector Leakage Current | $I_{CES}$  | --  | 1.5 | mA    | $V_{CE}=30V$ , $V_{BE}=0V$ , $T_F=25\pm5^\circ C$ . |
| 100%   | DC Current Gain                             | $H_{FE}$   | 10  | 150 | --    | $V_{CE}=5V$ , $I_C=0.1A$ , $T_F=25\pm5^\circ C$ .   |

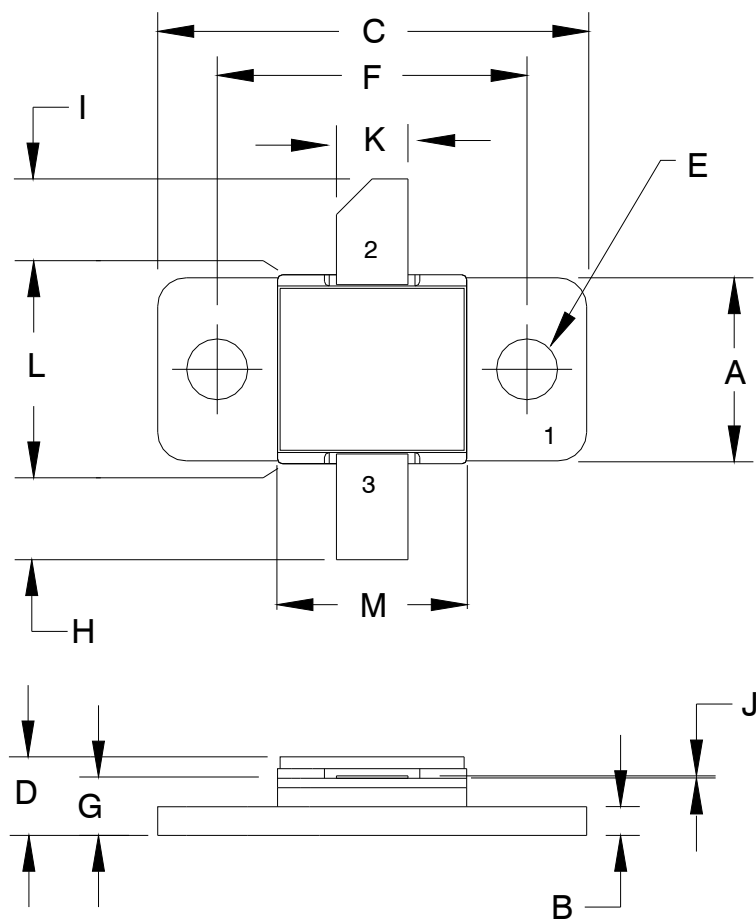
**RF ELECTRICAL CHARACTERISTICS**

| Screen | Parameter                                                                                                                                                 | Symbol   | Min   | Max   | Units | Test Conditions                                                                                                                                                                                                                                                                                                                    |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------|-------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 100%   | Input Return Loss                                                                                                                                         | IRL      | 8     | --    | dB    | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN1}$ , $P_{IN2}$ , $P_{IN3}$ , $F=F1$ , $F2$ , $F3$ .                                                                                                                                                                                                 |
| 100%   | Output Power 1                                                                                                                                            | $P_{O1}$ | 25    | --    | W     | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN1}$ , $F=F1$ .                                                                                                                                                                                                                                       |
| 100%   | Output Power 2                                                                                                                                            | $P_{O2}$ | 25    | --    | W     | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN2}$ , $F=F2$ .                                                                                                                                                                                                                                       |
| 100%   | Output Power 3                                                                                                                                            | $P_{O3}$ | 25    | --    | W     | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN3}$ , $F=F3$ .                                                                                                                                                                                                                                       |
| 100%   | Collector Efficiency ( $P_O/I_C/V_{CC}$ ) 1                                                                                                               | $N_{C1}$ | 36    | --    | %     | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN1}$ , $F=F1$ .                                                                                                                                                                                                                                       |
| 100%   | Collector Efficiency ( $P_O/I_C/V_{CC}$ ) 2                                                                                                               | $N_{C2}$ | 36    | --    | %     | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN2}$ , $F=F2$ .                                                                                                                                                                                                                                       |
| 100%   | Collector Efficiency ( $P_O/I_C/V_{CC}$ ) 3                                                                                                               | $N_{C3}$ | 36    | --    | %     | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN3}$ , $F=F3$ .                                                                                                                                                                                                                                       |
| 100%   | Pulse Amplitude Droop                                                                                                                                     | D        | -0.7  | --    | dB    | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN1}$ , $P_{IN2}$ , $P_{IN3}$ , $F=F1$ , $F2$ , $F3$ .                                                                                                                                                                                                 |
| 100%   | Output Power Flatness $=10*\text{LOG}(P_{OMAX}/P_{OMIN})$                                                                                                 | OPF      | --    | 1.0   | dB    | Calculate from $P_O$ at each frequency $F$ .                                                                                                                                                                                                                                                                                       |
| 100%   | Output Power Compression $=10*\text{LOG}(P_{OC}/P_O)$                                                                                                     | OPC      | -0.02 | +0.52 | dB    | $P_{OC}$ measured with $P_{IN}$ increased by 0.5dB at $F=F1$ , $F2$ , $F3$ .                                                                                                                                                                                                                                                       |
| 100%   | Delta Insertion Phase Variation                                                                                                                           | d-IP     | -30   | +30   | Deg   | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN2}$ , $F=F2$ , Mark in $5^\circ$ increments.                                                                                                                                                                                                         |
| 100%   | Stability into 1.5:1 VSWR                                                                                                                                 | VSWR-S   | --    | --    | --    | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN1} + 0.75$ dB, $F=F1$ , $F2$ , $F3$ .<br>Rotate 1.5:1 output VSWR through $360^\circ$ phase.<br>No oscillatory or pulse break-up characteristics allowed on detected output pulse.<br>All non-harmonically related signals must be at least -65 dBc. |
| 100%   | 3:1 Load Mismatch Tolerance                                                                                                                               | LMT      | --    | --    | --    | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN1}$ , $P_{IN2}$ , $P_{IN3}$ , $F=F1$ , $F2$ , $F3$ .<br>Rotate 3:1 output VSWR through $360^\circ$ phase.<br>Post test $P_O = \text{Pre test } P_O \pm 0.20$ dB.                                                                                     |
| BD     | Pulse Rise time                                                                                                                                           | RT       | --    | 150   | ns    | $V_{CC}=V1$ , $PW=PW1$ , $DF=DF1$ , $T_F=25\pm5^\circ\text{C}$ , $P_{IN}=P_{IN1}$ , $P_{IN2}$ , $P_{IN3}$ , $F=F1$ , $F2$ , $F3$ .<br>Measure between 10% and 90% detected power points.                                                                                                                                           |
| Note   | $V1 = 36\text{V}$ ; $PW1 = 200\mu\text{s}$ ; $DF1 = 10\%$ ; $P_{IN1} = P_{IN2} = P_{IN3} = 2.8\text{W}$ ; $F1 = 2.7$ GHz, $F2 = 2.9$ GHz, $F3 = 3.1$ GHz. |          |       |       |       |                                                                                                                                                                                                                                                                                                                                    |
| Note   | $T_F$ = Device flange temperature.                                                                                                                        |          |       |       |       |                                                                                                                                                                                                                                                                                                                                    |
| Note   | Parts are binned and marked in 5 degree increments for Insertion Phase IP : ITI -1, -2, -3, -4, -5, -6, -7, -8, -9, -10, -11, -12.                        |          |       |       |       |                                                                                                                                                                                                                                                                                                                                    |
| Note   | Screen 'BD' = parameter qualified By Design.                                                                                                              |          |       |       |       |                                                                                                                                                                                                                                                                                                                                    |

**BROADBAND RF TEST FIXTURE IMPEDANCE CHARACTERISTICS**

| Frequency (GHz)      | $Z_{IF}$ ( $\Omega$ )                                                                | $Z_{OF}$ ( $\Omega$ )                                                                 |
|----------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 2.7                  | 5.70 -j 9.16                                                                         | 20.17 -j 4.94                                                                         |
| 2.9                  | 4.70 -j 8.0                                                                          | 14.47 -j 5.18                                                                         |
| 3.1                  | 4.10 -j 7.0                                                                          | 12 -j 3.46                                                                            |
| Impedance Definition |  |  |

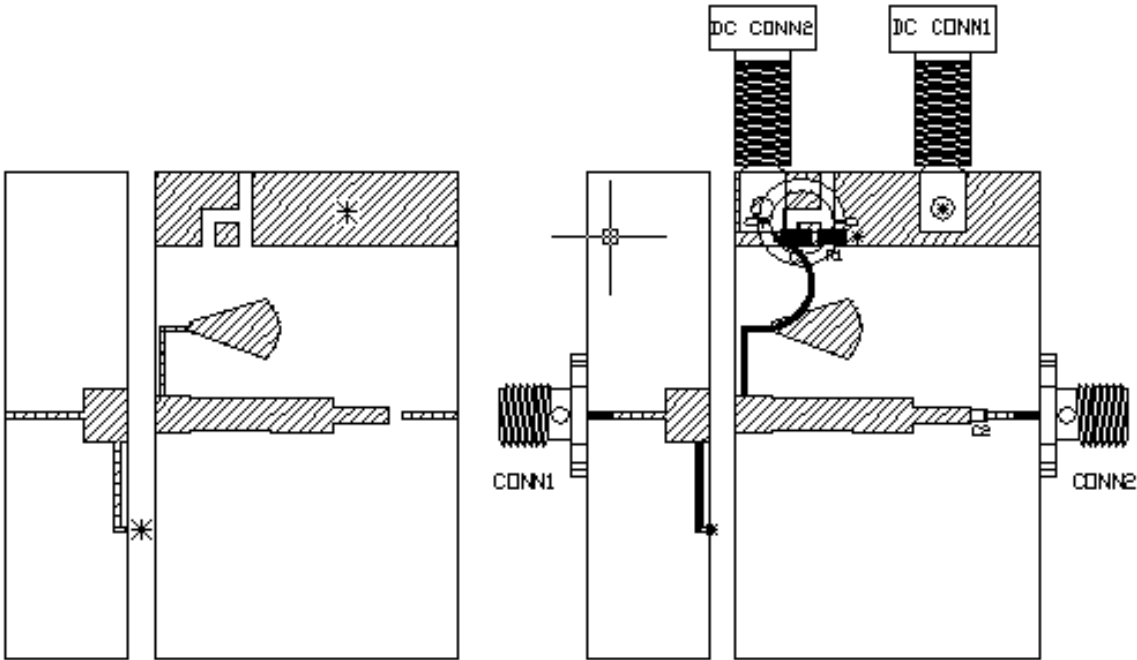
**PACKAGE DIMENSIONAL OUTLINE DRAWING**



| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.380  | 0.390 | 9.65        | 9.91  |
| B   | 0.058  | 0.062 | 1.47        | 1.57  |
| C   | 0.895  | 0.905 | 22.73       | 22.99 |
| D   | 0.155  | 0.175 | 3.93        | 4.44  |
| E   | 0.125  | 0.135 | 3.18        | 3.43  |
| F   | 0.645  | 0.655 | 16.38       | 16.64 |
| G   | 0.112  | 0.132 | 2.84        | 3.35  |
| H   | 0.190  | 0.210 | 4.82        | 5.33  |
| I   | 0.190  | 0.210 | 4.82        | 5.33  |
| J   | 0.002  | 0.005 | 0.05        | 0.13  |
| K   | 0.140  | 0.160 | 3.55        | 4.06  |
| L   | 0.392  | 0.402 | 9.95        | 10.21 |
| M   | 0.392  | 0.402 | 9.95        | 10.21 |

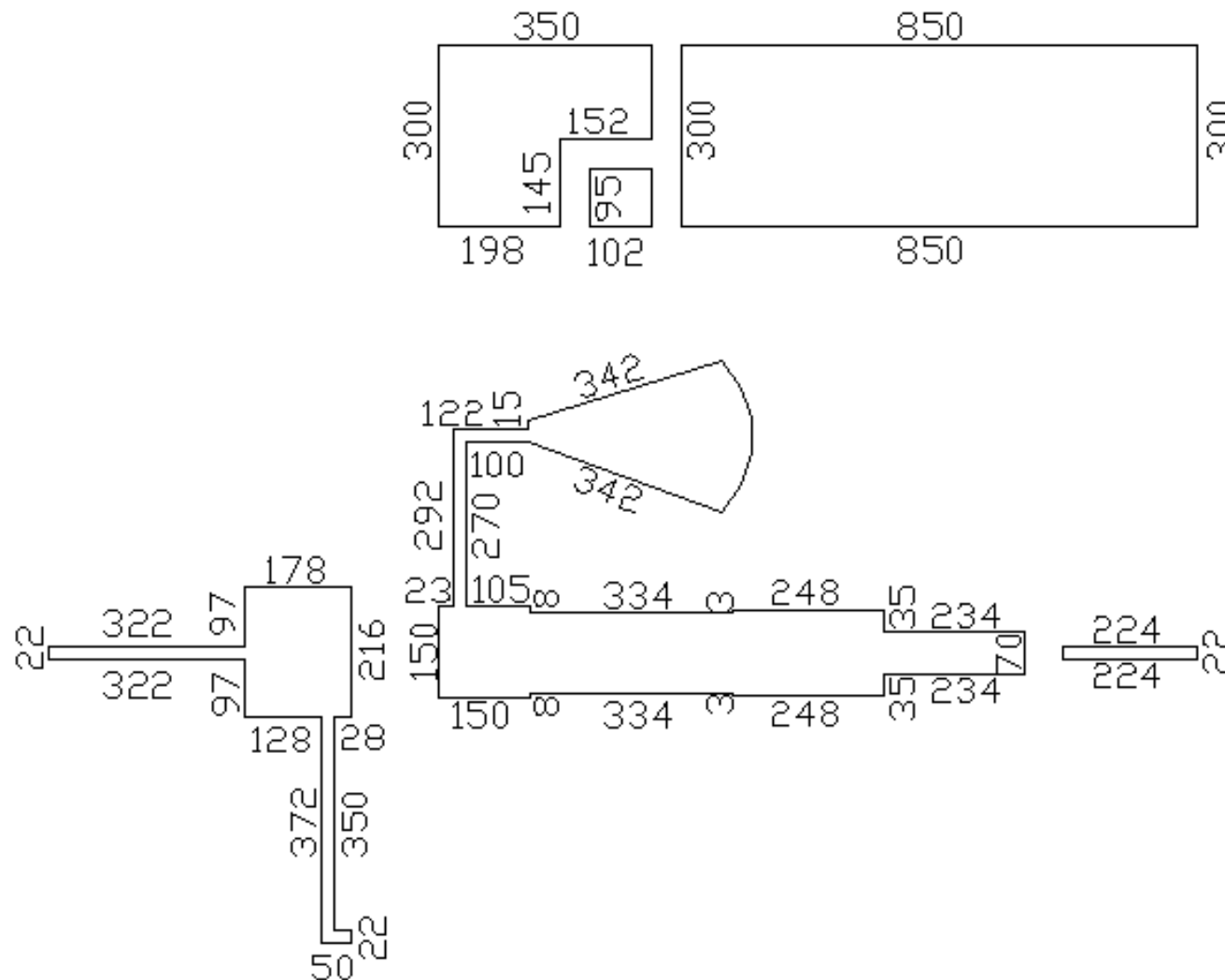
| PIN |           |
|-----|-----------|
| 1   | BASE      |
| 2   | COLLECTOR |
| 3   | EMITTER   |

BROADBAND RF TEST FIXTURE

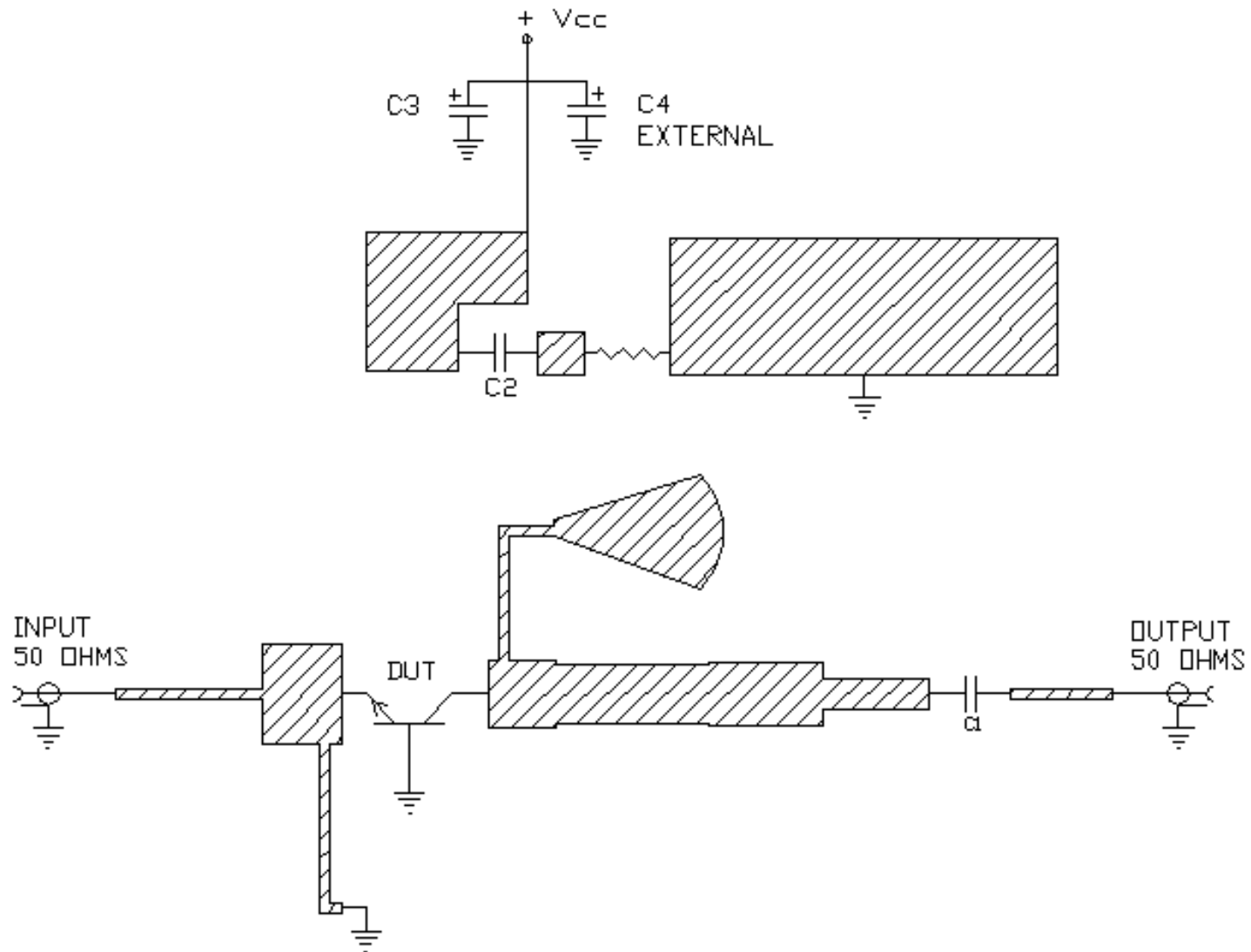


| COMPONENT               | DESCRIPTION                                     |
|-------------------------|-------------------------------------------------|
| DUT                     | TRANSISTOR #IB2731MH25, MOUNT HARD TO THE RIGHT |
| PC BOARD                | ROGERS #RD6010.2LM, TH=0.025" 1oz. Cu           |
| C1                      | SNOB CAPACITOR, 0.1uF                           |
| C2                      | CHIP CAPACITOR 39pF                             |
| C3                      | ELECTROLYTIC CAPACITOR 68uF/63V                 |
| C4 (NOT SHOWN)          | ELECTROLYTIC CAPACITOR 4700uF/50V               |
| R1                      | SNOB RESISTOR 6.81 OHMS                         |
| GS                      | GROUND SHIM, COPPER, TH=0.001"                  |
| CONN1, CONN2            | SMA CONNECTOR, TYPE DS #2052-5636-02            |
| INPUT PC BOARD CARRIER  | 2 INCH BRASS - 01 (0.5")                        |
| OUTPUT PC BOARD CARRIER | 2 INCH BRASS - 04 (1.25")                       |
| TRANSISTOR CARRIER      | 2 INCH COPPER - 02                              |
| TRANSISTOR CLAMP        | NORYL CLAMP - 02                                |
| HEATSINK                | 2 INCH HEATSINK - 09                            |
| DC CONN1                | BANANA JACK, BLACK                              |
| DC CONN2                | BANANA JACK, RED                                |
| NOTE                    | FIXTURE HARDWARE DRAWINGS AVAILABLE ON REQUEST  |

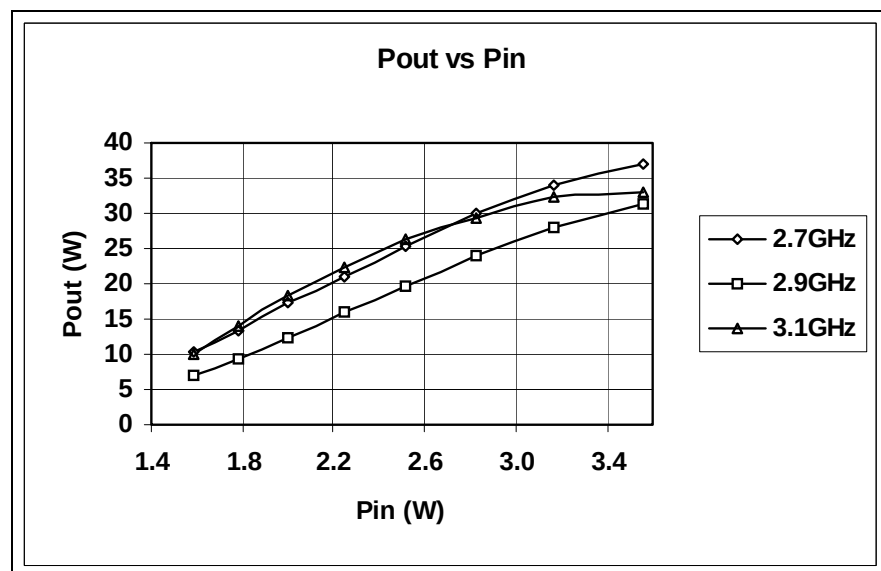
ASSEMBLY AND PARTS LIST



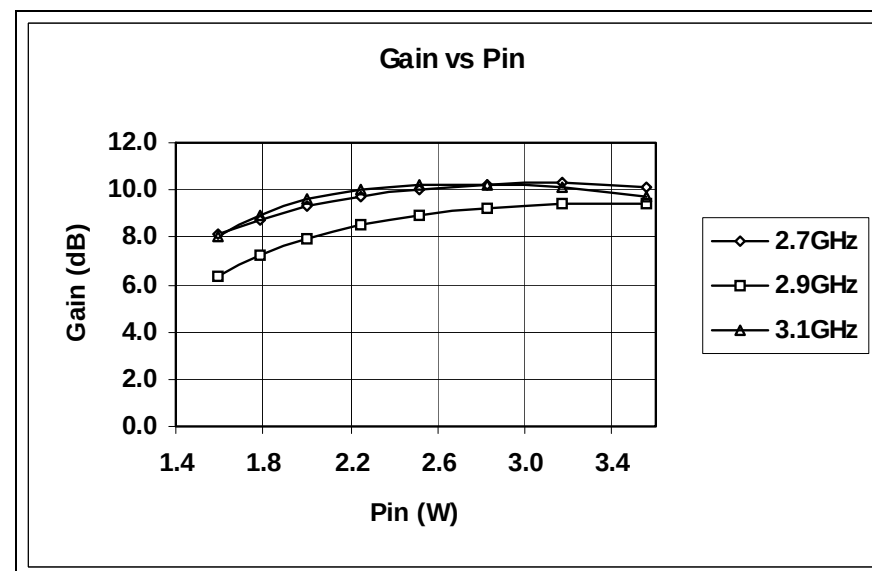
**CIRCUIT DIMENSIONS IN MILS**



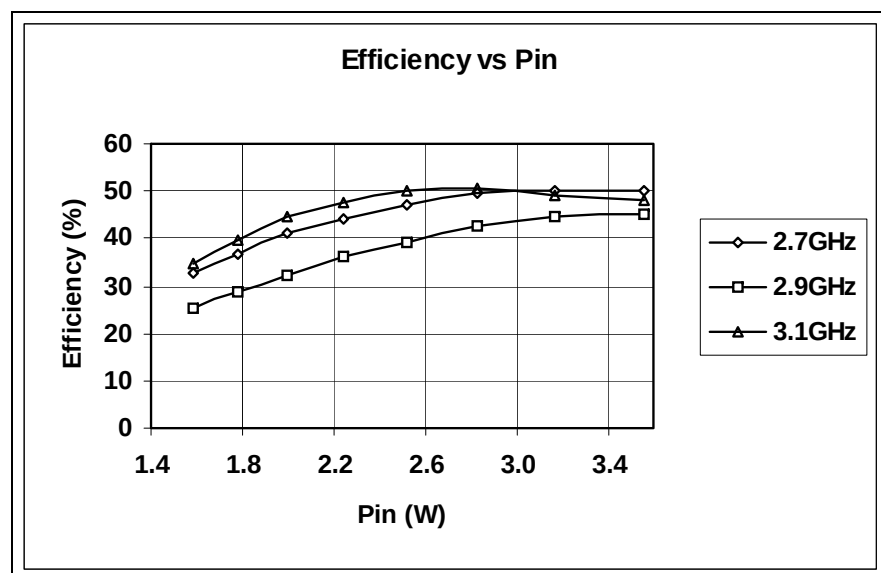
**ELECTRICAL SCHEMATIC**



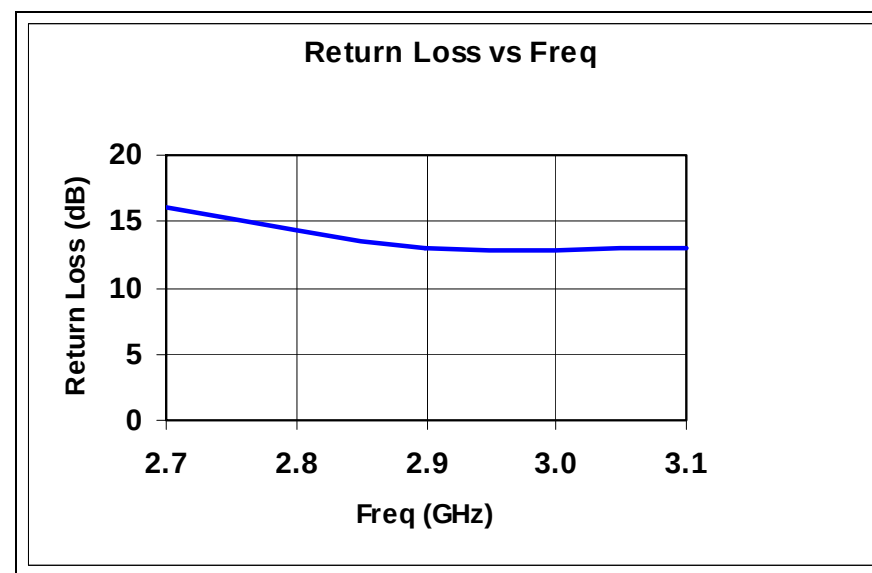
Typical values,  $V_{cb} = 36\text{ V}$ ,  $200\mu\text{s}$  RF pulse, 10% duty cycle



Typical values,  $V_{cb} = 36\text{ V}$ ,  $200\mu\text{s}$  RF pulse, 10% duty cycle



Typical values,  $V_{cb} = 36\text{ V}$ ,  $200\mu\text{s}$  RF pulse, 10% duty cycle



Typical values,  $V_{cb} = 36\text{ V}$ ,  $200\mu\text{s}$  RF pulse, 10% duty cycle,  $P_{in} = 3.3\text{ W}$



**DEFINITIONS**

| <b>Data Sheet Status</b>                                                                                                                                                                                                                                                                                                                                               |                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Proposed Specification                                                                                                                                                                                                                                                                                                                                                 | This data sheet contains proposed specifications.                                   |
| Preliminary Specification                                                                                                                                                                                                                                                                                                                                              | This data sheet contains specifications based on preliminary measurements and data. |
| Product Specification                                                                                                                                                                                                                                                                                                                                                  | This data sheet contains final product specifications.                              |
| <b>Maximum Ratings</b>                                                                                                                                                                                                                                                                                                                                                 |                                                                                     |
| Stress above one or more of the maximum ratings may cause permanent damage to the device. These are maximum ratings only and operation of the device at these or at any other conditions above those given in the characteristics sections of the specification is not implied. Exposure to maximum values for extended periods of time may affect device reliability. |                                                                                     |

**WARNING**

| <b>Product and environmental safety - toxic materials</b>                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| This product contains beryllium oxide. The product is entirely safe provided that the BeO base is not damaged. All persons who handle, use or dispose of this product should be aware of its nature and of the necessary safety precautions. After use, dispose of as chemical or special waste according to the regulations applying at the location of the user. It must never be thrown out with general or domestic waste. |

**DISCLAIMER**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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