

# RF LDMOS Wideband Integrated Power Amplifiers

The MW7IC18100N wideband integrated circuit is designed with on-chip matching that makes it usable from 1805 to 2050 MHz. This multi-stage structure is rated for 24 to 32 Volt operation and covers all typical cellular base station modulations including GSM EDGE and CDMA.

## Final Application

- Typical GSM Performance:  $V_{DD} = 28$  Volts,  $I_{DQ1} = 180$  mA,  $I_{DQ2} = 1000$  mA,  $P_{out} = 100$  Watts CW, 1805-1880 MHz or 1930-1990 MHz  
Power Gain — 30 dB  
Power Added Efficiency — 48%

## GSM EDGE Application

- Typical GSM EDGE Performance:  $V_{DD} = 28$  Volts,  $I_{DQ1} = 215$  mA,  $I_{DQ2} = 800$  mA,  $P_{out} = 40$  Watts Avg., 1805-1880 MHz or 1930-1990 MHz  
Power Gain — 31 dB  
Power Added Efficiency — 35%  
Spectral Regrowth @ 400 kHz Offset = -63 dBc  
Spectral Regrowth @ 600 kHz Offset = -80 dBc  
EVM — 1.5% rms
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 1990 MHz, 100 Watts CW Output Power
- Stable into a 5:1 VSWR. All Spurs Below -60 dBc @ 1 mW to 120 Watts CW  $P_{out}$ .

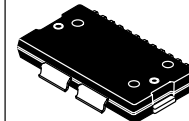
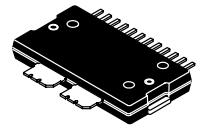
## Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source Scattering Parameters
- On-Chip Matching (50 Ohm Input, DC Blocked)
- Integrated Quiescent Current Temperature Compensation with Enable/Disable Function (1)
- Integrated ESD Protection
- 225°C Capable Plastic Package
- RoHS Compliant
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.

**MW7IC18100NR1**  
**MW7IC18100GNR1**  
**MW7IC18100NBR1**

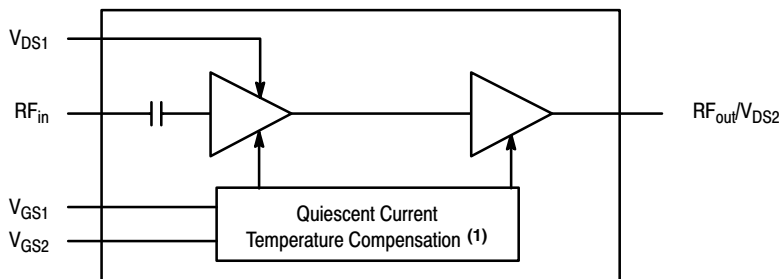
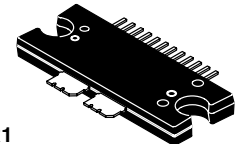
**1990 MHz, 100 W, 28 V**  
**GSM/GSM EDGE**  
**RF LDMOS WIDEBAND**  
**INTEGRATED POWER AMPLIFIERS**

**CASE 1618-02**  
**TO-270 WB-14**  
**PLASTIC**  
**MW7IC18100NR1**

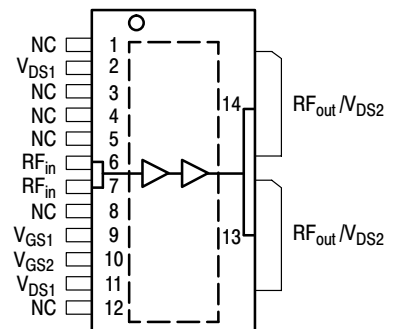


**CASE 1621-02**  
**TO-270 WB-14 GULL**  
**PLASTIC**  
**MW7IC18100GNR1**

**CASE 1617-02**  
**TO-272 WB-14**  
**PLASTIC**  
**MW7IC18100NBR1**



**Figure 1. Functional Block Diagram**



(Top View)

Note: Exposed backside of the package is the source terminal for the transistors.

**Figure 2. Pin Connections**

1. Refer to AN1977, Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family and to AN1987, Quiescent Current Control for the RF Integrated Circuit Device Family. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1977 or AN1987.

**Table 1. Maximum Ratings**

| Rating                               | Symbol    | Value       | Unit |
|--------------------------------------|-----------|-------------|------|
| Drain-Source Voltage                 | $V_{DS}$  | -0.5, +65   | Vdc  |
| Gate-Source Voltage                  | $V_{GS}$  | -0.5, +6    | Vdc  |
| Storage Temperature Range            | $T_{stg}$ | -65 to +150 | °C   |
| Case Operating Temperature           | $T_C$     | 150         | °C   |
| Operating Junction Temperature (1,2) | $T_J$     | 225         | °C   |

**Table 2. Thermal Characteristics**

| Characteristic                                                                     | Symbol          | Value (2,3) | Unit |
|------------------------------------------------------------------------------------|-----------------|-------------|------|
| Thermal Resistance, Junction to Case<br>GSM Application<br>( $P_{out} = 100$ W CW) | $R_{\theta JC}$ | 2.0<br>0.51 | °C/W |
| Stage 1, 28 Vdc, $I_{DQ1} = 180$ mA                                                |                 |             |      |
| Stage 2, 28 Vdc, $I_{DQ2} = 1000$ mA                                               |                 |             |      |

**Table 3. ESD Protection Characteristics**

| Test Methodology                      | Class         |
|---------------------------------------|---------------|
| Human Body Model (per JESD22-A114)    | 1 (Minimum)   |
| Machine Model (per EIA/JESD22-A115)   | A (Minimum)   |
| Charge Device Model (per JESD22-C101) | III (Minimum) |

**Table 4. Moisture Sensitivity Level**

| Test Methodology                      | Rating | Package Peak Temperature | Unit |
|---------------------------------------|--------|--------------------------|------|
| Per JESD 22-A113, IPC/JEDEC J-STD-020 | 3      | 260                      | °C   |

**Table 5. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**Functional Tests** (4) (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28$  Vdc,  $P_{out} = 100$  W CW,  $I_{DQ1} = 180$  mA,  $I_{DQ2} = 1000$  mA,  $f = 1990$  MHz.

|                                        |          |     |     |     |    |
|----------------------------------------|----------|-----|-----|-----|----|
| Power Gain                             | $G_{ps}$ | 27  | 30  | 31  | dB |
| Input Return Loss                      | IRL      | —   | -15 | -10 | dB |
| Power Added Efficiency                 | PAE      | 45  | 48  | —   | %  |
| $P_{out}$ @ 1 dB Compression Point, CW | P1dB     | 100 | 112 | —   | W  |

**Typical GSM EDGE Performances** (In Freescale GSM EDGE Test Fixture, 50 ohm system)  $V_{DD} = 28$  Vdc,  $I_{DQ1} = 215$  mA,  $I_{DQ2} = 800$  mA,  $P_{out} = 40$  W Avg., 1805-1880 MHz or 1930-1990 MHz EDGE Modulation.

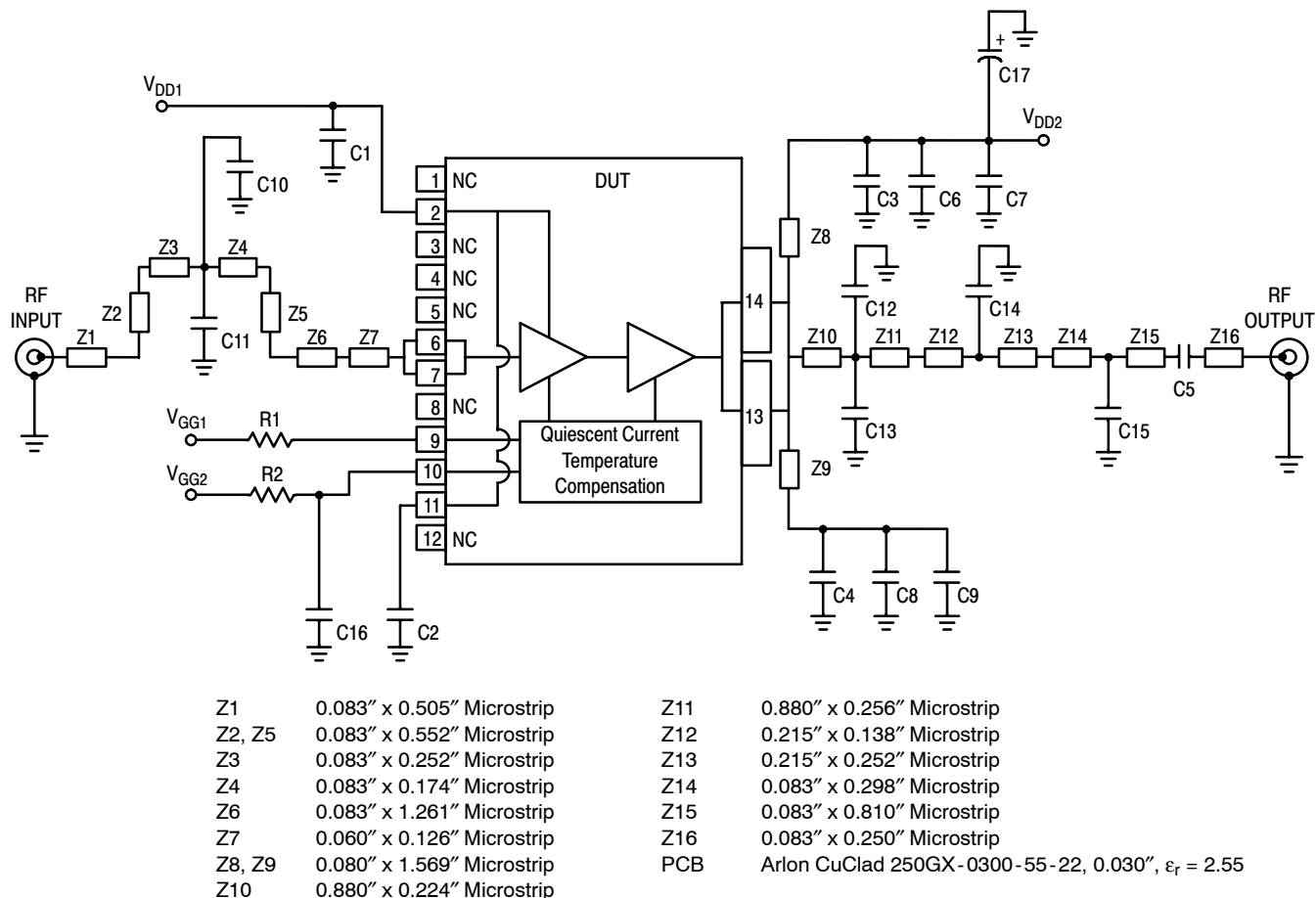
|                                     |          |   |     |   |       |
|-------------------------------------|----------|---|-----|---|-------|
| Power Gain                          | $G_{ps}$ | — | 31  | — | dB    |
| Power Added Efficiency              | PAE      | — | 35  | — | %     |
| Error Vector Magnitude              | EVM      | — | 1.5 | — | % rms |
| Spectral Regrowth at 400 kHz Offset | SR1      | — | -63 | — | dBc   |
| Spectral Regrowth at 600 kHz Offset | SR2      | — | -80 | — | dBc   |

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.
4. Measurement made with device in straight lead configuration before any lead forming operation is applied.

(continued)

**Table 5. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted) (continued)

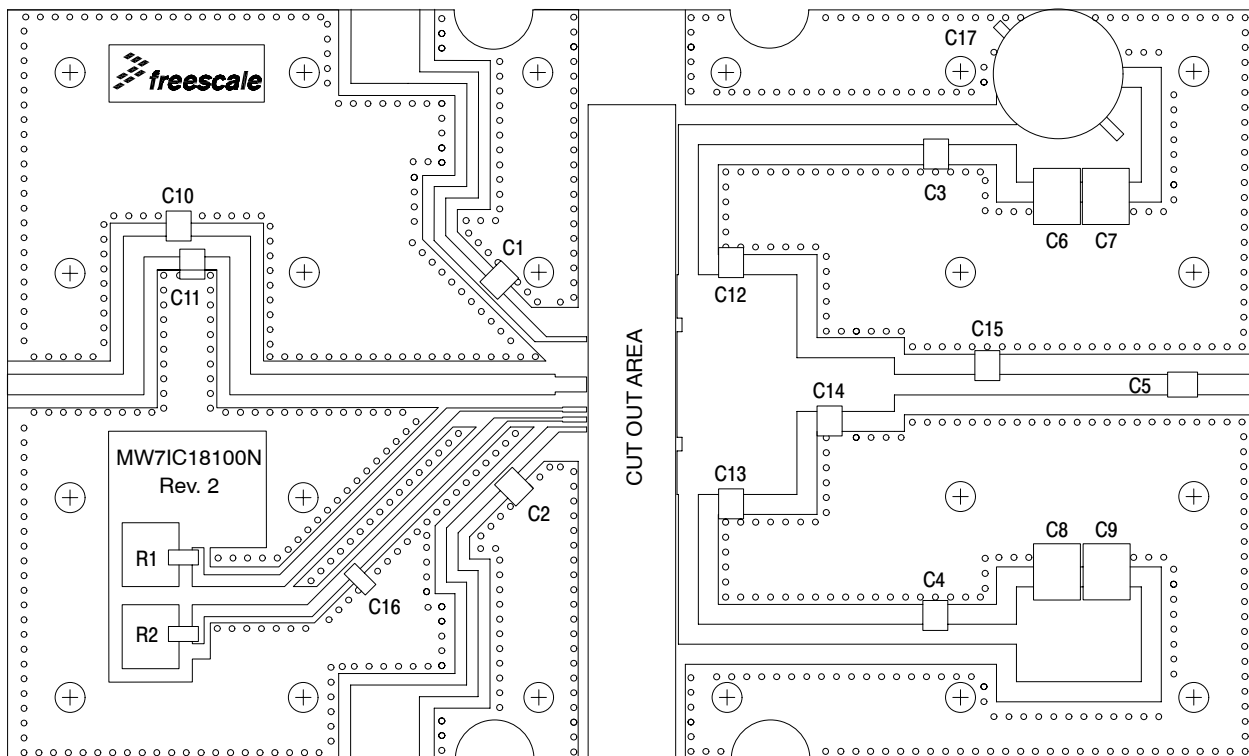
| Characteristic                                                                                                                                                                     | Symbol           | Min | Typ   | Max | Unit   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----|-------|-----|--------|
| <b>Typical Performances</b> (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$ , $I_{DQ1} = 180\text{ mA}$ , $I_{DQ2} = 1000\text{ mA}$ , 1930-1990 MHz Bandwidth |                  |     |       |     |        |
| Gain Flatness in 60 MHz Bandwidth @ $P_{out} = 100\text{ W CW}$                                                                                                                    | $G_F$            | —   | 0.37  | —   | dB     |
| Average Deviation from Linear Phase in 60 MHz Bandwidth @ $P_{out} = 100\text{ W CW}$                                                                                              | $\Phi$           | —   | 0.502 | —   | °      |
| Average Group Delay @ $P_{out} = 100\text{ W CW}$ , $f = 1960\text{ MHz}$                                                                                                          | Delay            | —   | 2.57  | —   | ns     |
| Part-to-Part Insertion Phase Variation @ $P_{out} = 100\text{ W CW}$ , $f = 1960\text{ MHz}$ , Six Sigma Window                                                                    | $\Delta\Phi$     | —   | 63.65 | —   | °      |
| Gain Variation over Temperature (-30°C to +85°C)                                                                                                                                   | $\Delta G$       | —   | 0.048 | —   | dB/°C  |
| Output Power Variation over Temperature (-30°C to +85°C)                                                                                                                           | $\Delta P_{1dB}$ | —   | 0.004 | —   | dBm/°C |



**Figure 3. MW7IC18100NR1(GNR1)(NBR1) Test Circuit Schematic — 1900 MHz**

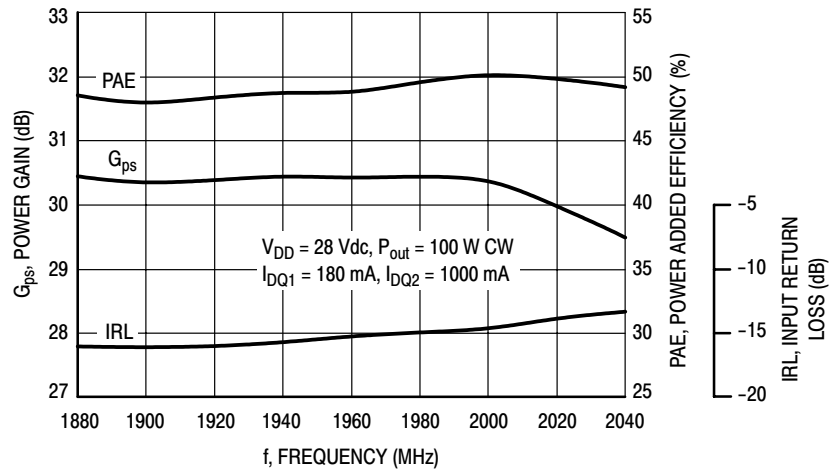
**Table 6. MW7IC18100NR1(GNR1)(NBR1) Test Circuit Component Designations and Values — 1900 MHz**

| Part               | Description                                      | Part Number        | Manufacturer       |
|--------------------|--------------------------------------------------|--------------------|--------------------|
| C1, C2, C3, C4, C5 | 6.8 pF Chip Capacitors                           | ATC100B6R8BT500XT  | ATC                |
| C6, C7, C8, C9     | 10 $\mu$ F, 50 V Chip Capacitors                 | GRM55DR61H106KA88L | Murata             |
| C10, C11           | 0.2 pF Chip Capacitors                           | ATC100B0R2BT500XT  | ATC                |
| C12, C13           | 0.5 pF Chip Capacitors                           | ATC100B0R5BT500XT  | ATC                |
| C14                | 0.8 pF Chip Capacitor                            | ATC100B0R8BT500XT  | ATC                |
| C15                | 1.5 pF Chip Capacitor                            | ATC100B1R5BT500XT  | ATC                |
| C16                | 2.2 $\mu$ F, 16 V Chip Capacitor                 | C1206C225K4RAC     | Kemet              |
| C17                | 470 $\mu$ F, 63 V Electrolytic Capacitor, Radial | 477KXM063M         | Illinois Capacitor |
| R1, R2             | 10 K $\Omega$ , 1/4 W Chip Resistors             | CRCW12061001FKEA   | Vishay             |

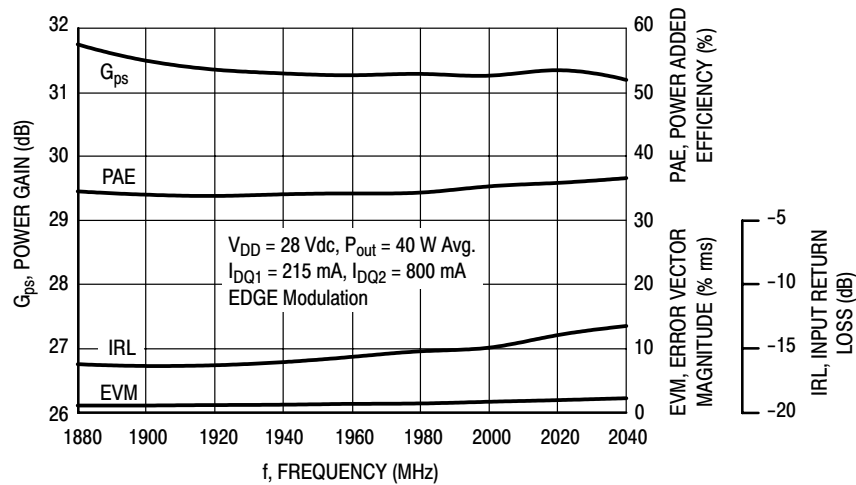


**Figure 4. MW7IC18100NR1(GNR1)(NBR1) Test Circuit Component Layout — 1900 MHz**

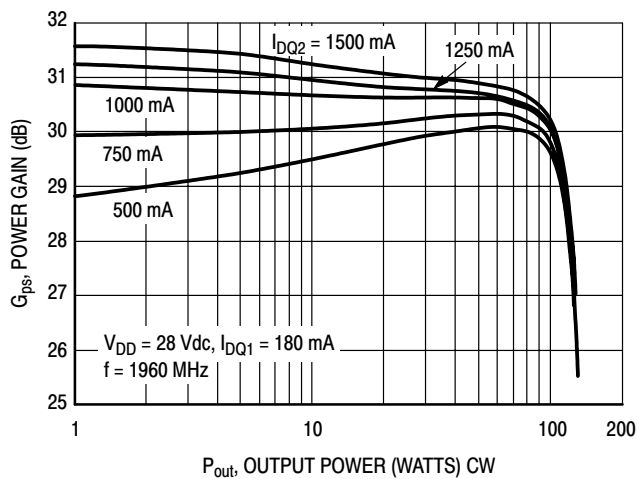
## TYPICAL CHARACTERISTICS — 1900 MHz



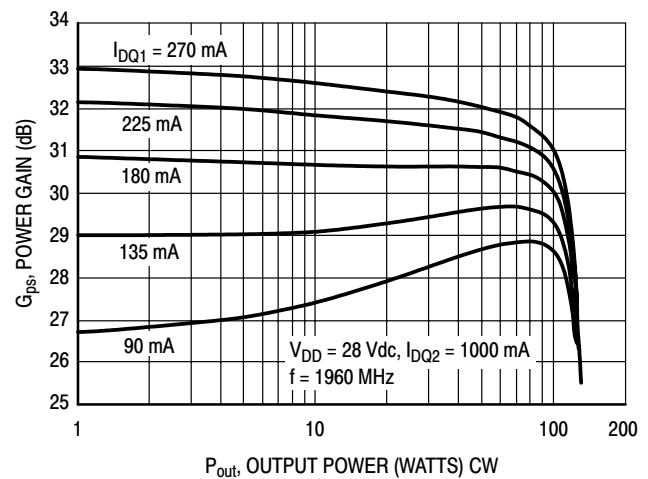
**Figure 5. Power Gain, Input Return Loss and Power Added Efficiency versus Frequency @  $P_{out} = 100$  Watts CW**



**Figure 6. Power Gain, Input Return Loss, EVM and Power Added Efficiency versus Frequency @  $P_{out} = 40$  Watts Avg.**

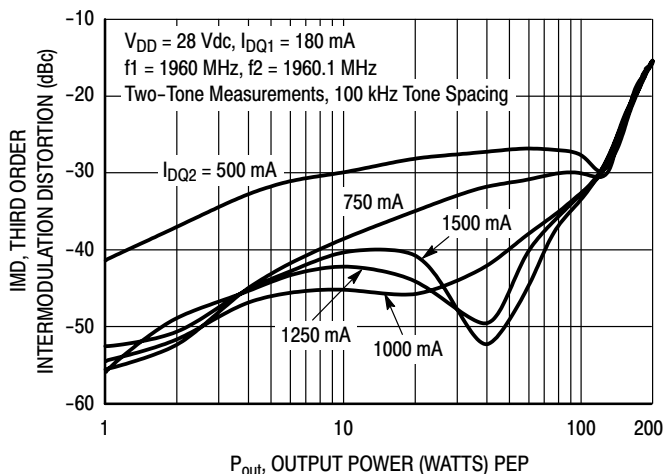


**Figure 7. Two-Tone Power Gain versus Output Power @  $I_{DQ1} = 180$  mA**

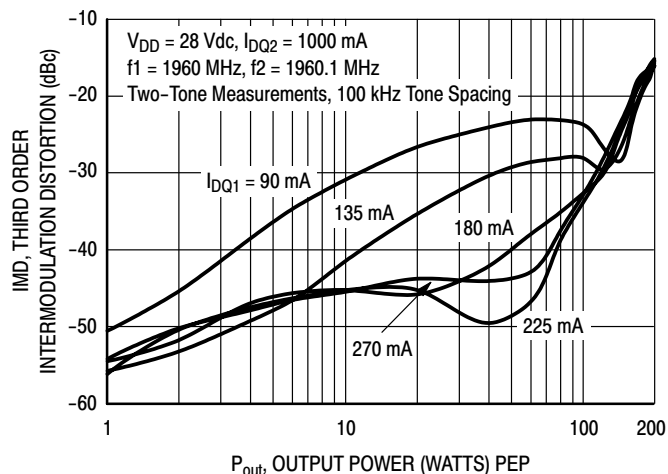


**Figure 8. Two-Tone Power Gain versus Output Power @  $I_{DQ2} = 1000$  mA**

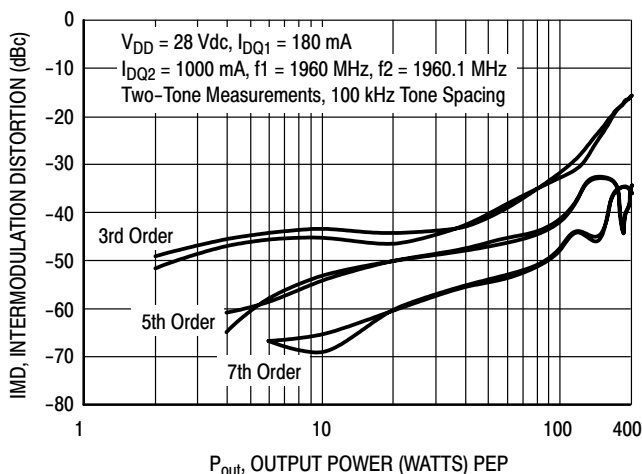
# TYPICAL CHARACTERISTICS — 1900 MHz



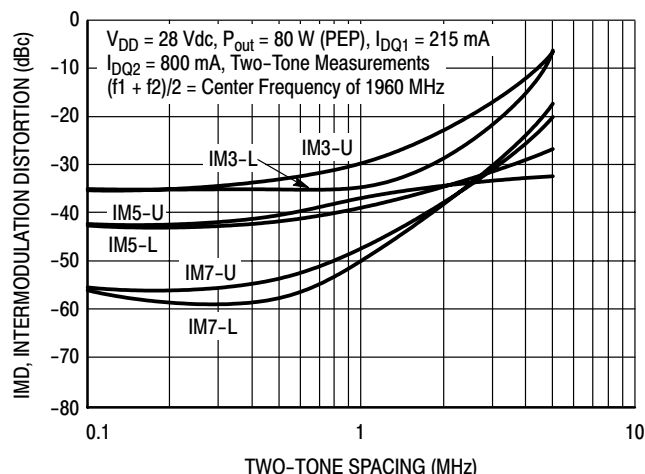
**Figure 9. Third Order Intermodulation Distortion versus Output Power @  $I_{DQ1} = 180$  mA**



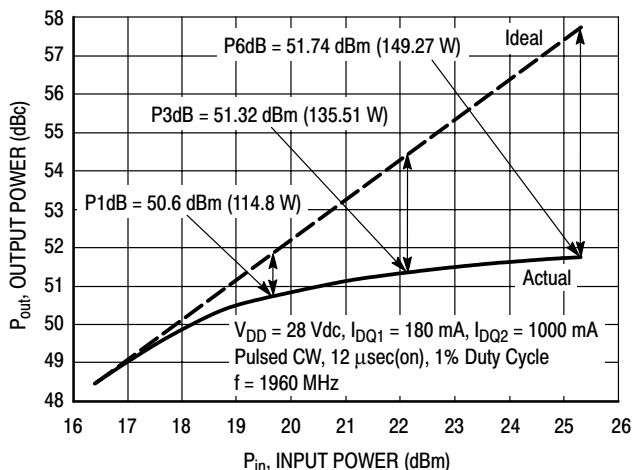
**Figure 10. Third Order Intermodulation Distortion versus Output Power @  $I_{DQ2} = 1000$  mA**



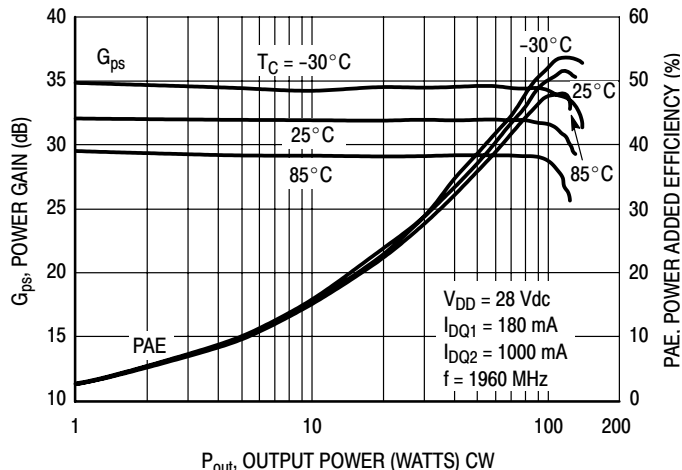
**Figure 11. Intermodulation Distortion Products versus Output Power**



**Figure 12. Intermodulation Distortion Products versus Tone Spacing**



**Figure 13. Pulsed CW Output Power versus Input Power**



**Figure 14. Power Gain and Power Added Efficiency versus Output Power**

MW7IC18100NR1 MW7IC18100GMR1 MW7IC18100NBR1

## TYPICAL CHARACTERISTICS — 1900 MHz

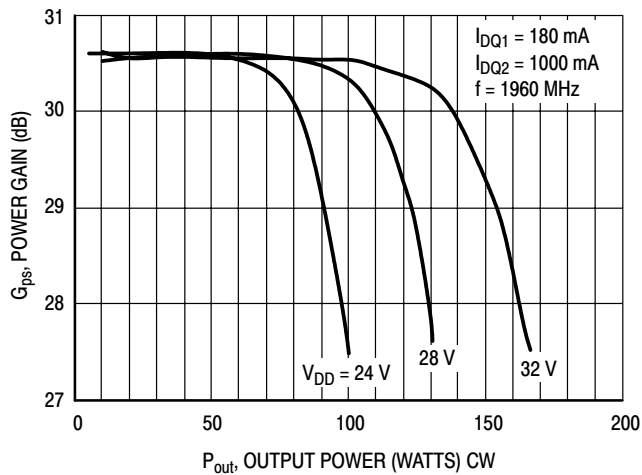


Figure 15. Power Gain versus Output Power

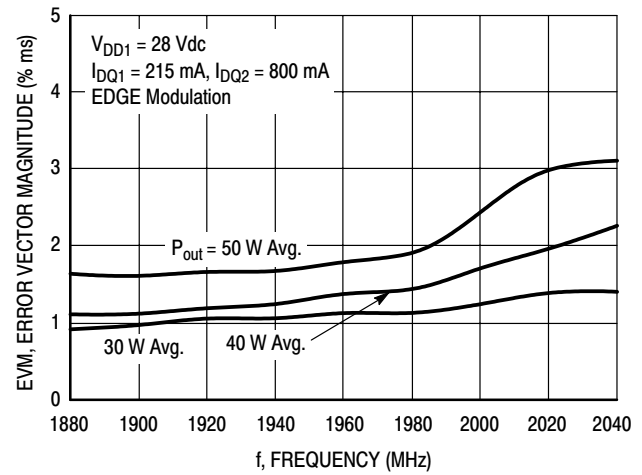


Figure 16. EVM versus Frequency

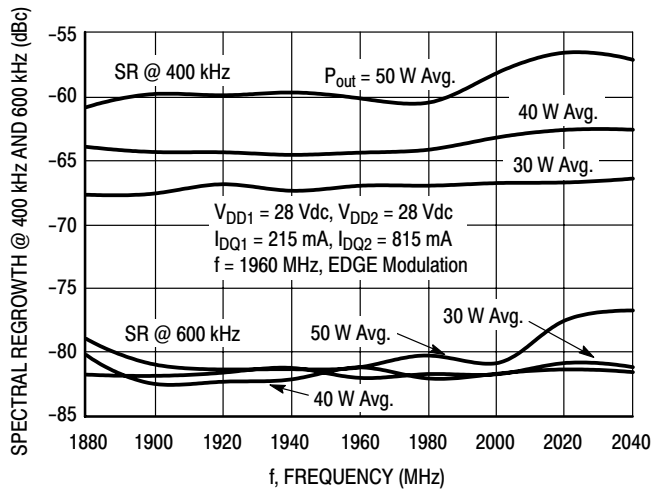


Figure 17. Spectral Regrowth at 400 kHz and 600 kHz versus Frequency

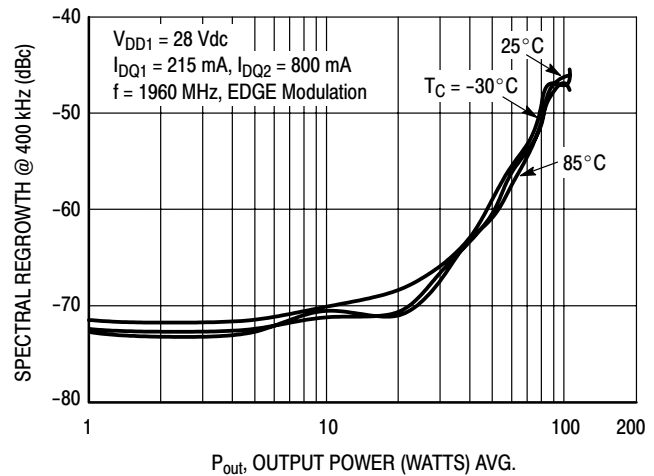


Figure 18. Spectral Regrowth at 400 kHz versus Output Power

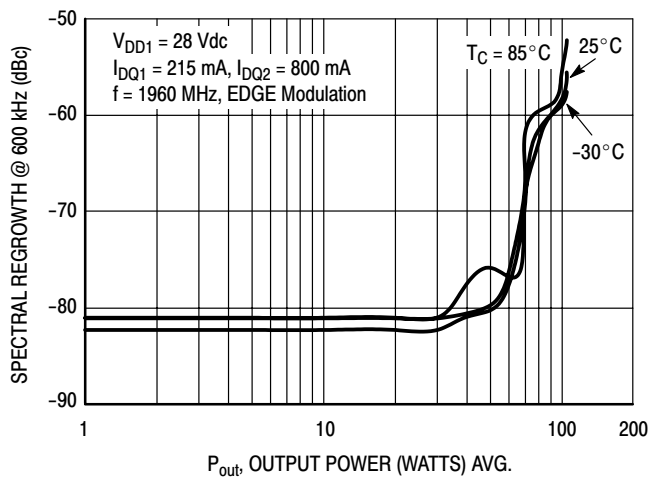


Figure 19. Spectral Regrowth at 600 kHz versus Output Power

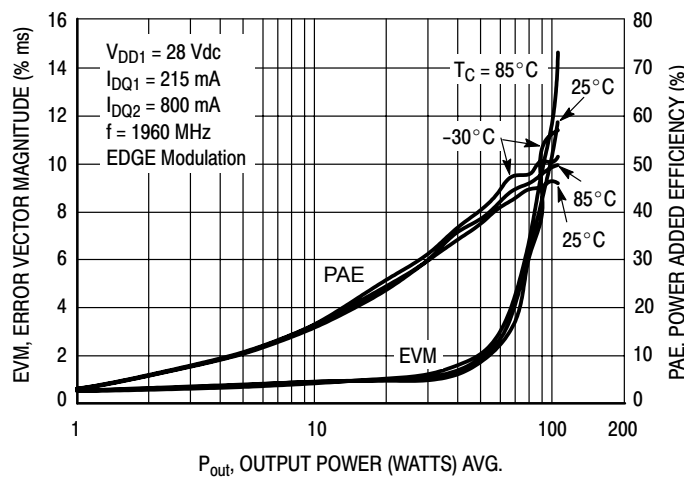


Figure 20. EVM and Power Added Efficiency versus Output Power



# TYPICAL CHARACTERISTICS — 1900 MHz

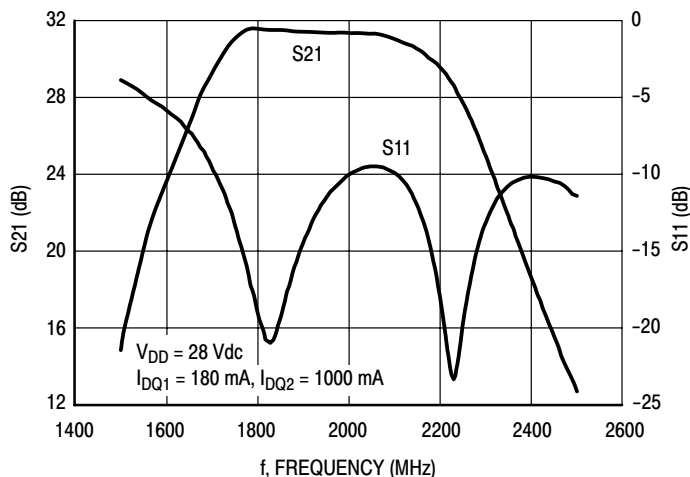


Figure 21. Broadband Frequency Response

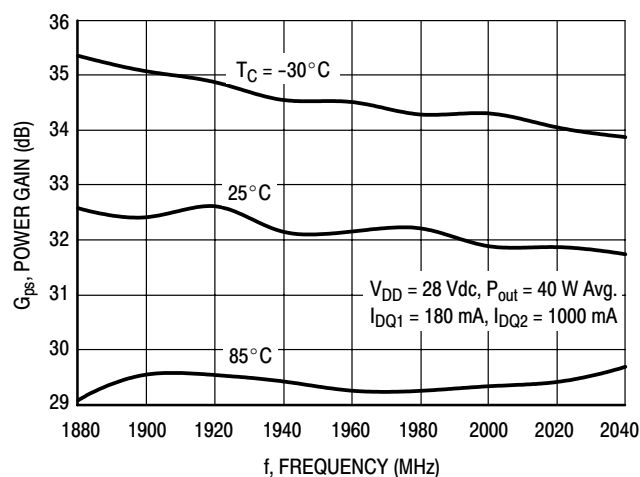
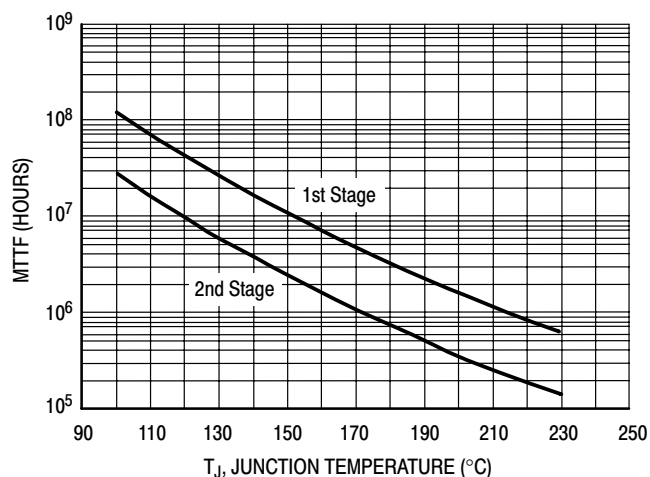


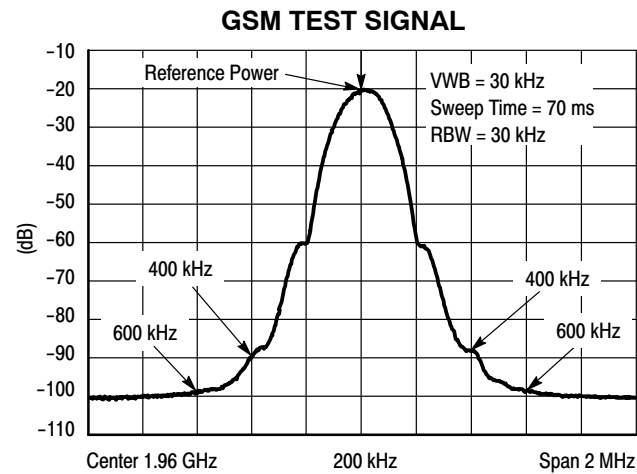
Figure 22. Power Gain versus Frequency



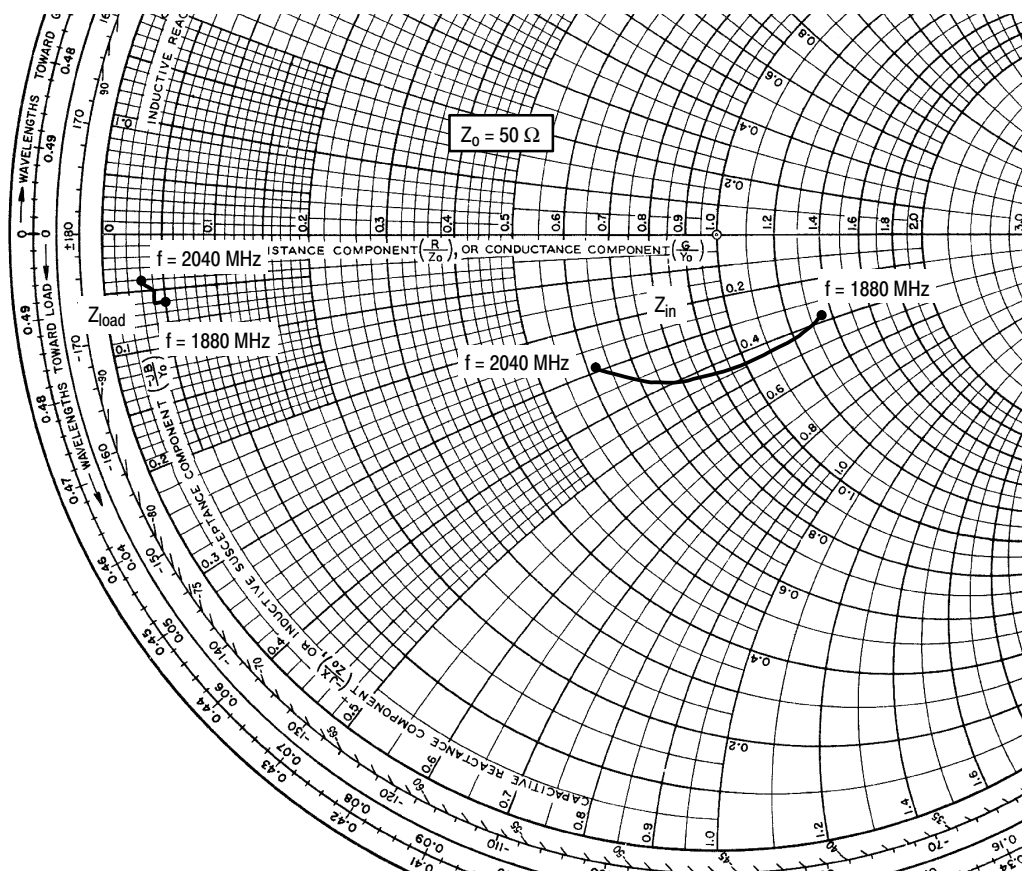
This above graph displays calculated MTTF in hours when the device is operated at  $V_{DD} = 28 \text{ Vdc}$ ,  $P_{out} = 100 \text{ W CW}$ , and  $PAE = 48\%$ .

MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

Figure 23. MTTF versus Junction Temperature



**Figure 24. EDGE Spectrum**



$V_{DD1} = V_{DD2} = 28 \text{ Vdc}$ ,  $I_{DQ1} = 180 \text{ mA}$ ,  $I_{DQ2} = 1000 \text{ mA}$ ,  $P_{out} = 100 \text{ W CW}$

| f<br>MHz | $Z_{in}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|----------------------|------------------------|
| 1880     | $67.48 - j17.89$     | $2.324 - j3.239$       |
| 1900     | $60.03 - j20.86$     | $2.234 - j3.105$       |
| 1920     | $53.65 - j21.94$     | $2.135 - j2.965$       |
| 1940     | $48.13 - j21.94$     | $2.037 - j2.818$       |
| 1960     | $43.52 - j21.22$     | $1.936 - j2.666$       |
| 1980     | $39.60 - j20.00$     | $1.851 - j2.509$       |
| 2000     | $36.14 - j18.52$     | $1.765 - j2.355$       |
| 2020     | $33.19 - j16.57$     | $1.669 - j2.193$       |
| 2040     | $30.96 - j14.58$     | $1.559 - j2.012$       |

$Z_{in}$  = Device input impedance as measured from gate to ground.

$Z_{load}$  = Test circuit impedance as measured from drain to ground.

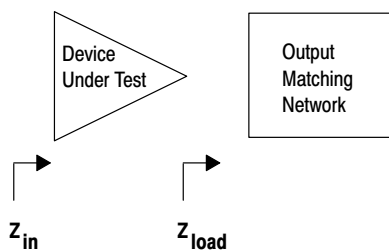
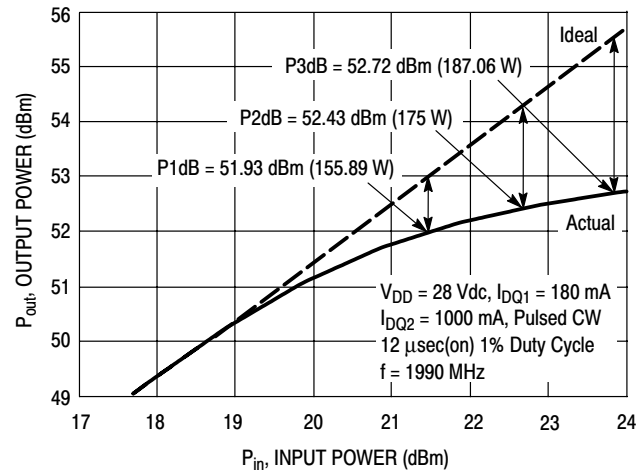


Figure 25. Series Equivalent Input and Load Impedance — 1900 MHz

**Table 7. Common Source S-Parameters ( $V_{DD} = 28\text{ V}$ ,  $I_{DQ1} = 180\text{ mA}$ ,  $I_{DQ2} = 1000\text{ mA}$ ,  $T_C = 25^\circ\text{C}$ , 50 Ohm System)**

| f<br>MHz | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               |
|----------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|
|          | S <sub>11</sub> | $\angle \phi$ | S <sub>21</sub> | $\angle \phi$ | S <sub>12</sub> | $\angle \phi$ | S <sub>22</sub> | $\angle \phi$ |
| 1500     | 0.612           | 118.5         | 6.369           | 69.06         | 0.002           | 102.9         | 0.615           | 47.74         |
| 1550     | 0.557           | 104.3         | 11.42           | 18.29         | 0.003           | 85.09         | 0.666           | -41.54        |
| 1600     | 0.491           | 88.33         | 16.92           | -34.34        | 0.005           | 59.06         | 0.844           | -113.4        |
| 1650     | 0.410           | 70.24         | 23.21           | -84.03        | 0.005           | 28.40         | 0.931           | -163.4        |
| 1700     | 0.313           | 48.99         | 30.49           | -135.7        | 0.006           | 7.983         | 0.887           | 155.6         |
| 1750     | 0.216           | 21.99         | 32.64           | 168.8         | 0.007           | -15.63        | 0.700           | 120.3         |
| 1800     | 0.131           | -22.83        | 32.93           | 114.0         | 0.006           | -35.27        | 0.475           | 95.71         |
| 1850     | 0.117           | -95.13        | 32.62           | 65.01         | 0.006           | -53.22        | 0.332           | 82.10         |
| 1900     | 0.185           | -146.3        | 32.58           | 20.45         | 0.006           | -77.03        | 0.252           | 68.30         |
| 1950     | 0.253           | -177.3        | 32.45           | -22.53        | 0.007           | -98.93        | 0.165           | 47.02         |
| 2000     | 0.303           | 160.4         | 32.41           | -65.29        | 0.007           | -108.4        | 0.052           | 8.742         |
| 2050     | 0.328           | 139.5         | 32.33           | -108.6        | 0.006           | -127.3        | 0.070           | -154.8        |
| 2100     | 0.331           | 117.9         | 32.50           | -152.7        | 0.008           | -145.8        | 0.161           | 179.9         |
| 2150     | 0.273           | 91.65         | 32.84           | 160.2         | 0.008           | -169.1        | 0.257           | 165.7         |
| 2200     | 0.141           | 64.27         | 32.52           | 109.2         | 0.008           | 162.7         | 0.424           | 150.3         |
| 2250     | 0.050           | 172.7         | 28.92           | 56.72         | 0.009           | 138.3         | 0.641           | 123.4         |
| 2300     | 0.194           | 163.4         | 21.30           | 8.112         | 0.007           | 112.6         | 0.804           | 91.99         |
| 2350     | 0.270           | 139.7         | 14.62           | -34.53        | 0.007           | 97.74         | 0.879           | 62.03         |
| 2400     | 0.288           | 118.9         | 9.878           | -72.70        | 0.007           | 84.37         | 0.910           | 34.57         |
| 2450     | 0.274           | 100.6         | 6.771           | -107.5        | 0.007           | 70.79         | 0.911           | 8.878         |
| 2500     | 0.236           | 83.35         | 4.579           | -141.3        | 0.007           | 55.31         | 0.903           | -16.73        |

## ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS — 1900 MHz

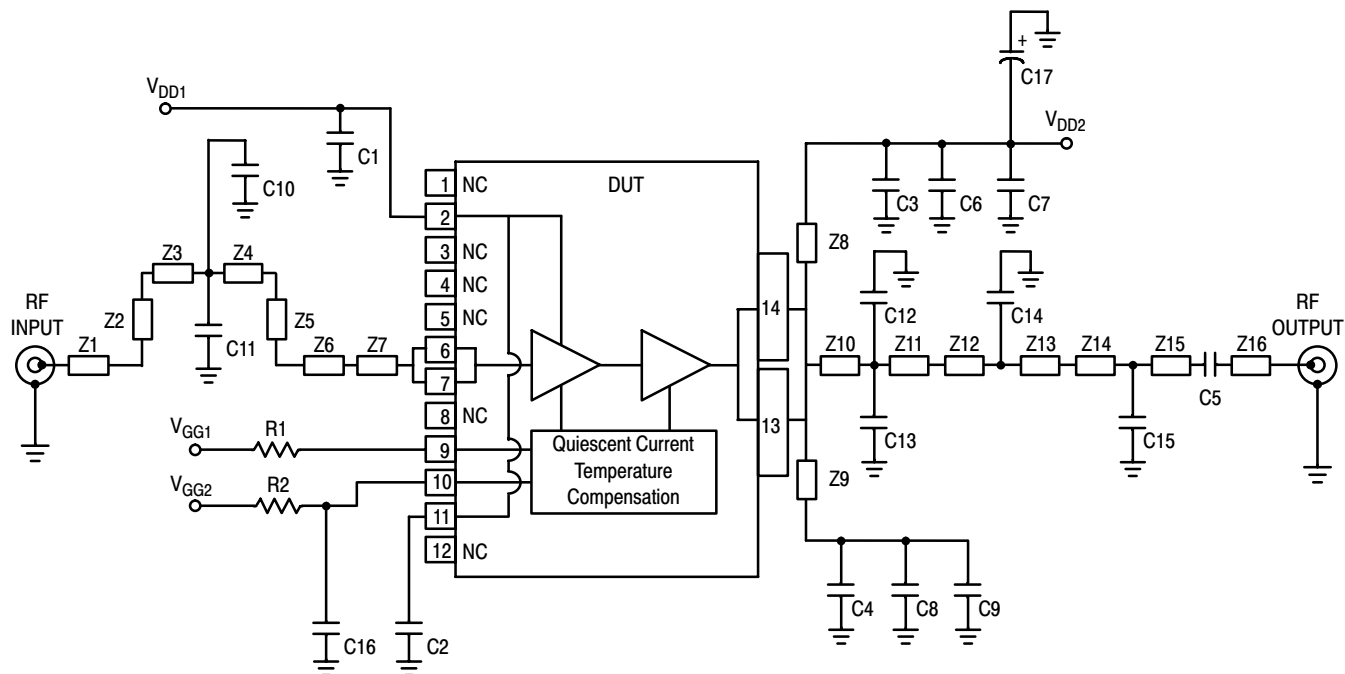


NOTE: Load Pull Test Fixture Tuned for Peak Output Power @ 28 V

Test Impedances per Compression Level

|      | $Z_{\text{source}}$<br>$\Omega$ | $Z_{\text{load}}$<br>$\Omega$ |
|------|---------------------------------|-------------------------------|
| P3dB | $40.2 - j30.91$                 | $0.96 - j3.14$                |

**Figure 26. Pulsed CW Output Power versus Input Power @ 28 V**

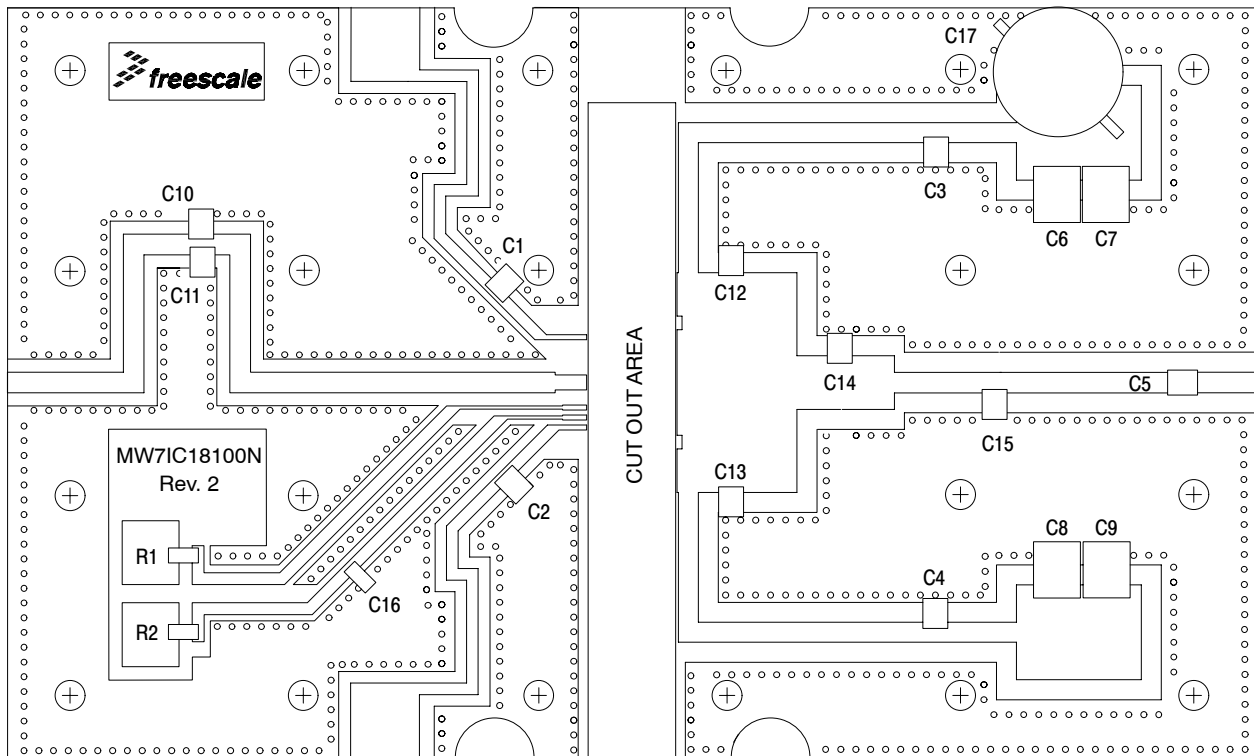


|        |                            |     |                                                            |
|--------|----------------------------|-----|------------------------------------------------------------|
| Z1     | 0.083" x 0.505" Microstrip | Z11 | 0.880" x 0.256" Microstrip                                 |
| Z2, Z5 | 0.083" x 0.552" Microstrip | Z12 | 0.215" x 0.138" Microstrip                                 |
| Z3     | 0.083" x 0.252" Microstrip | Z13 | 0.215" x 0.252" Microstrip                                 |
| Z4     | 0.083" x 0.174" Microstrip | Z14 | 0.083" x 0.298" Microstrip                                 |
| Z6     | 0.083" x 1.261" Microstrip | Z15 | 0.083" x 0.810" Microstrip                                 |
| Z7     | 0.060" x 0.126" Microstrip | Z16 | 0.083" x 0.250" Microstrip                                 |
| Z8, Z9 | 0.080" x 1.569" Microstrip | PCB | Arlon CuClad 250GX-0300-55-22, 0.030", $\epsilon_r = 2.55$ |
| Z10    | 0.880" x 0.224" Microstrip |     |                                                            |

**Figure 27. MW7IC18100NR1(GNR1)(NBR1) Test Circuit Schematic — 1800 MHz**

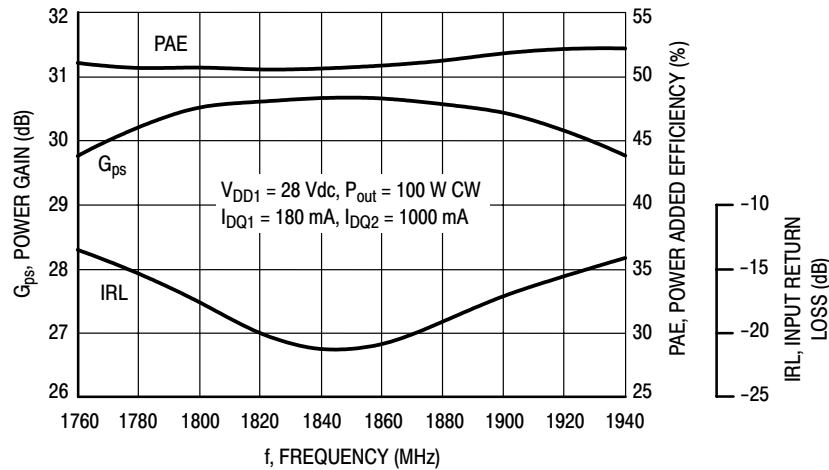
**Table 8. MW7IC18100NR1(GNR1)(NBR1) Test Circuit Component Designations and Values — 1800 MHz**

| Part               | Description                                      | Part Number        | Manufacturer       |
|--------------------|--------------------------------------------------|--------------------|--------------------|
| C1, C2, C3, C4, C5 | 6.8 pF Chip Capacitors                           | ATC100B6R8BT500XT  | ATC                |
| C6, C7, C8, C9     | 10 $\mu$ F, 50 V Chip Capacitors                 | GRM55DR61H106KA88L | Murata             |
| C10, C11           | 0.2 pF Chip Capacitors                           | ATC100B0R2BT500XT  | ATC                |
| C12, C13           | 0.8 pF Chip Capacitors                           | ATC100B0R8BT500XT  | ATC                |
| C14                | 1.2 pF Chip Capacitor                            | ATC100B1R2BT500XT  | ATC                |
| C15                | 1.0 pF Chip Capacitor                            | ATC100B1R0BT500XT  | ATC                |
| C16                | 2.2 $\mu$ F, 16 V Chip Capacitor                 | C1206C225K4RAC     | Kemet              |
| C17                | 470 $\mu$ F, 63 V Electrolytic Capacitor, Radial | 477KXM063M         | Illinois Capacitor |
| R1, R2             | 10 K $\Omega$ , 1/4 W Chip Resistors             | CRCW12061001FKEA   | Vishay             |

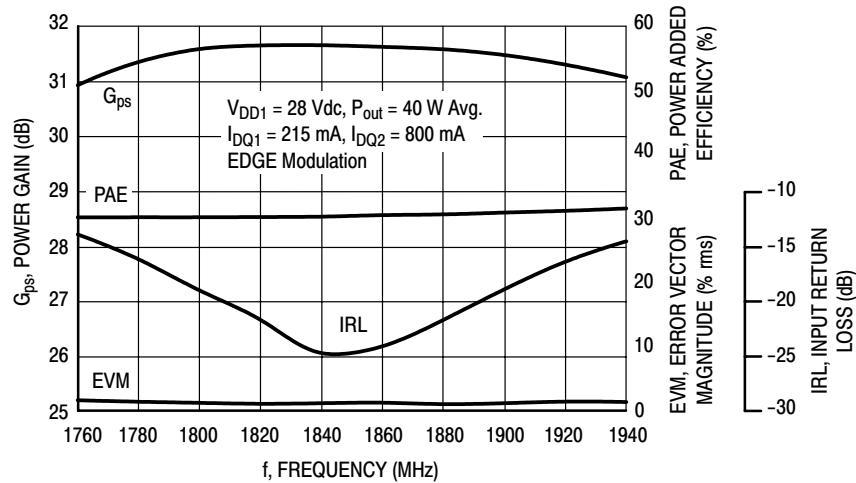


**Figure 28. MW7IC18100NR1(GNR1)(NBR1) Test Circuit Component Layout — 1800 MHz**

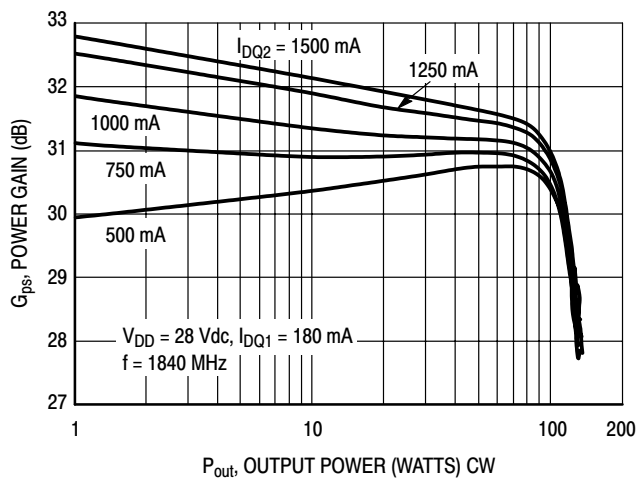
## TYPICAL CHARACTERISTICS — 1800 MHz



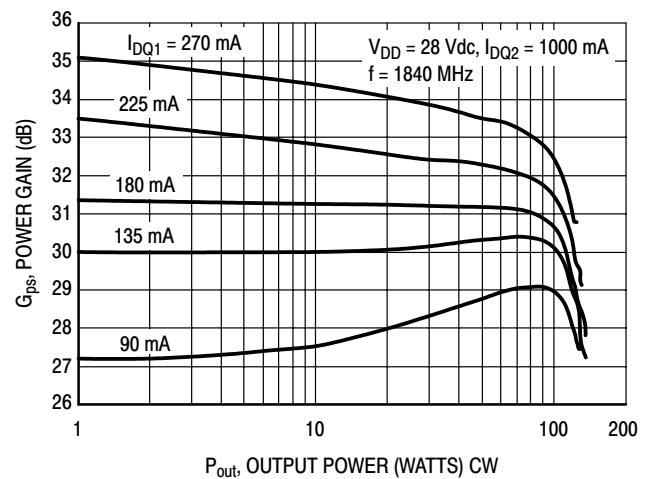
**Figure 29. Power Gain, Input Return Loss and Power Added Efficiency versus Frequency @  $P_{out} = 100$  Watts CW**



**Figure 30. Power Gain, Input Return Loss, EVM and Power Added Efficiency versus Frequency @  $P_{out} = 40$  Watts Avg.**



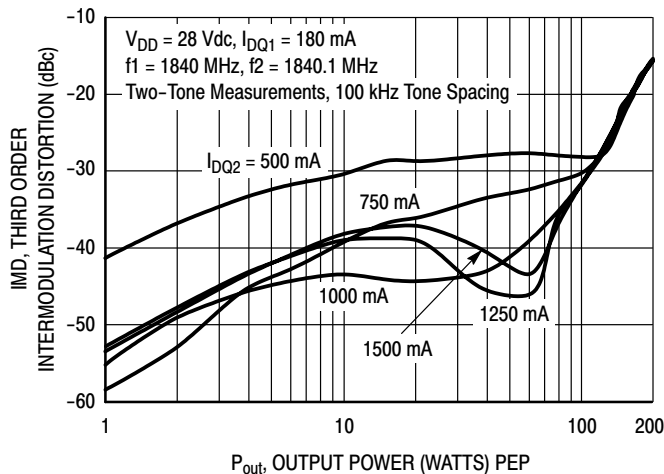
**Figure 31. Two-Tone Power Gain versus Output Power @  $I_{DQ1} = 180$  mA**



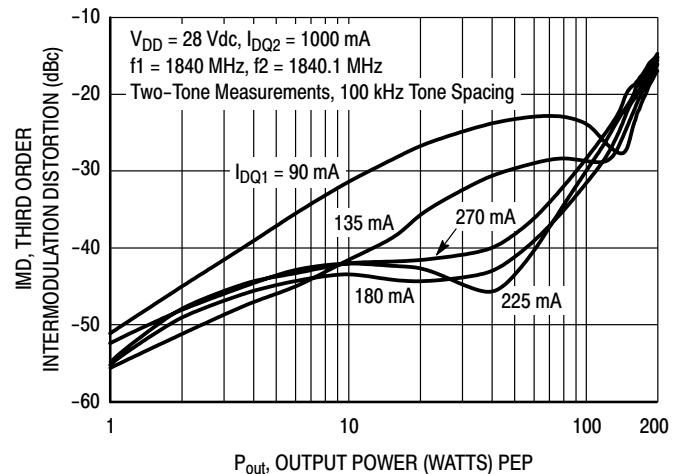
**Figure 32. Two-Tone Power Gain versus Output Power @  $I_{DQ2} = 1000$  mA**



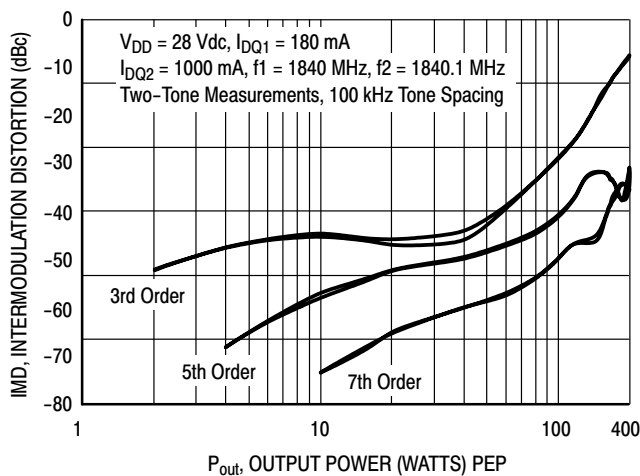
## TYPICAL CHARACTERISTICS — 1800 MHz



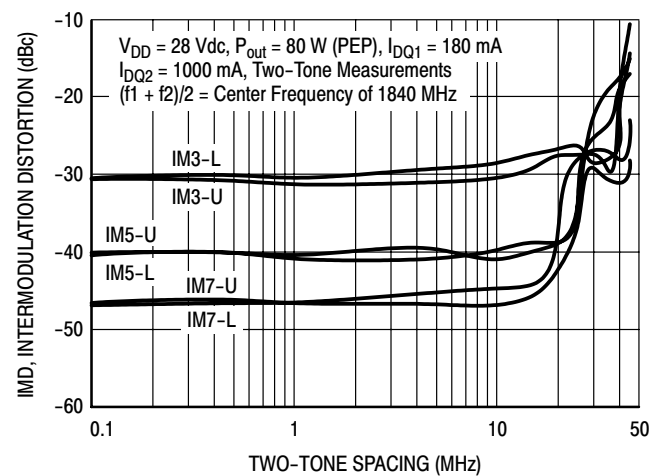
**Figure 33. Third Order Intermodulation Distortion versus Output Power @  $I_{DQ1} = 180$  mA**



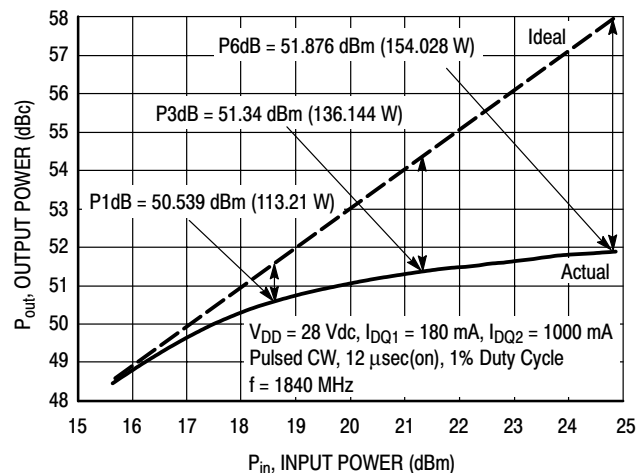
**Figure 34. Third Order Intermodulation Distortion versus Output Power @  $I_{DQ2} = 1000$  mA**



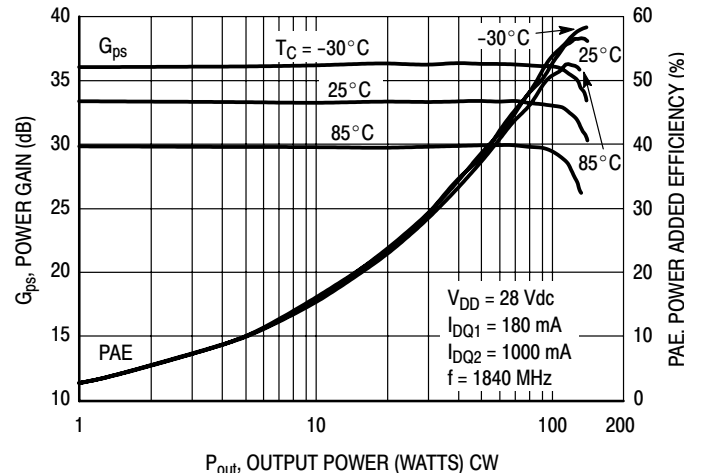
**Figure 35. Intermodulation Distortion Products versus Output Power**



**Figure 36. Intermodulation Distortion Products versus Tone Spacing**



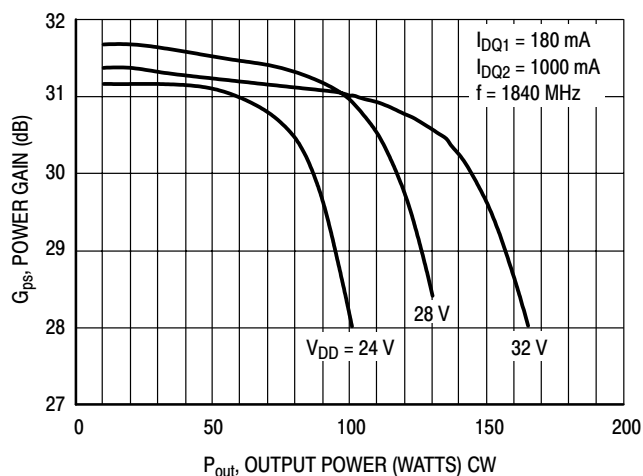
**Figure 37. Pulsed CW Output Power versus Input Power**



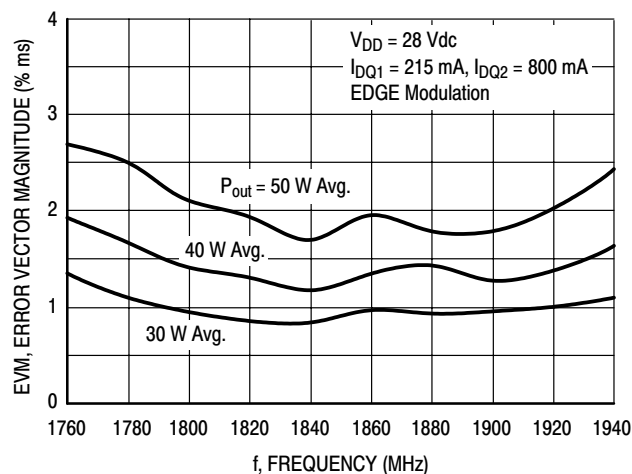
**Figure 38. Power Gain and Power Added Efficiency versus Output Power**

MW7IC18100NR1 MW7IC18100GNR1 MW7IC18100NBR1

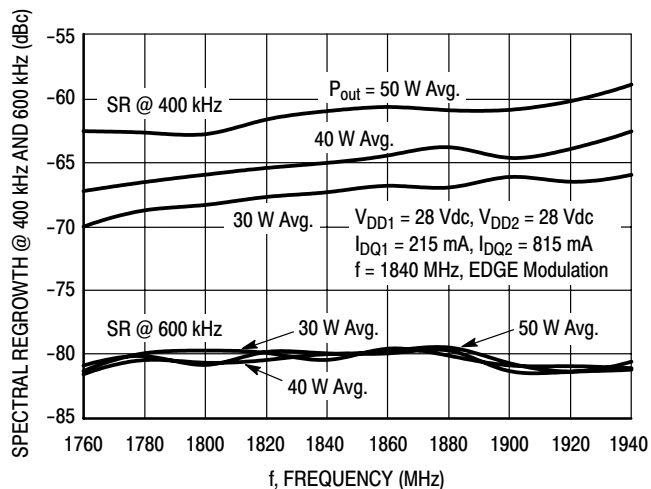
## TYPICAL CHARACTERISTICS — 1800 MHz



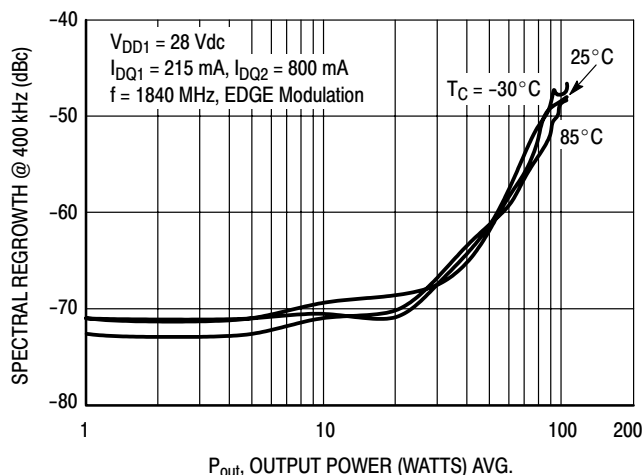
**Figure 39. Power Gain versus Output Power**



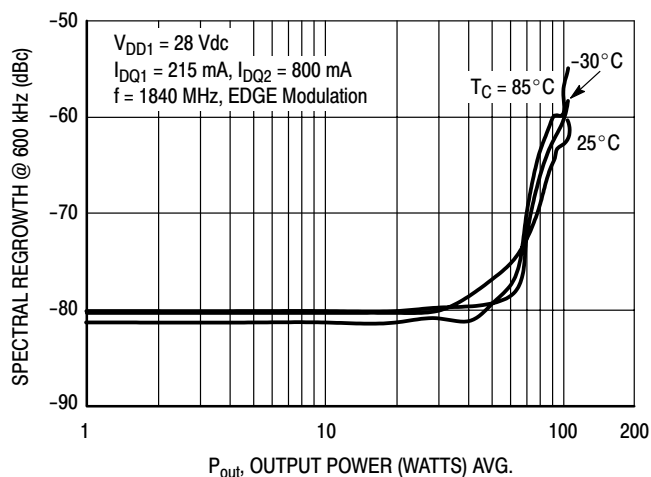
**Figure 40. EVM versus Frequency**



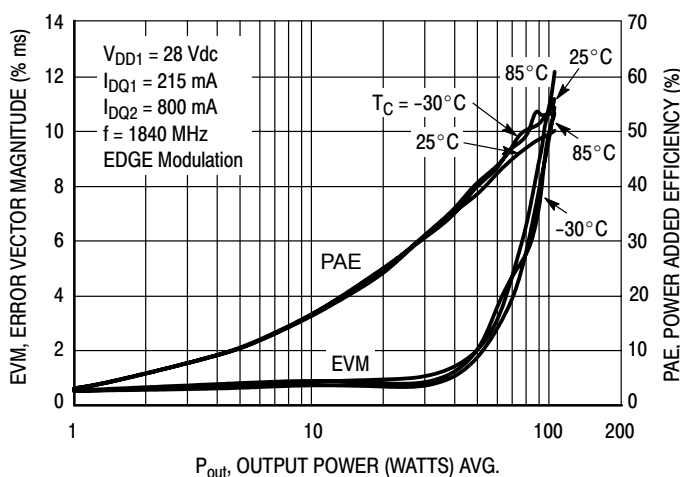
**Figure 41. Spectral Regrowth at 400 kHz and 600 kHz versus Frequency**



**Figure 42. Spectral Regrowth at 400 kHz versus Output Power**



**Figure 43. Spectral Regrowth at 600 kHz versus Output Power**



**Figure 44. EVM and Power Added Efficiency versus Output Power**

# TYPICAL CHARACTERISTICS — 1800 MHz

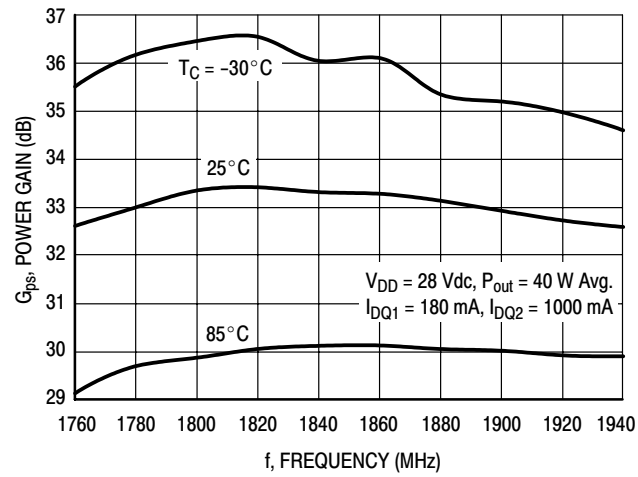
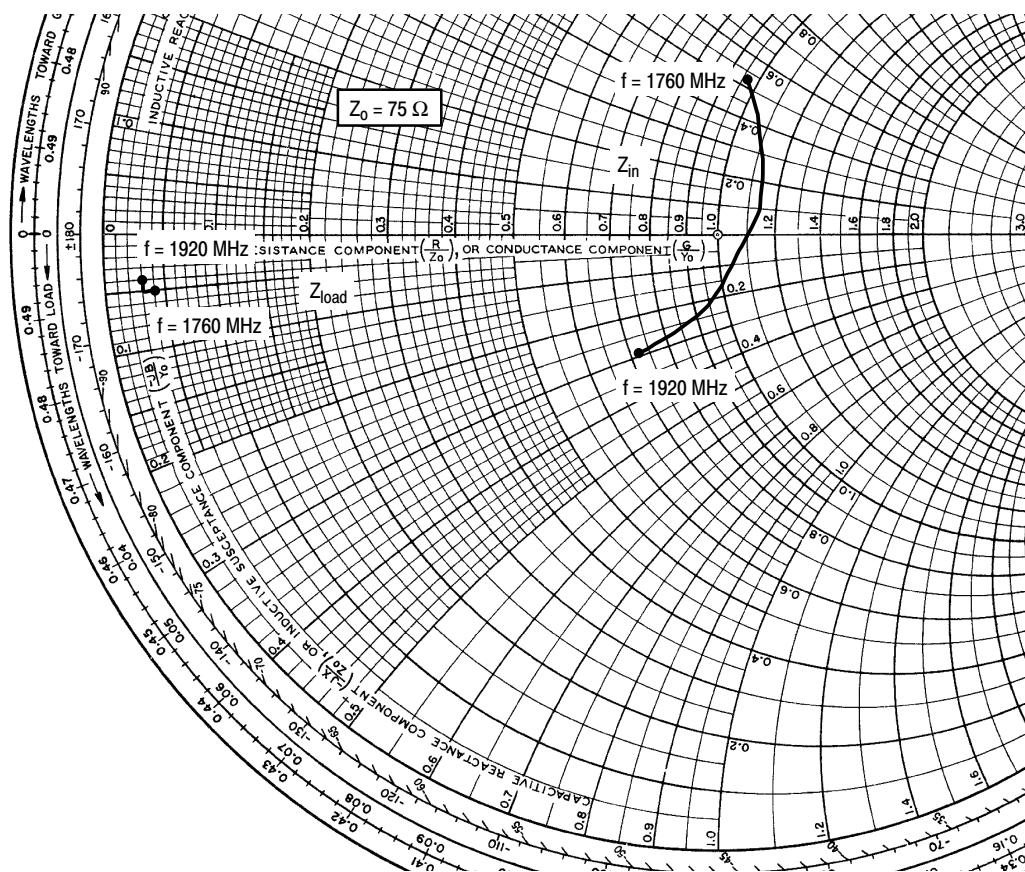


Figure 45. Power Gain versus Frequency



$V_{DD1} = V_{DD2} = 28 \text{ Vdc}$ ,  $I_{DQ1} = 180 \text{ mA}$ ,  $I_{DQ2} = 1000 \text{ mA}$ ,  $P_{out} = 100 \text{ W CW}$

| f<br>MHz | $Z_{in}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|----------------------|------------------------|
| 1760     | $71.78 + j40.05$     | $2.983 - j3.974$       |
| 1780     | $79.83 + j31.13$     | $2.872 - j3.861$       |
| 1800     | $84.35 + j19.44$     | $2.757 - j3.745$       |
| 1820     | $84.75 + j7.234$     | $2.636 - j3.639$       |
| 1840     | $81.21 - j4.076$     | $2.535 - j3.506$       |
| 1860     | $74.76 - j12.32$     | $2.434 - j3.376$       |
| 1880     | $67.49 - j17.89$     | $2.324 - j3.239$       |
| 1900     | $60.03 - j20.86$     | $2.234 - j3.105$       |
| 1920     | $53.65 - j21.94$     | $2.135 - j2.965$       |

$Z_{in}$  = Device input impedance as measured from gate to ground.

$Z_{load}$  = Test circuit impedance as measured from drain to ground.

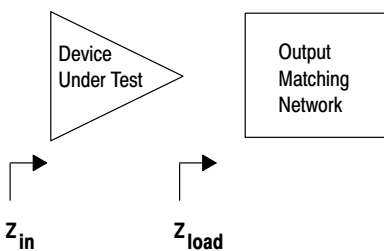
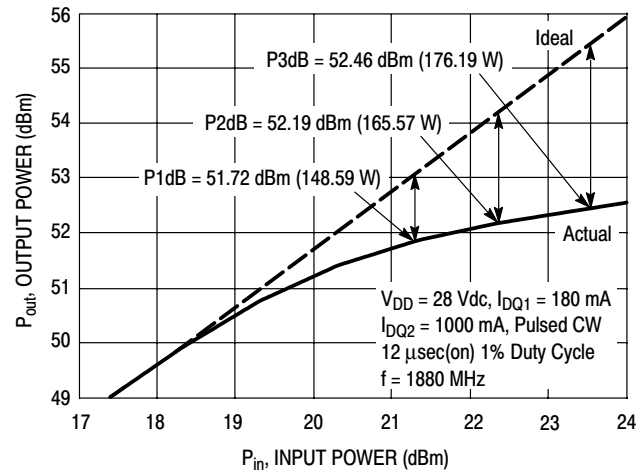


Figure 46. Series Equivalent Input and Load Impedance — 1800 MHz

## ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS — 1800 MHz



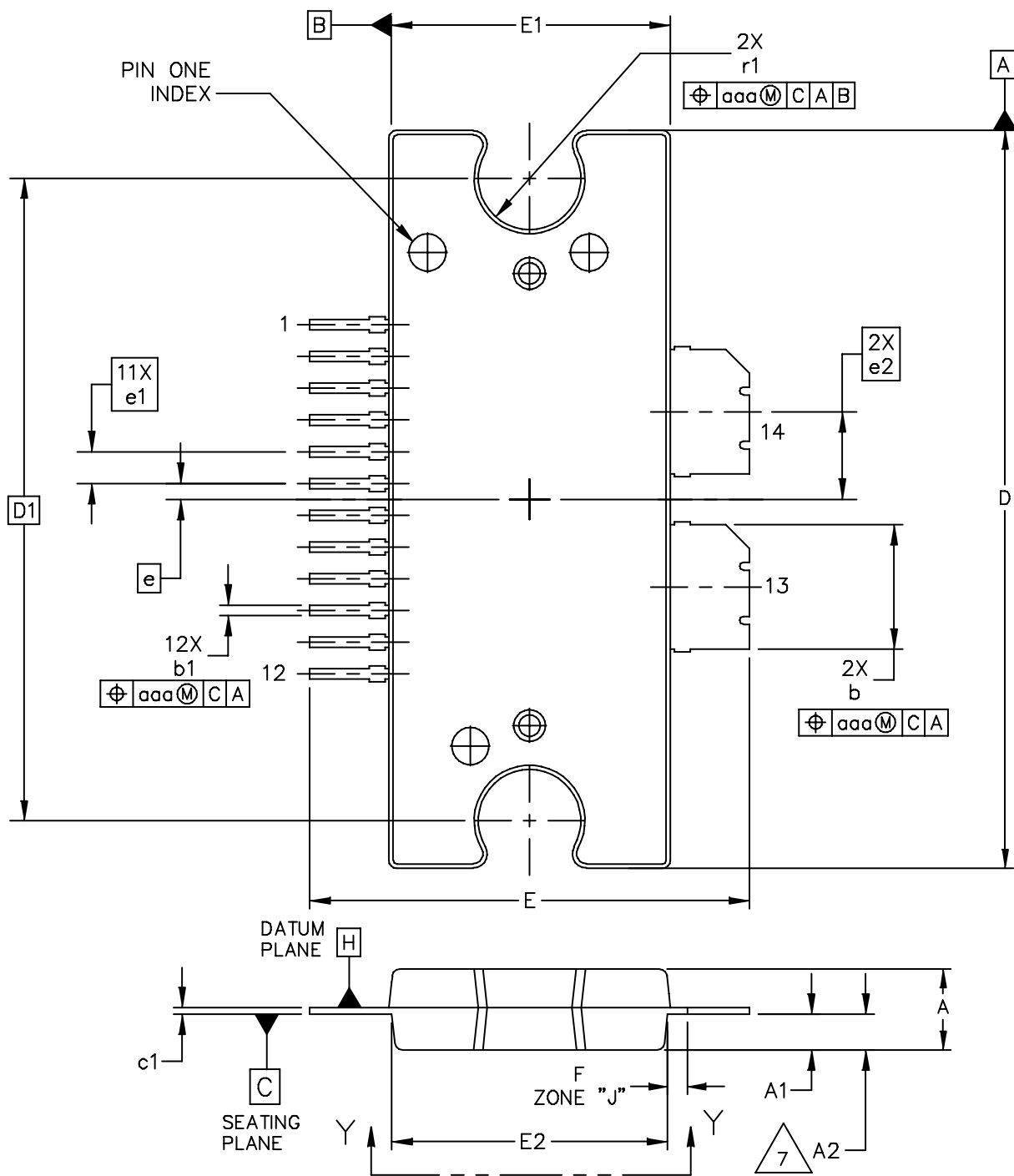
NOTE: Load Pull Test Fixture Tuned for Peak Output Power @ 28 V

Test Impedances per Compression Level

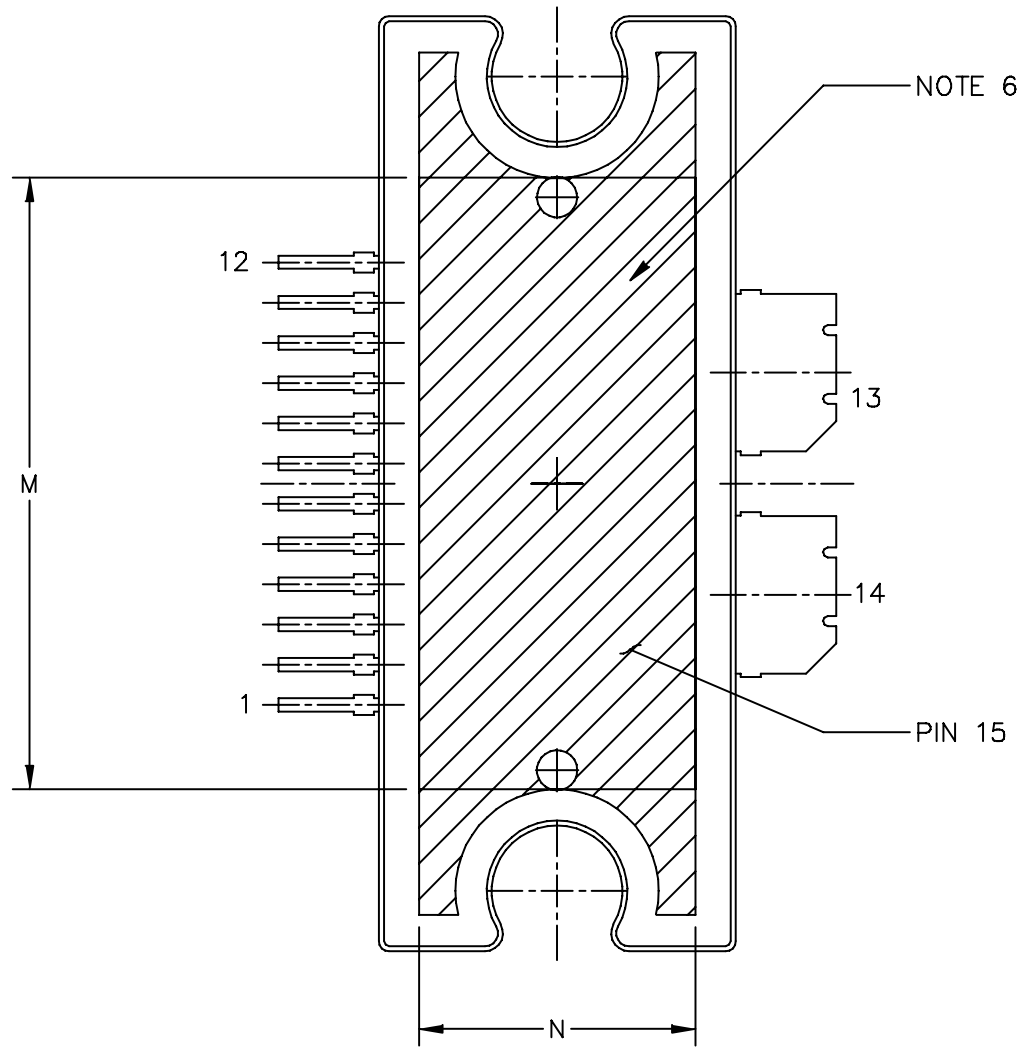
|      | $Z_{\text{source}}$<br>$\Omega$ | $Z_{\text{load}}$<br>$\Omega$ |
|------|---------------------------------|-------------------------------|
| P3dB | $83.04 - j2.44$                 | $1.36 - j3.19$                |

**Figure 47. Pulsed CW Output Power versus Input Power @ 28 V**

# PACKAGE DIMENSIONS



|                                                         |                    |                            |             |
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| TITLE:<br>TO-272 WIDE BODY<br>14 LEAD                   |                    | DOCUMENT NO: 98ASA10649D   | REV: A      |
|                                                         |                    | CASE NUMBER: 1617-02       | 27 JUN 2007 |
|                                                         |                    | STANDARD: NON-JEDEC        |             |



VIEW Y-Y

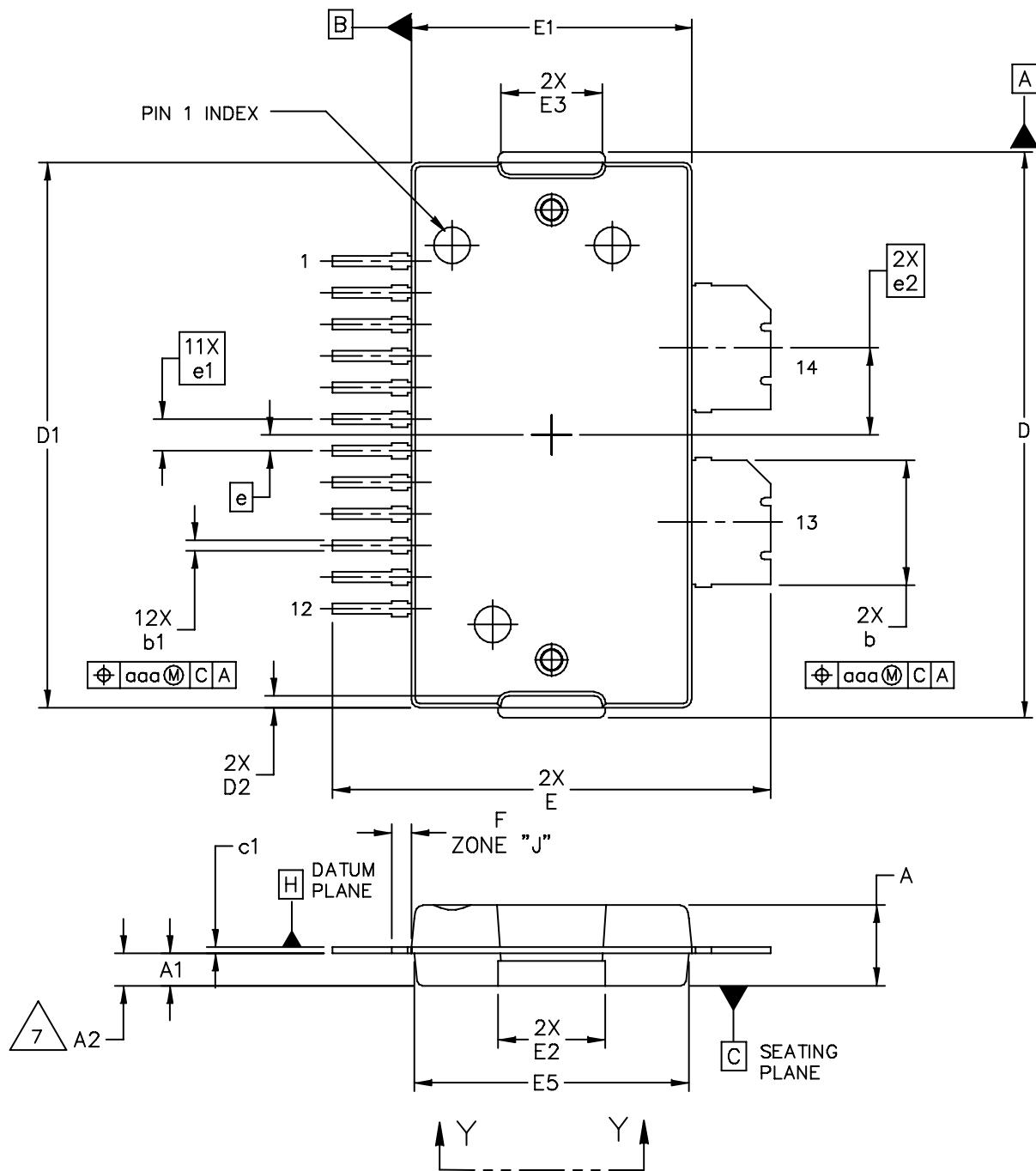
|                                                         |                          |                    |                            |
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| TITLE:<br>TO-272 WIDE BODY<br>14 LEAD                   | DOCUMENT NO: 98ASA10649D |                    | REV: A                     |
|                                                         | CASE NUMBER: 1617-02     |                    | 27 JUN 2007                |
|                                                         | STANDARD: NON-JEDEC      |                    |                            |

# NOTES:

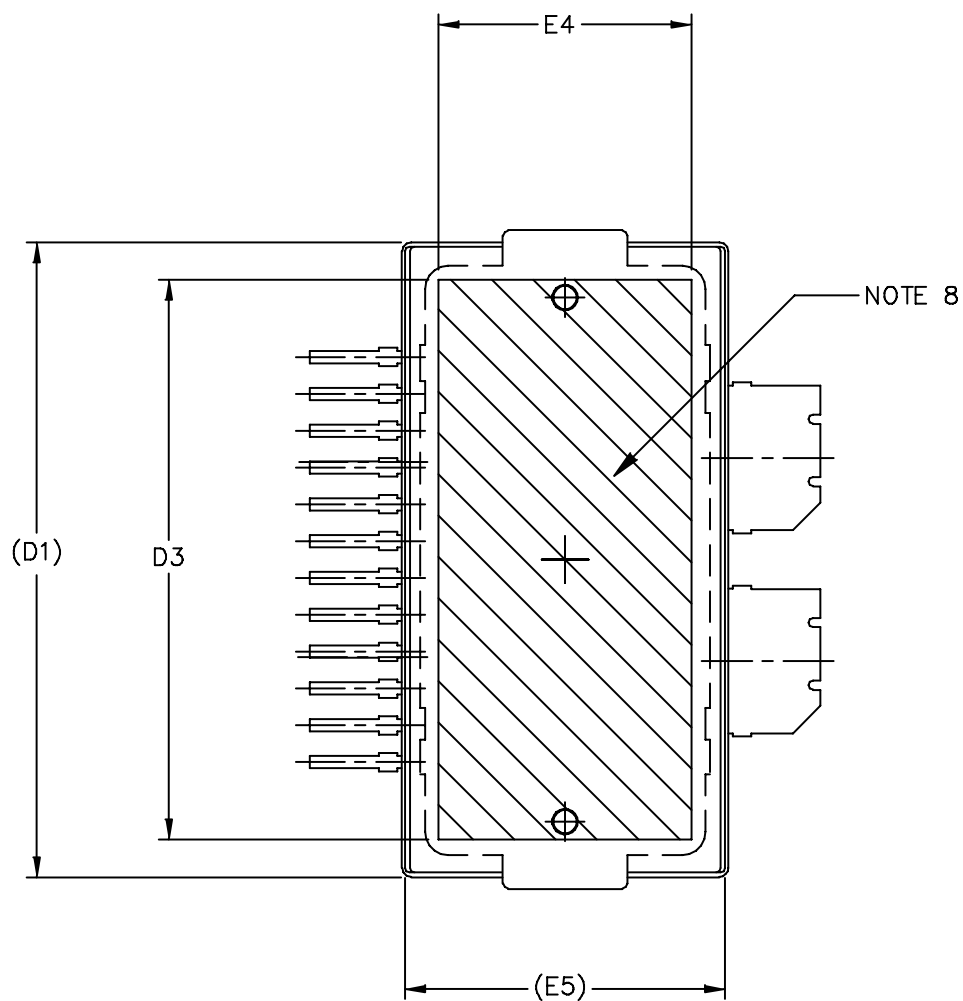
1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 (0.15) PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS "b" AND "b1" DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 (0.13) TOTAL IN EXCESS OF THE "b" AND "b1" DIMENSIONS AT MAXIMUM MATERIAL CONDITION.
6. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.
7. DIM A2 APPLIES WITHIN ZONE "J" ONLY.

| INCH                                                    |          |      | MILLIMETER         |       | INCH                     |                            |      | MILLIMETER  |      |
|---------------------------------------------------------|----------|------|--------------------|-------|--------------------------|----------------------------|------|-------------|------|
| DIM                                                     | MIN      | MAX  | MIN                | MAX   | DIM                      | MIN                        | MAX  | MIN         | MAX  |
| A                                                       | .100     | .104 | 2.54               | 2.64  | b                        | .154                       | .160 | 3.91        | 4.06 |
| A1                                                      | .039     | .043 | 0.99               | 1.09  | b1                       | .010                       | .016 | 0.25        | 0.41 |
| A2                                                      | .040     | .042 | 1.02               | 1.07  | c1                       | .007                       | .011 | 0.18        | 0.28 |
| D                                                       | .928     | .932 | 23.57              | 23.67 | e                        | .020 BSC                   |      | 0.51 BSC    |      |
| D1                                                      | .810 BSC |      | 20.57 BSC          |       | e1                       | .040 BSC                   |      | 1.02 BSC    |      |
| E                                                       | .551     | .559 | 14.00              | 14.20 | e2                       | .1105 BSC                  |      | 2.807 BSC   |      |
| E1                                                      | .353     | .357 | 8.97               | 9.07  | r1                       | .063                       | .068 | 1.6         | 1.73 |
| E2                                                      | .346     | .350 | 8.79               | 8.89  |                          |                            |      |             |      |
| F                                                       | .025 BSC |      | 0.64 BSC           |       | aaa                      | .004                       |      | 0.10        |      |
| M                                                       | .600     | ---- | 15.24              | ----  |                          |                            |      |             |      |
| N                                                       | .270     | ---- | 6.86               | ----  |                          |                            |      |             |      |
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|                                                         |          |      |                    |       | CASE NUMBER: 1617-02     |                            |      | 27 JUN 2007 |      |
|                                                         |          |      |                    |       | STANDARD: NON-JEDEC      |                            |      |             |      |





|                                                         |  |                    |                          |                            |             |
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|                                                         |  |                    | CASE NUMBER: 1618-02     |                            | 19 JUN 2007 |
|                                                         |  |                    | STANDARD: NON-JEDEC      |                            |             |



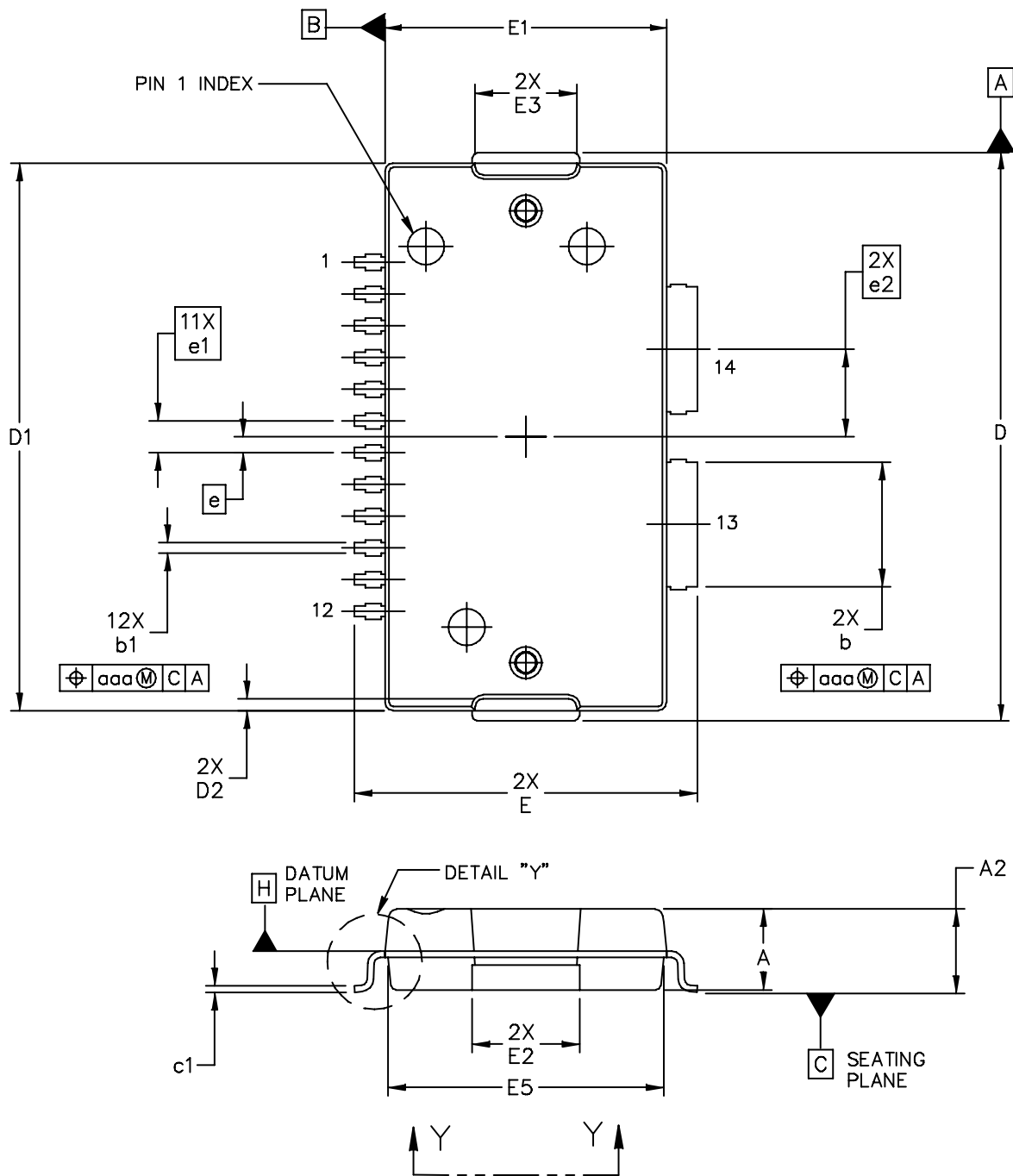
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| TITLE:<br>TO-270 WIDE BODY<br>14 LEAD                   | DOCUMENT NO: 98ASA10650D |                            | REV: A      |
|                                                         | CASE NUMBER: 1618-02     |                            | 19 JUN 2007 |
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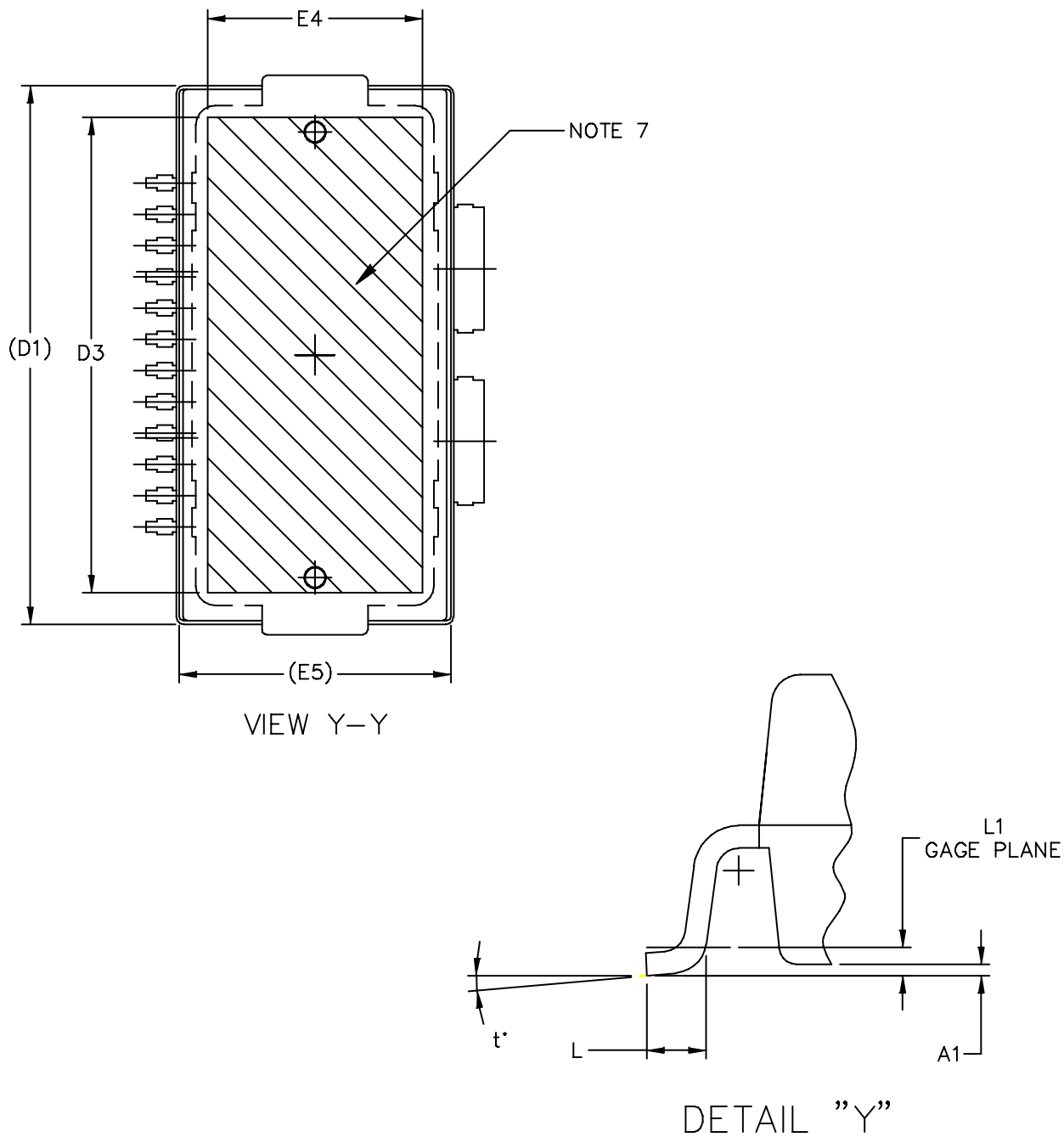
NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
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4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS "b" AND "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b" AND "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION A2 APPLIES WITHIN ZONE "J" ONLY.
8. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.

| INCH                                                    |      |      | MILLIMETER         |       | INCH                     |                            |      | MILLIMETER  |      |
|---------------------------------------------------------|------|------|--------------------|-------|--------------------------|----------------------------|------|-------------|------|
| DIM                                                     | MIN  | MAX  | MIN                | MAX   | DIM                      | MIN                        | MAX  | MIN         | MAX  |
| A                                                       | .100 | .104 | 2.54               | 2.64  | F                        | .025 BSC                   |      | 0.64 BSC    |      |
| A1                                                      | .039 | .043 | 0.99               | 1.09  | b                        | .154                       | .160 | 3.91        | 4.06 |
| A2                                                      | .040 | .042 | 1.02               | 1.07  | b1                       | .010                       | .016 | 0.25        | 0.41 |
| D                                                       | .712 | .720 | 18.08              | 18.29 | c1                       | .007                       | .011 | .18         | .28  |
| D1                                                      | .688 | .692 | 17.48              | 17.58 | e                        | .020 BSC                   |      | 0.51 BSC    |      |
| D2                                                      | .011 | .019 | 0.28               | 0.48  | e1                       | .040 BSC                   |      | 1.02 BSC    |      |
| D3                                                      | .600 | ---  | 15.24              | ---   | e2                       | .1105 BSC                  |      | 2.807 BSC   |      |
| E                                                       | .551 | .559 | 14                 | 14.2  | aaa                      | .004                       |      | .10         |      |
| E1                                                      | .353 | .357 | 8.97               | 9.07  |                          |                            |      |             |      |
| E2                                                      | .132 | .140 | 3.35               | 3.56  |                          |                            |      |             |      |
| E3                                                      | .124 | .132 | 3.15               | 3.35  |                          |                            |      |             |      |
| E4                                                      | .270 | ---  | 6.86               | ---   |                          |                            |      |             |      |
| E5                                                      | .346 | .350 | 8.79               | 8.89  |                          |                            |      |             |      |
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|                                                         |      |      |                    |       | CASE NUMBER: 1618-02     |                            |      | 19 JUN 2007 |      |
|                                                         |      |      |                    |       | STANDARD: NON-JEDEC      |                            |      |             |      |



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| TITLE: TO-270 WIDE BODY<br>14 LEAD<br>GULL WING         |  | DOCUMENT NO: 98ASA10653D |  | REV: A                     |  |
|                                                         |  | CASE NUMBER: 1621-02     |  | 19 JUN 2007                |  |
|                                                         |  | STANDARD: NON-JEDEC      |  |                            |  |



|                                                         |  |                          |  |                            |  |
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| TITLE: TO-270 WIDE BODY<br>14 LEAD<br>GULL WING         |  | DOCUMENT NO: 98ASA10653D |  | REV: A                     |  |
|                                                         |  | CASE NUMBER: 1621-02     |  | 19 JUN 2007                |  |
|                                                         |  | STANDARD: NON-JEDEC      |  |                            |  |

# NOTES:

1. CONTROLLING DIMENSION: INCH
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4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS "b" AND "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b" AND "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.

| INCH                                                    |      |      | MILLIMETER         |       | INCH                     |                            |      | MILLIMETER  |      |
|---------------------------------------------------------|------|------|--------------------|-------|--------------------------|----------------------------|------|-------------|------|
| DIM                                                     | MIN  | MAX  | MIN                | MAX   | DIM                      | MIN                        | MAX  | MIN         | MAX  |
| A                                                       | .100 | .104 | 2.54               | 2.64  | L                        | .018                       | .024 | 0.46        | 0.61 |
| A1                                                      | .001 | .004 | 0.02               | 0.10  | L1                       | .010 BSC                   |      | 0.25 BSC    |      |
| A2                                                      | .099 | .110 | 2.51               | 2.79  | b                        | .154                       | .160 | 3.91        | 4.06 |
| D                                                       | .712 | .720 | 18.08              | 18.29 | b1                       | .010                       | .016 | 0.25        | 0.41 |
| D1                                                      | .688 | .692 | 17.48              | 17.58 | c1                       | .007                       | .011 | .18         | .28  |
| D2                                                      | .011 | .019 | 0.28               | 0.48  | e                        | .020 BSC                   |      | 0.51 BSC    |      |
| D3                                                      | .600 | ---  | 15.24              | ---   | e1                       | .040 BSC                   |      | 1.02 BSC    |      |
| E                                                       | .429 | .437 | 10.9               | 11.1  | e2                       | .1105 BSC                  |      | 2.807 BSC   |      |
| E1                                                      | .353 | .357 | 8.97               | 9.07  | t                        | 2°                         | 8°   | 2°          | 8°   |
| E2                                                      | .132 | .140 | 3.35               | 3.56  | aaa                      | .004                       |      | .10         |      |
| E3                                                      | .124 | .132 | 3.15               | 3.35  |                          |                            |      |             |      |
| E4                                                      | .270 | ---  | 6.86               | ---   |                          |                            |      |             |      |
| E5                                                      | .346 | .350 | 8.79               | 8.89  |                          |                            |      |             |      |
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| TITLE: TO-270 WIDE BODY<br>14 LEAD<br>GULL WING         |      |      |                    |       | DOCUMENT NO: 98ASA10653D |                            |      | REV: A      |      |
|                                                         |      |      |                    |       | CASE NUMBER: 1621-02     |                            |      | 19 JUN 2007 |      |
|                                                         |      |      |                    |       | STANDARD: NON-JEDEC      |                            |      |             |      |

## PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

### Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Plastic Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN1977: Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family
- AN1987: Quiescent Current Control for the RF Integrated Circuit Device Family
- AN3263: Bolt Down Mounting Method for High Power RF Transistors and RFICs in Over-Molded Plastic Packages
- AN3789: Clamping of High Power RF Transistors and RFICs in Over-Molded Plastic Packages

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0        | May 2007  | <ul style="list-style-type: none"> <li>• Initial Release of Data Sheet</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 1        | June 2007 | <ul style="list-style-type: none"> <li>• Removed Case Operating Temperature from Maximum Ratings table, p. 2. Case Operating Temperature rating will be added to the Maximum Ratings table when parts' Operating Junction Temperature is increased to 225°C.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2        | Apr. 2008 | <ul style="list-style-type: none"> <li>• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table, related "Continuous use at maximum temperature will affect MTTF" footnote added and changed 200°C to 225°C in Capable Plastic Package bullet, p. 1, 2</li> <li>• Added Case Operating Temperature limit to the Maximum Ratings table and set limit to 150°C, p. 2</li> <li>• Updated PCB information to show more specific material details, Figs. 3, 27, Test Circuit Schematic, p. 4, 14</li> <li>• Updated Part Numbers in Tables 6, 8, Component Designations and Values, to RoHS compliant part numbers, p. 4, 14</li> <li>• Replaced Case Outline 1617-01 with 1617-02, Issue A, p. 22-24. Revised cross-hatched area for exposed heat spreader. Added pin numbers 1, 12, 13, and 14 to Sheets 1 and 2. Corrected mm Min and Max values for dimension A1 to 0.99 and 1.09, respectively.</li> <li>• Replaced Case Outline 1618-01 with 1618-02, Issue A, p. 25-27. Added pin numbers 1, 12, 13, and 14 and Pin 1 Index designation to Sheet 1. Corrected dimensions e and e1 on Sheet 1. Removed Pin 5 designation from Sheet 2.</li> <li>• Replaced Case Outline 1621-01 with 1621-02, Issue A, p. 28-30. Added pin numbers 1, 12, 13, and 14 and Pin 1 Index designation to Sheet 1. Corrected dimensions e and e1 on Sheets 1 and 3. Removed Pin 5 designation from Sheet 2.</li> </ul> |
| 3        | Mar. 2009 | <ul style="list-style-type: none"> <li>• Changed Storage Temperature Range in Max Ratings table from -65 to +200 to -65 to +150 for standardization across products, p. 2.</li> <li>• Updated Human Body Model ESD from Class 0 to 1 to reflect 2008 Human Body Model actual test data, p. 2</li> <li>• Added footnote, Measurement made with device in straight lead configuration before any lead forming operation is applied, to Functional Tests table, p. 2.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

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