

# RF LDMOS Wideband Integrated Power Amplifiers

The MW5IC2030 wideband integrated circuit is designed with on-chip matching that makes it usable from 1930 to 1990 MHz. This multi-stage structure is rated for 26 to 28 Volt operation and covers all typical cellular base station modulation formats.

## Final Application

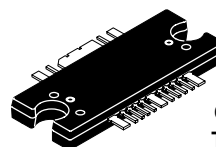
- Typical CDMA Performance:  $V_{DD} = 27$  Volts,  $I_{DQ1} = 160$  mA,  $I_{DQ2} = 230$  mA,  $P_{out} = 5$  Watts Avg., Full Frequency Band, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13), Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.  
Power Gain — 23 dB  
Drain Efficiency — 20%  
ACPR @ 885 kHz Offset — -49 dBc in 30 kHz Channel Bandwidth

## Driver Application

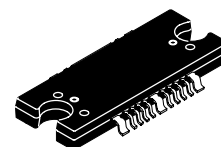
- Typical CDMA Performance:  $V_{DD} = 27$  Volts,  $I_{DQ1} = 220$  mA,  $I_{DQ2} = 240$  mA,  $P_{out} = 1$  Watt Avg., Full Frequency Band, IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13), Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.  
Power Gain — 24 dB  
ACPR @ 885 kHz Offset — -63 dBc in 30 kHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 27 Vdc, 1990 MHz, 30 Watts CW Output Power
- Stable into a 3:1 VSWR. All Spurs Below -60 dBc @ 0 to 43 dBm CW  $P_{out}$
- On-Chip Matching (50 Ohm Input, >4 Ohm Output)
- Integrated Temperature Compensation Capability with Enable/Disable Function
- On-Chip Current Mirror  $g_m$  Reference FET for Self Biasing Application (1)
- Integrated ESD Protection
- 200°C Capable Plastic Package
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel

**MW5IC2030MBR1**  
**MW5IC2030GMBR1**

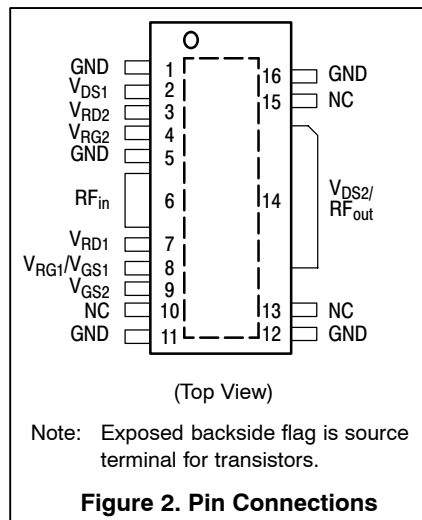
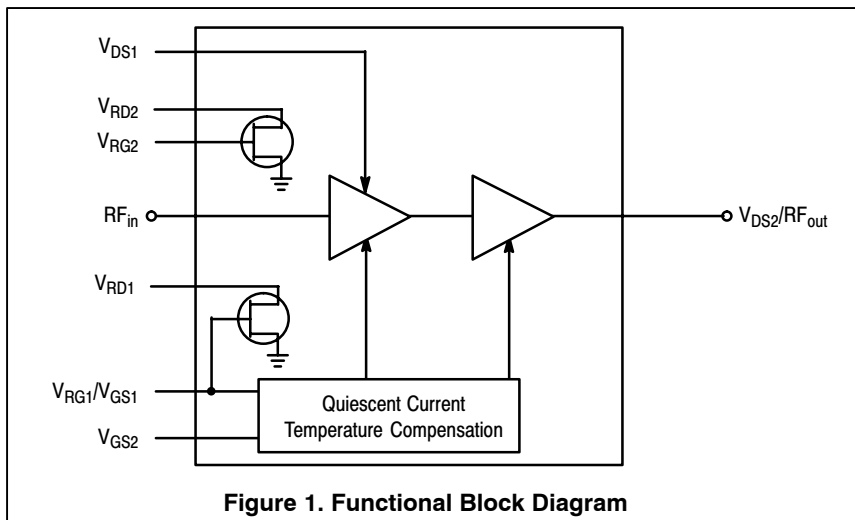
**1930-1990 MHz, 30 W, 26 V**  
**GSM/GSM EDGE, W-CDMA, PHS**  
**RF LDMOS WIDEBAND**  
**INTEGRATED POWER AMPLIFIERS**



**CASE 1329-09**  
**TO-272 WB-16**  
**PLASTIC**  
**MW5IC2030MBR1**



**CASE 1329A-03**  
**TO-272 WB-16 GULL**  
**PLASTIC**  
**MW5IC2030GMBR1**



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

**NOTE - CAUTION** - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

**Table 1. Maximum Ratings**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Drain-Source Voltage           | $V_{DS}$  | -0.5, +65   | Vdc  |
| Gate-Source Voltage            | $V_{GS}$  | -0.5, +15   | Vdc  |
| Storage Temperature Range      | $T_{stg}$ | -65 to +175 | °C   |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Input Power                    | $P_{in}$  | 20          | dBm  |

**Table 2. Thermal Characteristics**

| Characteristic                              | Symbol                                                                    | Value (1,2)  | Unit |
|---------------------------------------------|---------------------------------------------------------------------------|--------------|------|
| Thermal Resistance, Junction to Case        | $R_{\theta JC}$                                                           |              | °C/W |
| CDMA Application<br>( $P_{out} = 5$ W CW)   | Stage 1, 27 Vdc, $I_{DQ} = 160$ mA<br>Stage 2, 27 Vdc, $I_{DQ} = 230$ mA  | 4.89<br>1.75 |      |
| PHS Application<br>( $P_{out} = 12.6$ W CW) | Stage 1, 26 Vdc, $I_{DQ} = 300$ mA<br>Stage 2, 26 Vdc, $I_{DQ} = 1300$ mA | 4.85<br>1.61 |      |

**Table 3. ESD Protection Characteristics**

| Test Conditions     | Class        |
|---------------------|--------------|
| Human Body Model    | 1B (Minimum) |
| Machine Model       | A (Minimum)  |
| Charge Device Model | 3 (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 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|-----|-----|------|
| <b>CDMA Functional Tests</b> (In Freescale 1900 MHz Test Fixture, 50 ohm system) $V_{DD} = 27$ Vdc, $I_{DQ1} = 160$ mA, $I_{DQ2} = 230$ mA, $P_{out} = 5$ W Avg., 1960 MHz, Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Channel Bandwidth @ $\pm 885$ kHz Offset. PAR = 9.8 dB @ 0.01 Probability on CCDF. |          |      |     |     |      |
| Power Gain                                                                                                                                                                                                                                                                                                                                          | $G_{ps}$ | 21.5 | 23  | —   | dB   |
| Drain Efficiency                                                                                                                                                                                                                                                                                                                                    | $\eta_D$ | 18   | 20  | —   | %    |
| Input Return Loss                                                                                                                                                                                                                                                                                                                                   | IRL      | —    | -18 | -10 | dB   |
| Adjacent Channel Power Ratio                                                                                                                                                                                                                                                                                                                        | ACPR     | —    | -49 | -47 | dBc  |
| Gain Flatness in 30 MHz BW, 1930-1990 MHz                                                                                                                                                                                                                                                                                                           | $G_F$    | —    | 0.2 | 0.3 | dB   |

1. MTF calculator available at <http://www.freescale.com/rf>. Select Tools/Software/Application Software/Calculators to access the MTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

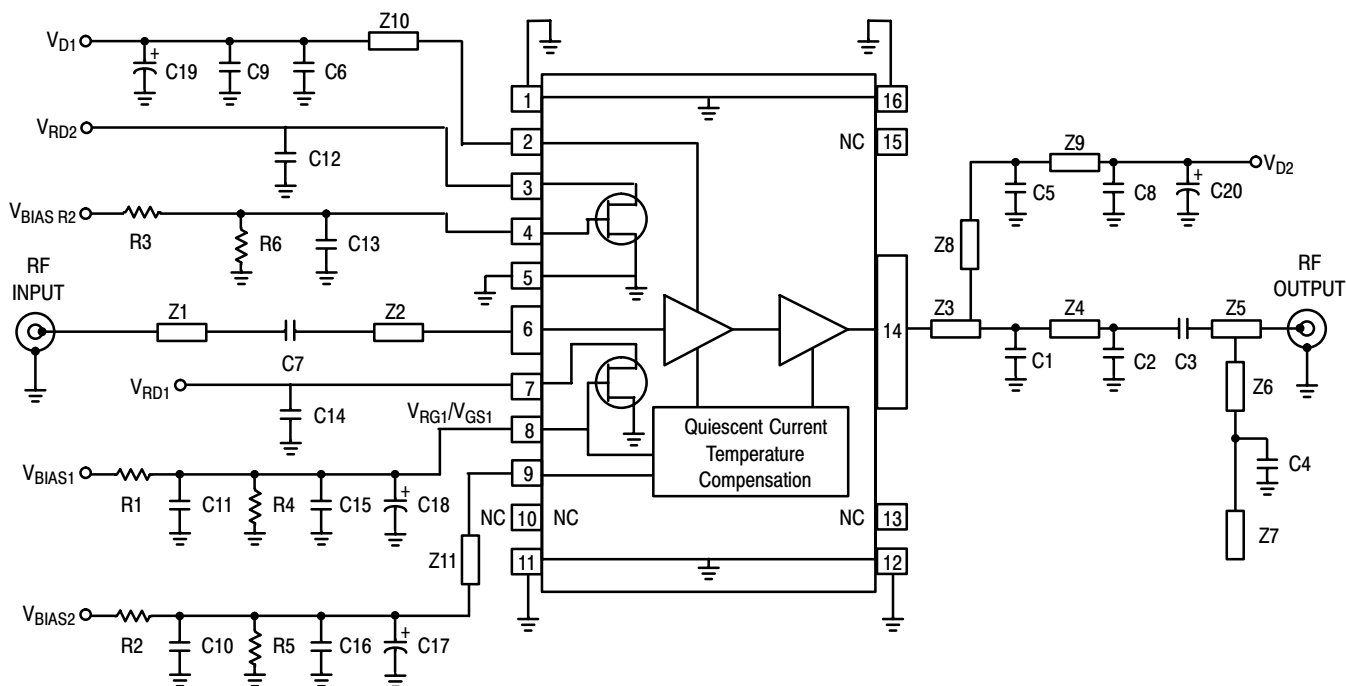
(continued)

**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) $V_{DD} = 26\text{ Vdc}$ , $I_{DQ1} = 160\text{ mA}$ , $I_{DQ2} = 230\text{ mA}$ , $P_{out} = 5\text{ W}$ , $f = 1960\text{ MHz}$ |              |     |           |     |          |
| $P_{out}$ @ 1 dB Compression Point, CW                                                                                                                                                    | P1dB         | —   | 30        | —   | W        |
| Deviation from Linear Phase in 30 MHz BW<br>(Characterized from 1930-1990 MHz)                                                                                                            | $\Phi$       | —   | $\pm 1$   | —   | $^\circ$ |
| Delay                                                                                                                                                                                     | Delay        | —   | 2.25      | —   | ns       |
| Part-to-Part Phase Variation                                                                                                                                                              | $\Delta\Phi$ | —   | $\pm 10$  | —   | $^\circ$ |
| Part-to-Part Gain Variation (Per Lot or Reel)                                                                                                                                             | $\Delta G$   | —   | $\pm 1.5$ | —   | dB       |
| Reference FET to RF FET Scaling Ratio Delta (Stages 1 and 2)                                                                                                                              |              | —   | 10        | —   | %        |

**Typical PHS Performances** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 26\text{ Vdc}$ ,  $I_{DQ1} = 260\text{ mA}$ ,  $I_{DQ2} = 1100\text{ mA}$ ,  $P_{out} = 12.6\text{ W}$ , 1900 MHz, PHS Signal Mask

|                                                                |          |   |     |   |     |
|----------------------------------------------------------------|----------|---|-----|---|-----|
| Power Gain                                                     | $G_{ps}$ | — | 24  | — | dB  |
| Drain Efficiency                                               | $\eta_D$ | — | 25  | — | %   |
| Input Return Loss                                              | IRL      | — | -15 | — | dB  |
| Adjacent Channel Power Ratio<br>(600 kHz Offset in 192 kHz BW) | ACPR     | — | -72 | — | dBc |

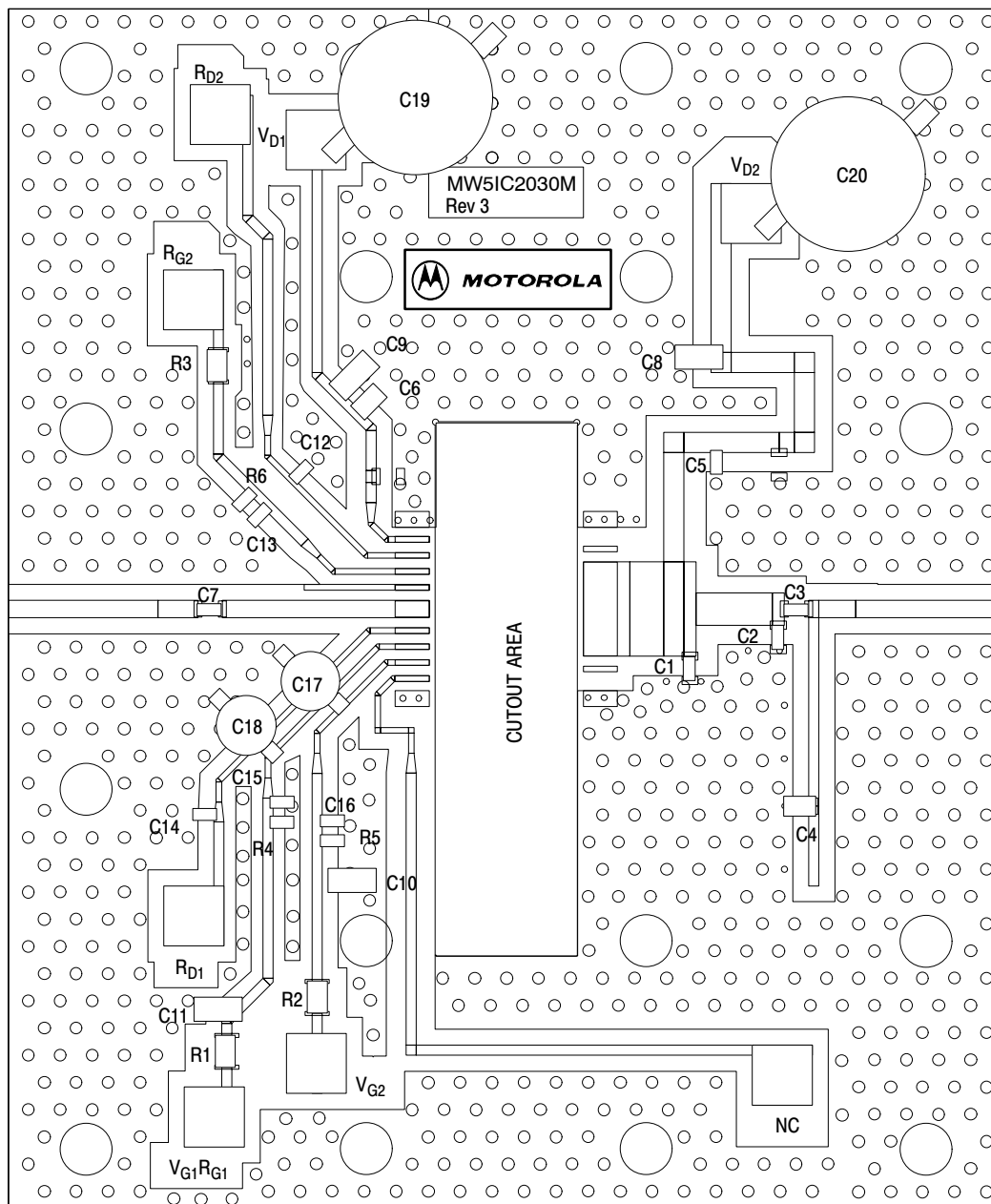


|    |                            |     |                                         |
|----|----------------------------|-----|-----------------------------------------|
| Z1 | 0.465" x 0.041" Microstrip | Z7  | 0.200" x 0.025" Microstrip              |
| Z2 | 0.518" x 0.041" Microstrip | Z8  | 0.274" x 0.050" Microstrip              |
| Z3 | 0.282" x 0.235" Microstrip | Z9  | 0.615" x 0.050" Microstrip              |
| Z4 | 0.221" x 0.081" Microstrip | Z10 | 0.450" x 0.025" Microstrip              |
| Z5 | 0.489" x 0.041" Microstrip | Z11 | 0.340" x 0.014" Microstrip              |
| Z6 | 0.471" x 0.025" Microstrip | PCB | Rogers 4350, 0.020", $\epsilon_r = 3.5$ |

**Figure 3. MW5IC2030MBR1(GMBR1) Test Circuit Schematic**

**Table 6. MW5IC2030MBR1(GMBR1) Test Circuit Component Designations and Values**

| Part                    | Description                                     | Part Number        | Manufacturer |
|-------------------------|-------------------------------------------------|--------------------|--------------|
| C1                      | 1.8 pF High Q Chip Capacitor (0603)             | 600S1R8AT -250 -T  | ATC          |
| C2                      | 1.5 pF High Q Chip Capacitor (0603)             | 600S1R5AT -250 -T  | ATC          |
| C3                      | 3.9 pF High Q Chip Capacitor (0603)             | 600S3R9AT -250 -T  | ATC          |
| C4                      | 6.8 pF High Q Chip Capacitor (0805)             | 600S6R8AT -250 -T  | ATC          |
| C5, C6                  | 100 pF Class 1 NPO Chip Capacitors (0805)       | GRM215CB1H101CZ01D | Murata       |
| C7                      | 4.7 pF Class 1 NPO Chip Capacitor (0805)        | GRM215CB1H4R7CZ01D | Murata       |
| C8, C9, C10, C11        | 0.1 $\mu$ F X7R Chip Capacitors (1206)          | C1206C104K5RACT    | Kemet        |
| C12, C13, C14, C15, C16 | 0.01 $\mu$ F Class 2 X7R Chip Capacitors (0805) | C0805C103K5RACT    | Kemet        |
| C17, C18                | 22 $\mu$ F, 35 V Electrolytic Capacitors        | ECE -1AVKS220      | Panasonic    |
| C19, C20                | 330 $\mu$ F, 50 V Electrolytic Capacitors       | ECA -1HM331        | Panasonic    |
| R1, R3                  | 1 k $\Omega$ , 5% Chip Resistors (0805)         |                    |              |
| R2                      | 499 $\Omega$ , 1% Chip Resistor (0805)          |                    |              |
| R4, R5, R6              | 100 k $\Omega$ , 5% Chip Resistors (0805)       |                    |              |



Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 4. MW5IC2030MBR1(GMBR1) Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS

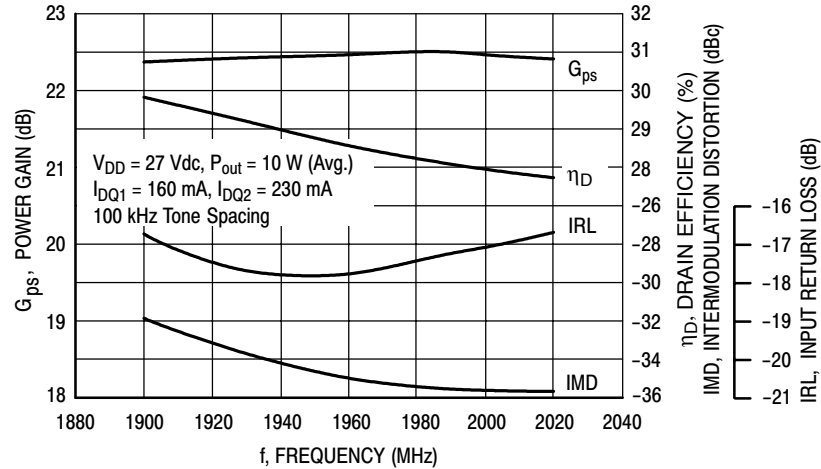


Figure 5. Two-Tone Broadband Performance @  $P_{out} = 10$  Watts Avg.

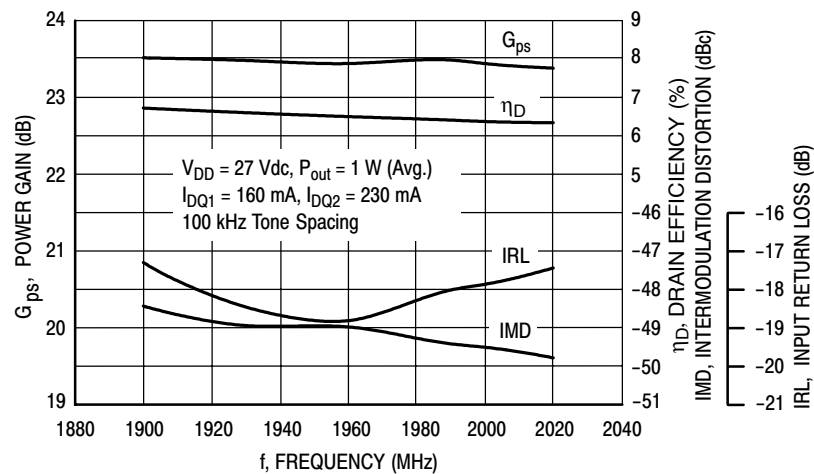


Figure 6. Two-Tone Broadband Performance @  $P_{out} = 1$  Watt Avg.

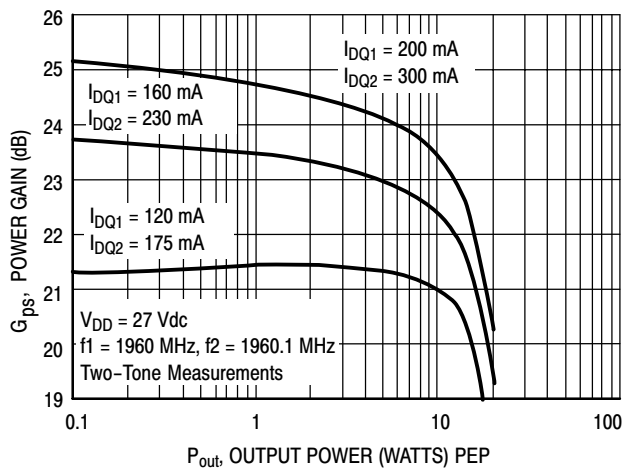


Figure 7. Two-Tone Power Gain versus Output Power

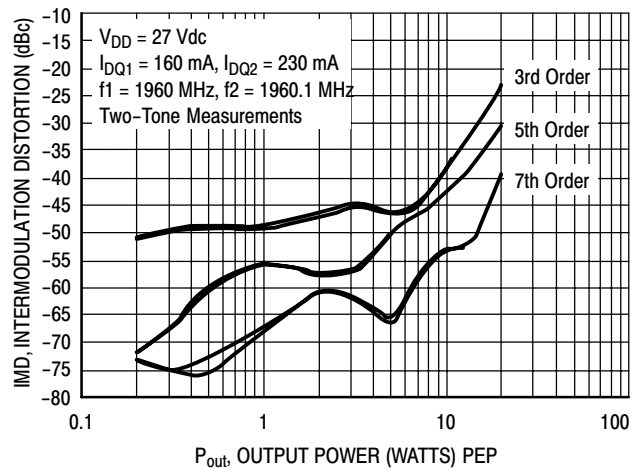
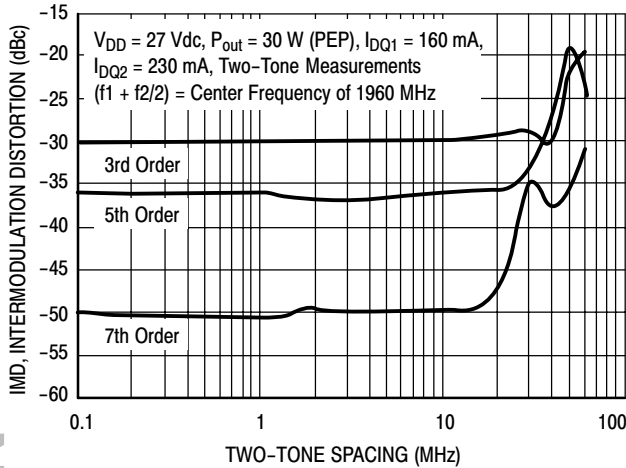
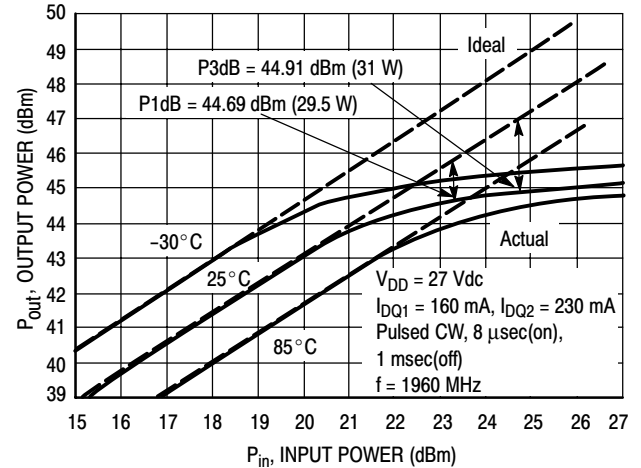


Figure 8. Intermodulation Distortion Products versus Output Power

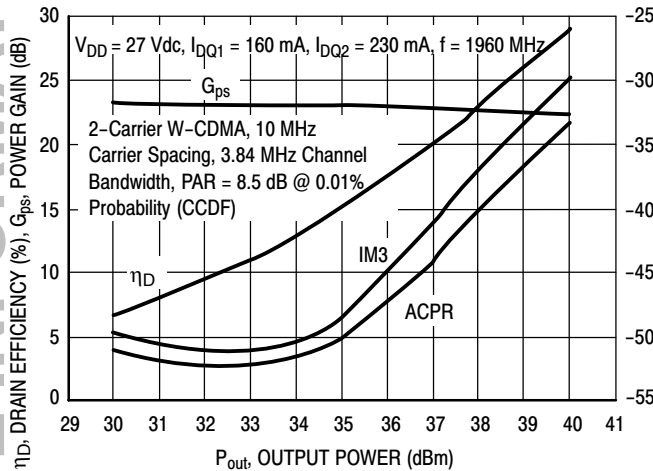
# TYPICAL CHARACTERISTICS



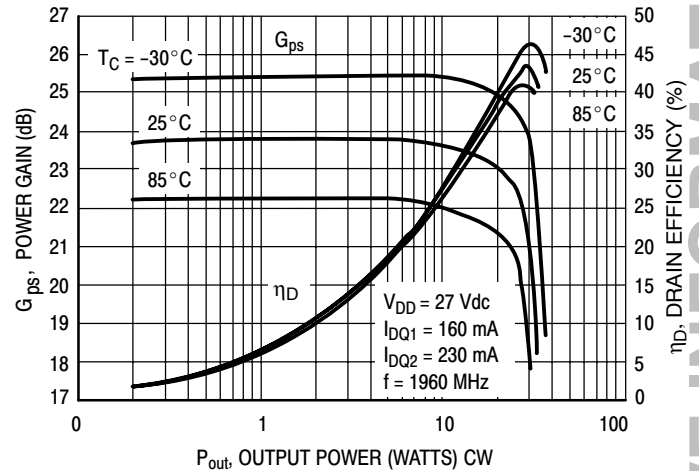
**Figure 9. Intermodulation Distortion Products versus Tone Spacing**



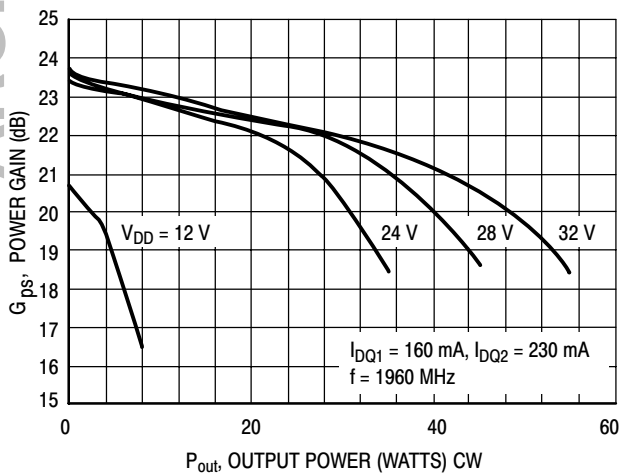
**Figure 10. Pulse CW Output Power versus Input Power**



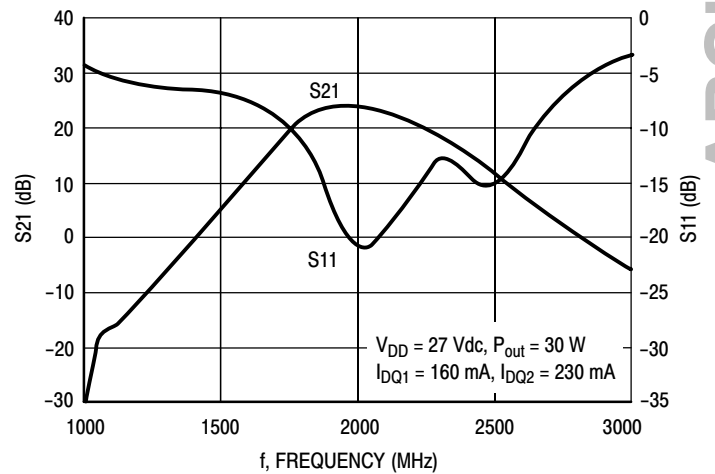
**Figure 11. 2-Carrier W-CDMA ACPR, IM3, Power Gain, and Drain Efficiency versus Output Power**



**Figure 12. Power Gain and Drain Efficiency versus Output Power**



**Figure 13. Power Gain versus Output Power**



**Figure 14. Broadband Frequency Response**

## TYPICAL CHARACTERISTICS

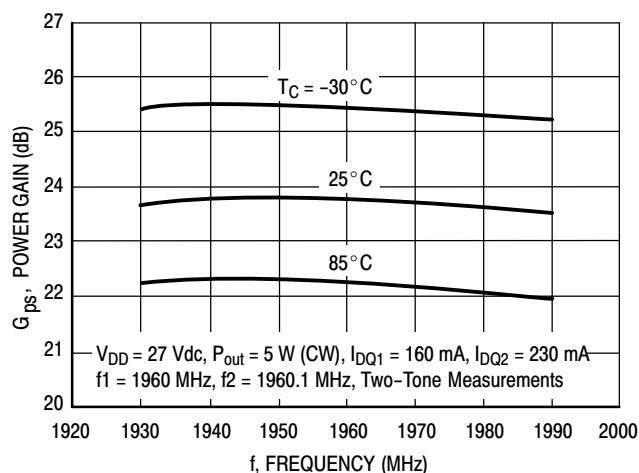


Figure 15. Power Gain versus Frequency

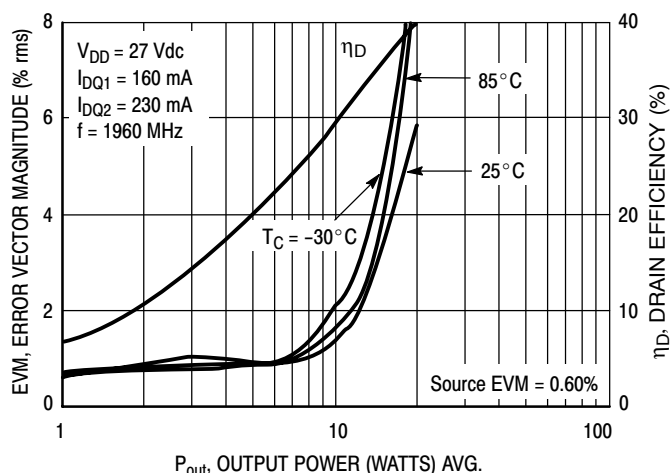


Figure 16. EVM and Drain Efficiency versus Output Power

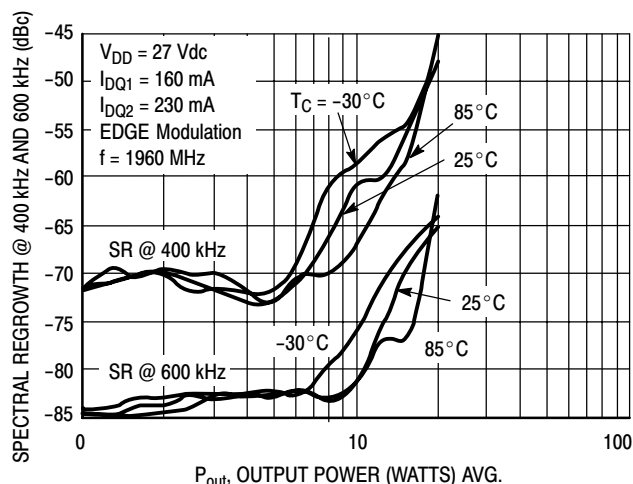


Figure 17. Spectral Regrowth at 400 kHz and 600 kHz versus Output Power

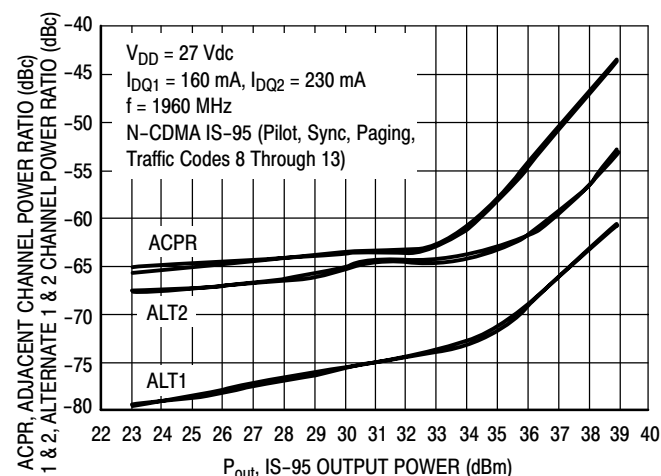


Figure 18. Single-Carrier N-CDMA ACPR, ALT1 and ALT2 versus Output Power

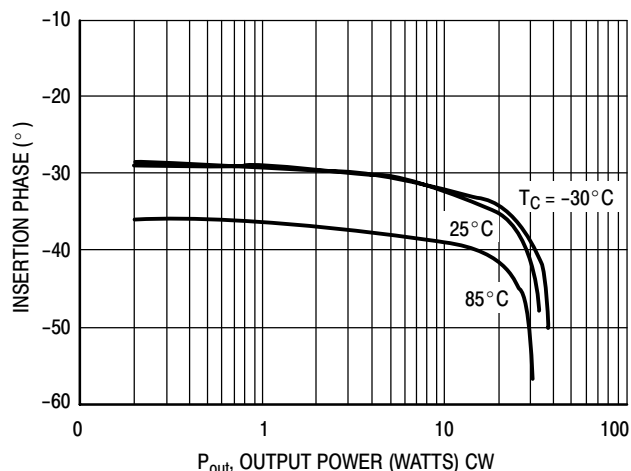
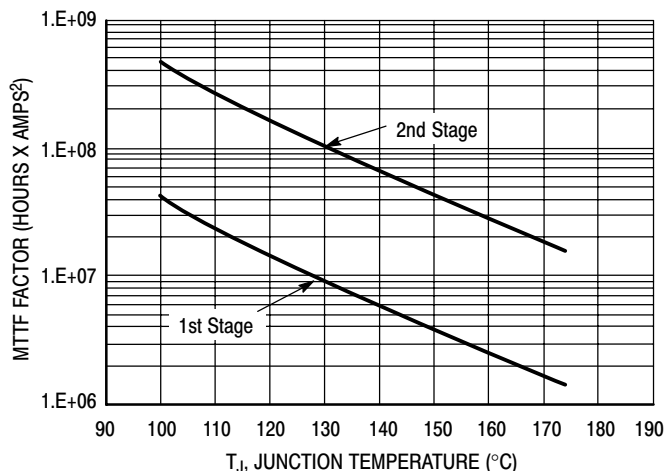


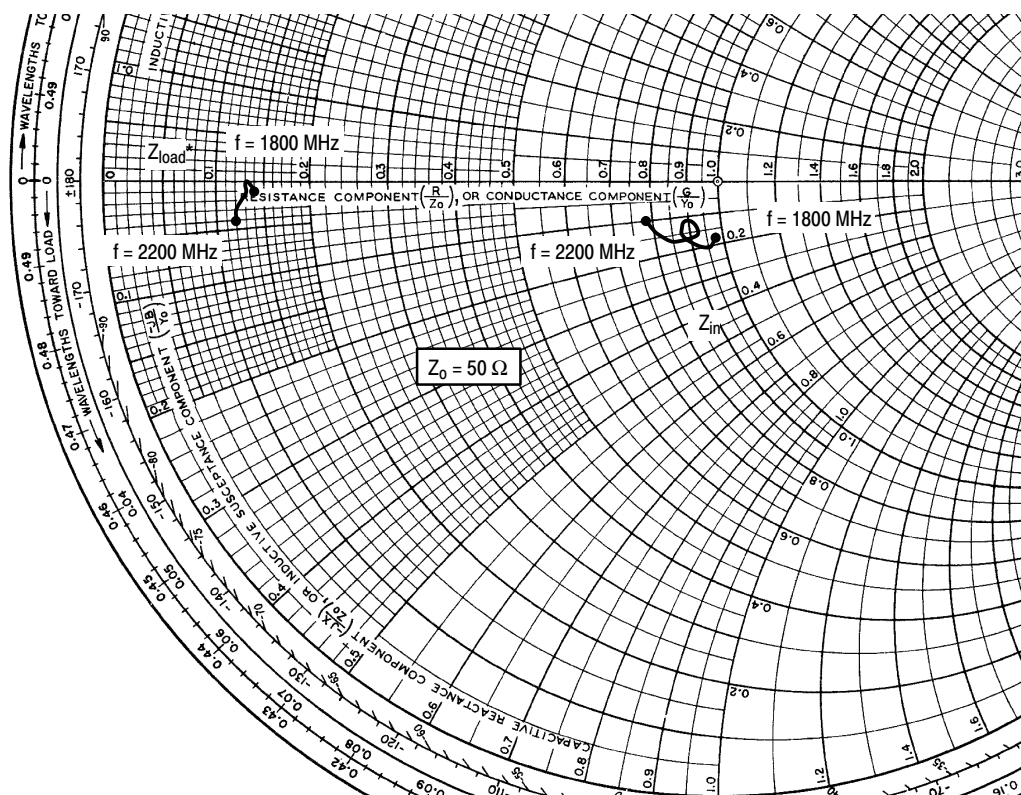
Figure 19. Insertion Phase versus Output Power



This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

Figure 20. MTTF Factor versus Junction Temperature





$V_{DD} = 27\text{ V}$ ,  $I_{DQ1} = 160\text{ mA}$ ,  $I_{DQ2} = 230\text{ mA}$

| f<br>MHz | $Z_{in}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|----------------------|------------------------|
| 1800     | 49.7 - j9.3          | 6.9 - j0.3             |
| 1850     | 47.7 - j9.8          | 6.9 - j0.3             |
| 1930     | 44.8 - j8.5          | 6.7 - j0.1             |
| 1960     | 44.0 - j7.3          | 6.6 - j0.0             |
| 1990     | 44.6 - j5.6          | 6.6 + j0.1             |
| 2050     | 45.7 - j8.6          | 6.4 + j0.4             |
| 2100     | 42.5 - j8.3          | 6.2 + j0.8             |
| 2150     | 40.6 - j6.8          | 6.1 + j1.1             |
| 2200     | 39.3 - j5.0          | 6.0 + j1.6             |

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

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

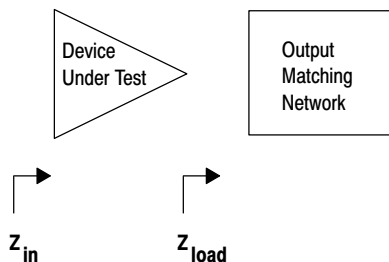
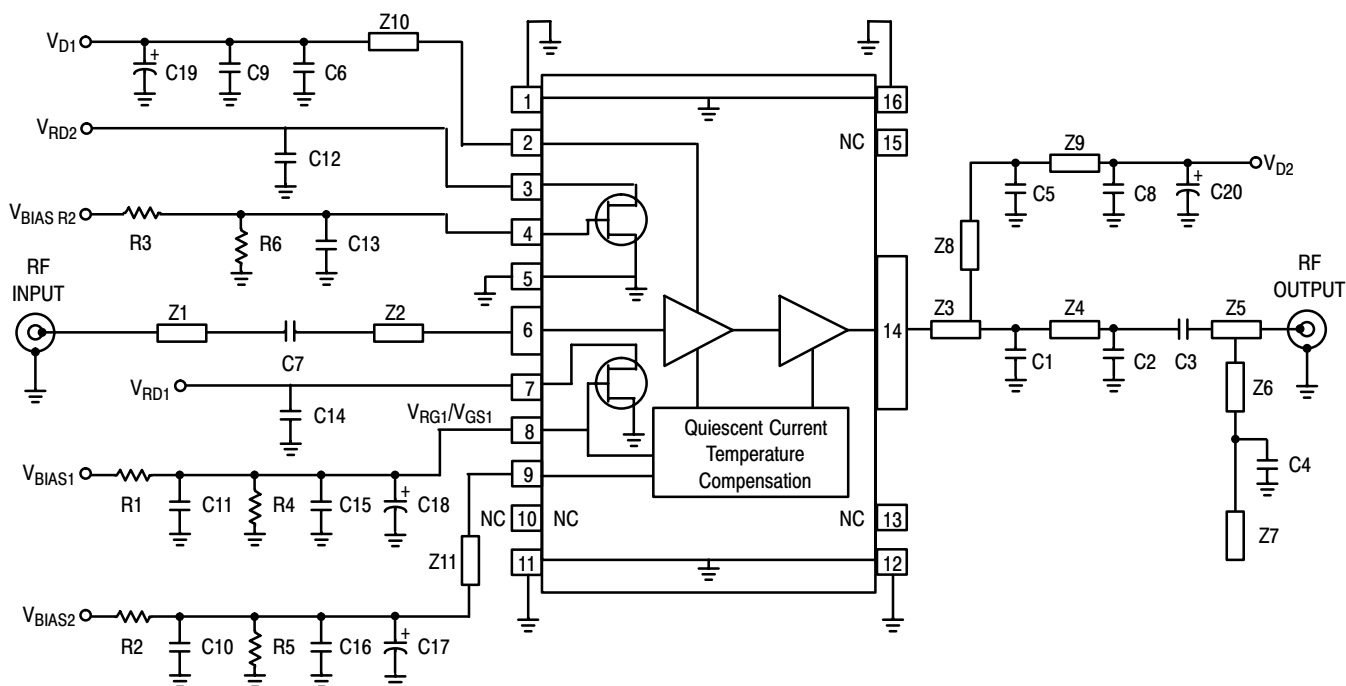


Figure 21. Series Equivalent Input and Load Impedance

MW5IC2030MBR1 MW5IC2030GMBR1

## DRIVER APPLICATION PERFORMANCE



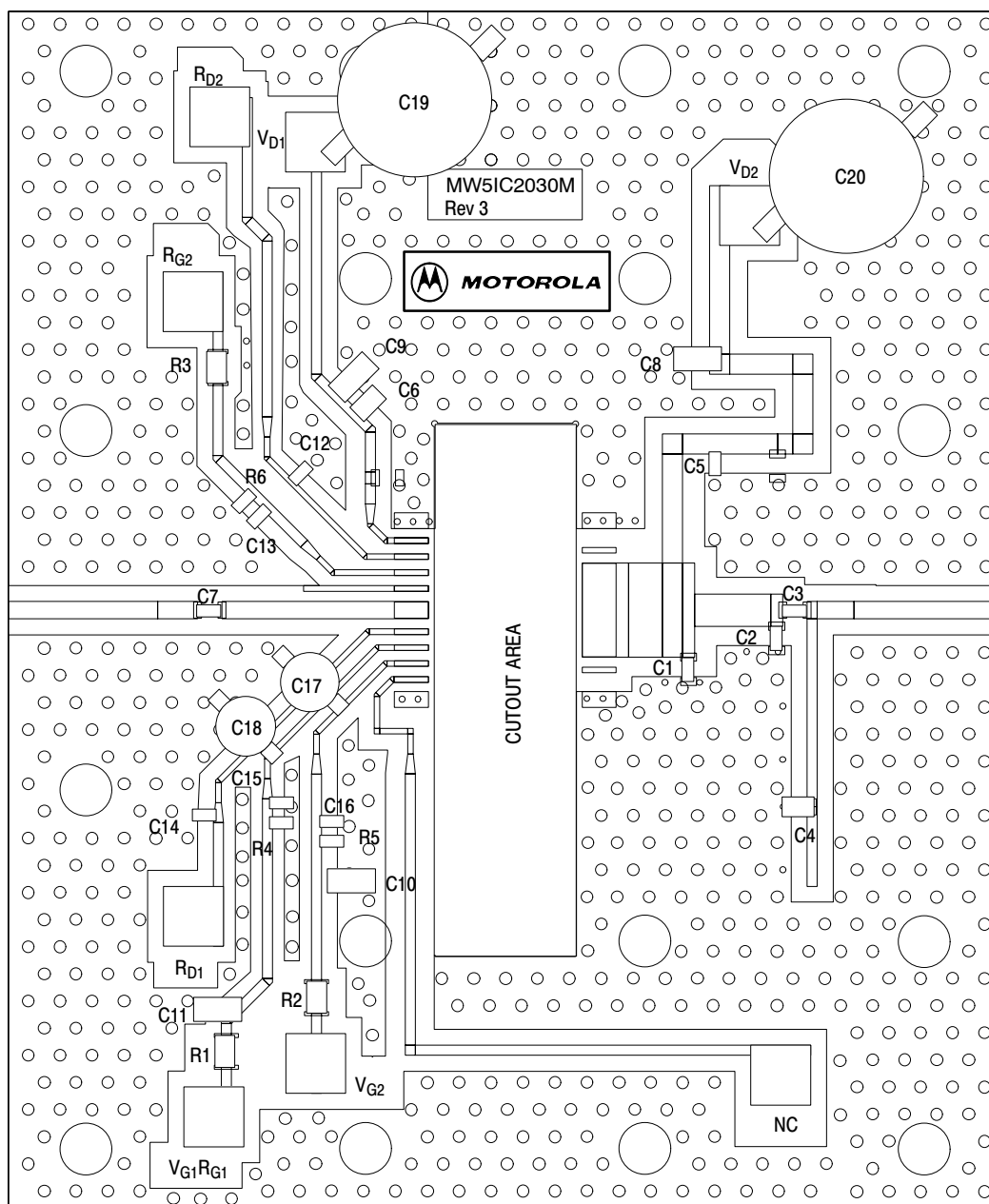
|    |                            |     |                                         |
|----|----------------------------|-----|-----------------------------------------|
| Z1 | 0.465" x 0.041" Microstrip | Z7  | 0.200" x 0.025" Microstrip              |
| Z2 | 0.518" x 0.041" Microstrip | Z8  | 0.274" x 0.050" Microstrip              |
| Z3 | 0.282" x 0.235" Microstrip | Z9  | 0.615" x 0.050" Microstrip              |
| Z4 | 0.221" x 0.081" Microstrip | Z10 | 0.450" x 0.025" Microstrip              |
| Z5 | 0.489" x 0.041" Microstrip | Z11 | 0.340" x 0.014" Microstrip              |
| Z6 | 0.471" x 0.025" Microstrip | PCB | Rogers 4350, 0.020", $\epsilon_r = 3.5$ |

Figure 22. MW5IC2030MBR1(GMBR1) Test Circuit Schematic for Driver Application Tests

Table 7. MW5IC2030MBR1(GMBR1) Test Circuit Component Designations and Values for Driver Application Tests

| Part                    | Description                                     | Part Number        | Manufacturer |
|-------------------------|-------------------------------------------------|--------------------|--------------|
| C1                      | 2.2 pF High Q Chip Capacitor (0603)             | 600S2R2AT -250 -T  | ATC          |
| C2                      | 1.8 pF High Q Chip Capacitor (0603)             | 600S1R8AT -250 -T  | ATC          |
| C3                      | 3.9 pF High Q Chip Capacitor (0603)             | 600S3R9AT -250 -T  | ATC          |
| C4                      | 6.8 pF High Q Chip Capacitor (0805)             | 600S6R8AT -250 -T  | ATC          |
| C5, C6                  | 100 pF Class 1 NPO Chip Capacitors (0805)       | GRM215CB1H101CZ01D | Murata       |
| C7                      | 4.7 pF Class 1 NPO Chip Capacitor (0805)        | GRM215CB1H47CZ01D  | Murata       |
| C8, C9, C10, C11        | 0.1 $\mu$ F X7R Chip Capacitors (1206)          | C1206C104K5RACT    | Kemet        |
| C12, C13, C14, C15, C16 | 0.01 $\mu$ F Class 2 X7R Chip Capacitors (0805) | C0805C103K5RACT    | Kemet        |
| C17, C18                | 22 $\mu$ F, 35 V Electrolytic Capacitors        | ECE - 1AVKS220     | Panasonic    |
| C19, C20                | 330 $\mu$ F, 50 V Electrolytic Capacitors       | ECA - 1HM331       | Panasonic    |
| R1, R3                  | 1 k $\Omega$ , 5% Chip Resistors (0805)         |                    |              |
| R2                      | 499 $\Omega$ , 1% Chip Resistor (0805)          |                    |              |
| R4, R5, R6              | 100 k $\Omega$ , 5% Chip Resistors (0805)       |                    |              |

# DRIVER APPLICATION PERFORMANCE



Freescall has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescall Semiconductor signature/logo. PCBs may have either Motorola or Freescall markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 23. MW5IC2030MBR1(GMBR1) Test Circuit Component Layout for Driver Application Tests**

# TYPICAL DRIVER APPLICATION CHARACTERISTICS

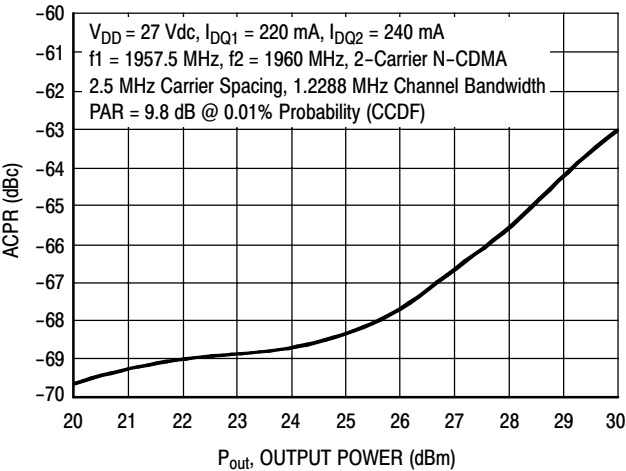
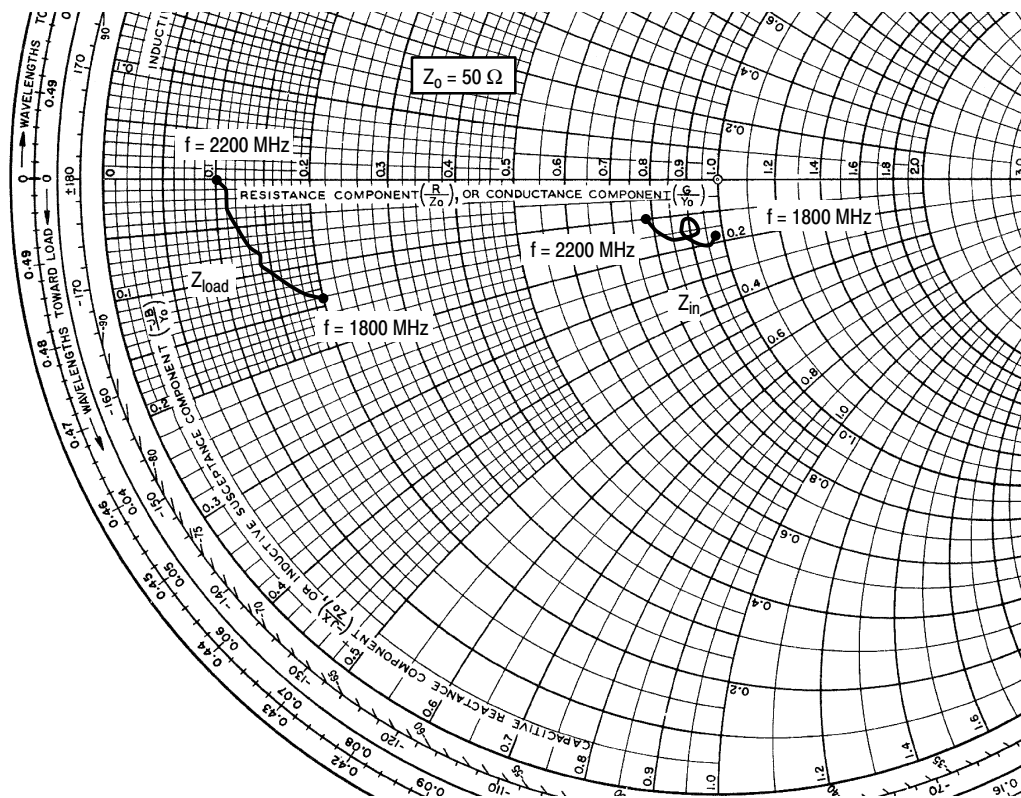


Figure 24. 2-Carrier N-CDMA ACPR versus Output Power



$V_{DD} = 27\text{ V}$ ,  $I_{DQ1} = 220\text{ mA}$ ,  $I_{DQ2} = 240\text{ mA}$

| f<br>MHz | $Z_{in}$<br>$\Omega$ | $Z_{load}$<br>$\Omega$ |
|----------|----------------------|------------------------|
| 1800     | 49.7 - j9.3          | 9.8 - j7.0             |
| 1850     | 47.7 - j9.8          | 8.9 - j6.3             |
| 1930     | 44.8 - j8.5          | 7.2 - j4.6             |
| 1960     | 44.0 - j7.3          | 6.8 - j3.9             |
| 1990     | 44.6 - j5.6          | 6.5 - j3.4             |
| 2050     | 45.7 - j8.6          | 5.9 - j2.3             |
| 2100     | 42.5 - j8.3          | 5.6 - j1.5             |
| 2150     | 40.6 - j6.8          | 5.4 - j0.7             |
| 2200     | 39.3 - j5.0          | 5.2 + j0.1             |

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

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

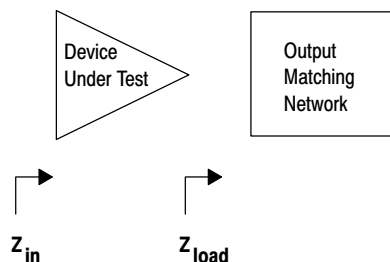
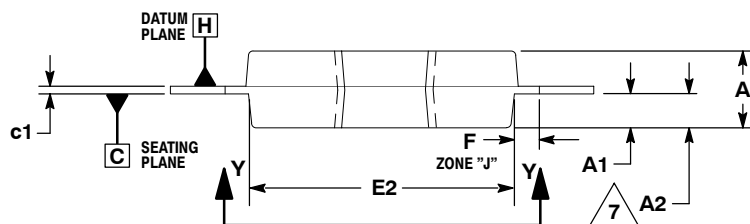
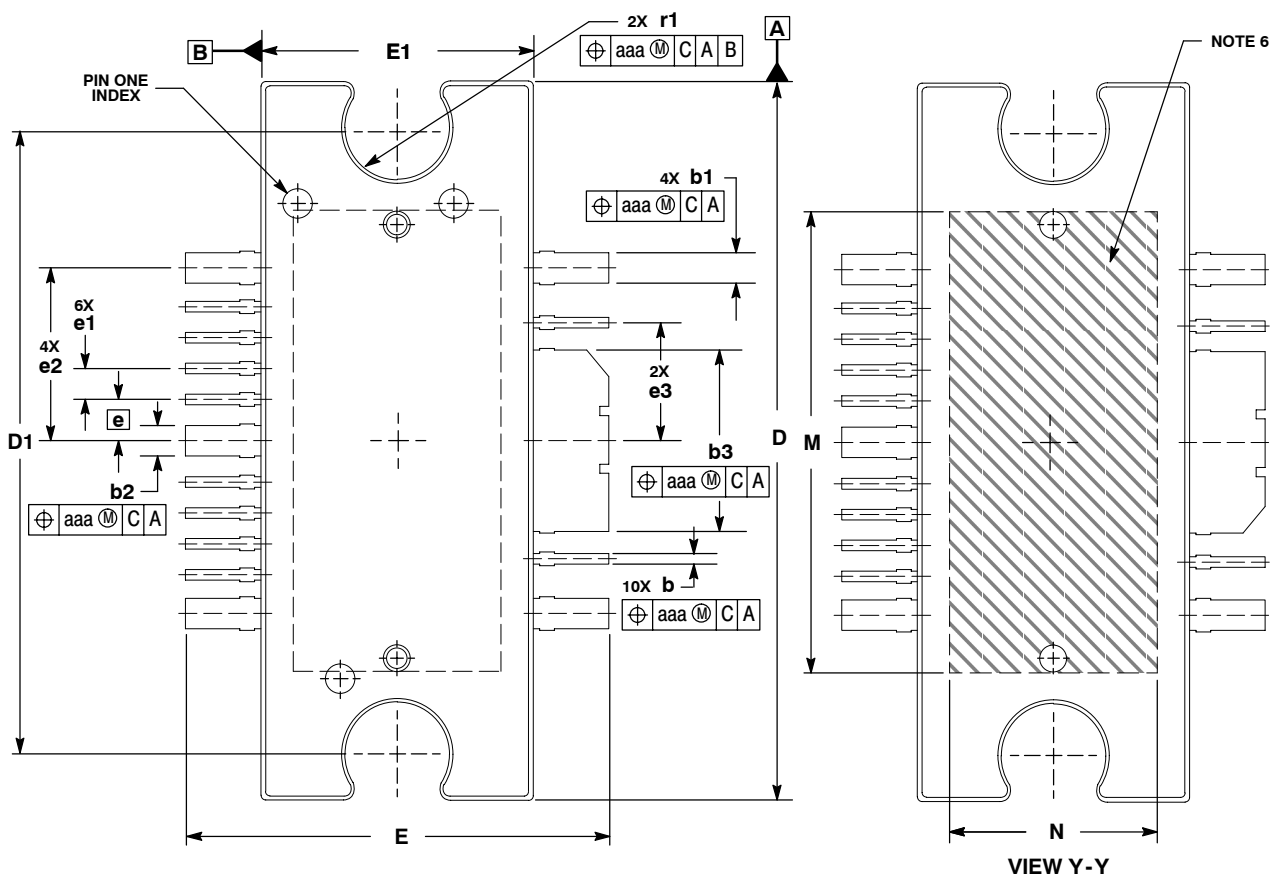


Figure 25. Series Equivalent Input and Load Impedance for Driver Application

## PACKAGE DIMENSIONS

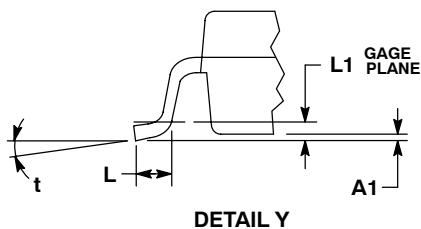
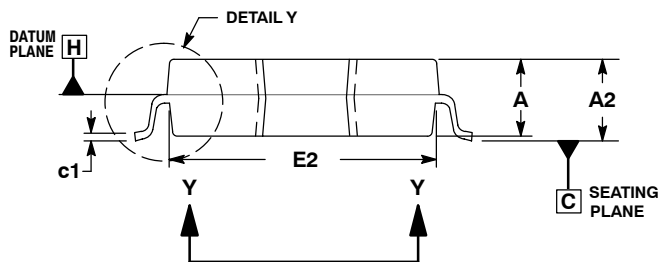
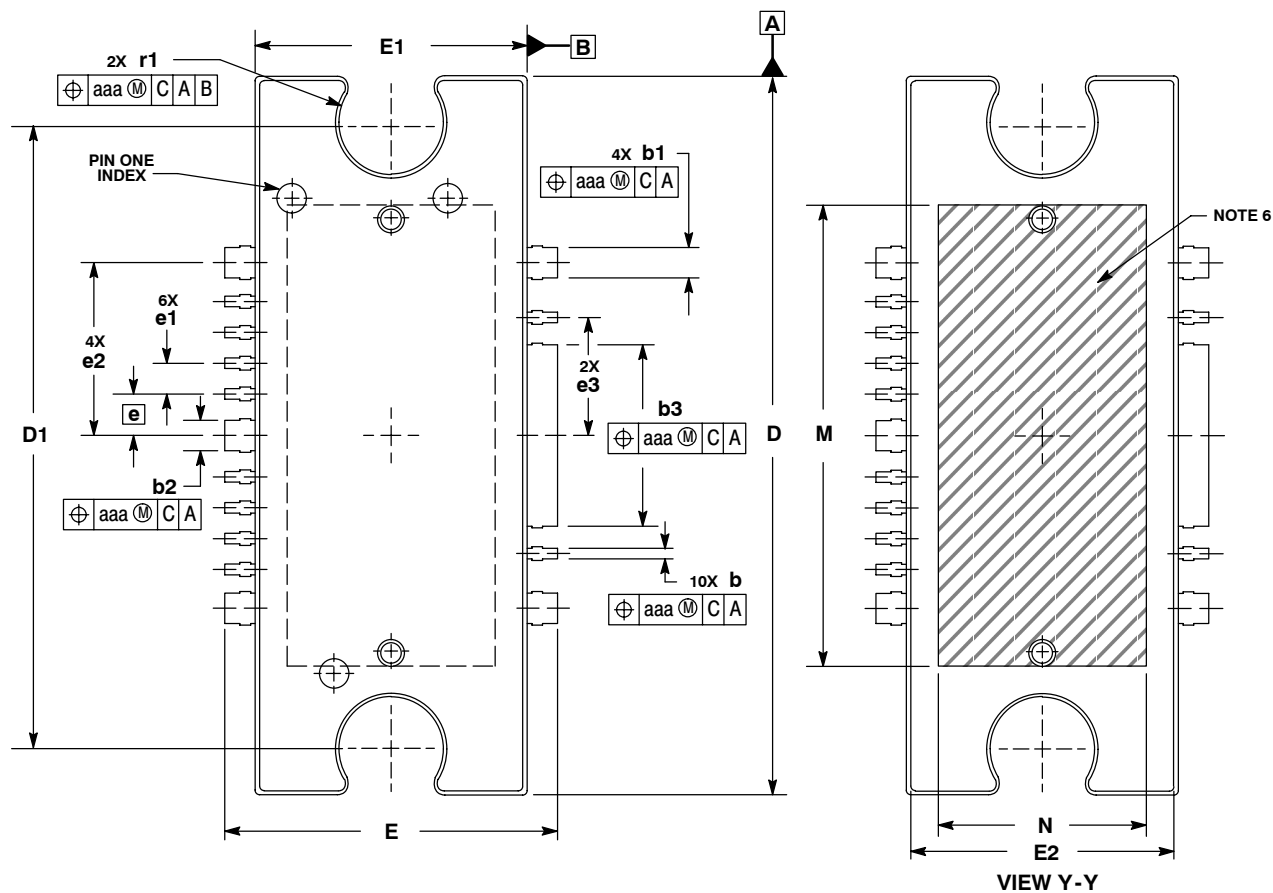


NOTES:

1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
  3. DATUM PLANE --H-- IS LOCATED AT 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", "b1", "b2" AND "b3" DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 (0.13) TOTAL IN EXCESS OF THE "b", "b1", "b2" AND "b3" DIMENSIONS AT MAXIMUM MATERIAL CONDITION.
  6. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG.
- △ DIM A2 APPLIES WITHIN ZONE "J" ONLY.

| DIM | INCHES   |      | MILLIMETERS |       |
|-----|----------|------|-------------|-------|
|     | MIN      | MAX  | MIN         | MAX   |
| A   | .100     | .104 | 2.54        | 2.64  |
| A1  | .038     | .044 | 0.96        | 1.1   |
| A2  | .040     | .042 | 1.02        | 1.07  |
| D   | .928     | .932 | 23.57       | 23.67 |
| D1  | .810 BSC |      | 20.57 BSC   |       |
| E   | .551     | .559 | 14.00       | 14.20 |
| E1  | .353     | .357 | 8.97        | 9.07  |
| E2  | .346     | .350 | 8.79        | 8.89  |
| F   | .025 BSC |      | 0.64 BSC    |       |
| M   | .600     | ---  | 15.24       | ---   |
| N   | .270     | ---  | 6.86        | ---   |
| b   | .011     | .017 | 0.28        | 0.43  |
| b1  | .037     | .043 | 0.94        | 1.09  |
| b2  | .037     | .043 | 0.94        | 1.09  |
| b3  | .225     | .231 | 5.72        | 5.87  |
| c1  | .007     | .011 | .18         | .28   |
| e   | .054 BSC |      | 1.37 BSC    |       |
| e1  | .040 BSC |      | 1.02 BSC    |       |
| e2  | .224 BSC |      | 5.69 BSC    |       |
| e3  | .150 BSC |      | 3.81 BSC    |       |
| r1  | .063     | .068 | 1.6         | 1.73  |
| aaa | .004     |      | .10         |       |

**CASE 1329-09  
ISSUE K  
TO-272 WB-16  
PLASTIC  
MW5IC2030MBR1**



#### NOTES:

1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT 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", "b1", "b2" AND "b3" DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 (0.13) TOTAL IN EXCESS OF THE "b", "b1", "b2" AND "b3" DIMENSIONS AT MAXIMUM MATERIAL CONDITION.
6. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SINK.

| DIM | INCHES   |      | MILLIMETERS |       |
|-----|----------|------|-------------|-------|
|     | MIN      | MAX  | MIN         | MAX   |
| A   | .100     | .104 | 2.54        | 2.64  |
| A1  | .001     | .004 | 0.02        | 0.10  |
| A2  | .099     | .110 | 2.51        | 2.79  |
| D   | .928     | .932 | 23.57       | 23.67 |
| D1  | .810 BSC |      | 20.57 BSC   |       |
| E   | .429     | .437 | 10.90       | 11.10 |
| E1  | .353     | .357 | 8.97        | 9.07  |
| E2  | .346     | .350 | 8.79        | 8.89  |
| L   | .018     | .024 | 4.90        | 5.06  |
| L1  | .01 BSC  |      | 0.25 BSC    |       |
| M   | .600     | ---  | 15.24       | ---   |
| N   | .270     | ---  | 6.86        | ---   |
| b   | .011     | .017 | 0.28        | 0.43  |
| b1  | .037     | .043 | 0.94        | 1.09  |
| b2  | .037     | .043 | 0.94        | 1.09  |
| b3  | .225     | .231 | 5.72        | 5.87  |
| c1  | .007     | .011 | .18         | .28   |
| e   | .054 BSC |      | 1.37 BSC    |       |
| e1  | .040 BSC |      | 1.02 BSC    |       |
| e2  | .224 BSC |      | 5.69 BSC    |       |
| e3  | .150 BSC |      | 3.81 BSC    |       |
| r1  | .063     | .068 | 1.6         | 1.73  |
| t   | 2°       | 8°   | 2°          | 8°    |
| aaa | .004     |      | .10         |       |

**CASE 1329A-03**  
**ISSUE D**  
**TO-272 WB-16 GULL**  
**PLASTIC**  
**MW5IC2030GMBR1**

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