√RoHS

# RF LDMOS Wideband Integrated Power Amplifiers

**MW7IC2220NR1**
**MW7IC2220GNR1**
**MW7IC2220NBR1**

The MW7IC2220N wideband integrated circuit is designed with on-chip matching that makes it usable from 2000 to 2200 MHz. This multi-stage structure is rated for 24 to 32 Volt operation and covers all typical cellular base station modulation formats including TD-SCDMA.

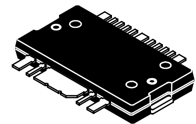
- Typical Single-Carrier W-CDMA Performance: $V_{DD}$ = 28 Volts, $I_{DQ1}$ = 80 mA, $I_{DQ2}$ = 300 mA, $P_{out}$ = 2 Watts Avg., f = 2167.5 MHz, IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.
  - Power Gain — 31 dB
  - Power Added Efficiency — 13%
  - ACPR @ 5 MHz Offset — -50 dBc in 3.84 MHz Bandwidth
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 2140 MHz, 20 Watts CW Output Power
- Stable into a 5:1 VSWR. All Spurs Below -60 dBc @ 100 mW to 5 Watts CW $P_{out}$.
- Typical $P_{out}$ @ 1 dB Compression Point ≃ 20 Watts CW

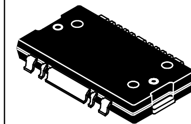
**Features**

- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source S-Parameters
- On-Chip Matching (50 Ohm Input, DC Blocked, >3 Ohm Output)
- 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, 44 mm Tape Width, 13 inch Reel.

**2110-2170 MHz, 2 W Avg., 28 V**
**SINGLE W-CDMA**
**RF LDMOS WIDEBAND**
**INTEGRATED POWER AMPLIFIERS**

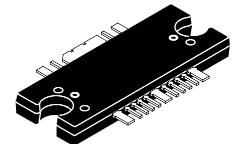
**CASE 1886-01**
**TO-270 WB-16**
**PLASTIC**
**MW7IC2220NR1**





**CASE 1887-01**
**TO-270 WB-16 GULL**
**PLASTIC**
**MW7IC2220GNR1**

**CASE 1329-09**
**TO-272 WB-16**
**PLASTIC**
**MW7IC2220NBR1**



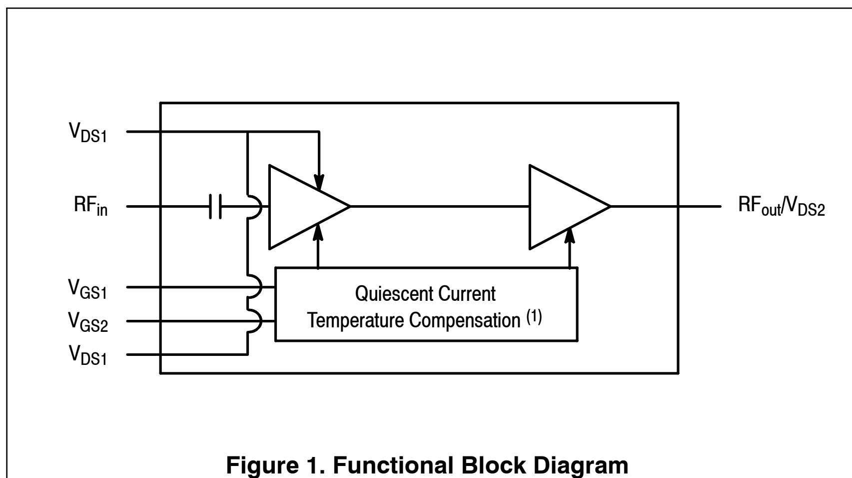
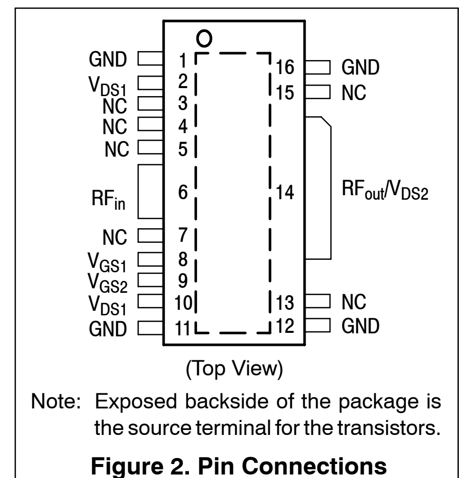



**Figure 1. Functional Block Diagram**




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.

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**Table 1. Maximum Ratings**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | -0.5, +65 | Vdc |
| Gate-Source Voltage | $V_{GS}$ | -0.5, +5 | Vdc |
| Operating Voltage | $V_{DD}$ | 32, +0 | 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 |
| Input Power | $P_{in}$ | 20 | dBm |

**Table 2. Thermal Characteristics**

| Characteristic | | Symbol | Value [2,3] | Unit |
|---|---|---|---|---|
| Thermal Resistance, Junction to Case | | $R_{\theta JC}$ | | °C/W |
| 2 W Avg. ($P_{out}$ = 2 W CW, Case Temperature = 78°C) | Stage 1, 28 Vdc, $I_{DQ1}$ = 80 mA | | 4.3 | |
| | Stage 2, 28 Vdc, $I_{DQ2}$ = 300 mA | | 1.5 | |
| 20 W Avg. ($P_{out}$ = 20 W CW, Case Temperature = 82°C) | Stage 1, 28 Vdc, $I_{DQ1}$ = 80 mA | | 4.3 | |
| | Stage 2, 28 Vdc, $I_{DQ2}$ = 300 mA | | 1.25 | |

**Table 3. ESD Protection Characteristics**

| Test Methodology | Class |
|---|---|
| Human Body Model (per JESD22-A114) | 0 (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 JESD22-A113, IPC/JEDEC J-STD-020 | 3 | 260 | °C |

**Table 5. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Stage 1 — Off Characteristics** | | | | | |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 65 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 28 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 1 | μAdc |
| Gate-Source Leakage Current ($V_{GS}$ = 5 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | — | — | 1 | μAdc |
| **Stage 1 — On Characteristics** | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 23 μAdc) | $V_{GS(th)}$ | 1.2 | 2 | 2.7 | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 28 Vdc, $I_{DQ1}$ = 80 mAdc) | $V_{GS(Q)}$ | — | 2.8 | — | Vdc |
| Fixture Gate Quiescent Voltage ($V_{DD}$ = 28 Vdc, $I_{DQ1}$ = 80 mAdc, Measured in Functional Test) | $V_{GG(Q)}$ | 9.5 | 12.2 | 16.5 | Vdc |

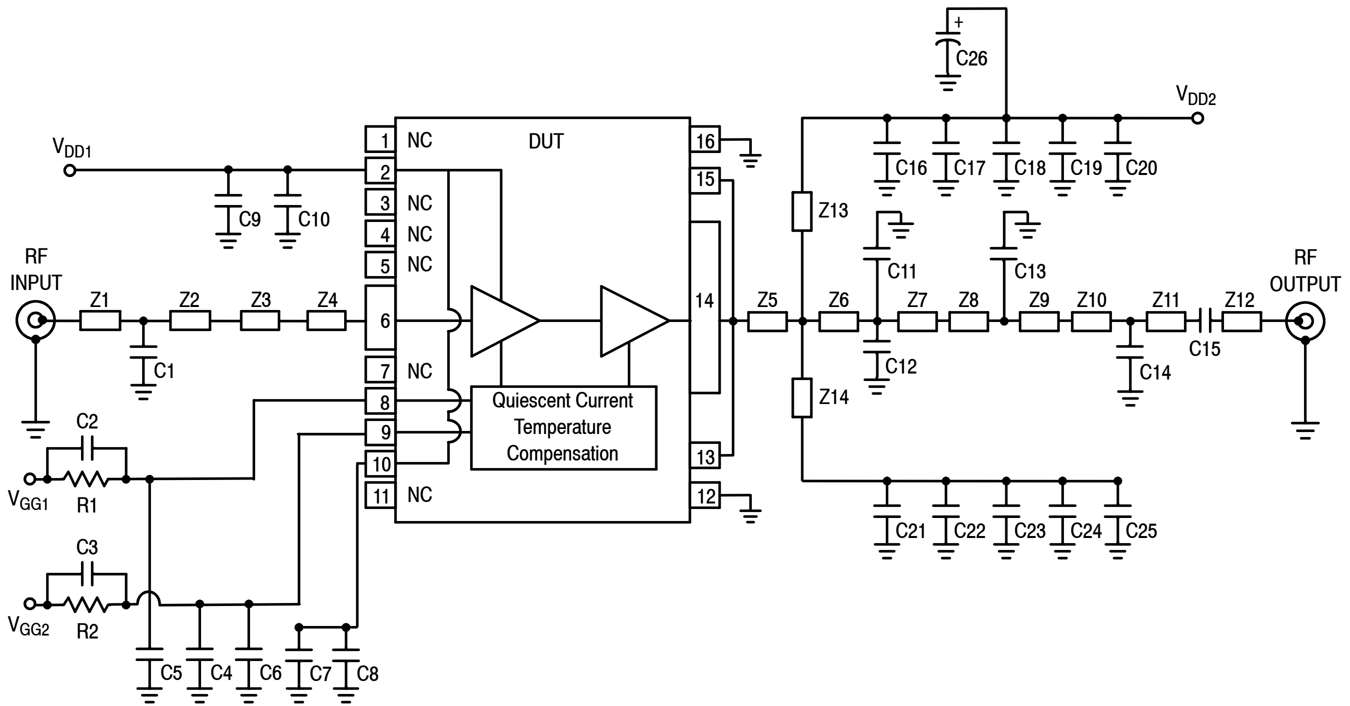
1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

(continued)

**Table 5. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted) **(continued)**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Stage 2 — Off Characteristics** | | | | | |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 65 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 28 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 1 | μAdc |
| Gate-Source Leakage Current ($V_{GS}$ = 5 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | — | — | 1 | μAdc |
| **Stage 2 — On Characteristics** | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 150 μAdc) | $V_{GS(th)}$ | 1.2 | 2 | 2.7 | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 28 Vdc, $I_{DQ2}$ = 300 mAdc) | $V_{GS(Q)}$ | — | 2.7 | — | Vdc |
| Fixture Gate Quiescent Voltage ($V_{DD}$ = 28 Vdc, $I_{DQ2}$ = 300 mAdc, Measured in Functional Test) | $V_{GG(Q)}$ | 7 | 8 | 12.5 | Vdc |
| Drain-Source On-Voltage ($V_{GS}$ = 10 Vdc, $I_D$ = 1 Adc) | $V_{DS(on)}$ | 0.2 | 0.39 | 1.2 | Vdc |
| **Stage 2 — Dynamic Characteristics** [1] | | | | | |
| Output Capacitance ($V_{DS}$ = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{oss}$ | — | 205 | — | pF |
| **Functional Tests** (In Freescale Wideband 2110-2170 MHz Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ1}$ = 80 mA, $I_{DQ2}$ = 300 mA, $P_{out}$ = 2 W Avg., f = 2167.5 MHz, Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. | | | | | |
| Power Gain | $G_{ps}$ | 29 | 31 | 34 | dB |
| Power Added Efficiency | PAE | 11 | 13 | — | % |
| Adjacent Channel Power Ratio | ACPR | — | -50 | -47 | dBc |
| Input Return Loss | IRL | — | -14 | -12 | dB |
| **Typical Performances** (In Freescale Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ1}$ = 80 mA, $I_{DQ2}$ = 300 mA, 2110-2170 MHz | | | | | |
| $P_{out}$ @ 1 dB Compression Point, CW | P1dB | — | 20 | — | W |
| IMD Symmetry @ 18 W PEP, $P_{out}$ where IMD Third Order Intermodulation ≅ 30 dBc (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands > 2 dB) | $IMD_{sym}$ | — | 40 | — | MHz |
| VBW Resonance Point (IMD Third Order Intermodulation Inflection Point) | $VBW_{res}$ | — | 70 | — | MHz |
| Gain Flatness in 60 MHz Bandwidth @ $P_{out}$ = 2 W Avg. | $G_F$ | — | 0.6 | — | dB |
| Average Deviation from Linear Phase in 60 MHz Bandwidth @ $P_{out}$ = 20 W CW | Φ | — | 1.2 | — | ° |
| Average Group Delay @ $P_{out}$ = 20 W CW, f = 2140 MHz | Delay | — | 2.5 | — | ns |
| Part-to-Part Insertion Phase Variation @ $P_{out}$ = 20 W CW, f = 2140 MHz, Six Sigma Window | ΔΦ | — | 15 | — | ° |
| Gain Variation over Temperature (-30°C to +85°C) | ΔG | — | 0.036 | — | dB/°C |
| Output Power Variation over Temperature (-30°C to +85°C) | ΔP1dB | — | 0.003 | — | dB/°C |

1. Part internally matched both on input and output.




| | | | |
|---|---|---|---|
| Z1 | 0.090″ x 0.083″ Microstrip | Z8 | 0.263″ x 0.123″ Microstrip |
| Z2 | 2.107″ x 0.083″ Microstrip | Z9 | 0.125″ x 0.123″ Microstrip |
| Z3 | 0.016″ x 0.083″ x 0.055″ Taper | Z10 | 0.280″ x 0.083″ Microstrip |
| Z4 | 0.106″ x 0.055″ Microstrip | Z11 | 0.373″ x 0.083″ Microstrip |
| Z5 | 0.570″ x 0.322″ Microstrip | Z12 | 0.364″ x 0.083″ Microstrip |
| Z6 | 0.204″ x 0.322″ Microstrip | Z13, Z14 | 1.042″ x 0.083″ Microstrip |
| Z7 | 0.050″ x 0.322″ Microstrip | PCB | Arlon CuClad 250GX-0300-55-22, 0.030″, $\varepsilon_r$ = 2.55 |

**Figure 3. MW7IC2220NR1(GNR1)(NBR1) Test Circuit Schematic**

**Table 6. MW7IC2220NR1(GNR1)(NBR1) Test Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1 | 0.1 pF Chip Capacitor | ATC100B0R1JT500XT | ATC |
| C2, C3 | 8.2 pF Chip Capacitors | ATC100B8R2BT500XT | ATC |
| C4 | 4.7 μF, 50 V Chip Capacitor | C4532X7R1H475KT | TDK |
| C5, C6 | 0.4 pF Chip Capacitors | ATC100B0R4JT500XT | ATC |
| C7, C9 | 10 μF, 50 V Chip Capacitors | C3225Y5V1H106ZT | TDK |
| C8, C10 | 5.6 pF Chip Capacitors | ATC100B5R6JT500XT | ATC |
| C11, C12 | 0.3 pF Chip Capacitors | ATC100B0R3JT500XT | ATC |
| C13 | 0.8 pF Chip Capacitor | ATC100B0R8JT500XT | ATC |
| C14 | 1.1 pF Chip Capacitor | ATC100B1R1JT500XT | ATC |
| C15, C16, C21 | 9.1 pF Chip Capacitors | ATC100B9R1JT500XT | ATC |
| C17, C22 | 0.1 μF, 250 V Chip Capacitors | C3216X7R2E104KT | TDK |
| C18, C23 | 6.8 μF, 50 V Chip Capacitors | C4532X7R1H685KT | TDK |
| C19, C24 | 4.7 μF, 50 V Chip Capacitors | C4532X7R1H475KT | TDK |
| C20, C25 | 10 μF, 50 V Chip Capacitors | C3225Y5V1H106ZT | TDK |
| C26 | 470 μF, 63 V Electrolytic Capacitor | 477KXM063M | Illinois Capacitor |
| R1, R2 | 10 kΩ, 1/4 W Chip Resistors | CRCW12061002FKEA | Vishay |

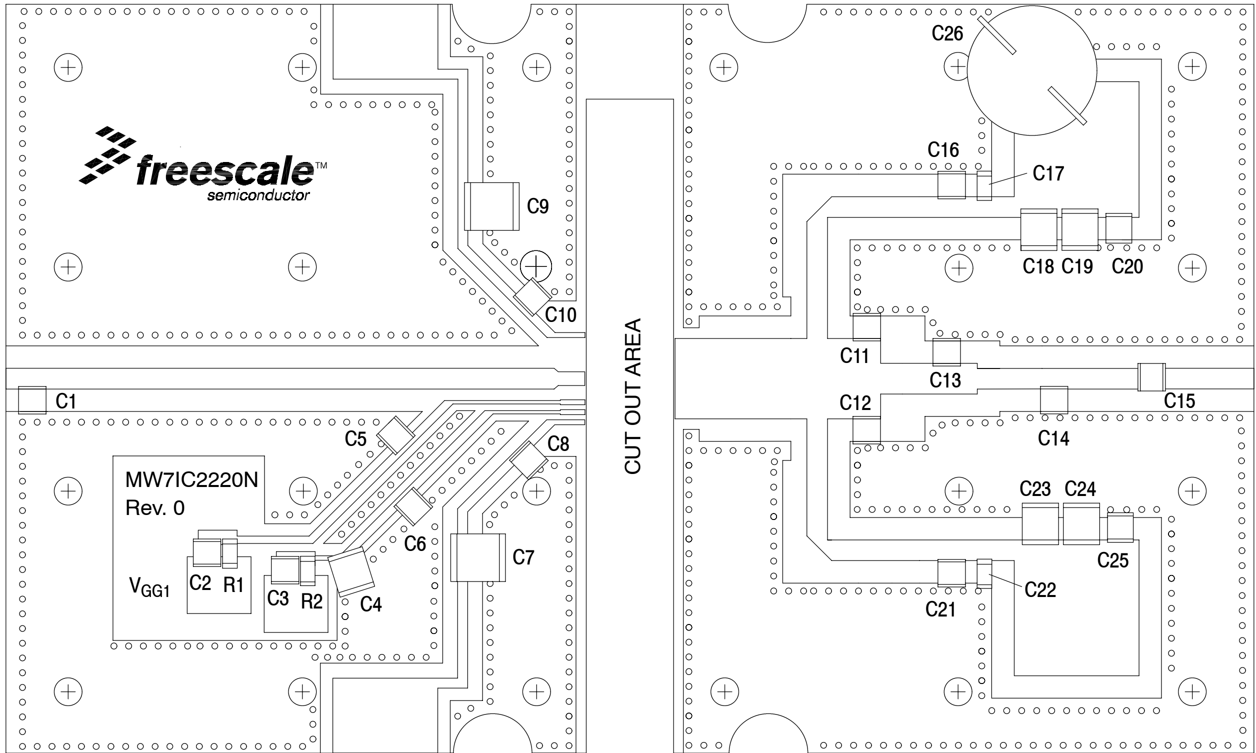



**Figure 4. MW7IC2220NR1(GNR1)(NBR1) Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS

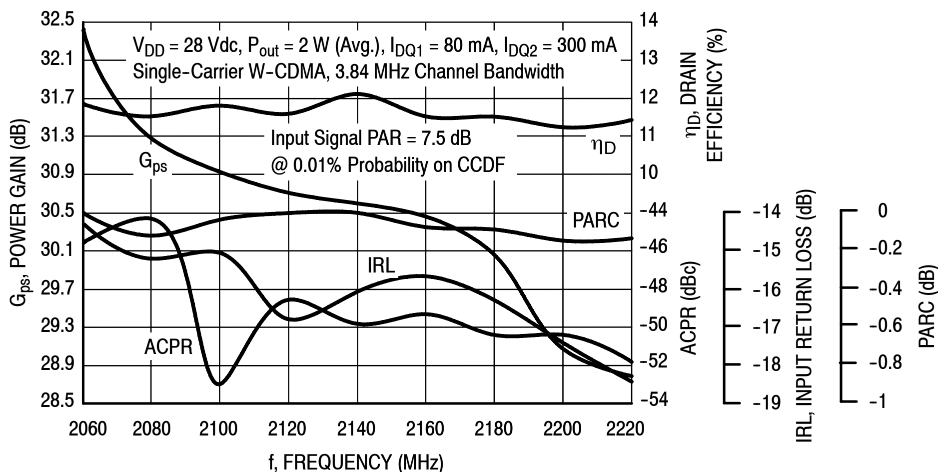



**Figure 5. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out}$ = 2 Watts Avg.**

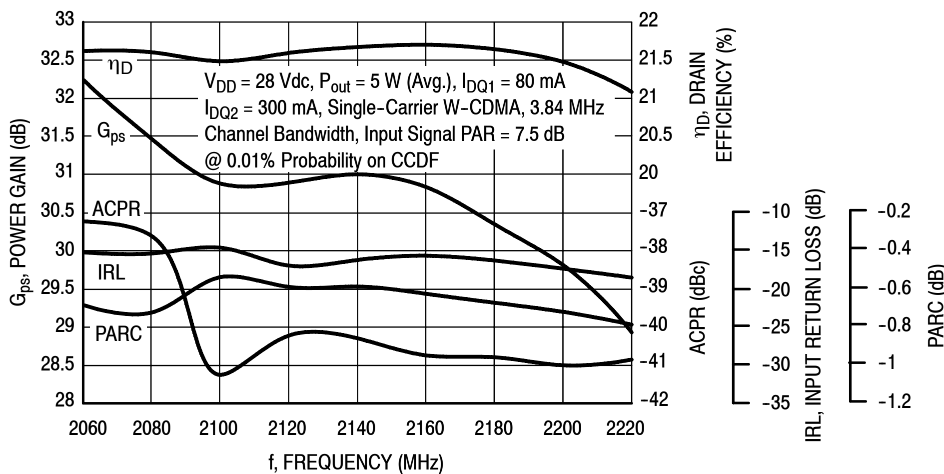



**Figure 6. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out}$ = 5 Watts Avg.**

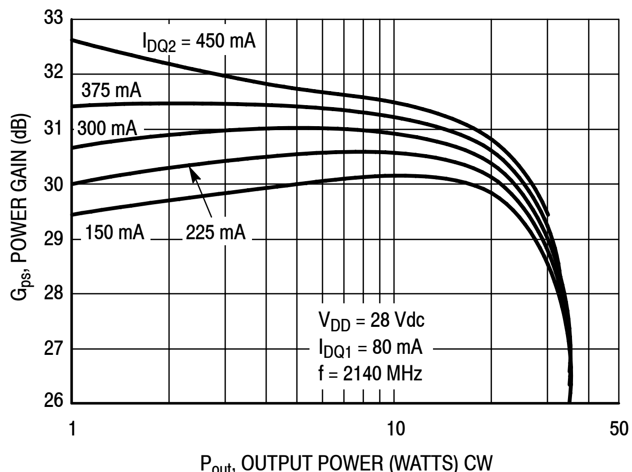



**Figure 7. Power Gain versus Output Power @ $I_{DQ1}$ = 80 mA**

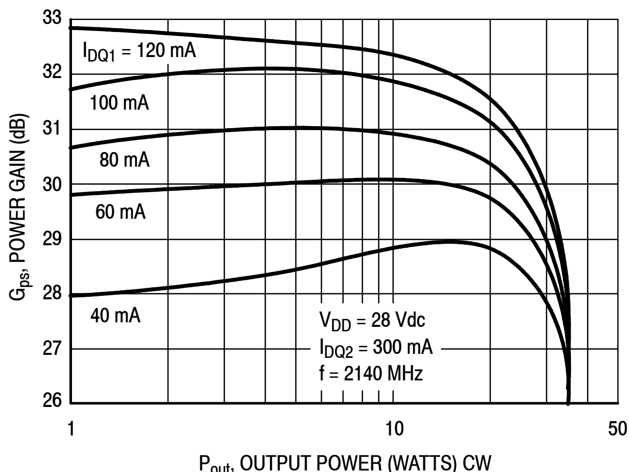



**Figure 8. Power Gain versus Output Power @ $I_{DQ2}$ = 300 mA**

## TYPICAL CHARACTERISTICS

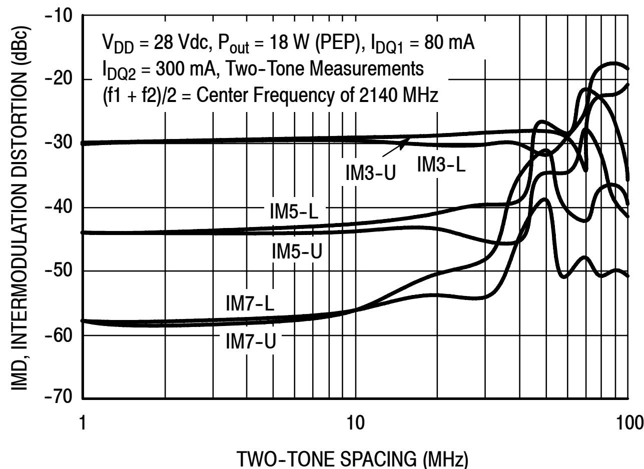



**Figure 9. Intermodulation Distortion Products versus Tone Spacing**

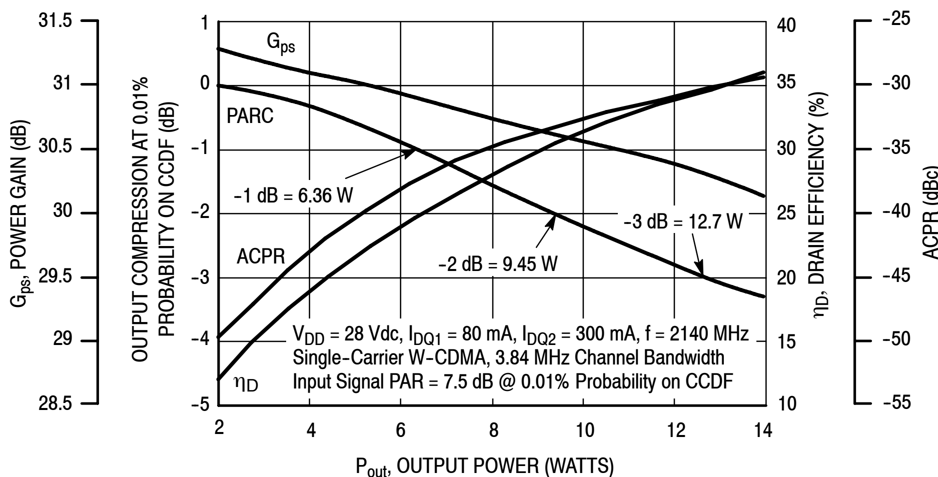



**Figure 10. Output Peak-to-Average Ratio Compression (PARC) versus Output Power**

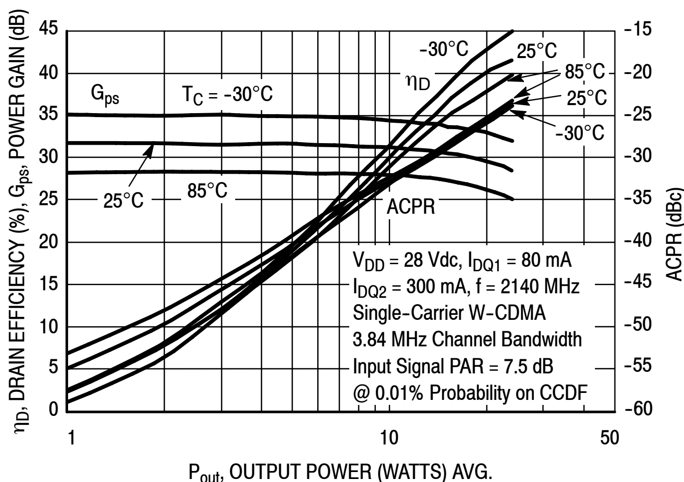



**Figure 11. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power**

## TYPICAL CHARACTERISTICS

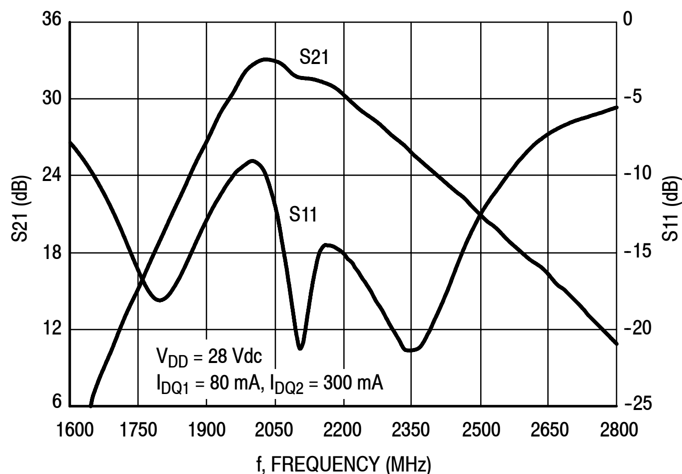



**Figure 12. Broadband Frequency Response**

## W-CDMA TEST SIGNAL

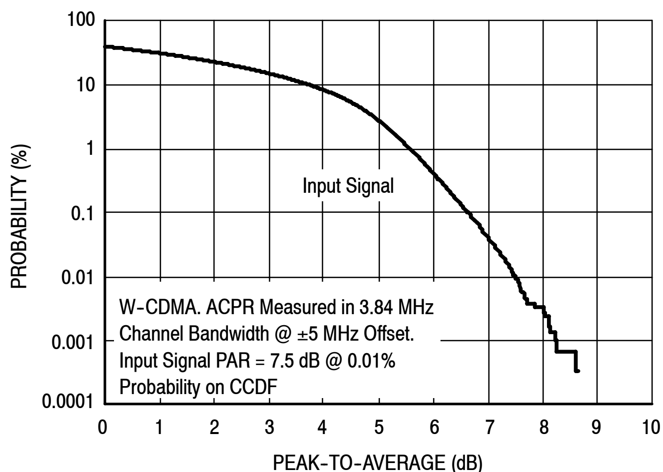



**Figure 13. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal**

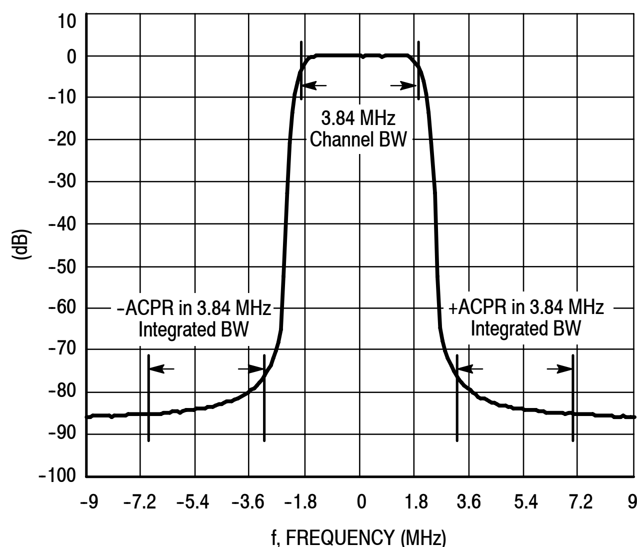
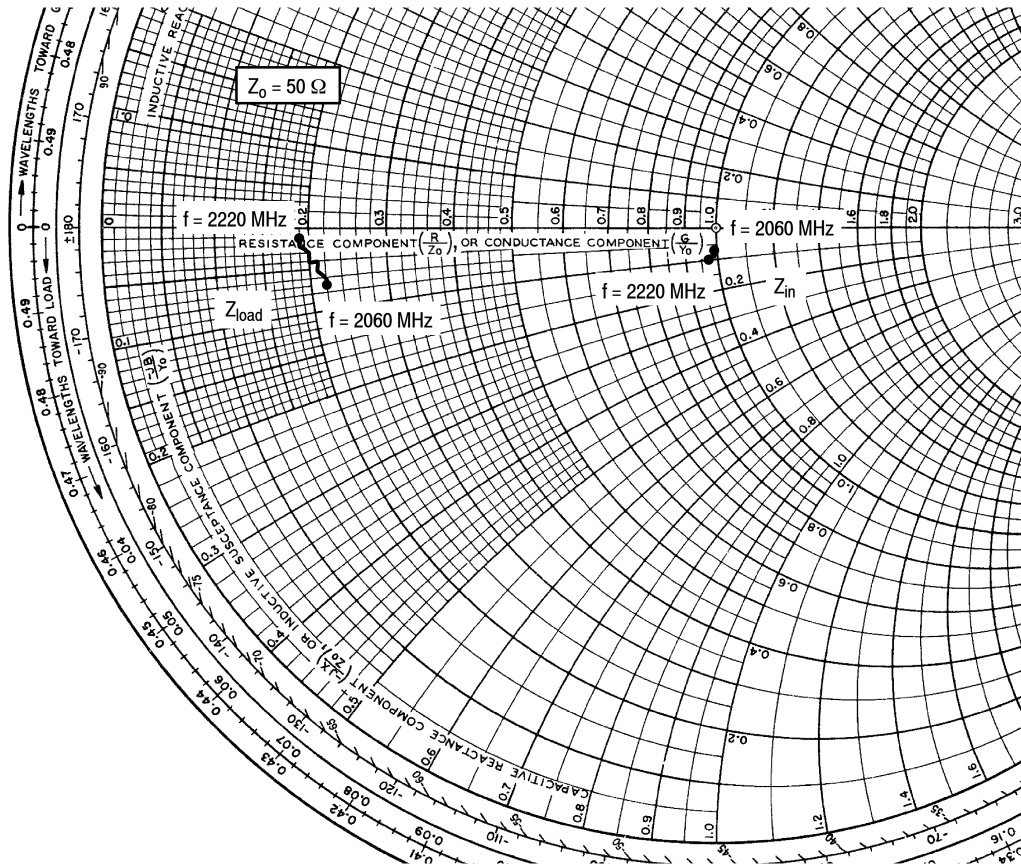



**Figure 14. Single-Carrier W-CDMA Spectrum**




$V_{DD}$ = 28 Vdc, $I_{DQ1}$ = 80 mA, $I_{DQ2}$ = 300 mA, $P_{out}$ = 2 W Avg.

| f MHz | $Z_{in}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| 2060 | 49.57 - j3.62 | 11.06 - j3.26 |
| 2080 | 49.49 - j3.77 | 10.83 - j2.96 |
| 2100 | 49.42 - j3.94 | 10.55 - j2.62 |
| 2120 | 49.35 - j4.12 | 10.30 - j2.23 |
| 2140 | 49.30 - j4.29 | 10.08 - j1.86 |
| 2160 | 49.25 - j4.48 | 9.86 - j1.51 |
| 2180 | 49.21 - j4.67 | 9.65 - j1.13 |
| 2200 | 49.17 - j4.86 | 9.45 - j0.76 |
| 2220 | 49.15 - j5.06 | 9.25 - j0.40 |

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

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

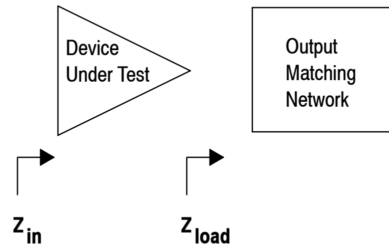



**Figure 15. Series Equivalent Input and Load Impedance**

**Table 7. Common Source S-Parameters** ($V_{DD}$ = 28 V, $I_{DQ1}$ = 90 mA, $I_{DQ2}$ = 420 mA, $T_A$ = 25°C, 50 Ohm System)

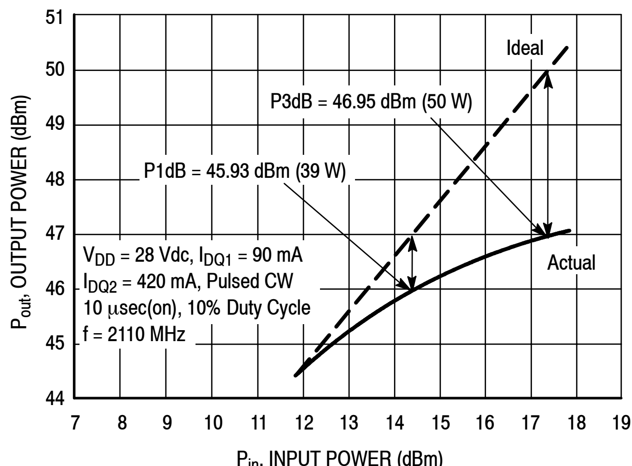
| f MHz | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| | $\|S_{11}\|$ | ∠ φ | $\|S_{21}\|$ | ∠ φ | $\|S_{12}\|$ | ∠ φ | $\|S_{22}\|$ | ∠ φ |
| 1500 | 0.452 | 134 | 0.356 | 7.81 | 0.001 | −108 | 0.979 | 160 |
| 1550 | 0.407 | 117 | 0.757 | −7.8 | 0.000 | −67.7 | 0.969 | 157 |
| 1600 | 0.354 | 96.5 | 1.430 | −31 | 0.000 | −65.8 | 0.955 | 154 |
| 1650 | 0.316 | 85.1 | 2.330 | −52.1 | 0.001 | −27.1 | 0.935 | 151 |
| 1700 | 0.279 | 68 | 3.690 | −73.6 | 0.001 | −43.4 | 0.909 | 148 |
| 1750 | 0.222 | 49.5 | 5.800 | −93.3 | 0.002 | −21.9 | 0.878 | 143 |
| 1800 | 0.140 | 30.4 | 9.570 | −113 | 0.003 | −24.8 | 0.833 | 137 |
| 1850 | 0.046 | 21.9 | 17.000 | −137 | 0.004 | −33.7 | 0.737 | 124 |
| 1900 | 0.094 | 135 | 33.600 | −173 | 0.007 | −41.8 | 0.476 | 91.7 |
| 1950 | 0.238 | 56.4 | 58.300 | 124 | 0.009 | −86.4 | 0.396 | −79.7 |
| 2000 | 0.254 | −29.2 | 47.800 | 59.5 | 0.006 | −118 | 0.873 | −149 |
| 2050 | 0.241 | −84.1 | 34.300 | 22.9 | 0.004 | −122 | 0.927 | −171 |
| 2100 | 0.252 | −120 | 27.700 | −3.98 | 0.004 | −125 | 0.911 | −179 |
| 2150 | 0.201 | −142 | 23.900 | −28.2 | 0.003 | −128 | 0.891 | 177 |
| 2200 | 0.174 | −162 | 21.100 | −51.8 | 0.003 | −130 | 0.878 | 175 |
| 2250 | 0.148 | 168 | 18.800 | −75.9 | 0.003 | −131 | 0.872 | 175 |
| 2300 | 0.135 | 103 | 15.800 | −100 | 0.003 | −139 | 0.882 | 175 |
| 2350 | 0.197 | 35.4 | 12.600 | −118 | 0.003 | −155 | 0.906 | 174 |
| 2400 | 0.244 | 1.73 | 11.100 | −132 | 0.002 | −156 | 0.919 | 173 |
| 2450 | 0.291 | −11.1 | 10.400 | −147 | 0.002 | −157 | 0.926 | 171 |
| 2500 | 0.340 | −19 | 9.750 | −163 | 0.002 | −147 | 0.933 | 170 |
| 2550 | 0.391 | −26.9 | 9.230 | −179 | 0.001 | −150 | 0.938 | 169 |
| 2600 | 0.435 | −35.2 | 8.760 | 164 | 0.001 | −144 | 0.942 | 168 |
| 2650 | 0.475 | −44.4 | 8.290 | 146 | 0.001 | −137 | 0.945 | 166 |
| 2700 | 0.455 | −46 | 7.050 | 129 | 0.001 | −90.2 | 0.950 | 166 |
| 2750 | 0.535 | −60.2 | 6.690 | 112 | 0.001 | −106 | 0.955 | 164 |
| 2800 | 0.571 | −71.2 | 5.980 | 95.1 | 0.001 | −103 | 0.955 | 163 |
| 2850 | 0.598 | −82 | 5.170 | 78.5 | 0.002 | −96.5 | 0.954 | 162 |
| 2900 | 0.623 | −92.9 | 4.370 | 63.1 | 0.002 | −103 | 0.955 | 162 |
| 2950 | 0.643 | −102 | 3.690 | 48.7 | 0.002 | −96.2 | 0.954 | 161 |
| 3000 | 0.668 | −109 | 3.100 | 35.4 | 0.002 | −106 | 0.951 | 161 |
| 3050 | 0.681 | −116 | 2.580 | 22.7 | 0.002 | −107 | 0.952 | 161 |
| 3100 | 0.694 | −121 | 2.130 | 11 | 0.002 | −87.9 | 0.957 | 160 |
| 3150 | 0.712 | −124 | 1.760 | −0.057 | 0.002 | −96.1 | 0.959 | 160 |
| 3200 | 0.724 | −127 | 1.440 | −10.9 | 0.002 | −99.6 | 0.959 | 160 |
| 3250 | 0.726 | −130 | 1.170 | −21.1 | 0.002 | −82.4 | 0.962 | 159 |
| 3300 | 0.705 | −130 | 0.928 | −28.7 | 0.003 | −66.9 | 0.963 | 159 |
| 3350 | 0.743 | −132 | 0.780 | −37 | 0.003 | −77.2 | 0.959 | 158 |
| 3400 | 0.748 | −135 | 0.652 | −44.3 | 0.003 | −88 | 0.955 | 157 |
| 3450 | 0.753 | −137 | 0.555 | −50.3 | 0.003 | −78.6 | 0.955 | 156 |

(continued)

**Table 7. Common Source S-Parameters** ($V_{DD}$ = 28 V, $I_{DQ1}$ = 90 mA, $I_{DQ2}$ = 420 mA, $T_A$ = 25°C, 50 Ohm System) **(continued)**

| f MHz | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| | $\|S_{11}\|$ | $\angle \phi$ | $\|S_{21}\|$ | $\angle \phi$ | $\|S_{12}\|$ | $\angle \phi$ | $\|S_{22}\|$ | $\angle \phi$ |
| 3500 | 0.759 | -140 | 0.486 | -56.1 | 0.004 | -81.1 | 0.954 | 155 |
| 3550 | 0.765 | -144 | 0.440 | -62.4 | 0.004 | -82 | 0.946 | 154 |
| 3600 | 0.770 | -148 | 0.401 | -69.7 | 0.004 | -85.9 | 0.941 | 153 |
| 3650 | 0.774 | -153 | 0.370 | -77.4 | 0.005 | -96.4 | 0.941 | 151 |
| 3700 | 0.780 | -159 | 0.338 | -85.1 | 0.006 | -94.9 | 0.940 | 150 |
| 3750 | 0.795 | -164 | 0.306 | -93.2 | 0.006 | -99.3 | 0.933 | 148 |
| 3800 | 0.810 | -170 | 0.273 | -101 | 0.008 | -110 | 0.928 | 146 |
| 3850 | 0.821 | -175 | 0.239 | -107 | 0.008 | -113 | 0.934 | 145 |
| 3900 | 0.839 | -178 | 0.207 | -111 | 0.008 | -112 | 0.936 | 144 |
| 3950 | 0.855 | 179 | 0.178 | -114 | 0.008 | -117 | 0.927 | 144 |
| 4000 | 0.862 | 176 | 0.156 | -116 | 0.008 | -123 | 0.935 | 144 |

## ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS

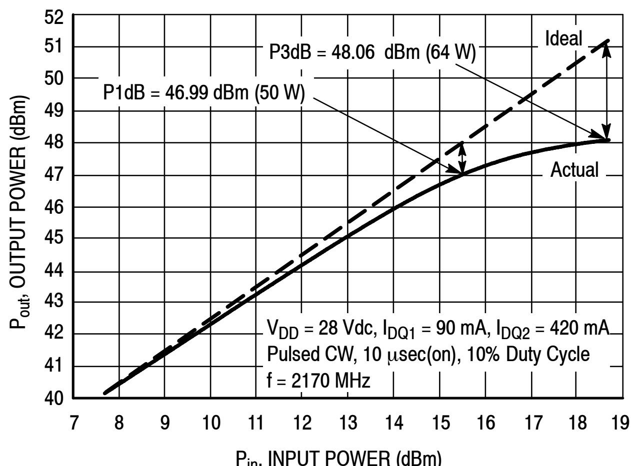



NOTE: Load Pull Test Fixture Tuned for Peak P1dB Output Power @ 28 V

Test Impedances per Compression Level

| | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| P1dB | 40.41 + j2.31 | 3.13 − j4.89 |

**Figure 16. Pulsed CW Output Power versus Input Power @ 28 V @ 2110 MHz**

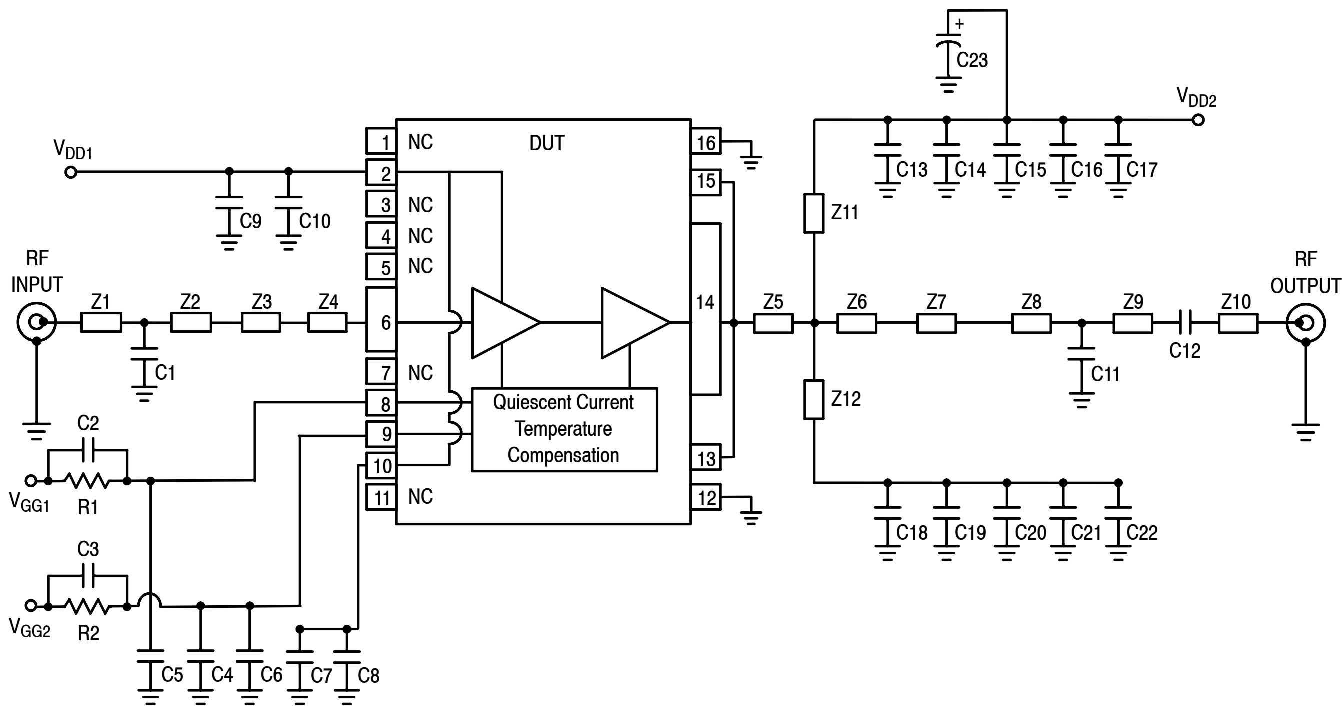



NOTE: Load Pull Test Fixture Tuned for Peak P1dB Output Power @ 28 V

Test Impedances per Compression Level

| | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| P1dB | 44.66 − j5.79 | 3.06 − j5.22 |

**Figure 17. Pulsed CW Output Power versus Input Power @ 28 V @ 2170 MHz**




| | | | |
|---|---|---|---|
| Z1 | 0.090″ x 0.083″ Microstrip | Z7 | 0.388″ x 0.123″ Microstrip |
| Z2 | 2.107″ x 0.083″ Microstrip | Z8 | 0.330″ x 0.083″ Microstrip |
| Z3 | 0.016″ x 0.083″ x 0.055″ Taper | Z9 | 0.323″ x 0.083″ Microstrip |
| Z4 | 0.106″ x 0.055″ Microstrip | Z10 | 0.364″ x 0.083″ Microstrip |
| Z5 | 0.570″ x 0.322″ Microstrip | Z11, Z12 | 1.042″ x 0.083″ Microstrip |
| Z6 | 0.254″ x 0.322″ Microstrip | PCB | Arlon CuClad 250GX-0300-55-22, 0.030″, $\varepsilon_r$ = 2.55 |

**Figure 18. MW7IC2220NR1(GNR1)(NBR1) Test Circuit Schematic — TD-SCDMA**

**Table 8. MW7IC2220NR1(GNR1)(NBR1) Test Circuit Component Designations and Values — TD-SCDMA**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1 | 1 pF Chip Capacitor | ATC100B1R0JT500XT | ATC |
| C2, C3 | 8.2 pF Chip Capacitors | ATC100B8R2BT500XT | ATC |
| C4 | 4.7 μF, 50 V Chip Capacitor | C4532X7R1H475KT | TDK |
| C5, C6 | 0.4 pF Chip Capacitors | ATC100B0R4JT500XT | ATC |
| C7, C9 | 10 μF, 50 V Chip Capacitors | C3225Y5V1H106ZT | TDK |
| C8, C10 | 5.6 pF Chip Capacitors | ATC100B5R6JT500XT | ATC |
| C11 | 1.1 pF Chip Capacitor | ATC100B1R1JT500XT | ATC |
| C12, C13, C18 | 9.1 pF Chip Capacitors | ATC100B9R1JT500XT | ATC |
| C14, C19 | 0.1 μF, 250 V Chip Capacitors | C3216X7R2E104KT | TDK |
| C15, C20 | 6.8 μF, 50 V Chip Capacitors | C4532X7R1H685KT | TDK |
| C16, C21 | 4.7 μF, 50 V Chip Capacitors | C4532X7R1H475KT | TDK |
| C17, C22 | 10 μF, 50 V Chip Capacitors | C3225Y5V1H106ZT | TDK |
| C23 | 470 μF, 63 V Electrolytic Capacitor | 477KXM063M | Illinois Capacitor |
| R1, R2 | 11 Ω, 1/4 W Chip Resistors | CRCW120611R0FKEA | Vishay |

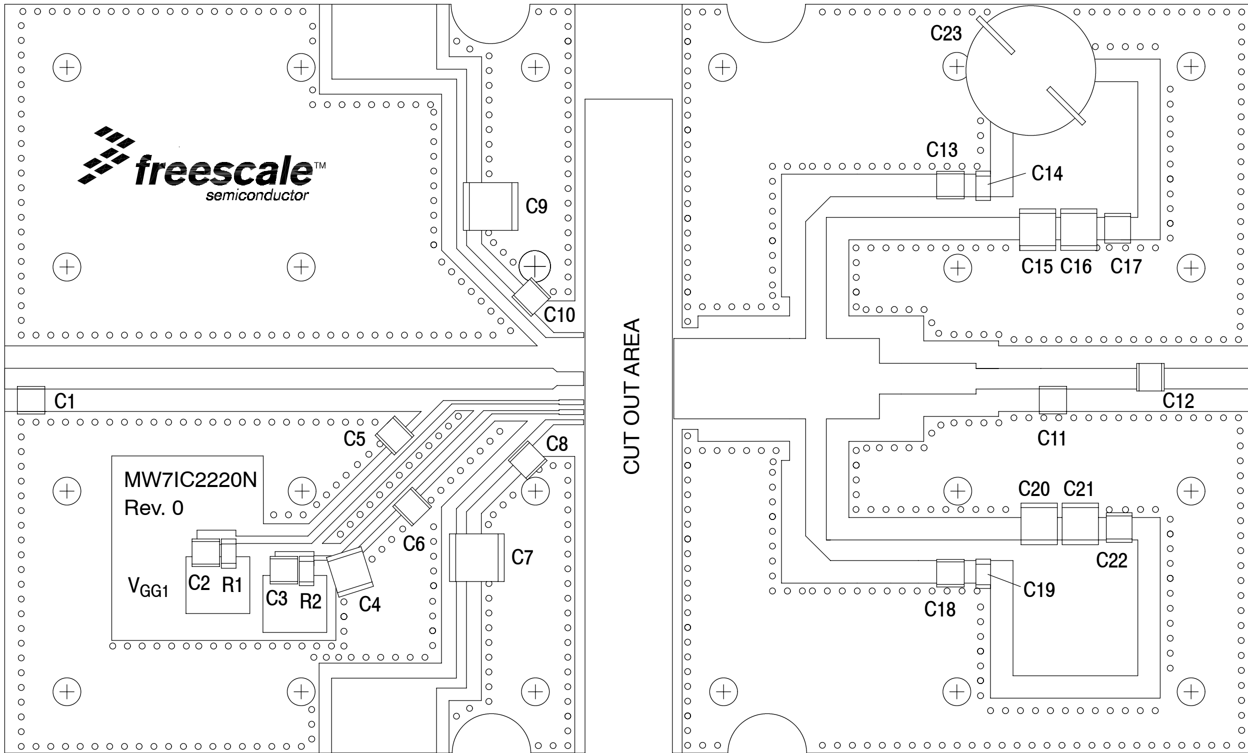



**Figure 19. MW7IC2220NR1(GNR1)(NBR1) Test Circuit Component Layout — TD-SCDMA**

## TYPICAL CHARACTERISTICS

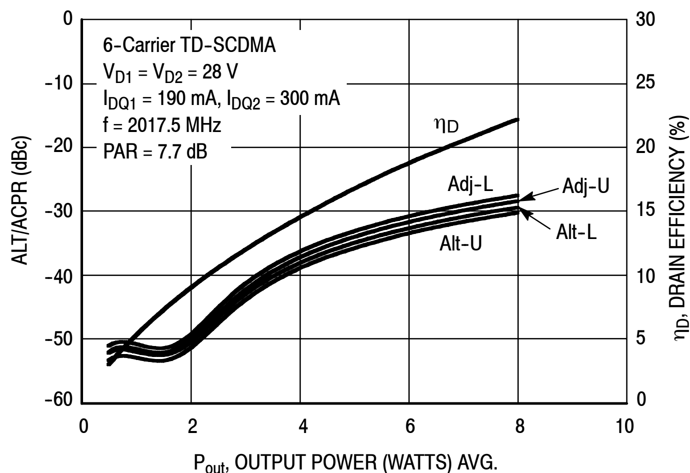



**Figure 20. 6-Carrier TD-SCDMA ACPR, ALT and Drain Efficiency versus Output Power**

## TD-SCDMA TEST SIGNAL

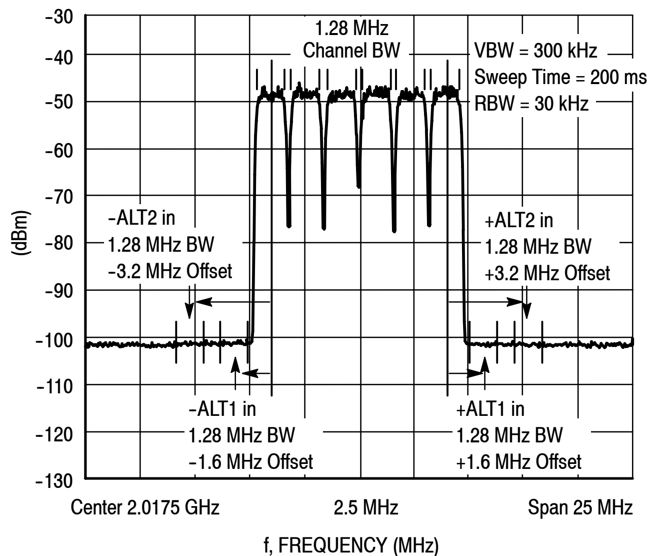
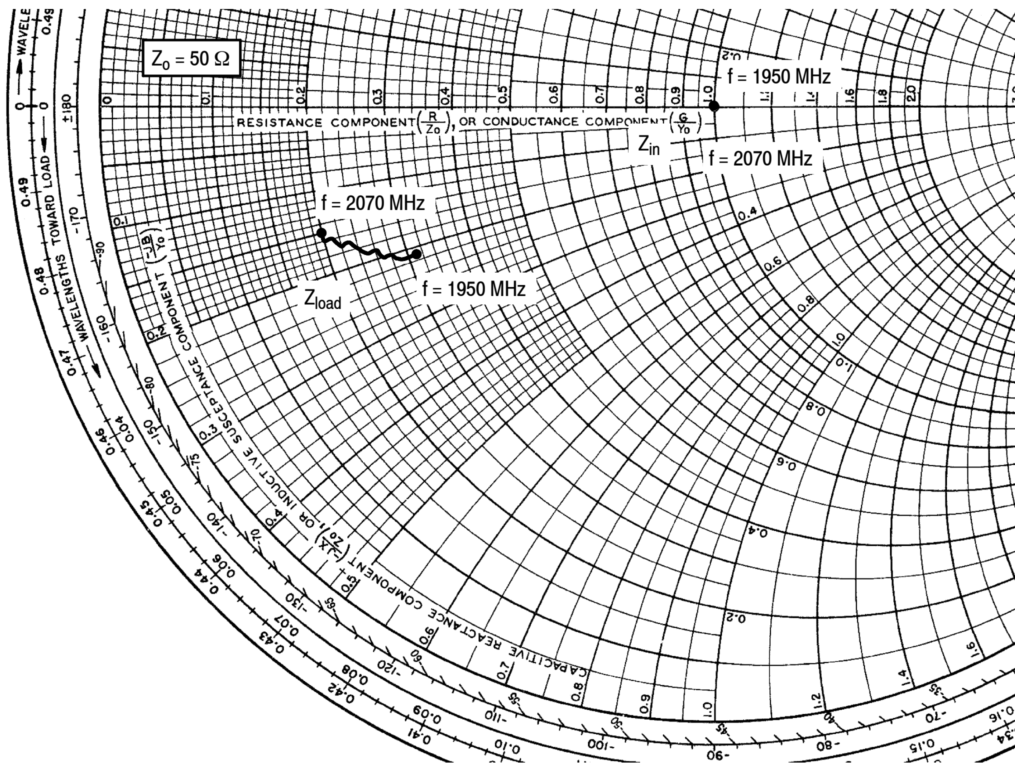



**Figure 21. 6-Carrier TD-SCDMA Spectrum**




$V_{DD}$ = 28 Vdc, $I_{DQ1}$ = 190 mA, $I_{DQ2}$ = 300 mA

| f<br>MHz | $Z_{in}$<br>Ω | $Z_{load}$<br>Ω |
|---|---|---|
| 1950 | 50 + j0 | 15.539 - j10.702 |
| 1960 | 50 + j0 | 14.953 - j10.522 |
| 1970 | 50 + j0 | 14.373 - j10.327 |
| 1980 | 50 + j0 | 13.837 - j10.120 |
| 1990 | 50 + j0 | 13.294 - j9.886 |
| 2000 | 50 + j0 | 12.768 - j9.608 |
| 2010 | 50 + j0 | 12.275 - j9.298 |
| 2020 | 50 + j0 | 11.832 - j9.000 |
| 2030 | 50 + j0 | 11.422 - j8.708 |
| 2040 | 50 + j0 | 11.015 - j8.441 |
| 2050 | 50 + j0 | 10.621 - j8.175 |
| 2060 | 50 + j0 | 10.235 - j7.916 |
| 2070 | 50 + j0 | 9.868 - j7.644 |

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

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

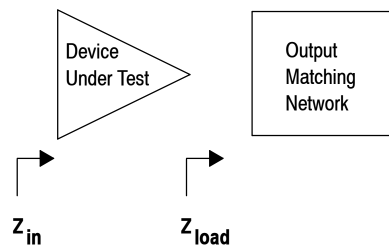
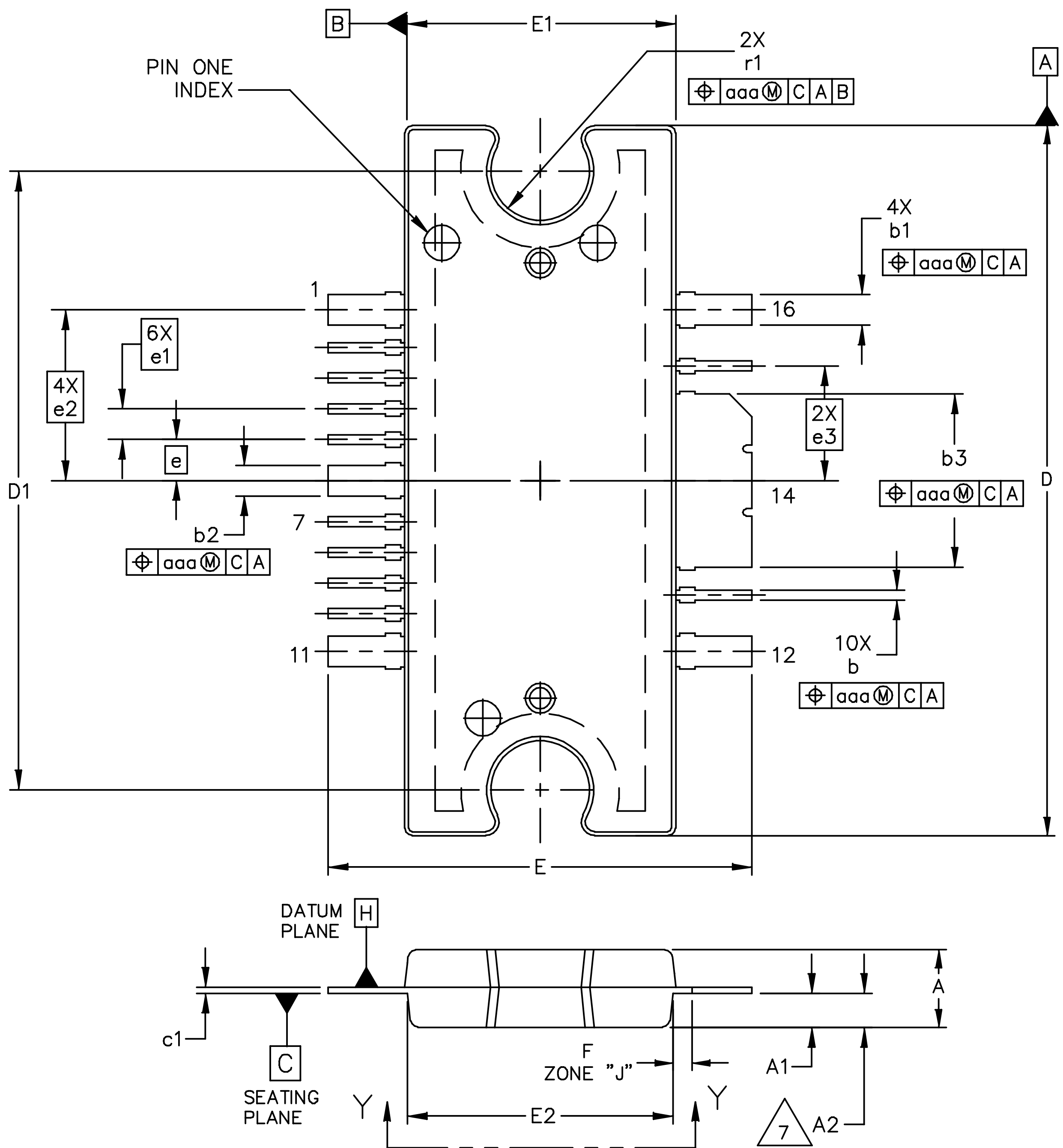



**Figure 22. Series Equivalent Input and Load Impedance — TD-SCDMA**

## PACKAGE DIMENSIONS

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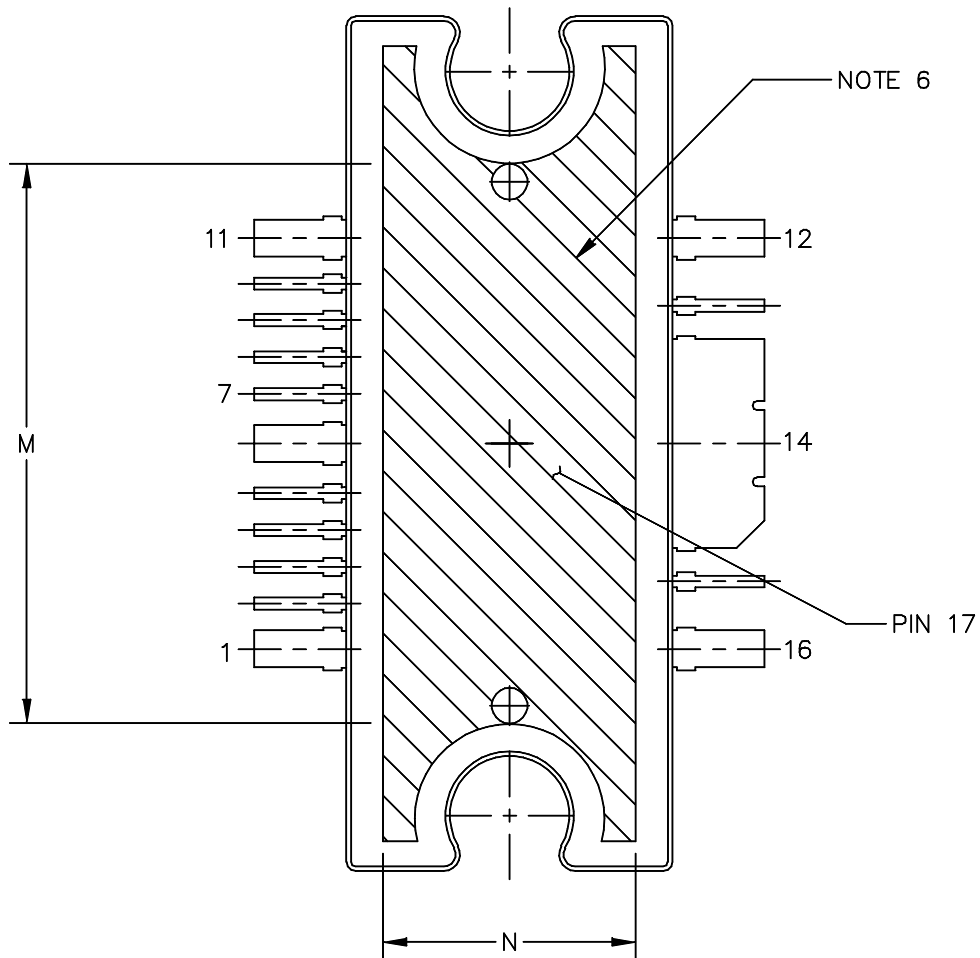


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NOTES:

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", "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 OFTHE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.
7. DIM A2 APPLIES WITHIN ZONE "J" ONLY.

| DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX |
|---|---|---|---|---|---|---|---|---|---|
| A | .100 | .104 | 2.54 | 2.64 | b | .011 | .017 | 0.28 | 0.43 |
| A1 | .038 | .044 | 0.96 | 1.12 | b1 | .037 | .043 | 0.94 | 1.09 |
| A2 | .040 | .042 | 1.02 | 1.07 | b2 | .037 | .043 | 0.94 | 1.09 |
| D | .928 | .932 | 23.57 | 23.67 | b3 | .225 | .231 | 5.72 | 5.87 |
| D1 | .810 BSC | | 20.57 BSC | | c1 | .007 | .011 | .18 | .28 |
| E | .551 | .559 | 14.00 | 14.20 | e | .054 BSC | | 1.37 BSC | |
| E1 | .353 | .357 | 8.97 | 9.07 | e1 | .040 BSC | | 1.02 BSC | |
| E2 | .346 | .350 | 8.79 | 8.89 | e2 | .224 BSC | | 5.69 BSC | |
| F | .025 BSC | | 0.64 BSC | | e3 | .150 BSC | | 3.81 BSC | |
| M | .600 | ---- | 15.24 | ---- | r1 | .063 | .068 | 1.6 | 1.73 |
| N | .270 | ---- | 6.86 | ---- | | | | | |
| | | | | | aaa | .004 | | .10 | |

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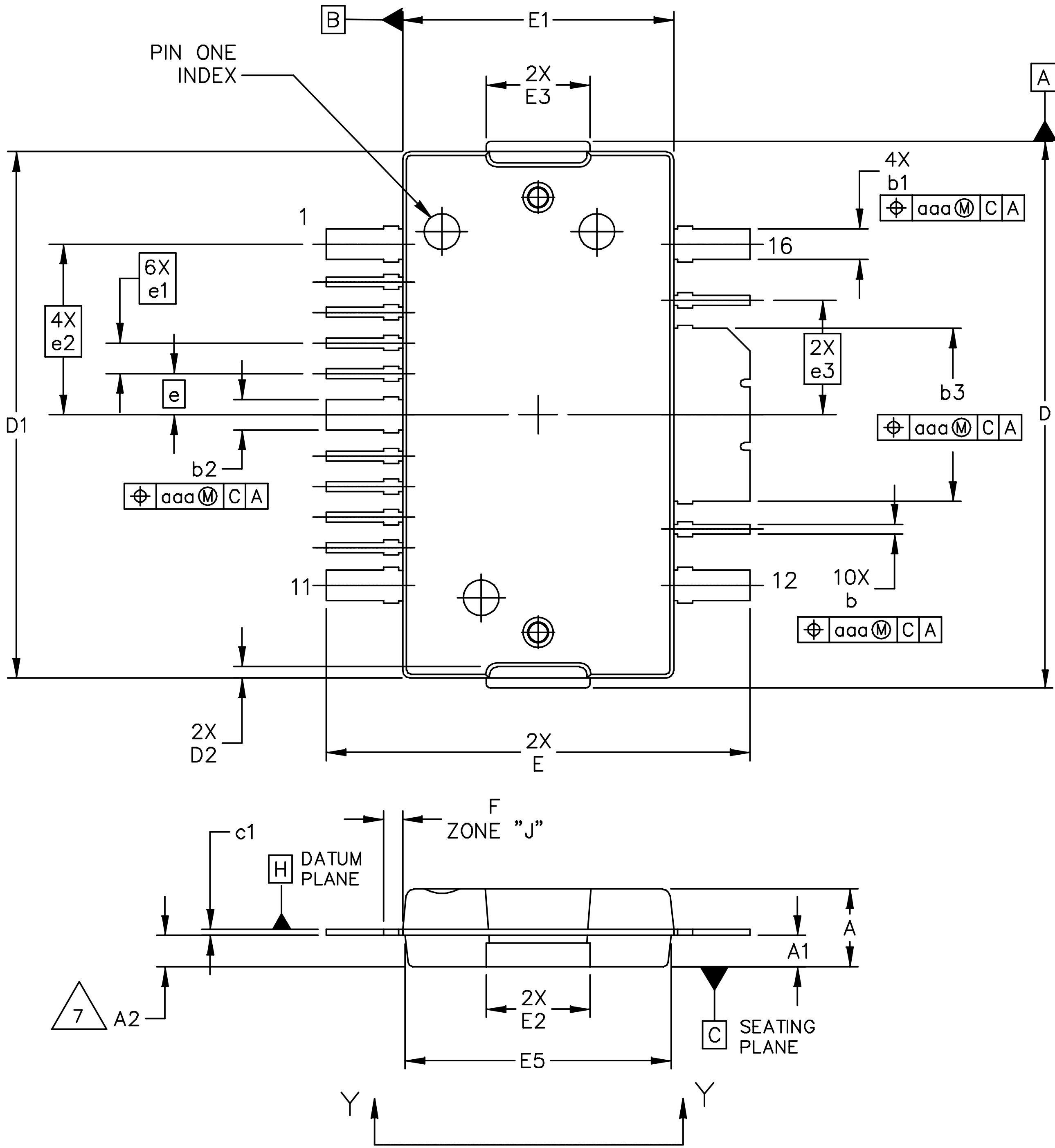


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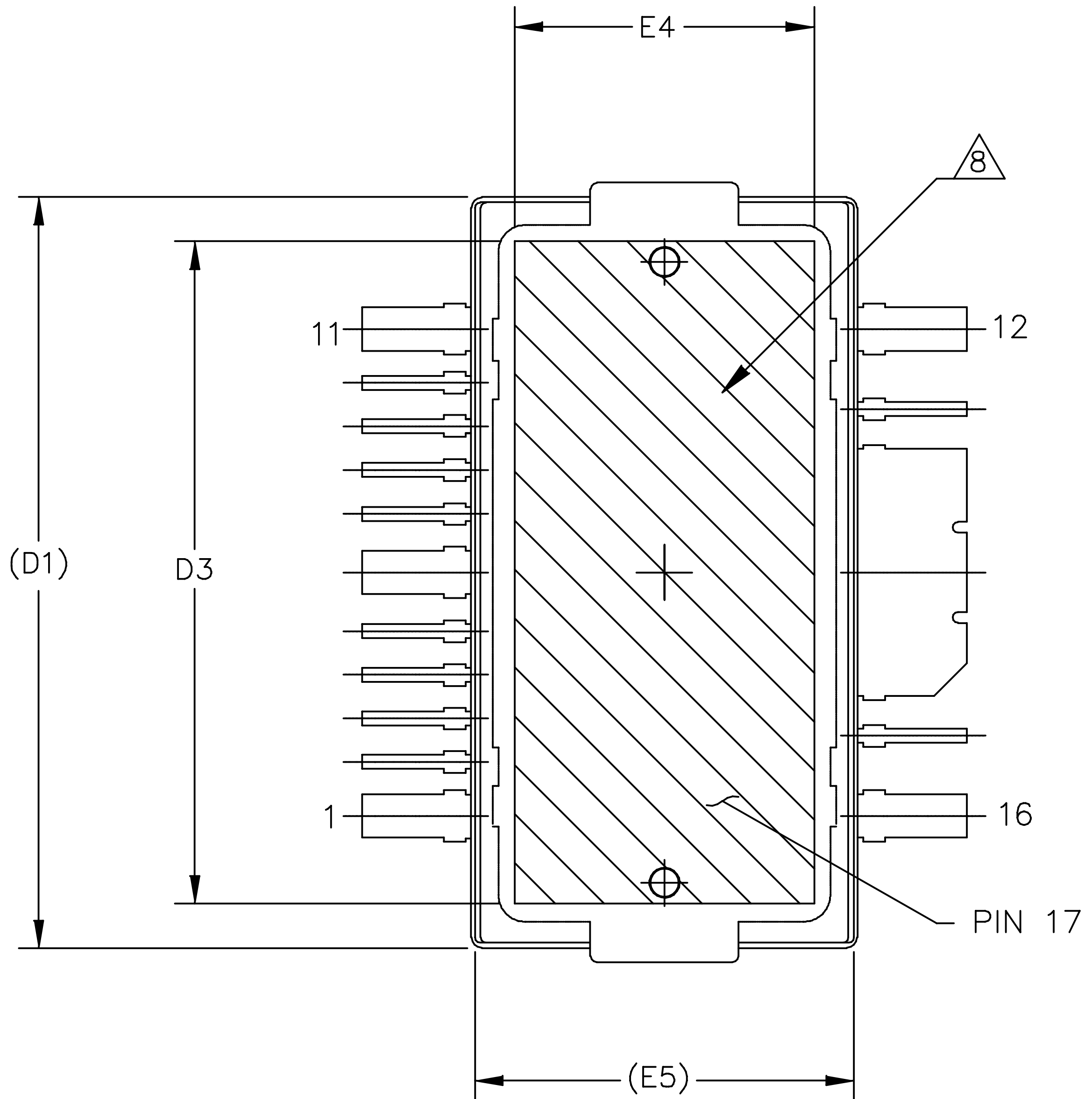


VIEW Y–Y

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NOTES:

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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. DATUM –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. HATCHED AREA SHOWN IS ON THE SAME PLANE.

| DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX |
|---|---|---|---|---|---|---|---|---|---|
| A | .100 | .104 | 2.54 | 2.64 | F | .025 BSC | | 0.64 BSC | |
| A1 | .039 | .043 | 0.99 | 1.09 | b | .011 | .017 | 0.28 | 0.43 |
| A2 | .040 | .042 | 1.02 | 1.07 | b1 | .037 | .043 | 0.94 | 1.09 |
| D | .712 | .720 | 18.08 | 18.29 | b2 | .037 | .043 | 0.94 | 1.09 |
| D1 | .688 | .692 | 17.48 | 17.58 | b3 | .225 | .231 | 5.72 | 5.87 |
| D2 | .011 | .019 | 0.28 | 0.48 | c1 | .007 | .011 | .18 | .28 |
| D3 | .600 | --- | 15.24 | --- | e | .054 BSC | | 1.37 BSC | |
| E | .551 | .559 | 14 | 14.2 | e1 | .040 BSC | | 1.02 BSC | |
| E1 | .353 | .357 | 8.97 | 9.07 | e2 | .224 BSC | | 5.69 BSC | |
| E2 | .132 | .140 | 3.35 | 3.56 | e3 | .150 BSC | | 3.81 BSC | |
| E3 | .124 | .132 | 3.15 | 3.35 | aaa | .004 | | .10 | |
| E4 | .270 | --- | 6.86 | --- | | | | | |
| E5 | .346 | .350 | 8.79 | 8.89 | | | | | |

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B
E1
2X
E3
A
PIN ONE
INDEX
4X
b1
⌖ aaa Ⓜ C A
1
16
6X
e1
4X
e2
2X
e3
e
b3
D1
⌖ aaa Ⓜ C A
D
b2
⌖ aaa Ⓜ C A
11
12
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b
⌖ aaa Ⓜ C A
2X
D2
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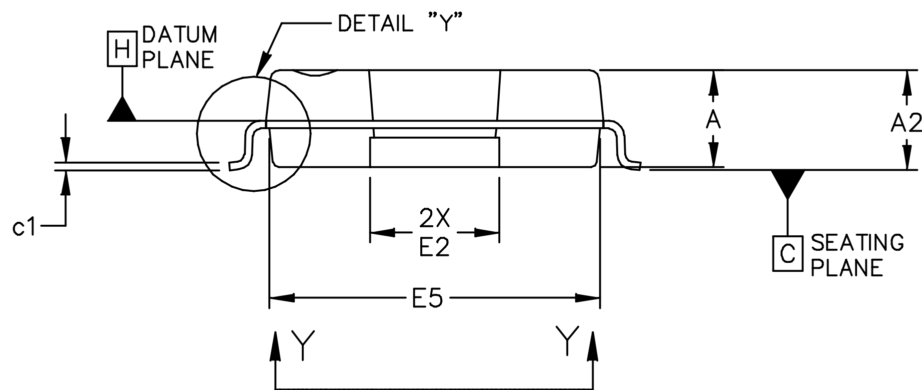
E

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E4

7

11

12

(D1)

D3

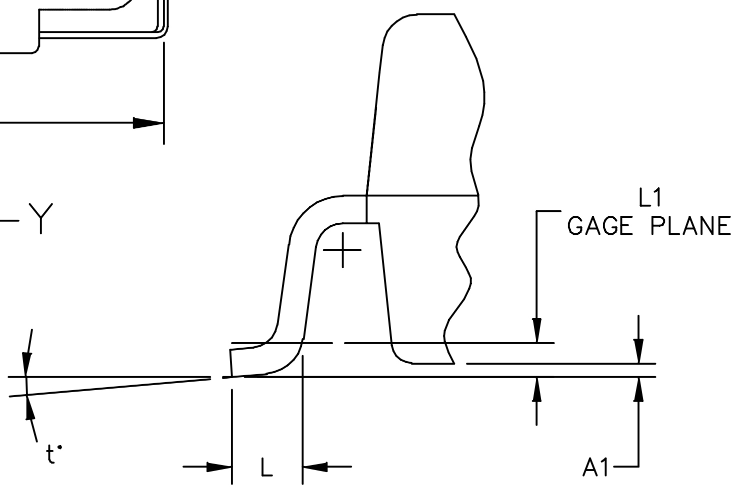
PIN 17

1

16

(E5)

VIEW Y–Y




DETAIL "Y"

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| | CASE NUMBER: 1887–01 | | 31 AUG 2007 |
| | STANDARD: NON–JEDEC | | |

NOTES:

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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", "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. DATUM —A— AND —B— TO BE DETERMINED AT DATUM PLANE —H—.

7. HATCHING REPRESENTS EXPOSED AREA OF THE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.

| DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER 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 | .011 | .017 | 0.28 | 0.43 |
| D | .712 | .720 | 18.08 | 18.29 | b1 | .037 | .043 | 0.94 | 1.09 |
| D1 | .688 | .692 | 17.48 | 17.58 | b2 | .037 | .043 | 0.94 | 1.09 |
| D2 | .011 | .019 | 0.28 | 0.48 | b3 | .225 | .231 | 5.72 | 5.87 |
| D3 | .600 | --- | 15.24 | --- | c1 | .007 | .011 | 0.18 | 0.28 |
| E | .429 | .437 | 10.9 | 11.1 | e | .054 BSC | | 1.37 BSC | |
| E1 | .353 | .357 | 8.97 | 9.07 | e1 | .040 BSC | | 1.02 BSC | |
| E2 | .132 | .140 | 3.35 | 3.56 | e2 | .224 BSC | | 5.69 BSC | |
| E3 | .124 | .132 | 3.15 | 3.35 | e3 | .150 BSC | | 3.81 BSC | |
| E4 | .270 | --- | 6.86 | --- | t | 2° | 8° | 2° | 8° |
| E5 | .346 | .350 | 8.79 | 8.89 | aaa | .004 | | 0.10 | |

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## PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents and software 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

**Software**

- Electromigration MTTF Calculator

For Software, do a Part Number search at http://www.freescale.com, and select the "Part Number" link. Go to the Software & Tools tab on the part's Product Summary page to download the respective tool.

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|---|---|---|
| 0 | Sept. 2008 | • Initial Release of Data Sheet |
| 1 | Jan. 2009 | • Added Fig. 13, MTTF versus Junction Temperature, p. 8 |
| 2 | May 2011 | • Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13628, p. 1, 3<br>• Fig. 3, Test Circuit Schematic, Z-list, changed Z13, Z14 from 0.564″ x 0.083″ Microstrip to 1.042″ x 0.083″ Microstrip, p. 4<br>• Fig. 18, Test Circuit Schematic, Z-list, changed Z11, Z12 from 0.564″ x 0.083″ Microstrip to 1.042″ x 0.083″ Microstrip, p. 13<br>• Changed ESD Human Body Model rating from Class 1B to Class 0 to reflect recent ESD test results of the device, p. 2<br>• Fig. 13, MTTF versus Junction Temperature removed, p. 8. Refer to the device's MTTF Calculator available at freescale.com/RFpower. Go to Design Resources > Software and Tools.<br>• Updated Fig. 14, CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal to better represent production test signal, p. 8 (renumbered as Fig. 13 after Fig. 13 removed)<br>• Updated Fig. 15, Single-Carrier W-CDMA Spectrum to show the undistorted input test signal, p. 8 (renumbered as Fig. 14 after Fig. 13 removed)<br>• Added AN3789, Clamping of High Power RF Transistors and RFICs in Over-Molded Plastic Packages to Product Documentation, Application Notes, p. 26<br>• Added Electromigration MTTF Calculator availability to Product Software, p. 26 |

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www.freescale.com/support

**Europe, Middle East, and Africa:**
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

**Japan:**
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

**Asia/Pacific:**
Freescale Semiconductor China Ltd.
Exchange Building 23F
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Chaoyang District
Beijing 100022
China
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