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## RF Reference Design Library

# RF Power Amplifier Lineup

InGaP HBT and N-Channel Enhancement-Mode Lateral MOSFET

**MMG3014N**
**Driving**
**MW7IC2240N**
**W- CDMA**

**2110-2170 MHz, 4.0 W AVG., 28 V**
**W-CDMA SMART DEMO**
**REFERENCE DESIGN**

### Amplifier Lineup Characteristics

Designed for W-CDMA and LTE base station applications with frequencies from 2110 to 2170 MHz. This high gain amplifier lineup provides all the necessary 50 ohm impedance matching, temperature compensation and biasing functions needed for a standard commercial amplifier design.

- Typical Single-Carrier W-CDMA Performance: $V_{CC}$ = 5 Volts, $I_{CC}$ = 135 mA, $V_{DD}$ = 28 Volts, $I_{DQ1}$ = 90 mA, $I_{DQ2}$ = 420 mA, $P_{out}$ = 4.0 Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.

| Frequency | $G_{ps}$ (dB) | $\eta_D$ (%) | Output PAR (dB) | ACPR (dBc) |
|---|---|---|---|---|
| 2110 MHz | 45.8 | 14.5 | 7.4 | -48.9 |
| 2140 MHz | 45.4 | 14.2 | 7.4 | -47.9 |
| 2170 MHz | 45.6 | 14.8 | 7.4 | -49.5 |

- Capable of Handling 5:1 VSWR, @ 28 Vdc, 2140 MHz, 40 Watts CW Output Power
- Stable into a 5:1 VSWR. All Spurs Below -60 dBc @ 100 mW to 10 Watts CW $P_{out}$.

## MMG3014N/MW7IC2240N REFERENCE DESIGN

This reference design is designed to demonstrate the RF performance characteristics of the MMG3014N/MW7IC2240N combination when applied to the 2110- 2170 MHz W- CDMA frequency band. The reference design is tuned for performance at 4.0 watts average output power, $V_{CC}$ = 5 volts, $I_{CC}$ = 135 mA, $V_{DD}$ = 28 volts, $I_{DQ1}$ = 90 mA, and $I_{DQ2}$ = 420 mA.

### REFERENCE DESIGN LIBRARY TERMS AND CONDITIONS

Freescale is pleased to make this reference design available for your use in development and testing of your own product or products, without charge. The reference design contains easy-to-copy, fully functional amplifier designs. Where possible, it consists of “no tune” distributed element matching circuits designed to be as small as possible, includes temperature compensated bias circuitry, and is designed to be used as “building blocks” for our customers.

### HEATSINKING

When operating this fixture please provide adequate heatsinking for the device. Excessive heating of the device will prevent repeating of the included measurements.

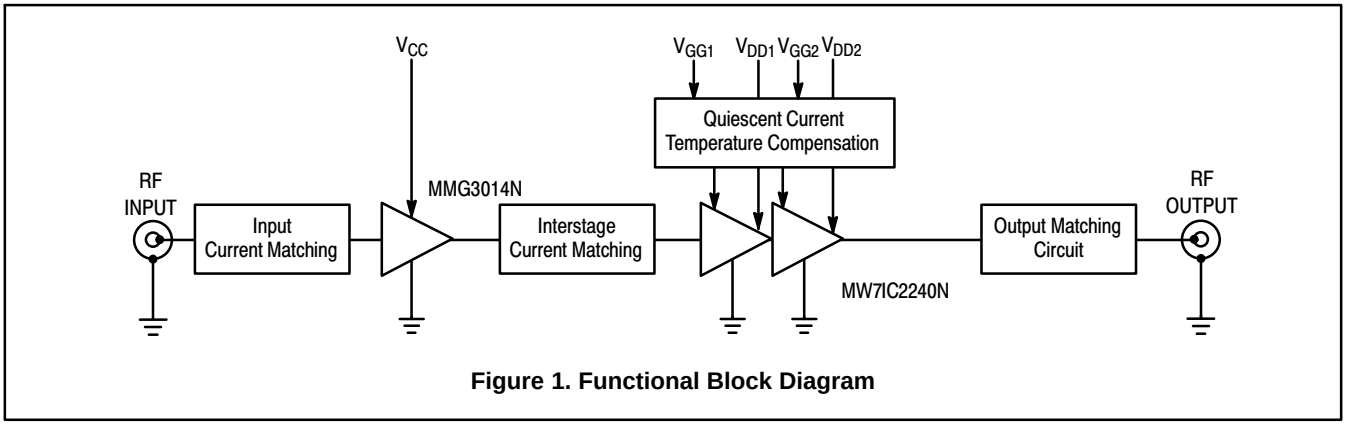



**Figure 1. Functional Block Diagram**

**Amplifier Lineup Alternate Characteristics**

- Typical Single-Carrier W-CDMA Performance: $V_{CC}$ = 5 Volts, $I_{CC}$ = 135 mA, $V_{DD}$ = 28 Volts, $I_{DQ1}$ = 90 mA, $I_{DQ2}$ = 420 mA, $P_{out}$ = 4.0 Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

| Frequency | $G_{ps}$ (dB) | $\eta_D$ (%) | Output PAR (dB) | ACPR (dBc) |
|---|---|---|---|---|
| 2110 MHz | 45.7 | 14.8 | 9.5 | -47.5 |
| 2140 MHz | 45.2 | 14.4 | 9.4 | -48.1 |
| 2170 MHz | 45.5 | 15.0 | 9.5 | -48.9 |

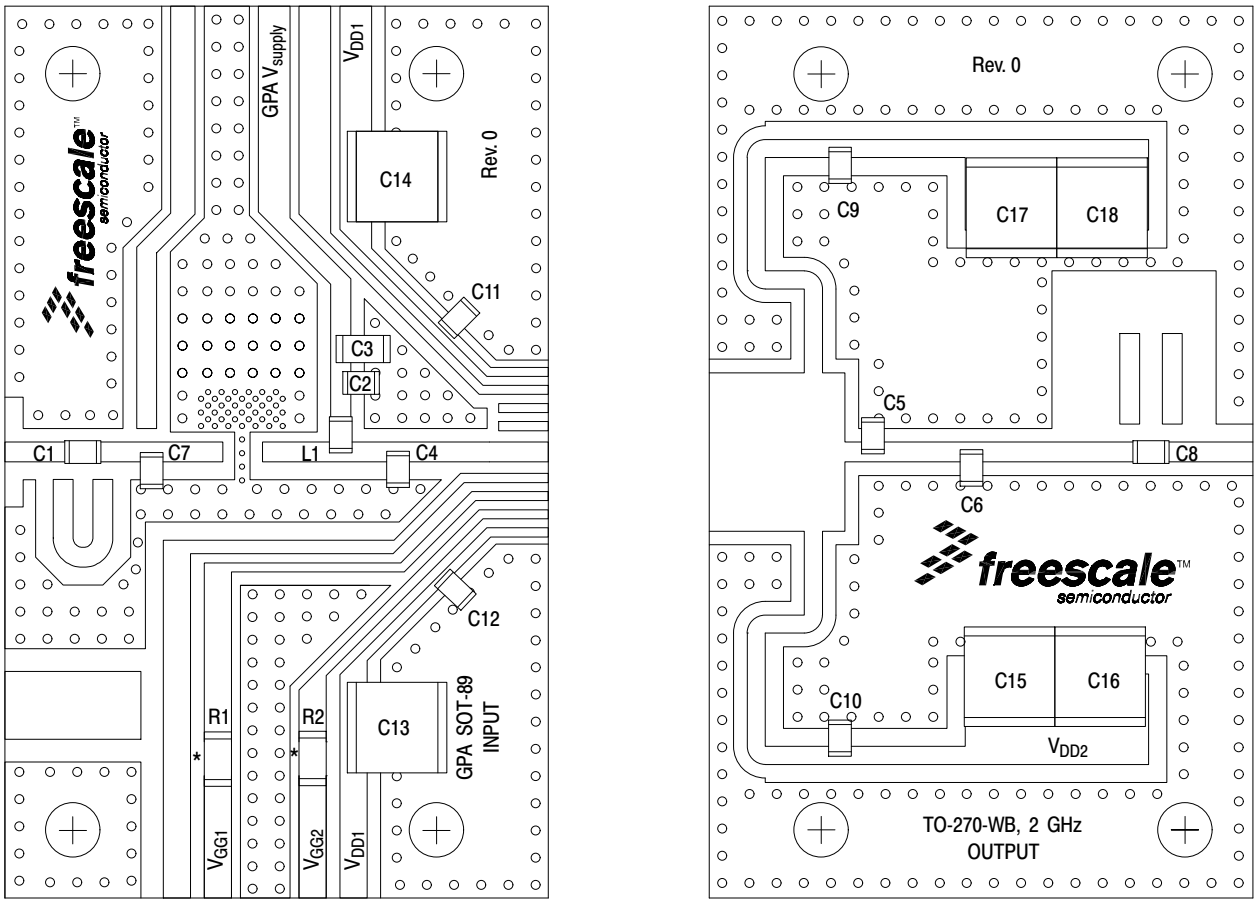
**MMG3014N Device Features**

- Small-Signal Gain: 15 dB @ 2140 MHz
- Third Order Output Intercept Point: 40.5 dBm @ 2140 MHz
- Single 5 Volt Supply
- Active Self Bias
- Low Cost SOT-89 Surface Mount Package

**MW7IC2240N Device 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

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.




*Trace will need to be cut under the resistors.

**Figure 2. MMG3014N Driving MW7IC2240N Board Layout**

**Table 1. MMG3014N Driving MW7IC2240N Test Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1 | 22 pF Chip Capacitor | ATC600F220JT250XT | ATC |
| C2 | 0.1 μF Chip Capacitor | C0603C104J5RAC | Kemet |
| C3 | 2.2 μF Chip Capacitor | C0805C225J4RAC | Kemet |
| C4, C5 | 0.5 pF Chip Capacitors | ATC600F0R5BT250XT | ATC |
| C6 | 1.0 pF Chip Capacitor | ATC600F1R0BT250XT | ATC |
| C7 | 1.5 pF Chip Capacitor | ATC600F1R5BT250XT | ATC |
| C8, C9, C10 | 33 pF Chip Capacitors | ATC600F330JT250XT | ATC |
| C11, C12 | 5.6 pF Chip Capacitors | ATC600F5R6BT250XT | ATC |
| C13, C14, C15, C16, C17, C18 | 10 μF Chip Capacitors | GRM55DR61H106KA88L | Murata |
| L1 | 15 nH Chip Capacitor | HK160815NJ-T | Taiyo Yuden |
| R1, R2 | 10 kΩ, 1/4 W Chip Resistor | CRCW120610K0FKEA | Vishay |
| PCB | 0.020″, $\varepsilon_r$ = 3.5 | RO4350B | Rogers |

**Note: See Appendix A for Tuning Tips.**

## CHARACTERISTICS — 7.5 dB Input PAR Test Signal

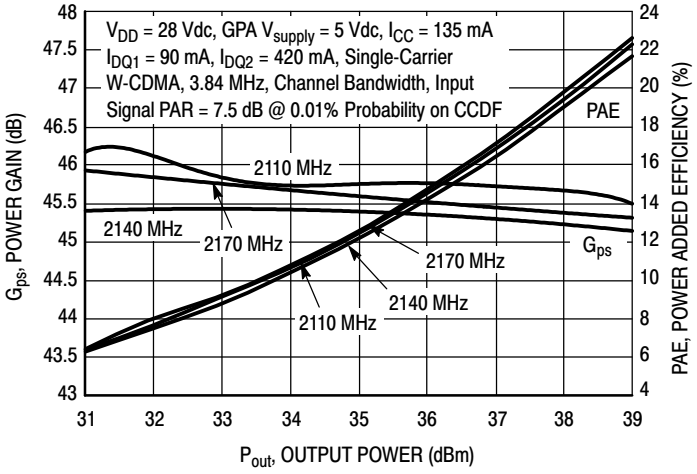



**Figure 3. Power Gain and Power Added Efficiency versus Output Power**

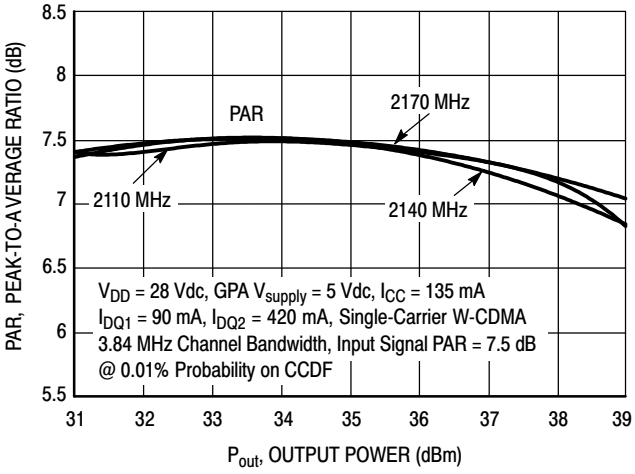



**Figure 4. Output Peak-to-Average Ratio (PAR) versus Output Power**

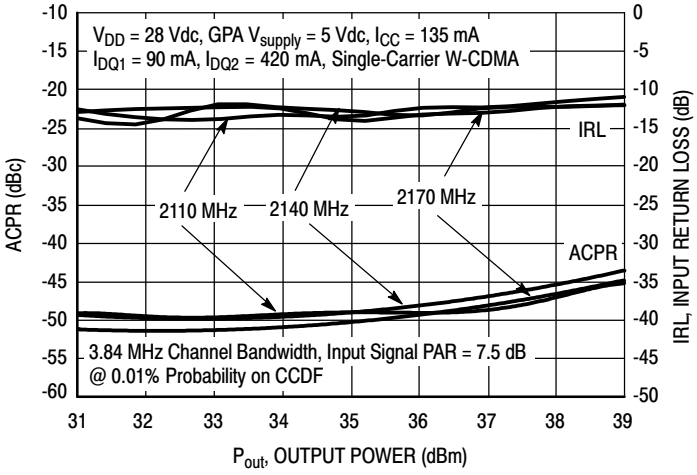



**Figure 5. ACPR and Input Return Loss versus Output Power**

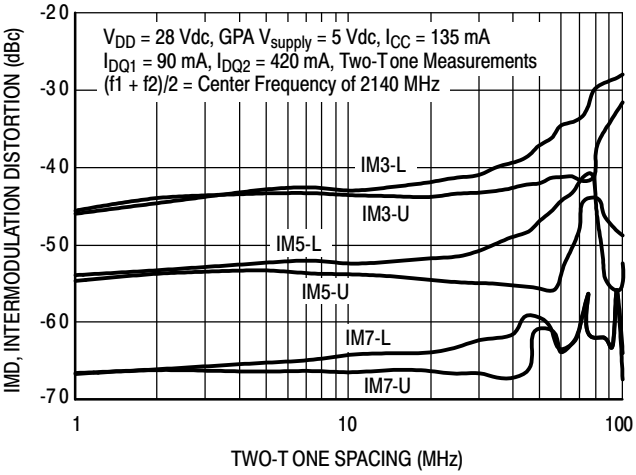



**Figure 6. Intermodulation Distortion Products versus Two-Tone Spacing**

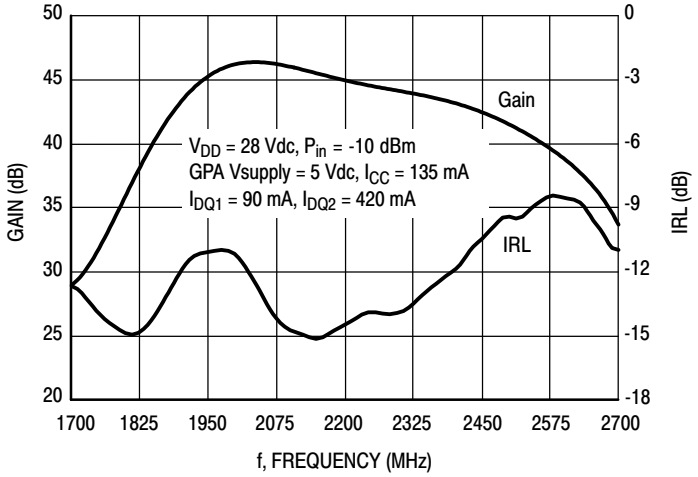



**Figure 7. Broadband Frequency Response**

## W-CDMA TEST SIGNAL

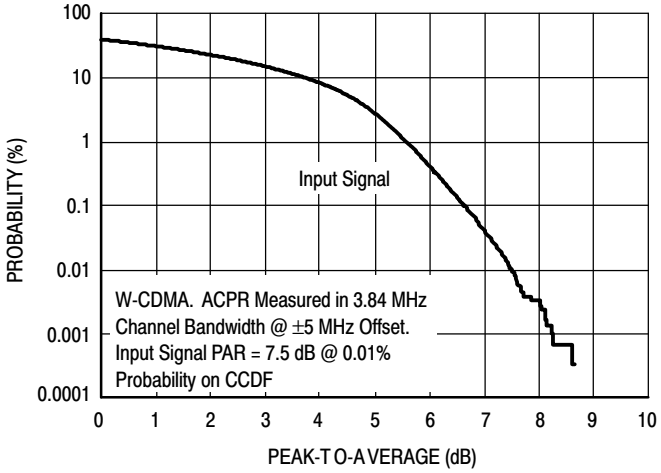



**Figure 8. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal**

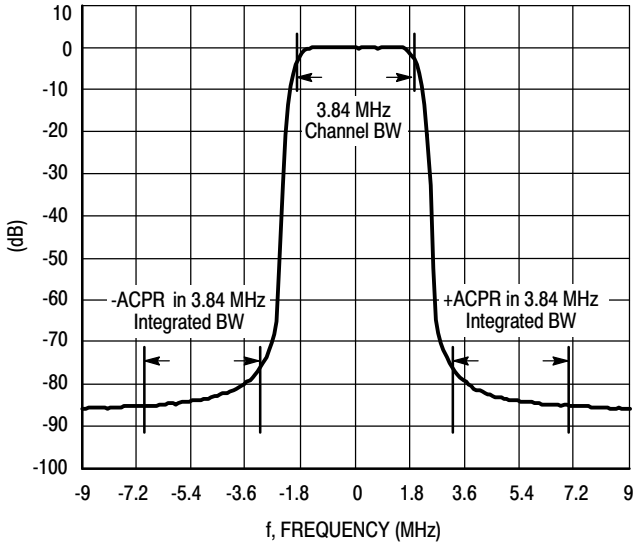



**Figure 9. Single-Carrier W-CDMA Spectrum**

## CHARACTERISTICS — 9.9 dB Input PAR Test Signal

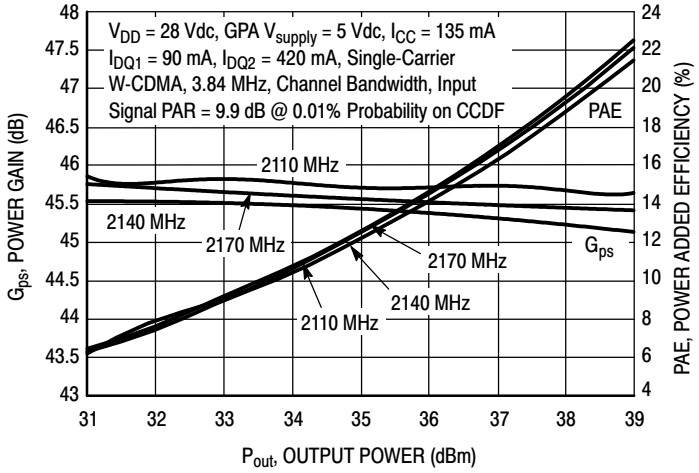



**Figure 10. Power Gain and Power Added Efficiency versus Output Power**

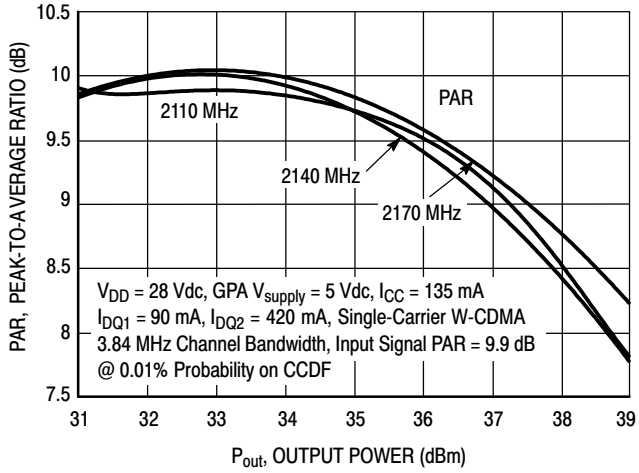



**Figure 11. Output Peak-to-Average Ratio (PAR) versus Output Power**

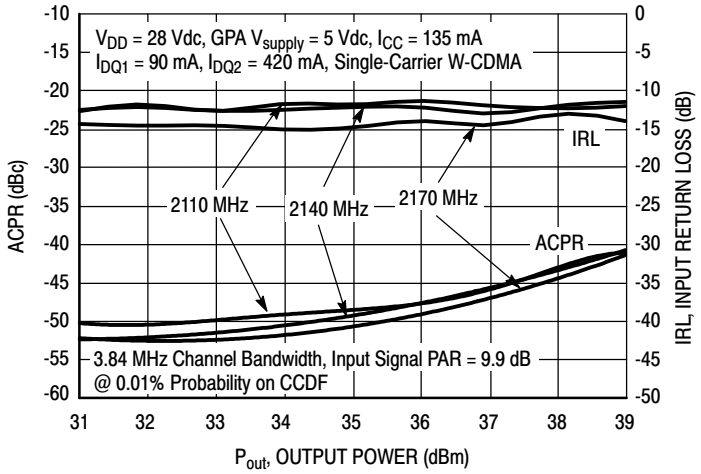



**Figure 12. ACPR and Input Return Loss versus Output Power**

## W-CDMA TEST SIGNAL

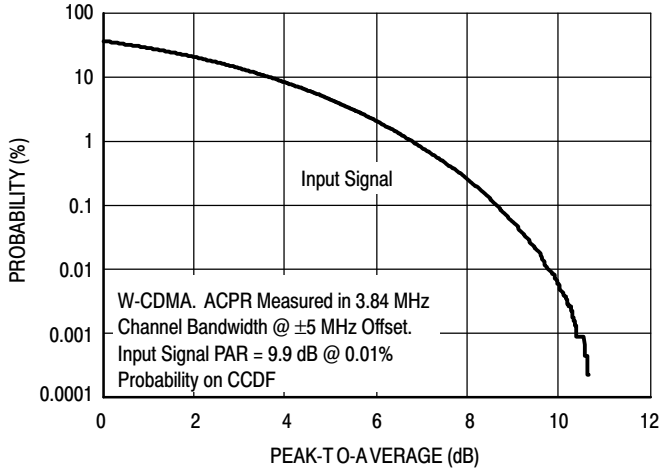



**Figure 13. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal**

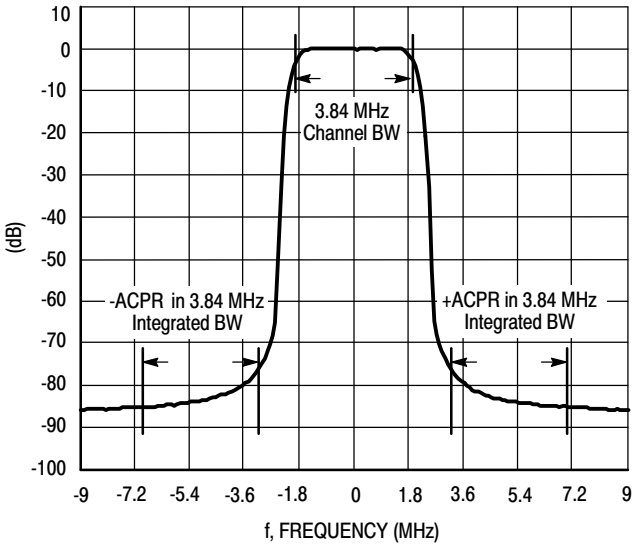



**Figure 14. Single-Carrier W-CDMA Spectrum**

## APPENDIX A

### MMG3014N Driving MW7IC2240N Tuning Tips

- Cut traces to insert R1 and R2 as indicated in Fig. 2, MMG3014N Driving MW7IC2240N Board Layout, p. 2.
- Install MW7IC2240N with Delrin hold-down clamp.
- Apply Drain 2 power on MW7IC2240N, adjust $V_{DD2}$ to 28 Vdc.
- Adjust $I_{CQ2}$ to 420 mA, $V_{GG2}$ range from 7-12.5 Vdc.
- Apply Drain 1 power on MW7IC2240N, adjust $V_{DD1}$ to 28 Vdc.
- Adjust $I_{CQ1}$ to 90 mA, $V_{GG2}$ range from 9.5-16.5 Vdc.
- Power on MMG3014N to 5 Vdc. $I_{CC}$ should be around 135 mA.
- Turn on W-CDMA for initial RF test, adjust the output power to 36 dBm or 4.0 watt. Gain should be around 45 dB.
- Move C7 left and right to optimize the return loss.
- Move C5 and C6 to adjust gain flatness and efficiency.

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