# AGR19090E
# 90 W, 1930 MHz—1990 MHz, PCS LDMOS RF Power Transistor

## Introduction

The AGR19090E is a 90 W, 28 V N-channel laterally diffused metal oxide semiconductor (LDMOS) RF power field effect transistor (FET) suitable for personal communication service (PCS) (1930 MHz—1990 MHz), wide-band code division multiple access (W-CDMA), global system for mobile communication (GSM/EDGE), time-division multiple access (TDMA), and single-carrier or multicarrier class AB power amplifier applications.

**AGR19090EU (unflanged) AGR19090EF (flanged)**

**Figure 1. Available Packages**

## N-CDMA Features

Typical 2 carrier N-CDMA performance: $V_{DD}$ = 28 V, $I_{DQ}$ = 850 mA, f1 = 1958.75 MHz, f2 = 1961.25 MHz, IS-95 CDMA (pilot, sync, paging, traffic codes 8—13). Peak/average (P/A) = 9.72 dB at 0.01% probability on CCDF. 1.2288 MHz transmission bandwidth (BW). Adjacent channel power ratio (ACPR) measured over 30 kHz BW at f1 – 885 kHz and f2 + 885 kHz. Third-order intermodulation (IM3) distortion measured over a 1.2288 MHz BW at f1 – 2.5 MHz and f2 + 2.5 MHz.
— Output power ($P_{OUT}$): 18 W.
— Power gain: 15.0 dB.
— Efficiency: 25.8%.
— IM3: –34.5 dBc.
— ACPR: –50 dBc.

## EDGE Features

Typical EDGE performance (1960 MHz, 26 V, $I_{DQ}$ = 800 mA):
— Output power ($P_{OUT}$): 36 W.
— Power gain: 15.0 dB.
— Efficiency: 38%.
— Modulation spectrum:
  @ ±400 kHz = –61.0 dBc.
  @ ±600 kHz = –73.0 dBc.
— Error vector magnitude (EVM) = 2.2%.

## GSM Features

Typical performance over entire GSM band:
— P1dB: 90 W typical.
— Continuous wave (CW) power gain: @ P1dB = 14.0 dB.
— CW Efficiency @ P1dB = 50% typical.
— Return loss: –12 dB.

## Device Performance Features

High-reliability, gold-metalization process.

Low hot carrier injection (HCI) induced bias drift over 20 years.

Internally matched.

High gain, efficiency, and linearity.

Integrated ESD protection.

Device can withstand 10:1 voltage standing wave ratio (VSWR) at 28 Vdc, 1930 MHz, 90 W CW output power.

Large signal impedance parameters available.

## ESD Rating*

| AGR19090E | Minimum (V) | Class |
|---|---|---|
| **HBM** | 500 | 1B |
| **MM** | 50 | A |
| **CDM** | 1500 | 4 |

* Although electrostatic discharge (ESD) protection circuitry has been designed into this device, proper precautions must be taken to avoid exposure to ESD and electrical overstress (EOS) during all handling, assembly, and test operations. PEAK Devices employs a human-body model (HBM), a machine model (MM), and a charged-device model (CDM) qualification requirement in order to determine ESD-susceptibility limits and protection design evaluation. ESD voltage thresholds are dependent on the circuit parameters used in each of the models, as defined by JEDEC's JESD22-A114B (HBM), JESD22-A115A (MM), and JESD22-C101A (CDM) standards.

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

## Electrical Characteristics

### Table 1. Thermal Characteristics

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case: | | | |
| AGR19090EU | $R_{\theta JC}$ | 0.75 | °C/W |
| AGR19090EF | $R_{\theta JC}$ | 0.75 | °C/W |

### Table 2. Absolute Maximum Ratings*

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain-source Voltage | $V_{DSS}$ | 65 | Vdc |
| Gate-source Voltage | $V_{GS}$ | –0.5, 15 | Vdc |
| Total Dissipation at $T_C$ = 25 °C: | | | |
| AGR19090EU | $P_D$ | 230 | W |
| AGR19090EF | $P_D$ | 230 | W |
| Derate Above 25 °C: | | | |
| AGR19090EU | — | 1.33 | W/°C |
| AGR19090EF | — | 1.33 | W/°C |
| Operating Junction Temperature | $T_J$ | 200 | °C |
| Storage Temperature Range | $T_{STG}$ | –65, 150 | °C |

* Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Recommended operating conditions apply unless otherwise specified: $T_C$ = 30 °C.

### Table 3. dc Characteristics

| Parameter | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics** | | | | | |
| Drain-source Breakdown Voltage ($V_{GS}$ = 0 V, $I_D$ = 300 µA) | $V_{(BR)DSS}$ | 65 | — | — | Vdc |
| Gate-source Leakage Current ($V_{GS}$ = 5 V, $V_{DS}$ = 0 V) | $I_{GSS}$ | — | — | 2.7 | µAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 28 V, $V_{GS}$ = 0 V) | $I_{DSS}$ | — | — | 150 | µAdc |
| **On Characteristics** | | | | | |
| Forward Transconductance ($V_{DS}$ = 10 V, $I_D$ = 0.67 A) | $G_{FS}$ | — | 6.0 | — | S |
| Gate Threshold Voltage ($V_{DS}$ = 10 V, $I_D$ = 270 µA) | $V_{GS(th)}$ | — | — | 4.8 | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 28 V, $I_D$ = 800 mA) | $V_{GS(Q)}$ | — | 3.7 | — | Vdc |
| Drain-source On-voltage ($V_{GS}$ = 10 V, $I_D$ = 0.67 A) | $V_{DS(on)}$ | — | 0.08 | — | Vdc |

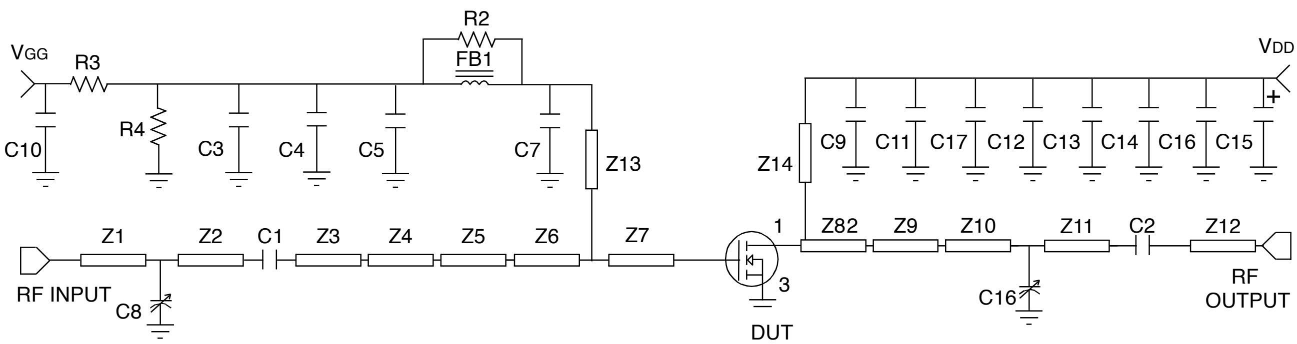
## Electrical Characteristics (continued)

Recommended operating conditions apply unless otherwise specified: $T_C$ = 30 °C.

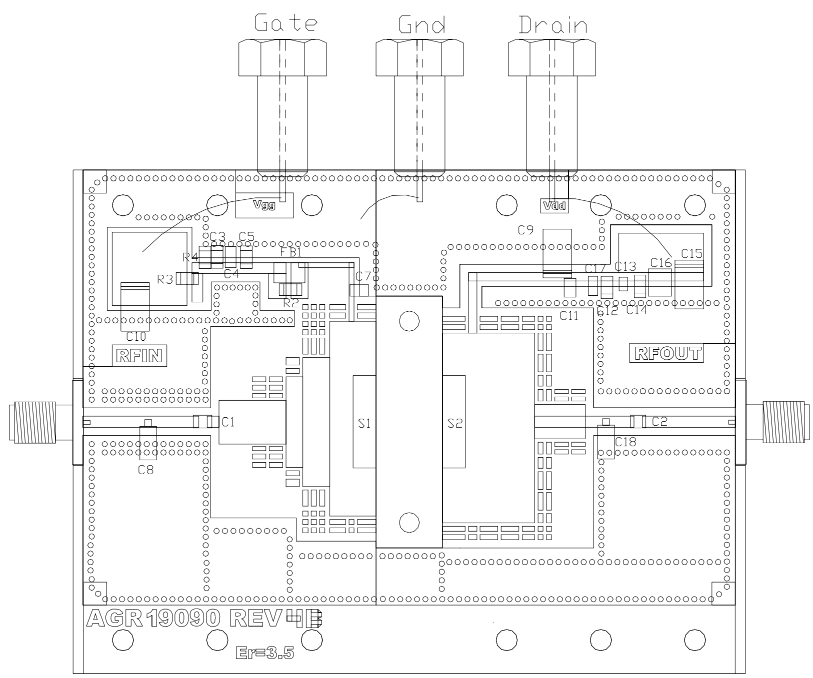
**Table 4. RF Characteristics**

| Parameter | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Dynamic Characteristics** | | | | | |
| Transfer Capacitance<br>($V_{DS}$ = 28 V, $V_{GS}$ = 0, f = 1 MHz)<br>(Part is internally matched both on input and output.) | $C_{RSS}$ | — | 2.0 | — | pF |
| **Functional Tests (in Supplied Test Fixture)** | | | | | |
| Common-source Amplifier Power Gain<br>($V_{DD}$ = 28 Vdc, $P_{OUT}$ = 18 W average, 2-Carrier N-CDMA, $I_{DQ}$ = 850 mA, f1 = 1930 MHz, f2 = 1932.5 MHz and f1 = 1987.5 MHz, f2 = 1990 MHz) | $G_{PS}$ | 14.5 | 15.5 | — | dB |
| Drain Efficiency<br>($V_{DD}$ = 28 Vdc, $P_{OUT}$ = 18 W average, 2-Carrier N-CDMA, $I_{DQ}$ = 850 mA, f1 = 1930 MHz, f2 = 1932.5 MHz and f1 = 1987.5 MHz, f2 = 1990 MHz) | $\eta$ | — | 25.8 | — | % |
| Third-order Intermodulation Distortion<br>($V_{DD}$ = 28 Vdc, $P_{OUT}$ = 18 W average, 2-Carrier N-CDMA, $I_{DQ}$ = 850 mA, f1 = 1930 MHz, f2 = 1932.5 MHz and f1 = 1987.5 MHz, f2 = 1990 MHz; IM3 measured in a 1.2288 MHz integration BW centered at f1 – 2.5 MHz and f2 + 2.5 MHz, referenced to the carrier channel power) | IM3 | — | –34.5 | — | dBc |
| Adjacent Channel Power Ratio<br>($V_{DD}$ = 28 Vdc, $P_{OUT}$ = 18 W average, 2-Carrier N-CDMA, $I_{DQ}$ = 850 mA, f1 = 1930 MHz, f2 = 1932.5 MHz and f1 = 1987.5 MHz, f2 = 1990 MHz; ACPR measured in a 1.2288 MHz integration BW centered at f1 – 2.5 MHz and f2 + 2.5 MHz, referenced to the carrier channel power) | ACPR | — | –50 | — | dBc |
| Input Return Loss<br>($V_{DD}$ = 28 Vdc, $P_{OUT}$ = 18 W average, 2-Carrier N-CDMA, $I_{DQ}$ = 850 mA, f1 = 1930 MHz, f2 = 1932.5 MHz and f1 = 1987.5 MHz, f2 = 1990 MHz) | IRL | — | –12 | — | dB |
| Output Power at 1 dB Gain Compression<br>($V_{DD}$ = 28 V, $P_{OUT}$ = 90 W CW, f = 1990 MHz, $I_{DQ}$ = 800 mA) | P1dB | 90 | 95 | — | W |
| Ruggedness<br>($V_{DD}$ = 28 V, $P_{OUT}$ = 90 W CW, $I_{DQ}$ = 800 mA, f = 1930 MHz, VSWR = 10:1 [all phase angles]) | $\Psi$ | No degradation in output power. | | | |

# Test Circuit Illustrations for AGR19090E




**A. Schematic**



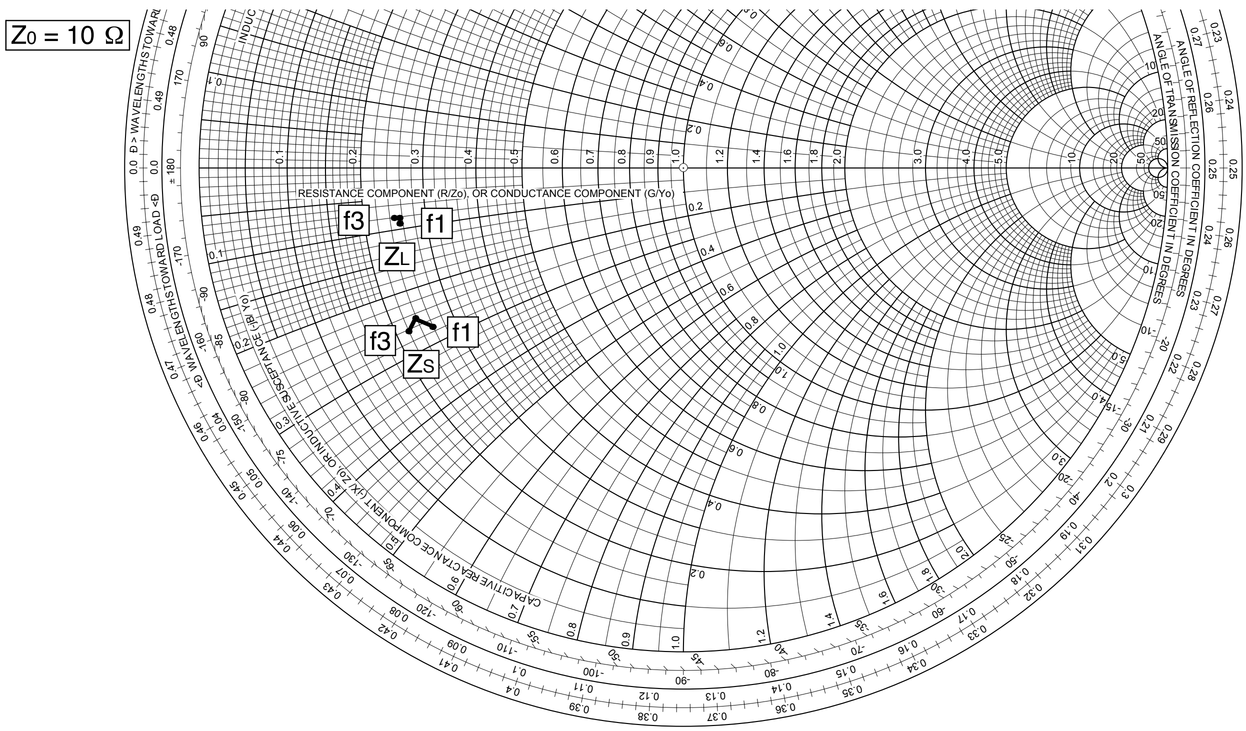

**B. Component Layout**

Parts List:

- Microstrip line: Z1 0.390 in. x 0.065 in.; Z2 0.300 in. x 0.065 in.; Z3 0.070 in. x 0.065 in.; Z4 0.400 in. x 0.260 in.; Z5 0.100 in. x 0.540 in.; Z6 0.160 in. x 0.770 in.; Z7 0.275 in. x 1.160 in.; Z8 0.550 in. x 1.130 in.; Z9 0.300 in. x 0.205 in.; Z10 0.120 in. x 0.065 in.; Z11 0.165 in. x 0.065 in.; Z12 0.555 in. x 0.065 in.; Z13 0.185 in. x 0.030 in.; Z14 0.845 in. x 0.050 in.
- *ATC*® B case chip capacitors: C1, C2, 10 pF, 100B100JCA500X; C7, C11, 8.2 pF, 100B8R2CA500X.
- *Sprague*® tantalum SMT: C9, C10, C15 22 $\mu$F, 35 V.
- *Kemet*®: B case chip capacitors: C3, C14 0.10 $\mu$F, CDR33BX104AKWS; tantalum capacitor: C16, 1 $\mu$F, 50 V T491C.
- *Vitramon*® 1206: C5, C12: 22000 pF.
- *Murata*®: 0805: C4, C13 0.01 $\mu$F, GRM40X7R103K100AL.
- 0603: C12 220 pF.
- *Johanson Giga-Trim*® variable capacitors: C8, C18 0.4 pF—2.5 pF.
- Fixed film chip resistors (0.25 W, 0.08 x 0.13): R2 4.7 Ω; R3 1.02 kΩ; R4 560 kΩ.
- *Fair-Rite*® ferrite bead: FB1: 2743019447.
- *Taconic*® ORCER RF-35: board material, 1 oz. copper, 30 mil thickness, $\varepsilon r$ = 3.5.

**Figure 2. AGR19090E Test Circuit**

## Typical Performance Characteristics




| MHz (f) | ZS Ω (Complex Source Impedance) | ZL Ω (Complex Optimum Load Impedance) |
|---|---|---|
| 1930 (f1) | 2.16 – j2.62 | 2.51 – j0.83 |
| 1960 (f2) | 2.44 – j2.57 | 2.50 – j0.82 |
| 1990 (f3) | 2.49 – j2.76 | 2.38 – j0.80 |

Note: ZL was chosen based on trade-offs between gain, output power, drain efficiency, and intermodulation distortion.

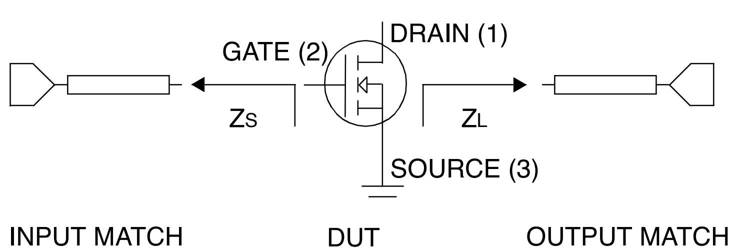
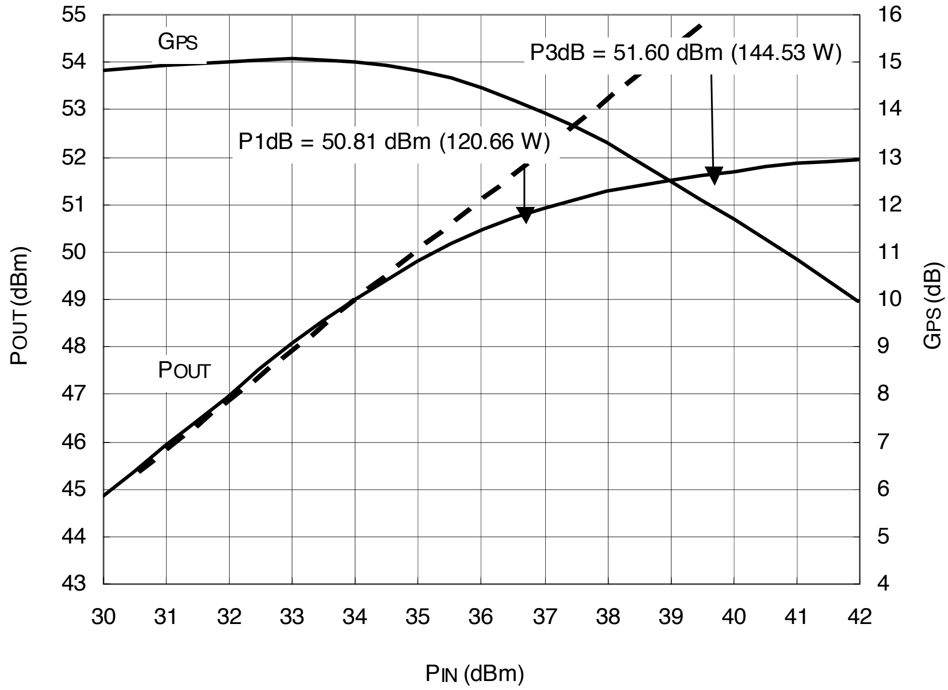


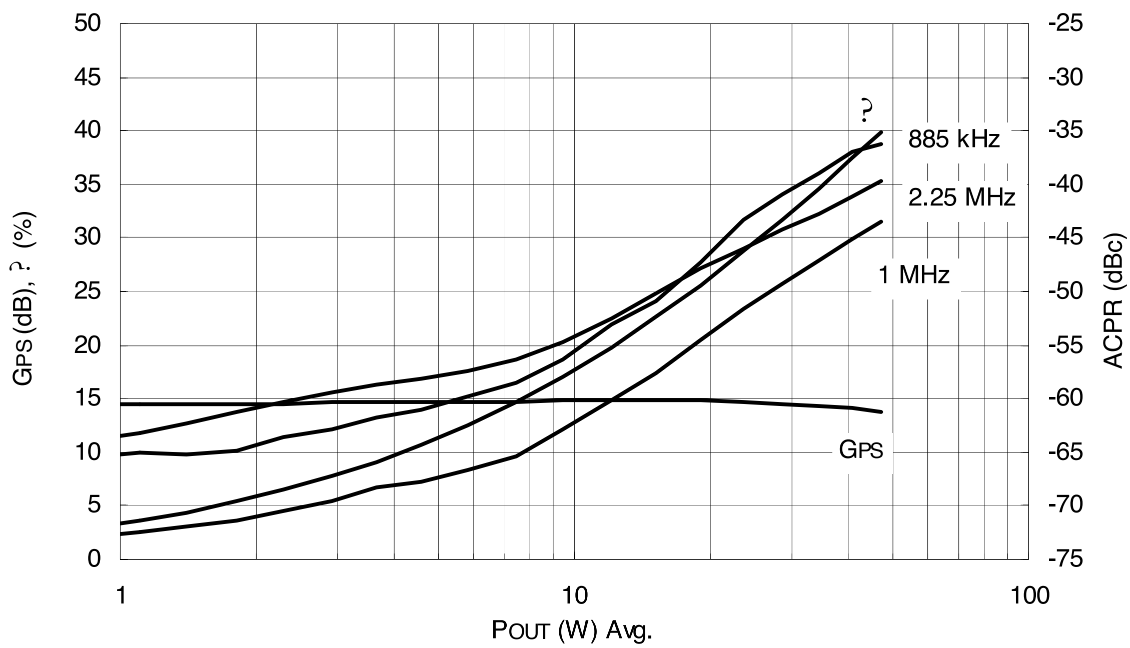

**Figure 3. Series Equivalent Input and Output Impedances**

## Typical Performance Characteristics (continued)




Test Conditions:
$V_{DD}$ = 28 Vdc, $I_{DQ}$ = 800 mA, pulsed CW, 4 μs (on), 40 μs (off), center frequency = 1960 MHz.

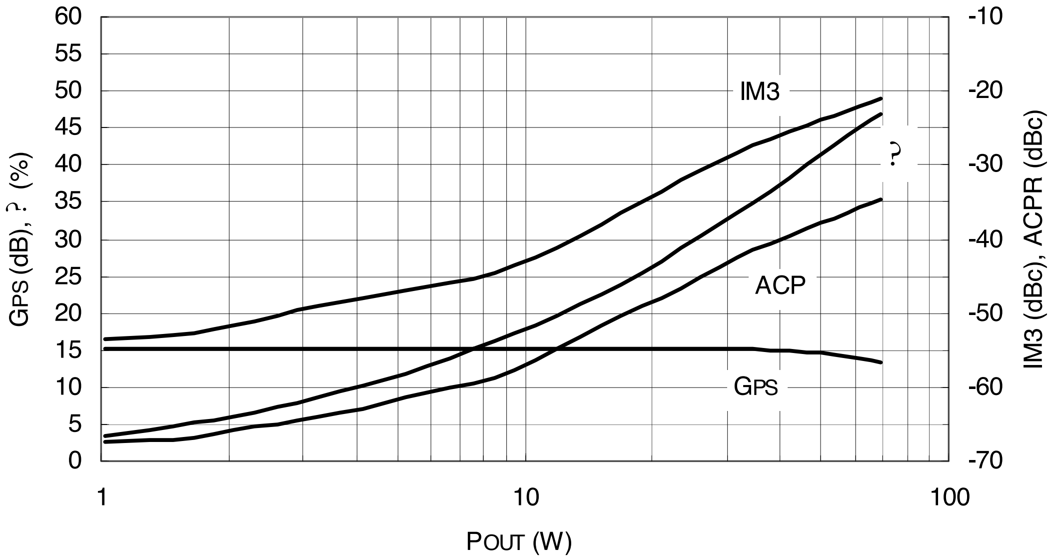
**Figure 4. Pulse CW $P_{OUT}$ vs. $P_{IN}$**




Test Conditions:
$V_{DD}$ = 28 Vdc, $I_{DQ}$ = 850 mA, f = 1960 MHz, N-CDMA, 2.5 MHz @ 1.2288 MHz BW, P/A = 9.72 dB @ 0.01% probability (CCDF), channel spacing (BW) 885 kHz (30 kHz), 1.25 MHz (12.5 kHz), 2.25 MHz (1 MHz).

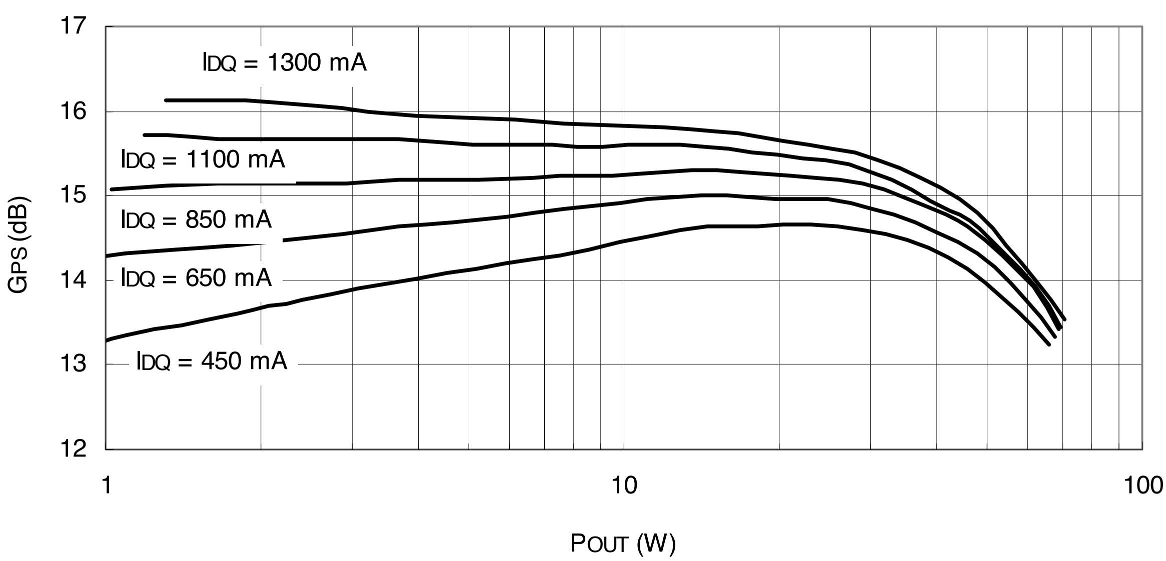
**Figure 5. N-CDMA ACPR, Power Gain, and Drain Efficiency vs. $P_{OUT}$**

## Typical Performance Characteristics (continued)




Test Conditions:
$V_{DD}$ = 28 Vdc, $I_{DQ}$ = 850 mA, f1 = 1958.75 MHz, f2 = 1961.25 MHz, 2 x N-CDMA, 2.5 MHz @ 1.2288 MHz BW, P/A = 9.72 dB @ 0.01% probability (CCDF), channel spacing (BW) ACPR: 885 kHz (30 kHz), IM3: 2.5 MHz (1.2288 MHz).

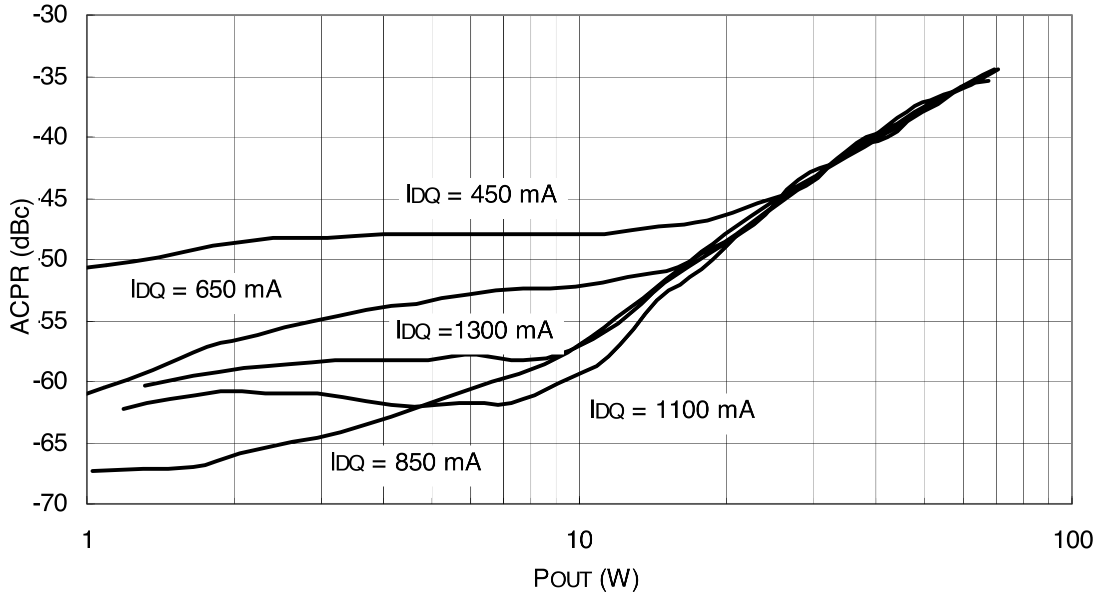
**Figure 6. 2-Carrier N-CDMA ACPR, IM3, Power Gain, and Drain Efficiency vs. $P_{OUT}$**




Test Conditions:
$V_{DD}$ = 28 Vdc, f1 = 1958.75 MHz, f2 = 1961.25 MHz, 2 carrier N-CDMA measurement.

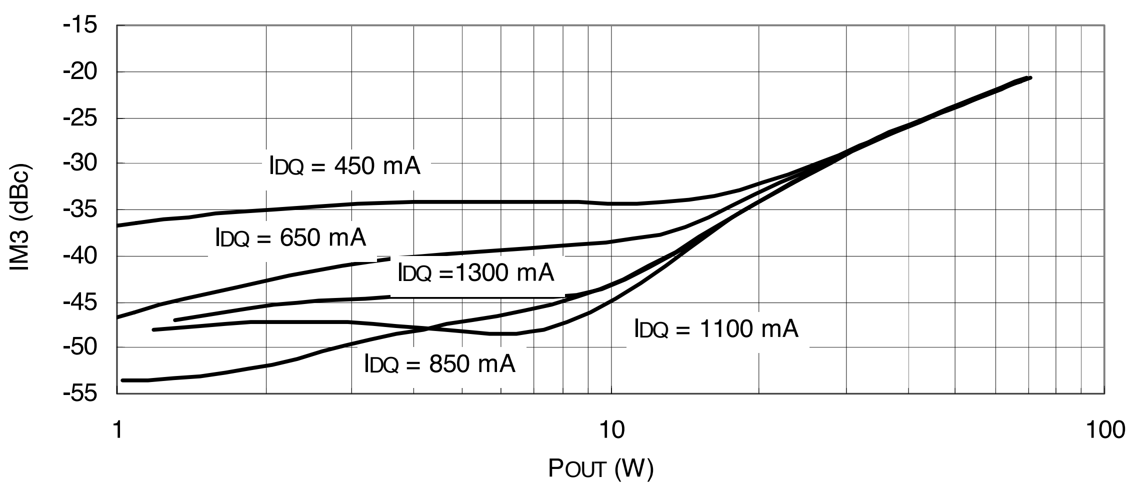
**Figure 7. 2-Carrier N-CDMA Power Gain vs. $P_{OUT}$**

## Typical Performance Characteristics (continued)




Test Conditions:
$V_{DD}$ = 28 Vdc, f1 = 1958.75 MHz, f2 = 1961.25 MHz, 2 carrier N-CDMA measurement.

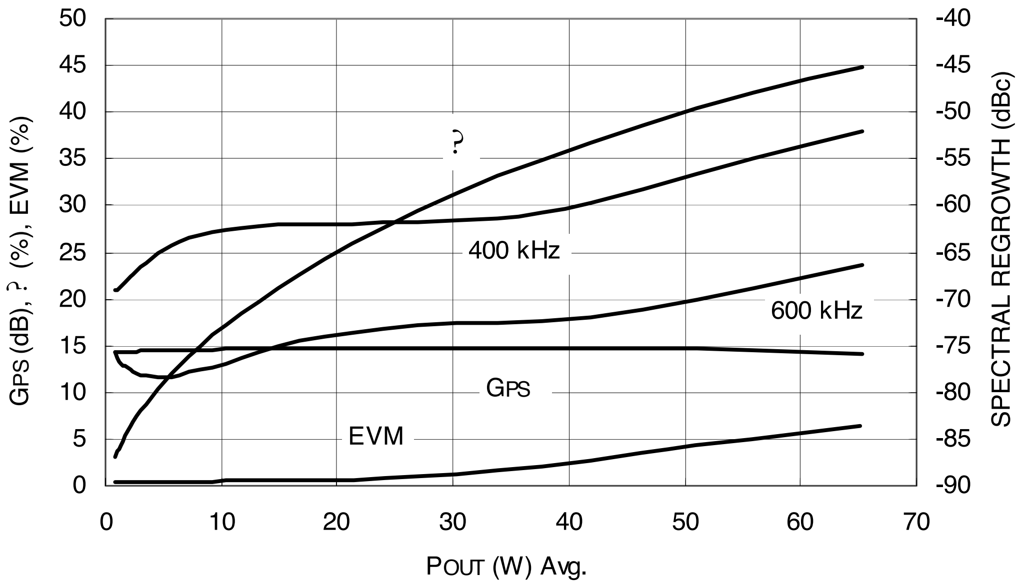
**Figure 8. ACPR vs. $P_{OUT}$**




Test Conditions:
$V_{DD}$ = 28 Vdc, f1 = 1958.75 MHz, f2 = 1961.25 MHz, 2 carrier N-CDMA measurement.

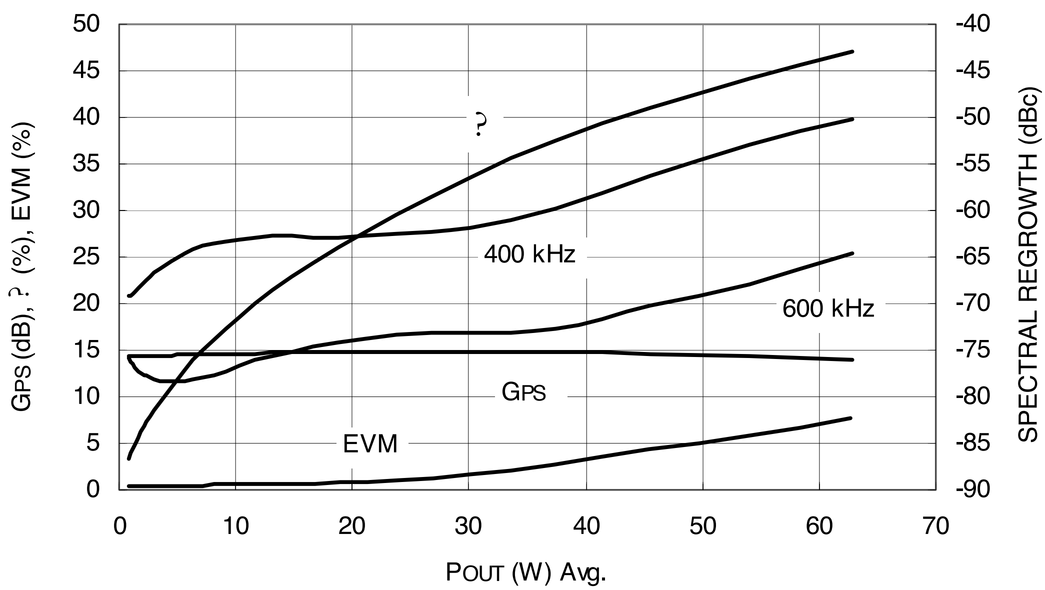
**Figure 9. IM3 vs. $P_{OUT}$**

## Typical Performance Characteristics (continued)




Test Conditions:
$V_{DD}$ = 28 Vdc, $I_{DQ}$ = 800 mA, f = 1960 MHz, modulation = GSM/EDGE.

**Figure 10. GSM/EDGE Power Gain, Drain Efficiency, Spectral Regrowth, and EVM vs. $P_{OUT}$**



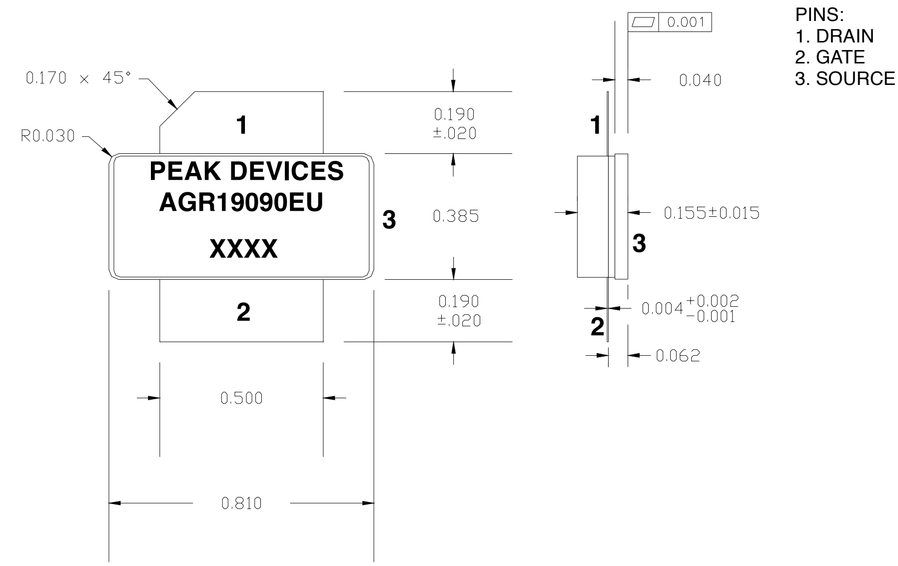

Test Conditions:
$V_{DD}$ = 26 Vdc, $I_{DQ}$ = 800 mA, f = 1960 MHz, modulation = GSM/EDGE.

**Figure 11. GSM/EDGE Power Gain, Drain Efficiency, Spectral Regrowth, and EVM vs. $P_{OUT}$**

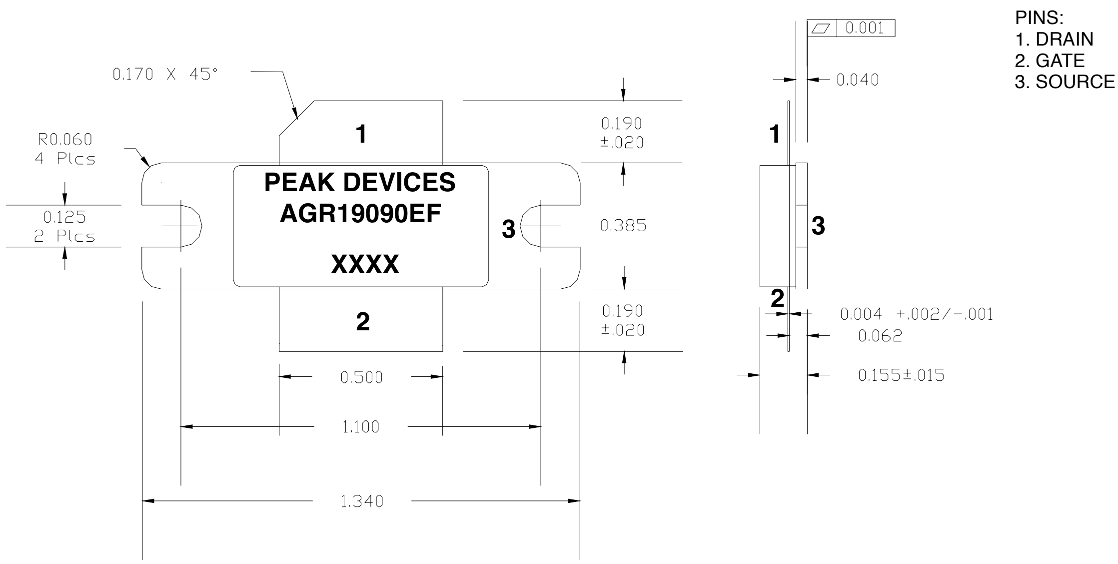
## Package Dimensions

All dimensions are in inches. Tolerances are ±0.005 in. unless specified.

### AGR19090EU




### AGR19090EF

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