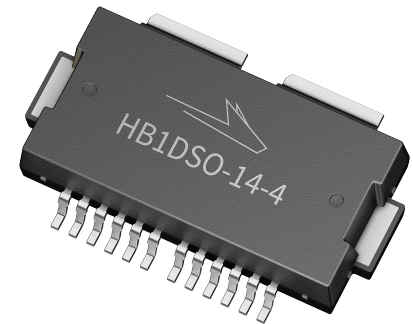


# PTGA090304MD

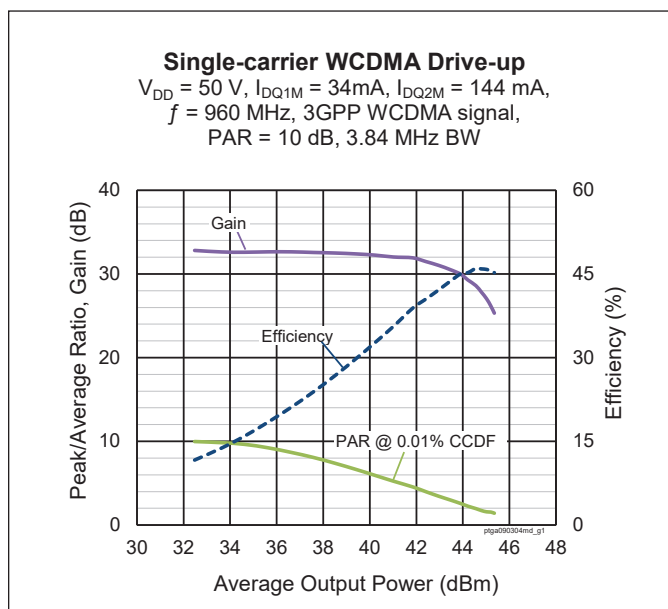
Wideband LDMOS Two-stage Integrated Power Amplifier  
2 X 15 W, 48 V, 575 – 960 MHz



Package Types: PG-HB1DSO-14-4

## Description

The PTGA090304MD is a wideband, two-stage, LDMOS integrated power amplifier. Fabricated with WolfSpeed's 50 V LDMOS process, it incorporates internal matching for operation from 575 MHz to 960 MHz, and dual independent outputs of 15 W each. It is available in a 14-lead plastic overmold package with gull wing leads.



## Features

- On-chip matching for broadband operation
- Designed for ultra wideband performance
- Typical CW performance, 960 MHz, 50 V, combined outputs
  - Output power at  $P_{1dB} = 45\text{ dBm}$
  - Output power at  $P_{3dB} = 45.9\text{ dBm}$
  - Linear Gain at  $P_{1dB} = 31\text{ dB}$
  - Efficiency at  $P_{1dB} = 48.1\%$
- Capable of handling 10:1 VSWR @50 V, 30 W CW output power
- Integrated ESD protection
- Human Body Model Class 1C (per ANSI/ESDA/ JEDEC JS-001)
- Integrated temperature compensation
- Pb-free and RoHS compliant

## RF Characteristics

**Single-carrier WCDMA Specifications** (tested in WolfSpeed Class AB production test fixture, combined outputs)

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  $P_{OUT} = 3.9\text{ W avg}$ ,  $f = 960\text{ MHz}$ , 3GPP WCDMA signal, channel bandwidth = 3.84 MHz, peak/average = 10 dB @ 0.01% CCDF

| Characteristic                          | Symbol   | Min. | Typ. | Max.  | Unit |
|---|----------|------|------|-------|------|
| Gain                                    | $G_{ps}$ | 30.2 | 32   | —     | dB   |
| Drain Efficiency                        | $\eta_D$ | 17.5 | 19   | —     | %    |
| Adjacent Channel Power Ratio            | ACPR     | —    | -44  | -46.5 | dBc  |
| Output PAR at 0.01% probability on CCDF | OPAR     | 8.5  | 9    | —     | dB   |

Note:

All published data at  $T_{CASE} = 25^\circ\text{C}$  unless otherwise indicated

ESD: Electrostatic discharge sensitive device—observe handling precautions!



**Typical Performance, 920 – 960 MHz** (tested in Wolfspeed narrowband test fixture)
 $V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ , 3GPP WCDMA signal, channel bandwidth = 3.84 MHz, peak/average = 10 dB @ 0.01% CCDF

| Freq [MHz] | Gain [dB] | RL [dB] | Eff [%] | $P_{OUT}$ [dBm] | ACPL [dBc] | ACPU [dBc] | ACP max [dBc] |
|------------|-----------|---------|---------|-----------------|------------|------------|---------------|
| 920        | 32.9      | -37.1   | 19.8    | 35.9            | -44.7      | -44.6      | -44.64        |
| 940        | 32.8      | -43.6   | 19.4    | 35.9            | -44.4      | -44.1      | -44.05        |
| 960        | 32.6      | -38.9   | 19.2    | 35.9            | -43.8      | -43.9      | -43.75        |

**Typical Broadband Performance, 575 – 960 MHz** (tested in Wolfspeed broadband test fixture)
 $V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ , 3GPP WCDMA signal, channel bandwidth = 3.84 MHz, peak/average = 10 dB @ 0.01% CCDF

| Freq [MHz] | Gain [dB] | RL [dB] | Eff [%] | $P_{OUT}$ [dBm] | PAR [dB] | ACPL [dBc] | ACPU [dBc] | ACP max [dBc] |
|------------|-----------|---------|---------|-----------------|----------|------------|------------|---------------|
| 575        | 29.1      | -22.3   | 17.7    | 35.9            | 9.2      | -37.5      | -37.3      | -37.30        |
| 590        | 30.1      | -22.7   | 17.8    | 35.9            | 9.2      | -39.4      | -39.5      | -39.41        |
| 660        | 32.0      | -24.8   | 18.1    | 35.9            | 9.3      | -44.5      | -45.1      | -44.54        |
| 746        | 30.8      | -28.0   | 17.1    | 35.9            | 9.5      | -45.6      | -45.8      | -45.57        |
| 860        | 30.2      | -23.4   | 15.8    | 35.9            | 9.5      | -45.0      | -45.5      | -45.05        |
| 960        | 30.4      | -26.9   | 15.0    | 35.9            | 9.4      | -44.0      | -44.0      | -43.98        |

**DC Characteristics**

| Characteristics                          | Symbol        | Min. | Typ. | Max. | Unit          | Conditions   |
|--|---------------|------|------|------|---------------|--|
| Drain-Source Breakdown Voltage           | $V_{(BR)DSS}$ | 105  | —    | —    | V             | $V_{GS} = 0\text{ V}$ , $I_{DS} = 136\text{ }\mu\text{A}$                |
| Drain Leakage Current – Stage 1          | $I_{DSS}$     | —    | —    | 0.1  | $\mu\text{A}$ | $V_{DS} = 50\text{ V}$ , $V_{GS} = 0\text{ V}$                           |
|  |               | —    | —    | 1.0  |               | $V_{DS} = 105\text{ V}$ , $V_{GS} = 0\text{ V}$                          |
| Drain Leakage Current – Stage 2          |               | —    | —    | 0.1  |               | $V_{DS} = 50\text{ V}$ , $V_{GS} = 0\text{ V}$                           |
|  |               | —    | —    | 1.0  |               | $V_{DS} = 105\text{ V}$ , $V_{GS} = 0\text{ V}$                          |
| Gate Leakage Current – Stage 1           | $I_{GSS}$     | —    | —    | 0.1  | V             | $V_{GS} = 1\text{ V}$ , $V_{DS} = 0\text{ V}$                            |
| Gate Leakage Current – Stage 2           |               | —    | —    |      |               |  |
| On-State Resistance – Stage 1            | $R_{DS(on)}$  | —    | 22.5 | —    | $\Omega$      | $V_{GS} = 10\text{ V}$ , $V_{DS} = 0.1\text{ V}$ , $I_D = 24\text{ mA}$  |
| On-State Resistance – Stage 2            |               | —    | 2.6  | —    |               | $V_{GS} = 10\text{ V}$ , $V_{DS} = 0.1\text{ V}$ , $I_D = 136\text{ mA}$ |
| Operating Gate Voltage – Stage 1         | $V_{GS1}$     | —    | 3.9  | —    | V             | $V_{DS} = 50\text{ V}$ , $I_{DQ1M} = 34\text{ mA}$                       |
| Operating Gate Voltage – Stage 2         | $V_{GS2}$     | —    | 3.8  | —    |               | $V_{DS} = 50\text{ V}$ , $I_{DQ2M} = 144\text{ mA}$                      |
| Fixture Operating Gate Voltage – Stage 1 | $V_{GS1}$     | —    | 5.8  | —    |               | $V_{DS} = 50\text{ V}$ , $I_{DQ1M} = 34\text{ mA}$                       |
| Fixture Operating Gate Voltage – Stage 2 | $V_{GS2}$     | —    | 5.7  | —    |               | $V_{DS} = 50\text{ V}$ , $I_{DQ2M} = 144\text{ mA}$                      |



## Maximum Ratings

| Parameter                 | Symbol    | Value       | Unit |
|---------------------------|-----------|-------------|------|
| Drain-Source Voltage      | $V_{DSS}$ | 105         | V    |
| Gate-Source Voltage       | $V_{GS}$  | -6 to +12   |      |
| Operating Voltage         | $V_{DD}$  | 0 to +55    |      |
| Junction Temperature      | $T_J$     | 225         | °C   |
| Storage Temperature Range | $T_{STG}$ | -65 to +150 |      |

1. Operation above the maximum values listed here may cause permanent damage. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the component. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. For reliable continuous operation, the device should be operated within the operating voltage range ( $V_{DD}$ ) specified above.
2. Parameters values can be affected by end application and product usage. Values may change over time.

## Thermal Characteristics

| Parameter                    | Symbol          | Value | Unit | Conditions                                  |
|------------------------------|-----------------|-------|------|---|
| Thermal Resistance – Stage 1 | $R_{\theta JC}$ | 7.8   | °C/W | $T_{CASE} = 70^{\circ}\text{C}$ , 4 W WCDMA |
| Thermal Resistance – Stage 2 |                 | 3.3   |      | $T_{CASE} = 70^{\circ}\text{C}$ , 4 W WCDMA |

## Moisture Sensitivity Level

| Level | Test Standard       | Package Temperature | Unit |
|-------|---------------------|---------------------|------|
| 3     | IPC/JEDEC J-STD-020 | 260                 | °C   |

## Ordering Information

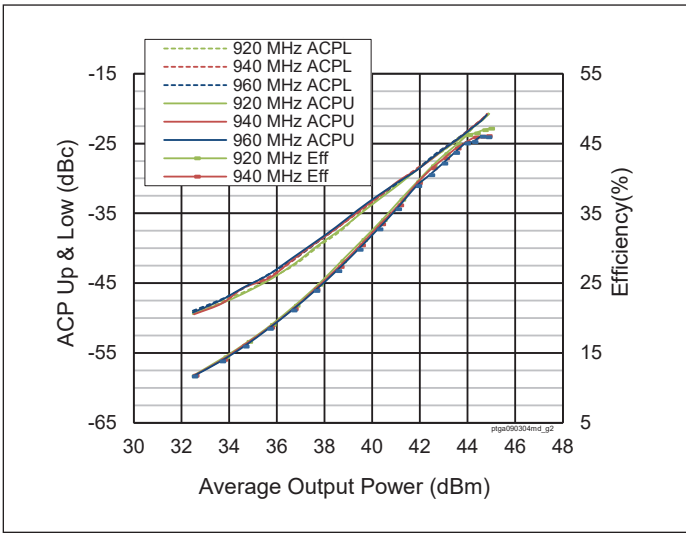
| Type and Version   | Order Code         | Package Description | Shipping             |
|--------------------|--------------------|---------------------|----------------------|
| PTGA090304MD V2 R5 | PTGA090304MD-V2-R5 | PG-HB1DSO-14-4      | Tape & Reel, 500 pcs |

## Evaluation Boards

| Order Code          | Frequency     | Description                            |
|---------------------|---------------|--|
| LTN/PTGA090304MD-V2 | 920 – 960 MHz | Class AB with combined outputs, R04350 |
| LTN/PTGA090304MD-E2 | 728 – 768 MHz | Class AB with combined outputs, R04350 |
| LTN/PTGA090304MD-E3 | 575 – 960 MHz | Class AB with combined outputs, R04350 |

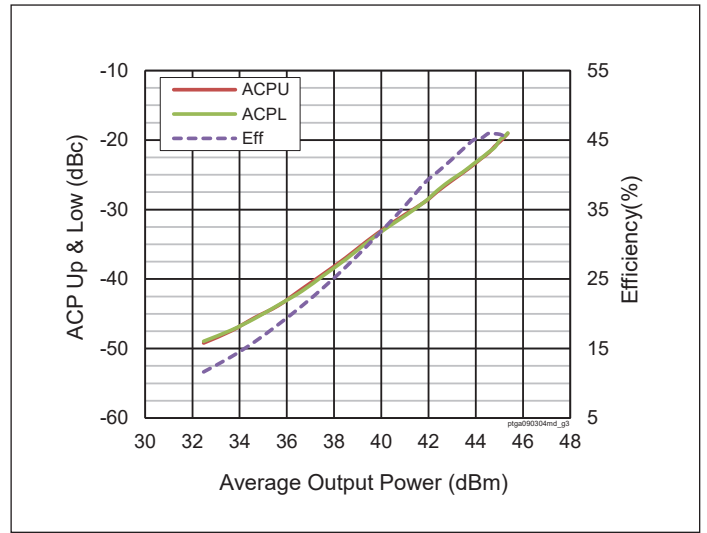


**Typical Performance, 920 – 960 MHz** (data taken in test fixture)



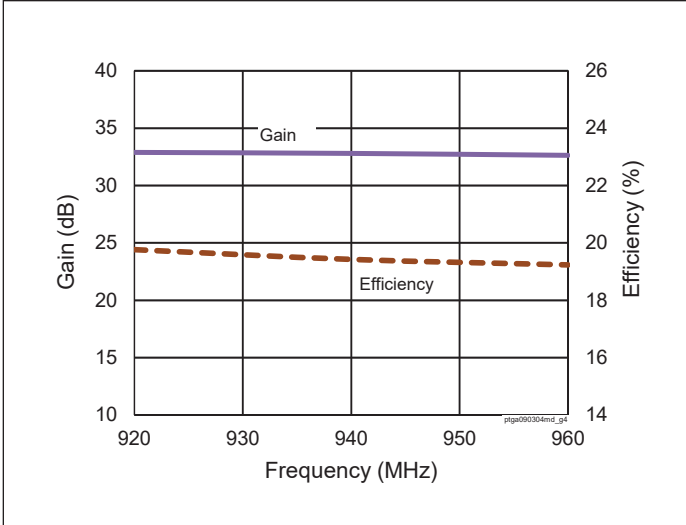
**Figure 1.** Single-carrier WCDMA 3GPP Drive-up

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  
 $f = 920\text{-}960\text{ MHz}$ , 3GPP WCDMA signal,  
 PAR = 10 dB, BW = 3.84 MHz



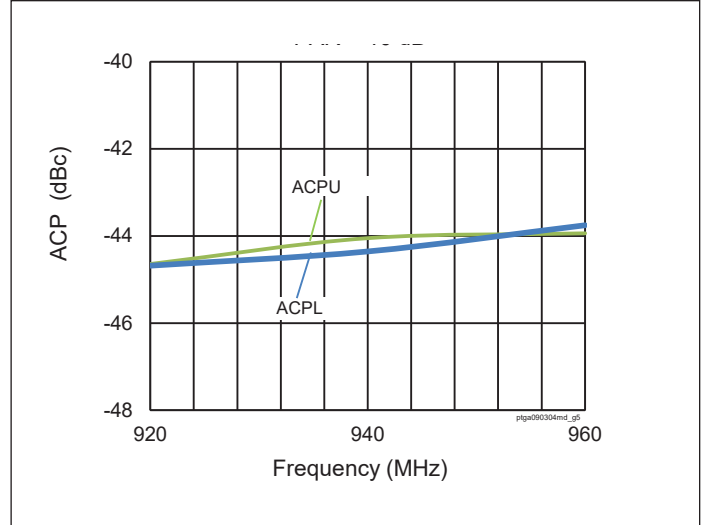
**Figure 2.** Single-carrier WCDMA Drive-up

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1} = 34\text{ mA}$ ,  $I_{DQ2} = 144\text{ mA}$ ,  
 $f = 960\text{ MHz}$ , 3GPP WCDMA signal,  
 PAR = 10 dB, 3.84 MHz BW



**Figure 3.** Single-carrier WCDMA Broadband Performance

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  
 $P_{OUT} = 35.9\text{ dBm}$ , 3GPP WCDMA signal,  
 PAR = 10 dB

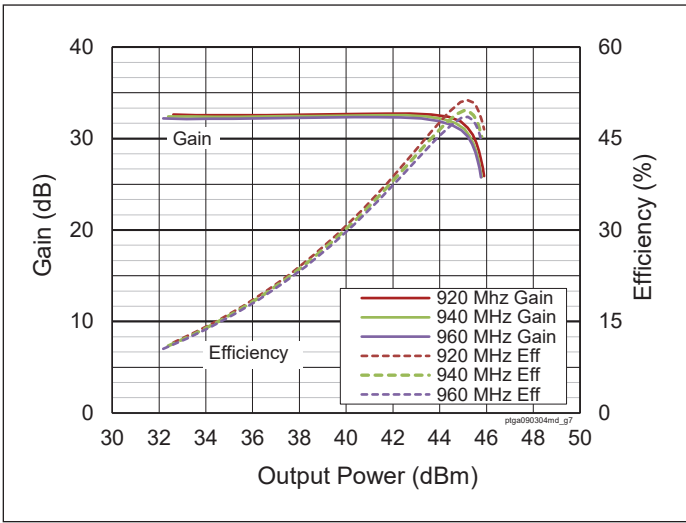


**Figure 4.** Single-carrier WCDMA Broadband Performance

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  
 $P_{OUT} = 35.9\text{ dBm}$ , 3GPP WCDMA signal,  
 PAR = 10 dB

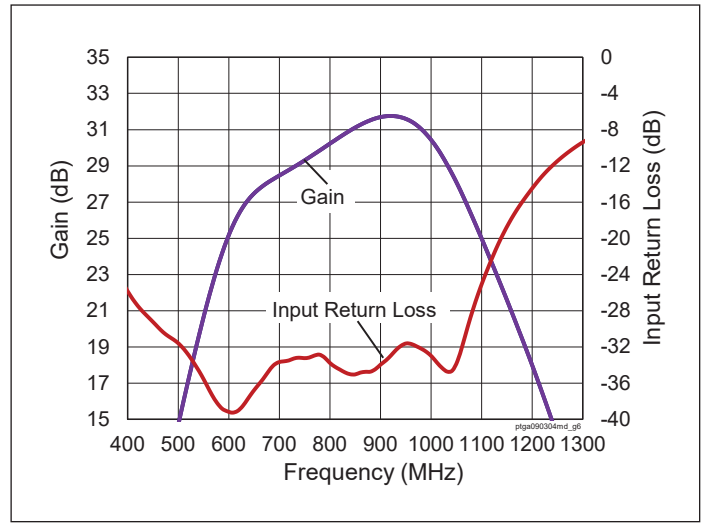


**Typical Performance, 920 – 960 MHz** (data taken in test fixture)



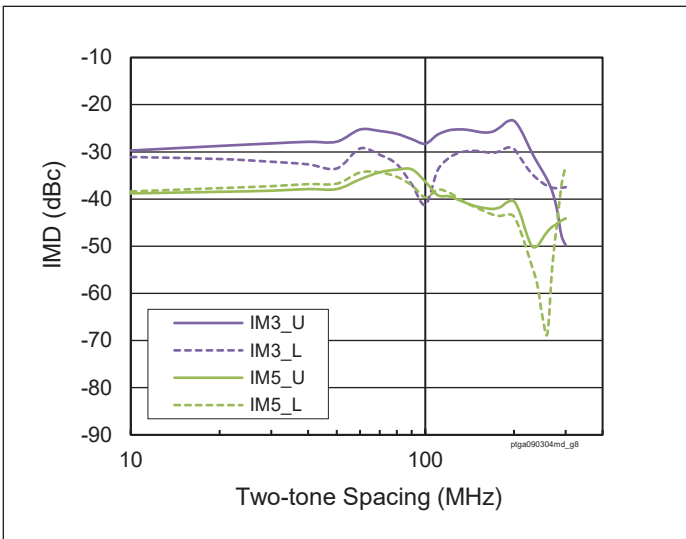
**Figure 5. CW Performance**

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$



**Figure 6. Small Signal CW Gain & Return Loss**

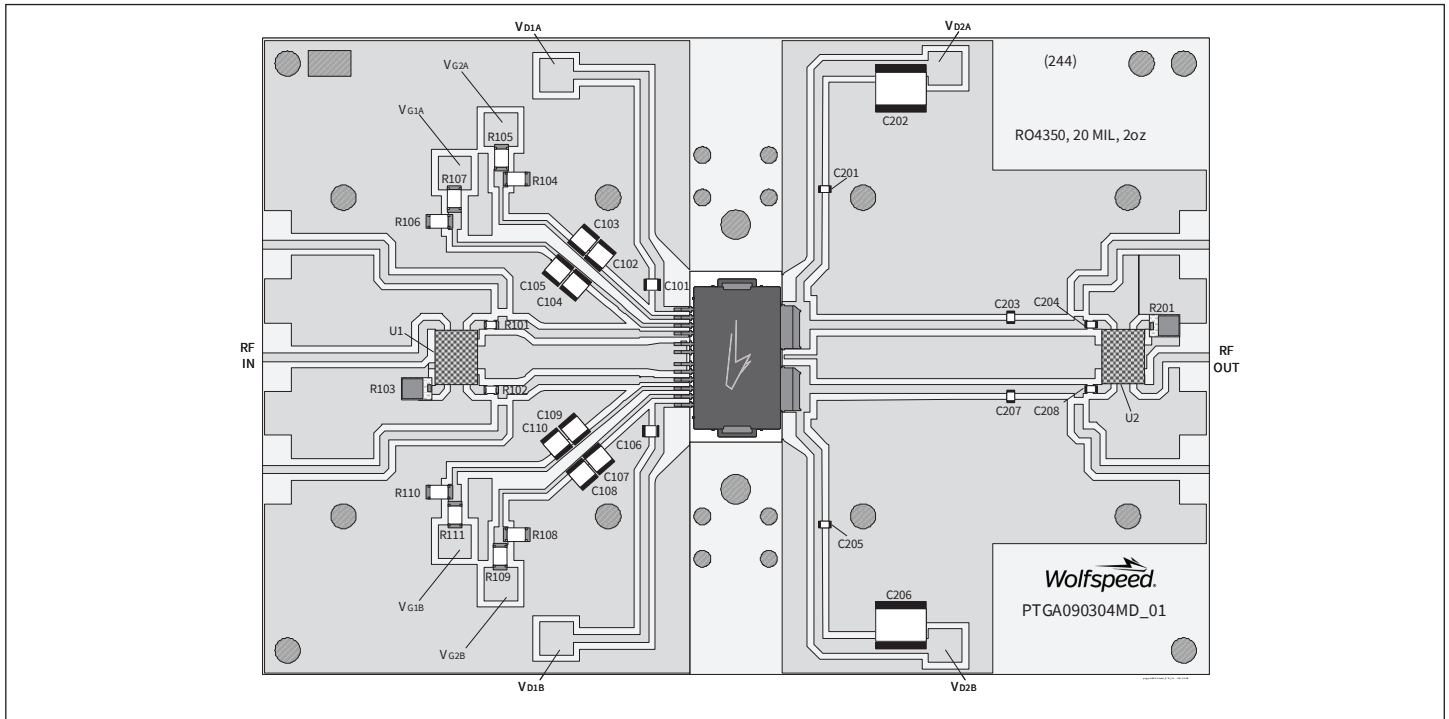
$V_{DD} = 50\text{ V}$ ,  $I_{DQ1} = 34\text{ mA}$ ,  $I_{DQ2} = 144\text{ mA}$



**Figure 7. IMD versus two-tone spacing**

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  
 $(f_1+f_2)/2 = \text{Center Frequency of } 940\text{ MHz}$

## Evaluation Board, 920 – 960 MHz



Reference circuit assembly diagram (not to scale)

|                              |   |
|------------------------------|---|
| Evaluation Board Part Number | LTN/PTGA090304MD-V2   |
| PCB Information              | Rogers 4350, 0.508 mm [0.020"] thick, 2 oz. copper, $\epsilon_r = 3.66$ , $f = 920 - 960$ MHz |

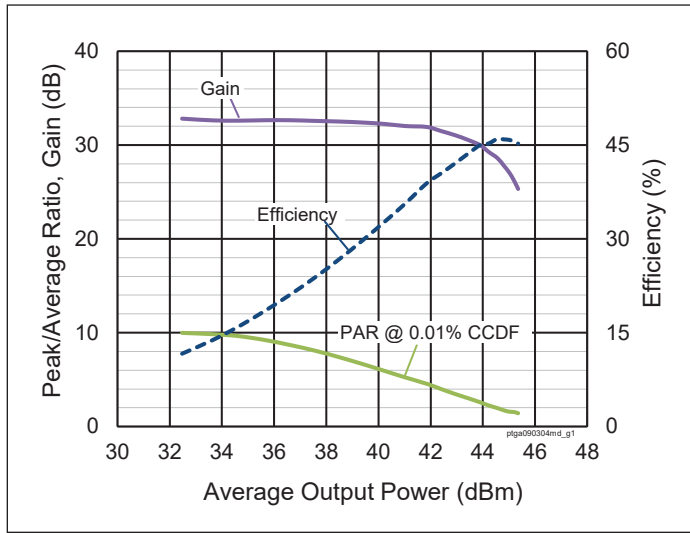
Find Gerber files for this test fixture on the WolfSpeed Web site at [www.wolfspeed.com/RF](http://www.wolfspeed.com/RF)

## Components Information

| Component              | Description                  | Manufacturer                     | P/N                 |
|------------------------|------------------------------|----------------------------------|---------------------|
| C101, C106             | Capacitor, 0.1 $\mu$ F       | TDK Corporation                  | C3216X7R2A104M160AA |
| C102, C104, C107, C109 | Capacitor, 100 V, 10 $\mu$ F | Murata Electronics North America | GRM32EC72A106KE05L  |
| C103, C105, C108, C110 | Capacitor, 4.7 $\mu$ F       | Murata Electronics North America | GRM32ER71H475KA88L  |
| C201, C204, C205, C208 | Capacitor, 100 pF            | ATC                              | ATC800A101JT250T    |
| C202, C206             | Capacitor, 100 V, 10 $\mu$ F | TDK Corporation                  | C5750X7S2A106M230KB |
| C203, C207             | Capacitor, 0.1 pF            | ATC                              | ATC800A0R1CT250T    |
| R101, R102             | Resistor, 0 ohms             | Panasonic Electronic Components  | ERJ-3GEY0R00V       |
| R103, R201             | Resistor, 50 ohms            | Anaren                           | C8A50Z4A            |
| R104, R106, R108, R110 | Resistor, 4.3K ohms          | Panasonic Electronic Components  | ERJ-8GEYJ432V       |
| R105, R107, R109, R111 | Resistor, 1K ohms            | Panasonic Electronic Components  | ERJ-8GEYJ102V       |
| U1, U2                 | Hybrid coupler               | Anaren                           | X3C07P1-03S         |

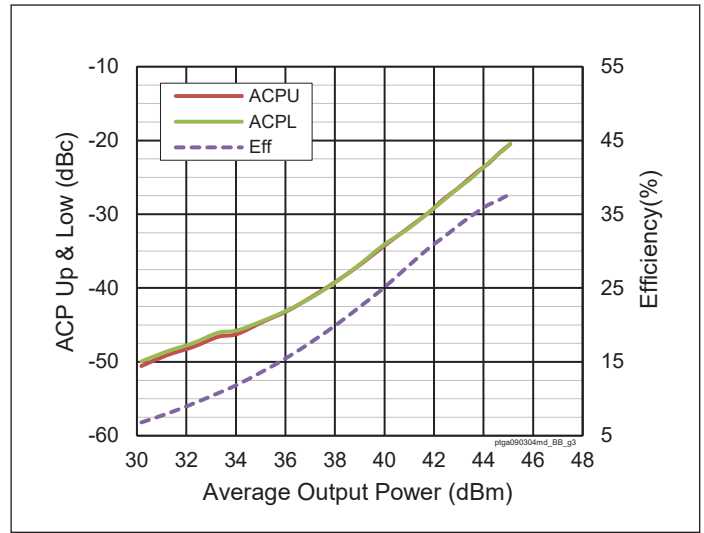


**Typical Broadband Performance, 575 – 960 MHz** (data taken in test fixture)



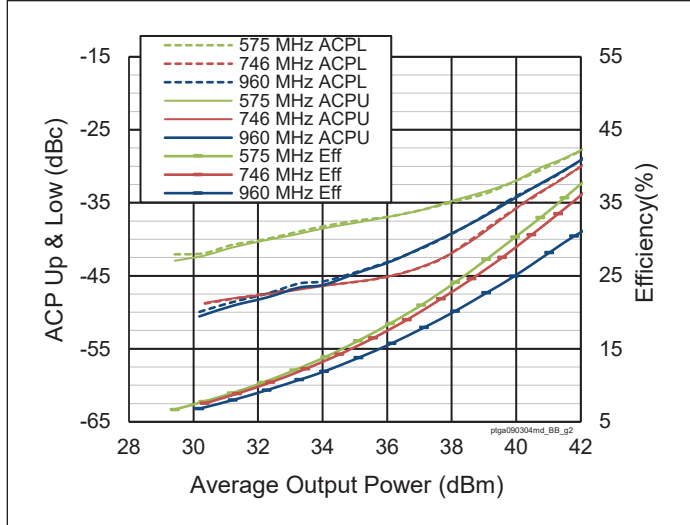
**Figure 8.** Single-carrier WCDMA Drive-up

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  
 $f = 960\text{ MHz}$ , 3GPP WCDMA signal,  
 PAR = 10 dB, 3.84 MHz BW



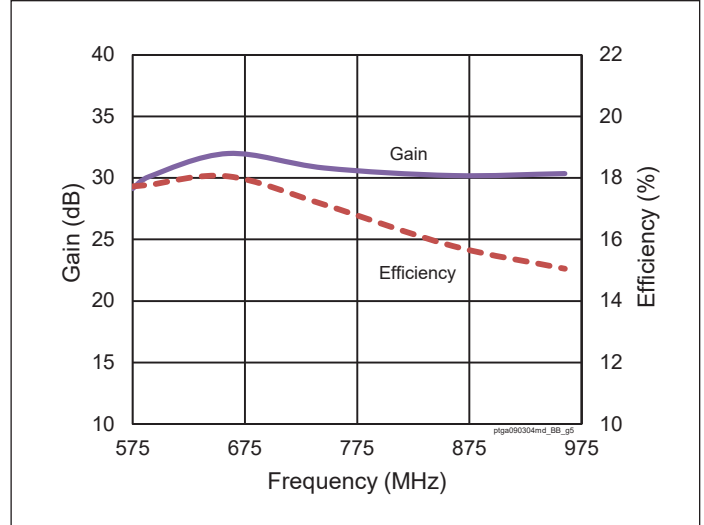
**Figure 9.** Single-carrier WCDMA Drive-up

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1} = 34\text{ mA}$ ,  $I_{DQ2} = 144\text{ mA}$ ,  
 $f = 960\text{ MHz}$ , 3GPP WCDMA signal,  
 PAR = 10 dB, 3.84 MHz BW



**Figure 10.** Single-carrier WCDMA 3GPP Drive-up

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  
 $f = 575\text{--}960\text{ MHz}$ , 3GPP WCDMA signal,  
 PAR = 10 dB, BW = 3.84 MHz

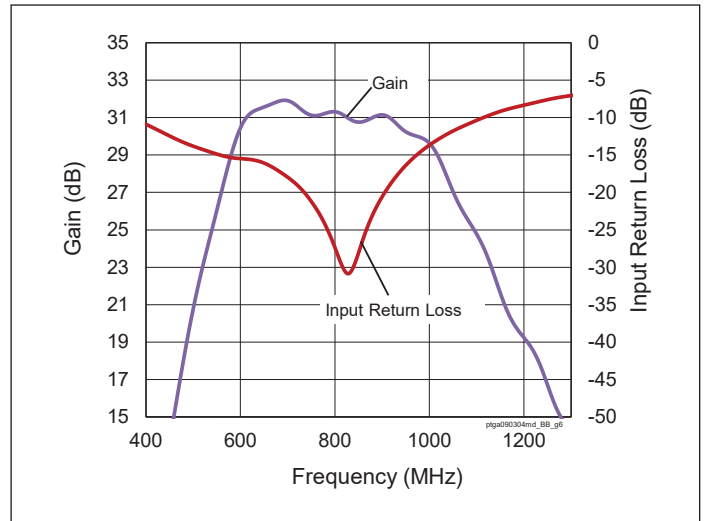
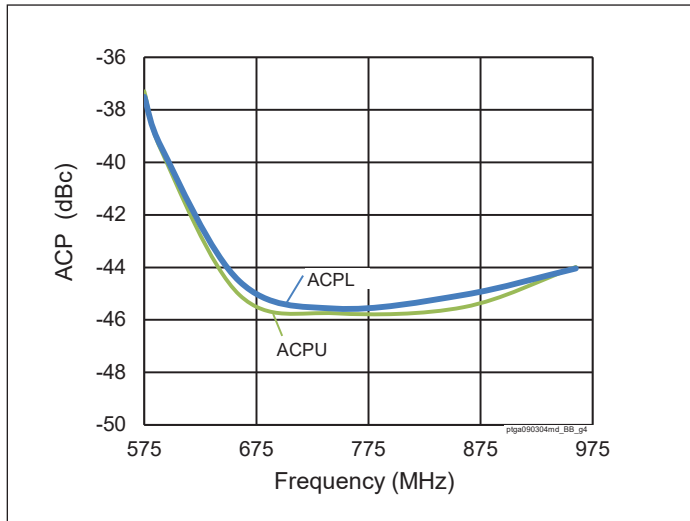


**Figure 11.** Single-carrier WCDMA Broadband Performance

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  
 $P_{OUT} = 35.9\text{ dBm}$ , 3GPP WCDMA signal,  
 PAR = 10 dB



**Typical Broadband Performance, 575 – 960 MHz** (data taken in test fixture)



**Figure 12.** Single-carrier WCDMA Broadband Performance

**Figure 6.** Small Signal CW Gain & Input Return Loss

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1M} = 34\text{ mA}$ ,  $I_{DQ2M} = 144\text{ mA}$ ,  
 $P_{OUT} = 35.9\text{ dBm}$ , 3GPP WCDMA signal,  
 PAR = 10 dB

$V_{DD} = 50\text{ V}$ ,  $I_{DQ1} = 34\text{ mA}$ ,  $I_{DQ2} = 144\text{ mA}$

**Load Pull Performance**

CW signal: 50 V,  $I_{DQ} = 17\text{ mA}$ , 72 mA

|            |           | $P_{1dB}$        |           |                 |               |         |            |           |                 |               |         |
|------------|-----------|------------------|-----------|-----------------|---------------|---------|------------|-----------|-----------------|---------------|---------|
|            |           | Max Output Power |           |                 |               |         | Max PAE    |           |                 |               |         |
| Freq [MHz] | $Z_s$ [W] | $Z_l$ [W]        | Gain [dB] | $P_{OUT}$ [dBm] | $P_{OUT}$ [W] | PAE [%] | $Z_l$ [W]  | Gain [dB] | $P_{OUT}$ [dBm] | $P_{OUT}$ [W] | PAE [%] |
| 575        | 50+j0.00  | 29.6+j22.6       | 30.0      | 42.9            | 19.3          | 61.6    | 13.6+j32.8 | 34.0      | 40.4            | 10.9          | 72.5    |
| 746        | 50+j0.00  | 20.8+j18.8       | 31.3      | 43.1            | 20.4          | 57.1    | 9+j23.5    | 34.2      | 41.0            | 12.5          | 66.9    |
| 920        | 50+j0.00  | 13.8+j16.6       | 31.6      | 43.1            | 20.6          | 56.3    | 7+j20.3    | 34.4      | 41.3            | 13.4          | 68.6    |
| 940        | 50+j0.00  | 15.4+j16.8       | 31.4      | 43.1            | 20.5          | 55.3    | 5.8+j20    | 35.2      | 40.5            | 11.3          | 70.1    |
| 960        | 50+j0.00  | 15.6+j16.8       | 31.7      | 43.2            | 20.8          | 57.6    | 6+j20      | 35.8      | 40.7            | 11.8          | 77.5    |

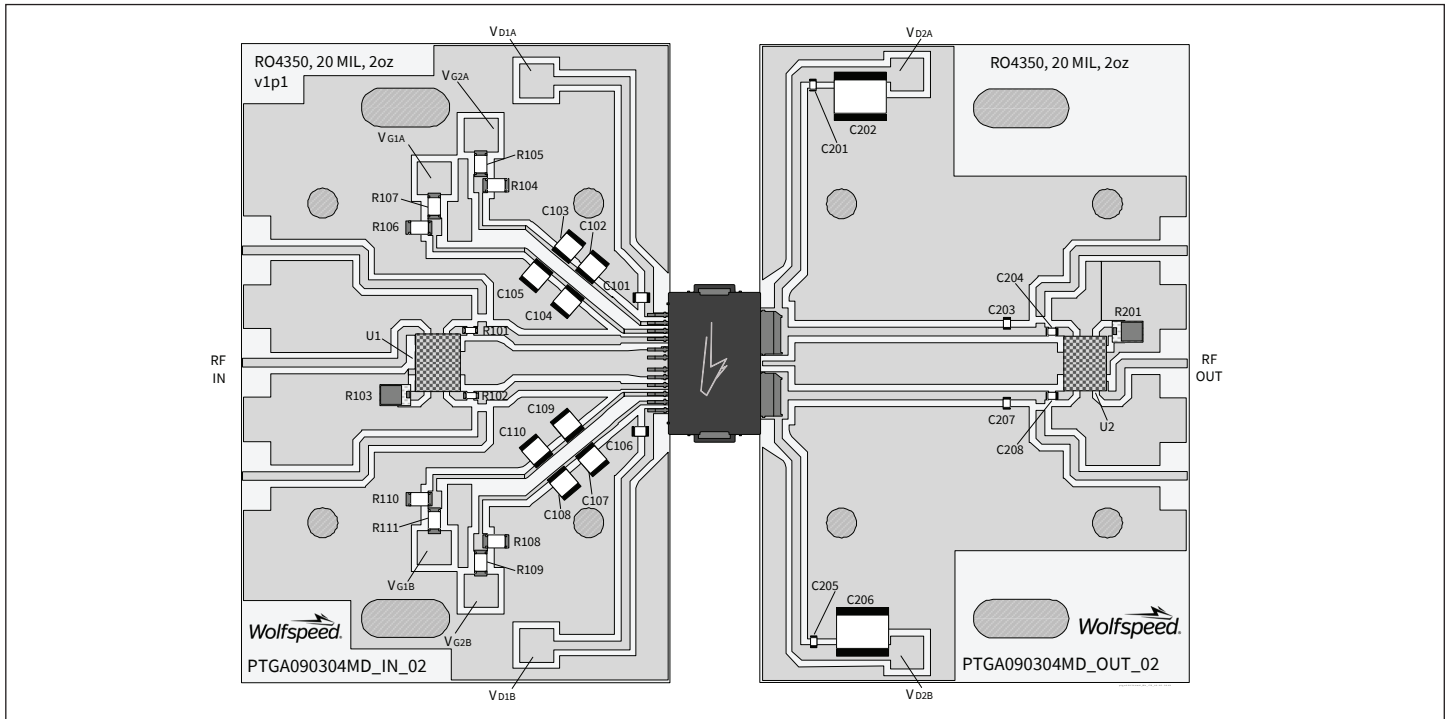
|            |           | $P_{3dB}$        |           |                 |               |         |           |           |                 |               |         |
|------------|-----------|------------------|-----------|-----------------|---------------|---------|-----------|-----------|-----------------|---------------|---------|
|            |           | Max Output Power |           |                 |               |         | Max PAE   |           |                 |               |         |
| Freq [MHz] | $Z_s$ [W] | $Z_l$ [W]        | Gain [dB] | $P_{OUT}$ [dBm] | $P_{OUT}$ [W] | PAE [%] | $Z_l$ [W] | Gain [dB] | $P_{OUT}$ [dBm] | $P_{OUT}$ [W] | PAE [%] |
| 575        | 50+j0.00  | 29.2+j20.1       | 27.7      | 43.5            | 22.3          | 60.8    | 14+j32.8  | 31.9      | 41.0            | 12.5          | 71.2    |
| 746        | 50+j0.00  | 18.1+j16.5       | 29.3      | 43.8            | 24.0          | 58.1    | 9.5+j23.9 | 32.1      | 41.6            | 14.5          | 65.4    |
| 920        | 50+j0.00  | 14.2+j16.6       | 29.5      | 43.8            | 24.1          | 56.4    | 6.6+j20   | 32.5      | 41.8            | 15.0          | 66.2    |
| 940        | 50+j0.00  | 15.7+j16.5       | 29.3      | 43.8            | 23.9          | 54.9    | 5.4+j20   | 33.4      | 40.9            | 12.4          | 68.1    |
| 960        | 50+j0.00  | 15.8+j16.5       | 29.6      | 43.9            | 24.5          | 57.5    | 6+j20     | 33.8      | 41.3            | 13.5          | 75.5    |

\*Please note max PAE contours not closed





**Evaluation Board, 575 – 960 MHz**



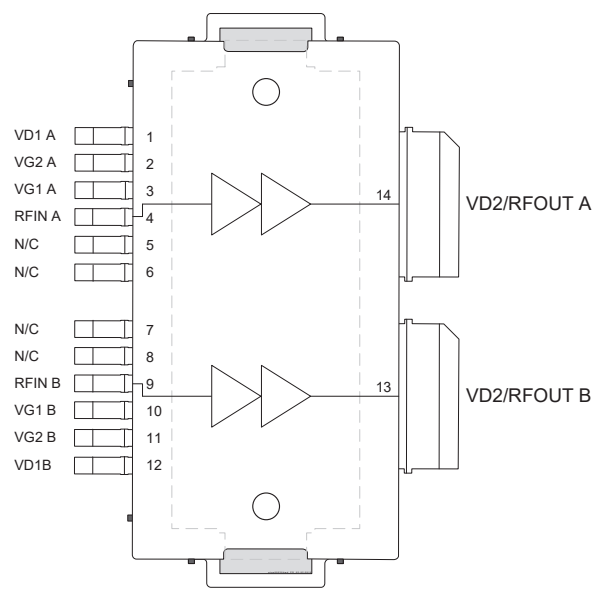
Reference circuit assembly diagram (not to scale)

|                              |   |
|------------------------------|---|
| Evaluation Board Part Number | LTN/PTGA090304MD-E3   |
| PCB Information              | Rogers 4350, 0.508 mm [0.020"] thick, 2 oz. copper, $\epsilon_r = 3.66$ , $f = 575 - 960$ MHz |

Find Gerber files for this test fixture on the Wolfstreak Web site at [www.wolfstreak.com/RF](http://www.wolfstreak.com/RF)

**Reference Circuit, 575 – 960 MHz** (cont.)**Components Information**

| Component              | Description                  | Manufacturer                     | P/N                 |
|------------------------|------------------------------|----------------------------------|---------------------|
| <b>Input</b>           |                              |                                  |                     |
| C101, C106             | Capacitor, 0.1 $\mu$ F       | TDK Corporation                  | C3216X7R2A104M160AA |
| C102, C104, C107, C109 | Capacitor, 10 $\mu$ F, 100 V | Murata Electronics North America | GRM32EC72A106KE05L  |
| C103, C105, C108, C110 | Capacitor, 4.7 $\mu$ F       | Murata Electronics North America | GRM32ER71H475KA88L  |
| R101, R102             | Resistor, 0.0 ohms           | Panasonic Electronic Components  | ERJ-3GEY0R00V       |
| R103                   | Resistor, 50 ohms            | Anaren                           | C8A50Z4A            |
| R104, R106, R108, R110 | Resistor, 4.3K ohms          | Panasonic Electronic Components  | ERJ-8GEYJ432V       |
| R105, R107, R109, R111 | Resistor, 1K ohms            | Panasonic Electronic Components  | ERJ-8GEYJ102V       |
| U1                     | Hybrid Coupler               | Anaren                           | X3C07P1-03S         |
| <b>Output</b>          |                              |                                  |                     |
| C201, C204, C205, C208 | Capacitor, 100 pF            | ATC                              | ATC800A101JT250T    |
| C202, C206             | Capacitor, 10 $\mu$ F, 100 V | TDK Corporation                  | C5750X7S2A106M230KB |
| C203, C207             | Capacitor, 1.1 pF            | ATC                              | ATC800A1R1CT250T    |
| R201                   | Resistor, 50 ohms            | Anaren                           | C8A50Z4A            |
| U2                     | Hybrid Coupler               | Anaren                           | X3C07P1-03S         |

**Pinout Diagram** (top view)

Source: plated copper heat slug on backside of package

Lead connections for PTGA090304MD



**Package Outline Specifications – Package PG-HB1DSO-14-4**

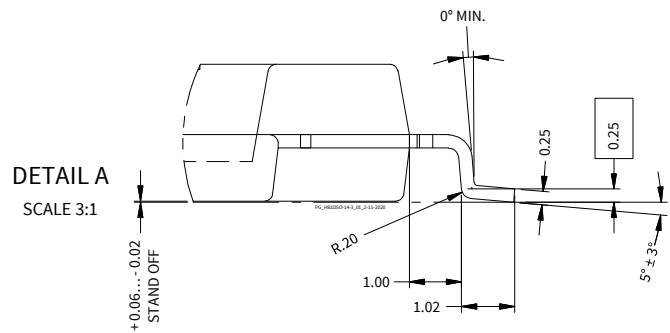
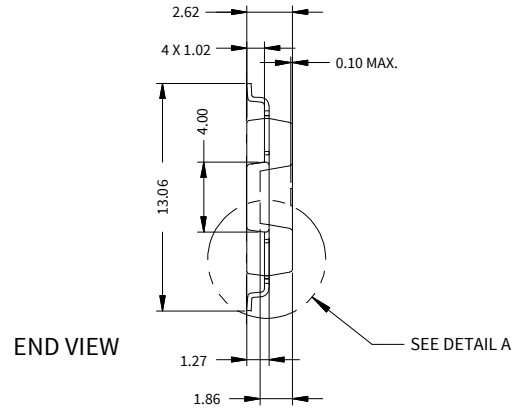
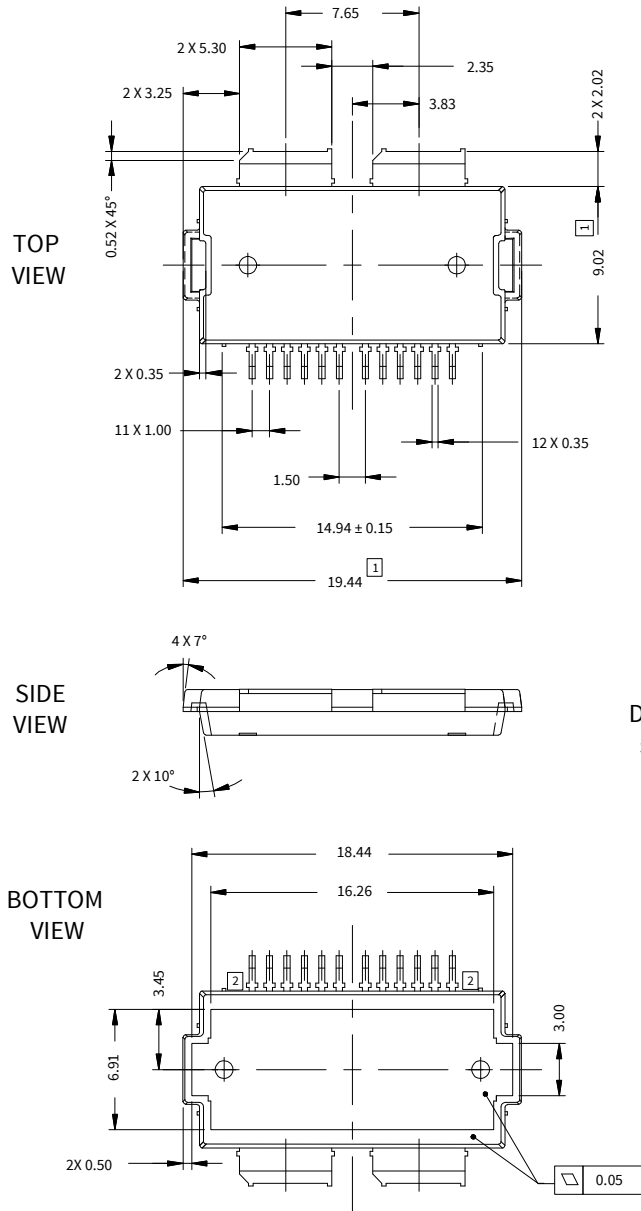


Diagram Notes—unless otherwise specified:

1. Mold/Dam Bar/Metal protusion of 0.30 mm max per side not included.
2. Metal protusion are connected to source and shall not exceed 0.10 mm max.
3. Fillets and radii: all radii are 0.3 mm max.
4. Interpret dimensions and tolerances per ISO 8015.
5. Dimensions are mm.
6. All tolerances ± 0.1 mm unless specified otherwise.
7. All metal surfaces are tin-plated, except area of cut.
8. Lead thickness: 0.25 mm.

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## Notes & Disclaimer

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