



Preliminary Product Information
December 1997 (1 of 6)

1.85 to 1.91 GHz 5V, 31 dBm, PCS/PCN Power Amplifier

Features

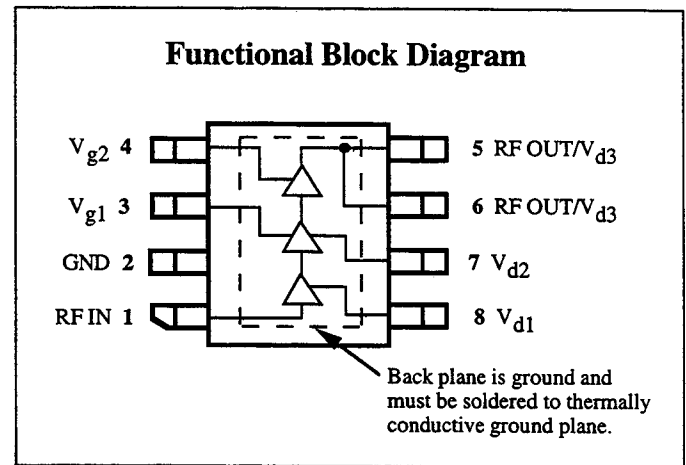
- ❑ 35% Linear Power Added Efficiency
- ❑ 31 dBm Output Power (IS-136 TDMA)
- ❑ 29 dBm Output Power (J-STD-18 CDMA)
- ❑ 32 dB Gain
- ❑ Tested Under Digital Modulation
- ❑ Low Cost SO-8 Surface Mount Package

Applications

- ❑ PCS Handsets
- ❑ PCS Base Stations
- ❑ Wireless Local Loop Subscriber Units
- ❑ 1.6 GHz Satellite Subscriber Units

Description

The CMM1333 is a 5 V linear power amplifier intended for use in PCS handsets, wireless local loop subscriber units and PCS base stations. As a pin-compatible member of the new **Triniti DX™** amplifier family, the CMM1333 offers maximum performance and flexibility. The amplifier can be biased to support the requirements of PCS-1900, IS-136 (TDMA), J-STD-18 (CDMA) or DCS-1800 systems.



The CMM1333 is packaged in a low-cost, space efficient SO-8 power package that gives excellent electrical stability and thermal handling performance with a R_{θ} of less than 18°C/W . The part is designed to require minimal external circuitry for bias and matching, simplifying design and keeping board space and cost to a minimum. Through matching adjustment, equivalent performance can also be achieved for the 1.93 to 1.99 GHz PCS bands as well as the 1.6 GHz satellite bands.

Absolute Maximum Ratings

| Parameter | Rating | Parameter | Rating | Parameter | Rating |
|----------------------------|----------|---------------------|-----------------|-----------------------|------------------|
| Drain Voltage ($+V_d$) | +8.0 V* | Power Dissipation | 5 W | Operating Temperature | -40°C to +100°C |
| Drain Current (I_d) | 1.8 A | Thermal Resistance | 18°C/W | Channel Temperature | 175°C |
| RF Input Power | +15 dBm* | Storage Temperature | -65°C to +150°C | Soldering Temperature | 260°C for 5 Sec. |
| DC Gate Voltage ($-V_g$) | -4.0 V* | | | | |

* Max ($+V_d$) and ($-V_g$) under linear operation. Max potential difference across the device in RF compression ($2V_d + |-V_g|$) not to exceed the minimum breakdown voltage (V_{br}) of +18V.

Recommended Operating Conditions

| Parameter | Typ | Units | Parameter | Typ | Units |
|--------------------------|------------|-------|----------------------------------|------------|-------|
| Drain Voltage ($+V_d$) | 4.5 to 5.1 | Volts | Operating Temperature (PC Board) | -30 to +80 | °C |

Electrical Characteristics

Unless otherwise specified, the following specifications are guaranteed at room temperature with drain voltage ($+V_d$) = 4.8 V in Celeritek test fixture.

| Parameter | Condition | Min | Typ | Std Deviation | Max | Units |
|--|------------------------------------|------|------|---------------|------|-------|
| Frequency Range | | 1.85 | | | 1.91 | GHz |
| Gain | @ Digital power output | 29 | 32 | 0.95 | | dB |
| Power Output | Meets IS-136 TDMA mask | 30 | 31 | 0.31 | | dBm |
| | Meets J-STD-18 CDMA mask | 28.5 | 29 | | | dBm |
| Harmonics | 2nd @ Digital power output | | -35 | | -30 | dBc |
| | 3rd @ Digital power output | | -40 | | -35 | dBc |
| Noise Figure | | | 4.5 | 0.2 | 5.0 | dB |
| Return Loss | | | 10 | | | dB |
| Efficiency | Pout IS-136 TDMA | 30 | 35 | 1.1 | | % |
| | Pout J-STD-18 CDMA | 27 | 30 | | | % |
| Positive Supply Current (I_d) | Pout IS-136 TDMA | | 600 | 20 | | mA |
| | Pout J-STD-18 CDMA | | 500 | 20 | | mA |
| Quiescent Current (I_q) [†] | No RF | | 350 | 20 | | mA |
| Negative Supply Current ($-I_g$) | Includes external resistor divider | | 1.1 | 0.2 | 2.0 | mA |
| Negative Supply Voltage ($-V_g$) | Into external resistor divider | -1.3 | -1.7 | 0.16 | -2.2 | V |

[†] For dynamic bias applications see Typical Performance chart on page 4.

Small Signal S-Parameters (Deimbed from external matching circuitry)

4.8 V, 500 mA [Output stage = 330 mA, Driver stages = 170 mA]

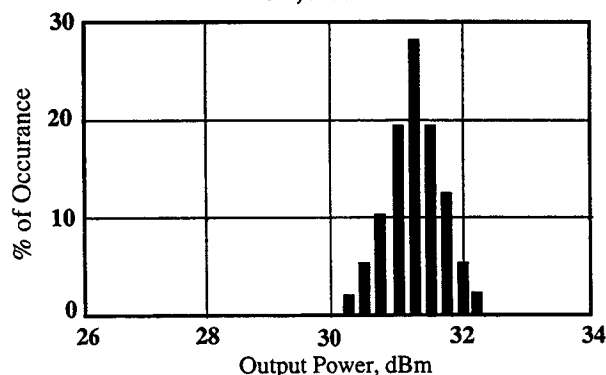
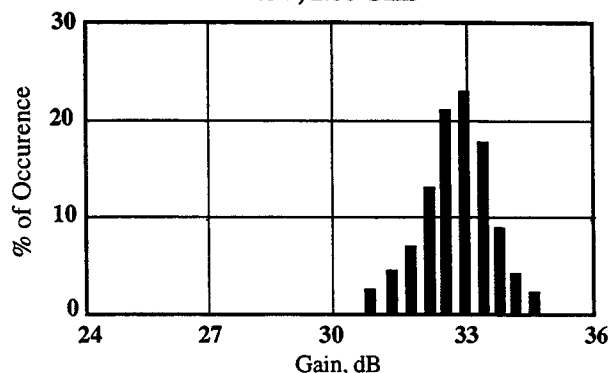
| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|--------|-----------------|--------|-----------------|-------|-----------------|--------|
| | Mag | ANG | Mag | ANG | Mag | ANG | Mag | ANG |
| 0.6 | 0.99 | -42.2 | 0.53 | 12.1 | 0.001 | 167.0 | 0.56 | -173.4 |
| 1.0 | 0.97 | -75.7 | 0.57 | 30.3 | 0.002 | -63.1 | 0.76 | 168.7 |
| 1.3 | 0.92 | -101.8 | 13.34 | -34.2 | 0.002 | 71.1 | 0.71 | 174.2 |
| 1.4 | 0.89 | -111.9 | 26.51 | -78.8 | 0.003 | 126.2 | 0.86 | 176.1 |
| 1.5 | 0.80 | -126.0 | 39.98 | -131.1 | 0.003 | 72.7 | 1.04 | 164.2 |
| 1.6 | 0.64 | -141.7 | 45.29 | 179.6 | 0.002 | 65.0 | 1.03 | 148.4 |
| 1.7 | 0.42 | -157.6 | 45.01 | 138.3 | 0.003 | 3.7 | 0.91 | 138.8 |
| 1.8 | 0.19 | -171.5 | 42.38 | 101.8 | 0.001 | -10.4 | 0.82 | 132.9 |
| 1.9 | 0.02 | -90.9 | 37.99 | 69.4 | 0.002 | 14.8 | 0.78 | 130.0 |
| 2.0 | 0.14 | -32.9 | 33.02 | 40.8 | 0.002 | 17.6 | 0.75 | 126.7 |
| 2.1 | 0.21 | -36.5 | 28.20 | 15.5 | 0.002 | 85.2 | 0.72 | 123.0 |
| 2.2 | 0.25 | -40.3 | 24.10 | -6.8 | 0.001 | -3.0 | 0.72 | 122.0 |
| 3.0 | 0.28 | -69.0 | 7.29 | -132.5 | 0.002 | 54.2 | 0.81 | 117.0 |
| 3.5 | 0.52 | -111.5 | 3.69 | 173.2 | 0.004 | 105.5 | 0.82 | 121.7 |
| 4.0 | 0.73 | -118.0 | 2.19 | 133.6 | 0.007 | 95.2 | 0.69 | 112.3 |

Small Signal S-Parameters (Deimbed from external matching circuitry)

4.8 V, 300 mA [Output stage = 184 mA, Driver stages = 116 mA]

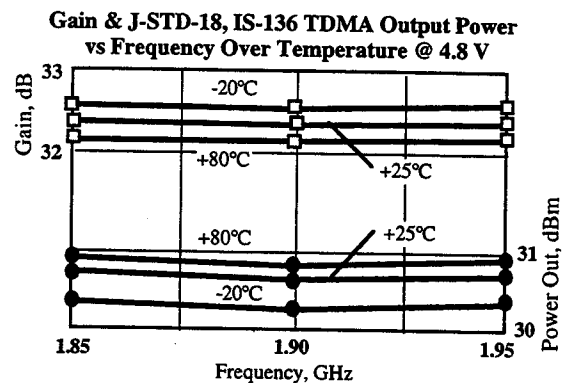
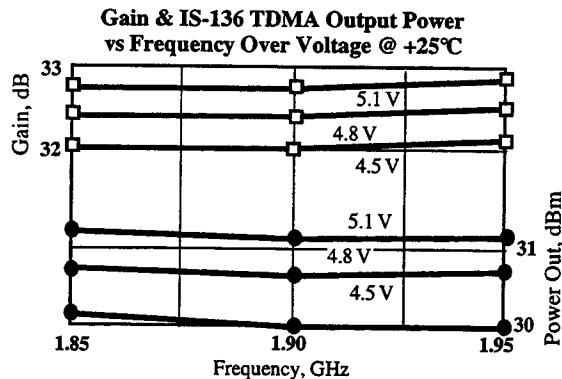
| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|--------|-----------------|--------|-----------------|--------|-----------------|--------|
| | Mag | ANG | Mag | ANG | Mag | ANG | Mag | ANG |
| 0.6 | 0.99 | -42.5 | 0.46 | 9.0 | 0.001 | 65.1 | 0.55 | -169.4 |
| 1.0 | 0.97 | -75.4 | 0.53 | 33.2 | 0.001 | 129.2 | 0.73 | 170.3 |
| 1.3 | 0.92 | -101.5 | 11.44 | -32.2 | 0.002 | 118.7 | 0.69 | 177.3 |
| 1.4 | 0.88 | -112.3 | 22.43 | -76.1 | 0.002 | 112.4 | 0.84 | 179.2 |
| 1.5 | 0.80 | -126.0 | 33.80 | -127.3 | 0.004 | 100.9 | 1.02 | 167.1 |
| 1.6 | 0.64 | -141.1 | 38.86 | -175.6 | 0.003 | 75.7 | 1.02 | 152.0 |
| 1.7 | 0.42 | -156.7 | 39.39 | 143.7 | 0.003 | 40.8 | 0.92 | 141.9 |
| 1.8 | 0.20 | -169.7 | 37.60 | 107.4 | 0.001 | -31.6 | 0.84 | 135.8 |
| 1.9 | 0.02 | -115.9 | 34.50 | 74.9 | 0.002 | -7.9 | 0.78 | 131.5 |
| 2.0 | 0.14 | -30.1 | 30.55 | 45.8 | 0.001 | -39.6 | 0.74 | 128.0 |
| 2.1 | 0.21 | -38.3 | 26.51 | 20.1 | 0.002 | 2.9 | 0.73 | 123.7 |
| 2.2 | 0.25 | -41.6 | 22.82 | -2.8 | 0.001 | -140.5 | 0.71 | 122.6 |
| 3.0 | 0.27 | -64.9 | 6.91 | -132.7 | 0.005 | 113.2 | 0.80 | 118.2 |
| 3.5 | 0.52 | -110.1 | 3.46 | 171.9 | 0.001 | 56.3 | 0.82 | 122.4 |
| 4.0 | 0.73 | -117.5 | 2.03 | 132.5 | 0.007 | 41.9 | 0.69 | 113.6 |

Note: Electronic copies of the S-Parameters above can be obtained by contacting the factory.

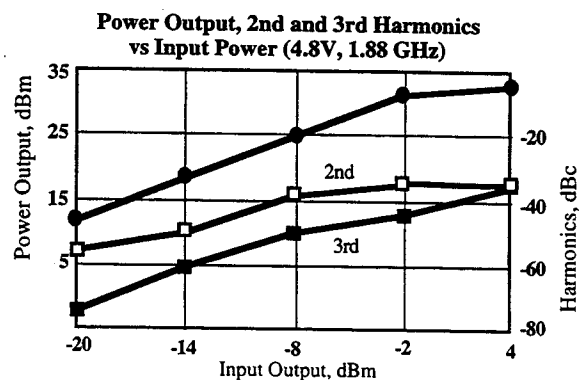
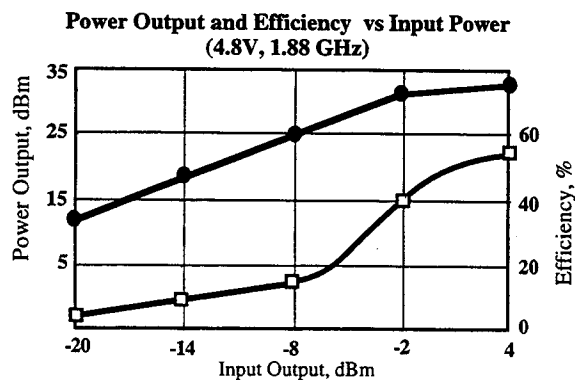
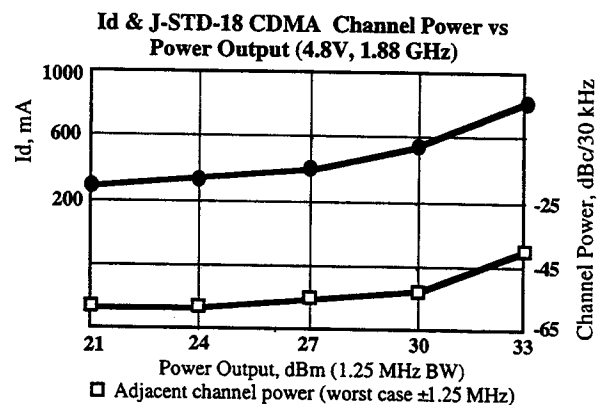
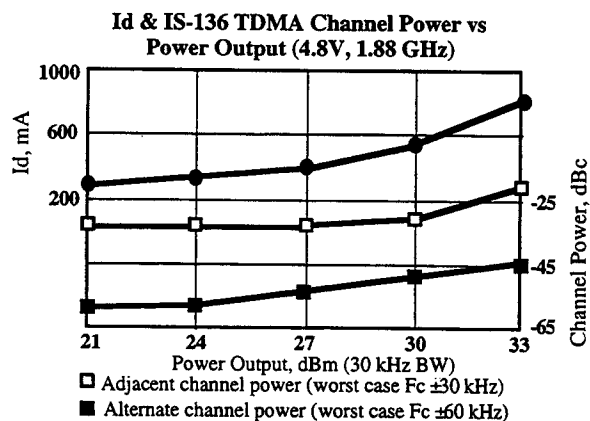
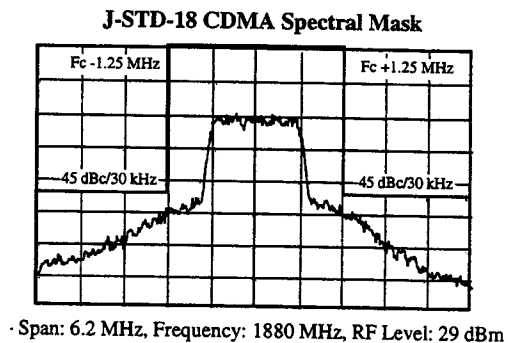
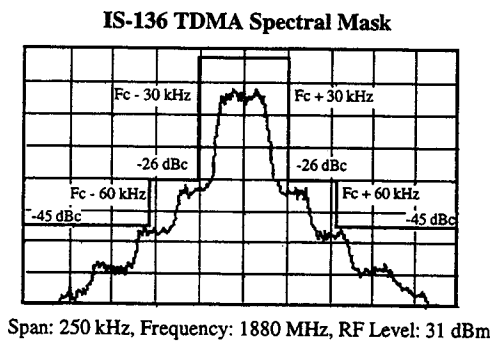
Typical Performance**Distribution of IS-136 TDMA Output Power**
4.8V, 1.88 GHz**Distribution of Gain**
4.8V, 1.88 GHz



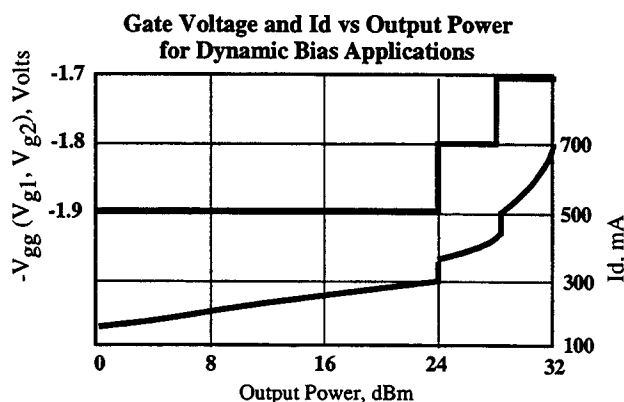
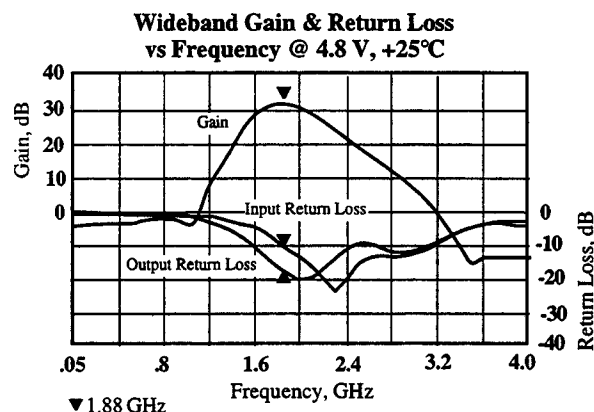
Typical Performance



Note: As the device is temperature compensated, a design guideline of ± 0.008 dB/°C is recommended.



Typical Performance (Continued)



Application Information

The CMM1333 is a three stage amplifier that requires a positive and negative supply voltage for proper operation. It is essential when turning on the device that the negative supply be applied before the positive supply. When turning the device off, the positive supply should be removed before the negative supply is removed.

The CMM1333 can be operated over a range of supply voltages and bias points. It is important that the maximum power dissipation of the package be observed at all times and that the maximum voltage across the device, as specified, is not exceeded.

Design Considerations

Biasing A negative voltage is needed to bias the 3 stage GaAs FET power amplifier. The first stage bias is controlled internally via the gate bias to the second stage (V_{g1}). The output stage is controlled via V_{g2} .

The positive supply voltage is applied to pins 5, 6 and 7. The negative voltage supply should be adjusted to achieve the typical quiescent current specified prior to characterization. See performance curve above for use in dynamic bias applications.

Matching Circuits Input and output matching circuits are required. The CMM1333 S-Parameters are on page 2, and the evaluation board schematic and layout are on page 5. The test board is designed to be used at multiple frequencies. The matching elements for proper operation at 1.85– 1.91 GHz are described on page 5.

Two shunt capacitors ($C7$ & $C15$) are used to match the output.

Note: Circuit board 8217 is a multiple-use test board. The portions of the board that are used with the CMM1333 are

shown as solid traces on the board layout drawing on Page 5. The interface/connection points to the evaluation board are shown. These connection points may not be labeled identically on Celeritek's PB-CMM1333 evaluation board. Contact the factory for support in translating the external match to a specific application.

Supply Ramping To obtain the necessary power ramp, supply side switching should be used. Drain voltages should be tied together and ramped to produce the required power vs. time response.

Modulation When biased as specified, the CMM1333 will achieve the required adjacent channel response for the digital PCS system specified. Celeritek tests each product under digital modulation to ensure correlation to customer applications.

S-Parameters The S-parameters shown in this data sheet are taken at a small signal bias. They do not apply at large signal conditions or when the device is biased for maximum efficiency. Electronic copies may be obtained by contacting the factory.

Thermal

1. The copper pad on the backside of the CMM1333 must be soldered to the ground plane.
2. All 8 leads of the package must be soldered to the appropriate electrical connection.
3. A large ground plane area with plated thru-holes as shown on the PCB layout should be used as a backside connection.

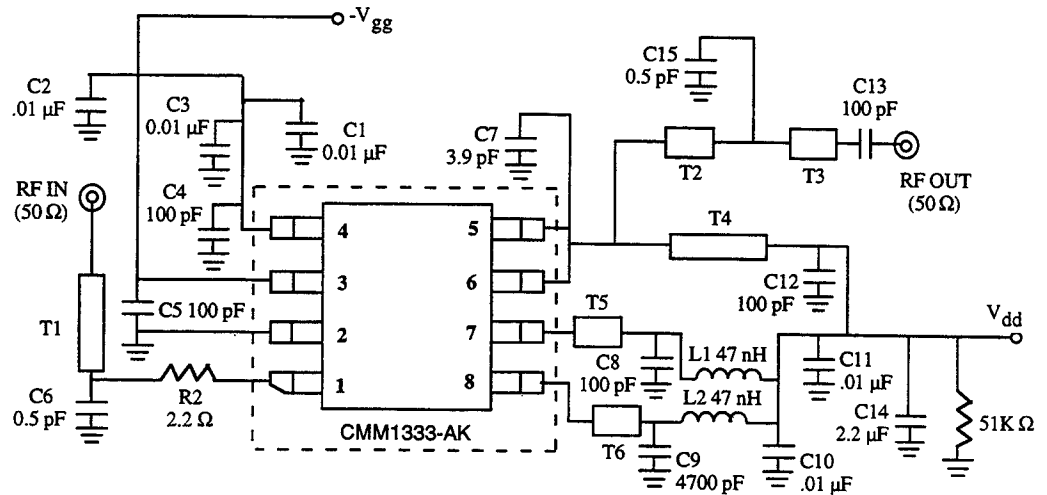
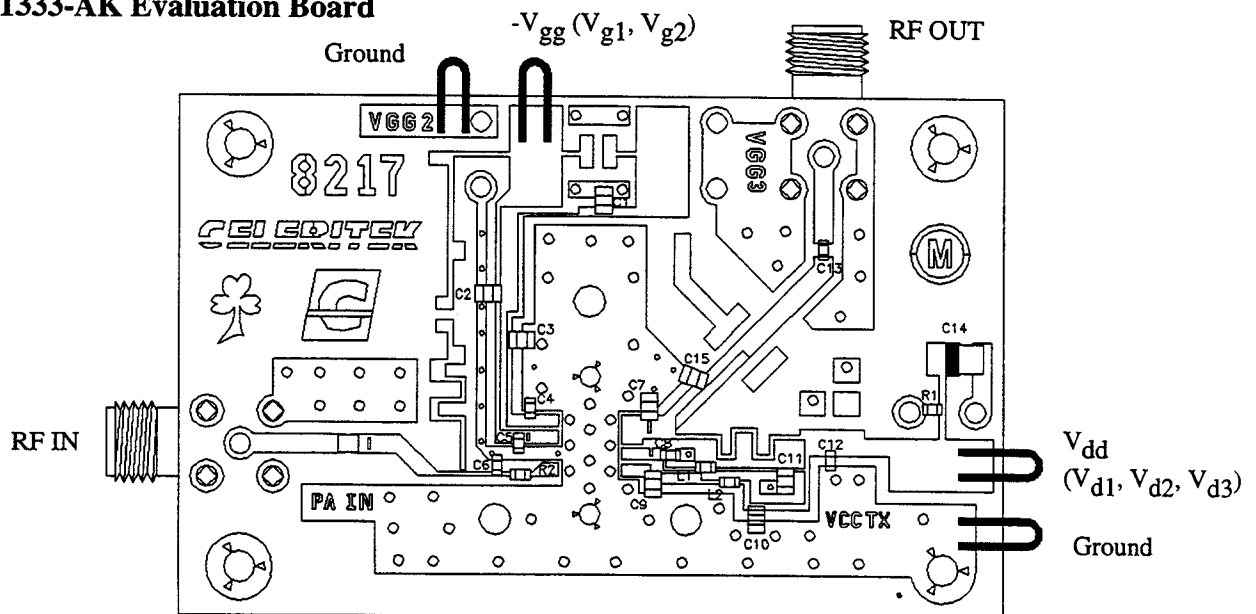
Contact the factory for a copy of a manufacturing application note containing more detailed information.

**Test Circuits****Evaluation Board Schematic**

Board substrate:
ER = 4.60
Thickness = 0.031 in.

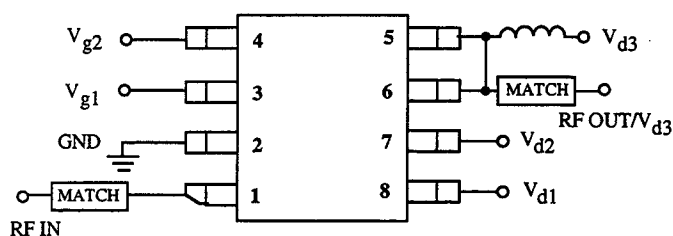
Transmission line electrical
lengths at 1.88 GHz.
(Dimensions in inches)

| Line | (W) | (L) | Z(Ω) | E(°) |
|------|------|------|------|------|
| T1 | .010 | .225 | 104 | 23 |
| T2 | .030 | .100 | 69 | 10 |
| T3 | .030 | .110 | 69 | 11 |
| T4 | .015 | .666 | 91 | 68 |
| T5 | .036 | .068 | 63 | 7 |
| T6 | .036 | .025 | 63 | 3 |

**PB-CMM1333-AK Evaluation Board****Evaluation Board Parts List**

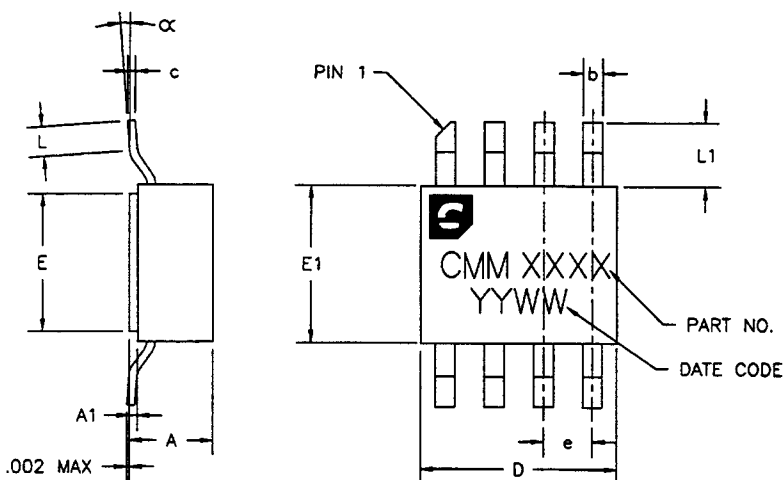
| Part Type | Reference Designator | Description | Manufacturer | Part Number |
|-----------|----------------------|------------------|--------------|------------------|
| Resistor | R2 | 2.2 Ω 0603 | Rohm | MCR03J 2R2 |
| Resistor | R1 | 51 K Ω 0603 | Rohm | MCR03J 513 |
| Capacitor | C14 | 2.2 μF Tantalum | Matsuo | 267M2002225M |
| Capacitor | C1, C2, C3, C10, C11 | 0.01 μF 0805 X7R | Rohm | MCH215 C103KK |
| Capacitor | C9 | 4700 pF 0805 X7R | Rohm | MCH215 C472KK |
| Capacitor | C15 | 0.5 pF 0805 NPO | Rohm | MCH215 AOR5CK |
| Capacitor | C7 | 3.9 pF 0805 | ATC | ATC100A3R9CP150X |
| Capacitor | C6 | 0.5 pF 0603 NPO | Rohm | MCH185A 0R5CK |
| Capacitor | C4, C5, C8, C12, C13 | 100 pF 0603 NPO | Rohm | MCH185A 101JK |
| Inductor | L1, L2 | 47 nH 0603 | Panasonic | ELJ-RC47NJF2 |

Connection Diagram and Pin Descriptions



| Pin # | Name | Description |
|-------|------------------------|--|
| 1 | RF IN | RF input (internally DC blocked) |
| 2 | GND | Ground |
| 3 | V _{g1} | Input and intermediate stage gate bias |
| 4 | V _{g2} | Output stage gate bias |
| 5 | RF OUT/V _{d3} | RF output and V _{d3} . External matching circuit required |
| 6 | RF OUT/V _{d3} | RF output and V _{d3} . External matching circuit required |
| 7 | V _{d2} | Intermediate stage drain bias |
| 8 | V _{d1} | Input stage drain bias |

Physical Dimensions



| DIMENSION | MINIMUM | NOMINAL | MAXIMUM |
|-----------|-------------|-------------|-------------|
| A | | .086[2.184] | .100[2.540] |
| A1 | .005[.1270] | .008[.2032] | .011[.2794] |
| b | .017[.4318] | .020[.5080] | .023[.5842] |
| c | .007[.1778] | .008[.2032] | .009[.2286] |
| D | .195[4.953] | .200[5.080] | .205[5.207] |
| E | .135[3.429] | .140[3.556] | .145[3.683] |
| E1 | .155[3.937] | .160[4.064] | .165[4.191] |
| e | | .050[1.270] | |
| L | .020[.5080] | | .040[1.016] |
| L1 | .055[1.397] | .065[1.651] | .075[1.905] |
| α | 0° | | 8° |

DIMENSIONS IN INCHES [MILLIMETERS]

Ordering Information

The CMM1333 is available in a surface mount SO-8 power package and devices are available in tape and reel.

Part Number for Ordering

CMM1333-AK-00S0

CMM1333-AK-00ST

CMM1333-AK-00T0

CMM1333-AK-00TT

PB-CMM1333-AK

Package

SO-8 surface mount power package for CDMA

SO-8 surface mount power package in tape and reel for CDMA

SO-8 surface mount power package for TDMA

SO-8 surface mount power package in tape and reel for TDMA

Evaluation Board with SMA connectors

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