GENERAL DESCRIPTION

The F2250 is a low insertion loss Voltage Variable RF Attenuator (VVA) designed for a multitude of wireless and other RF applications. This device covers a broad frequency range from 50MHz to 6000MHz. In addition to providing low insertion loss, the F2250 provides excellent linearity performance over its entire voltage control and attenuation range.

The F2250 uses a single positive supply voltage of 3.15V to 5.25V. Other features include the VMODE pin allowing either positive or negative voltage control slope vs attenuation and multi-directional operation meaning the RF input can be applied to either RF1 or RF2 pins. Control voltage ranges from 0V to 3.6V using either positive or negative control voltage slope.

COMPETITIVE ADVANTAGE

F2250 provides extremely low insertion loss and superb IP3, IP2, Return Loss and Slope Linearity across the control range. Comparing to the previous state-of-the-art for silicon VVAs this device is better as follows:

- Insertion Loss @ 2000MHz: 1.4dB vs. 2.8dB
- Insertion Loss @ 6000MHz: 2.7dB vs. 7dB
- Maximum Attenuation Slope: 33dB/Volt vs. 53dB/Volt
- Minimum Return Loss up to 6000MHz: 12.5dB vs. 7dB
- Minimum Output IP3: 31dBm vs. 15dBm
- Minimum Input IP2: 87dBm vs. 80dBm
- Maximum Operating Temperature: +105°C vs. +85°C

APPLICATIONS

- Base Station 2G, 3G, 4G
- Portable Wireless
- Repeaters and E911 systems
- Digital Pre-Distortion
- Point to Point Infrastructure
- Public Safety Infrastructure
- WIMAX Receivers and Transmitters
- Military Systems, JTRS radios
- RFID handheld and portable readers
- Cable Infrastructure
- Wireless LAN
- Test / ATE Equipment

FEATURES

- Low Insertion Loss: 1.4dB @ 2000MHz
- Typical / Min IP3: 65dBm / 47dBm
- Typical / Min IP2: 95dBm / 87dBm
- 33.6dB Attenuation Range
- Bi-directional RF ports
- +34.4dBm Input P1dB compression
- VMODE pin allows either positive or negative attenuation control response
- Linear-in-dB attenuation characteristic
- Supply voltage: 3.15V to 5.25V
- VCTRL range: 0V to 3.6V using 5V supply
- +105°C max operating temperature
- 3mm x 3mm, 16-pin QFN package

DEVICE BLOCK DIAGRAM

ORDERING INFORMATION

PART# MATRIX

<table>
<thead>
<tr>
<th>Part#</th>
<th>RF Freq Range (MHz)</th>
<th>Insertion Loss (dB)</th>
<th>IIP3 (dBm)</th>
<th>Pinout Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2250</td>
<td>50 - 6000</td>
<td>1.4 (at 2GHz)</td>
<td>+65</td>
<td>RFMD</td>
</tr>
<tr>
<td>F2255</td>
<td>1 - 3000</td>
<td>1.1 (at 500MHz)</td>
<td>+60</td>
<td></td>
</tr>
<tr>
<td>F2258</td>
<td>50 - 6000</td>
<td>1.4 (at 2GHz)</td>
<td>+65</td>
<td>Hittite</td>
</tr>
</tbody>
</table>
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter / Condition</th>
<th>Symbol</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;DD&lt;/sub&gt; to GND</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt;</td>
<td>-0.3</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;MODE&lt;/sub&gt; to GND</td>
<td>V&lt;sub&gt;MODE&lt;/sub&gt;</td>
<td>-0.3</td>
<td>Minimum ( V&lt;sub&gt;DD&lt;/sub&gt;, 3.9 )</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CTRL&lt;/sub&gt; to GND</td>
<td>V&lt;sub&gt;CTRL&lt;/sub&gt;</td>
<td>-0.3</td>
<td>Minimum ( V&lt;sub&gt;DD&lt;/sub&gt;, 4.0 )</td>
<td>V</td>
</tr>
<tr>
<td>RF1, RF2 to GND</td>
<td>V&lt;sub&gt;RF&lt;/sub&gt;</td>
<td>-0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td>RF1 or RF2 Input Power applied for 24 hours maximum (V&lt;sub&gt;DD&lt;/sub&gt; applied @ 2GHz and +85°C)</td>
<td>P&lt;sub&gt;MAX24&lt;/sub&gt;</td>
<td>30</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>RF1 or RF2 Continuous Operating Power</td>
<td>P&lt;sub&gt;MAX_OP&lt;/sub&gt;</td>
<td>See Figure 1</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>T&lt;sub&gt;MAX&lt;/sub&gt;</td>
<td>+150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>T&lt;sub&gt;ST&lt;/sub&gt;</td>
<td>-65</td>
<td>+150</td>
<td>°C</td>
</tr>
<tr>
<td>Lead Temperature (soldering, 10s)</td>
<td>T&lt;sub&gt;LEAD&lt;/sub&gt;</td>
<td>+260</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>ESD Voltage – HBM (Per ESD STM5.1-2007)</td>
<td>V&lt;sub&gt;ESDHBM&lt;/sub&gt;</td>
<td>Class 1C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESD Voltage – CDM (Per ESD STM5.3.1-2009)</td>
<td>V&lt;sub&gt;ESDCDM&lt;/sub&gt;</td>
<td>Class C3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1: Maximum RF Input Power vs. RF Frequency**

Stresses above those listed above may cause permanent damage to the device. Functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### Package Thermal and Moisture Characteristics

-Θ<sub>JA</sub> (Junction – Ambient) 80.6°C/W
-Θ<sub>JC</sub> (Junction – Case) The Case is defined as the exposed paddle 5.1°C/W
-Moisture Sensitivity Rating (Per J-STD-020) MSL 1
### F2250 Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Freq Range</td>
<td>$F_{RF}$</td>
<td></td>
<td>50</td>
<td></td>
<td>6000</td>
<td>MHz</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>$V_{DD}$</td>
<td></td>
<td>3.15</td>
<td></td>
<td>5.25</td>
<td>V</td>
</tr>
<tr>
<td>$V_{MODE}$ Logic</td>
<td>$V_{IH}$</td>
<td>$V_{DD} &gt; 3.9$V</td>
<td>1.17</td>
<td></td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{IL}$</td>
<td>$V_{DD} = 3.15$V to 3.9V</td>
<td>1.17</td>
<td></td>
<td>$V_{DD} - 0.3$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CTRL}$ Range</td>
<td>$V_{CTRL}$</td>
<td>$V_{DD} = 3.9$V to 5.25V</td>
<td>0</td>
<td></td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 3.15$V to 3.9V</td>
<td>0</td>
<td></td>
<td>$V_{DD} - 0.3$</td>
<td>V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>$I_{DD}$</td>
<td></td>
<td>0.5</td>
<td>1.17</td>
<td>2</td>
<td>mA</td>
</tr>
<tr>
<td>Logic Current</td>
<td>$I_{MODE}$</td>
<td></td>
<td>-1</td>
<td></td>
<td>38</td>
<td>$\mu$A</td>
</tr>
<tr>
<td>$I_{CTRL}$ Current</td>
<td>$I_{CTRL}$</td>
<td></td>
<td>-1</td>
<td></td>
<td>14</td>
<td>$\mu$A</td>
</tr>
<tr>
<td>RF Operating Power</td>
<td>$P_{MAX, CW}$</td>
<td></td>
<td>See Figure 1</td>
<td></td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>RF1 Port Impedance</td>
<td>$Z_{RF1}$</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td>$\Omega$</td>
</tr>
<tr>
<td>RF2 Port Impedance</td>
<td>$Z_{RF2}$</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td>$\Omega$</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>T$_{CASE}$</td>
<td>Exposed Paddle Temperature</td>
<td>-40</td>
<td></td>
<td>+105</td>
<td>°C</td>
</tr>
</tbody>
</table>

Operating Conditions Notes:
1 – Items in min/max columns in **bold italics** are Guaranteed by Test.
2 – Items in min/max columns that are not bold/italics are Guaranteed by Design Characterization.
3 – Refer to the Maximum Operating RF Input Power vs. RF Frequency curves in Figure 1.
## F2250 Specification

Refer to EVKit / Applications Circuit, $V_{DD} = +3.3V$, $T_C = +25^\circ C$, signals applied to RF1 input, $F_{RF} = 2000MHz$, minimum attenuation, $P_{IN} = 0$dBm for small signal parameters, $+20$dBm for single tone linearity tests, $+20$dBm per tone for two tone tests, two tone delta frequency = 50MHz, PCB board traces and connector losses are de-embedded unless otherwise noted. Refer to Typical Operating Curves for performance over entire frequency band.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Comment</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion Loss, $IL$ (Minimum Attenuation)</td>
<td>$A_{MIN}$</td>
<td>2GHz</td>
<td>1.4</td>
<td>1.6</td>
<td>1.9</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3GHz</td>
<td>1.6</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6GHz</td>
<td>2.6</td>
<td>3.1</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Maximum Attenuation</td>
<td>$A_{MAX}$</td>
<td></td>
<td>34</td>
<td>35</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Insertion Phase $\Delta$</td>
<td>$\Phi_{\Delta MAX}$</td>
<td>At 36dB attenuation relative to Insertion Loss</td>
<td>27</td>
<td></td>
<td></td>
<td>deg</td>
</tr>
<tr>
<td></td>
<td>$\Phi_{\Delta MID}$</td>
<td>At 18dB attenuation relative to Insertion Loss</td>
<td>10</td>
<td></td>
<td></td>
<td>deg</td>
</tr>
<tr>
<td>Input 1dB Compression $^3$</td>
<td>$P_{1dB}$</td>
<td></td>
<td>34.4</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Minimum RF1 Return Loss over control voltage range</td>
<td>$S_{11}$</td>
<td>50MHz $^4$</td>
<td>16</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>700MHz</td>
<td>17</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2000MHz</td>
<td>17</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6000MHz</td>
<td>15</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Minimum RF2 Return Loss over control voltage range</td>
<td>$S_{22}$</td>
<td>50MHz $^4$</td>
<td>16</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>700MHz</td>
<td>15</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2000MHz</td>
<td>16</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6000MHz</td>
<td>13</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Input IP3</td>
<td>$IIP3$</td>
<td></td>
<td>65</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Input IP3 over Attenuation $^3$</td>
<td>$IIP3_{ATTEN}$</td>
<td>All attenuation settings</td>
<td>44</td>
<td>47</td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Minimum Output IP3</td>
<td>$OIP3_{MIN}$</td>
<td>Maximum attenuation</td>
<td>35</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Input IP2</td>
<td>$IIP2$</td>
<td>$P_{IN} + IM2_{dBc}$, IM2 term is $F1+F2$</td>
<td>95</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Minimum Input IP2</td>
<td>$IIP2_{MIN}$</td>
<td>All attenuation settings</td>
<td>87</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Input IH2</td>
<td>$HD2$</td>
<td>$P_{IN} + H2_{dBc}$</td>
<td>90</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Input IH3</td>
<td>$HD3$</td>
<td>$P_{IN} + (H3_{dBc}/2)$</td>
<td>54</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Settling Time</td>
<td>$T_{SETTL0.1dB}$</td>
<td>Any 1dB step in the 0dB to 33dB control range 50% $V_{CTRL}$ to RF settled to within ± 0.1dB</td>
<td>15</td>
<td></td>
<td></td>
<td>µsec</td>
</tr>
</tbody>
</table>

Specification Notes:

1 – Items in min/max columns in **bold italics** are Guaranteed by Test.

2 – Items in min/max columns that are not bold/italics are Guaranteed by Design Characterization.

3 – The input 1dB compression point is a linearity figure of merit. Refer to Absolute Maximum Ratings section along with Figure 1 for the maximum RF input power vs. RF frequency.

4 – Set blocking capacitors C7 & C8 to 0.01uF to achieve best return loss performance at 50MHz.
**TYPICAL OPERATING CONDITIONS**

Unless otherwise noted, the following conditions apply:

- $V_{DD} = +3.3V$ or $+5.0V$
- $T_C = +25^\circ C$
- $V_{MODE} = 0V$
- RF trace and connector losses are de-embedded for S-parameters
- Pin = 0dBm for all small signal tests
- Pin = +20dBm for single tone linearity tests (RF1 port driven)
- Pin = +20dBm/tone for two tone linearity tests (RF1 port driven)
- Two tone frequency spacing = 50MHz
TYPICAL OPERATING CONDITIONS [S2P BROADBAND PERFORMANCE] (-1-)

Attenuation vs. $V_{CTRL}$

-40C / $V_{ctrl} = 0.0V$
-40C / $V_{ctrl} = 3.0V$
-40C / $V_{ctrl} = 3.0V$
-40C / $V_{ctrl} = 3.0V$
105C / $V_{ctrl} = 0.0V$
105C / $V_{ctrl} = 3.0V$
105C / $V_{ctrl} = 1.6V$

Min. & Max. Attenuation vs. Frequency

Attenuation Delta to 25C vs. Frequency
**TYPICAL OPERATING CURVES [S2P vs. $V_{CTRL}$] (−2−)**

**Attenuation vs. $V_{CTRL}$**

- $V_{CTRL}$ (V)
- Attenuation (dB)
- Frequencies: 0.4GHz, 0.7GHz, 1.5GHz, 2.7GHz, 4.0GHz, 5.0GHz, 6.0GHz

**Attenuation Slope vs. $V_{CTRL}$**

- $V_{CTRL}$ (V)
- Attenuation Slope (dB/V)
- Frequencies: 0.4GHz, 0.7GHz, 1.5GHz, 2.7GHz, 4.0GHz, 5.0GHz, 6.0GHz

**RF1 Return Loss vs. $V_{CTRL}$**

- $V_{CTRL}$ (V)
- RF1 Return Loss (dB)
- Frequencies: 0.4GHz, 0.7GHz, 1.5GHz, 2.7GHz, 4.0GHz, 5.0GHz, 6.0GHz

**RF2 Return Loss vs. $V_{CTRL}$**

- $V_{CTRL}$ (V)
- RF2 Return Loss (dB)
- Frequencies: 0.4GHz, 0.7GHz, 1.5GHz, 2.7GHz, 4.0GHz, 5.0GHz, 6.0GHz

**Insertion Phase $\Delta$ vs. $V_{CTRL}$**

- $V_{CTRL}$ (V)
- Insertion Phase Δ (deg)
- (positive phase = electrically shorter)
- Frequencies: 0.4GHz, 0.7GHz, 1.5GHz, 2.7GHz, 4.0GHz, 5.0GHz, 6.0GHz

**Insertion Phase Slope vs. $V_{CTRL}$**

- $V_{CTRL}$ (V)
- Insertion Phase Slope (deg/V)
- Frequencies: 0.4GHz, 0.7GHz, 1.5GHz, 2.7GHz, 4.0GHz, 5.0GHz, 6.0GHz
#### TYPICAL OPERATING CONDITIONS [S2P VS. VCTRL & TEMPERATURE] (-3-)

**Attenuation Response vs. VCTRL**

-40C / 0.9GHz
-25C / 0.9GHz
105C / 0.9GHz
-40C / 2.0GHz
-25C / 2.0GHz
105C / 2.0GHz
-40C / 3.0GHz
-25C / 3.0GHz
105C / 3.0GHz

(positive phase = electrically shorter)

**Attenuation Slope vs. VCTRL**

-40C / 0.9GHz
25C / 0.9GHz
105C / 0.9GHz
-40C / 2.0GHz
25C / 2.0GHz
105C / 2.0GHz
-40C / 3.0GHz
25C / 3.0GHz
105C / 3.0GHz

**RF1 Return Loss vs. VCTRL**

-40C / 0.9GHz
25C / 0.9GHz
105C / 0.9GHz
-40C / 2.0GHz
25C / 2.0GHz
105C / 2.0GHz
-40C / 3.0GHz
25C / 3.0GHz
105C / 3.0GHz

**RF2 Return Loss vs. VCTRL**

-40C / 0.9GHz
25C / 0.9GHz
105C / 0.9GHz
-40C / 2.0GHz
25C / 2.0GHz
105C / 2.0GHz
-40C / 3.0GHz
25C / 3.0GHz
105C / 3.0GHz

**Insertion Phase Δ vs. VCTRL**

-40C / 0.9GHz
-25C / 0.9GHz
105C / 0.9GHz
-40C / 2.0GHz
-25C / 2.0GHz
105C / 2.0GHz
-40C / 3.0GHz
-25C / 3.0GHz
105C / 3.0GHz

**Insertion Phase Slope vs. VCTRL**

-40C / 0.9GHz
-25C / 0.9GHz
105C / 0.9GHz
-40C / 2.0GHz
-25C / 2.0GHz
105C / 2.0GHz
-40C / 3.0GHz
-25C / 3.0GHz
105C / 3.0GHz

(positive phase = electrically shorter)
**Typical Operating Conditions [S2P vs. Attenuation & Temperature]**

**RF1 Return Loss vs. Attenuation**

- **Frequency Bands:** 0.4GHz, 0.7GHz, 1.5GHz, 2.7GHz, 4.0GHz, 5.0GHz, 6.0GHz
- **Temperature Conditions:** -40C / 0.9GHz, -40C / 2.0GHz, -40C / 3.0GHz, 25C / 0.9GHz, 25C / 2.0GHz, 25C / 3.0GHz, 105C / 0.9GHz, 105C / 2.0GHz, 105C / 3.0GHz

**RF2 Return Loss vs. Attenuation**

- **Frequency Bands:** 0.4GHz, 0.7GHz, 1.5GHz, 2.7GHz, 4.0GHz, 5.0GHz, 6.0GHz
- **Temperature Conditions:** -40C / 0.9GHz, -40C / 2.0GHz, -40C / 3.0GHz, 25C / 0.9GHz, 25C / 2.0GHz, 25C / 3.0GHz, 105C / 0.9GHz, 105C / 2.0GHz, 105C / 3.0GHz

**Insertion Phase Δ vs. Attenuation**

- **Temperature Conditions:** -40C, 25C, 105C

*(positive phase = electrically shorter)*
TYPICAL OPERATING CONDITIONS [S2P vs. FREQUENCY] (-5-)

Min. & Max. Attenuation vs. Frequency

Worst-Case RF1 Return Loss vs. Frequency

Max. Insertion Phase Δ vs. Frequency

Gain Compression vs. Frequency

VCTRL varied from 0.8V to 1.8V

Min. & Max. Attenuation Slope vs. Frequency

Worst-Case RF2 Return Loss vs. Frequency

Gain Compression vs. RF Input Power (dBm)
TYPICAL OPERATING CONDITIONS [S2P @ LOW FREQUENCY, GROUP DELAY] (-6-

Min. & Max. Attenuation vs. Low Frequency

Low-Frequency Attenuation vs. VCTRL

Low-Frequency RF1 Return Loss vs. VCTRL

Low-Frequency RF2 Return Loss vs. VCTRL

Worst-Case Return Loss vs. Low Frequency

Group Delay vs. VCTRL

(C7,C8 set to 0.1uF)
TYPICAL OPERATING CONDITIONS 2GHz, \( V_{DD}=3.3V \) [IP3, IP2, IH2, IH3 vs. \( V_{CTRL}, V_{MODE} \)]

**Input IP3 vs. \( V_{CTRL} \)**

**Output IP3 vs. \( V_{CTRL} \)**

**Input IP2 vs. \( V_{CTRL} \)**

**Output IP2 vs. \( V_{CTRL} \)**

**2nd Harm Input Intercept Point vs. \( V_{CTRL} \)**

**3rd Harm Input Intercept Point vs. \( V_{CTRL} \)**
TYPICAL OPERATING CONDITIONS 2GHz, $V_{DD}=3.3V$ [IP3, IP2, IH2, IH3 vs. $V_{CTRL}$ RF1/RF2 DRIVEN] (-8-)

**Input IP3 vs. $V_{CTRL}$**

![Graph of Input IP3 vs. $V_{CTRL}$]

**Output IP3 vs. $V_{CTRL}$**

![Graph of Output IP3 vs. $V_{CTRL}$]

**Input IP2 vs. $V_{CTRL}$**

![Graph of Input IP2 vs. $V_{CTRL}$]

**Output IP2 vs. $V_{CTRL}$**

![Graph of Output IP2 vs. $V_{CTRL}$]

**2nd Harm Input Intercept Point vs. $V_{CTRL}$**

![Graph of 2nd Harm Input Intercept Point vs. $V_{CTRL}$]

**3rd Harm Input Intercept Point vs. $V_{CTRL}$**

![Graph of 3rd Harm Input Intercept Point vs. $V_{CTRL}$]
Typical Operating Conditions 2GHz, $V_{DD}=3.3V$ [IP3, IP2, IH2, IH3 vs. Attenuation] (-9-)

Input IP3 vs. Attenuation

Output IP3 vs. Attenuation

Input IP2 vs. Attenuation

Output IP2 vs. Attenuation

2nd Harm Input Intercept Point vs. Attenuation

3rd Harm Input Intercept Point vs. Attenuation
TYPICAL OPERATING CONDITIONS 2GHz, $V_{DD}=3.3V$ [IP3, IP2, IH2, IH3 vs. ATTEN, RF1/RF2 DRIVEN] (-10-)

Input IP3 vs. Attenuation

Output IP3 vs. Attenuation

Input IP2 vs. Attenuation

Output IP2 vs. Attenuation

2nd Harm Input Intercept Point vs. Attenuation

3rd Harm Input Intercept Point vs. Attenuation
PACKAGE DRAWING (3x3 16 PIN)
PINOUT & BLOCK DIAGRAM

Voltage Variable RF Attenuator

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### Pin Description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 5, 6, 7, 8, 12, 13</td>
<td>GND</td>
<td>Ground these pins as close to the device as possible.</td>
</tr>
<tr>
<td>2, 4, 9, 11</td>
<td>NC</td>
<td>No internal connection. These pins can be left unconnected or connected to ground (recommended).</td>
</tr>
<tr>
<td>3</td>
<td>RF1</td>
<td>RF Port 1. Matched to 50 ohms. Must use an external AC coupling capacitor as close to the device as possible. For low frequency operation increase the capacitor value to result in a low reactance at the frequency of interest.</td>
</tr>
<tr>
<td>10</td>
<td>RF2</td>
<td>RF Port 2. Matched to 50 ohms. Must use an external AC coupling capacitor as close to the device as possible. For low frequency operation increase the capacitor value to result in a low reactance at the frequency of interest.</td>
</tr>
<tr>
<td>14</td>
<td>( V_{\text{CTRL}} )</td>
<td>Attenuator control voltage. Apply a voltage in the range as specified in the Operating Conditions. See application section for details about ( V_{\text{CTRL}} ).</td>
</tr>
<tr>
<td>15</td>
<td>( V_{\text{DD}} )</td>
<td>Power supply input. Bypass to GND with capacitors close as possible to pin.</td>
</tr>
<tr>
<td>16</td>
<td>( V_{\text{MODE}} )</td>
<td>Attenuator slope control. Set to logic LOW to enable negative attenuation slope. Set to logic HIGH to enable positive attenuation slope.</td>
</tr>
<tr>
<td>—</td>
<td>EP</td>
<td>Exposed Pad. Internally connected to GND. Solder this exposed pad to a PCB pad that uses multiple ground vias to achieve the specified RF performance.</td>
</tr>
</tbody>
</table>
APPLICATIONS INFORMATION

Default Start-up

V_{\text{MODE}} must be tied to either GND or Logic HIGH. If V_{\text{CTRL}} pin is left floating, the part will power up in the minimum attenuation state when V_{\text{MODE}} = GND, or the maximum attenuation state when V_{\text{MODE}} = High.

V_{\text{CTRL}}

The V_{\text{CTRL}} pin is used to control the attenuation of the F2250. With V_{\text{MODE}} set to a logic low (high) this places the device in a negative (positive) slope mode where increasing (decreasing) voltage produces an increasing (a decreasing) attenuation from min attenuation (max attenuation) to max attenuation (min attenuation) respectively. The V_{\text{CTRL}} pin has an on-chip pullup ESD diode so V_{\text{DD}} should be applied before V_{\text{CTRL}} is applied. If this sequencing is not possible, then resistor R2 should be set for 1kΩ to limit the current into the V_{\text{CTRL}} pin.

V_{\text{MODE}}

The V_{\text{MODE}} pin is used to set the attenuation vs. V_{\text{CTRL}} slope. With V_{\text{MODE}} set to logic low (high) this will set the attenuation slope to be negative (positive). A negative (positive) slope is defined as increased (decreased) attenuation with increasing (decreasing) V_{\text{CTRL}} voltage. The EVKIT provides an on-board jumper to manually set the V_{\text{MODE}}. Installing a jumper on header J2 from VMODE to GND (VHI) to set the device for a negative (positive) slope.

RF1 and RF2 Ports

The F2250 is a bi-directional device thus allowing RF1 or RF2 to be used as the RF input. As displayed in the Typical Operating Conditions curves, RF1 shows some enhanced linearity performance and therefore should be used as the RF input, if possible, for best results. This F2250 has been designed to accept high RF input power levels, therefore V_{\text{DD}} must be applied prior to the application of RF power to ensure reliability. DC blocking capacitors are required on the RF pins and should be set to a value that results in a low reactance over the frequency range of interest.

Power Supplies

The supply pin should be bypassed with external capacitors to minimize noise and fast transients. Supply noise can degrade noise figure and fast transients can trigger ESD clamps and cause them to fail. Supply voltage change or transients should have a slew rate smaller than 1V/20μS. In addition, all control pins should remain at 0V (+/-0.3V) while the supply voltage ramps or while it returns to zero.
Control Pin Interface

If control signal integrity is a concern and clean signals cannot be guaranteed due to overshoot, undershoot, ringing, etc., the following circuit at the input of control pins 14 and 16 is recommended as shown below.
Short GND pin to VMODE pin to set for negative attenuation slope. For positive attenuation slope move shorting shunt from VMODE to VHI.
EVkit Picture / Layout (Bottom Side)
EVkit BOM

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C4, C5</td>
<td>3</td>
<td>10nF ±5%, 50V, X7R Ceramic Capacitors (0603)</td>
<td>GRM188R71H103J</td>
<td>Murata</td>
</tr>
<tr>
<td>C2, C3, C6</td>
<td>3</td>
<td>1000pF ±5%, 50V, C0G Ceramic Capacitors (0402)</td>
<td>GRM1555C1H102J</td>
<td>Murata</td>
</tr>
<tr>
<td>C7, C8</td>
<td>2</td>
<td>100pF ±5%, 50V, COG Ceramic Capacitors (0402)</td>
<td>GRM1555C1H101J</td>
<td>Murata</td>
</tr>
<tr>
<td>R1, R2, R5</td>
<td>3</td>
<td>0Ω Resistors (0402)</td>
<td>ERJ-2GE0R00X</td>
<td>Panasonic</td>
</tr>
<tr>
<td>R3, R4</td>
<td>2</td>
<td>100kΩ ±1%, 1/10W, Resistor (0402)</td>
<td>ERJ-2RKF1003X</td>
<td>Panasonic</td>
</tr>
<tr>
<td>J1, J3-J5</td>
<td>4</td>
<td>Edge Launch SMA (0.375 inch pitch ground tabs)</td>
<td>142-0701-851</td>
<td>Emerson Johnson</td>
</tr>
<tr>
<td>J2</td>
<td>1</td>
<td>CONN HEADER VERT SGL 3 X 1 POS GOLD</td>
<td>961103-6404-AR</td>
<td>3M</td>
</tr>
<tr>
<td>U1</td>
<td>1</td>
<td>Voltage Variable Attenuator</td>
<td>F2250NLGK</td>
<td>IDT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Printed Circuit Board</td>
<td>F225x REV (02)</td>
<td>IDT</td>
</tr>
</tbody>
</table>

Top Markings

![Top Markings Diagram]

- **Lot Code**: 04Y
- **Assembler Code**: 446L
- **Part Number**: F2250
- **Date Code [YWW]** (Week 46 of 2014)
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