

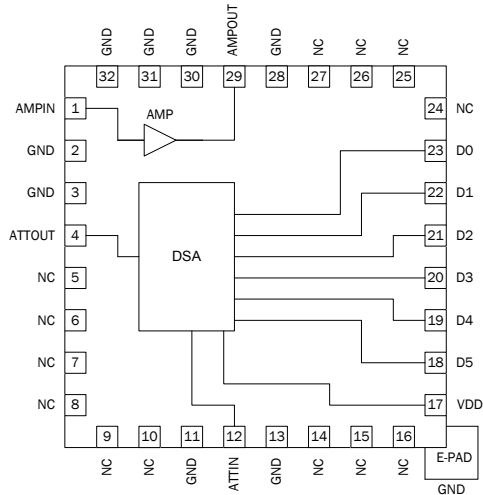


### Features

- 500MHz to 2500MHz Operation
- 6-Bit Digital Step Attenuator
- Parallel Control Interface
- 31.5 dB Attenuation Range (0.5dB Step)
- High OIP3/P1dB= +43/25 dBm
- Gain=-20dB to +11.5dB at 2017 MHz
- Single +5V Supply
- Footprint Compatible with 32-Pin 5mmx5mm QFN

### Applications

- Cellular, PCS, 3G Infrastructure
- WiBro, WiMax, LTE
- High Linearity Power Control



Functional Block Diagram

### Product Description

RFMD's RFDA2015 is a digital controlled variable gain amplifier featuring high linearity over the entire gain control range. The 6-bit digital step attenuator is programmed with a parallel mode control interface. The RFDA2015 is packaged in a small 5.2mmx5.2mm leadless laminate MCM with plated through thermal vias for ultra low thermal resistance. The footprint for this module is directly compatible with most 32-pin 5mmx5mm QFNs. The output amplifier is externally matched, allowing for optimum performance over specific bands within 500MHz to 2500MHz.

### Ordering Information

|                 |   |
|-----------------|---|
| RFDA2015SQ      | Sample bag with 25 pieces                         |
| RFDA2015SR      | 7" Reel with 100 pieces                           |
| RFDA2015TR7     | 7" Reel with 750 pieces                           |
| RFDA2015TR13    | 13" Reel with 2500 pieces                         |
| RFDA2015PCK-410 | 1800 MHz to 2200 MHz PCBA with 5-piece sample bag |

### Optimum Technology Matching® Applied

- |  |                                      |  |                                   |
|--|--------------------------------------|--|-----------------------------------|
| <input checked="" type="checkbox"/> GaAs HBT | <input type="checkbox"/> SiGe BiCMOS | <input checked="" type="checkbox"/> GaAs pHEMT | <input type="checkbox"/> GaN HEMT |
| <input type="checkbox"/> GaAs MESFET         | <input type="checkbox"/> Si BiCMOS   | <input type="checkbox"/> Si CMOS               | <input type="checkbox"/> RF MEMS  |
| <input type="checkbox"/> InGaP HBT           | <input type="checkbox"/> SiGe HBT    | <input type="checkbox"/> Si BJT                | <input type="checkbox"/> LDMOS    |

## Absolute Maximum Ratings

| Parameter                                     | Rating      | Unit |
|---|-------------|------|
| Supply Voltage ( $V_{CC}$ , $V_{DD}$ )        | 5.5         | V    |
| Collector Current ( $I_C$ )                   | 200         | mA   |
| Power Dissipation <sup>1</sup> ( $P_{DISS}$ ) | 750         | mW   |
| RF Input Power                                | 20          | dBm  |
| Operating Temperature ( $T_{CASE}$ )          | -40 to +85  | °C   |
| Junction Temperature ( $T_J$ )                | 150         | °C   |
| Storage Temperature                           | -40 to +150 | °C   |
| ESD Rating (HBM)                              | Class 1B    |      |
| Moisture Sensitivity Level                    | MSL 3       |      |



**Caution!** ESD sensitive device.

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

RoHS status based on EUDirective2002/95/EC (at time of this document revision).

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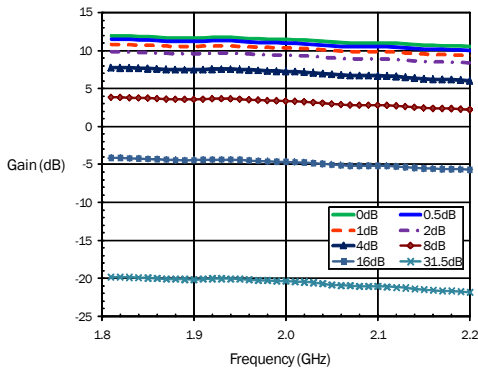
Notes:

$$1. P_{DISS} = V_{CC} * I_C - \text{RF Output Power} + \text{RF Input Power}$$

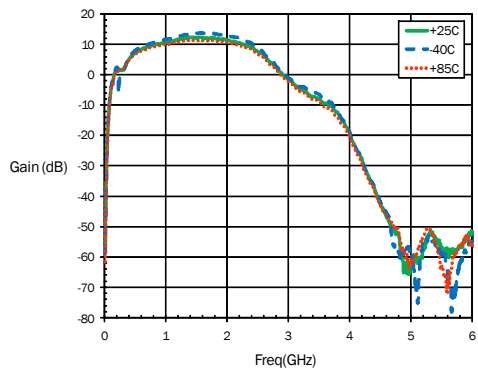
| Parameter  | Specification  |      |      | Unit | Condition                                      |
|--|--|------|------|------|--|
|  | Min.   | Typ. | Max. |      |  |
| <b>Frequency Range</b>   | 500  |      | 2500 | MHz  |  |
| Gain (Max Gain State)  | 10.0   | 11.5 | 13.0 | dB   | Attenuation=0dB, 2017 MHz                      |
| Gain Control Range   |  | 31.5 |      | dB   | 0.5dB LSB, 6 bits                              |
| Step Accuracy  | ±(0.1 +5% attenuation setting)   |      |      | dB   | Major state max error                          |
| Output IP3   | 40   | 43   |      | dBm  | 2017 MHz, $P_{OUT}$ =5 dBm/ tone, 1MHz spacing |
| Output P1dB  | 23   | 25   |      | dBm  | Attenuation=0dB, 2017 MHz                      |
| Input Return Loss  |  | 17   |      | dB   | 2017 MHz                                       |
| Output Return Loss   |  | 11   |      | dB   | 2017 MHz                                       |
| Noise Figure   |  | 7    |      | dB   | 2017 MHz, Attenuation=0dB                      |
| $t_{RISE}$ , $t_{FALL}$  |  | 200  |      | ns   | 10/90% RF                                      |
| Amplifier Supply Voltage ( $V_{CC}$ )  | 4.75   | 5.00 | 5.25 | V    |  |
| Attenuator Supply Voltage ( $V_{DD}$ )   | 3.30   | 5.00 | 5.25 | V    |  |
| Total Supply Current   | 90   | 115  | 135  | mA   | Sum of currents from $V_{DD}$ and $V_{CC}$     |
| Thermal Resistance   |  | 87   |      | °C/W |  |
| Control Interface  | 6 Bit, Parallel  |      |      |      |  |
| Control Voltages   | Low, $V_{CTL}$ = 0 to 0.8 $V_{DC}$<br>High, $V_{CTL}$ = 2.0 to $V_{DD}$ $V_{DC}$ |      |      | V    |  |
| Notes:   |  |      |      |      |  |
| 1. All measurements based on the 1800MHz to 2200MHz Application Circuit, T=25 °C |  |      |      |      |  |
| 2. $V_{CC}$ = $V_{DD}$ =+5V, $V_{CTL}$ =0/5V                                     |  |      |      |      |  |

**Typical Performance - 1.8GHz to 2.2GHz Application Circuit Performance**

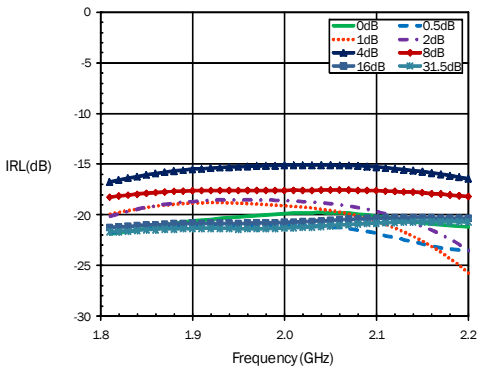
**Gain, Major States, 25 °C**



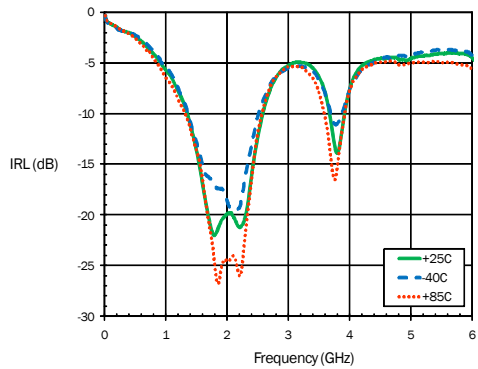
**S21 over Temperature, Max Gain**



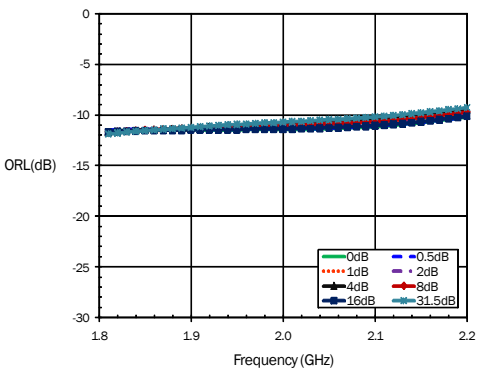
**Input RL, Major States, 25 °C**



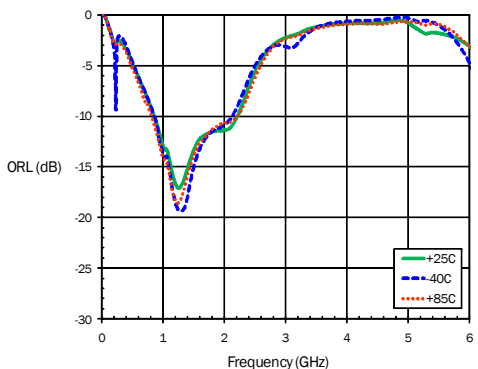
**Input Return Loss over Temperature, Max Gain**



**Output RL, Major States, 25 °C**

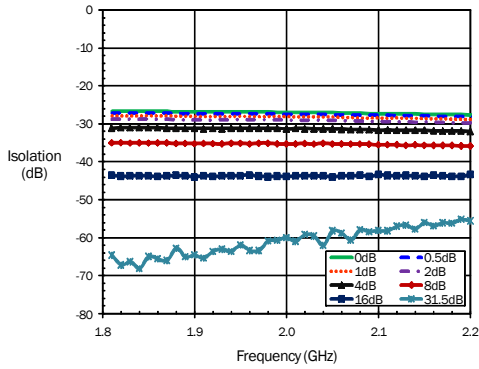


**Output Return Loss over Temperature, Max Gain**

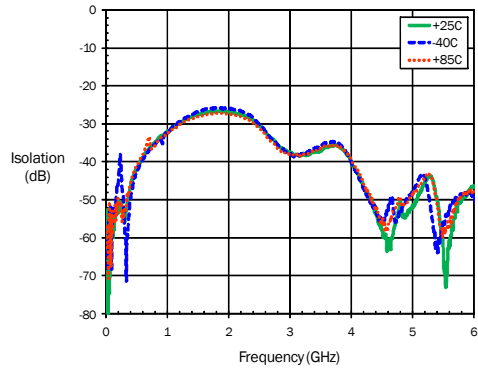


## Typical Performance - 1.8GHz to 2.2GHz Application Circuit Performance

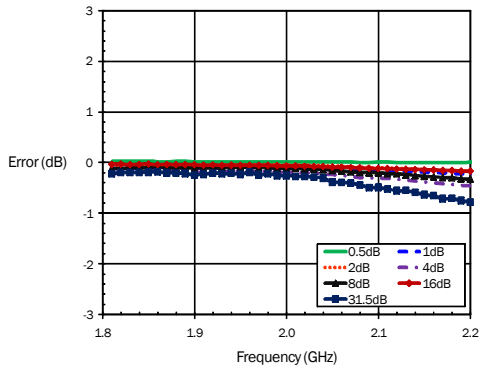
Isolation, Major States, 25 °C



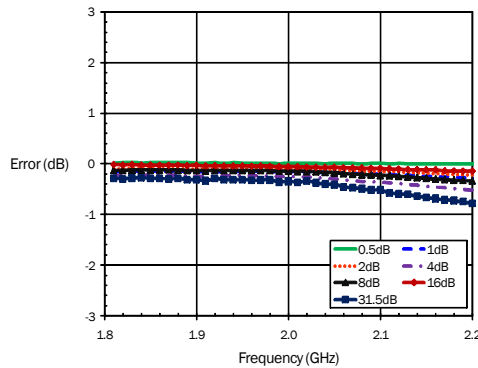
Isolation over Temperature, Max Gain



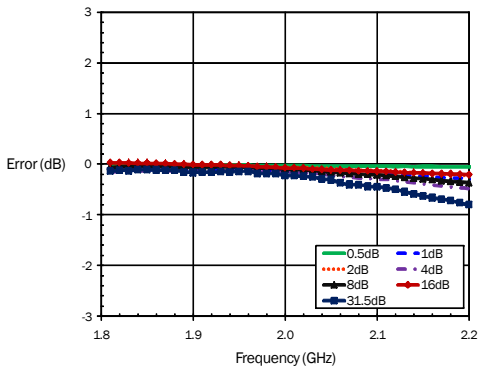
Attenuation Error, Major States, 25 °C



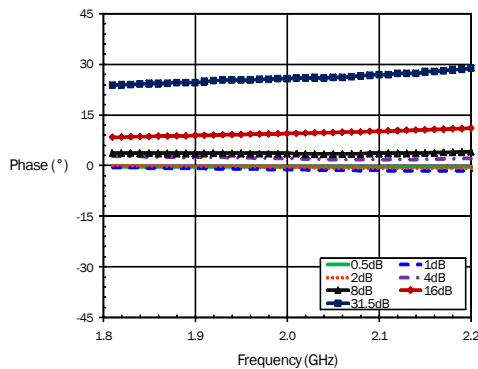
Attenuation Error, Major States, 85 °C



Attenuation Error, Major States, -40 °C

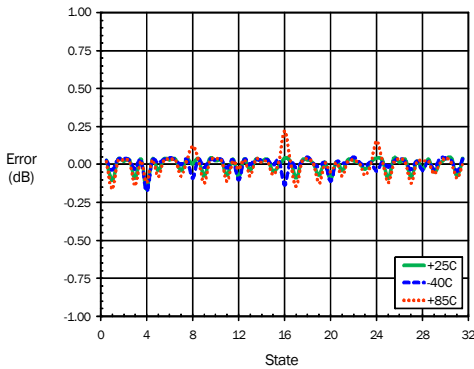


Normalized Phase Error, Major States, 25 °C

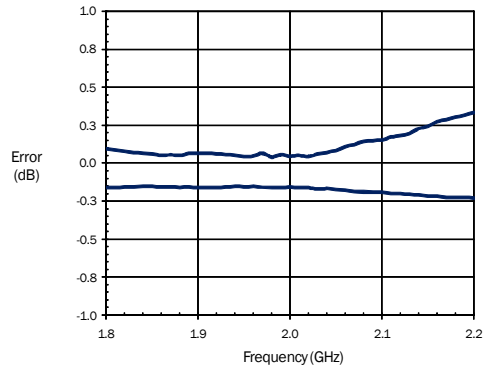


**Typical Performance: 1.8GHz to 2.2GHz Application Circuit Performance**

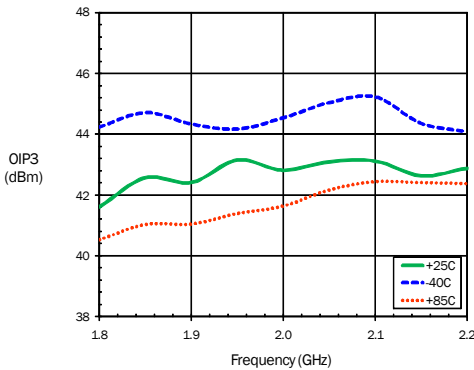
**Successive Step Error at 2020MHz**



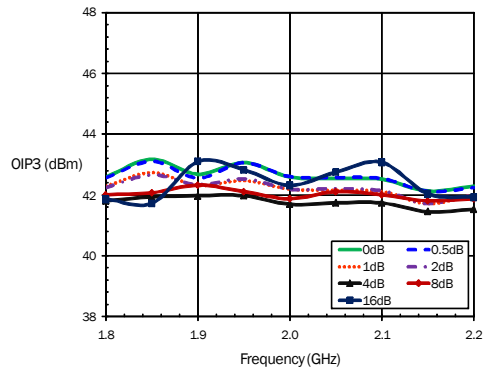
**Worst Case Successive Step Error, 25 °C**



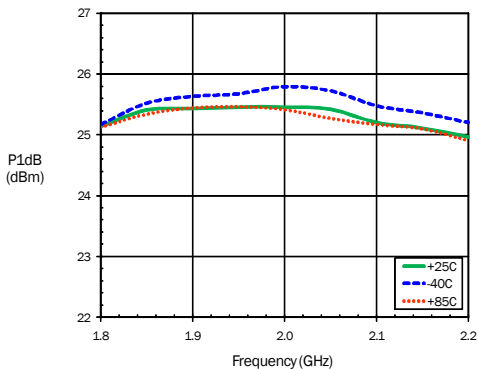
**OIP3 over Temperature, Max Gain**



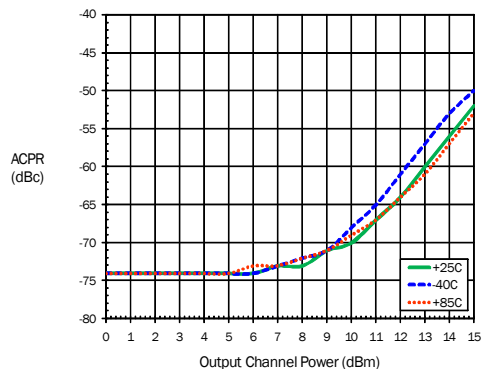
**OIP3, Major States, 25 °C**



**P1dB over Temperature, Max Gain**

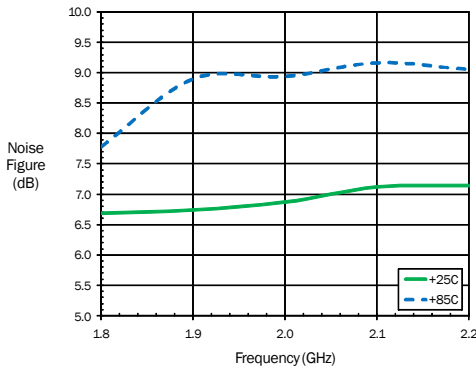


**ACPR over Temperature, Max Gain  
WCDMA, 64 DPCH, 2017MHz**

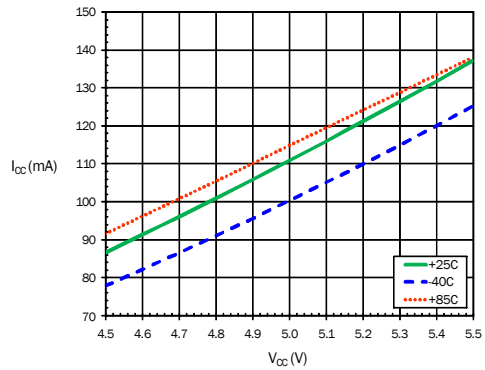


## Typical Performance - 1.8GHz to 2.2GHz Application Circuit Performance

Noise Figure over Temperature, Max Gain



DCIV over Temperature, Max Gain



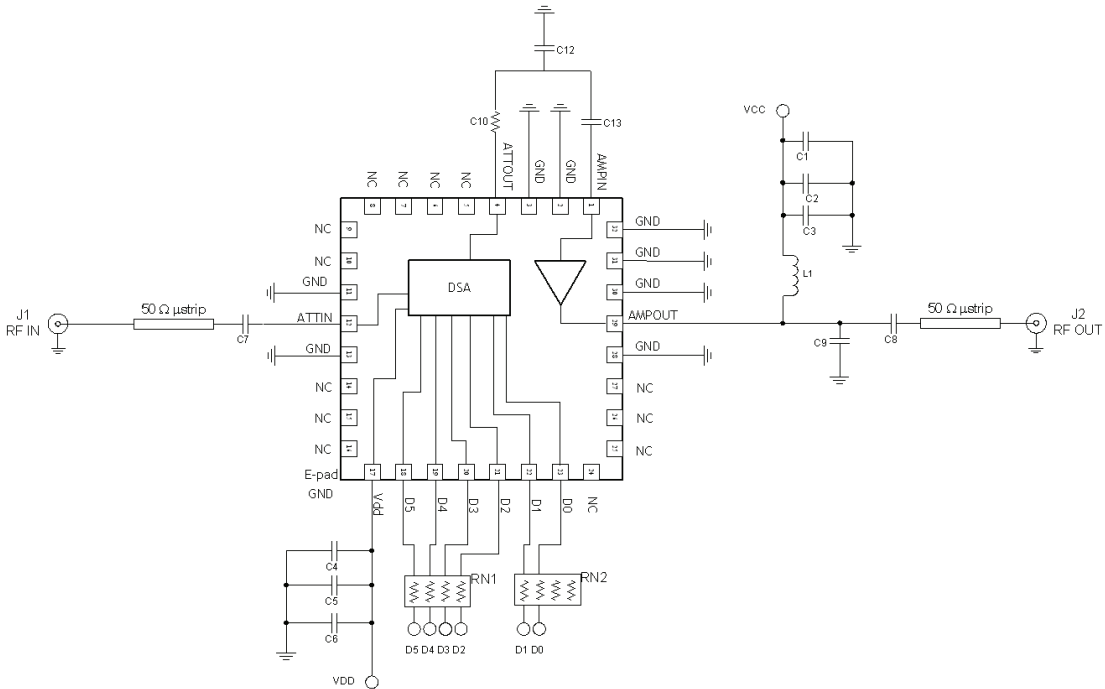
### Truth Table

| Control Voltage Input |           |           |           |           |             | Relative Gain Setting |
|-----------------------|-----------|-----------|-----------|-----------|-------------|-----------------------|
| D5<br>16dB            | D4<br>8dB | D3<br>4dB | D2<br>2dB | D1<br>1dB | D0<br>0.5dB |                       |
| 1                     | 1         | 1         | 1         | 1         | 1           | Max Gain              |
| 1                     | 1         | 1         | 1         | 1         | 0           | -0.5dB                |
| 1                     | 1         | 1         | 1         | 0         | 1           | -1dB                  |
| 1                     | 1         | 1         | 0         | 1         | 1           | -2dB                  |
| 1                     | 1         | 0         | 1         | 1         | 1           | -4dB                  |
| 1                     | 0         | 1         | 1         | 1         | 1           | -8dB                  |
| 0                     | 1         | 1         | 1         | 1         | 1           | -16dB                 |
| 0                     | 0         | 0         | 0         | 0         | 0           | -31.5dB               |

0=Low, V<sub>CTL</sub>=0 to 0.8 V<sub>DC</sub>  
 1=High, V<sub>CTL</sub>=2.0 to V<sub>DD</sub> V<sub>DC</sub>

| Pin | Function          | Description  |
|-----|-------------------|--|
| 1   | <b>AMPIN</b>      | Amplifier Input - DC Block Required.   |
| 2   | <b>GND</b>        | RF/DC Ground Connection.   |
| 3   | <b>GND</b>        | RF/DC Ground Connection.   |
| 4   | <b>ATTOUT</b>     | Digital Attenuator Output - DC Block Required.                               |
| 5   | <b>ACG1</b>       | No Internal Connection.  |
| 6   | <b>ACG2</b>       | No Internal Connection.  |
| 7   | <b>ACG3</b>       | No Internal Connection.  |
| 8   | <b>ACG4</b>       | No Internal Connection.  |
| 9   | <b>ACG5</b>       | No Internal Connection.  |
| 10  | <b>ACG6</b>       | No Internal Connection.  |
| 11  | <b>GND</b>        | RF/DC Ground Connection.   |
| 12  | <b>ATTIN</b>      | Digital Attenuator Input - DC Block Required.                                |
| 13  | <b>GND</b>        | RF/DC Ground Connection.   |
| 14  | <b>NC</b>         | No Internal Connection.  |
| 15  | <b>NC</b>         | No Internal Connection.  |
| 16  | <b>NC</b>         | No Internal Connection.  |
| 17  | <b>VDD</b>        | Digital Attenuator Supply Voltage.   |
| 18  | <b>D5</b>         | Digital Attenuator Parallel Control Line - 16dB Bit.                         |
| 19  | <b>D4</b>         | Digital Attenuator Parallel Control Line - 8dB Bit.                          |
| 20  | <b>D3</b>         | Digital Attenuator Parallel Control Line - 4dB Bit.                          |
| 21  | <b>D2</b>         | Digital Attenuator Parallel Control Line - 2dB Bit.                          |
| 22  | <b>D1</b>         | Digital Attenuator Parallel Control Line - 1dB Bit.                          |
| 23  | <b>D0</b>         | Digital Attenuator Parallel Control Line - 0.5dB Bit.                        |
| 24  | <b>NC</b>         | No Internal Connection.  |
| 25  | <b>NC</b>         | No Internal Connection.  |
| 26  | <b>NC</b>         | No Internal Connection.  |
| 27  | <b>NC</b>         | No Internal Connection.  |
| 28  | <b>GND</b>        | RF/DC Ground Connection.   |
| 29  | <b>AMPOUT/VCC</b> | Amplifier Output and Bias. External Choke, Bypassing and DC Blocks Required. |
| 30  | <b>GND</b>        | RF/DC Ground Connection.   |
| 31  | <b>GND</b>        | RF/DC Ground Connection.   |
| 32  | <b>GND</b>        | RF/DC Ground Connection.   |

## Evaluation Schematic - 1800MHz to 2200MHz Application Circuit

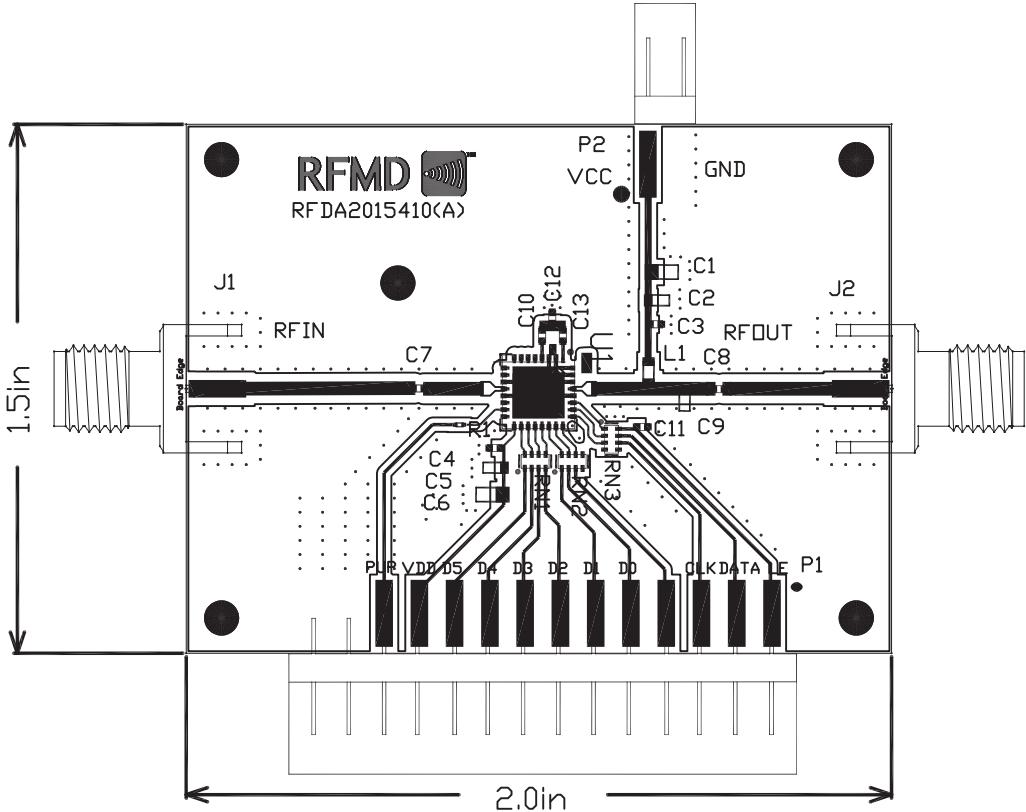


### Bill of Materials - 1800MHz to 2200MHz Application Circuit

| Description                             | Reference Designator | Manufacturer            | Manufacturer's P/N |
|---|----------------------|-------------------------|--------------------|
| RFDA2015SB                              | U1                   | RFMD                    | RFDA2015           |
| RFDA2015, PCB                           |                      |                         | RFDA2015410 (A)    |
| CONN, SMA, END LNCH, FLT, 0.062"        | J1, J2               | Emerson Network Power   | 142-0701-821       |
| CAP, 1000pF, 10%, 50V, X7R, 0603        | C2, C5               | Murata Electronics      | GRM188R71H102KA01D |
| CAP, 22pF, 5%, 50V, COG, 0402           | C3, C7, C8           | PANASONIC INDUSTRIAL CO | ECJ-0EC1H220J      |
| CAP, 1uF, 10%, 16V, X7R, 0805           | C1, C6               | Murata Electronics      | GRM21BR71C105KA01K |
| CAP, 100pF, 5%, 50V, COG, 0402          | C4                   | PANASONIC INDUSTRIAL CO | ECJ-0EC1H101J      |
| CAP, 1.2pF, +/-0.1pF, 50V, COG, 0402    | C9                   | Murata Electronics      | GRM1555C1H1R2BZ01E |
| IND, 18nH, 5%, M/L, 0603                | L1                   | Toko America, Inc.      | LL1608-FSL18NJ     |
| RES, 0 OHM, 0402                        | C10                  | Kamaya, Inc             | RMC1/16SJPTH       |
| RES ARRAY, 4-ELEM, 1K, 5%, SMD 4 X 0402 | RN1, RN2             | KOA                     | CN1E4KTTD102J      |
| CAP, 3.3pF, +/-0.1pF, 50V, COG, 0402    | C13                  | Murata Electronics      | GRM1555C1H3R3BZ01E |
| CONN, HDR, ST, PLRZD, 2-PIN, 0.100"     | P2                   | ITW Pancon              | MPSS100-2-C        |
| CONN, HDR, ST, PLRZD, 14-PIN, 0.100"    | P1                   | ITW Pancon              | MPSS100-14-C       |
| DNP                                     | C11, C12, RN3, R1    |                         |                    |

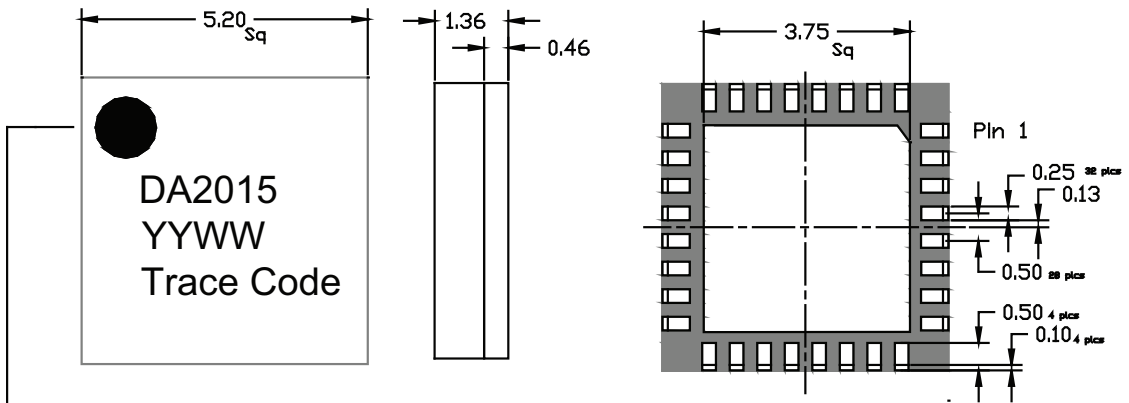


**Evaluation PCB - 1800MHz to 2200MHz Application Circuit**



## Package Drawing

5.2mmx5.2mm Laminate Module



Pin 1 Indicator

Dimensions in millimeters

YY = Year  
WW = Week

Trace Code to be assigned by SubCon