

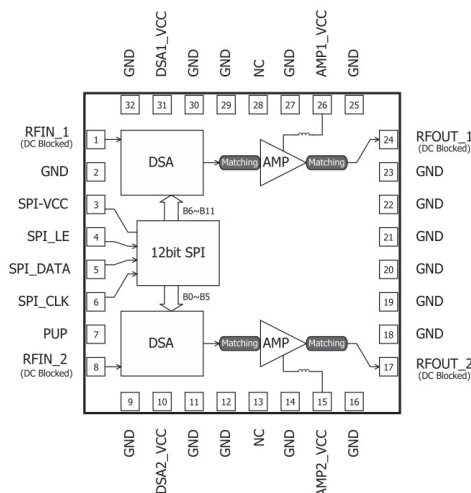


### Features

- Dual Channel VGA
- Frequency Range 400MHz to 2700MHz
- Full Internal Matching and No External Bias Inductors
- Two 6-Bit Digital Step Attenuators
- 12-Bit SPI Serial Control Programming
- High Channel Isolation = 50dBc
- Max Gain = 18.5dB at 900MHz
- Gain Control Range = 31.5dB (0.5dB Step Size)
- High OIP3/P1dB = +37dBm/19dBm at 900MHz
- Single + 5V Supply
- Small 32-Pin, 7.0mm x 7.0mm, MCM
- Power-up Programming

### Applications

- Cellular, 3G Infrastructure
- WiBro, WiMAX, LTE
- Microwave Radio
- High Linearity Power Control



Functional Block Diagram

### Product Description

RFMD's RFDA0057 is a dual-channel, digital controlled variable gain amplifier featuring high linearity over the entire gain control range with noise figure less than 7dB in its maximum gain state. The gains of two 6-bit digital step attenuators are programmed with a serial mode control interface (SPI). The RFDA0057 is packaged in a small 7.0mm x 7.0mm leadless laminate MCM, which contains plated through thermal vias for ultra-low thermal resistance. This module is easy to use with no external matching components required.

### Ordering Information

|                 |                                                |
|-----------------|------------------------------------------------|
| RFDA0057SR      | 7" Sample reel with 100 pieces                 |
| RFDA0057SQ      | Sample bag with 25 pieces                      |
| RFDA0057TR7     | 7" Reel with 750 pieces                        |
| RFDA0057TR13    | 13" Reel with 2500 pieces                      |
| RFDA0057PCK-410 | 400MHz to 2700MHz PCBA with 5-piece sample bag |

### Optimum Technology Matching® Applied

|                                               |                                      |                                                |                                    |
|-----------------------------------------------|--------------------------------------|------------------------------------------------|------------------------------------|
| <input 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 checked="" type="checkbox"/> Si CMOS    | <input type="checkbox"/> BIFET HBT |
| <input checked="" type="checkbox"/> InGaP HBT | <input type="checkbox"/> SiGe HBT    | <input type="checkbox"/> Si BJT                | <input type="checkbox"/> SOI       |

## Absolute Maximum Ratings

| Parameter                                  | Rating          | Unit            |
|--------------------------------------------|-----------------|-----------------|
| Supply Voltage                             | +5.5            | V <sub>DC</sub> |
| DS Supply Current                          | 205             | mA              |
| Power Dissipation                          | 1100            | mW              |
| Maximum Input RF Power                     | 24              | dBm             |
| Operating Temperature (T <sub>CASE</sub> ) | -40 to +85      | °C              |
| Storage Temperature                        | -40 to +150     | °C              |
| Junction Temperature                       | 165             | °C              |
| ESD Rating (HBM)                           | 1000 (Class 1C) | V               |
| Moisture Sensitivity Level                 | MSL 3           |                 |

MTTF = 1.0E6 hours at 165 °C junction temperature



**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 EU Directive 2011/65/EU (at time of this document revision).

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RFMD Green: RoHS compliant per EU Directive 2011/65/EU, halogen free per IEC 61249-2-21, < 1000 ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

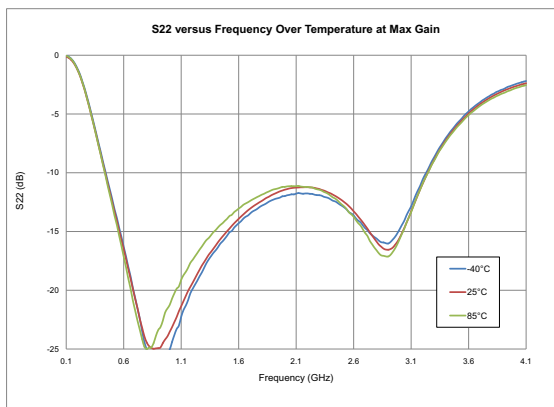
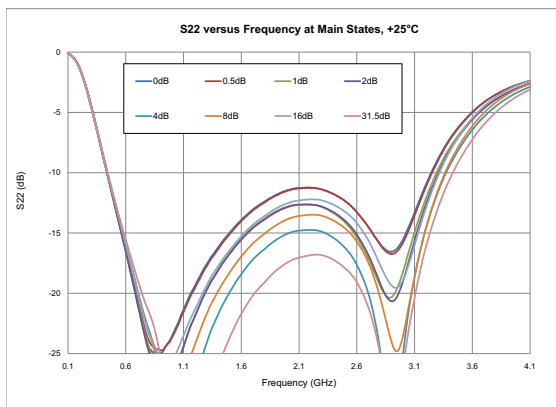
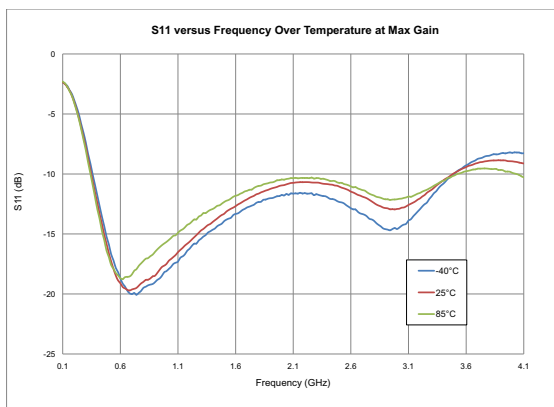
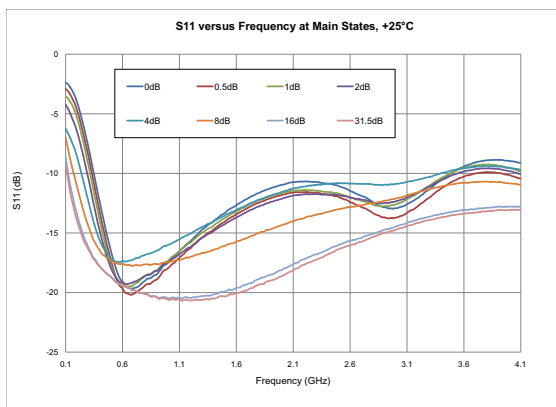
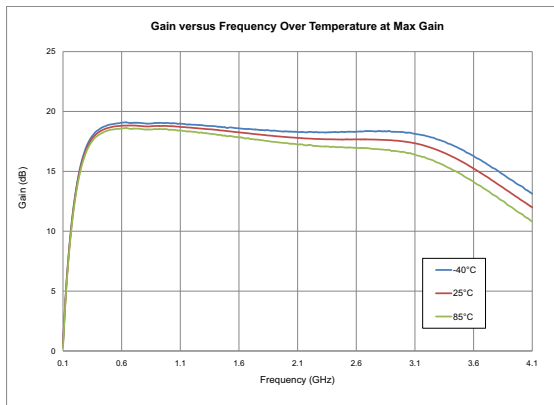
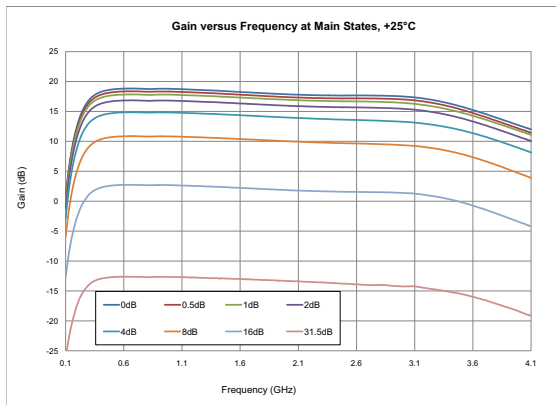
| Parameter                    | Specification                     |      |      | Unit | Condition                                                                          |
|------------------------------|-----------------------------------|------|------|------|------------------------------------------------------------------------------------|
|                              | Min.                              | Typ. | Max. |      |                                                                                    |
| <b>Overall</b>               |                                   |      |      |      | Temp = 25 °C, V <sub>CC</sub> = V <sub>DD</sub> = 5V, standard application circuit |
| Frequency                    | 400                               |      | 2700 | MHz  |                                                                                    |
| Max Gain                     |                                   | 18.5 |      | dB   | Attenuation = 0dB                                                                  |
| Gain Control Range           |                                   | 31.5 |      | dB   |                                                                                    |
| Step Accuracy                | +/- (0.15+5% attenuation setting) |      |      | dB   | Major state error up to 2700MHz                                                    |
| P1dB                         |                                   | 19   |      | dBm  | Attenuation = 0dB at 900MHz                                                        |
| Output IP3                   |                                   | 37   |      | dBm  | P <sub>OUT</sub> = 0dBm/tone, 1MHz spacing at 900MHz                               |
| Control Interface            |                                   | 12   |      | bit  | SPI interface                                                                      |
| Settling Time                |                                   | 250  |      | ns   | t <sub>ON</sub> , t <sub>OFF</sub> (10%/90% RF)                                    |
| Noise Figure                 |                                   | 7    |      | dB   | Attenuation = 0dB                                                                  |
| Channel-to-Channel Isolation |                                   | 50   |      | dB   | Input at RFIN1 (or RFIN2), the isolation between two outputs                       |
| Impedance                    |                                   | 50   |      | Ω    |                                                                                    |
| Input Return Loss            |                                   | -15  |      | dB   | 900MHz                                                                             |
| Output Return Loss           |                                   | -15  |      | dB   | 900MHz                                                                             |
| Total Supply Voltage         | 4.75                              | 5.0  | 5.25 | V    |                                                                                    |
| Supply Current               |                                   | 155  |      | mA   | From V <sub>CC-SPI</sub> , V <sub>CC-AMP1</sub> and V <sub>CC-AMP2</sub>           |
| Thermal Resistance           |                                   | 40   |      | °C/W | Junction to backside of device                                                     |

## Typical RF Performance at Key Operating Frequencies

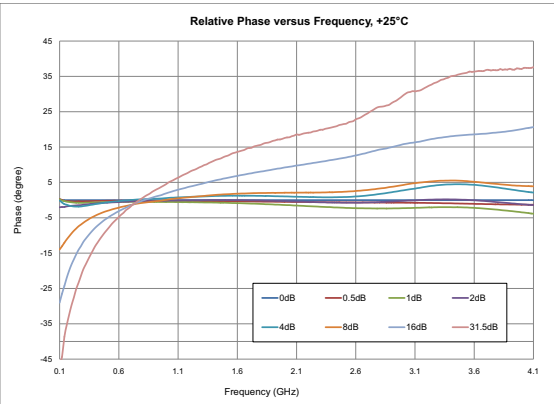
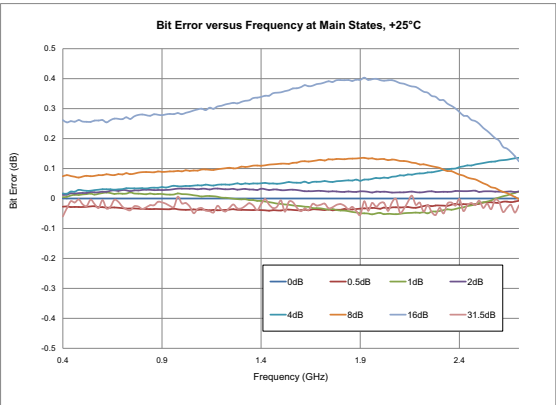
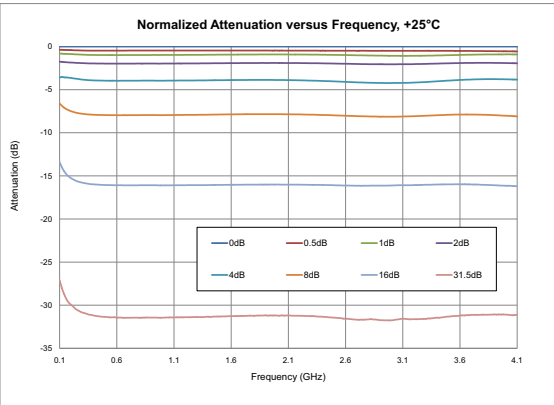
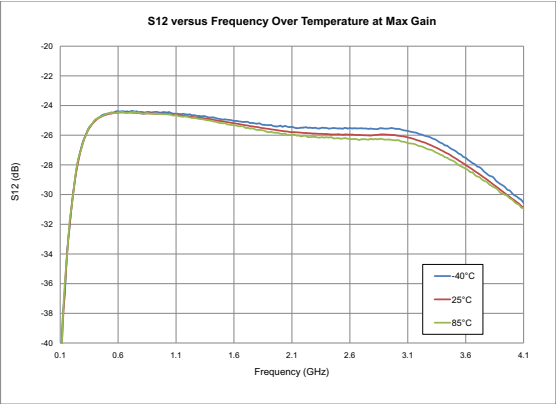
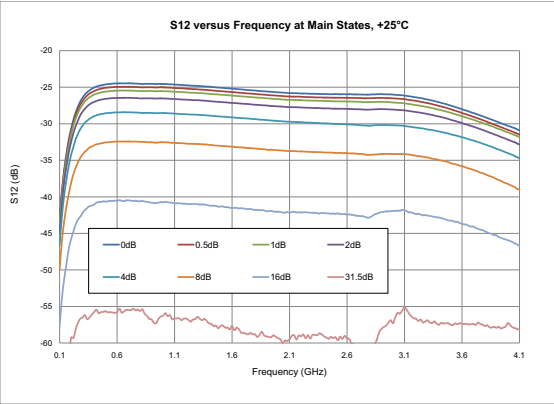
| Parameter             | Unit | 700MHz | 900MHz | 1700MHz | 2300MHz | 2500MHz | 2700MHz |
|-----------------------|------|--------|--------|---------|---------|---------|---------|
| Max Small Signal Gain | dB   | 18.5   | 18.5   | 18      | 17.5    | 17.5    | 17.5    |
| Output P1dB           | dBm  | 19     | 19     | 19      | 19      | 18.5    | 18.5    |
| Output IP3*           | dBm  | 38     | 37     | 34.5    | 32.5    | 32      | 31.5    |
| Noise Figure          | dB   | 5.7    | 5.7    | 6.5     | 7       | 6.9     | 7.2     |

\*Note: OIP3 is tested at P<sub>OUT</sub> = 0dBm/Tone and 1MHz spacing

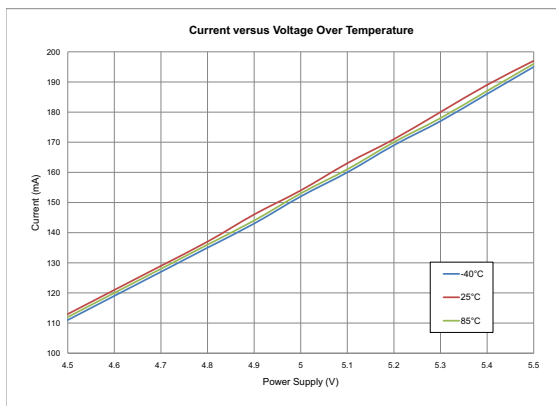
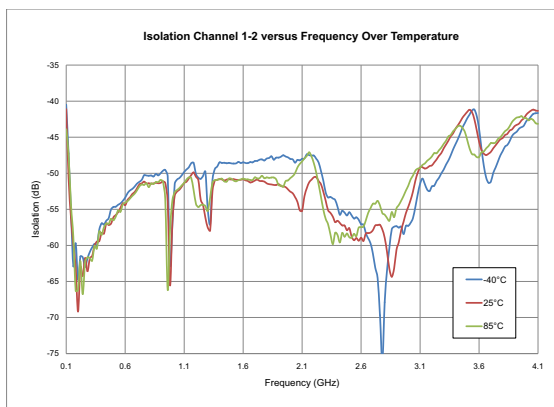
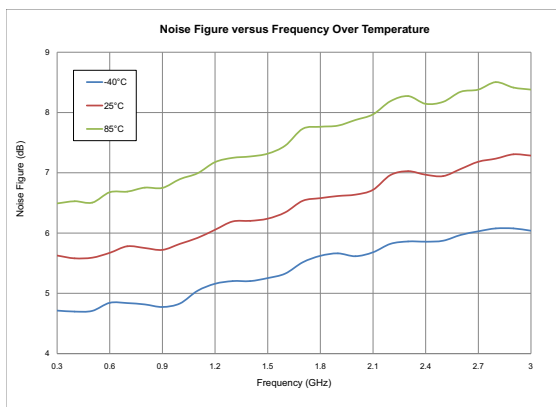
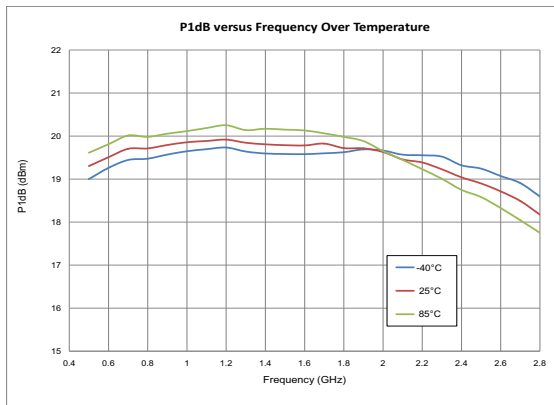
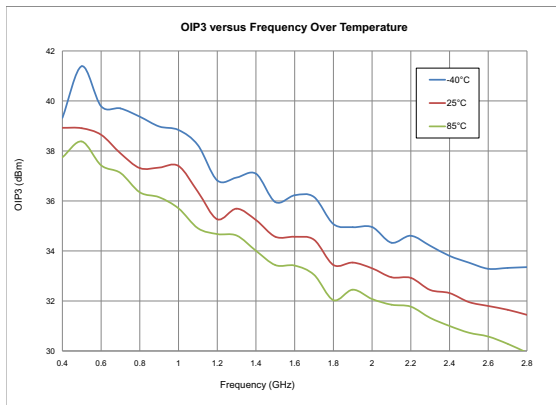
## Typical Broadband Performance $V_{CC} = 5.0V$ , $I_{CC} = 155mA$



Typical Broadband Performance  $V_{CC} = 5.0V$ ,  $I_{CC} = 155mA$



## Typical Broadband Performance $V_{CC} = 5.0V$ , $I_{CC} = 155mA$



### Truth Table

| Channel 1 Control Bit |     |    |    |    |    | Gain Relative to Maximum Gain |
|-----------------------|-----|----|----|----|----|-------------------------------|
| D11                   | D10 | D9 | D8 | D7 | D6 |                               |
| 1                     | 1   | 1  | 1  | 1  | 1  | 0dB                           |
| 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                       |

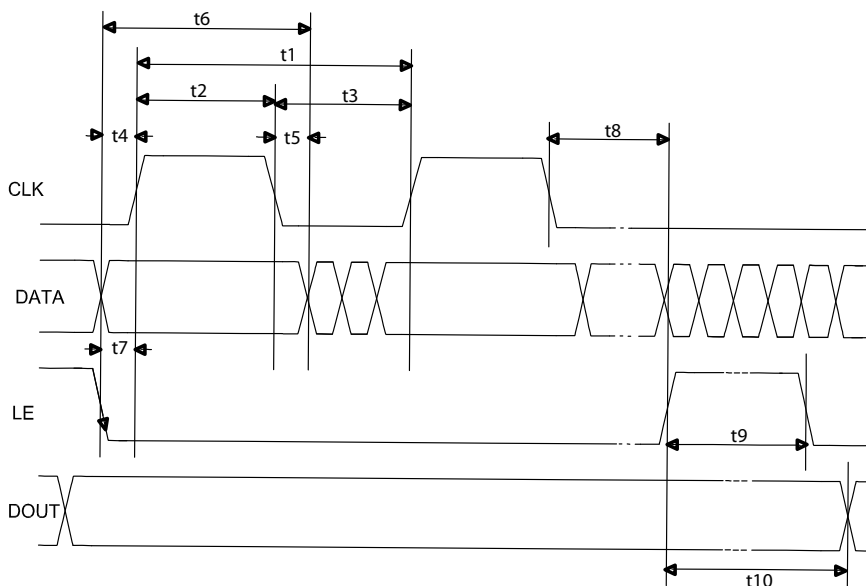
| Channel 2 Control Bit |    |    |    |    |    | Gain Relative to Maximum Gain |
|-----------------------|----|----|----|----|----|-------------------------------|
| D5                    | D4 | D3 | D2 | D1 | D0 |                               |
| 1                     | 1  | 1  | 1  | 1  | 1  | 0dB                           |
| 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                       |

| Power-up Programming Truth Table |                            |
|----------------------------------|----------------------------|
| PUP                              | Attenuator Setting         |
| High                             | Attenuation at min, 0dB    |
| Low                              | Attenuation at max, 31.5dB |

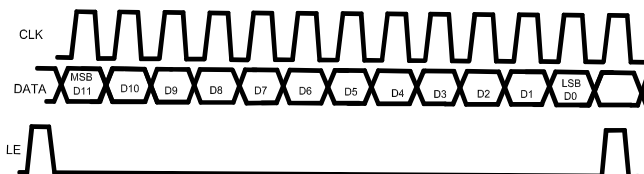
| Logic Voltage Levels |              |
|----------------------|--------------|
| State                | Logic        |
| Low                  | 0V to 0.8V   |
| High                 | 2.0V to 5.0V |

## Serial Port Interface

### SPI Timing Diagram



### Programming Example - 12 Bit



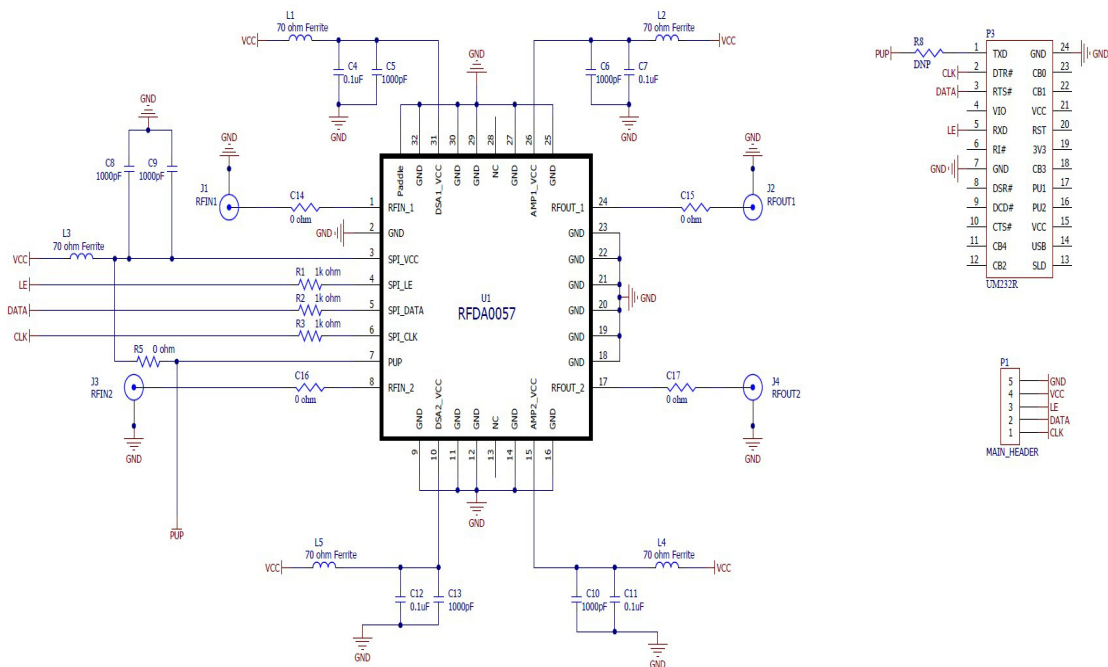
### SPI Timing Diagram Specifications

| Parameter | Limit | Unit    | Comment                |
|-----------|-------|---------|------------------------|
| t1        | 25    | MHz max | CLK Frequency          |
| t2        | 20    | ns min  | CLK High               |
| t3        | 20    | ns min  | CLK Low                |
| t4        | 5     | ns min  | DATA to CLK Setup Time |
| t5        | 5     | ns min  | DATA to CLK Hold Time  |
| t6        | 30    | ns min  | DATA Valid             |
| t7        | 5     | ns min  | LE to CLK Setup Time   |
| t8        | 5     | ns min  | CLK to LE Setup Time   |
| t9        | 10    | ns min  | LE Pulse Width         |
| t10       | 20    | ns max  | Output Set             |

### Pin Names and Descriptions

| Pin | Name     | Description                    |
|-----|----------|--------------------------------|
| 1   | RFIN_1   | AMP 1 RF Input                 |
| 2   | GND      | RF/DC Ground Connection        |
| 3   | SPI_VCC  | Supply Voltage for SPI Chip    |
| 4   | SPI_LE   | Serial Latch Enable Input      |
| 5   | SPI_DATA | Serial Data Input              |
| 6   | SPI_CLK  | Serial Clock Input             |
| 7   | PUP      | Power-up Programming Pin       |
| 8   | RFIN_2   | AMP 2 RF Input                 |
| 9   | GND      | RF/DC Ground Connection        |
| 10  | DSA2_VCC | Supply Voltage for DSA2 Chip   |
| 11  | GND      | RF/DC Ground Connection        |
| 12  | GND      | RF/DC Ground Connection        |
| 13  | NC       | No Connect                     |
| 14  | GND      | RF/DC Ground Connection        |
| 15  | AMP2_VCC | Supply Voltage for Amplifier 2 |
| 16  | GND      | RF/DC Ground Connection        |
| 17  | RFOUT_2  | AMP 2 RF Output                |
| 18  | GND      | RF/DC Ground Connection        |
| 19  | GND      | RF/DC Ground Connection        |
| 20  | GND      | RF/DC Ground Connection        |
| 21  | GND      | RF/DC Ground Connection        |
| 22  | GND      | RF/DC Ground Connection        |
| 23  | GND      | RF/DC Ground Connection        |
| 24  | RFOUT_1  | AMP 1 RF Output                |
| 25  | GND      | RF/DC Ground Connection        |
| 26  | AMP1_VCC | Supply Voltage for Amplifier 1 |
| 27  | GND      | RF/DC Ground Connection        |
| 28  | NC       | No Connect                     |
| 29  | GND      | RF/DC Ground Connection        |
| 30  | GND      | RF/DC Ground Connection        |
| 31  | DSA1_VCC | Supply Voltage for DSA1 Chip   |
| 32  | GND      | RF/DC Ground Connection        |

## Evaluation Schematic - 400MHz to 2700MHz Application Circuit

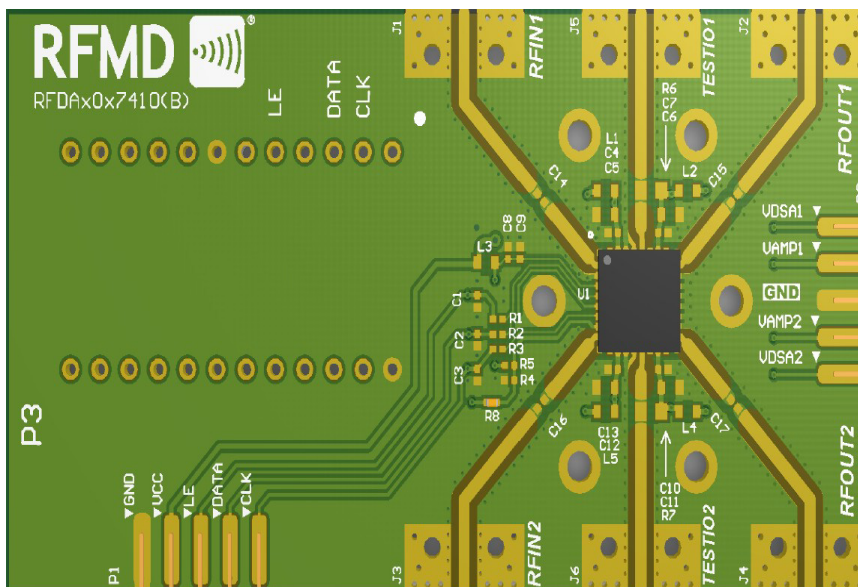


## Evaluation Board Build of Materials

### 400MHz to 2700MHz Application Circuit

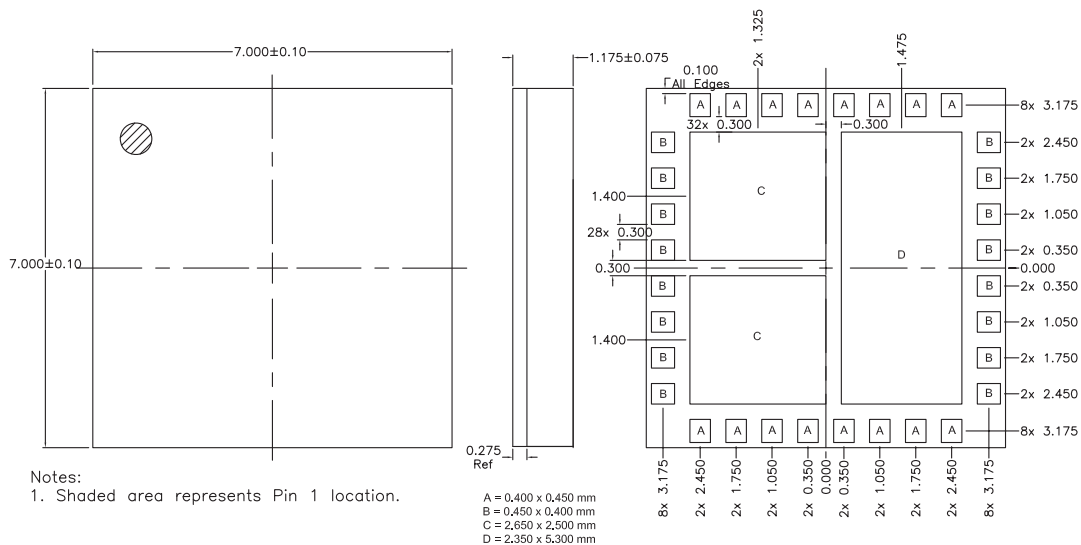
| Description                          | Reference Designator      | Manufacturer       | Manufacturer's P/N |
|--------------------------------------|---------------------------|--------------------|--------------------|
| RFDAx0x7, PCB                        |                           | DDI                | RFDAx0x7410        |
| RFDA0057SB                           | U1                        | RFMD               | RFDA0057           |
| RES, 0Ω, 0402                        | C14-C17, R5               | Kamaya, Inc        | RMC1/16SJPTH       |
| CAP, 1000pF, 10%, 50V, X7R, 0402     | C1-C3, C5-C6, C8-C10, C13 | Murata Electronics | GRM155R71H102KA01E |
| CAP, 0.1μF, 10%, 16V, X7R, 0603      | C4, C7, C11-C12           | Murata Electronics | GRM188R71C104KA01D |
| FER, BEAD, 70Ω, 4A, 0603             | L1-L5                     | Murata Electronics | BLM18SG700TN1D     |
| RES, 1K, 5%, 1/16W, 0402             | R1-R3                     | KOA Speer          | RK73B1ETTP102J     |
| CONN, SMA, END LNCH, RND PIN, 0.059" | J1-J4                     | Gigalane           | PSF-S01-006        |
| CONN, HDR, ST, PLRZD, 5-PIN, 0.100"  | P1                        | ITW Pancon         | MPSS100-5-C        |

## 400MHz to 2700MHz Application Circuit

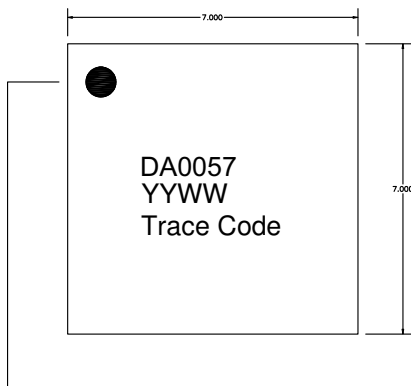


## Package Drawing

### 7.0mm x 7.0mm Laminate Module



## Branding Drawing



Pin 1 Indicator

Fill in the YYWW Notation with the Date Code

YY = Year

WW = Week

Trace Code to be assigned by SubCon