

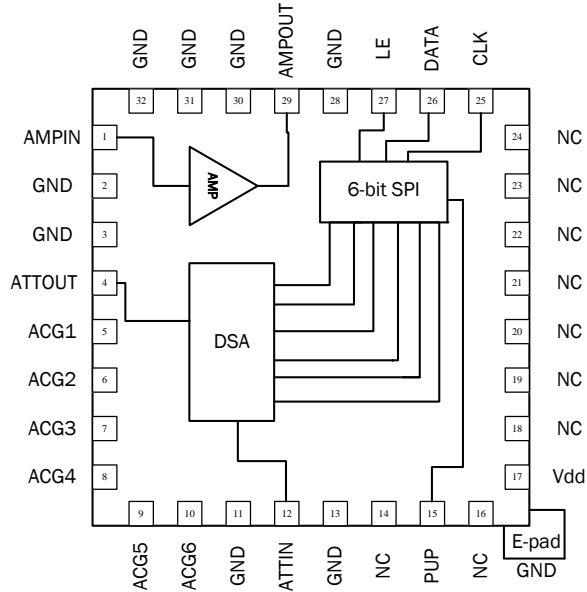


### Features

- Broadband 50MHz to 4000MHz Operation
- 6-Bit Digital Step Attenuator
- Serial Mode Programming
- Gain = -13.5dB to +18dB (0.5dB Step Size)
- High OIP3/P1dB = +36dB/20dBm
- Single +5V Supply
- Small 32-Pin, 5.2mm x 5.2mm, MCM (Footprint Compatible with 5mm x 5mm 32-Pin QFN)

### Applications

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



Functional Block Diagram

### Product Description

RFMD's RDA1005L is a digitally controlled variable gain amplifier featuring high linearity over the entire gain control range with noise figure less than 6dB in its maximum gain state. The gain of the 6-bit digital step attenuator is programmed with a serial mode control interface. The RDA1005L is packaged in a small 5.2mm x 5.2mm leadless laminate MCM which contains plated through thermal vias for ultra-low thermal resistance. The footprint for this module is directly compatible with a 5mm x 5mm QFN. This module is easy to use with no external matching components required.

### Ordering Information

|                 |   |
|-----------------|---|
| RDA1005LSQ      | Sample bag with 25 pieces                     |
| RDA1005LSR      | 7" Sample reel with 100 pieces                |
| RDA1005LTR7     | 7" Reel with 750 pieces                       |
| RDA1005LTR13    | 13" Reel with 2500 pieces                     |
| RDA1005LPCK-410 | 50MHz to 4000MHz 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                |                                    |

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## Absolute Maximum Ratings

| Parameter                                  | Rating          | Unit            |
|--|-----------------|-----------------|
| Supply Voltage                             | +5.5            | V <sub>DC</sub> |
| DC Supply Current                          | 110             | mA              |
| Power Dissipation                          | 605             | mW              |
| Max RF Input Power                         | 20              | dBm             |
| Operating Temperature (T <sub>CASE</sub> ) | -40 to +85      | °C              |
| Storage Temperature                        | -40 to +150     | °C              |
| Junction Temp                              | 165*            | °C              |
| ESD Rating (HBM)                           | 1000 (Class 1C) | V               |
| Moisture Sensitivity Level                 | MSL3            |                 |

\* 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.

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RFMD Green: RoHS compliant per EU Directive 2002/95/EC, halogen free per IEC 61249-2-21, < 1000ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

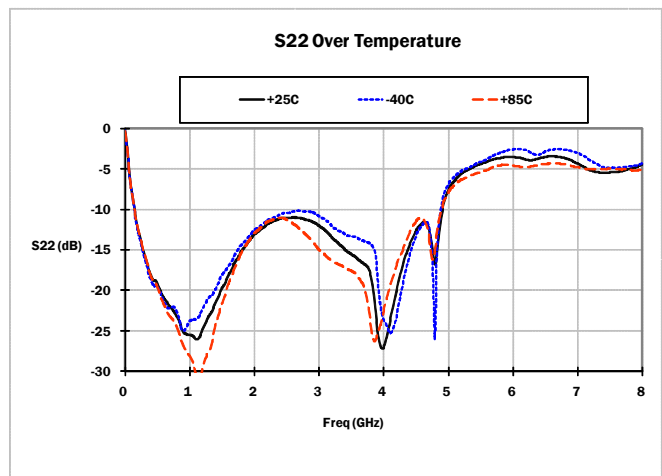
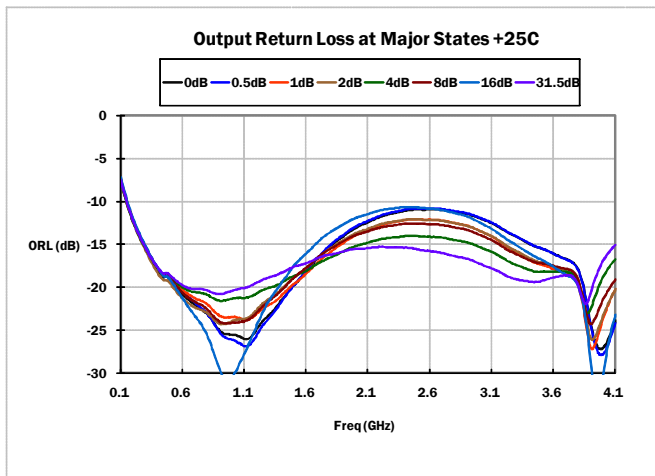
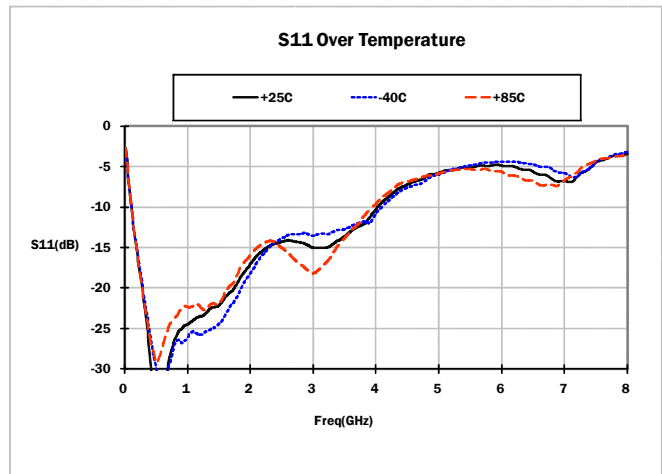
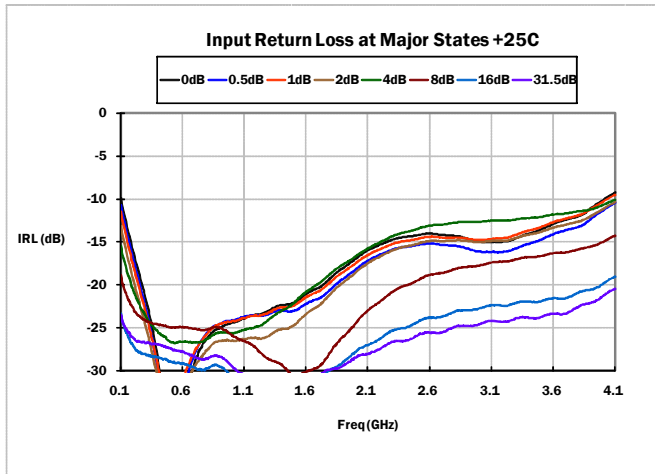
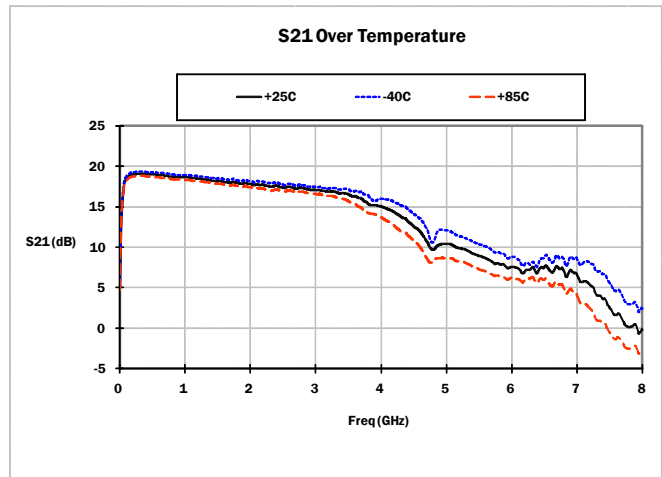
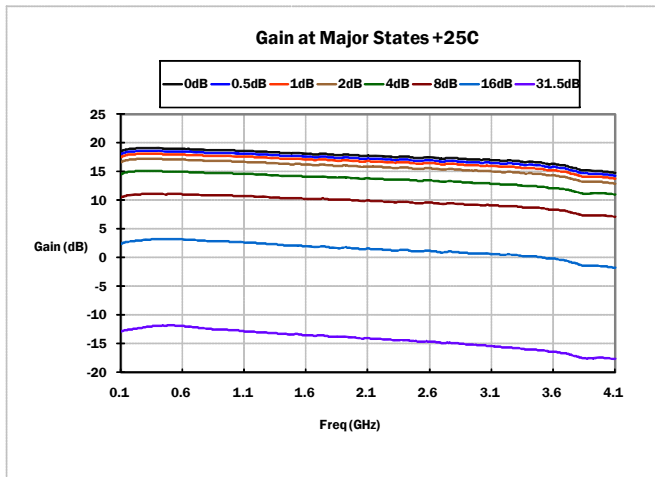
| Parameter                 | Specification                  |      |      | Unit | Condition                                      |
|---------------------------|--------------------------------|------|------|------|--|
|                           | Min.                           | Typ. | Max. |      |  |
| <b>General Parameters</b> |                                |      |      |      | TA = 25 °C, V <sub>DD</sub> = 5V               |
| <b>Frequency Range</b>    | 50                             |      | 4000 | MHz  |  |
| Gain Max 500MHz           | 17.5                           | 19.0 | 20.5 | dB   | Attenuation = 0dB                              |
| Gain Max 2700MHz          | 15.5                           | 17.5 | 18.5 | dB   |  |
| Step Accuracy             | ±(0.1 +5% attenuation setting) |      |      | dB   | Major state max error up to 2700MHz            |
| Output P1dB 1900MHz       |                                | 20   |      | dBm  | Attenuation = 0dB                              |
| Output P1dB 2700MHz       |                                | 19   |      | dBm  |  |
| Output IP3 1900MHz        |                                | 36   |      | dBm  |  |
| Output IP3 2700MHz        |                                | 33   |      | dBm  |  |
| Control Interface         |                                | 6    |      | bit  | Serial mode                                    |
| Settling Time             |                                | 250  |      | ns   | t <sub>ON</sub> , t <sub>OFF</sub> (10/90% RF) |
| Noise Figure 1900MHz      |                                | 6.3  |      | dB   | Attenuation = 0dB                              |
| Impedance                 |                                | 50   |      | Ω    |  |
| Input Return Loss         |                                | -15  |      | dB   |  |
| Output Return Loss        |                                | -15  |      | dB   |  |
| Supply Voltage            | 4.75                           | 5.0  | 5.25 | V    |  |
| Supply Current            |                                | 82   |      | mA   |  |
| Thermal Resistance        |                                | 80.7 |      | °C/W | Junction to backside of device                 |

## Typical RF Performance at Key Operating Frequencies

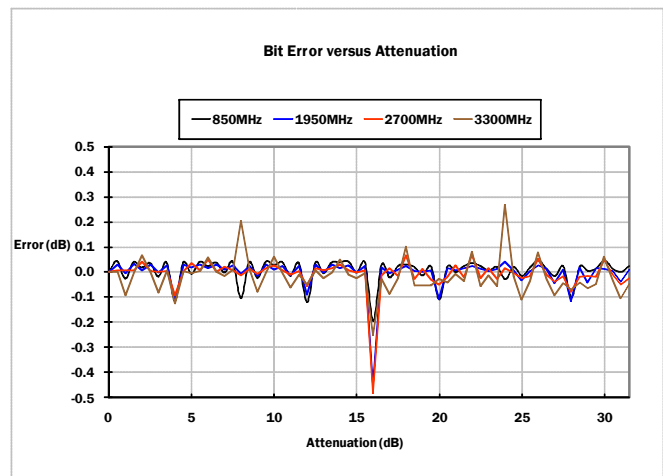
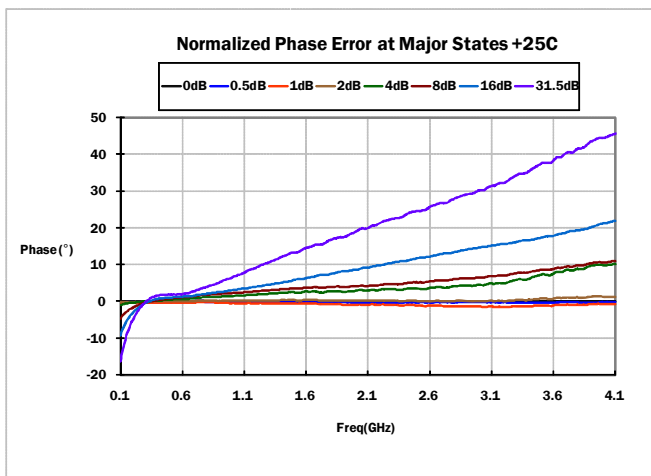
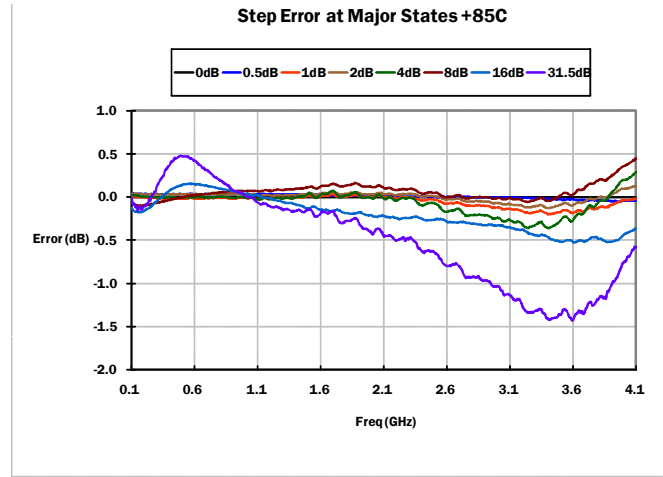
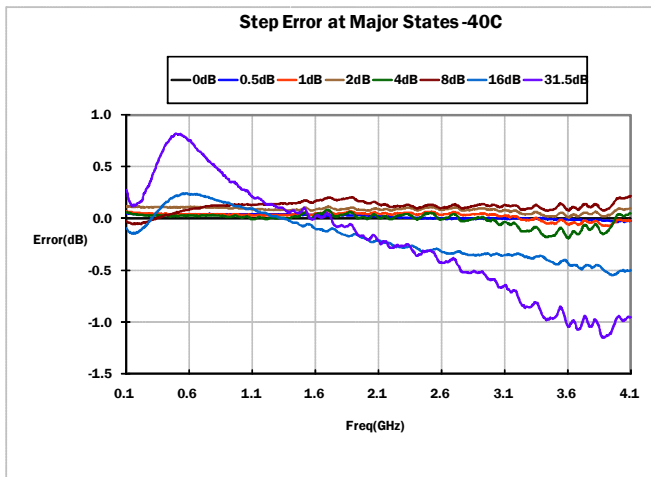
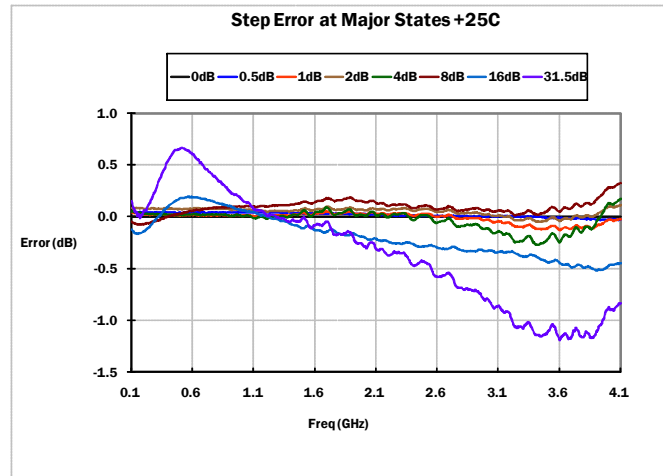
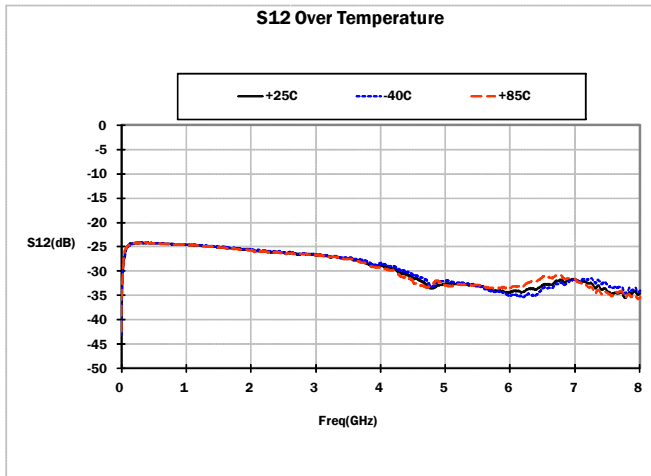
(Note: Broadband Application Circuit)

| Parameter                 | Unit | 500MHz | 850MHz | 1.95GHz | 2.4GHz | 3.5GHz | 4GHz |
|---------------------------|------|--------|--------|---------|--------|--------|------|
| Maximum Small Signal Gain | dB   | 18.9   | 18.7   | 17.6    | 17.2   | 15.7   | 13.7 |
| Output P1dB               | dBm  | 20.5   | 20.4   | 20.4    | 19.4   | 16.9   | 14.7 |
| Output IP3                | dBm  | 39     | 40     | 36      | 34.8   | 28.5   | 27.1 |
| Input Return Loss         | dB   | -36    | -24    | -16     | -15    | -14    | -10  |
| Output Return Loss        | dB   | -18    | -22    | -15     | -11    | -16    | -27  |
| Noise Figure              | dB   | 5.5    | 5.5    | 5.9     | 6.2    | -      | -    |

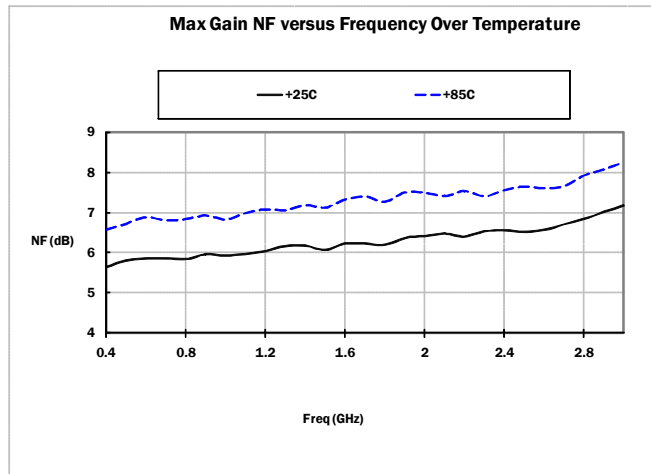
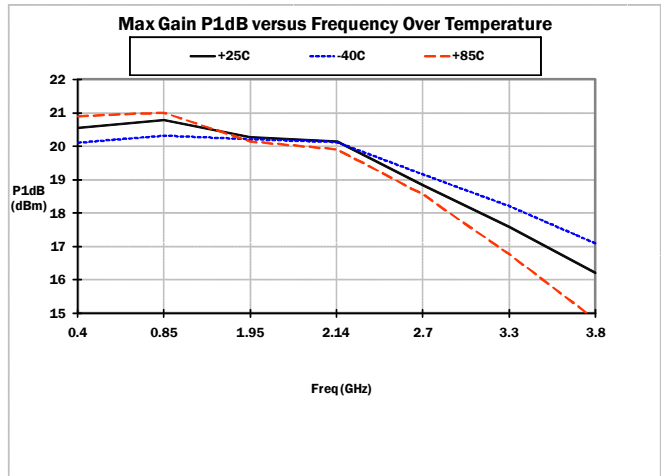
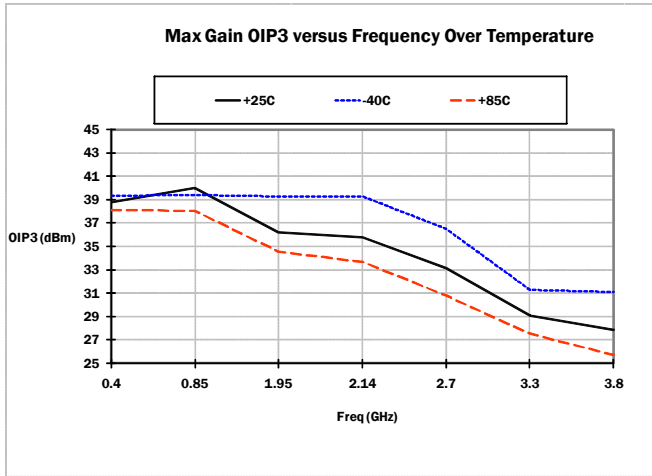
### Typical Performance - Broadband Application Circuit



## Typical Performance - Broadband Application Circuit



**Typical Performance - Broadband Application Circuit**

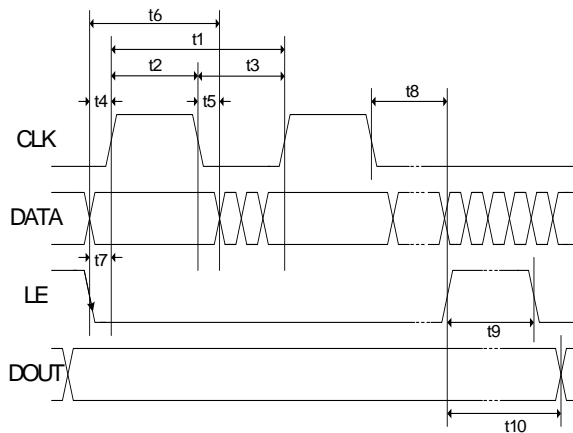


## Truth Table

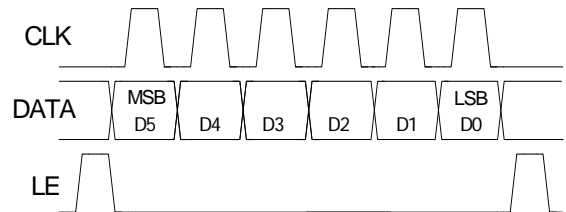
| Control Bit |    |    |    |    |    | Gain Relative to Maximum Gain |
|-------------|----|----|----|----|----|-------------------------------|
| D5          | D4 | D3 | D2 | D1 | D0 |                               |
| 1           | 1  | 1  | 1  | 1  | 1  | 0dB                           |
| 1     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

## Serial Port Interface:

SPI Timing Diagram



Programming example - 6-bit



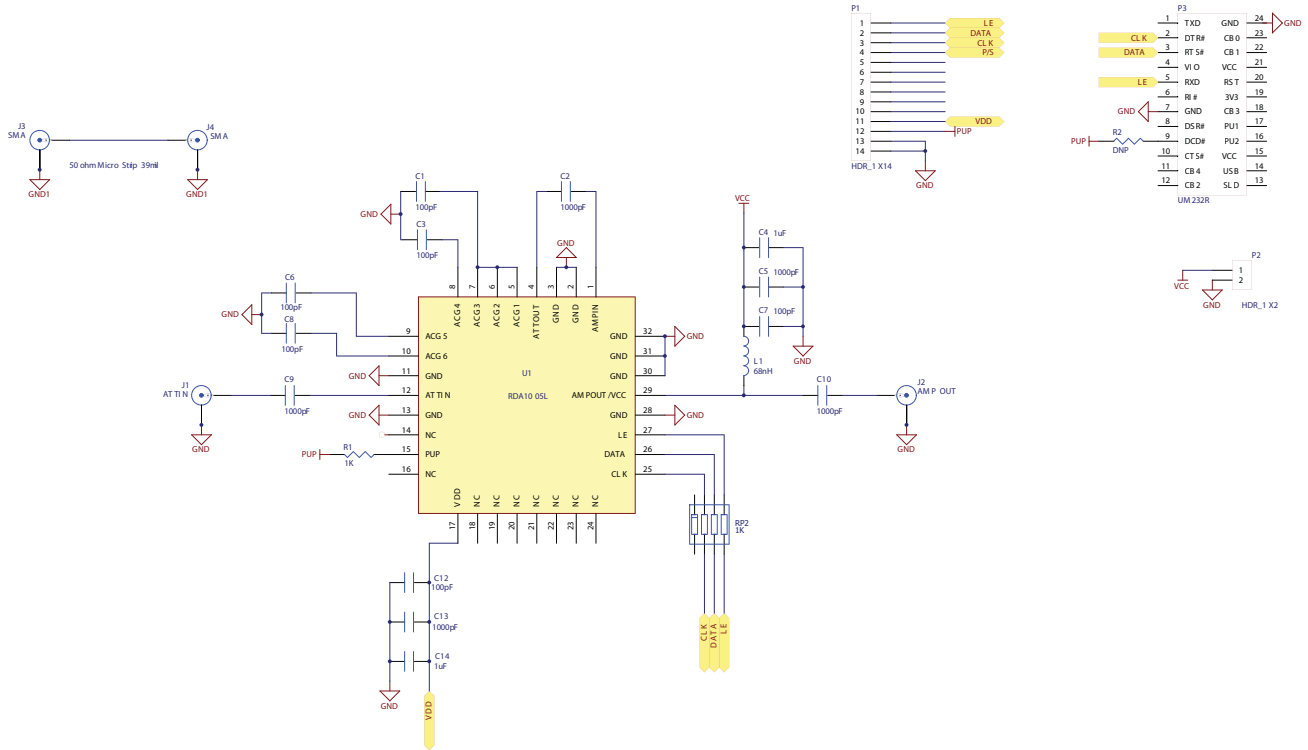
## Specifications: SPI Timing Diagram

| 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             |

| Control Voltage Table |                        |                        |
|-----------------------|------------------------|------------------------|
| State                 | V <sub>DD</sub> = +3V  | V <sub>DD</sub> = +5V  |
| Low                   | 0V to 0.8V             | 0V to 0.8V             |
| High                  | 2.0 to V <sub>DD</sub> | 2.0 to V <sub>DD</sub> |

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

## Evaluation Board Schematic



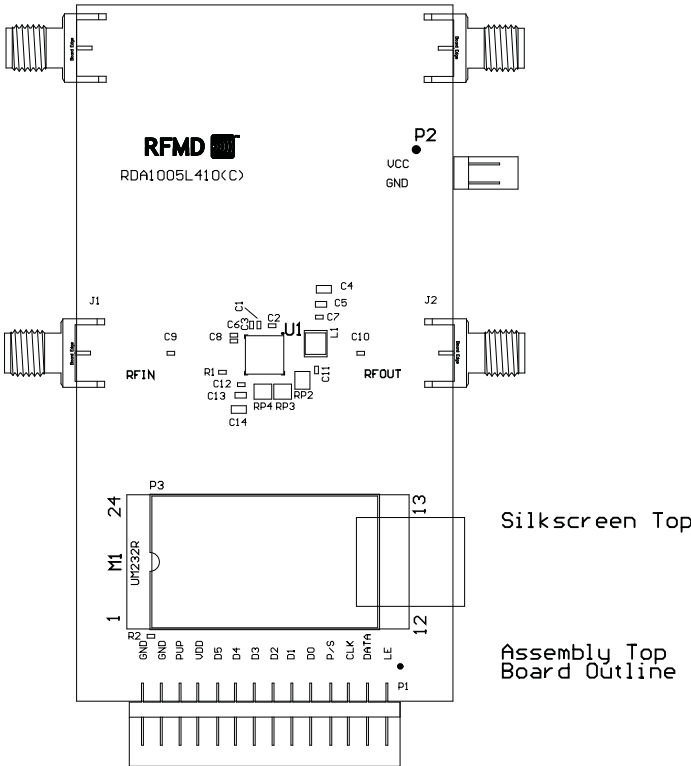
## Evaluation Board Bill of Materials (BOM)

| Description                                 | Reference Designator | Manufacturer                    | Manufacturer's P/N |
|---|----------------------|---------------------------------|--------------------|
| RDA1005L w/USB Evaluation Board             | PCB Itself           | Dynamic Details (DDI) Toronto   | RDA1005L410(C)     |
| RDA1005L, 5.2 x 5.2 sq. mm, 32-Pin Laminate | U1                   | RFMD                            | RDA1005LSB         |
| CAP, 1000pF, 10%, 50V, X7R, 0402            | C2, C9-C10           | Murata Electronics              | GRM155R71H102KA01E |
| CAP, 1µF, 10%, 16V, X7R, 0805               | C4, C14              | Murata Electronics              | GRM21BR71C105KA01K |
| CAP, 1000pF, 10%, 50V, X7R, 0603            | C5, C13              | Murata Electronics              | GRM188R71H102KA01D |
| CAP, 100pF, 5%, 50V, COG, 0402              | C1, C3, C6-C8, C12   | Murata Electronics              | GRM1555C1H101JD01D |
| IND, 68nH, 5%, W/W, 0603                    | L1                   | Coilcraft                       | 1008CS-680XJLC     |
| RES ARRAY, 4-ELEM, 1K, 5%, SMD 4 X 0402     | R1                   | Panasonic Industrial            | ERJ-2RKF1001       |
| RES ARRAY, 4-ELEM, 1K, 5%, SMD 4 X 0402     | RP2                  | KOA                             | CN1E4KTTD102J      |
| CONN, SMA, END LNCH, FLT, 0.062"            | J1-J4                | Emerson Network Power           | 142-0701-821       |
| CONN, HDR, ST, PLRZD, 14-PIN, 0.100"        | P1                   | ITW Pancon                      | MPSS100-14-C       |
| CONN, HDR, ST, PLRZD, 2-PIN, 0.100"         | P2                   | ITW Pancon                      | MPSS100-2-C        |
| CONN, SKT, 24-Pin DIP, 0.600", T/H          | P3                   | Aries Electronics Inc.          | 24-6518-10         |
| MOD, USB TO SERIAL UART, SSOP-28            | M1 [1]               | Future Technology Devices Int'l | UM232R             |
| DNP or DNI                                  | C11, R2, RP3-RP4     | N/A                             | N/A                |

Notes:

[1] M1 is to be mounted into P3 with respect to the Pin 1 alignment of M1 and P3.

## Evaluation Board Assembly Drawing

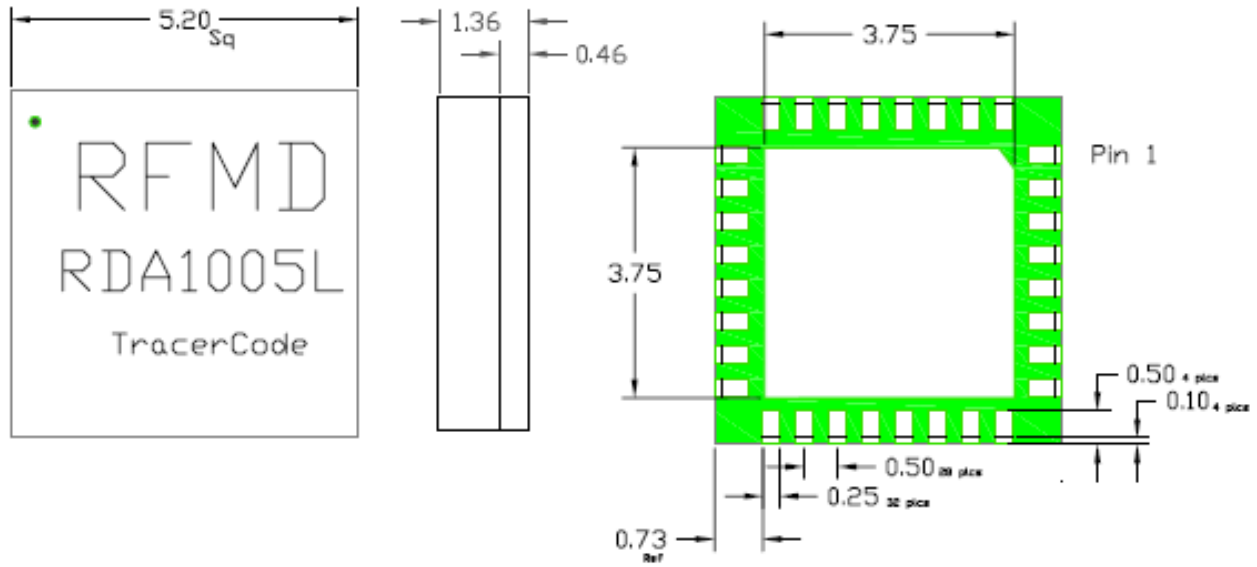




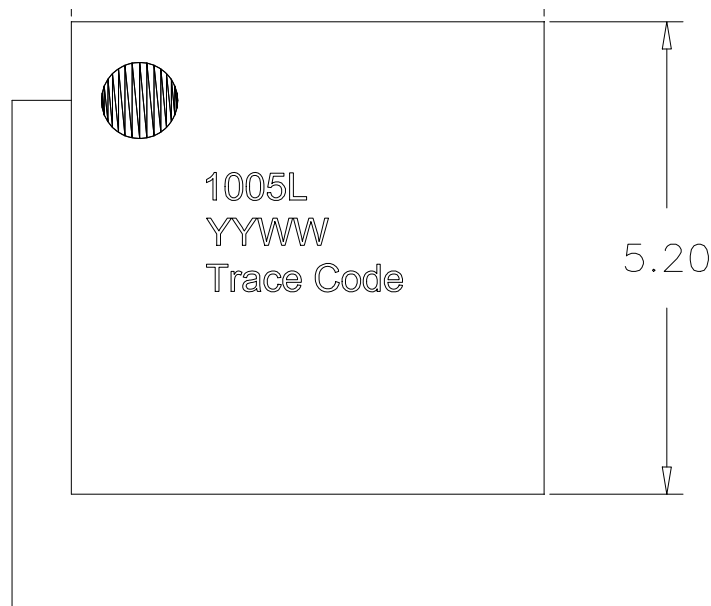
### Pin Names and Descriptions

| Pin | Name          | Description  |
|-----|---------------|--|
| 1   | <b>AMPIN</b>  | RF Amplifier Input.  |
| 2   | <b>GND</b>    | RF/DC Ground Connection.   |
| 3   | <b>GND</b>    | RF/DC Ground Connection.   |
| 4   | <b>ATTOUT</b> | Digital Attenuator Output.   |
| 5   | <b>ACG1</b>   | Place external capacitor to ground.  |
| 6   | <b>ACG2</b>   | Place external capacitor to ground.  |
| 7   | <b>ACG3</b>   | Place external capacitor to ground.  |
| 8   | <b>ACG4</b>   | Place external capacitor to ground.  |
| 9   | <b>ACG5</b>   | Place external capacitor to ground.  |
| 10  | <b>ACG6</b>   | Place external capacitor to ground.  |
| 11  | <b>GND</b>    | RF/DC Ground Connection.   |
| 12  | <b>ATTIN</b>  | Digital Attenuator Input.  |
| 13  | <b>GND</b>    | RF/DC Ground Connection.   |
| 14  | <b>NC</b>     | No connection; leave open or ground.   |
| 15  | <b>PUP</b>    | Power up programming pin.<br>Low = Max attenuation setting at power up, -31.5dB<br>High = Min attenuation setting at power up, 0dB |
| 16  | <b>NC</b>     | No Connection, leave open or GND.  |
| 17  | <b>VDD</b>    | Supply Voltage.  |
| 18  | <b>NC</b>     | No Connection, leave open or GND.  |
| 19  | <b>NC</b>     | No Connection, leave open or GND.  |
| 20  | <b>NC</b>     | No Connection, leave open or GND.  |
| 21  | <b>NC</b>     | No Connection, leave open or GND.  |
| 22  | <b>NC</b>     | No Connection, leave open or GND.  |
| 23  | <b>NC</b>     | No Connection, leave open or GND.  |
| 24  | <b>NC</b>     | No Connection, leave open or GND.  |
| 25  | <b>CLK</b>    | Serial Clock.  |
| 26  | <b>DATA</b>   | Serial Data.   |
| 27  | <b>LE</b>     | Latch Enable.  |
| 28  | <b>GND</b>    | RF/DC Ground Connection.   |
| 29  | <b>AMPOUT</b> | RF Amplifier Output.   |
| 30  | <b>GND</b>    | RF/DC Ground Connection.   |
| 31  | <b>GND</b>    | RF/DC Ground Connection.   |
| 32  | <b>GND</b>    | RF/DC Ground Connection.   |

## Package Drawing 5.2mm x 5.2mm Laminate Module



## Branding Diagram



Pin 1 Indicator  
YY = Year  
WW = Week

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