

RFSA3715

5MHz to 4000MHz, Digital Step Attenuator

The RFMD's RFSA3715 is a 7-bit digital step attenuator (DSA) that features high linearity over the entire 31.75dB gain control range with 0.25dB steps. The RFSA3715 features three modes of control: serial addressable, latched parallel and direct parallel programming. The RFSA3715 has a low insertion loss of 1.5dB at 2GHz. Patent pending circuit architecture providing overshoot-free transient switching performance. External address pins allow up to eight DSAs to be controlled on a single bus. The RFSA3715 is available in a 5mm x 5mm QFN package.



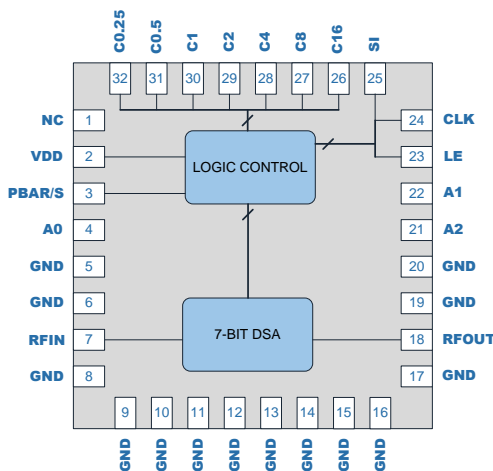
Package: QFN, 32-pin,
5.0mm x 5.0mm x 0.85mm

Features

- 7-Bit, 31.75dB Range, 0.25dB Step
- Patent Pending Circuit Architecture
- Overshoot-free Transient Switching Performance
- Frequency Range 5MHz to 4000MHz
- High Linearity, IIP3 >55dBm
- Serial and Parallel Control Interface
- Fast Switching Speed, <120nsec
- Serial Addressable Supports Up to Eight Addresses
- Single Supply 3V to 5V Operation
- RF Pins Have No DC Voltage, Can Be DC Grounded Externally
- Power-up Default Setting is Maximum Attenuation

Applications

- 2G through 4G Base Stations
- Point-to-Point
- WiMax/WiFi
- Test Equipment



Functional Block Diagram

Ordering Information

| | |
|-----------------|--|
| RFSA3715SQ | Sample bag with 25 pieces |
| RFSA3715SR | 7" Reel with 100 pieces |
| RFSA3715TR13 | 13" Reel with 2500 pieces |
| RFSA3715PCK-410 | 5MHz to 4000MHz PCBA with 5-piece sample bag |

Absolute Maximum Ratings

| Parameter | Rating | Unit |
|--|------------------|------|
| Supply Voltage (V_{DD}) | -0.5 to +6.0 | V |
| All Other DC and Logic Pins | -0.5 to V_{DD} | V |
| Maximum Input Power at RFIN Pin at 85°C | +30 | dBm |
| Maximum Input Power at RFOUT Pin at 85°C | +27 | dBm |
| Storage Temperature Range | -40 to +150 | °C |
| ESD Rating - Human Body Model (HBM) | 1000 | V |
| Moisture Sensitivity Level | MSL1 | |



Caution! ESD sensitive device.



RFMD Green: RoHS status based on EU Directive 2011/65/EU (at time of this document revision), 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.

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.

Recommended Operating Condition

| Parameter | Specification | | | Unit |
|--|---------------|-----|------|------|
| | Min | Typ | Max | |
| Operating Temperature Range (RF Input Power Handling Derates Above 85°C) | -40 | | +105 | °C |
| Operating Junction Temperature | | | 125 | °C |
| Supply Voltage | 2.7 | | 5.5 | V |

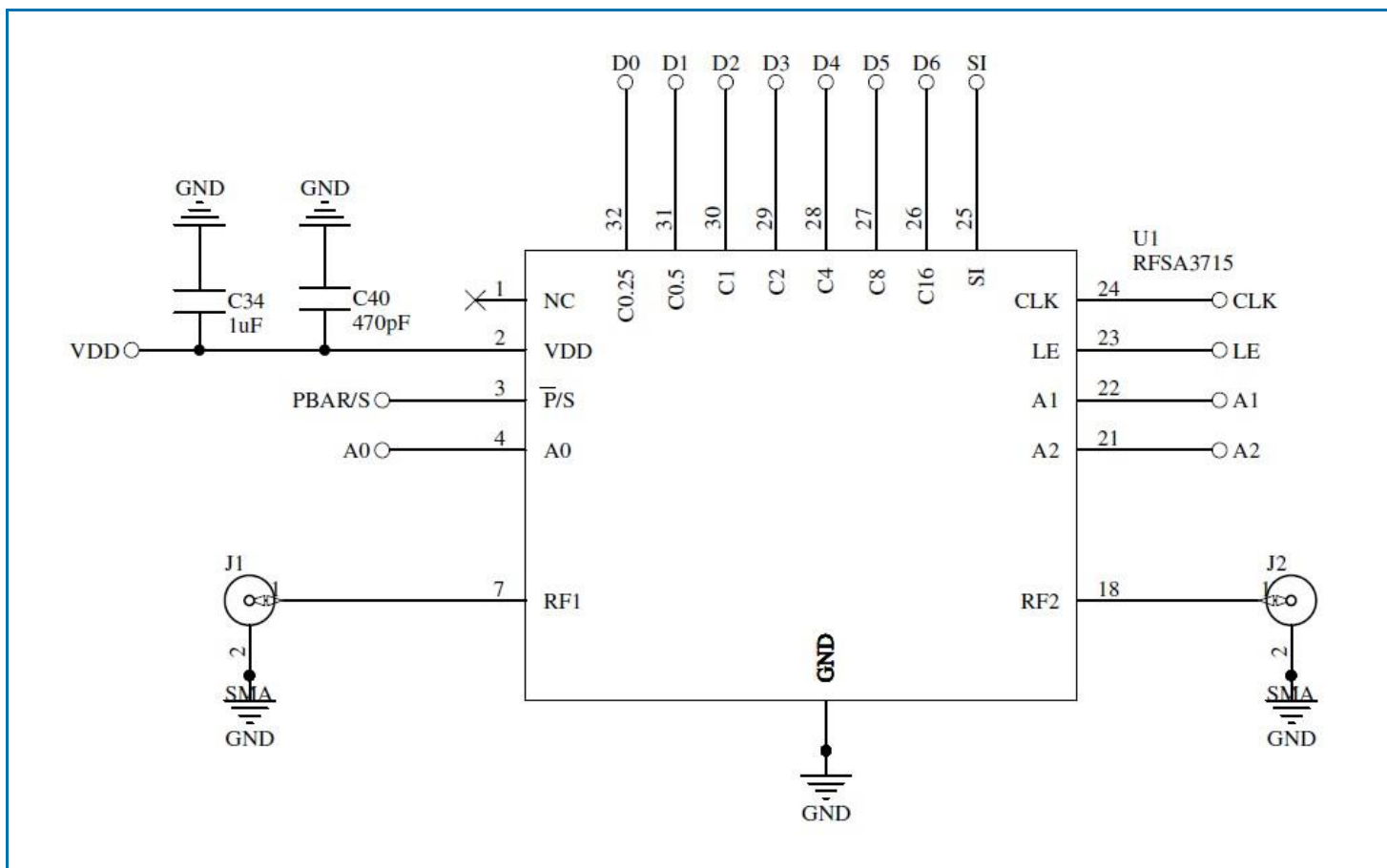
Nominal Operating Parameters

| Parameter | Specification | | | Unit | Condition |
|-----------------------------|---------------|-------|------|------|--|
| | Min | Typ | Max | | |
| General Performance | | | | | |
| Supply Current | | 180 | | μA | Steady state operation, current draw during attenuation state transitions is higher. |
| Thermal Resistance | | 55 | | °C/W | |
| RF Input Power at RFIN Pin | | | 27 | dBm | Continuous operation at +85°C case temperature |
| RF Input Power at RFOUT Pin | | | 20 | dBm | |
| RF Performance | | | | | |
| Frequency Range | 5 | | 4000 | MHz | |
| Insertion Loss | | 1.5 | | dB | 2000MHz, 0dB attenuation |
| Attenuation Range | | 31.75 | | dB | 0.25dB step size |
| Absolute Attenuation Error | ±(0.2 + 4%) | | | dB | |
| Input IP3 | | 55 | | dBm | |
| Input P0.1dB | | 30 | | dBm | |
| Return Loss | | 15 | | dB | |
| Input and Output Impedance | | 50 | | Ω | |

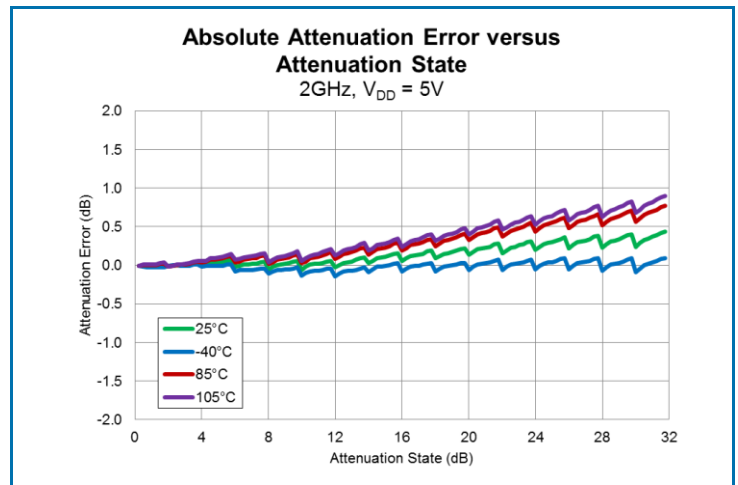
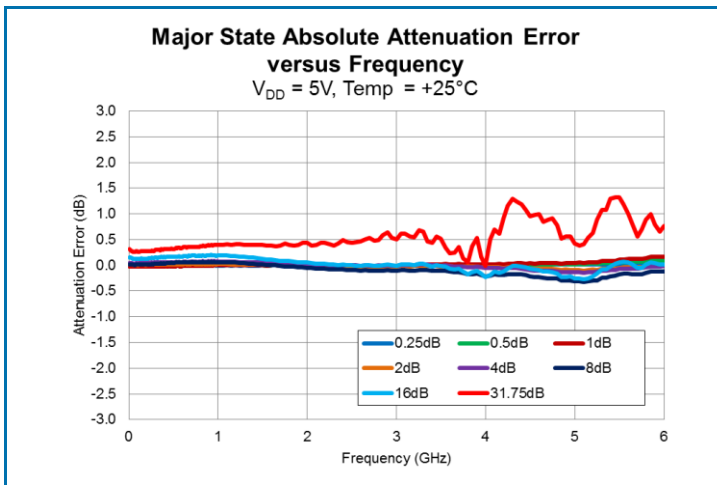
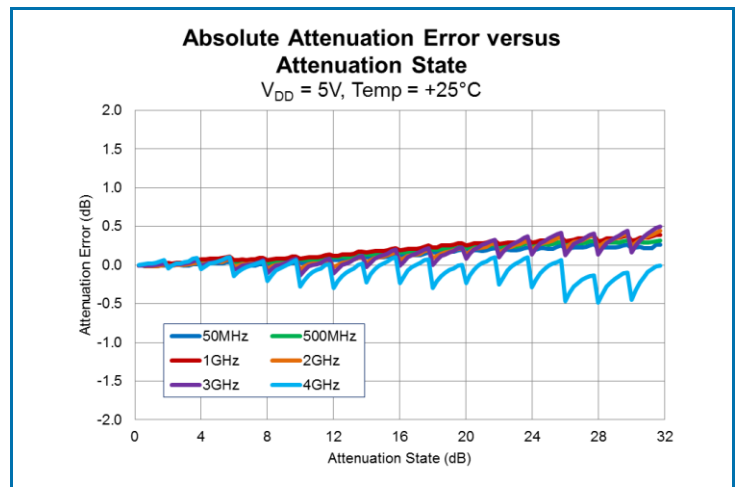
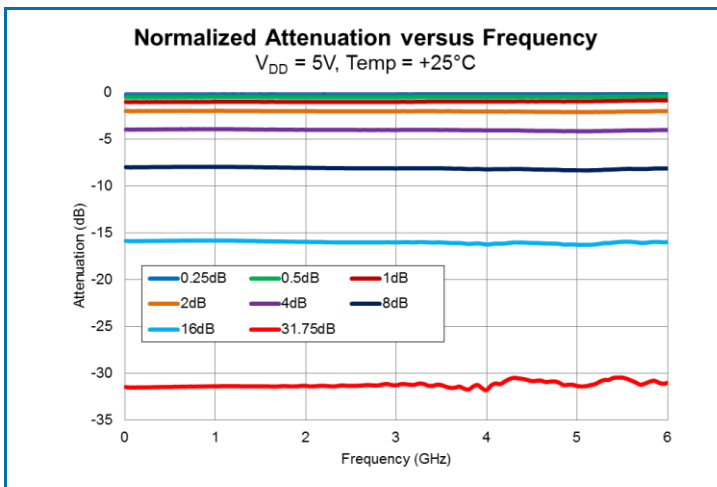
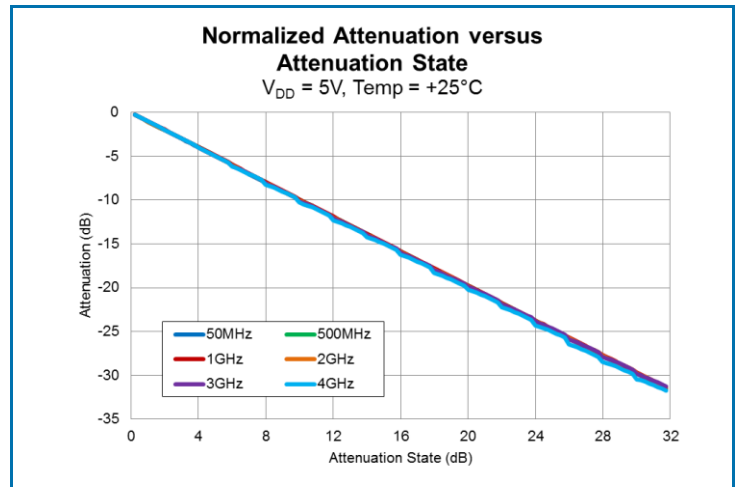
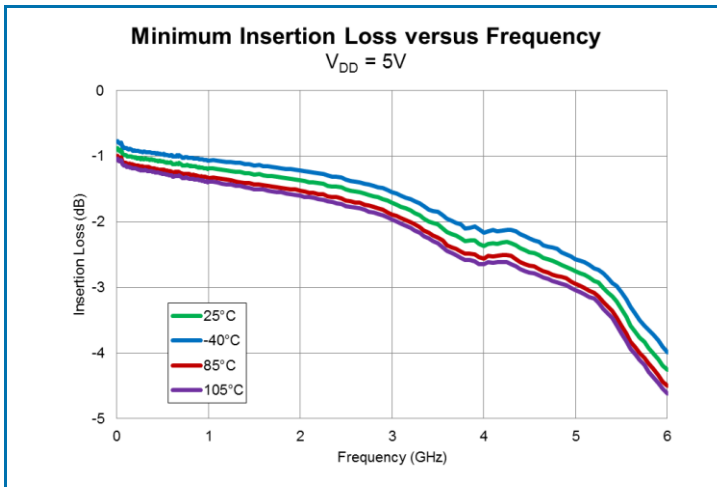
| Parameter | Specification | | | Unit | Condition |
|-----------------------------|---------------|-----|------|------|---------------------------|
| | Min | Typ | Max | | |
| General Performance | | | | | |
| Switching Speed | | 120 | | nsec | 50% control to 10%/90% RF |
| Successive Step Phase Delta | | 2 | | Deg | 2000MHz |
| Control | | | | | |
| Digital Logic Low | | | 0.63 | V | |
| Digital Logic High | 1.17 | | | V | |

Note: Typical performance at these conditions: +25°C, 2000MHz, 5V supply voltage

Typical Application Schematic

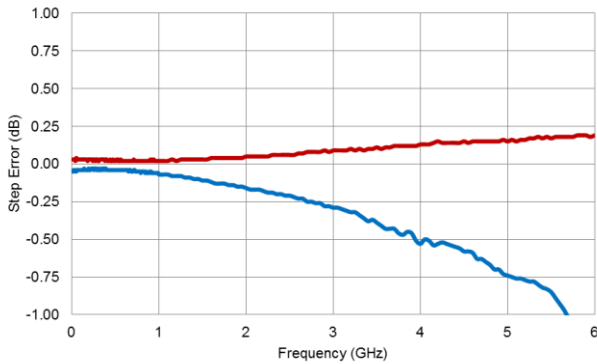


Typical Performance:

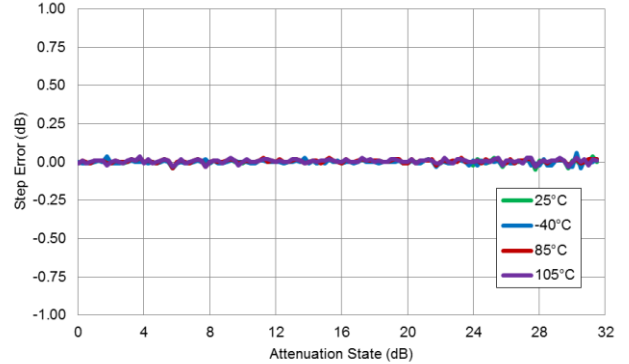


Typical Performance:

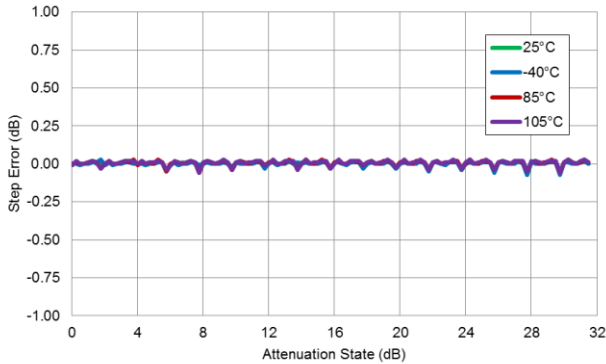
Worst Case Successive Step Error versus Frequency
0.25dB Steps, $V_{DD} = 5V$, Temp = +25°C



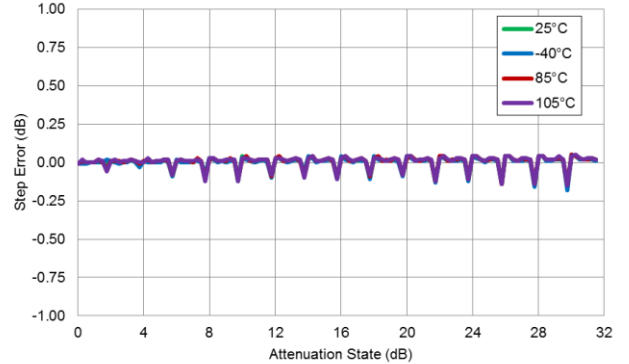
Successive Step Error versus Attenuation State
50MHz, 0.25dB Steps, $V_{DD} = 5V$



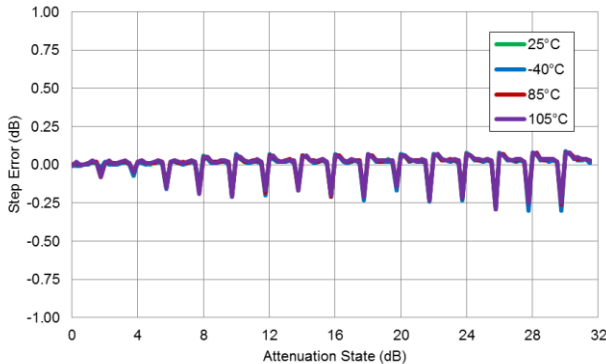
Successive Step Error versus Attenuation State
1GHz, 0.25dB Steps, $V_{DD} = 5V$



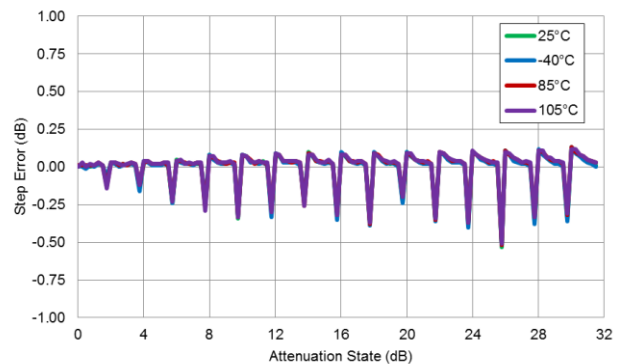
Successive Step Error versus Attenuation State
2GHz, 0.25dB Steps, $V_{DD} = 5V$



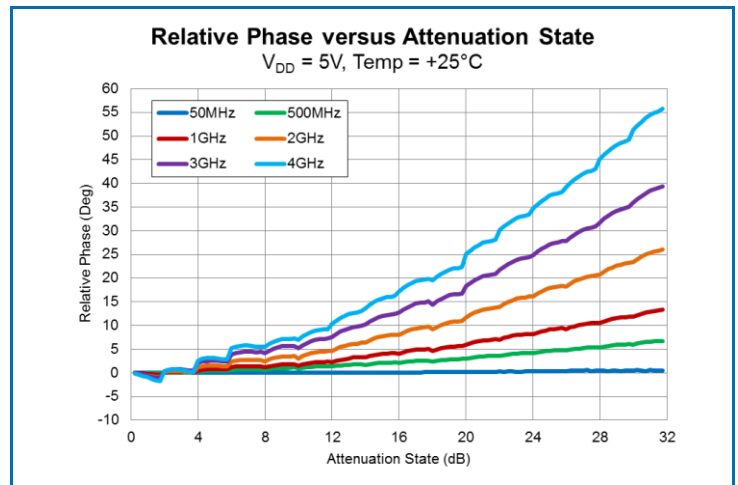
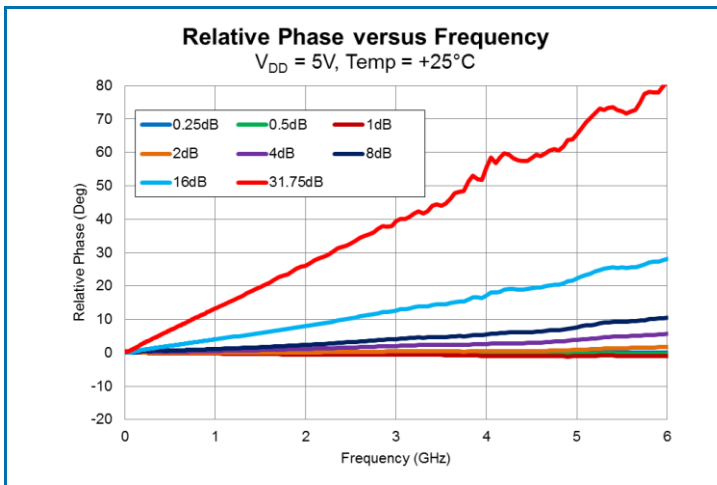
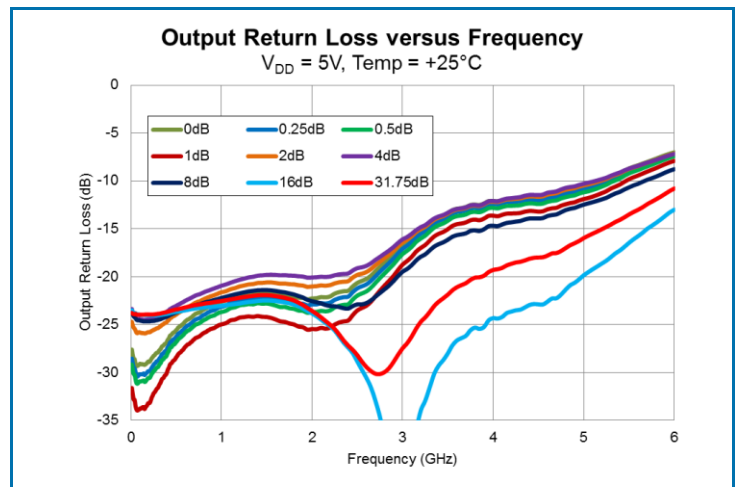
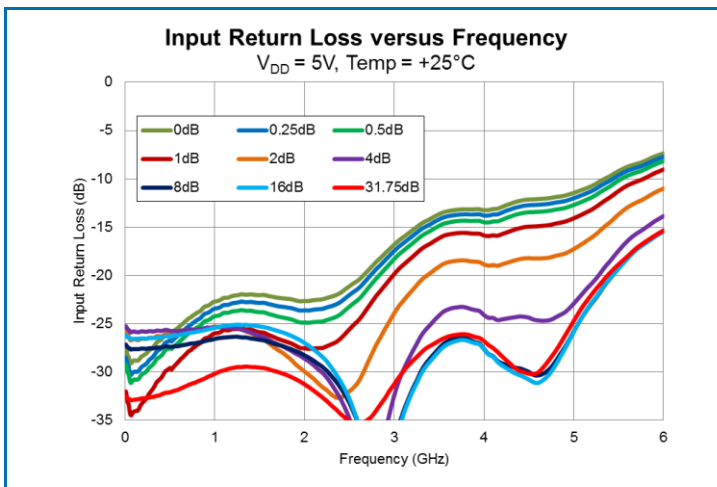
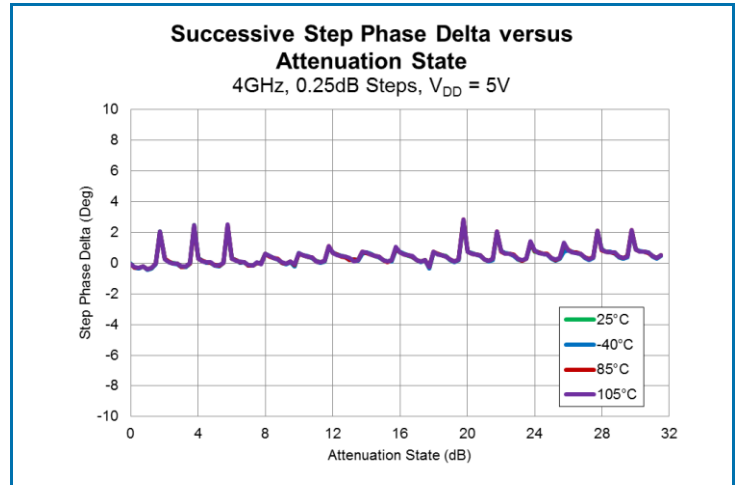
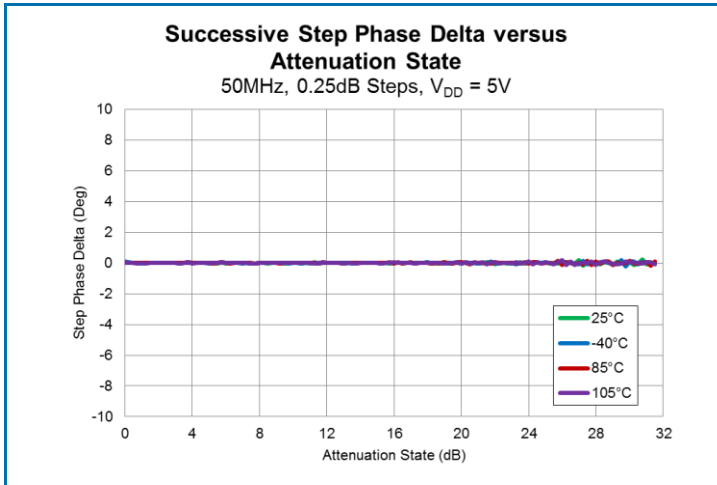
Successive Step Error versus Attenuation State
3GHz, 0.25dB Steps, $V_{DD} = 5V$



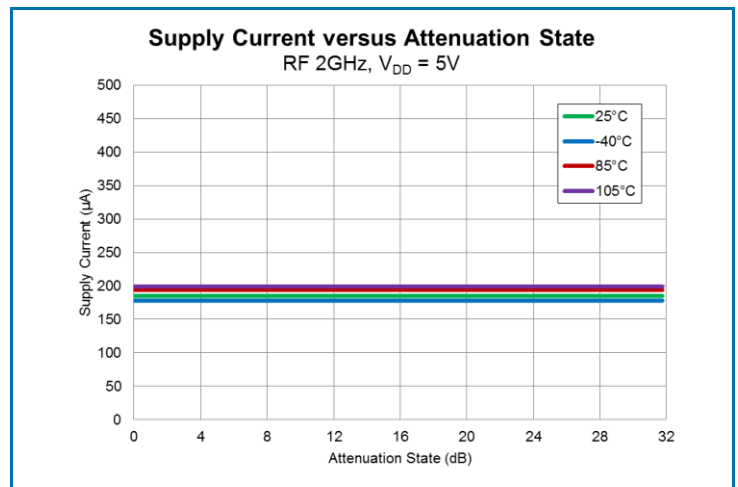
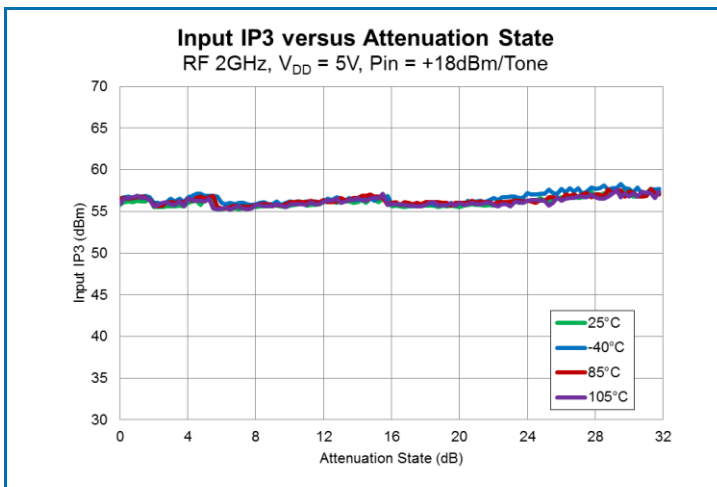
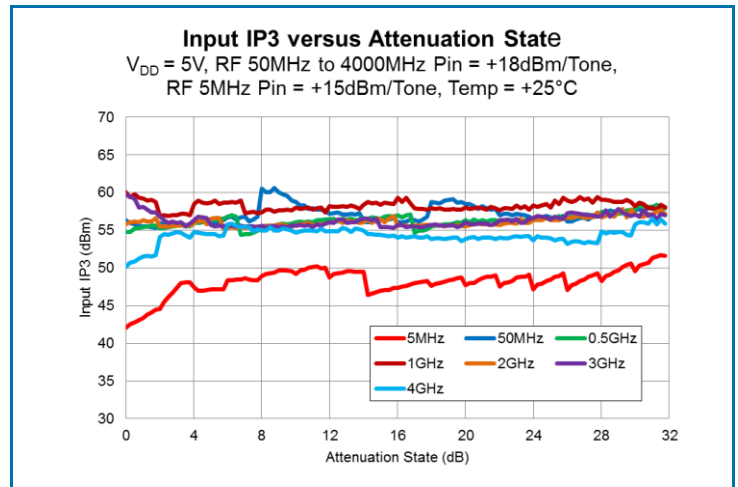
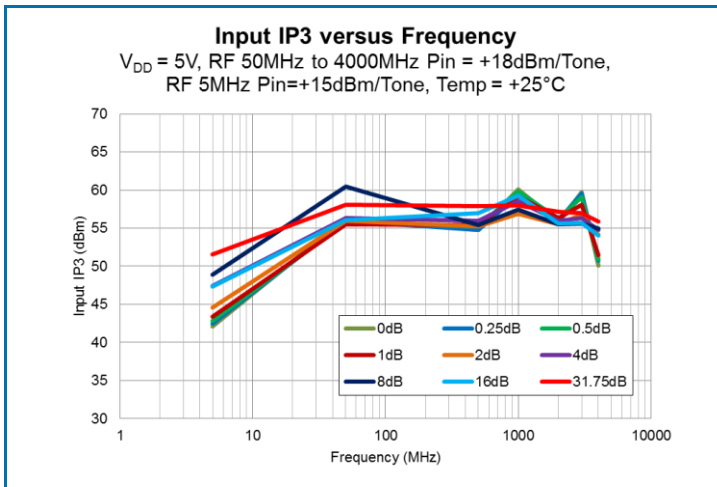
Successive Step Error versus Attenuation State
4GHz, 0.25dB Steps, $V_{DD} = 5V$



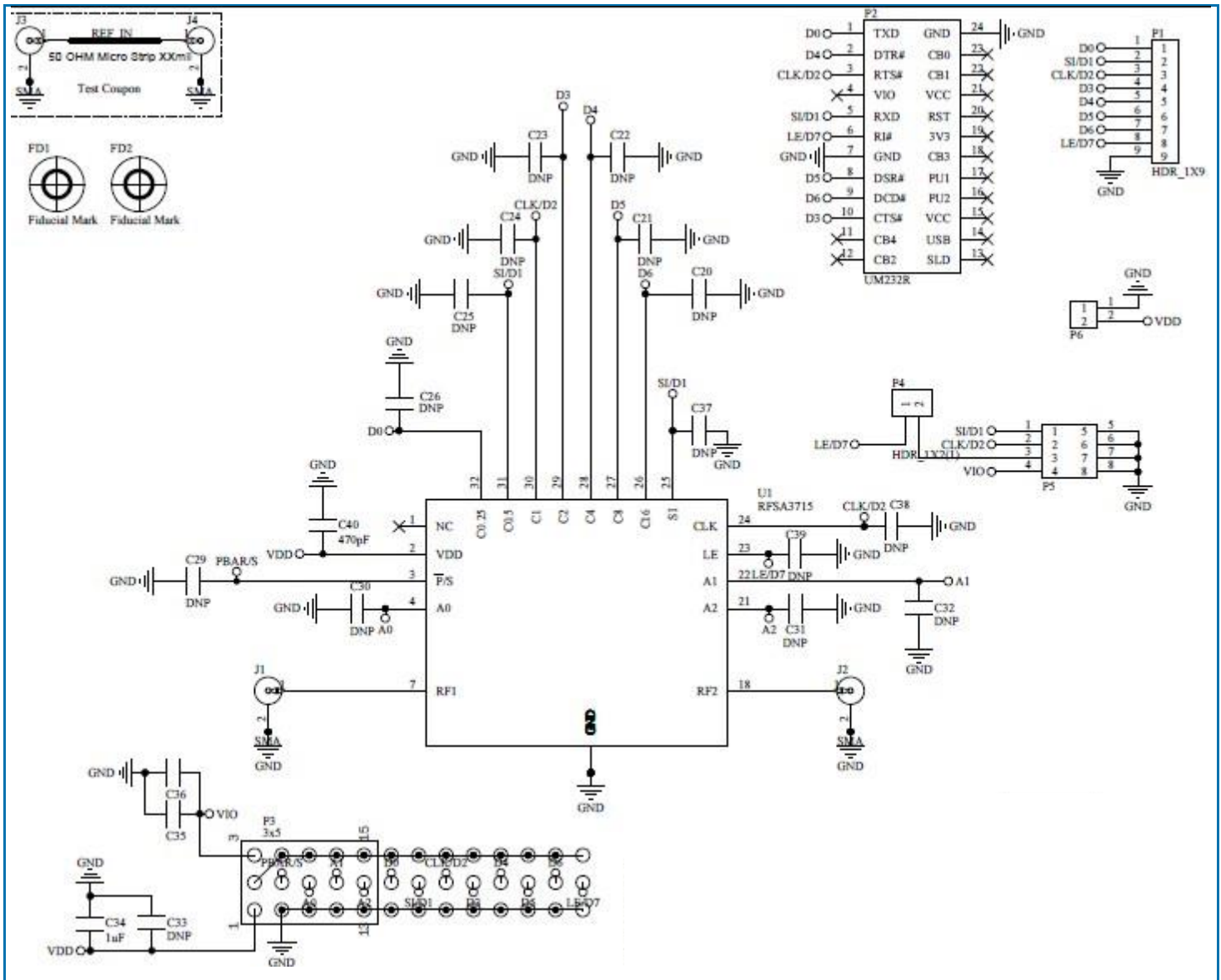
Typical Performance:



Typical Performance:



Evaluation Board Schematic



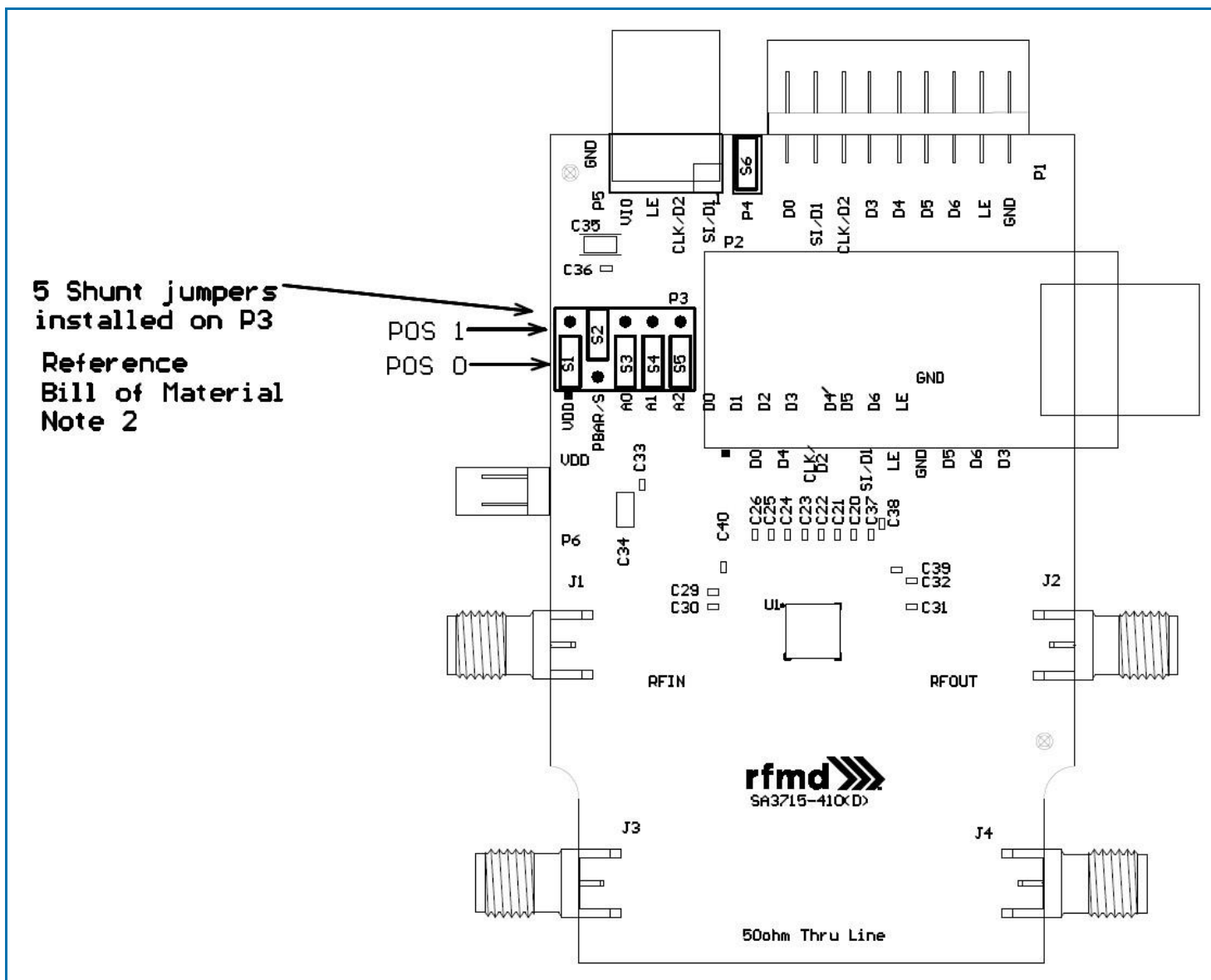
Evaluation Board Bill of Materials (BOM)

| Description | Reference Designator | Manufacturer | Manufacturer's P/N |
|---|-------------------------------|---------------------------------|--------------------|
| SA3715-410 | | Dynamic Details (DDI) Toronto | SA3715-410(D) |
| Digital Step Attenuator 5MHz to 4000MHz | U1 | RFMD | RFSA3715SB |
| CAP, 1 μ F, 10%, 25V, X7R, 1206 | C34 | Taiyo Yuden (USA), Inc. | CE TMK316BJ105KL-T |
| CONN, SMA, EL FLT VIPER, MAT-21-1038 | J1-J4 | Amphenol RF Asia Corporation | 901-10425 |
| CONN, HDR, ST, 9-PIN, 0.100" | P1 | Samtec Inc. | TSW-109-07-G-S |
| CONN, HDR, ST, PLRZD, 2-PIN, 0.100" | P6 | ITW Pancon | 24-6518-10 |
| CONN, HDR, ST, 3 x 5, 0.100", T/H | P3 | Samtec Inc. | TSW-105-07-L-T |
| CONN, HDR, ST, 2-PIN, 0.100" | P4 | Samtec Inc. | TSW-102-07-G-S |
| CONN, HDR, 2 x 4, RA, 0.100", T/H | P5 | Samtec Inc. | TSW-104-08-G-D-RA |
| CONN, SKT, 24-PIN DIP, 0.600", T/H | P2 | Aries Electronics Inc. | 24-6518-10 |
| MOD, USB TO SERIAL UART, SSOP-28 | M1 (See Note) | Future Technology Devices Int'l | UM232R |
| CAP, 470pF, 5%, 50V, C0G, 0402 | C40 | Murata Electronics | GRM1555C1H471JA01D |
| Jumper, 2-Pin | S1-S5 | 3M Interconnect Solutions | 929950-00 |
| DNP | C20-C26, C29-C33, C35-C39, S6 | N/A | N/A |

Notes:

1. M1 should be mounted into P2 with respect to the Pin 1 alignment of M1 and P2
2. Jumpers S1 thru S5 installed on P3

Evaluation Board Assembly Drawing



Evaluation Board Jumper Programming

| Jumpers | Connector | Signal | Position | U1 Connection | Comment |
|---------|-----------|---------------|-----------|--------------------|----------------------|
| S1 | P3 | Logic Voltage | 0 | VDD (From P6) | |
| | | | 1 | VIO (From P5) | |
| S2 | | PBar/S | 0 | GND | Parallel Mode |
| | | | 1 | U1_VDD | Serial Mode |
| S3 | | AO | 0 | GND | External Address |
| | | | 1 | U1_VDD | |
| S4 | | A1 | 0 | GND | External Address |
| | | | 1 | U1_VDD | |
| S5 | | A2 | 0 | GND | External Address |
| | | | 1 | U1_VDD | |
| S6 | P4 | LE | OPEN | LE | All Other Modes |
| | | | INSTALLED | LE (From P5 Pin 3) | Serial Mode Using P5 |

Note: Default jumper settings are **BOLD**.

Evaluation Board Programming Using USB Interface

Serial Addressable Mode

All programming jumpers on the evaluation board are set to the default values indicated in the table. Refer to the Control Bit Generator (CBG) Software Reference Manual for detailed instructions on how to setup the software for use. Apply the supply voltage to P6. Select 'RFSA3715' from the RFMD parts list of the CBG user interface. Set the attenuation value using the CBG user interface. The attenuator is set to the desired state and measurements can be taken. Note that the external address bits must all be set to '0' when using the USB interface as the CGB software does not have the capability to set the external address in the serial data stream at this time.

Latched Parallel Mode

Evaluation board programming jumper S2 is set to '0'. All other programming jumpers are not required and can be set to any position. Refer to the Control Bit Generator (CBG) Software Reference Manual for detailed instructions on how to setup the software for use. Apply the supply voltage to P6. Select 'RFSA3715-P' from the RFMD parts list of the CBG user interface. Set the attenuation value using the CBG user interface. The attenuator is set to the desired state and measurements can be taken.

Evaluation Board Programming Using External Bus

Serial Addressable Mode

This configuration allows the user to control the attenuator through the P5 connector using an external harness. Remove the USB interface board if it is currently installed on the evaluation board. Connect a user-supplied harness to the P5 connector. Note that the top row of P5 contains the serial bus signals and the bottom row is ground. Programming jumper S1 is set to '0' and S2 is set to '1'. External address jumpers S3 through S5 can be set to any value desired by the user. Jumper S6 is installed and allows the LE signal to be routed from the P5 connector to the attenuator. Apply the supply voltage to P6. Send the appropriate signals onto the serial bus lines in accordance with the Serial Addressable Mode Timing Diagram. The attenuator is set to the desired state and measurements can be taken.

Latched Parallel Mode

This configuration allows the user to control the attenuator through the P1 connector using an external harness. Remove the USB interface if it is currently installed on the evaluation board. Connect a user-supplied harness to the P1 connector. The parallel bus signal names for P1 are indicated on the evaluation board. Programming jumper S2 is set to '0' to select parallel mode. All other programming jumpers are not required and can be set to any position. Apply the supply voltage to P6. Send the appropriate signals onto the parallel bus lines in accordance with the Latched Parallel Mode Timing Diagram. The attenuator is set to the desired state and measurements can be taken.

Direct Parallel Mode

This configuration allows the user to control the attenuator through the P1 connector using an external harness. When using this mode the LE signal is held at logic high so that the attenuation will change immediately when there is a change in logic state for any of the parallel bus signals. Remove the USB interface if it is currently installed on the evaluation board. Connect a user-supplied harness to the P1 connector. The parallel bus signal names for P1 are indicated on the evaluation board. Programming jumper S2 is set to '0' to select parallel mode. All other programming jumpers are not required and can be set to any position. Apply the supply voltage to P6. Send the appropriate signals onto the parallel bus lines. The attenuator is set to the desired state and measurements can be taken.

Default Power-up State

This default attenuation state is maximum (31.75dB) when supply voltage is applied to the attenuator in both serial and parallel modes. If a different attenuation state is desired during power-up, this can be accomplished by applying signals according to the Parallel Mode Truth Table. The attenuator will power-up to the state applied to the parallel bus during turn on. The LE signal must be held to logic '0' during power-up.

Pin Names and Descriptions

| Pin | Name | Description |
|-----|--------|--|
| 1 | NC | No Connect |
| 2 | VDD | Supply Voltage |
| 3 | PBAR/S | Mode Select Pin Logic Low = Parallel Logic High = Serial |
| 4 | A0 | A0 External Address Pin |
| 5 | GND | Ground Pin |
| 6 | GND | Ground Pin |
| 7 | RFIN | RF Input Pin, Incident RF power must enter this pin for rated thermal performance and reliability. Do not apply DC power to this pin. Pin may be DC grounded externally and is grounded thru resistors internal to the part. |
| 8 | GND | Ground Pin |
| 9 | GND | Ground Pin |
| 10 | GND | Ground Pin |
| 11 | GND | Ground Pin |
| 12 | GND | Ground Pin |
| 13 | GND | Ground Pin |
| 14 | GND | Ground Pin |
| 15 | GND | Ground Pin |
| 16 | GND | Ground Pin |
| 17 | GND | Ground Pin |
| 18 | RFOUT | RF Output Pin; Do not apply DC power to this pin. Pin may be DC grounded externally and is grounded thru resistors internal to the part. |
| 19 | GND | Ground Pin |
| 20 | GND | Ground Pin |
| 21 | A2 | A2 External Address Pin |
| 22 | A1 | A1 External Address Pin |
| 23 | LE | Latch Enable, The leading edge of signal on LE causes the attenuator to change setting for serial and latched parallel modes. For direct parallel mode keep LE at a logic high level. |
| 24 | CLK | Serial Clock Input |
| 25 | SI | Serial Data Input |
| 26 | C16 | 16dB Parallel Control Bit |
| 27 | C8 | 8dB Parallel Control Bit |
| 28 | C4 | 4dB Parallel Control Bit |
| 29 | C2 | 2dB Parallel Control Bit |
| 30 | C1 | 1dB Parallel Control Bit |
| 31 | C0.5 | 0.5dB Parallel Control Bit |
| 32 | C0.25 | 0.25dB Parallel Control Bit |

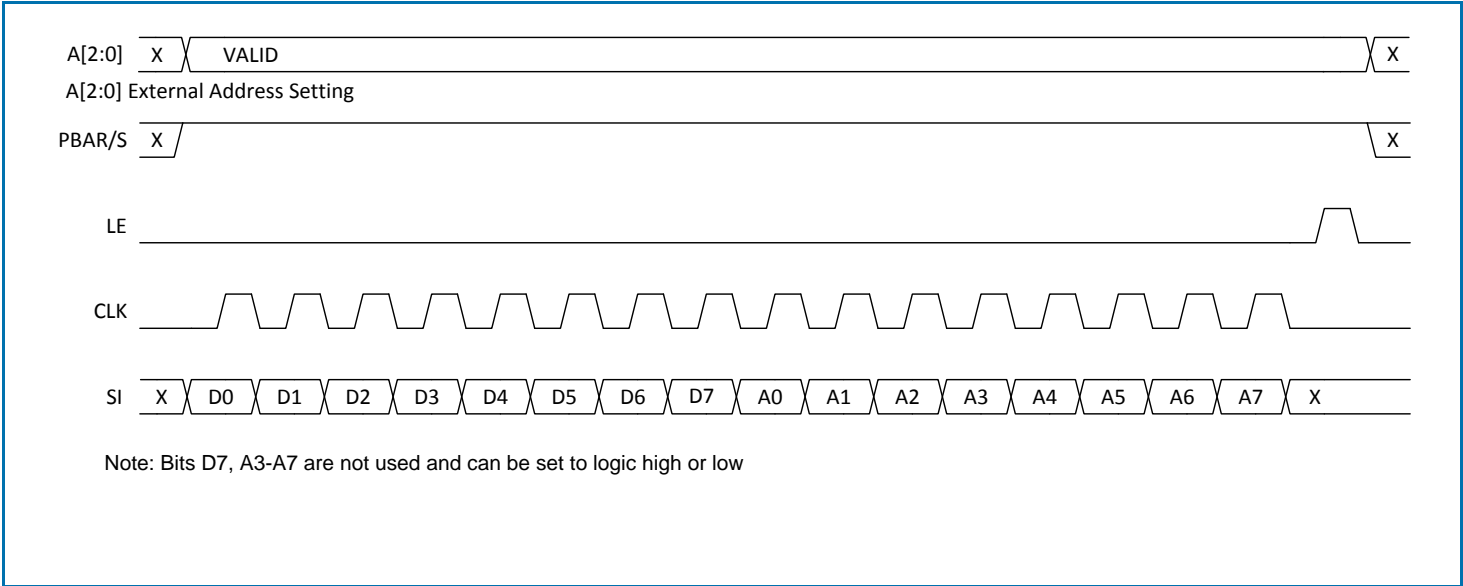
Serial Addressable Mode Attenuation Word Truth Table

| Attenuation Word | | | | | | | | Attenuation State |
|------------------|----|----|----|----|----|----|----------|--------------------------------|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 (LSB) | |
| X | L | L | L | L | L | L | L | 0dB / Reference Insertion Loss |
| X | L | L | L | L | L | L | H | 0.25dB |
| X | L | L | L | L | L | H | L | 0.5dB |
| X | L | L | L | L | H | L | L | 1dB |
| X | L | L | L | H | L | L | L | 2dB |
| X | L | L | H | L | L | L | L | 4dB |
| X | L | H | L | L | L | L | L | 8dB |
| X | H | L | L | L | L | L | L | 16dB |
| X | H | H | H | H | H | H | H | 31.75dB |

Serial Addressable Mode Address Word Truth Table

| Address Word | | | | | | | | Address Setting |
|--------------|----|----|----|----|----|----|----|-----------------|
| A7 (MSB) | A6 | A5 | A4 | A3 | A2 | A1 | A0 | |
| X | X | X | X | X | L | L | L | 000 |
| X | X | X | X | X | L | L | H | 001 |
| X | X | X | X | X | L | H | L | 010 |
| X | X | X | X | X | L | H | H | 011 |
| X | X | X | X | X | H | L | L | 100 |
| X | X | X | X | X | H | L | H | 101 |
| X | X | X | X | X | H | H | L | 110 |
| X | X | X | X | X | H | H | H | 111 |

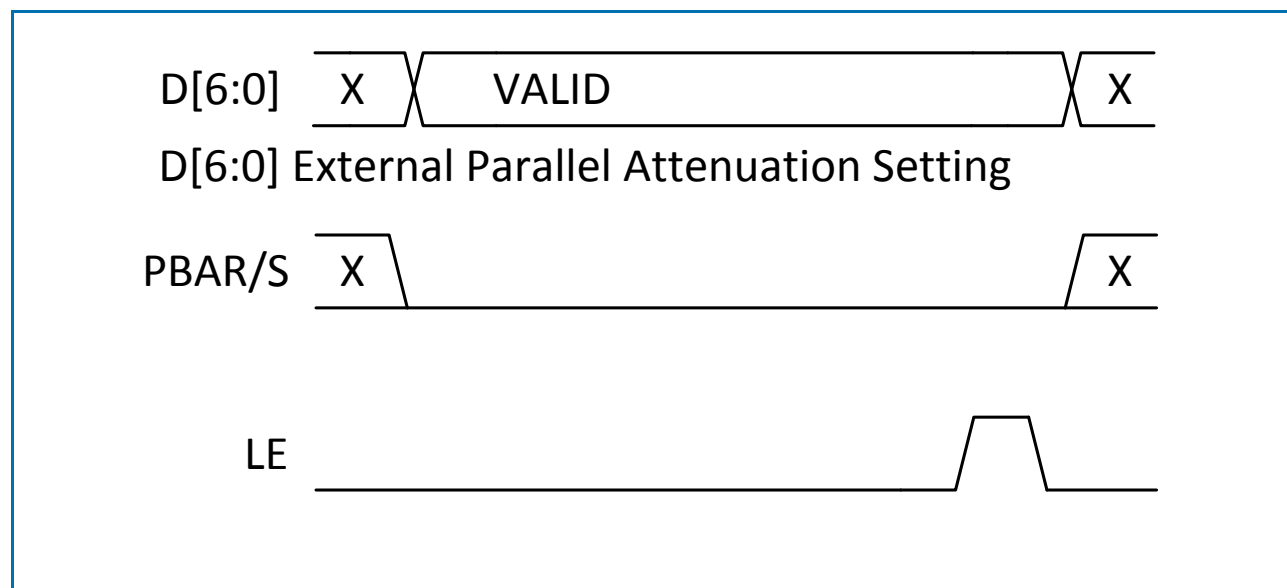
Serial Addressable Mode Timing Diagram



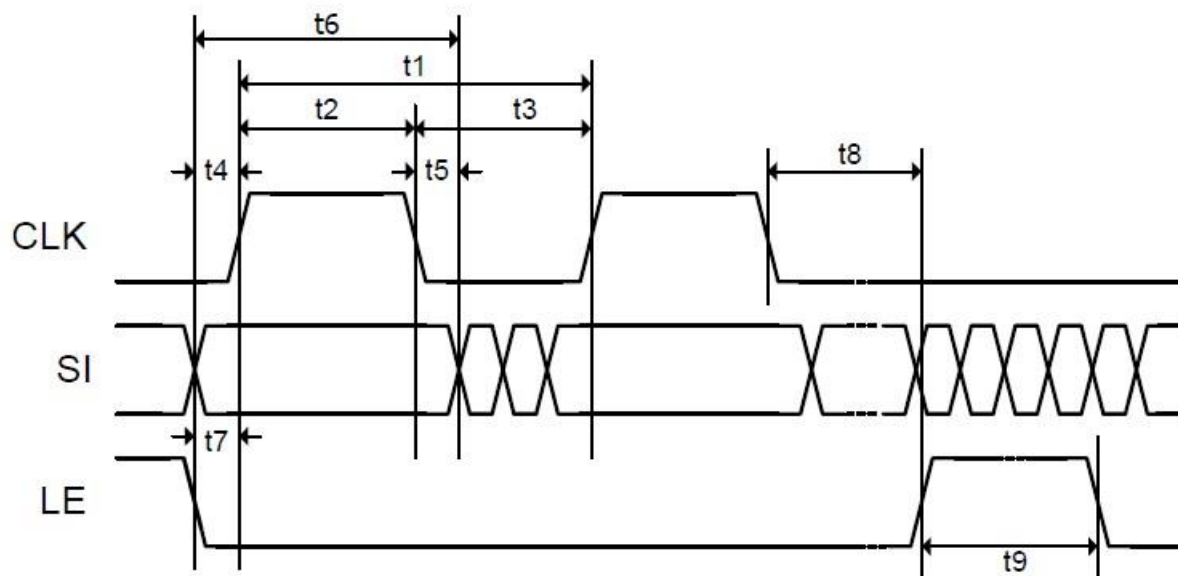
Parallel Mode Truth Table

| Parallel Input Control Setting | | | | | | | Attenuation State |
|--------------------------------|------------|------------|------------|------------|--------------|---------------|--------------------------------|
| D6 (C16) | D5 (C8) | D4 (C4) | D3 (C2) | D2 (C1) | D1 (C0.5) | D0 (C0.25) | |
| L | L | L | L | L | L | L | 0dB / Reference Insertion Loss |
| L | L | L | L | L | L | H | 0.25dB |
| L | L | L | L | L | H | L | 0.5dB |
| L | L | L | L | H | L | L | 1dB |
| L | L | L | H | L | L | L | 2dB |
| L | L | H | L | L | L | L | 4dB |
| L | H | L | L | L | L | L | 8dB |
| H | L | L | L | L | L | L | 16dB |
| H | H | H | H | H | H | H | 31.75dB |

Latched Parallel Mode Timing Diagram

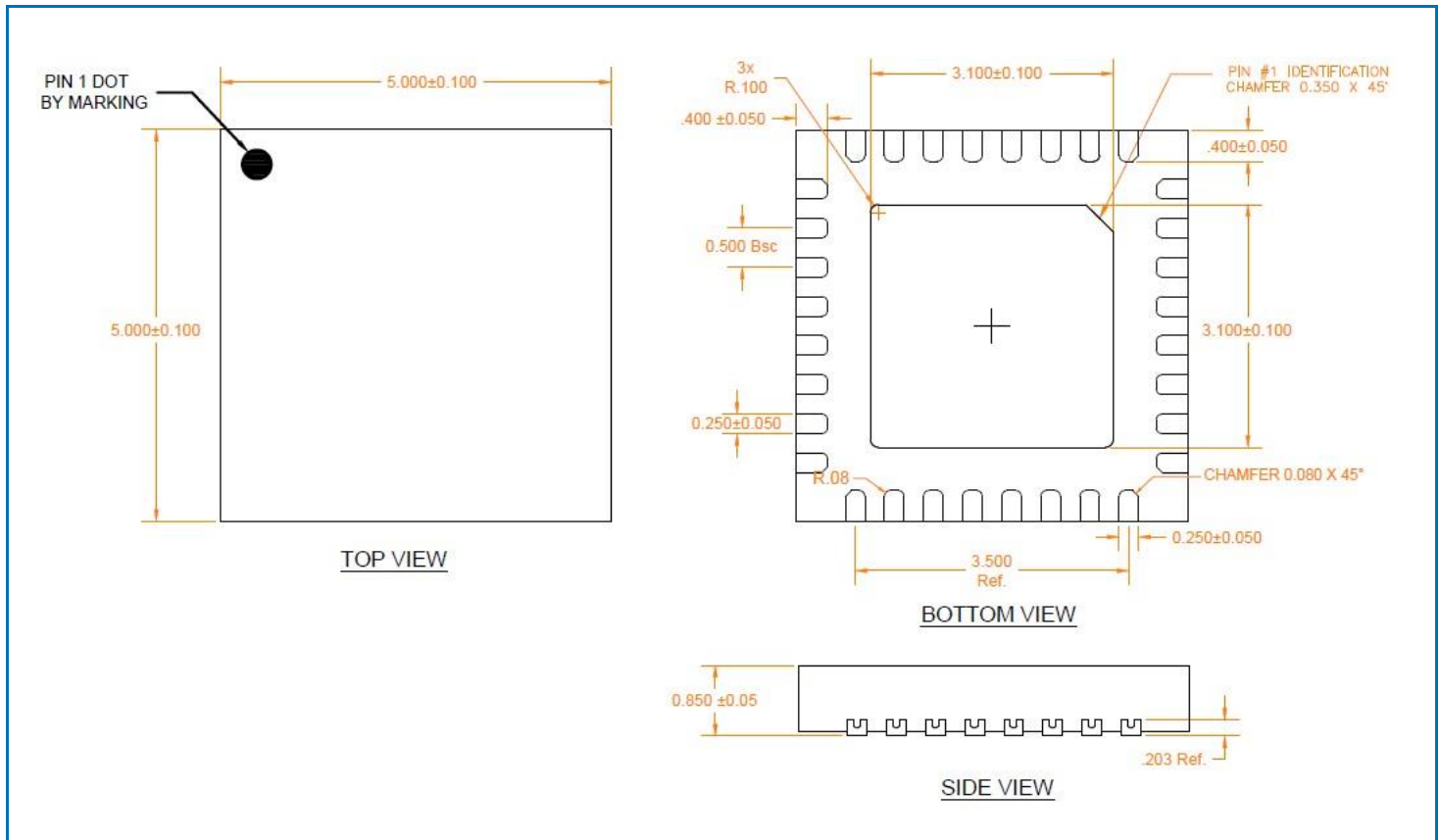


Serial Bus Timing Specifications

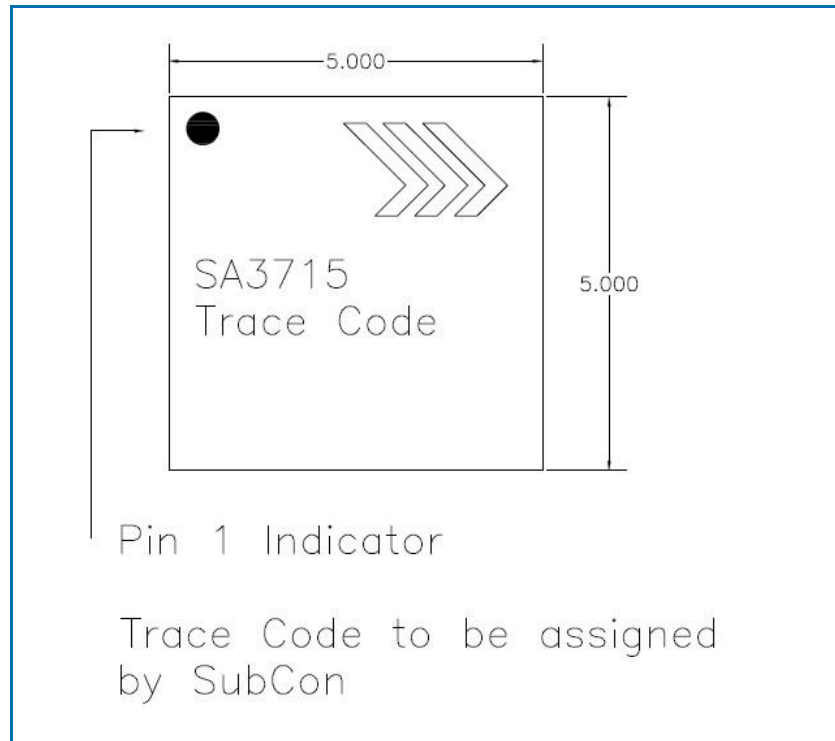


| Parameter | Limit | Unit | Comment |
|-----------|-------|---------|----------------------|
| t1 | 25 | MHz max | CLK Frequency |
| t2 | 20 | ns min | CLK High |
| t3 | 20 | ns min | CLK Low |
| t4 | 5 | ns min | SI to CLK Setup Time |
| t5 | 5 | ns min | SI to CLK Hold Time |
| t6 | 30 | ns min | SI 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 |

Package Outline Drawing (Dimensions in millimeters)



Branding Diagram



Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Qorvo:

[RFSA3715](#) [RFSA3715TR13](#) [RFSA3715SR](#) [RFSA3715PCK-410](#)