# RFSA2514

## SERIAL CONTROLLED DIGITAL STEP ATTENUATOR
## 50MHz TO 4000MHz, 5-BIT, 0.5dB LSB

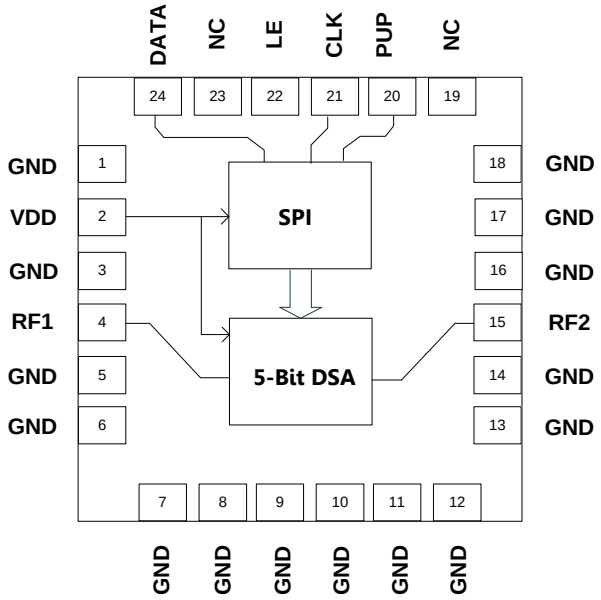
Package: MCM, 24-Pin, 4.2mm x 4.2mm


## Features

- Frequency Range 50MHz to 4000MHz
- 5-Bits, 15.5dB Range, 0.5dB Step
- High Linearity, IIP3 >48dBm
- 3V and 5V Logic Compatible
- Serial-to-Parallel Controller
- Serial Programming Interface
- Power-up Programming Modes
- On-chip ESD Protection Class 1C HBM
- Single Supply, 3V to 5V Operation
- Footprint Compatible with Most 24-Pin, 4mm x 4mm, QFNs

## Applications

- Transceiver RF and IF Applications
- Cellular, PCS, GSM, UMTS, LTE, WiMax/WiFi
- Wireless Data, Satellite Terminals
- Test Equipment




Functional Block Diagram

## Product Description

RFMD's RFSA2514 is a 5-bit digital step attenuator (DSA) that features high linearity over the entire 15.5dB gain control range with excellent step accuracy in 0.5dB steps. The RFSA2514 is programmed via a serial mode control interface that is both 3V and 5V compatible. The RFSA2514 also offers a rugged Class 1C HBM ESD rating via on-chip ESD circuitry. The MCM package is footprint compatible with most 24-pin, 4mm x 4mm, QFN packages.

### Ordering Information

| | |
|---|---|
| RFSA2514SR | 7” reel with 100 pieces |
| RFSA2514SQ | Sample bag with 25 pieces |
| RFSA2514TR7 | 7” reel with 750 pieces |
| RFSA2514TR13 | 13” reel with 2500 pieces |
| RFSA2514PCK-410 | 50MHz to 4000MHz PCBA with 5-piece sample bag |

### Optimum Technology Matching® Applied

| | | | |
|---|---|---|---|
| ☐ GaAs HBT | ☐ SiGe BiCMOS | ☑ GaAs pHEMT | ☐ GaN HEMT |
| ☐ GaAs MESFET | ☐ Si BiCMOS | ☑ Si CMOS | ☐ BiFET HBT |
| ☐ InGaP HBT | ☐ SiGe HBT | ☐ Si BJT | |





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## Absolute Maximum Ratings

| Parameter | Rating | Unit |
|---|---|---|
| Supply Voltage | +5.5 | V |
| DC Supply Current | 15 | mA |
| Power Dissipation | 83 | mW |
| Max RF Input Power | 28.3 | dBm |
| Operating Temperature ($T_{CASE}$) | -40 to +85 | °C |
| Storage Temperature | -40 to +150 | °C |
| Junction Temperature | 150 | °C |
| ESD Rating (HBM) | Class 1C | |
| Moisture Sensitivity Level | MSL3 | |

**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.



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. | | |
| Frequency Range | 50 | | 4000 | MHz | |
| Insertion Loss | | 0.67 | | dB | 50MHz, 0dB attenuation |
| | | 0.78 | | dB | 500MHz, 0dB attenuation |
| | | 0.88 | | dB | 850MHz, 0dB attenuation |
| | | 1.23 | | dB | 2100MHz, 0dB attenuation |
| | | 1.41 | | dB | 2700MHz, 0dB attenuation |
| | | 2.15 | | dB | 4000MHz, 0dB attenuation |
| Gain Control Range | | 15.5 | | dB | 0.5dB step size |
| Step Accuracy | ±(0.1 + 5.0% attenuation setting) | | | dB | |
| Input IP3 | 48 | 50 | | dBm | 50MHz to 3000MHz, Min. 48dBm 8dB Bit |
| Input P0.5dB | | 26 | | dBm | 50MHz to 100MHz, all states |
| | | 28 | | dBm | 150MHz to 2500MHz, all states |
| Input Return Loss | | 29 | | dB | 50MHz to 2700MHz, all states |
| | | 17 | | dB | 2700MHz to 4000MHz, all states |
| Output Return Loss | | 24 | | dB | 50MHz to 2700MHz, all states |
| | | 15 | | dB | 2700MHz to 4000MHz, all states |
| Control Interface | | 5-bit, Serial | | bit | Serial interface |
| Settling Time | | 200 | | ns | $t_{RISE}$, $t_{FALL}$ (10%/90% RF) |
| Switching Speed | | 200 | | ns | $t_{ON}$, $t_{OFF}$ (50% CTL to 10%/90% RF) |
| Supply Voltage ($V_{DD}$) | 4.75 | 5.0 | 5.25 | V | Typical performance based on 5V operation. |
| Supply Current | | 5.3 | | mA | |
| Control Voltage ($V_{CTL}$) | Low, $V_{CTL}$ = 0V to 0.8V | | | V | |
| | High, $V_{CTL}$ = 2.0V to $V_{DD}$ | | | V | |

Notes:
1. $V_{DD}$ = 5V, $V_{CTL}$ = 5V, T = 25 °C
2. IIP3 measured with $P_{IN}$ = +12dBm/tone, 1MHz spacing



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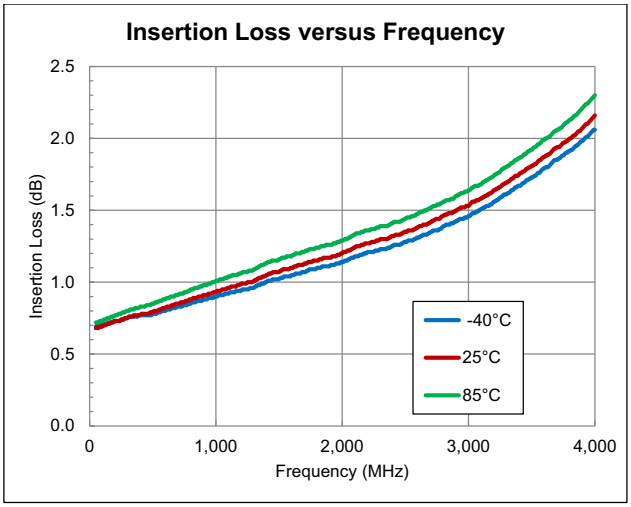
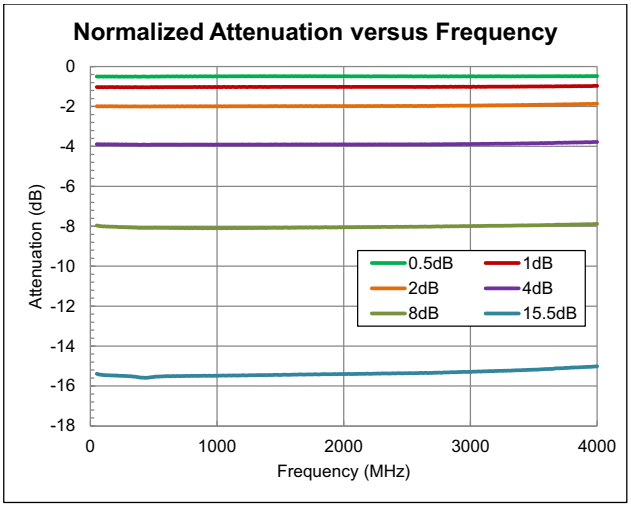
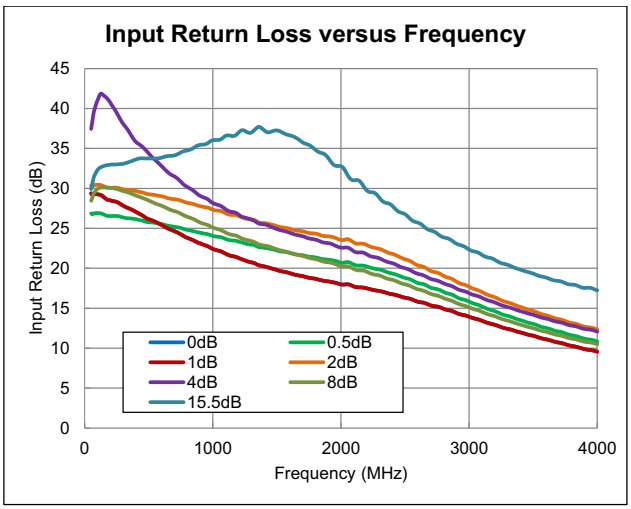
| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| Frequency Range | 50 | | 4000 | MHz | |
| Insertion Loss | | 0.75 | | dB | 50MHz, 0dB attenuation |
| | | 0.86 | | dB | 500MHz, 0dB attenuation |
| | | 0.96 | | dB | 850MHz, 0dB attenuation |
| | | 1.32 | | dB | 2100MHz, 0dB attenuation |
| | | 1.51 | | dB | 2700MHz, 0dB attenuation |
| | | 2.27 | | dB | 4000MHz, 0dB attenuation |
| Gain Control Range | | 15.5 | | dB | 0.5dB step size |
| Step Accuracy | ±(0.1 + 5.0% attenuation setting) | | | dB | |
| Input IP3 | | 40 | | dBm | 50MHz to 100MHz |
| | 45 | 50 | | dBm | 100MHz to 3000MHz, Min. 45dBm 8dB Bit |
| Input P0.5dB | | 19 | | dBm | 50MHz to 100MHz, all states |
| | | 21 | | dBm | 150MHz to 2500MHz, all states |
| Input Return Loss | | 29 | | dB | 50MHz to 2700MHz, all states |
| | | 17 | | dB | 2700MHz to 4000MHz, all states |
| Output Return Loss | | 24 | | dB | 50MHz to 2700MHz, all states |
| | | 15 | | dB | 2700MHz to 4000MHz, all states |
| Control Interface | | 5-bit, Serial | | bit | Serial interface |
| Settling Time | | 200 | | ns | $t_{RISE}$, $t_{FALL}$ (10%/90% RF) |
| Switching Speed | | 200 | | ns | $t_{ON}$, $t_{OFF}$ (50% CTL to 10%/90% RF) |
| Supply Voltage ($V_{DD}$) | 2.8 | 3.0 | 3.3 | V | Typical performance based on 3V operation. |
| Supply Current | | 5 | | mA | |
| Control Voltage ($V_{CTL}$) | Low, $V_{CTL}$ = 0V to 0.8V | | | V | |
| | High, $V_{CTL}$ = 2.0V to $V_{DD}$ | | | V | |

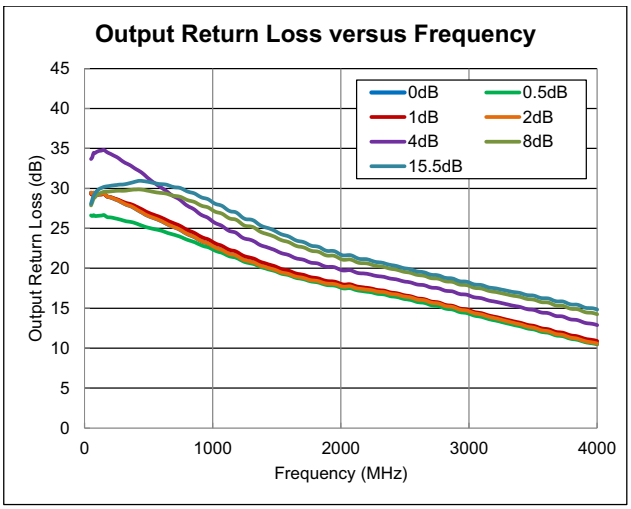
Notes:
1. $V_{DD}$ = 3V, $V_{CTL}$ = 3V, T = 25 °C
2. IIP3 measured with $P_{IN}$ = +12dBm/tone, 1MHz spacing

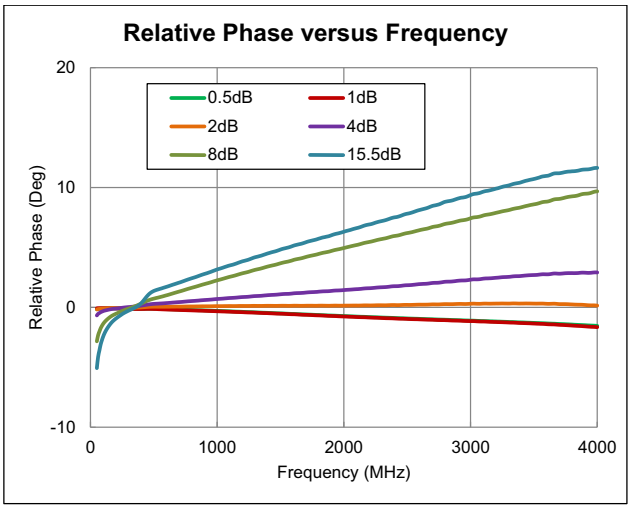
## Typical Performance at 5V $V_{DD}$ - Broadband Application Circuit

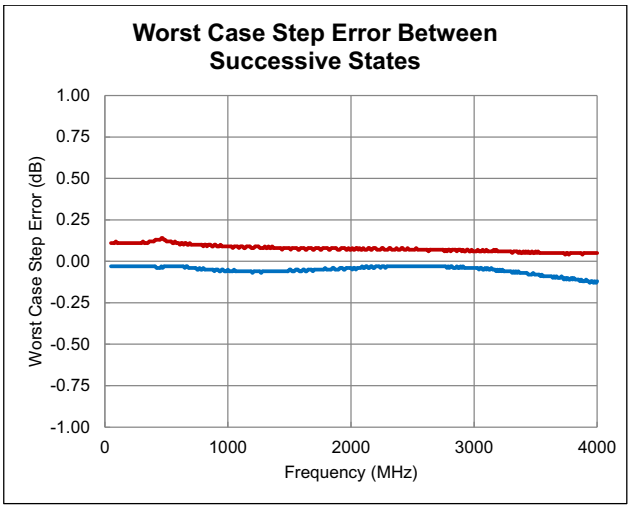


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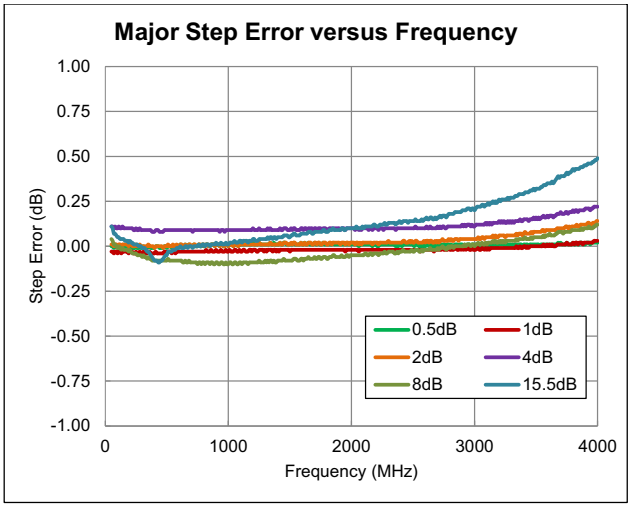
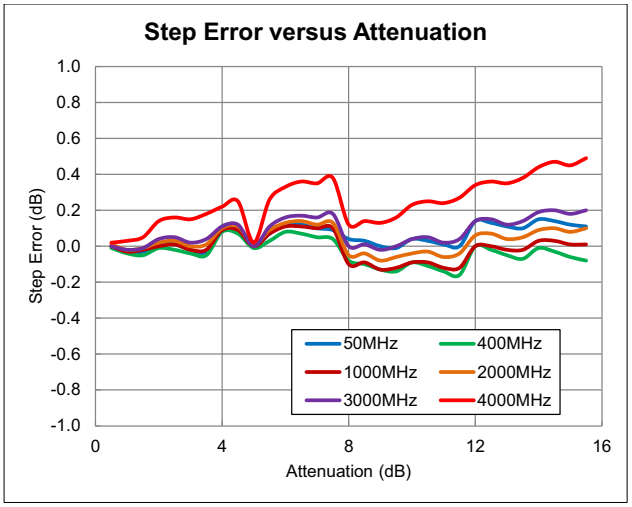
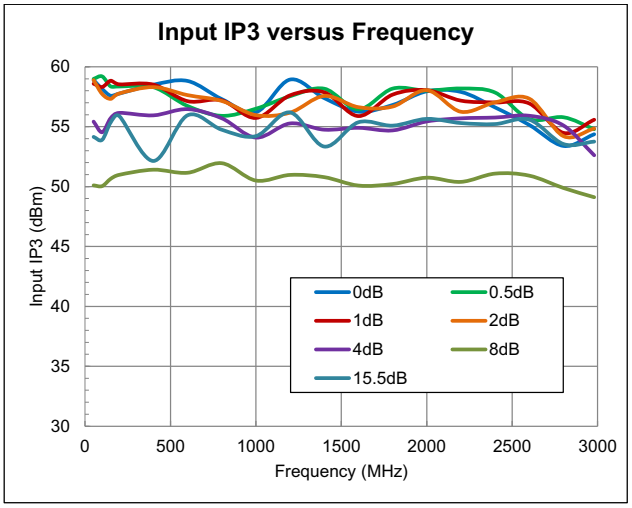
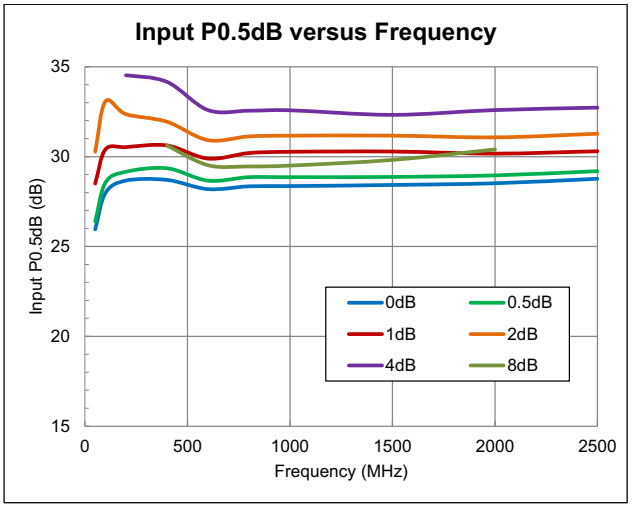
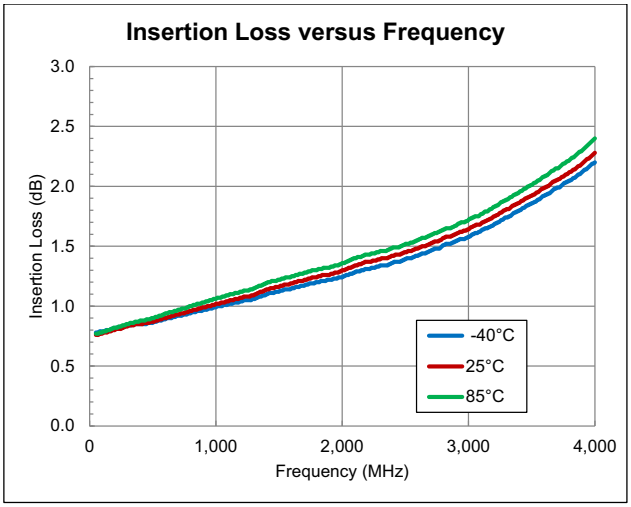


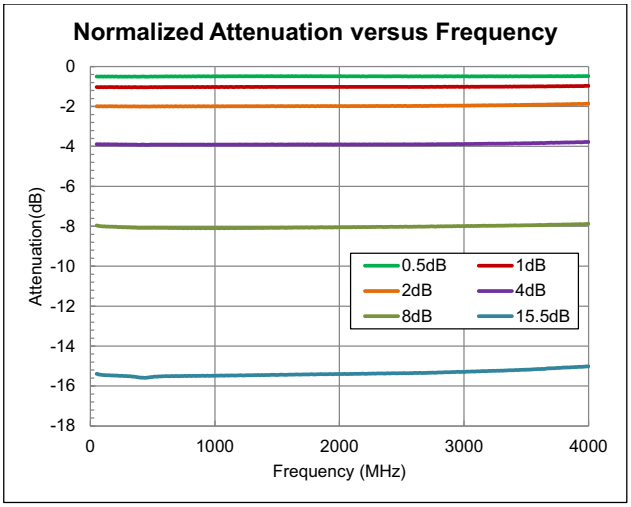



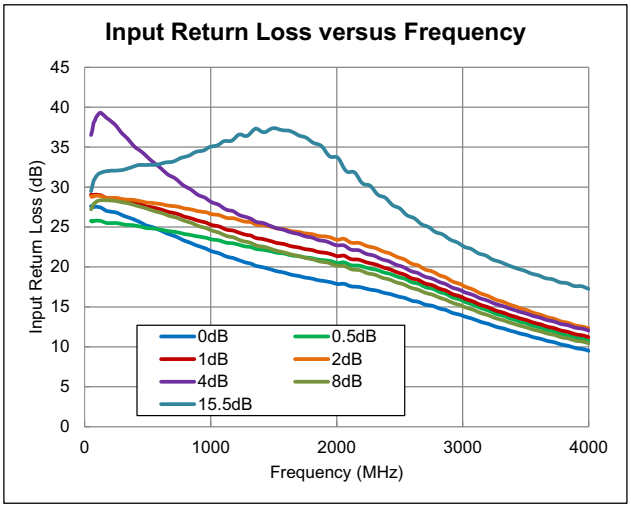



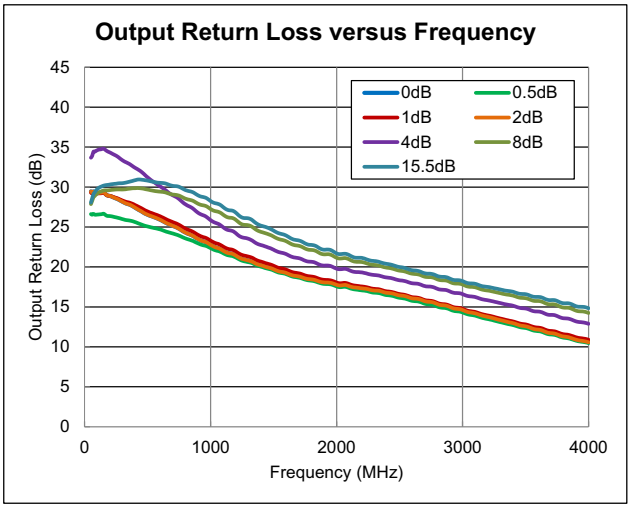



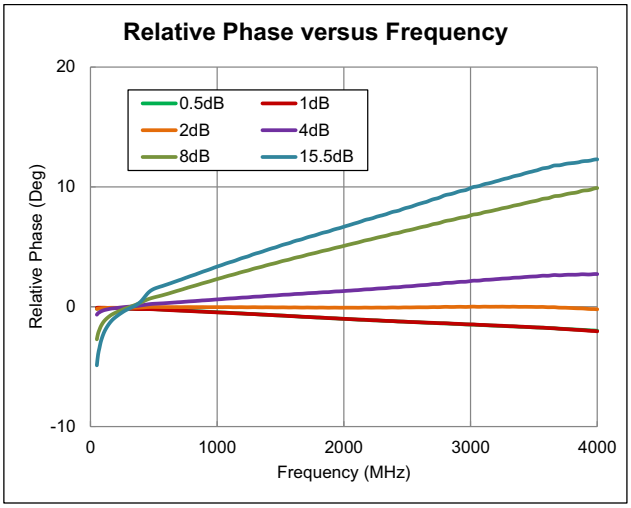
## Typical Performance at 3V $V_{DD}$ - Broadband Application Circuit

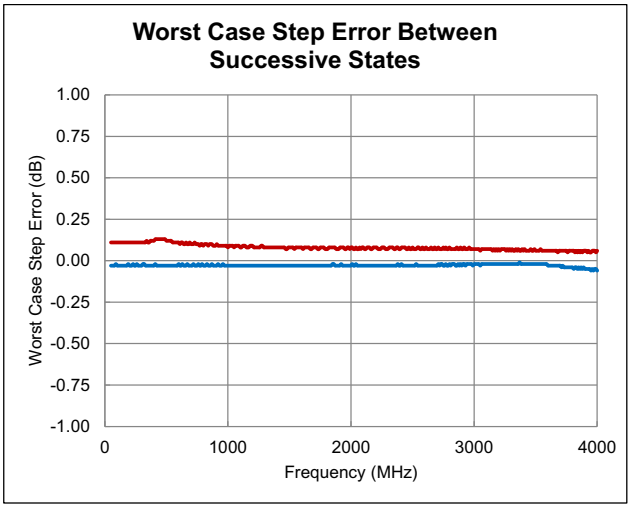


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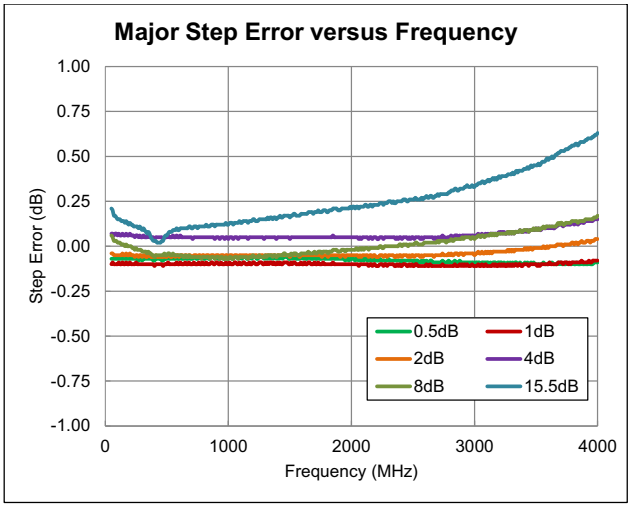
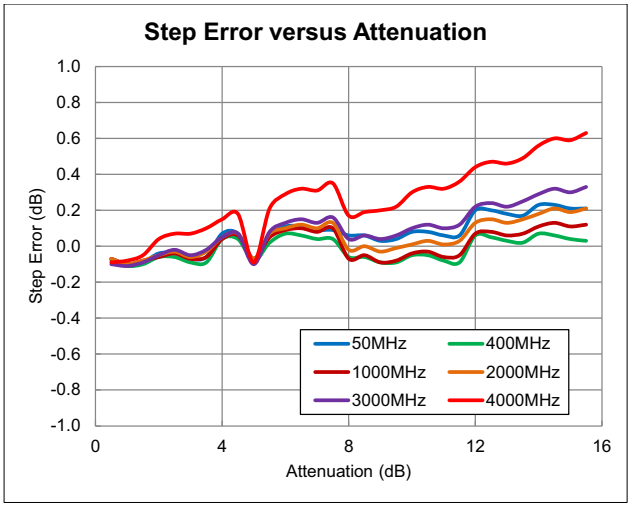
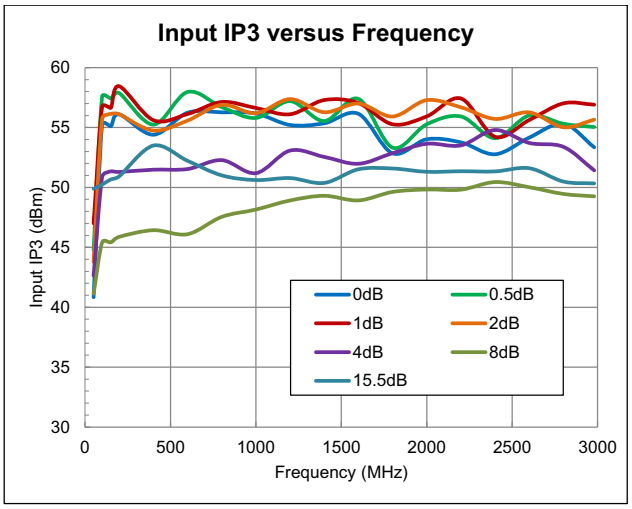
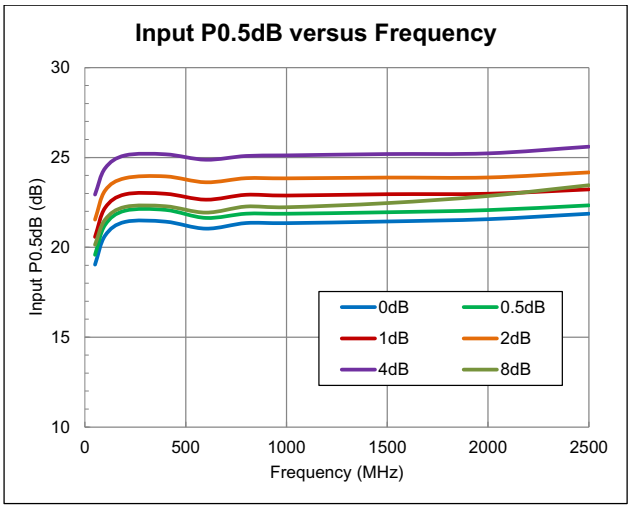
## Typical Performance at 3V $V_{DD}$ - Broadband Application Circuit



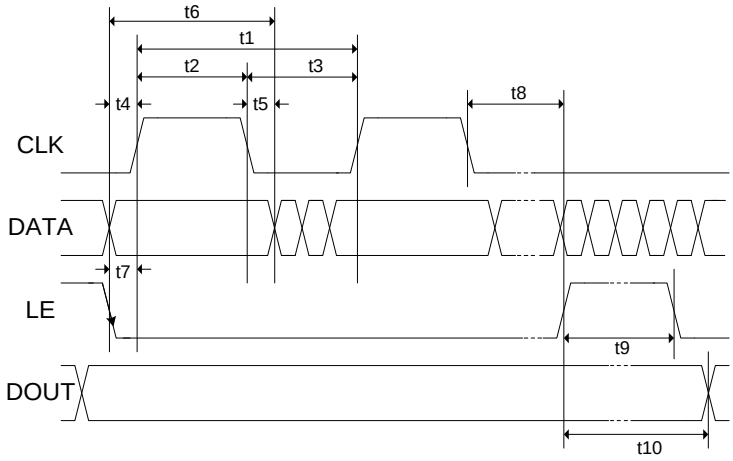



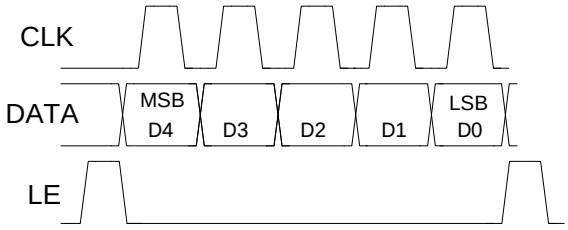



## Serial Port Interface

SPI Timing Diagram




Programming Example - 5-Bit




## Truth Table

| Control Bits | | | | | Relative Gain Setting |
|---|---|---|---|---|---|
| C8 | C4 | C2 | C1 | C0.5 | |
| 1 | 1 | 1 | 1 | 1 | Max gain |
| 1 | 1 | 1 | 1 | 0 | -0.5dB |
| 1 | 1 | 1 | 0 | 1 | -1dB |
| 1 | 1 | 0 | 1 | 1 | -2dB |
| 1 | 0 | 1 | 1 | 1 | -4dB |
| 0 | 1 | 1 | 1 | 1 | -8dB |
| 0 | 0 | 0 | 0 | 0 | -15.5dB |

## 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 |

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

| Power-up Programming Truth Table | |
|---|---|
| PUP | Attenuator Setting |
| Low | Attenuation at max, 15.5dB |
| High | Attenuation at min, 0dB |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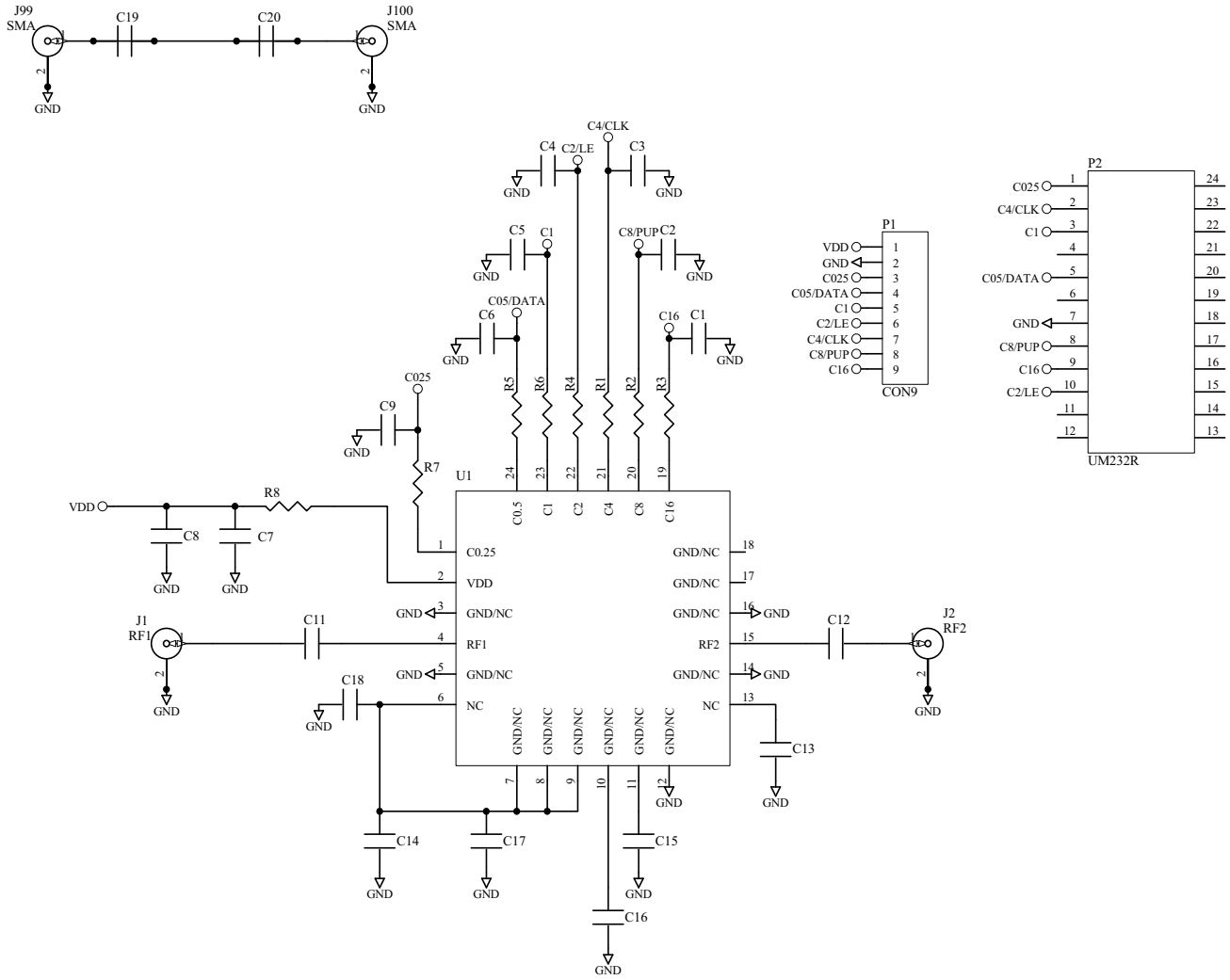
## Evaluation Board Schematic



## Evaluation Board Bill of Materials (BOM)

| Description | Reference Designator | Manufacturer | Manufacturer's P/N |
|---|---|---|---|
| RFSA2714 Evaluation Board | | Dynamic Details (DDI) Toronto | SA2714410(A) |
| 50MHz to 4000MHz Serial 5-Bit DSA 0.5dB Step | U1 | RFMD | RFSA2514SB |
| CAP, 10000pF, 10%, 25V, X7R, 0402 | C11-C12 | Murata Electronics | GRM155R71E103KA01D |
| CAP, 1000pF, 10%, 50V, X7R, 0402 | C7 | Taiyo Yuden (USA), Inc. | RM UMK105BJ102KV-F |
| RES, 0Ω, 0402 | R1-R2, R4-R5, R8 | Kamaya, Inc | RMC1/16SJPTH |
| CONN, SMA, END LNCH, UNIV, HYB MNT, FLT | J1-J2, J99-J100 | Molex | SD-73251-4000 |
| CONN, HDR, ST, PLRZD, 9-PIN | P1 | ITW Pancon | MPSS100-9-C |
| CONN, SKT, 24-PIN DIP, .600", T/H | P2 | Aries Electronics Inc. | 24-6518-10 |
| MOD, USB TO SERIAL UART, SSOP-28 | M1 (See Note Below) | Future Technology Devices Int'l | UM232R |
| DNP | C1-C6, C8-C9, C13-C20 | NA | NA |
| DNP | R3, R6-R7 | NA | NA |

Notes: M1 is to be mounted into P2 with respect to the Pin 1 alignment of M1 and P2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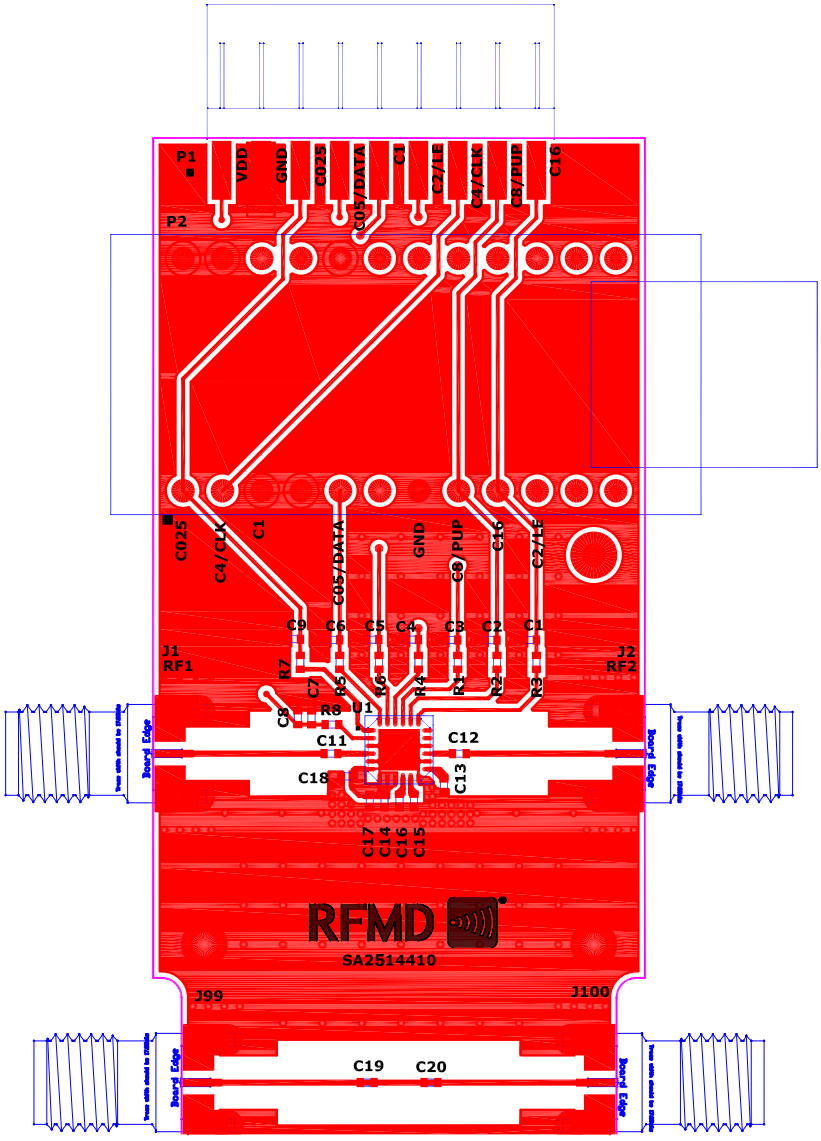
## Evaluation Board Assembly Drawing



## Pin Names and Descriptions

| Pin | Name | Description |
|---|---|---|
| 1 | GND | Connect to Low Inductance Path to Ground |
| 2 | VDD | Power Supply |
| 3 | GND | Connect to Low Inductance Path to Ground |
| 4 | RF1 | RF port. External DC block required |
| 5 | GND | Connect to Low Inductance Path to Ground |
| 6 | GND | Connect to Low Inductance Path to Ground |
| 7 | GND | Connect to Low Inductance Path to Ground |
| 8 | GND | Connect to Low Inductance Path to Ground |
| 9 | GND | Connect to Low Inductance Path to Ground |
| 10 | GND | Connect to Low Inductance Path to Ground |
| 11 | GND | Connect to Low Inductance Path to Ground |
| 12 | GND | Connect to Low Inductance Path to Ground |
| 13 | GND | Connect to Low Inductance Path to Ground |
| 14 | GND | Connect to Low Inductance Path to Ground |
| 15 | RF2 | RF port. External DC block required. |
| 16 | GND | Connect to Low Inductance Path to Ground |
| 17 | GND | Connect to Low Inductance Path to Ground |
| 18 | GND | Connect to Low Inductance Path to Ground |
| 19 | NC | No internal connection. EVB can be ground or no connect |
| 20 | PUP | Power-up Programming pin<br>Low = max attenuation (15.5dB) at power-up<br>High = min attenuation (0dB) at power-up |
| 21 | CLK | Serial Clock |
| 22 | LE | Latch Enable |
| 23 | NC | No internal connection; EVB can be ground or no connect |
| 24 | DATA | Serial Data |
| EPAD | GND | DC and RF Ground; Must be soldered to EVB ground plane over a bed of vias for thermal and RF performance. |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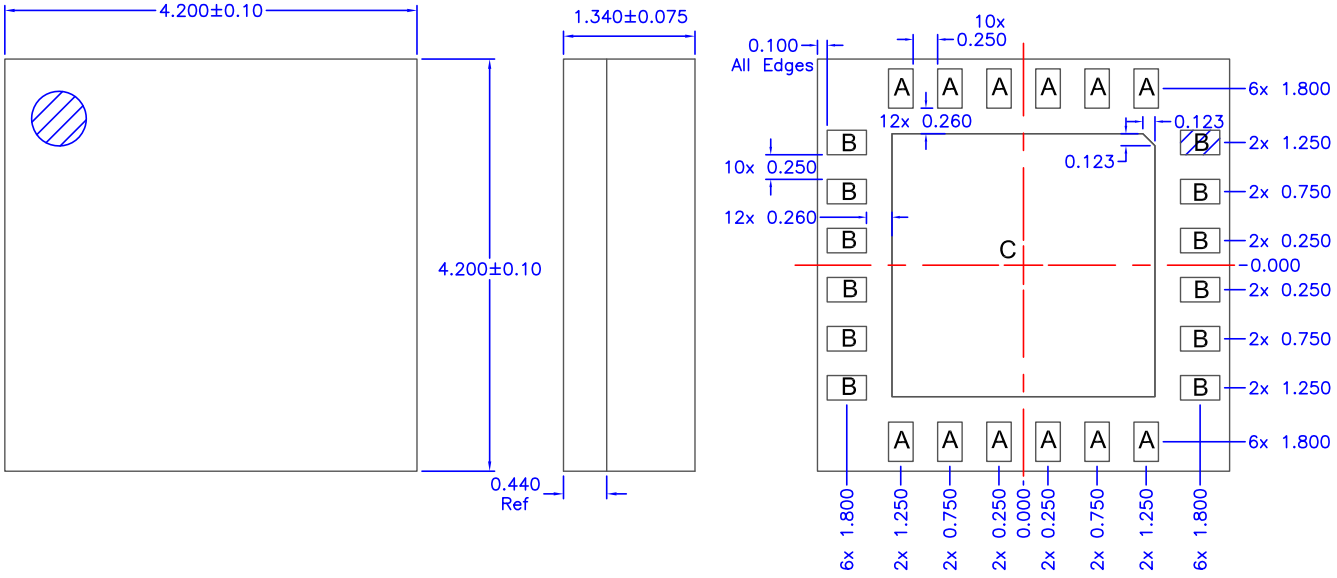
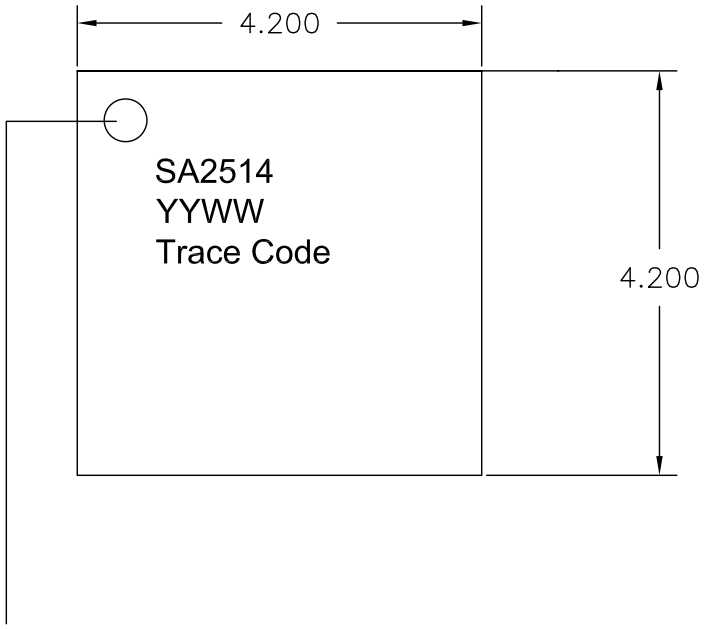
## Package Drawing




Notes:
1. Shaded area represents Pin 1 location.

A = 0.250 x 0.400 mm
B = 0.400 x 0.250 mm
C = 2.680 x 2.680 mm

## Branding Diagram




Pin 1 Indicator
YY = Year
WW = Week