

### Product Overview

The RFMD's RFSA3413 is a 4-bit digital step attenuator (DSA) that features high linearity over the entire 15dB gain control range with 1.0dB steps. The RFSA3413 uses parallel control interface. The RFSA3413 has a low insertion loss of 1.4dB at 2GHz. Patent pending circuit architecture provides overshoot-free transient switching performance. The RFSA3413 is available in a 3mm x 3mm QFN package.

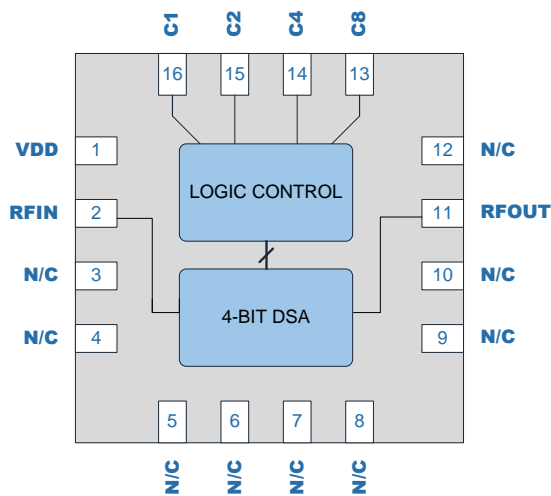


16 Pad 3.0 x 3.0 x 0.85 mm QFN Package

### Key Features

- 4-Bit, 15 dB Range, 1.0 dB Step
- Patented Circuit Architecture
- Overshoot-free Transient Switching Performance
- Frequency Range 5 MHz to 6000 MHz
- High Linearity, IIP3 > +55 dBm
- Parallel Control Interface
- Fast Switching, 120 ns Typical
- Single Supply 3 V to 5 V Operation
- 3V CMOS Logic Compatible
- RF Oins have No DC Voltage present, Can be DC Grounded Externally

### Functional Block Diagram



Top View

### Applications

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

### Ordering Information

| Part No.        | Description                                    |
|-----------------|--|
| RFSA3413TR7     | 7" Reel with 2500 pieces                       |
| RFSA3413PCK-410 | 5 MHz to 6000 MHz PCBA with 5-piece sample bag |

## Absolute Maximum Ratings

| Parameter  | Rating         |
|--|----------------|
| Storage Temperature  | -40 to +150 °C |
| RF Input Power at RFIN, T <sub>C</sub> =85°C   | +30 dBm        |
| RF Input Power at RFOUT, T <sub>C</sub> =85°C  | +27 dBm        |
| Device Supply Voltage (V <sub>DD</sub> )   | -0.5 to +6 V   |
| All Other DC and Logic Pins, V <sub>DD</sub> Applied Prior to Any Other Pin Voltages | -0.5 to +6 V   |

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.

## Recommended Operating Conditions

| Parameter   | Min  | Typ | Max             | Units |
|---|------|-----|-----------------|-------|
| Device Supply Voltage (V <sub>DD</sub> ) <sup>(1)</sup> | +2.7 |     | +5.5            | V     |
| Digital Logic High                                      | +1.6 |     | V <sub>DD</sub> | V     |
| Digital Logic Low                                       | -0.2 |     | +0.9            |       |
| Operating Temperature <sup>(2)</sup>                    | -40  |     | +105            | °C    |
| Operating Junction Temperature                          |      |     | +125            | °C    |

(1) Device performance is constant over this range; LDO on chip

(2) Derate RF Input Handling about 85°C

## Electrical Specifications

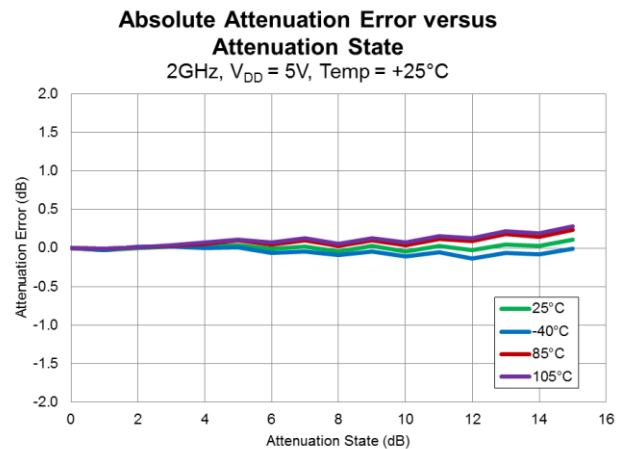
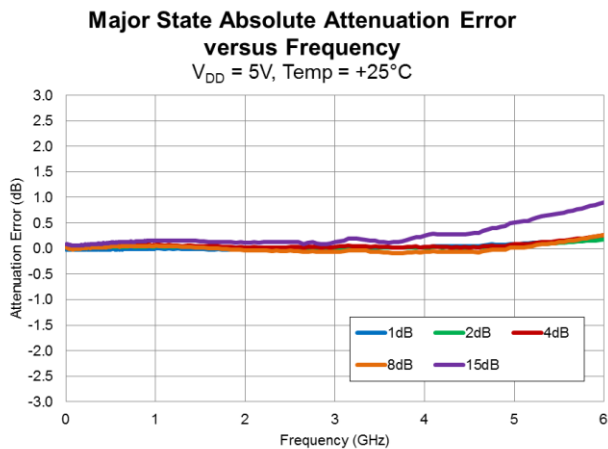
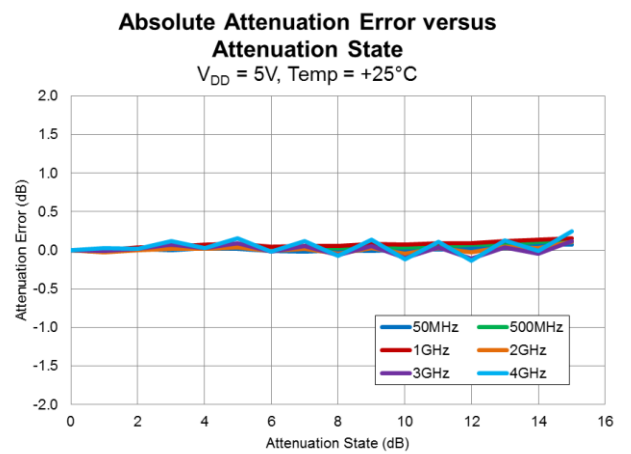
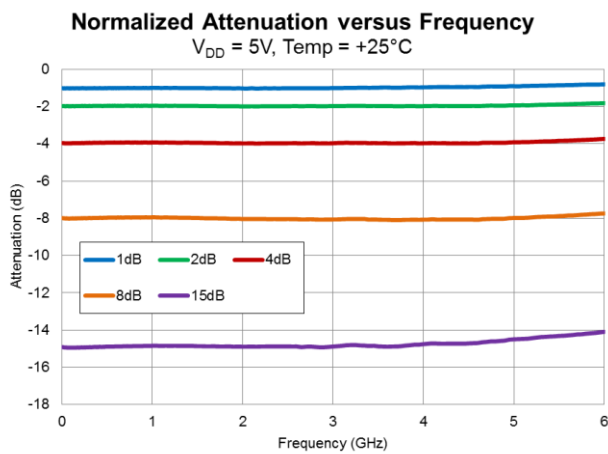
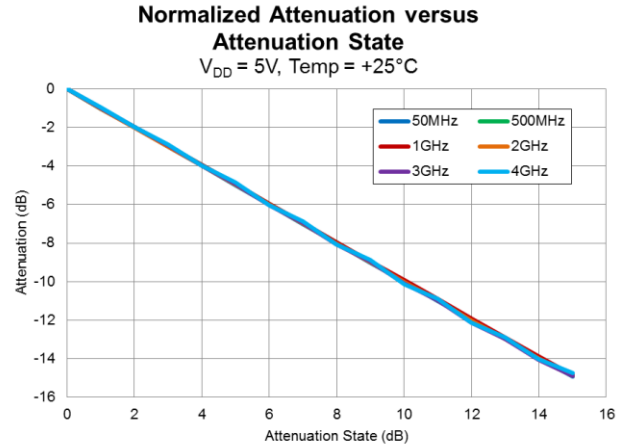
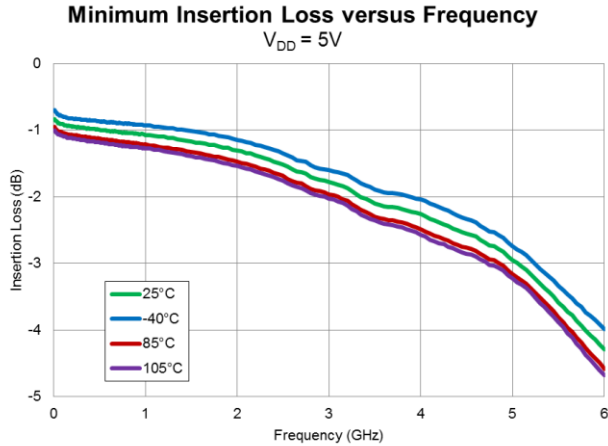
| Parameter                           | Conditions <sup>(1)</sup>                      | Min | Typ     | Max  | Units |
|-------------------------------------|--|-----|---------|------|-------|
| Operational Frequency Range         |  | 5   |         | 6000 | MHz   |
| Insertion Loss                      | 2000MHz, 0 dB attenuation                      |     | 1.4     | 2.8  | dB    |
| Attenuation Range                   | 1.0 dB step size                               |     | 15      |      | dB    |
| Absolute Attenuation Error          |  |     | 0.2 ±4% |      | dB    |
| Input IP3                           |  |     | +55     |      | dBm   |
| Input P0.1dB                        |  |     | +30     |      | dBm   |
| Input/Output Return Loss            |  |     | 15      |      | dB    |
| Input and Output Impedance          |  |     | 50      |      | Ω     |
| Attenuation Step Time               | 50% control signal level to 10% / 90% RF       |     | 120     |      | nsec  |
| Successive Step Phase Delta         | 2000MHz  |     | 2       |      | Deg   |
| Supply Current, I <sub>DD</sub>     | Steady state, transient between states higher  |     | 180     | 300  | μA    |
| RF Input Power at RFIN              | Continuous operation at +85°C case temperature |     |         | +27  | dBm   |
| RF Input Power at RFOUT             | Continuous operation at +85°C case temperature |     |         | +20  | dBm   |
| Thermal Resistance, θ <sub>Jc</sub> | At maximum attenuation state with RF power     |     | 55      |      | °C/W  |

Notes:

1. Test conditions unless otherwise noted: V<sub>DD</sub> = +5.0 V, Temp = +25 °C, 2000MHz, 50 Ω system.

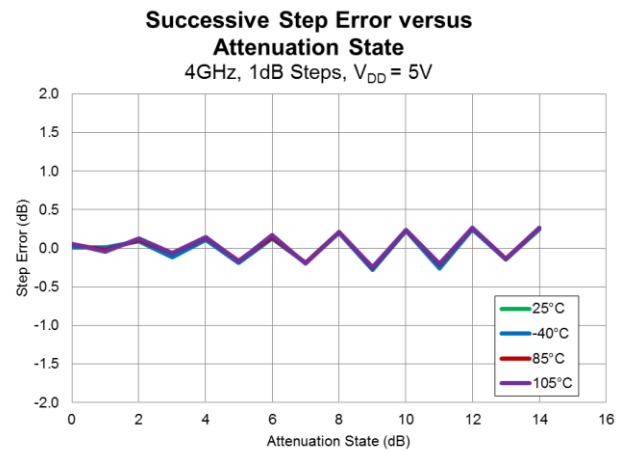
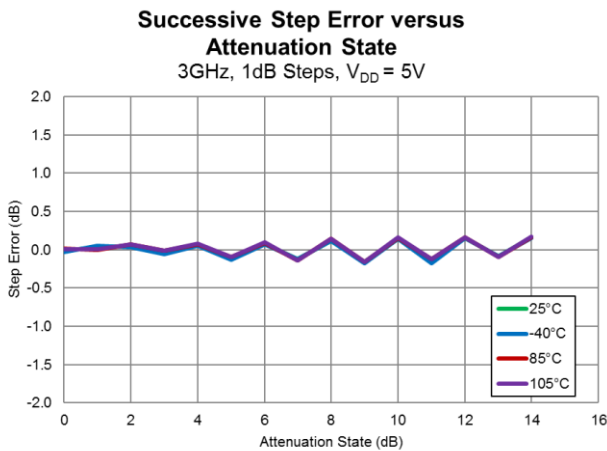
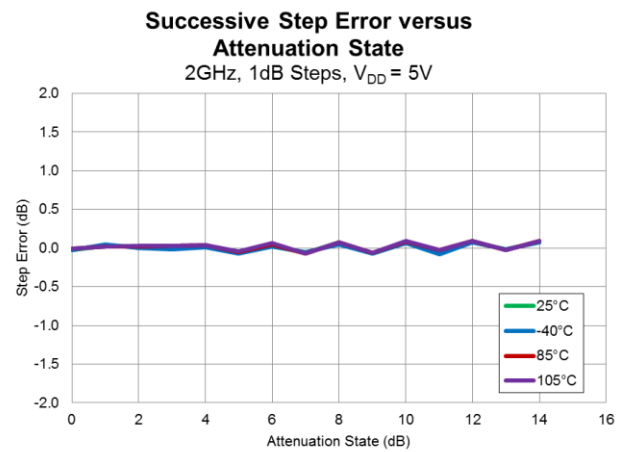
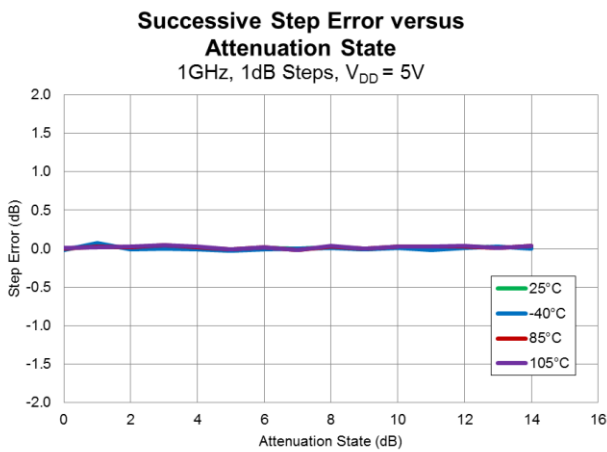
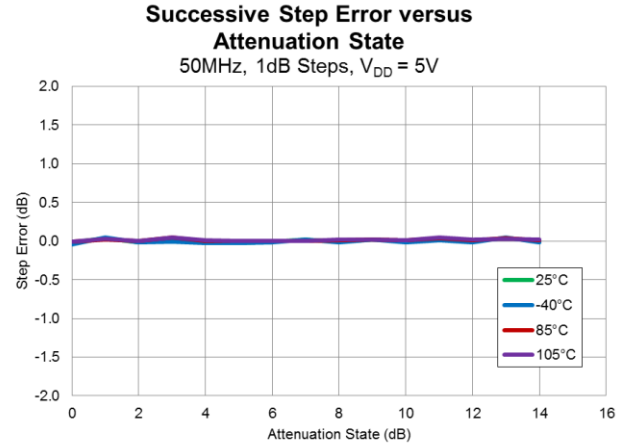
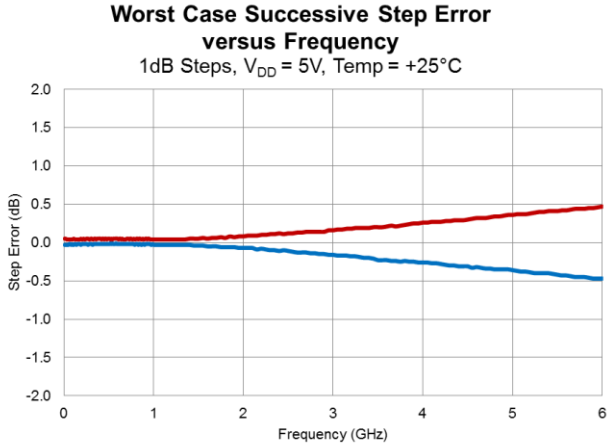
RF Typical Performance Plots

T = 25°C, V<sub>DD</sub> = 5V unless otherwise noted



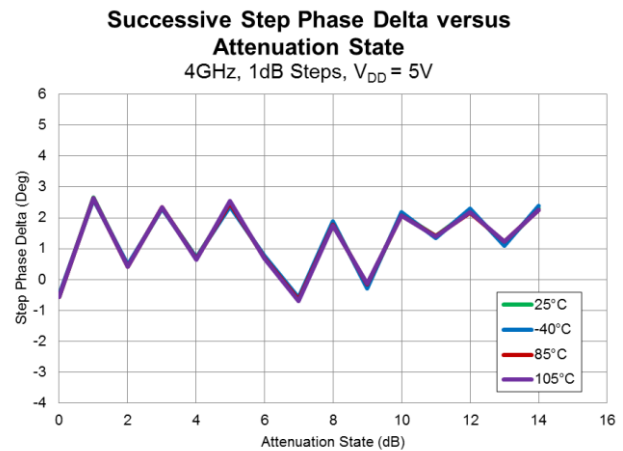
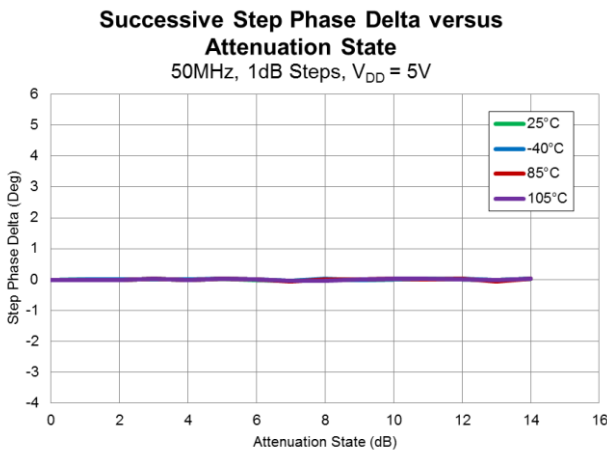
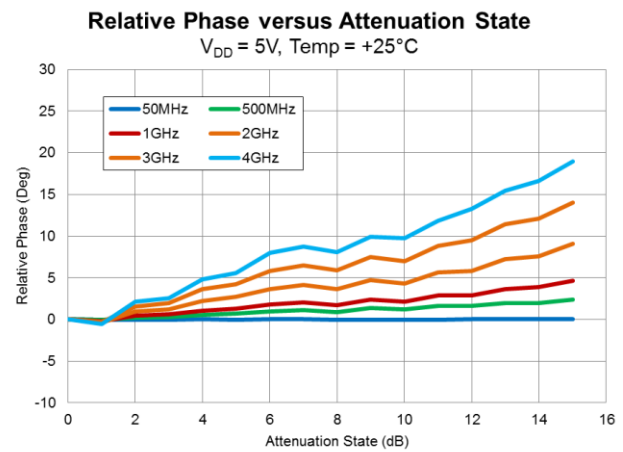
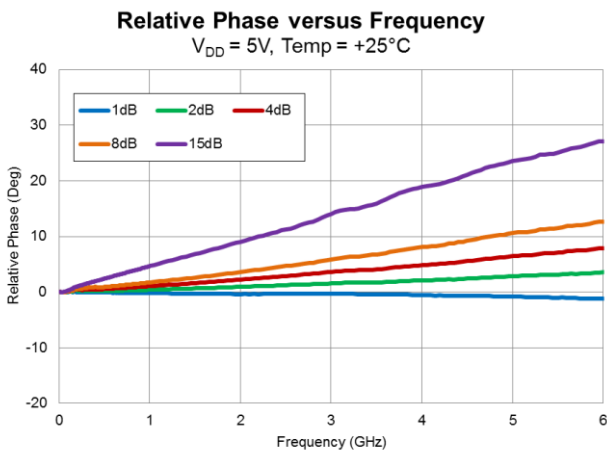
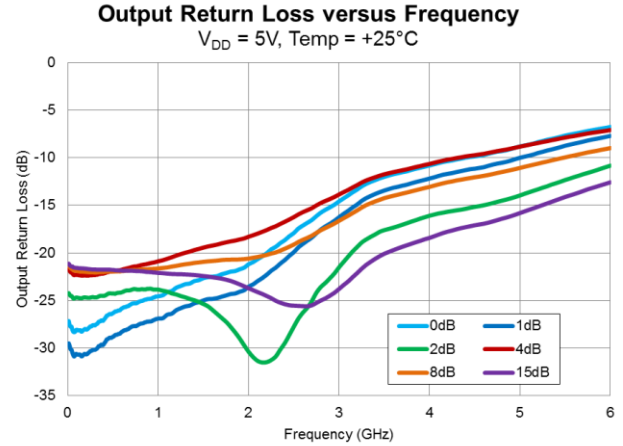
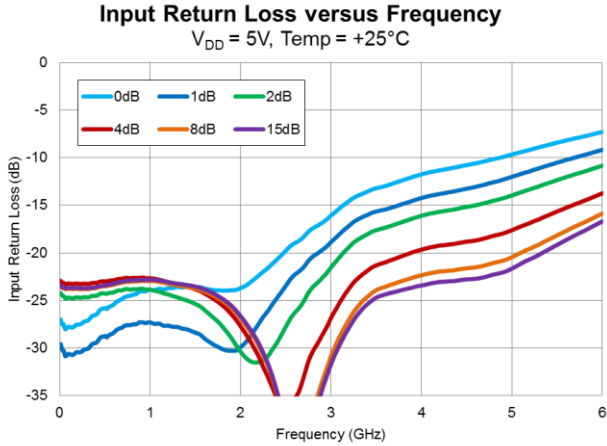
RF Typical Performance Plots (continue)

T = 25°C, V<sub>DD</sub> = 5V unless otherwise noted



RF Typical Performance Plots (continue)

T = 25°C, V<sub>DD</sub> = 5V unless otherwise noted

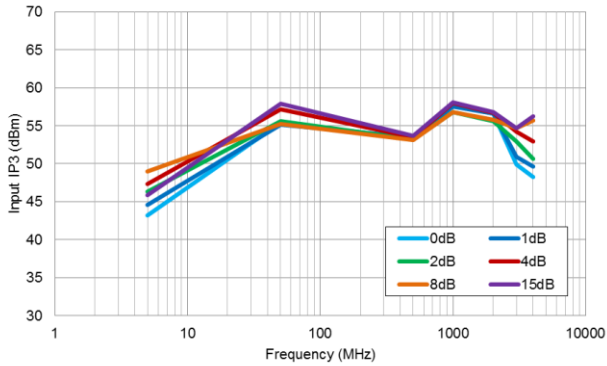


RF Typical Performance Plots (continue)

T = 25°C, V<sub>DD</sub> = 5V unless otherwise noted

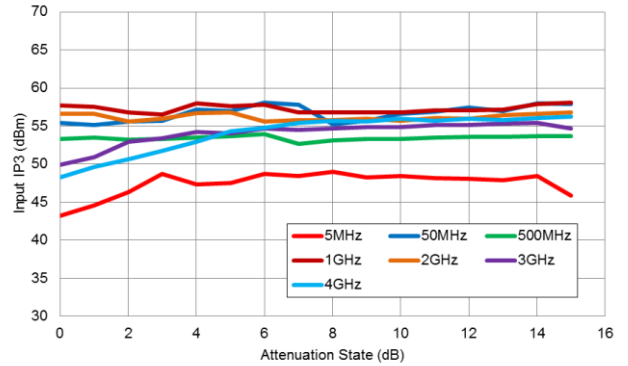
**Input IP3 versus Frequency**

V<sub>DD</sub> = 5V, RF 50MHz to 4000MHz Pin = +18dBm/Tone,  
RF 5MHz Pin = +15dBm/Tone, Temp = +25°C



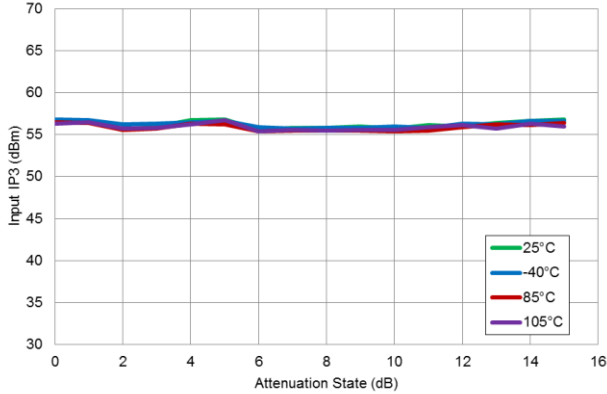
**Input IP3 versus Attenuation State**

V<sub>DD</sub> = 5V, RF 50MHz to 4000MHz Pin = +18dBm/Tone,  
RF 5MHz Pin = +15dBm/Tone, Temp = +25°C



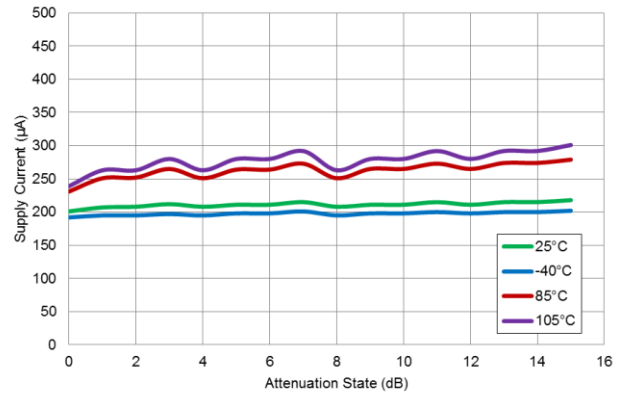
**Input IP3 versus Attenuation State**

RF 2GHz, V<sub>DD</sub>=5V, Pin=+18dBm/Tone

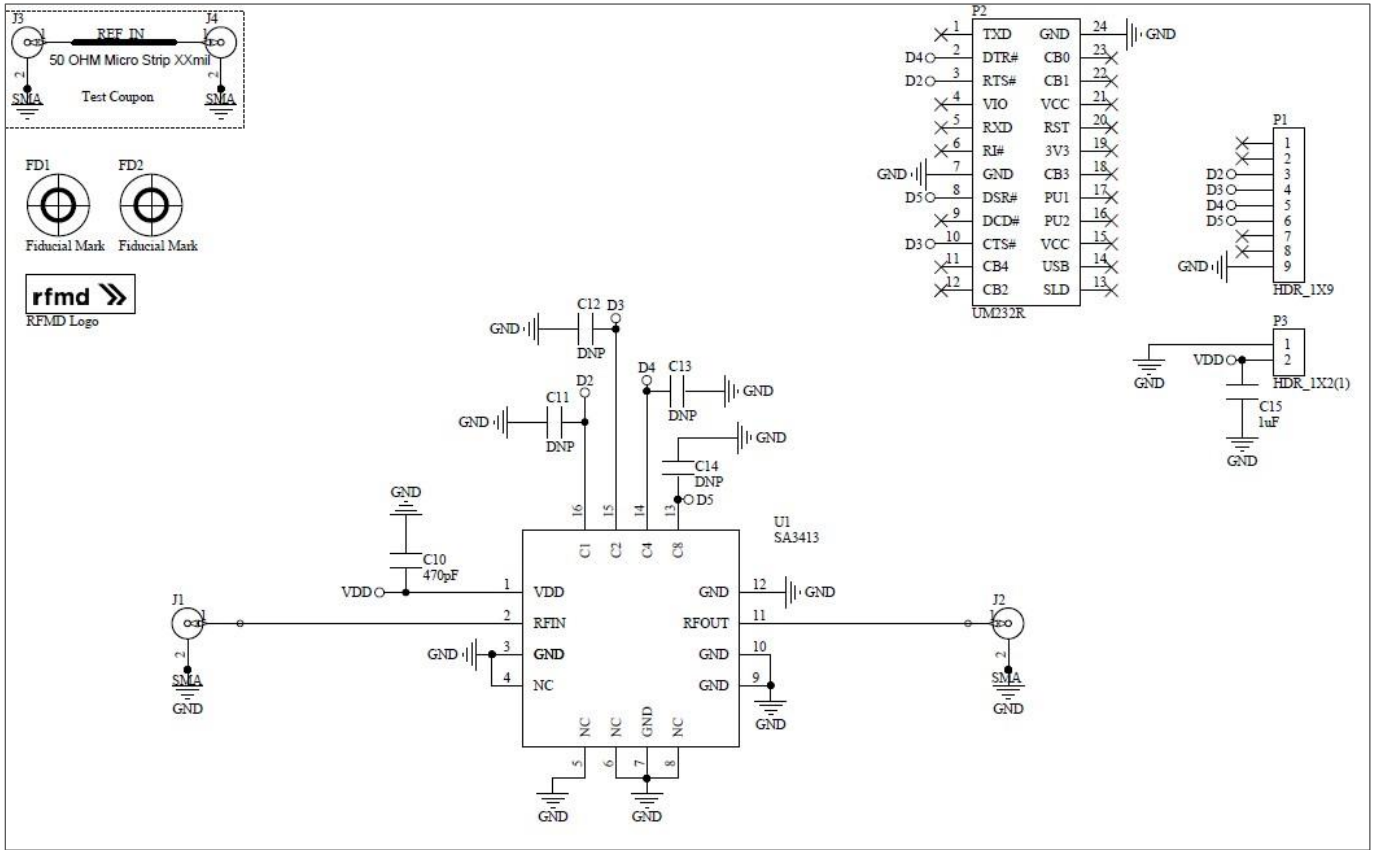


**Supply Current versus Attenuation State**

RF 2GHz, V<sub>DD</sub> = 5V



### Evaluation Board Schematic, RFSA2534PCK-410 5MHz to 6000MHz



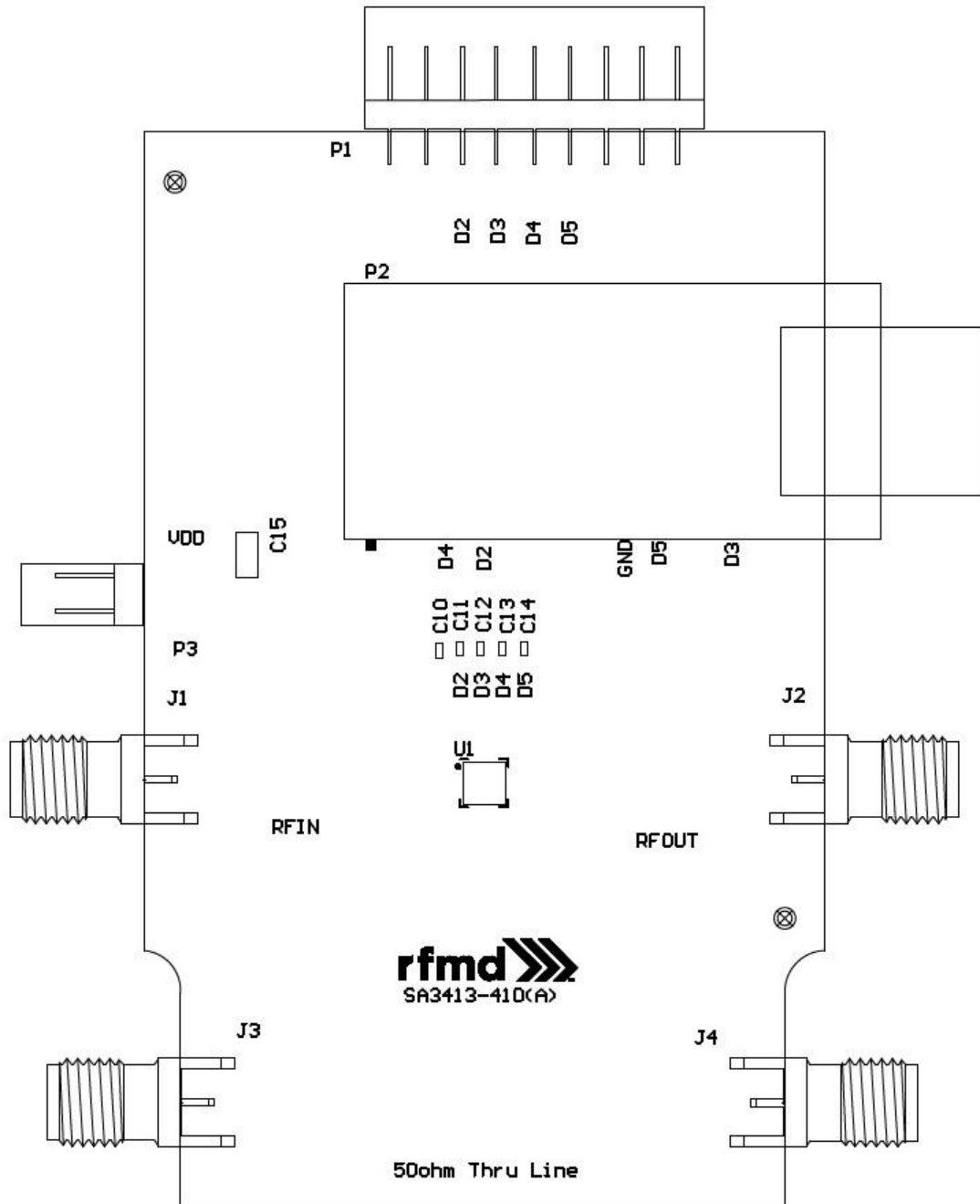
### Bill of Material – RFSA3413PCK-410

| Reference Des. | Value  | Description                                | Manuf.                    | Part Number        |
|----------------|--------|--|---------------------------|--------------------|
| n/a            | n/a    | Printed Circuit Board                      | Qorvo                     | SA3413-410(A)      |
| U1             | n/a    | Module, Digital Step Attenuator, 5-6000MHz | Qorvo                     | RFSA3413           |
| C10            | 470 pF | CAP, 470pF, 5%, 50V, C0G, 0402             | Murata Electronics        | GRM1555C1H471JA01D |
| C15            | 1 µF   | CAP, 1 µF, 10%, 25V, X7R, 1206             | Taiyo Yuden (USA), Inc.   | CE TMK316BJ105KL-T |
| J1, J2, J3, J4 | n/a    | CONN, SMA, END LNCH, UNIV, HYB MNT, FLT    | Molex                     | SD-73251-4000      |
| P1             | n/a    | CONN, HDR, ST, 9-PIN, 0.100"               | SAMTEC                    | TSW-109-07-G-S     |
| P2             | n/a    | CONN, SKT, 24-PIN DIP, 0.600", T/H         | Aries Electronics Inc.    | 24-6518-10         |
| P3             | n/a    | CONN, HDR, ST, PLRZD, 2-PIN, 0.100"        | ITW Pancon                | MPSS100-2-C        |
| M1             | n/a    | Module, USB to Serial Uart, SSOP-28        | Future Technology Devices | UM232R             |

**Notes:**

1. M1 should be mounted into P2 with respect to the Pin 1 alignment of M1 and P2.

**Evaluation Board Assembly, RFSA3413PCK-410 5MHz to 6000MHz**





## RFSA3413 Programming by Using USB Interface

Refer to Qorvo Control Bit Generator (CBG) Software Reference Manual for detailed instructions on how to setup the software for use. Apply the supply voltage to P3. Select RFSA3413 from the Qorvo Parts List of the CBG user interface. Set the attenuation value using the CBG Graphic User Interface (GUI). The attenuator is set to the desired state and measurements can be taken.

## RFSA3413 Programming by Using Its Parallel Bus

This configuration allows the user to control the attenuator through the P1 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 P1 connector. The parallel bus signal names for P1 are indicated on the evaluation board. Cross reference for device pin names to P1 connector signals is as follows: C1 = D2, C2 = D3, C4 = D4, C8 = D5. Apply the supply voltage to P3. Send the appropriate signals onto the parallel bus lines in accordance with the Parallel Interface Attenuation Truth Table. The attenuator is set to the desired state and measurements can be taken.

## Power-up State

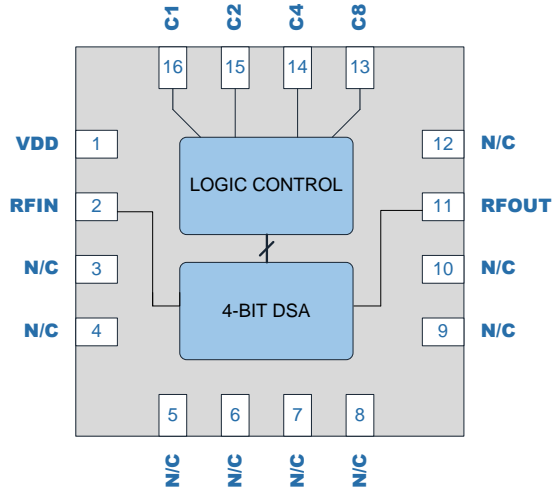
The default state is minimum attenuation (0dB) when supply voltage is applied to the attenuator. If a different attenuation state is desired during power up, this can be accomplished by applying signals according to the Parallel Interface Attenuation Truth Table. The attenuator will power up to the state applied to the parallel bus during turn on.

## Control Bit Truth Table (Major States)

| D5<br>(C8) | D4<br>(C4) | D3<br>(C2) | D2<br>(C1) | Attenuation State |
|------------|------------|------------|------------|-------------------|
| H          | H          | H          | H          | 0 dB *            |
| H          | H          | H          | L          | 1 dB              |
| H          | H          | L          | H          | 2 dB              |
| H          | L          | H          | H          | 4 dB              |
| L          | H          | H          | H          | 8 dB              |
| L          | L          | L          | L          | 15 dB             |

\*0 dB Reference State with the Insertion Loss as specified

## Pad Configuration and Description

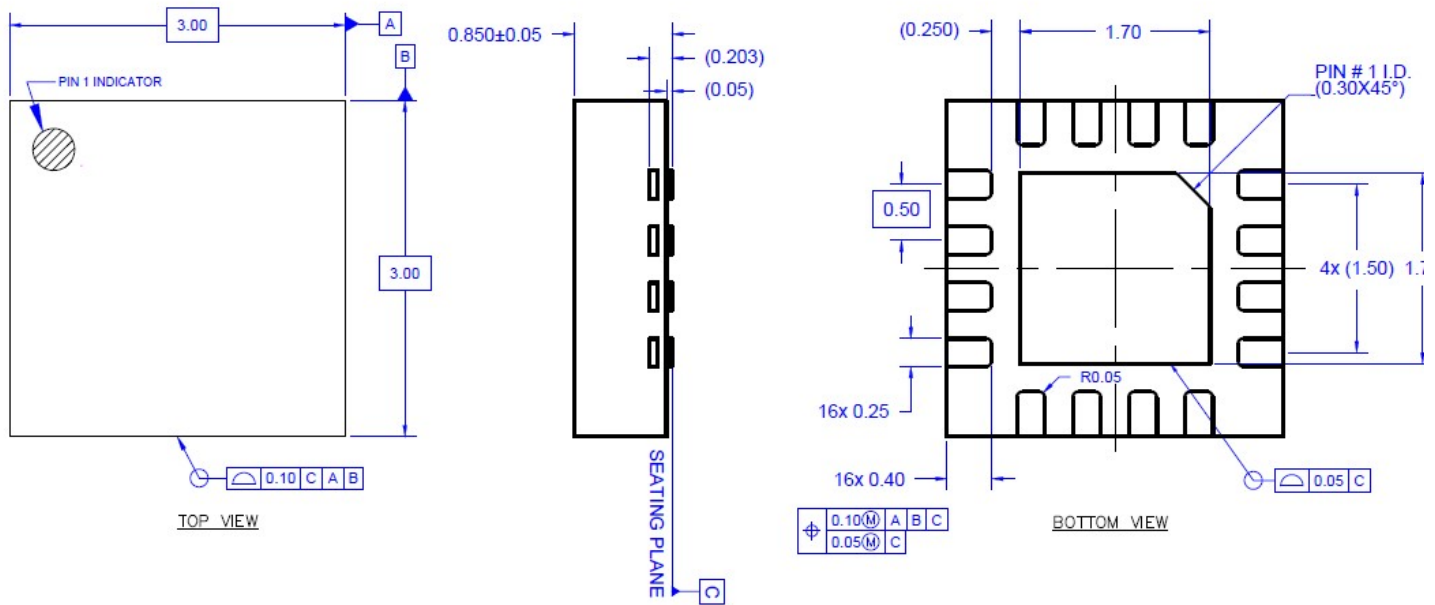


Top View

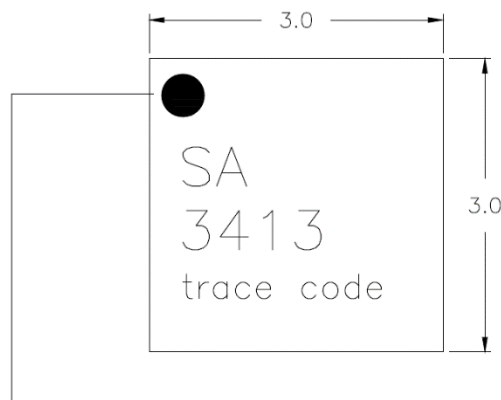
| Pad No.                     | Label | Description  |
|-----------------------------|-------|--|
| 1                           | VDD   | DC Supply Voltage Input  |
| 2                           | RFIN  | RF Input, Incident RF power must enter this pin for rated thermal performance and reliability. Do not apply DC to this pin. Can be DC grounded externally. Internally, a resistors in between this Pin and ground. |
| 3, 4, 5, 6, 7, 8, 9, 10, 12 | NC    | No Internal Connection. Land pads should be provided on PCB for mounting integrity.  |
| 11                          | RFOUT | RF Output, Can be DC grounded externally. Internally, a resistors in between this Pin and ground.  |
| 13                          | C8    | 8 dB Bit, Parallel Control Input; 3V CMOS compatible logic.  |
| 14                          | C4    | 4 dB Bit, Parallel Control Input; 3V CMOS compatible logic.  |
| 15                          | C2    | 2 dB Bit, Parallel Control Input; 3V CMOS compatible logic.  |
| 16                          | C1    | 1 dB Bit, Parallel Control Input; 3V CMOS compatible logic.  |
| Backside Paddle             | GND   | RF/DC ground. Quantity 9 Ground via holes recommended.   |

**Package Outline**

(Dimensions in Millimeters)

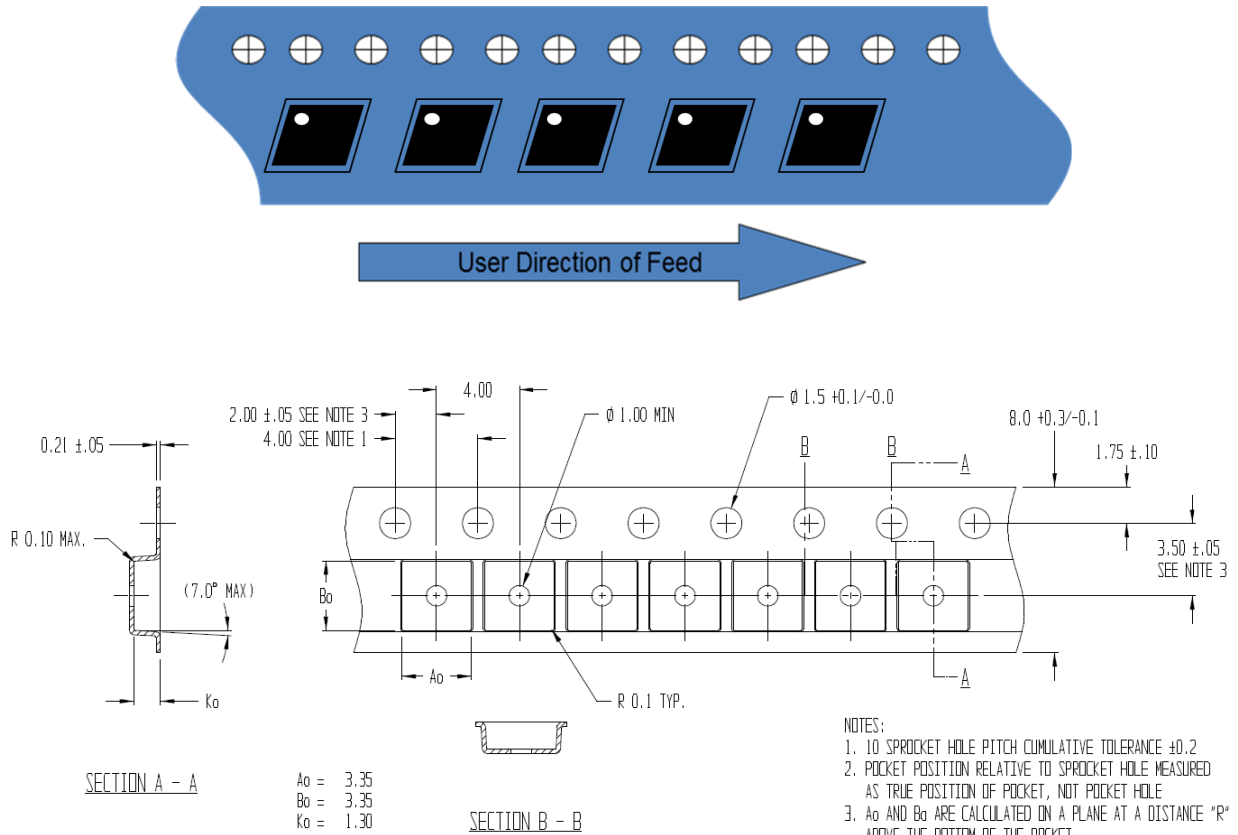


**Package Marking**



Pin 1 Indicator  
 Trace code to be assigned by Subcon

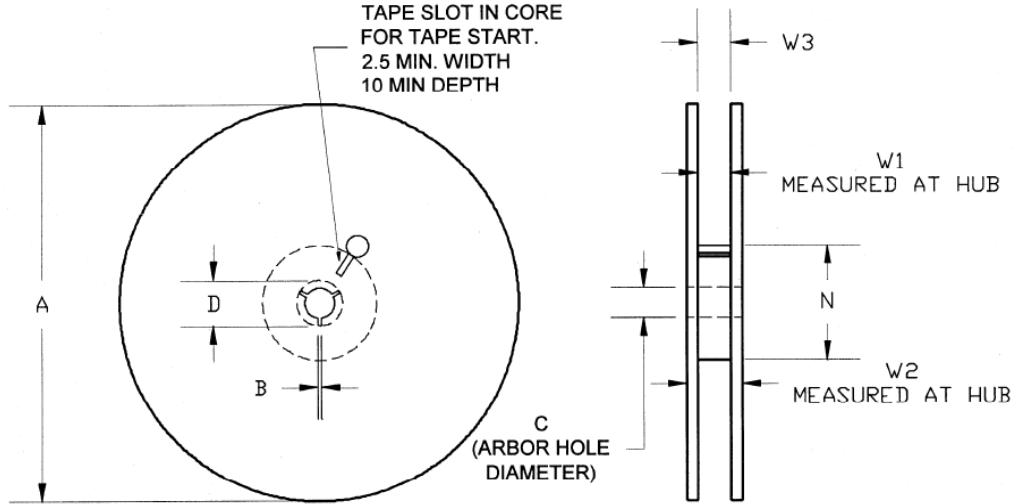
Tape and Reel Information – Carrier and Cover Tape Dimensions



| Feature             | Measure                                  | Symbol | Size (in) | Size (mm) |
|---------------------|--|--------|-----------|-----------|
| Cavity              | Length                                   | A0     | 0.132     | 3.35      |
|                     | Width                                    | B0     | 0.132     | 3.35      |
|                     | Depth                                    | K0     | 0.051     | 1.30      |
|                     | Pitch                                    | P1     | 0.315     | 4.00      |
| Centerline Distance | Cavity to Perforation - Length Direction | P2     | 0.079     | 2.00      |
|                     | Cavity to Perforation - Width Direction  | F      | 0.138     | 3.50      |
| Cover Tape          | Width                                    | C      | 0.362     | 5.40      |
| Carrier Tape        | Width                                    | W      | 0.315     | 8.00      |

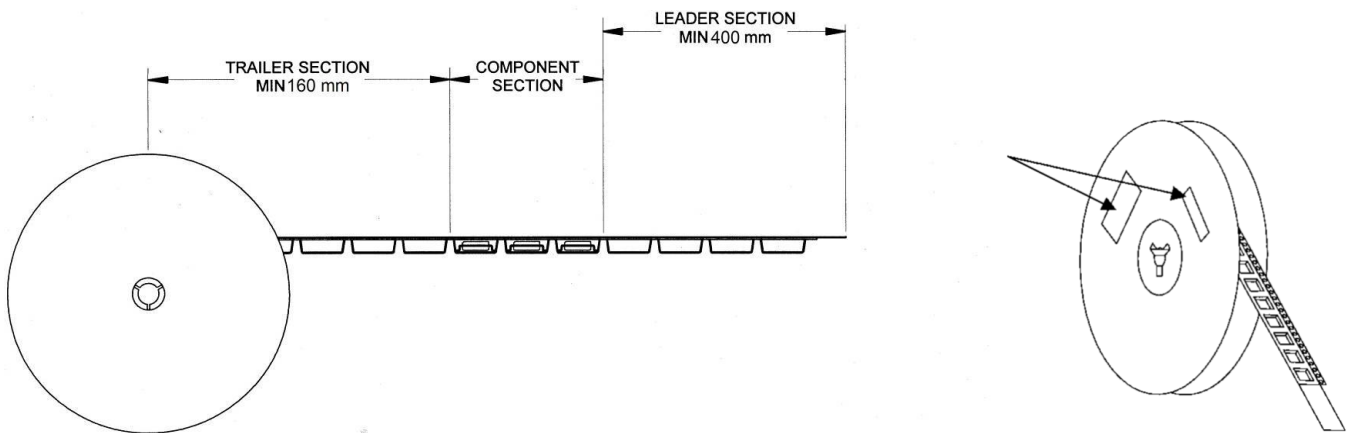
**Tape and Reel Information – Reel Dimensions**

Standard T/R size = 2500 pieces on a 7" reel.



| Feature | Measure              | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange  | Diameter             | A      | 6.969     | 177.0     |
|         | Thickness            | W2     | 0.559     | 14.2      |
|         | Space Between Flange | W1     | 0.346     | 8.8       |
| Hub     | Outer Diameter       | N      | 2.283     | 58.0      |
|         | Arbor Hole Diameter  | C      | 0.512     | 13.0      |
|         | Key Slit Width       | B      | 0.079     | 2.0       |
|         | Key Slit Diameter    | D      | 0.787     | 20.0      |

**Tape and Reel Information – Tape Length and Label Placement**



Notes:

1. Empty part cavities at the trailing and leading ends are sealed with cover tape. See EIA 481-1-A.
2. Labels are placed on the flange opposite the sprockets in the carrier tape.