

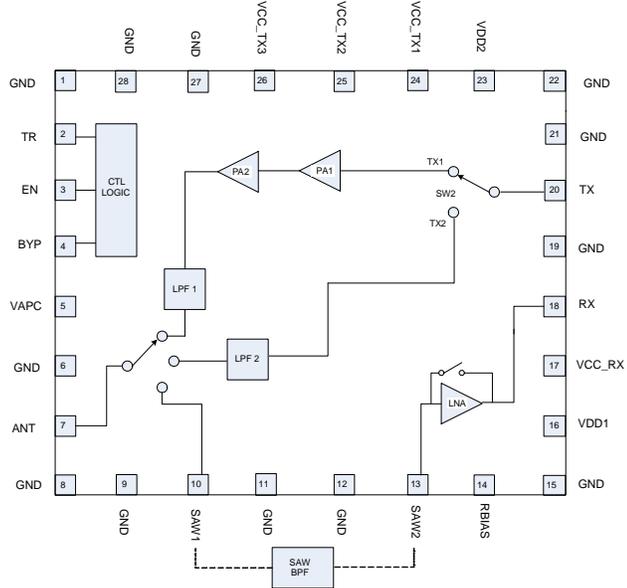


Features

- Integrated 50Ω Input/Output Match
- Tx Output Power: 30dBm
- Single 50Ω Bi-directional Transceiver Interface
- Integrated PA, filtering LNA with Bypass Mode
- Transmit Thru path

Applications

- 400MHz ISM Bands
- Single Chip RF Front End Module
- Wireless Automatic Metering
- Portable Battery Powered Equipment
- Smart Energy



Functional Block Diagram

Product Description

The RFFM6403 is a single-chip front end module (FEM) for applications in the 405MHz and 475MHz ISM Bands. The RFFM6403 addresses the need for aggressive size reduction for typical portable equipment RF front-end design and greatly reduces the number of components outside of the core chipset thus minimizing the footprint and assembly cost of the overall solution. The RFFM6403 contains an integrated 1 Watt PA, SP3T Antenna switch, integrated Tx harmonic filter, Tx thru path, LNA with bypass mode, and matching components. The RFFM6403 is packaged in a 28-pin, 6.0mm x 6.0mm x 0.975mm over-molded laminate package with backside ground which greatly minimizes next level board space and allows for simplified integration.

Ordering Information

| | |
|------------------|--|
| RFFM6403 | 2.7V to 4.2V Module for Integration with 400MHz Smart Energy |
| RFFM6403PCBA-410 | Fully Assembled Evaluation Board |

Absolute Maximum Ratings

| Parameter | Rating | Unit |
|--------------------------------------|-------------|------|
| Voltage | 5.25 | V |
| Storage Temperature Range | -40 to +150 | °C |
| Operating Temperature Range | -40 to +85 | °C |
| Receive RF Input Power (SAW2) | +5 | dBm |
| Transmit RF Input Power (PA Enabled) | +15 | dBm |
| Transmit RF Input Power (PA Bypass) | +20 | dBm |
| Receive RF Input Power (ANT) | +33 | dBm |
| T/R Port Load VSWR in Transmit Mode | 10:1 | |
| ESD, HBM | 500 | V |
| ESD, CDM | 1000 | V |
| 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.

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RoHS (Restriction of Hazardous Substances): Compliant per EU Directive 2002/95/EC.

Nominal Operating Parameters

| Parameter | Specification | | | Unit | Condition |
|---------------------------------------|---------------|------|------|----------|--|
| | Min. | Typ. | Max. | | |
| Frequency | 405 | 440 | 475 | MHz | |
| RF Port Impedance | | 50 | | Ω | |
| Operating Voltage | 2.5 | 3.6 | 4.2 | V | |
| Leakage Current | | | | | $V_{CC}TX1 = 3.6V, V_{CC}TX2 = 3.6V, V_{CC}TX3 = 3.6V, V_{DD1} = 3.6V, V_{DD2} = 3.6V, V_{CC}RX = 3.6V, V_{APC} = 0.0V, EN = 0.0V, TR = 0.0V, BYP = 0.0V, RF = Off, Temperature = 25^{\circ}C$ |
| V_{DD2} | | 0.5 | 1 | μA | |
| $V_{CC}TX$ | | 0.5 | 5 | μA | $I_{CC}V_{CC}TX1 + I_{CC}V_{CC}TX2 + I_{CC}V_{CC}TX3$ |
| $V_{CC}RX$ | | 0.5 | 2.5 | μA | |
| Operating Voltages | | | | | |
| $V_{CC}TX1/2/3$ | 2.5 | 3.6 | 4.2 | V | |
| $V_{CC}RX$ | 2.5 | 3.3 | 4.2 | V | |
| V_{DD1} | 2.5 | 3.3 | 4.2 | V | |
| V_{DD2} | 2.5 | 3.6 | 4.2 | V | |
| Tx Output Power Control (V_{APC}) | 0.00 | 2.25 | 2.50 | V | V_{APC} operates such that the transmitter output power is saturated at a level lower than 1.9V and minimal variation in output power of the device occurs above that level |

| Parameter | Specification | | | Unit | Condition |
|---------------------------------|---------------|------|------|---------|--|
| | Min. | Typ. | Max. | | |
| Transmit High Power Mode | | | | | $V_{CC}Tx1 = 3.6V, V_{CC}Tx2 = 3.6V, V_{CC}Tx3 = 3.6V, V_{DD1} = 0.0V, V_{DD2} = 3.6V, V_{CC}Rx = 0.0V, V_{APC} = 2.25V, EN = 1.8V, T_R = 1.8V, BYP = 0.2V, \text{Measured Path} = TX \text{ to ANT}, \text{Temperature} = 25^\circ C$ |
| Output Power | 30.0 | 30.5 | | dBm | $P_{IN} = +10dBm$ |
| | 26.0 | | | | |
| Input Return Loss | 10 | | | dB | |
| Output Return Loss | 10 | | | dB | |
| Operating Current | | 1250 | 1500 | mA | $P_{OUT} = 30.5dBm, I_{CC} TX1 + I_{CC} TX2 + I_{CC} TX3$ |
| Quiescent Current | | 120 | | mA | $I_{CC} TX1 + I_{CC} TX2 + I_{CC} TX3, RF = \text{Off}$ |
| I_{DD2} | | 14 | | mA | $P_{OUT} = 30.5dBm$ |
| Second Harmonic | | | -70 | dBc | $P_{OUT} = 30.5dBm$ |
| Third - Tenth Harmonic | | | -63 | dBc | $P_{OUT} = 30.5dBm$ |
| Transmit Bypass Mode | | | | | $V_{CC}Tx1 = 3.6V, V_{CC}Tx2 = 3.6V, V_{CC}Tx3 = 3.6V, V_{DD1} = 0.0V, V_{DD2} = 3.6V, V_{CC}Rx = 0.0V, V_{APC} = 0.0V, EN = 1.8V, T_R = 1.8V, BYP = 1.8V, \text{Measured Path} = TX \text{ to ANT}, \text{Temperature} = 25^\circ C$ |
| Insertion Loss | | 2 | 2.5 | dB | |
| Input P1dB | 22 | 30 | | dBm | |
| Input IP3 | | 40 | | dBm | |
| Input Return Loss | 10 | | | dB | |
| Output Return Loss | 10 | | | dB | |
| Second Harmonic | | | -40 | dBc | $P_{IN} = +12dBm$ |
| Third - Tenth Harmonic | | | -40 | dBc | $P_{IN} = +12dBm$ |
| Receive Mode | | | | | $V_{CC}Tx1 = 3.6V, V_{CC}Tx2 = 3.6V, V_{CC}Tx3 = 3.6V, V_{DD1} = 3.6V, V_{DD2} = 3.6V, V_{CC}Rx = 3.6V, V_{APC} = 0.0V, EN = 1.8V, T_R = 0.2V, BYP = 0.2V, \text{Measured Path} = SAW2 \text{ to RX}, \text{Temperature} = 25^\circ C$ |
| IP1dB | | -3 | | dBm | |
| Gain | 15 | 16 | 17.5 | dB | |
| Current | 4 | 5 | 6 | mA | |
| IDD2 | | 1 | | mA | |
| Noise Figure | | 1.7 | 2.0 | dB | |
| IIP3 | -2 | -5 | | dBm | |
| Input Return Loss | 10 | | | dB | |
| Output Return Loss | 10 | | | dB | |
| Receive Bypass Mode | | | | | $V_{CC}Tx1 = 3.3V, V_{CC}Tx2 = 3.3V, V_{CC}Tx3 = 3.3V, V_{DD1} = 3.3V, V_{DD2} = 3.3V, V_{CC}Rx = 3.3V, V_{APC} = 0.0V, EN = 1.8V, T_R = 0.2V, BYP = 1.8V, \text{Measured Path} = SAW2 \text{ to RX}, \text{Temperature} = 25^\circ C$ |
| Insertion Loss | | 3 | | dB | |
| Current | | 10 | | μA | |
| IP1dB | | 17 | | dBm | |
| IIP3 | | 15 | | dBm | |
| Input Return Loss | 8 | | | dB | |
| Output Return Loss | 10 | | | dB | |

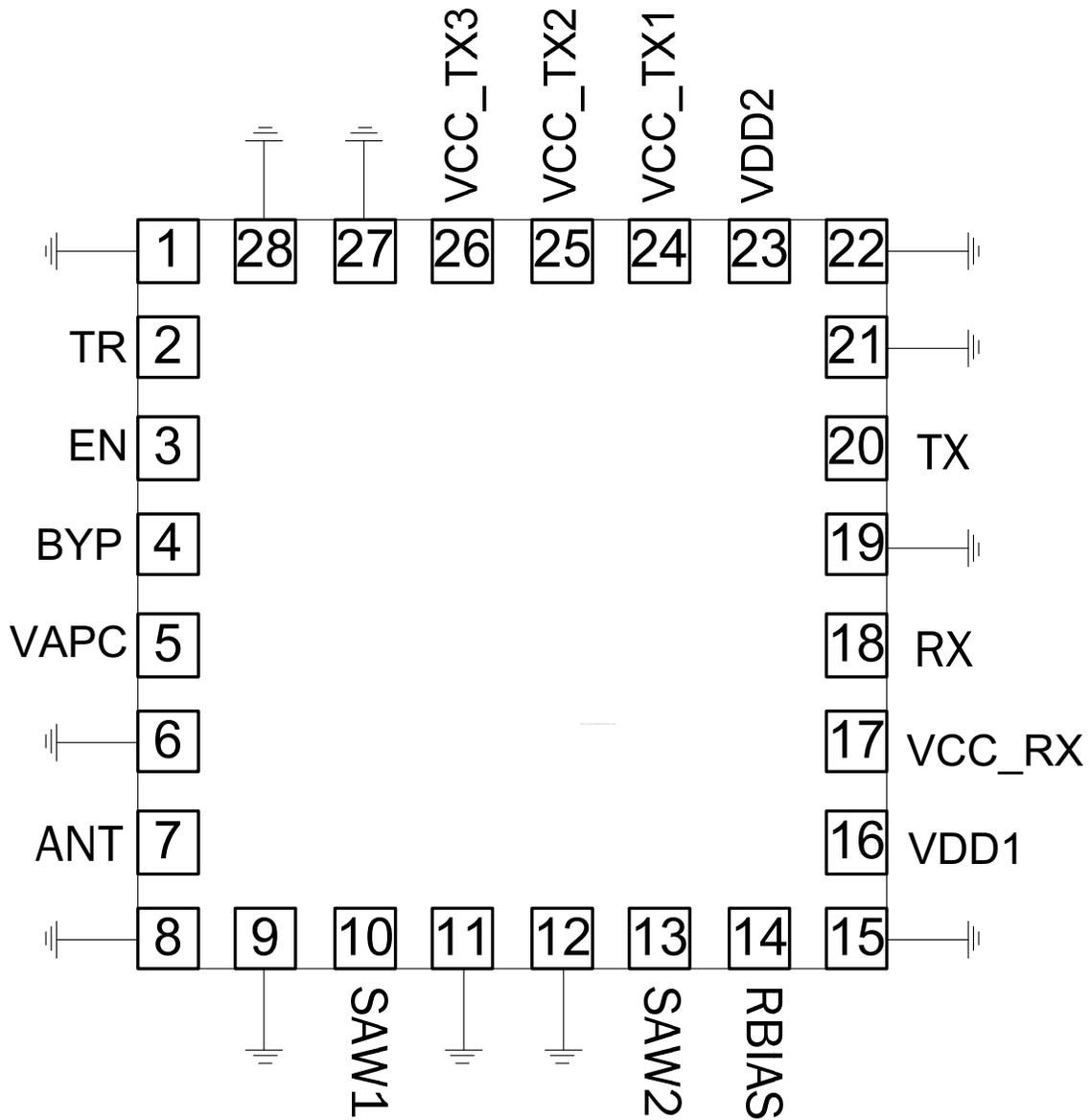
| Parameter | Specification | | | Unit | Condition |
|----------------------------|---------------|------|------|---------|--|
| | Min. | Typ. | Max. | | |
| Antenna Switch | | | | | Measured ANT to SAW1, RX & RX BYPASS Modes |
| Insertion Loss | | 0.5 | | dB | |
| Input Return Loss | 10 | 15 | | dB | |
| Output Return Loss | 10 | 15 | | dB | |
| Isolation | | | | | |
| Isolation | 20 | | | dB | Any used port to any unused port |
| Logic | | | | | EN, TR, BYP |
| Control Logic HIGH | 1.6 | | 4.0 | V | Max Control Logic High = $V_{DD2} - 0.2V_{DC}$ |
| Control Logic LOW | | 0.2 | 0.3 | V | |
| Control Logic HIGH Current | | 20 | | μA | |
| Control Logic LOW Current | | 0.1 | | μA | |

| Operating Mode | TR | EN | BYP | PA | LNA |
|-----------------|--------|--------|--------|-----|-----|
| | (Pin2) | (Pin3) | (Pin4) | | |
| Transmit | High | High | Low | ON | OFF |
| Transmit Bypass | High | High | High | OFF | OFF |
| Receive | Low | High | Low | OFF | ON |
| Receive Bypass | Low | High | High | OFF | OFF |
| Shutdown | X | Low | X | OFF | OFF |

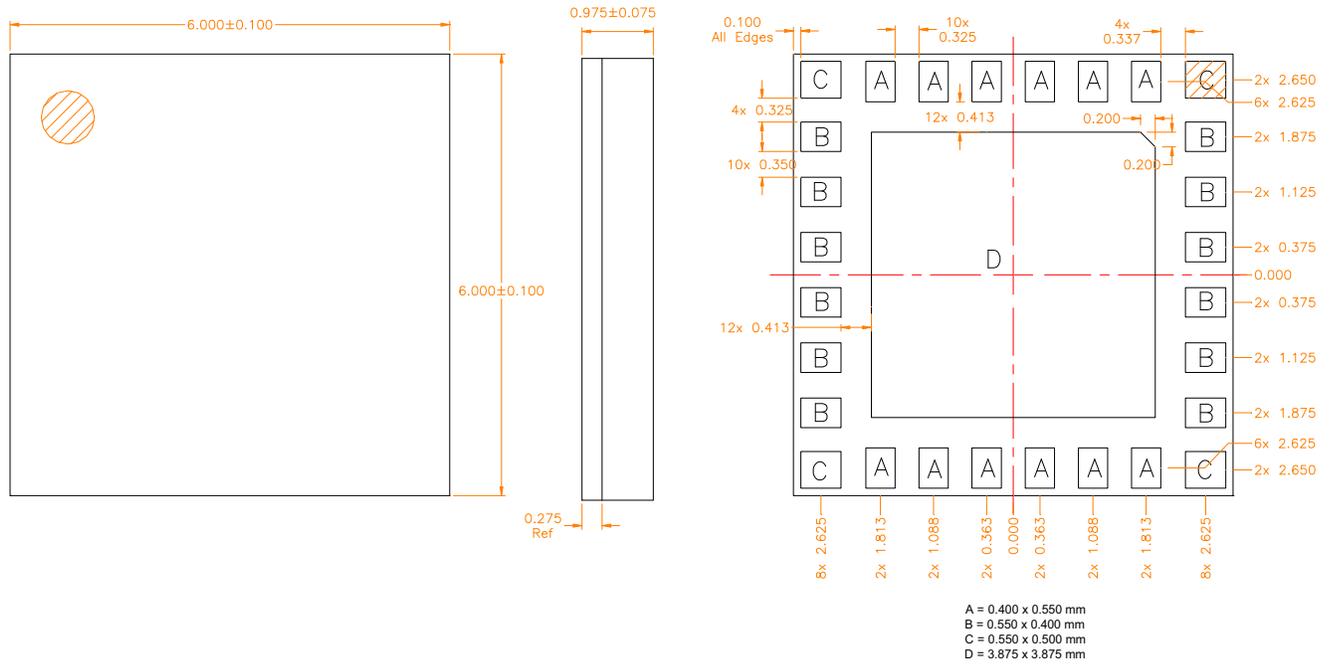
Pin Names and Descriptions

| Pin | Name | Description |
|-----|---------|---|
| 1 | GND | Ground |
| 2 | TR | Digital Input: Transmit/Receive Control |
| 3 | EN | Digital Input: FEM Enable Control |
| 4 | BYP | Digital Input: RX Bypass Control |
| 5 | VAPC | Analog Input: Output Power Adjustment |
| 6 | GND | Ground |
| 7 | ANT | Antenna Port, internally matched to 50Ω and DC blocked |
| 8 | GND | Ground |
| 9 | GND | Ground |
| 10 | SAW1 | Receive side of antenna switch, internally matched to 50Ω and DC blocked |
| 11 | GND | Ground |
| 12 | GND | Ground |
| 13 | SAW2 | LNA RX and RX bypass input port, internally matched to 50Ω and DC blocked |
| 14 | RBIAS | LNA bias setting resistor (not used) |
| 15 | GND | Ground |
| 16 | VDD1 | Logic power supply (not used) |
| 17 | VCC_RX | LNA Power supply |
| 18 | RX | Receive output, internally matched to 50Ω and DC blocked |
| 19 | GND | Ground |
| 20 | TX | Transmit path input port, internally matched to 50Ω and DC blocked |
| 21 | GND | Ground |
| 22 | GND | Ground |
| 23 | VDD2 | Power Supply to the Logic Controller and PA and LNA bias networks |
| 24 | VCC_TX1 | Power supply to PA 1st stage |
| 25 | VCC_TX2 | Power supply (not used) |
| 26 | VCC_TX3 | Power supply to PA final stage |
| 27 | GND | Ground |
| 28 | GND | Ground |

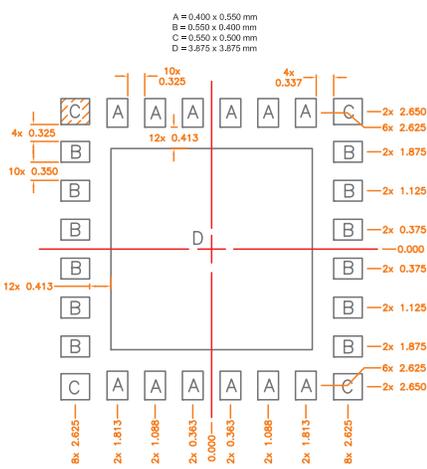
Pin Out



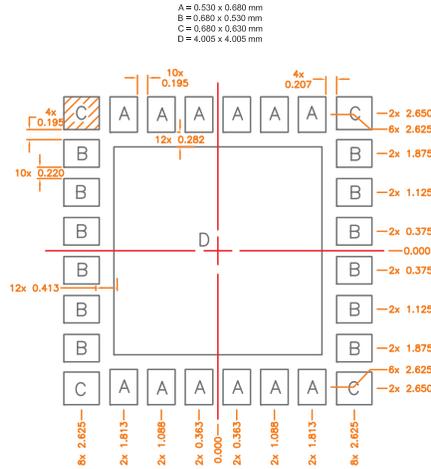
Package Drawing



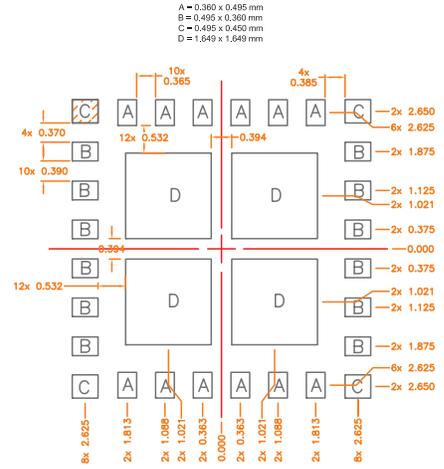
PCB Patterns Drawing



PCB Metal Land Pattern



PCB Solder Mask Pattern



PCB Stencil Pattern

Notes:

1. Shaded area represents Pin 1 location.

Application Schematic

