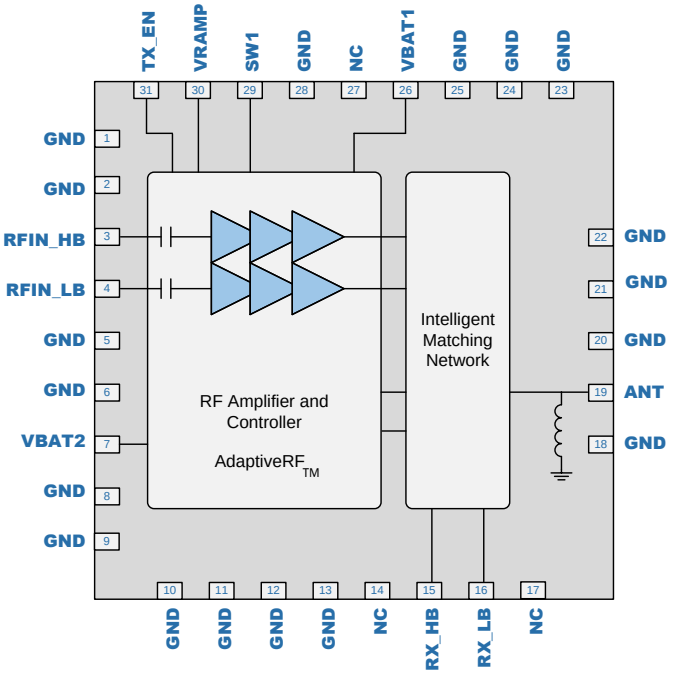
RF7198

Quad-Band GSM850/GSM900/DCS1800/PCS1900 TX Module

The RF7198 is a complete high-power, high-efficiency transmit module for low-cost quad-band GSM/GPRS mobile handsets. Power Amplifier, Power Controller and Switch functionality have been implemented on a single standard CMOS die.



Functional Block Diagram

Ordering Information

RF7198SB	Sample bag with 5 pieces
RF7198SQ	Sample bag with 25 pieces
RF7198SR	Sample reel with 100 pieces
RF7198TR13	13" Reel with 5,000 pieces
RF7198PCK-410	Fully Assembled EVB

Package: LGA, 31-pin, 5.25mm x 5.30mm

Features

- 33.0dBm min Pout GSM850/900
- 30.5dBm min Pout DCS1800 and PCS1900
- Extended Power Added Efficiency
  - 40% PAE GSM850 and GSM900 at 33.0dBm
  - 39% PAE EGSM900 at 33.0dBm
  - 37% PAE for DCS1800 at 30.0dBm
  - 35% PAE for PCS1900 at 30.0dBm
- Ultra-small Form Factor
  - 5.25mm x 5.30mm x 0.73mm LGA package
- Robust Operation
  - Industry leading TRP performance with ±0.5dB power variation over 3:1 VSWR
  - No damage or degradation into 20:1 load VSWR

Applications

- Battery Powered 2G Handsets
- GSM850, EGSM900, DCS1800 and PCS1900 Band Products
- Multislot Class 12 Products (4 Transmit Timeslots)

RF Micro Devices Inc. 7628 Thorndike Road, Greensboro, NC 27409-9421
For sales or technical support, contact RFMD at +1.336.678.5570 or customerservice@rfmd.com.

DS140618

Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage, Non-operating	-0.5 to +5.5	V
Ramp Voltage (V_{RAMP})	-0.5 to +3.0	V
Control Voltage	-0.3 to +3.0	V
RF Input Power	+10	dBm
Max Duty Cycle	50	%
Output Load VSWR	20:1	
Operating Case Temperature	-30 to +85	°C
Storage Temperature	-55 to +150	°C
ESD All Pins, HBM, JESD22-A114	2,000	V

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.

Nominal Operating Parameters

Parameter	Specification			Unit	
	Min	Typ	Max		
General Performance					
Power Supply					
Supply Voltage	3.0	3.5	4.5	V	
Leakage Current (Standby Mode)		1	10	µA	Temp = +25°C, $V_{BATT} \leq 4.5V$
Power Control (V_{RAMP})					
V_{RAMP} Max			1.8	V	
V_{RAMP} Min		0.10		V	
V_{RAMP} Capacitance		5	68	pF	
V_{RAMP} Current			40	µA	$V_{RAMP} = V_{RAMP}$ Max
Turn On/Off Time			2	µs	$V_{RAMP} = V_{RAMP}$ Min to V_{RAMP} Max
Pedestal (pre-ramp) Voltage, V_{PED}		160		mV	$V_{RAMP} = V_{PED}$ prior to onset of ramp-up
Control Signals					
Input Voltage – Logic 'Low'	0	0	0.40	V	TXEN, SW1
Input Voltage – Logic 'High'	1.40	1.80	2.80	V	TXEN, SW1
Input Current – Logic 'High'		10	30	µA	TXEN, SW1
ESD					
ESD RX Pins	2,000			V	HBM, JESD22-A114
	500			V	CDM, JESD22-C101C
ESD All Other Pins	2,000			V	HBM, JESD22-A114

Parameter	Specification			Unit	
	Min	Typ	Max		
GSM850 Band					Unless otherwise stated: All RF ports terminated in 50Ω. V_{BATT} = 3.5V, P_{IN} = 3dBm, Temp = +25°C, P_{OUT} = 33dBm, Duty Cycle = 12.5%, Pulse Width = 577µs, TX_EN = 'High', SW1 = 'Low'
Operating Frequency Range	824		849	MHz	
Output Power					V_{RAMP} up to 1.8V
RF Output Power, Nominal	33.0	34.0			V_{RAMP} = 1.8V
RF Output Power, Extreme	30.5			dBm	V_{BATT} = 3.0V, P_{IN} = 0dBm, Temp = +85°C
Power-Added Efficiency and Supply Current					
Efficiency at Rated Power		40		%	P_{OUT} = 33.0dBm typ.
Maximum Efficiency		40		%	P_{OUT} = 33.5dBm typ.
Efficiency at Backed-Off power		29		%	P_{OUT} = 29.0dBm
Current Drain at Rated Power		1.4		A	P_{OUT} = 33.0dBm
TRP					P_{OUT} set to 33.0dBm into 1:1 VSWR
Output Power Variation		±0.5		dB	3:1 VSWR all Phases
Minimum Power		30		dBm	3:1 VSWR all Phases
Maximum Supply Current		1.6		A	3:1 VSWR all Phases
Spurious					
Harmonic Peak 2fo to 14fo		-40	-33	dBm	P_{OUT} = 5dBm to 33.0dBm
Non-Harmonic Spurious			-36	dBm	P_{OUT} = 5dBm to 33.0dBm
Noise Power		-84	-82	dBm	RBW = 100kHz, P_{OUT} ≤ 33.0dBm, P_{IN} = 0dBm to 6dBm, f = 869MHz to 894MHz
		-82	-80	dBm	RBW =100kHz, P_{OUT} ≤ 33.0dBm, P_{IN}=0dBm to 6dBm, f = 1805MHz to 1880MHz
Output Load VSWR Stability (Spurious)			-36	dBm	VSWR = 10:1 for all phase angles. P_{OUT} set to ≤ 33.0dBm into 50Ω load. RBW = 3MHz
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR = 20:1 for all phase angles. P_{OUT} set to ≤ 33.0dBm into 50Ω load
Output Load Impedance		50		Ω	Load impedance presented at Antenna pad
Input Port Characteristics					
Input Power Range	0	3	6	dBm	
Input Impedance	0	50		Ω	
Input VSWR			2.5:1		Over P_{OUT} range (5dBm to 33.5dBm)

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
GSM850 Band (continued)					
Power Control					
Power Control Range	55	60		dB	V_{RAMP} = V_{RAMP} Min to V_{RAMP} Max
Power Output Variation from nominal conditions P_{OUT} = 15dBm to 28.5dBm	-1.0		1.0	dB	P_{IN} = 0dBm to 6dBm, Temp = -20°C to +85°C 3.0V ≤ V_{BATT} ≤ 4.5V Relative to Nominal Output Power Condition: V_{BATT} = 3.5V, P_{IN} = 3dBm, f = 836.5MHz
P_{OUT} = 5dBm to 15dBm	-2.0		2.0	dB	
Forward Isolation 1		-55	-40	dBm	TX_EN='Low', V_{RAMP} = 0.16V
Forward Isolation 2		-25	-22	dBm	TX_EN='High', V_{RAMP} = 0.16V

Parameter	Specification			Unit	
	Min	Typ	Max		
GSM900 Band					Unless otherwise stated: All RF ports terminated in 50Ω. V_{BATT} = 3.5V, P_{IN} = 3dBm, Temp = +25°C, P_{OUT} = 33dBm, Duty Cycle = 12.5%, Pulse Width = 577µs, TX_EN = 'High', SW1 = 'Low'
Operating Frequency Range	880		915	MHz	
Output Power					V_{RAMP} up to 1.8V
RF Output Power, Nominal	33.0	33.6		dBm	V_{RAMP} = 1.8V
RF Output Power, Extreme	30.5			dBm	V_{BATT} = 3.0V, P_{IN} = 0dBm, Temp = +85°C
Power-Added Efficiency and Supply Current					
Efficiency at Rated Power		39		%	P_{OUT} = 33.0dBm typ.
Maximum Efficiency		39		%	P_{OUT} = 33.5dBm typ.
Efficiency at Backed-Off power		29		%	P_{OUT} = 29.0dBm
Current Drain at Rated Power		1.4		A	P_{OUT} = 33.0dBm
TRP					P_{OUT} set to 33.0dBm into 1:1 VSWR
Output Power Variation		±0.8		dB	3:1 VSWR all Phases
Minimum Power		30		dBm	3:1 VSWR all Phases
Maximum Supply Current		1.6		A	3:1 VSWR all Phases
Spurious					
Harmonic Peak 2fo to 14fo		-40	-33	dBm	P_{OUT} = 5dBm to 33.0dBm
Non-Harmonic Spurious			-36	dBm	P_{OUT} = 5dBm to 33.0dBm
Noise Power		-76	-72	dBm	RBW = 100kHz, P_{OUT} ≤ 33.0dBm, P_{IN} = 0dBm to 6dBm, f = 925MHz to 935MHz
		-84	-82	dBm	RBW = 100kHz, P_{OUT} ≤ 33.0dBm, P_{IN} = 0dBm to 6dBm, f = 935MHz to 960MHz
		-82	-80	dBm	RBW = 100kHz, P_{OUT} ≤ 33.0dBm, P_{IN} = 0dBm to 6dBm, f = 1805MHz to 1880MHz
Output Load VSWR Stability (Spurious)			-36	dBm	VSWR = 10:1 for all phase angles. P_{OUT} set to ≤ 33.0dBm into 50Ω load. RBW = 3MHz
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR = 20:1 for all phase angles. P_{OUT} set to ≤ 33.0dBm into 50Ω load
Output Load Impedance		50		Ω	Load impedance presented at Antenna pad
Input Port Characteristics					
Input Power Range	0	3	6	dBm	
Input Impedance	0	50		Ω	
Input VSWR			2.5:1		Over P_{OUT} range (5dBm to 33.5dBm)

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
GSM900 Band (continued)					
Power Control					
Power Control Range	55	60		dB	V_{RAMP} = V_{RAMP} Min to V_{RAMP} Max
Power Output Variation from nominal conditions P_{OUT} = 15dBm to 28.5dBm	-1.0		1.0	dB	P_{IN} = 0dBm to 6dBm, Temp = -20°C to +85°C 3.0V ≤ V_{BATT} ≤ 4.5V Relative to Nominal Output Power Condition: V_{BATT} = 3.5V, P_{IN} = 3dBm, f = 897.5MHz
P_{OUT} = 5dBm to 15dBm	-2.0		2.0	dB	
Forward Isolation 1		-55	-40	dBm	TX_EN = 'Low', V_{RAMP} = 0.16V
Forward Isolation 2		-25	-22	dBm	TX_EN = 'High', V_{RAMP} = 0.16V

Parameter	Specification			Unit	
	Min	Typ	Max		
DCS1800 Band					Unless otherwise stated: All RF ports terminated in 50Ω. V_{BATT} = 3.5V, P_{IN} = 3dBm, Temp = +25°C, P_{OUT} = 30dBm, Duty Cycle = 12.5%, Pulse Width = 577µs, TX_EN = 'High', SW1 = 'High'
Operating Frequency Range	1710		1785	MHz	
Output Power					V_{RAMP} up to 1.8V
RF Output Power, Nominal	30.5	31.0		dBm	V_{RAMP} = 1.8V
RF Output Power, Extreme	28.5			dBm	V_{BATT} = 3.0V, P_{IN} = 0dBm, Temp = +85°C
Power-Added Efficiency and Supply Current					
Efficiency at Rated Power		37		%	P_{OUT} = 30.0dBm typ.
Maximum Efficiency		37		%	P_{OUT} = 31.0dBm typ.
Efficiency at Backed-Off power		31		%	P_{OUT} = 28.0dBm
Current Drain at Rated Power		0.8		A	P_{OUT} = 30.0dBm
TRP					P_{OUT} set to 30.0dBm into 1:1 VSWR
Output Power Variation		±0.5		dB	3:1 VSWR all Phases
Minimum Power		28		dBm	3:1 VSWR all Phases
Maximum Supply Current		1.0		A	3:1 VSWR all Phases
Spurious					
Harmonic Peak 2fo to 7fo		-40	-33	dBm	P_{OUT} = 0dBm to 30.0dBm
Non-Harmonic Spurious			-36	dBm	P_{OUT} = 0dBm to 30.0dBm
Noise Power		-84	-82	dBm	RBW = 100kHz, P_{OUT} ≤ 30.0dBm, P_{IN} = 0dBm to 6dBm, f = 1805MHz to 1880MHz
		-77	-75	dBm	RBW = 100kHz, P_{OUT} ≤ 30.0dBm, P_{IN} = 0dBm to 6dBm, f = 925MHz to 960MHz
Output Load VSWR Stability (Spurious)			-36	dBm	VSWR = 10:1 for all phase angles. P_{OUT} set to ≤ 30.0dBm into 50Ω load. RBW = 3MHz
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR = 20:1 for all phase angles. P_{OUT} set to ≤ 30.0dBm into 50Ω load
Output Load Impedance		50		Ω	Load impedance presented at Antenna
Input Port Characteristics					
Input Power Range	0	3	6	dBm	
Input Impedance	0	50		Ω	
Input VSWR			2.5:1		Over P_{OUT} range (0dBm to 30.0dBm)

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
DCS1800 Band (continued)					
Power Control					
Power Control Range	55	60		dB	
Power Output Variation from nominal conditions P_{OUT} = 15dBm to 28.5dBm	-1.0		1.0	dB	P_{IN} = 0dBm to 6dBm, Temp = -20°C to +85°C, 3.0V ≤ V_{BATT} ≤ 4.5V, Relative to Nominal Output Power Condition: V_{BATT} = 3.5V, P_{IN} = 3dBm, f = 1747.5MHz
P_{OUT} = 5dBm to 15dBm	-3.0		3.0	dB	
Forward Isolation 1		-55	-52	dBm	TX_EN = 'Low', V_{RAMP} = 0.16V
Forward Isolation 2		-30	-25	dBm	TX_EN = 'High', V_{RAMP} = 0.16V

Parameter	Specification			Unit	
	Min	Typ	Max		
PCS1900 Band					Unless otherwise stated: All RF ports terminated in 50Ω. V_{BATT} = 3.5V, P_{IN} = 3dBm, Temp = +25°C, P_{OUT} = 30dBm, Duty Cycle = 12.5%, Pulse Width = 577µs, TX_EN = 'High', SW1 = 'High'
Operating Frequency Range	1850		1910	MHz	
Output Power					V_{RAMP} up to 1.8V
RF Output Power, Nominal	30.5	31.0		dBm	V_{RAMP} = 1.8V
RF Output Power, Extreme	28.5			dBm	V_{BATT} = 3.0V, P_{IN} = 0dBm, Temp = +85°C
Power-Added Efficiency and Supply Current					
Efficiency at Rated Power		35		%	P_{OUT} = 30.0dBm typ.
Maximum Efficiency		35		%	P_{OUT} = 31.0dBm typ.
Efficiency at Backed-Off power		30		%	P_{OUT} = 28.0dBm
Current Drain at Rated Power		0.8		A	P_{OUT} = 30.0dBm
TRP					P_{OUT} set to 30.0dBm into 1:1 VSWR
Output Power Variation		±0.5		dB	3:1 VSWR all Phases
Minimum Power		28		dBm	3:1 VSWR all Phases
Maximum Supply Current		1.0		A	3:1 VSWR all Phases
Spurious					
Harmonic Peak 2fo to 7fo		-40	-33	dBm	P_{OUT} = 0dBm to 30.0dBm
Non-Harmonic Spurious			-36	dBm	P_{OUT} = 0dBm to 30.0dBm
Noise Power		-84	-82	dBm	RBW = 100kHz, P_{OUT} ≤ 30.0dBm, P_{IN} = 0dBm to 6dBm, f = 1930MHz to 1990MHz
		-77	-75	dBm	RBW = 100kHz, P_{OUT} ≤ 30.0dBm, P_{IN} = 0dBm to 6dBm, f = 869MHz to 894MHz
Output Load VSWR Stability (Spurious)			-36	dBm	VSWR = 10:1 for all phase angles. P_{OUT} set to ≤ 30.0dBm into 50Ω load. RBW = 3MHz
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR = 20:1 for all phase angles. P_{OUT} set to ≤ 30.0dBm into 50Ω load
Output Load Impedance		50		Ω	Load impedance presented at Antenna
Input Port Characteristics					
Input Power Range	0	3	6	dBm	
Input Impedance	0	50		Ω	
Input VSWR			2.5:1		Over P_{OUT} range (0dBm to 30.0dBm)

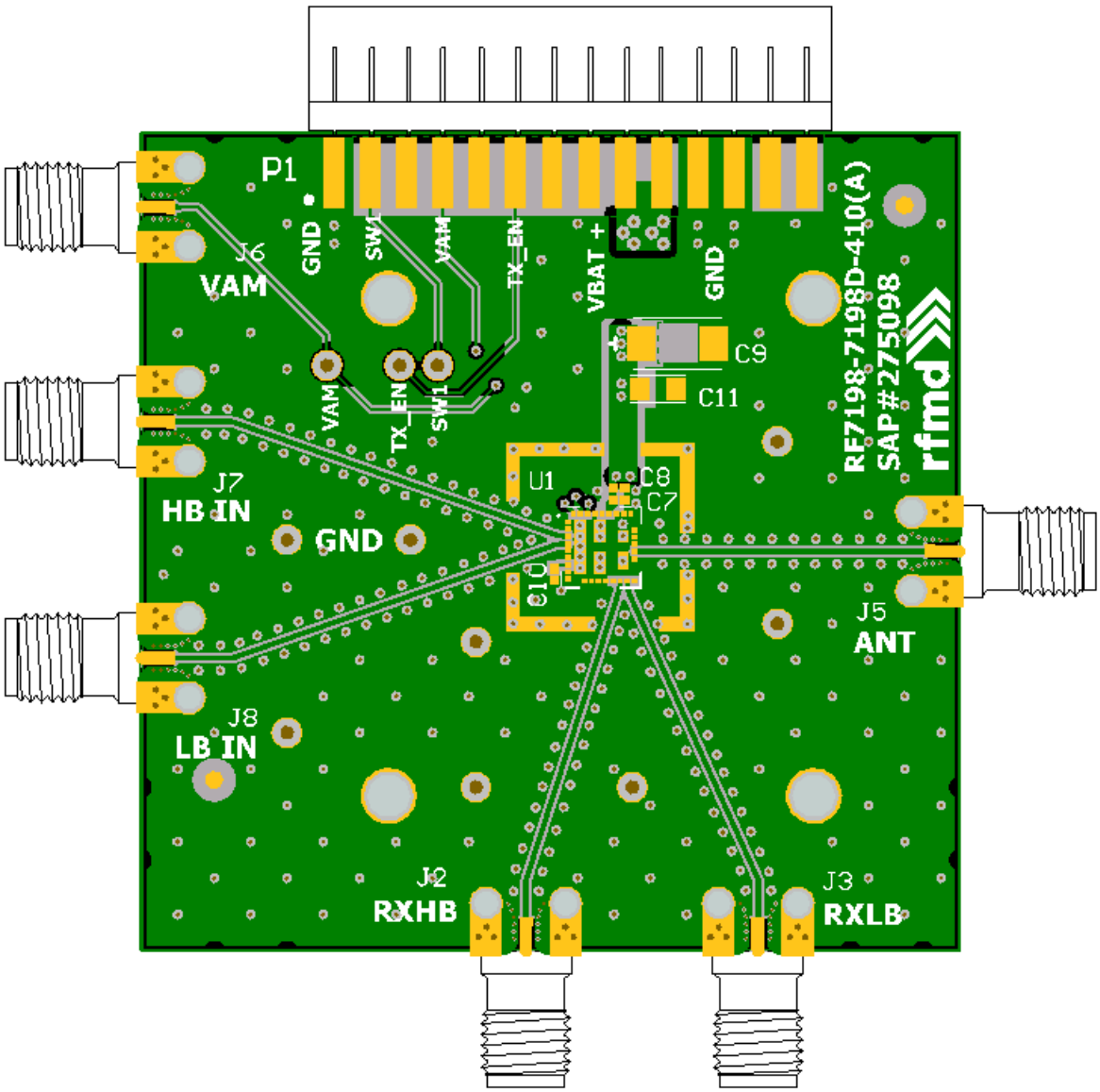
Parameter	Specification			Unit	Condition
	Min	Typ	Max		
PCS1900 Band (continued)					
Power Control					
Power Control Range	55	60		dB	
Power Output Variation from nominal conditions P_{OUT} = 15dBm to 28.5dBm	-1.0		1.0	dB	P_{IN} = 0dBm to 6dBm, Temp = -20°C to +85°C, 3.0V ≤ V_{BATT} ≤ 4.5V, Relative to Nominal Output Power Condition: V_{BATT} = 3.5V, P_{IN} = 3dBm, f = 1747.5MHz
P_{OUT} = 5dBm to 15dBm	-3.0		3.0	dB	
Forward Isolation 1		-55	-52	dBm	TX_EN = 'Low', V_{RAMP} = 0.16V
Forward Isolation 2		-30	-25	dBm	TX_EN = 'High', V_{RAMP} = 0.16V

Parameter	Specification			Unit	
	Min	Typ	Max		
RX Section					Unless otherwise stated: All RF ports terminated in 50Ω. V_{BATT} = 3.5V, P_{IN} = 3dBm, Temp = +25°C, Duty Cycle = 12.5%, Pulse Width = 577µs, TX_EN = 'Low'
Insertion Loss ANT-RX_LB		2.1			f = 869MHz to 894MHz and 925MHz to 960MHz, see Module Control Logic Table
Insertion Loss ANT- RX_HB		2.1			f = 1805MHz to 1880MHz and 1930MHz to 1990MHz, see Module Control Logic Table
Coupled power P_{OUT} to RX_LB		-3	8	dBm	P_{OUT} = 33.0dBm, TX_EN = High', SW1 = 'Low'
Coupled power P_{OUT} to RX_HB		5	8	dBm	P_{OUT} = 30.0dBm, TX_EN = High', SW1 = 'High'
Input VSWR ANT- RX_LB and ANT- RX_HB Ports		1.6:1			f = 869MHz to 894MHz, 925MHz to 960MHz, 1805MHz to 1880MHz and 1930MHz to 1990MHz, see Module Control Logic Table

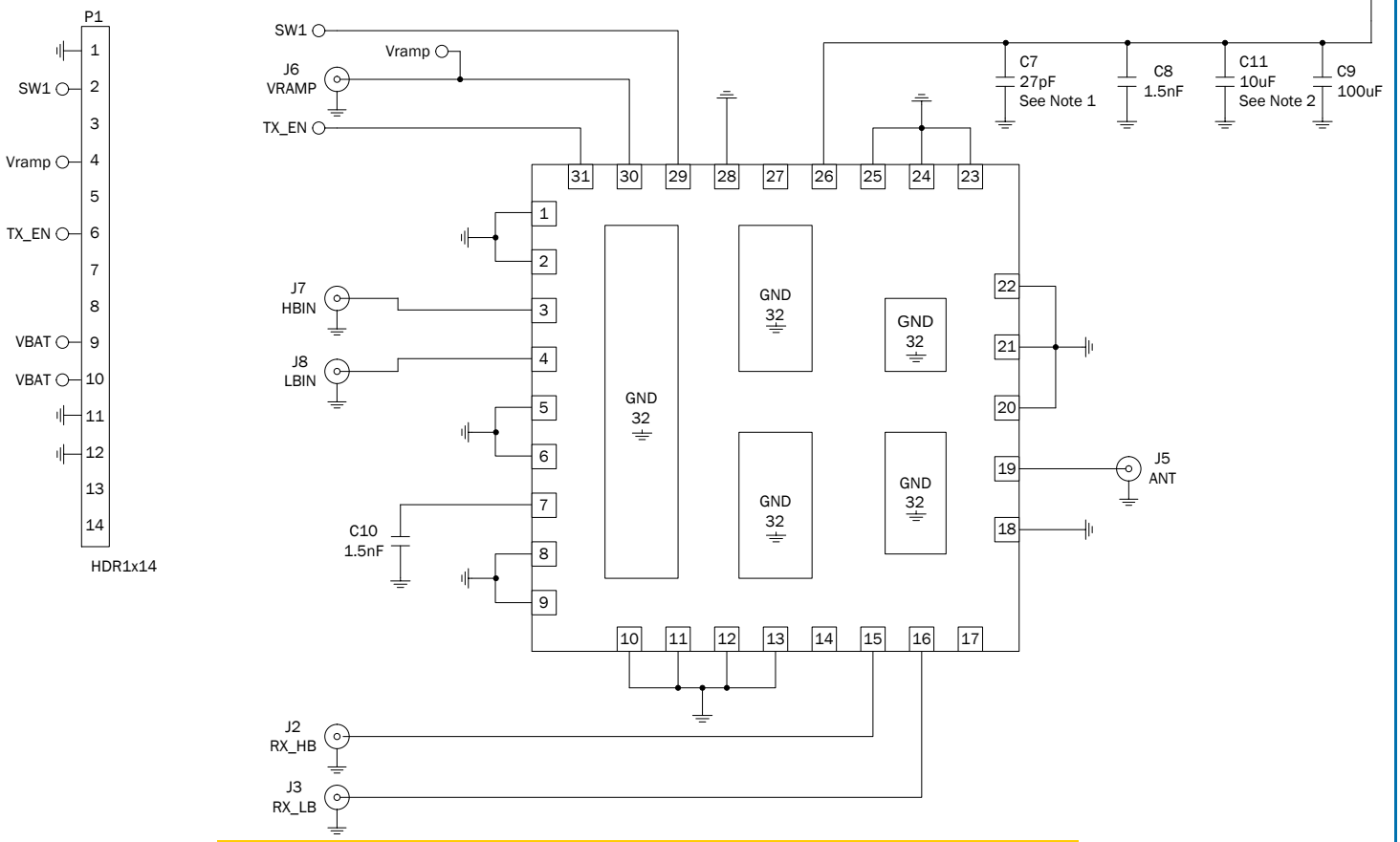
Module Control Logic

Logic State	V_{RAMP}	TX_EN	SW1
Standby	X	0	0
RX_LB	X	0	0
RX_HB	X	0	1
TX_LB	PwrCtl	1	0
TX_HB	PwrCtl	1	1

Evaluation Board Layout

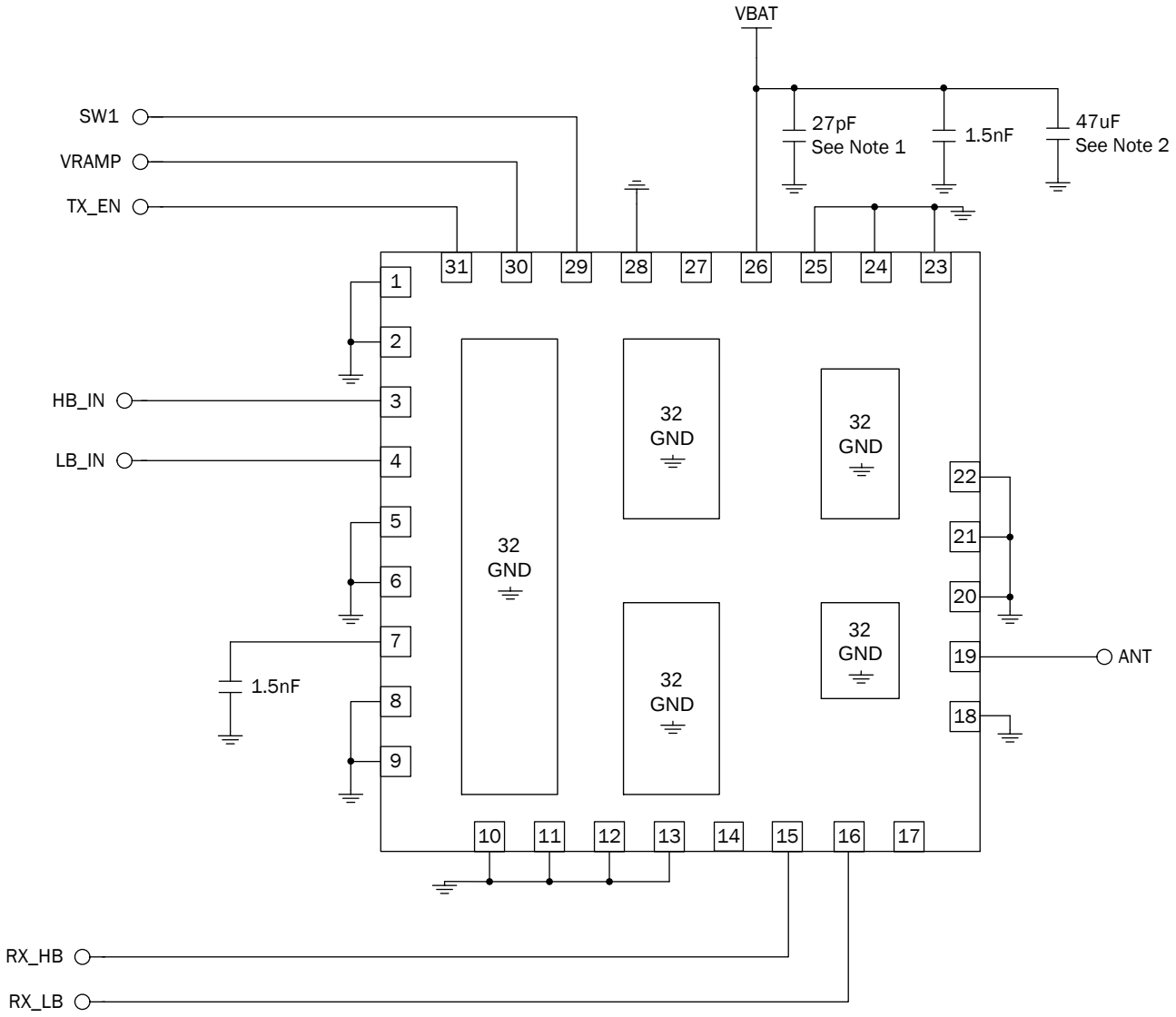


Evaluation Board Schematic



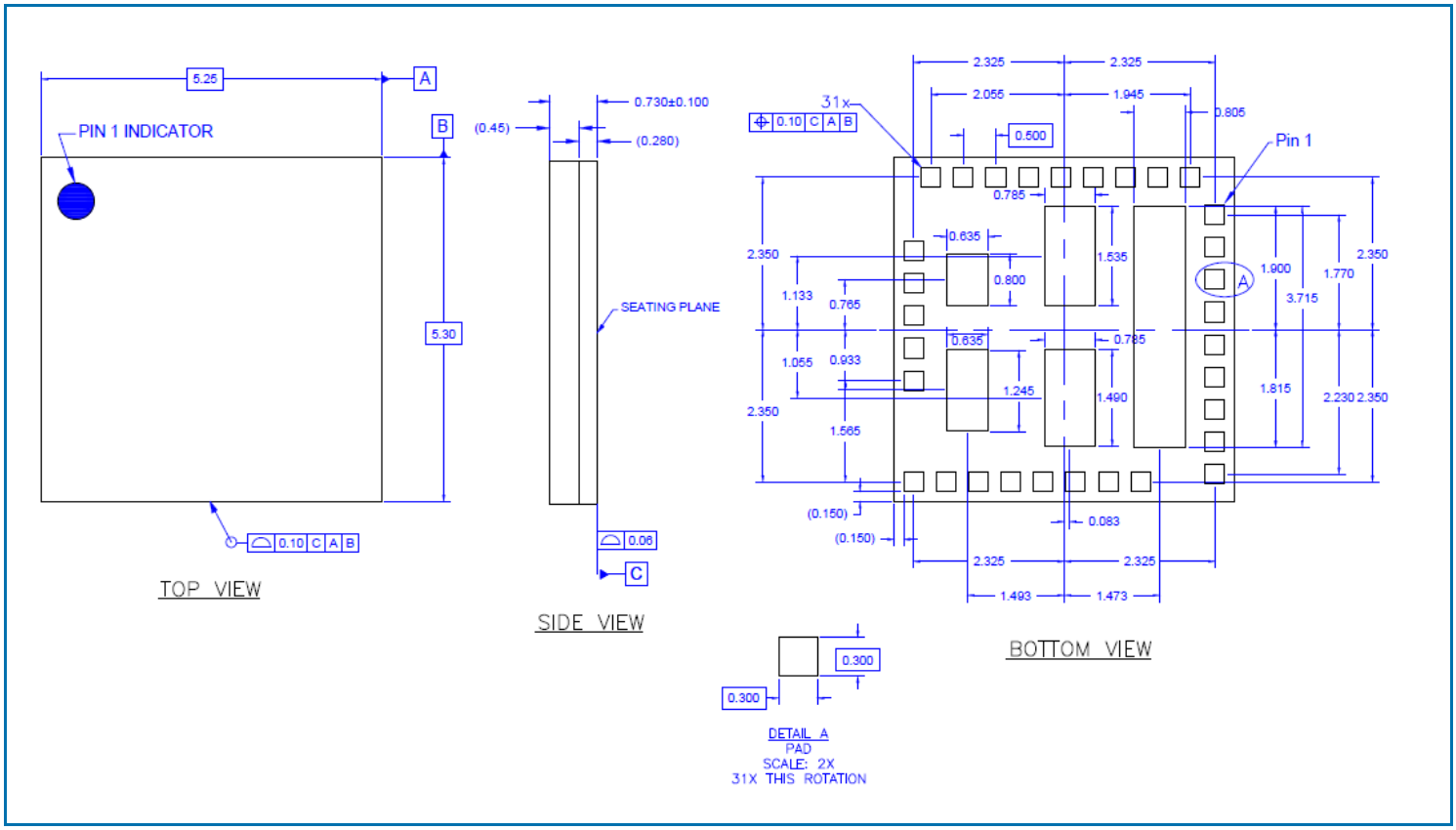
Notes:
1) It is mandatory to place this 27pF capacitor as close to the device as possible.
2) All RF paths should be designed as 50 ohm microstrip or stripline.

Application Schematic

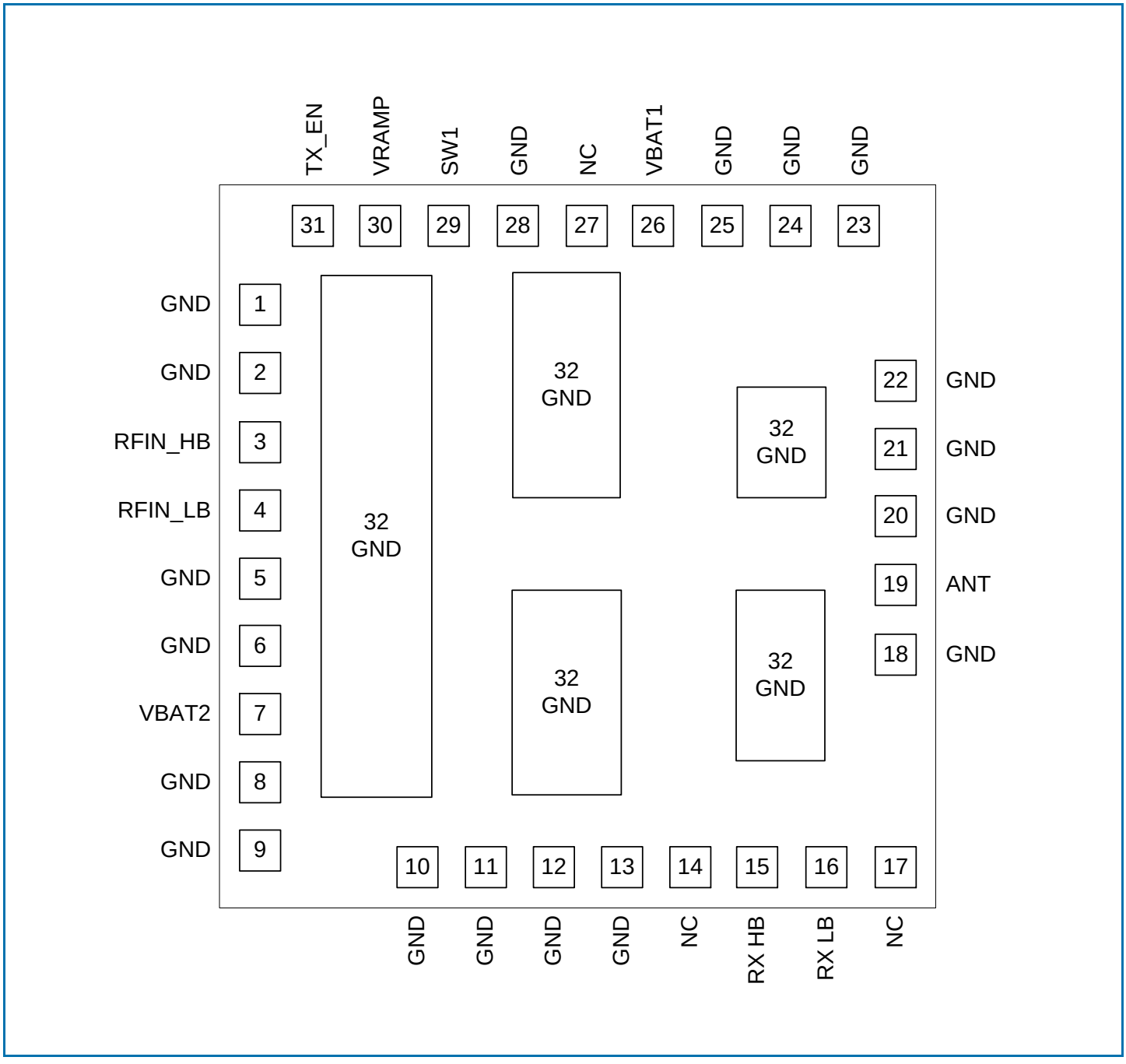


Notes:
1) It is mandatory to place this 27pF as close to the device as possible.
2) The 47uF is optional depending on board power supply properties.
3) All RF paths should be designed as 50 ohm microstrip or stripline.

Package Outline and Branding Drawing (Dimensions in millimeters)



Pin Out



Pin Names and Descriptions

Pin	Name	Details
1-2	GND	
3	RFIN_HB	RF Input – DCS1800/PCS1900. 50Ω input, DC blocked
4	RFIN_LB	RF Input – GSM850/GSM900. 50Ω input, DC blocked
5-6	GND	
7	VBAT2	An external 1.5nF capacitor to GND should be connected to this pin but external connection to VBAT1 is not needed.
8-13	GND	
14	NC	Do not connect this pin
15	RX_HB	RX Port for DCS1800 and PCS1900. 50Ω input/output not DC blocked. No DC block is needed unless there is DC voltage present from TCVR/BB. This pin cannot be DC biased.
16	RX_LB	RX Port for GSM850 and GSM900. 50Ω input/output not DC blocked. No DC block is needed unless there is DC voltage present from TCVR/BB. This pin cannot be DC biased.
17	NC	Do not connect this pin
18	GND	
19	ANT	Antenna port. 50Ω input/output
20-25	GND	
26	VBAT1	Primary Power Supply .This should be connected directly to the battery
27	NC	Do not connect this pin
28	GND	
29	SW1	Control signal selecting band of operation. Logic ‘Low’ = Low-band Logic ‘High’ = High-band This pin is a high impedance CMOS input with no pull-up or pull-down resistors.
30	VRAMP	Analog Power Control Signal Input. 350kHz Low-Pass filter is integrated into the device. No external filtering is required.
31	TX_EN	Enable power core for output power. Logic ‘Low’ = Disabled or RX mode Logic ‘High’ = Enable Output Power This pin is a high impedance CMOS input with no pull-up or pull-down resistors.
32	GND	

PCB Design Requirements

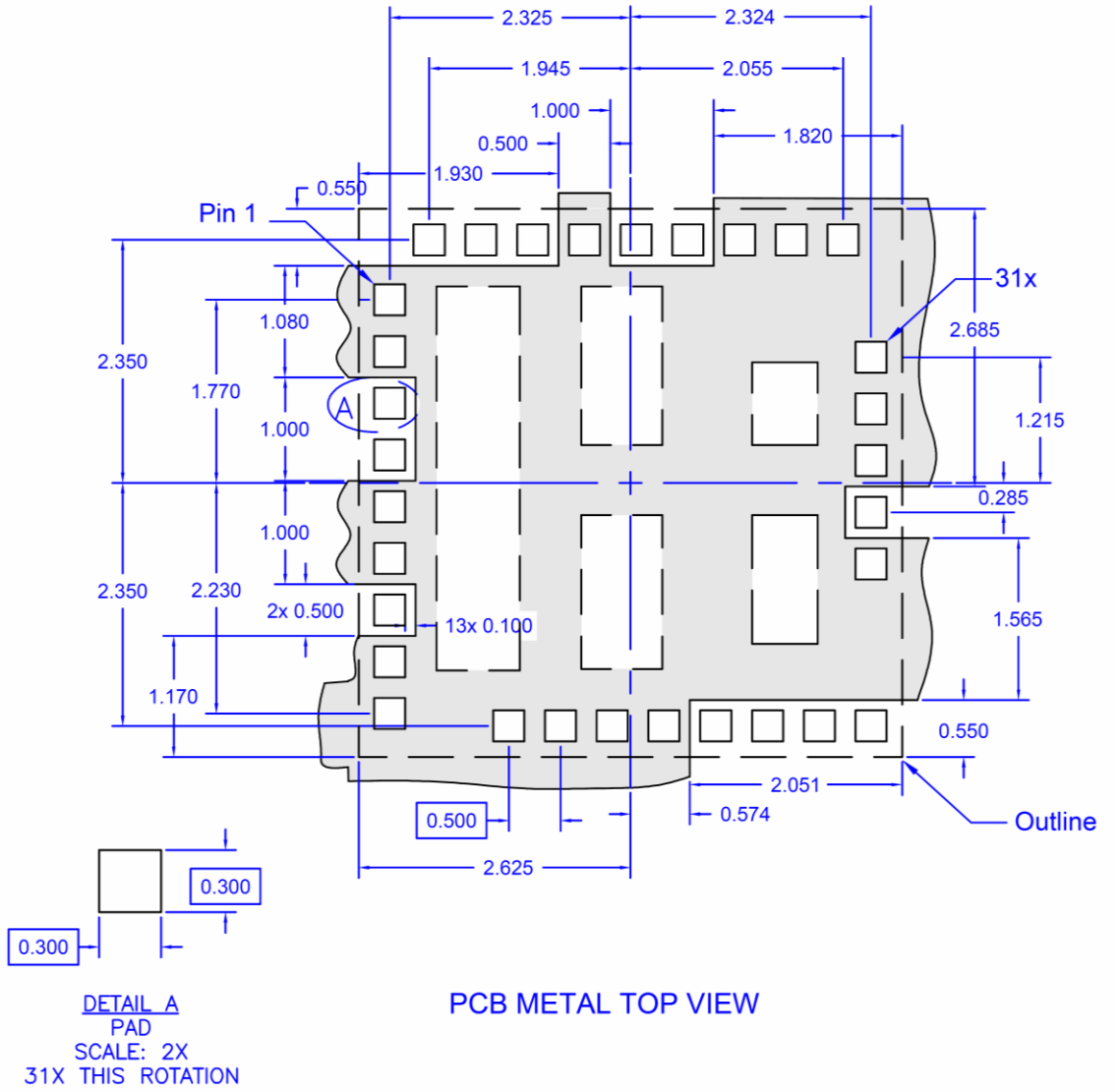
PCB Surface Finish

The PCB surface finish used for RFMD's qualification process is electroless nickel, immersion gold. Typical thickness is 2 to 5 µinch gold over 180 µinch nickel.

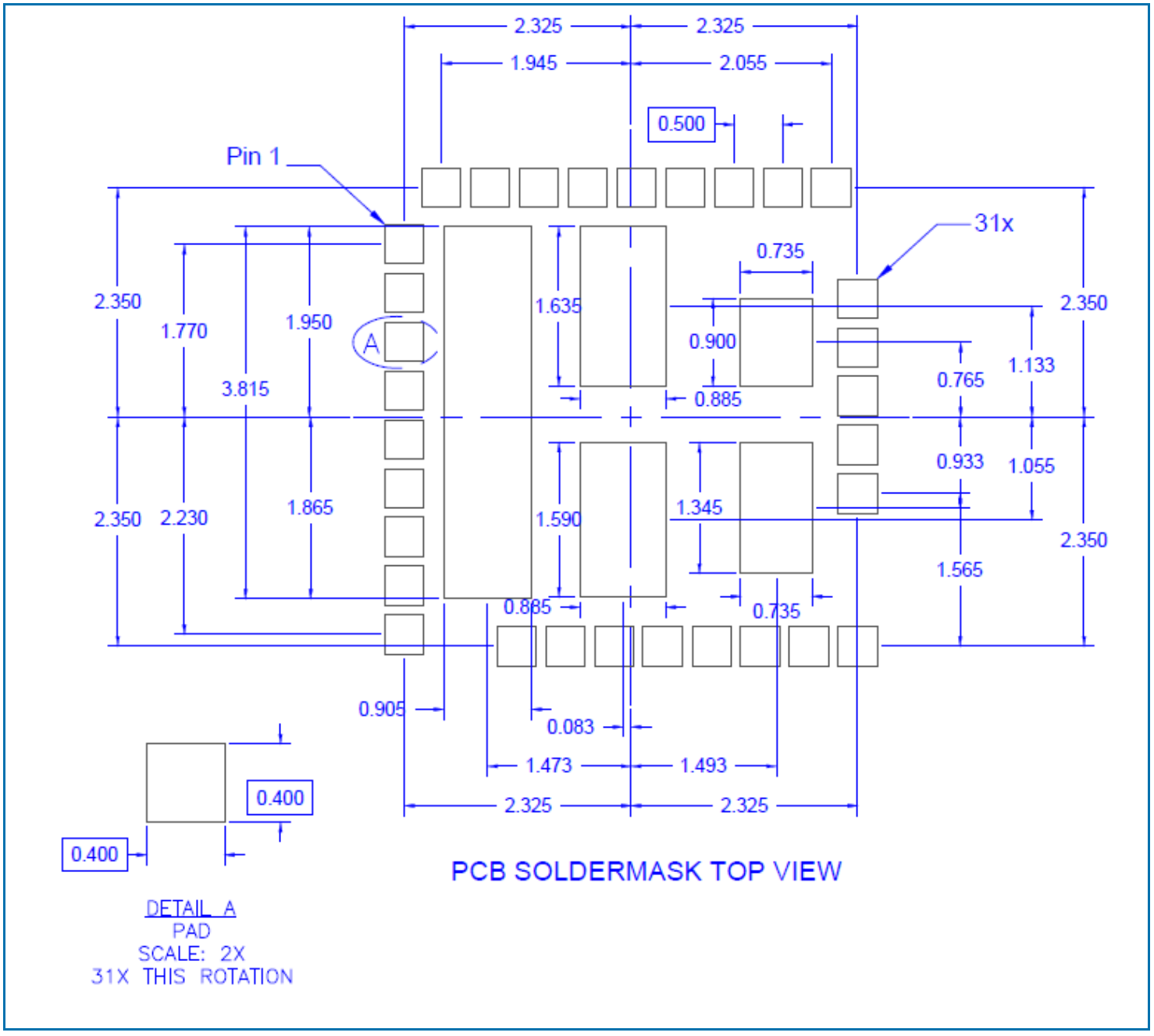
PCB Land Pattern Recommendation

PCB land patterns for RFMD components are based on IPC-7351 standards and RFMD empirical data. The pad pattern shown has been developed and tested for optimized assembly at RFMD. The PCB land pattern has been developed to accommodate lead and package tolerances. Since surface mount processes vary from company to company, careful process development is recommended.

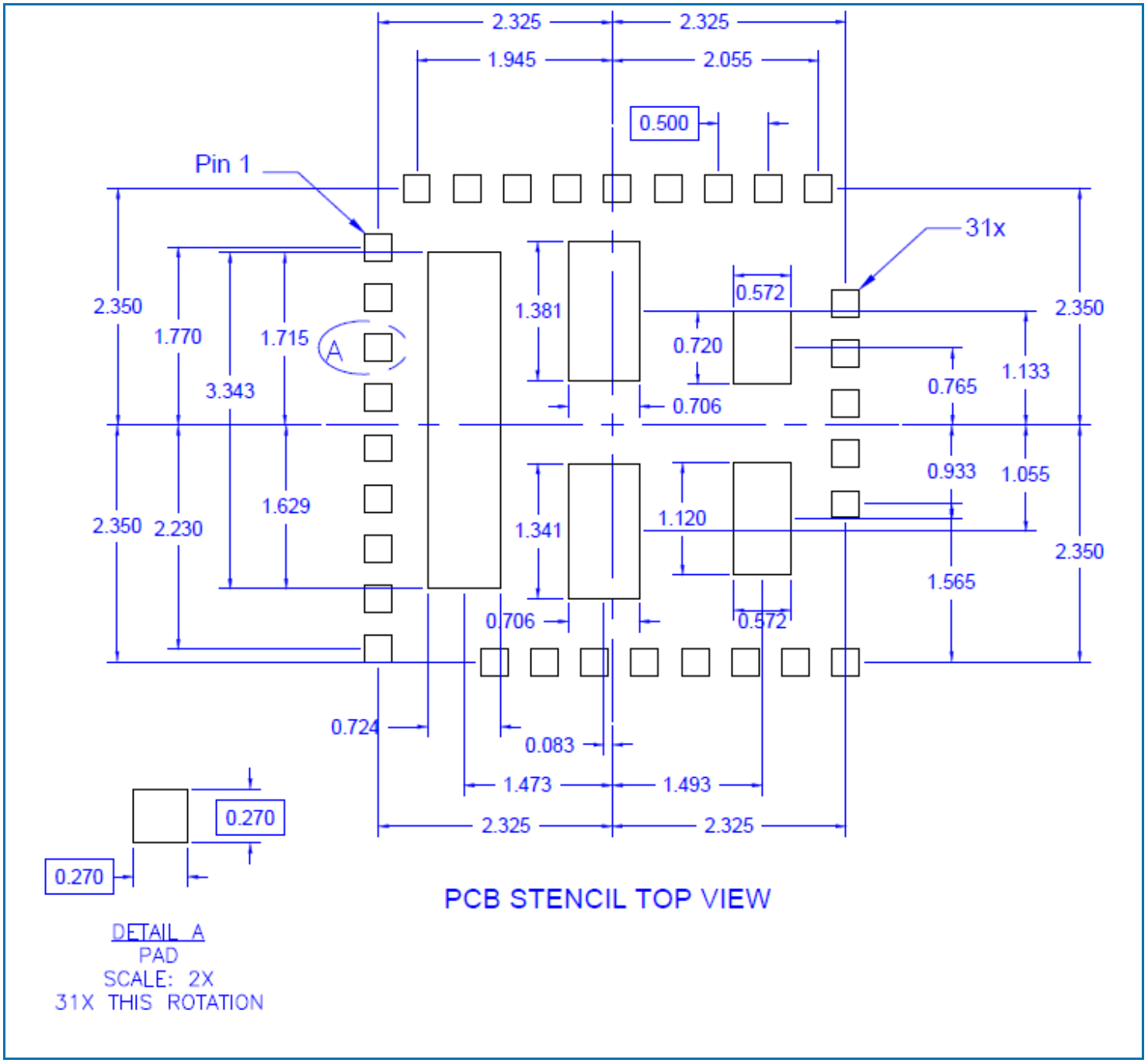
PCB Metal Land Pattern



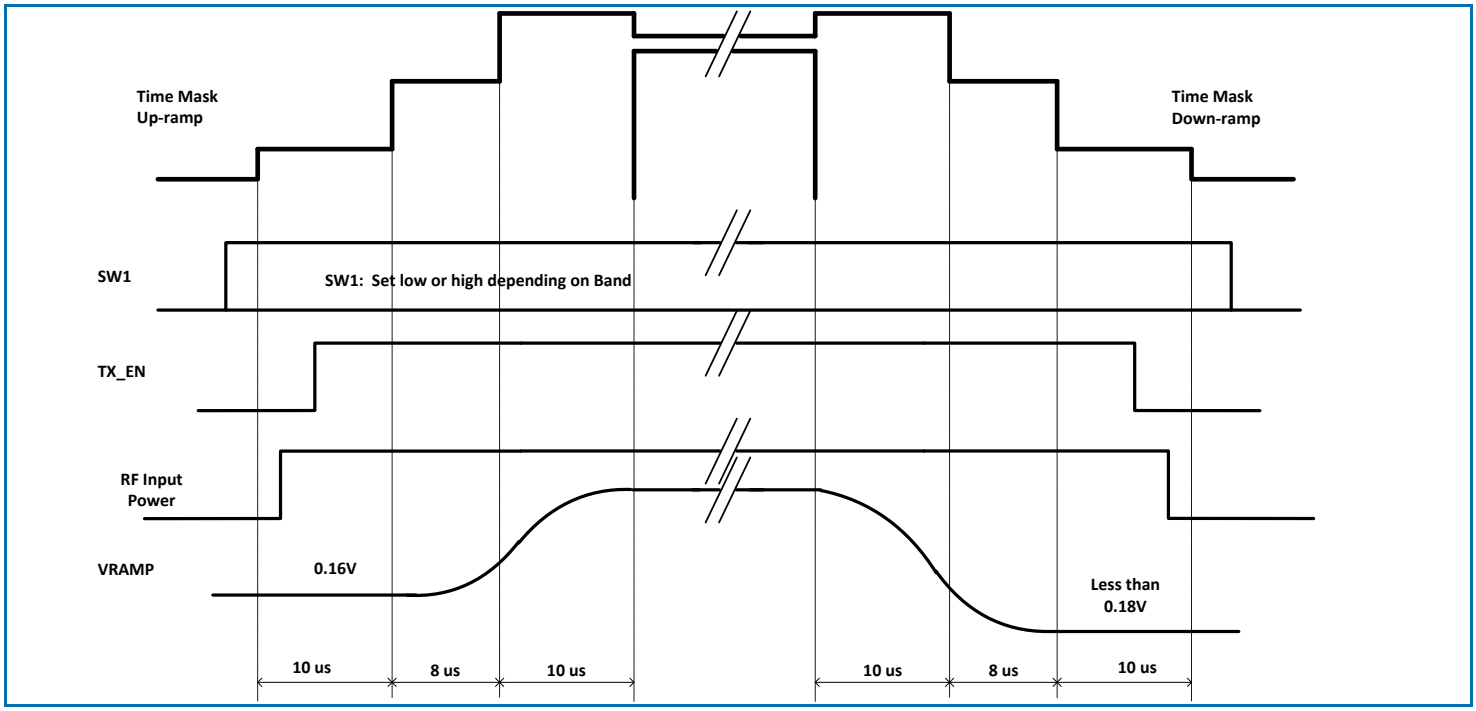
PCB Soldermask Pattern



PCB Stencil Pattern



Timing Diagram



Tape and Reel

Carrier tape basic dimensions are based on EIA 481. The pocket is designed to hold the part for shipping and loading onto SMT manufacturing equipment, while protecting the body and the solder terminals from damaging stresses. The individual pocket design can vary from vendor to vendor, but width and pitch will be consistent.

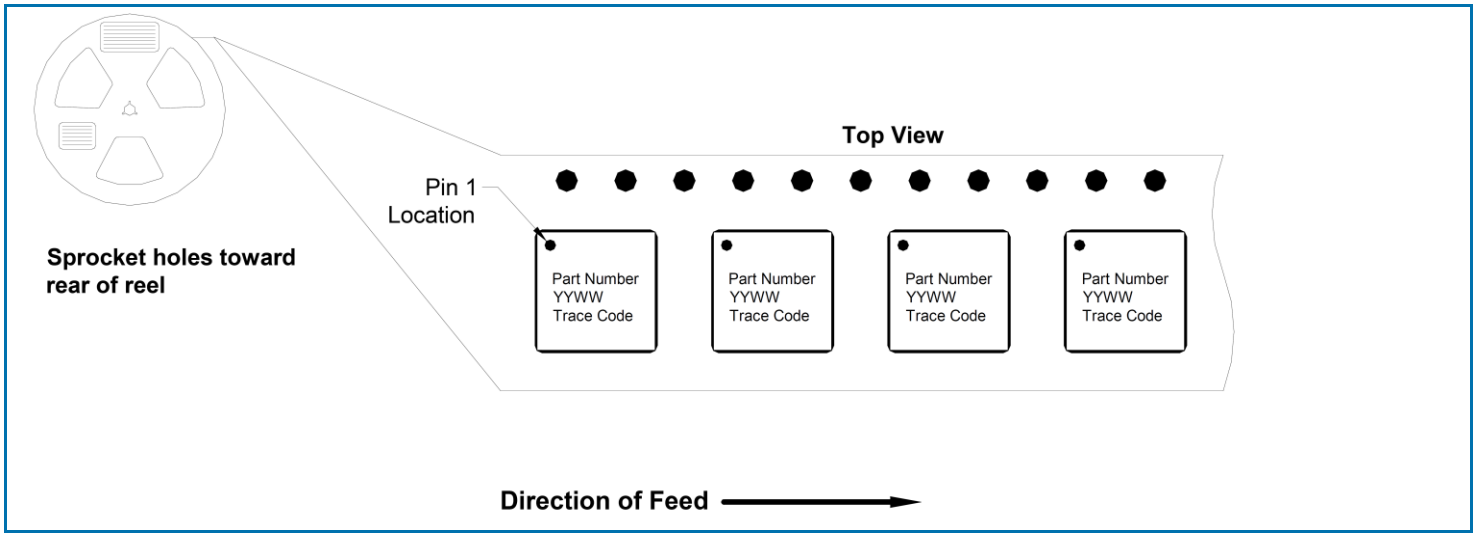
Carrier tape is wound or placed onto a shipping reel either 330mm (13 inches) in diameter or 178mm (7 inches) in diameter. The center hub design is large enough to ensure the radius formed by the carrier tape around it does not put unnecessary stress on the parts.

Prior to shipping, moisture sensitive parts (MSL level 2a-5a) are baked and placed into the pockets of the carrier tape. A covertape is sealed over the top of the entire length of the carrier tape. The reel is sealed in a moisture barrier ESD bag with the appropriate units of desiccant and a humidity indicator card, which is placed in a cardboard shipping box. It is important to note that unused moisture sensitive parts need to be resealed in the moisture barrier bag. If the reels exceed the exposure limit and need to be rebaked, most carrier tape and shipping reels are not rated as bakeable at 125°C. If baking is required, devices may be baked according to section 4, table 4-1, of Joint Industry Standard IPC/JEDEC J-STD-033.

The table below provides information for carrier tape and reels used for shipping the devices described in this document.

RFMD Part Number	Reel Diameter Inches (mm)	Hub Diameter Inches (mm)	Width (mm)	Pocket Pitch (mm)	Feed	Units per Reel
RF7198TR13	13 (330)	4 (102)	16	8	Single	5,000
RF7198SR	7 (178)	2.4 (61)	16	8	Single	100

Unless otherwise specified, all dimension tolerances per EIA-481.



5.25mmx5.30mm (Carrier Tape Drawing with Part Orientation)