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RF6515

3.3V, 2.4GHz FRONT-END MODULE

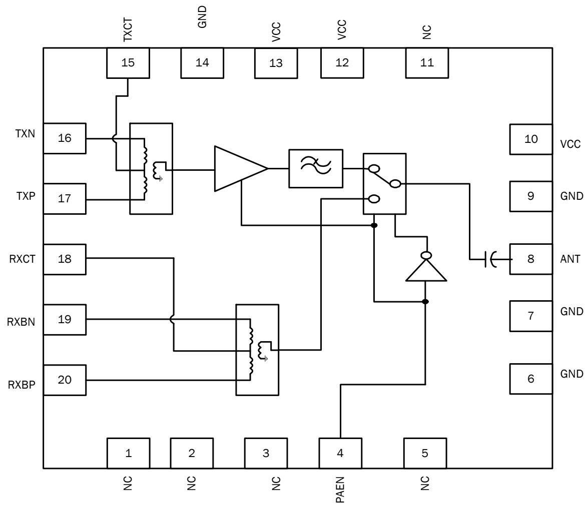
Package Style: QFN, 20-Pin, 3.5mmx3.5mmx0.5mm

Features

- TX Output Power: 22dBm
- RX NF: 1.5dB
- Integrated RF Front End Module with TX/RX balun, PA, filter, and SP2T switch.
- Dual Differential Transceiver interface.

Applications

- ZigBee® 802.15.4 Based Systems for Remote Monitoring and Control
- Smart Meters for Energy Management.
- 2.4GHz ISM Band applications.
- Portable battery powered equipment.



Functional Block Diagram

Product Description

The RF6515 integrates a complete solution in a single Front End Module (FEM) for-WiFi and ZigBee® applications in the 2.4GHz to 2.5GHz band. This FEM integrates the PA plus harmonic filter in the transmit path. It also provides balanced input and output signals for both the TX and RX paths respectively.

The RF6515 FEM is ideal for ZigBee® systems operating with a minimum output power of 22dBm and high efficiency requirements. On the receive path, the NF is down to 1.5dB. This FEM meets or exceeds the system requirements for WiFi and ZigBee® applications operating in the 2.4GHz to 2.5GHz band. The device is provided in 3.5mm x 3.5mm x 0.5mm, 20 pin QFN package.

Ordering Information

RF6515SQ	Standard 25 piece bag
RF6515SR	Standard 100 piece reel
RF6515TR7	Standard 750 piece reel
RF6515TR13	Standard 2500 piece reel
RF6515PCK-410	Fully assembled evaluation board tuned for 2.4GHz to 2.5GHz and 5 piece loose samples

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	☐ LDMOS

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Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage	5	V
Operating Case Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C
ESD Human Body Model RF Pins	1000	V
ESD Human Body Model All Other Pins	500	V
ESD Charge Device Model All Pins	500	V
Moisture Sensitivity Level	MSL 2	
Maximum Input Power to PA and RX Ports (no damage)	+5	dBm

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.

RoHS status based on EU Directive 2002/95/EC (at time of this document revision).

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Overall					Specifications must be met across supply voltage, control voltage, and temperature ranges unless otherwise noted. Typical conditions: T=25°C, V_{CC}=3.3V, PAEN=ON
Operating Frequency Range	2400		2500	MHz	
Operating Voltage (VCC)	2.85	3.3	4.2	V	
Leakage Current		10	40	uA	V_{CC}=3.3V, RF=OFF, PAEN=0V
Transmit Parameters					
Frequency	2400		2483	MHz	
Input Return Loss		-13	-9	dB	Over frequency, V_{CC}, and Temperature
Amplitude Imbalance	-1		1	dB	
Phase Imbalance	-15		15	deg	
Output Return Loss		-13	-9		Over frequency, V_{CC}, and Temperature
Gain	26	28		dB	At rated power 22dBm
Gain Flatness	-1		+1	dB	Over frequency
Gain Variation	-1.5		+1.5	dB	Over temperature at 22dBm
Rated Output Power		22		dBm	VBAT=3.0V, Temp=25°C. Using 802.15.4 OQPSK modulation waveform
Output Power	20			dBm	All conditions
Supply current		200		mA	P_O=22dBm 802.15.4 OQPSK. Over frequency, V_{CC}, and Temperature
Supply current		170		mA	P_O=20dBm 802.15.4 OQPSK. Over frequency, V_{CC}, and Temperature
Thermal Resistance		53		°C/W	V_{CC} = 3.6V, P_{OUT} = 22dBm, T_{REF} = 85°C
2nd harmonic level		-47	-43	dBm/MHz	At nominal conditions
3rd harmonic level		-50	-43	dBm/MHz	At nominal conditions

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Transmit Parameters, cont.					
VSWR No damage			10:1		
Gain settling time		1	2	uS	
Current sourced through TXCT pin			18.0	mA	
Voltage drop from TXCT pin to TXP/TXN			0.1	V	
Receive Parameters					
Frequency	2400		2483	MHz	
Noise Figure/Insertion Loss		1.7	2.3	dB	From antenna to RX pin (entire RX path). Over frequency, V_{CC}, and Temperature
Gain flatness	-0.5		0.5	dB	
Input return loss		-13	-10	dB	Over frequency, V_{CC}, and Temperature
Output return loss		-13	-10	dB	Over frequency, V_{CC}, and Temperature
Amplitude imbalance	-1		1	dB	
Phase imbalance	-15		15	deg	
Current sourced through RXCT pin			1	mA	
Voltage drop from RXCT pin to RXP/RXN			0.1	V	
Antenna Switch					
RF-to-ANT Isolation	17	20		dB	Measured from Antenna to RX port while in Transmit mode. Measured from Antenna to TX port while in Receive mode.
PAEN = HIGH	1.6	1.8	2.0	V	TX mode.
PAEN = LOW		0.0	0.2	V	RX mode.
Switch Control Current. Logic HIGH		10		µA	
Switch Control Current. Logic LOW		0.1		µA	
T/R Switching Time			1	uS	

Pin	Function	Description
1	NC	No connect pin. Must be left floating.
2	NC	No connect pin. Must be left floating.
3	NC	No connect pin. Must be left floating.
4	PAEN	Enable pin for PA + TX switch (HIGH) and RX switch (LOW). See Control Logic Table for operation.
5	NC	No connect pin. Must be left floating.
6	GND	Ground.
7	GND	Ground.
8	ANT	This is the common port (antenna). It is matched to 50Ω and DC-block is provided internally
9	GND	Ground.
10	VCC	Voltage Supply. An external 1uF capacitor might be needed for low frequency decoupling
11	NC	No connect pin. Must be left floating.
12	VCC	Voltage Supply. An external 1uF capacitor might be needed for low frequency decoupling
13	VCC	Voltage Supply. An external 1 uF capacitor might be needed for low frequency decoupling
14	GND	Ground.
15	TXCT	Center tap for passing thru voltage to TXVR SOIC.
16	TXN	Single Ended; 200Ω differential.
17	TXP	Single Ended; 200Ω differential.
18	RXCT	Center tap for passing thru voltage to TXVR SOIC.
19	RXBN	Single Ended; 200Ω differential.
20	RXBP	Single Ended; 200Ω differential.

Mode	PAEN (Logic)	VBATT_PA (mA)	PAEN (mA
TX-ANT	HIGH	170	0.01
RX-ANT	LOW	0.0001	0.0001

Operating currents at nominal conditions.

RF6515 Biasing Instructions

TX Mode

- With the RF source disabled, apply 3.3V to V_{CC} with PAEN set to 0V
- Apply 1.8V to PAEN
- V_{CC} current should rise to 70mA to 80mA quiescent current
- Enable the RF source; V_{CC} current should rise to a maximum of 200mA depending on output power

RX Mode

- With the RF source disabled, apply 3.3V to V_{CC} with PAN set to 0V
- VCC current should rise to 100uA
- Enable the RF source

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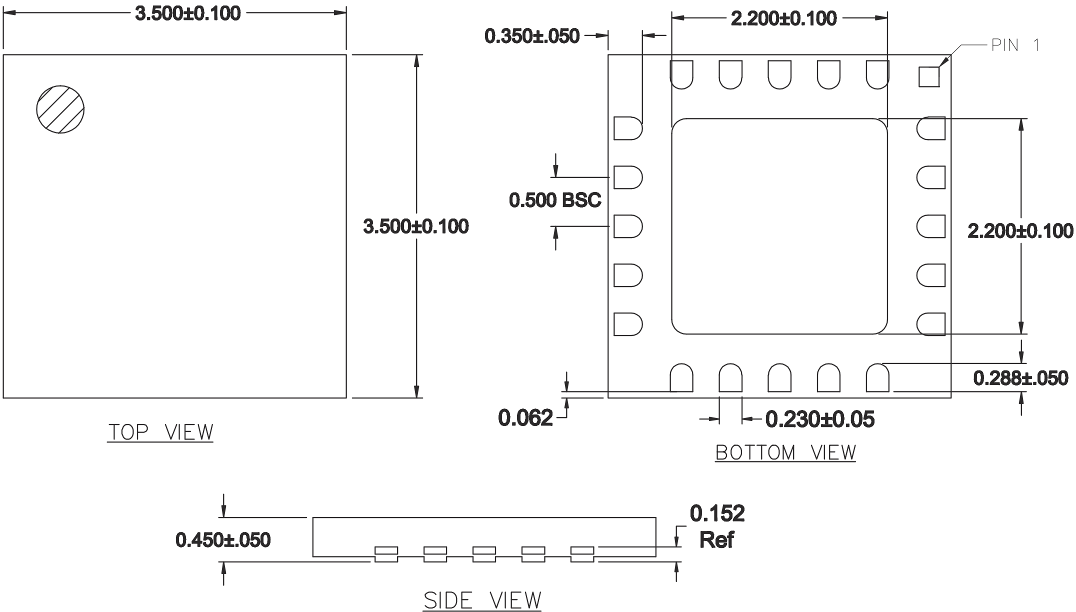
Package Drawing



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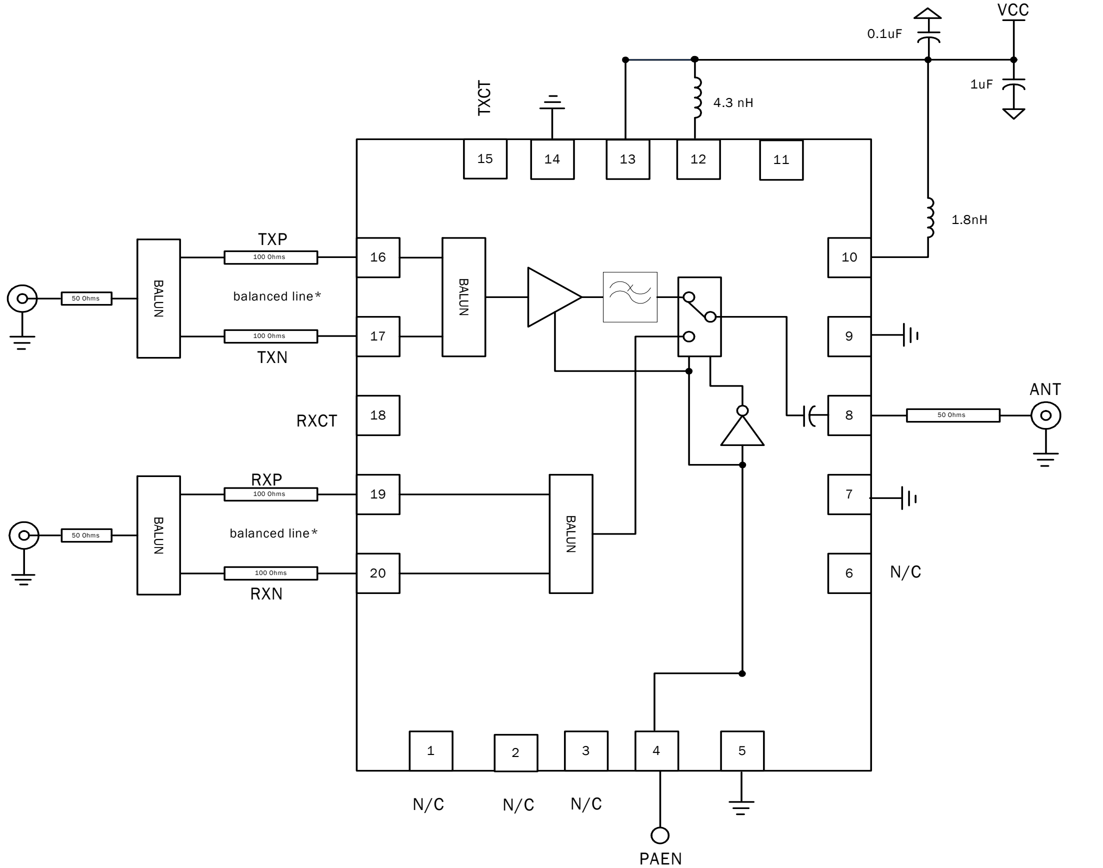
Evaluation Board Schematic



* These lines need to be balanced 100-ohm and should be short relative to a wavelength at the frequency of operation.

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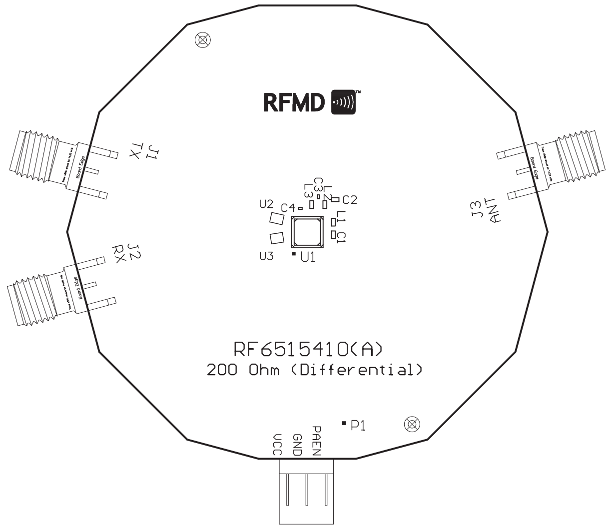
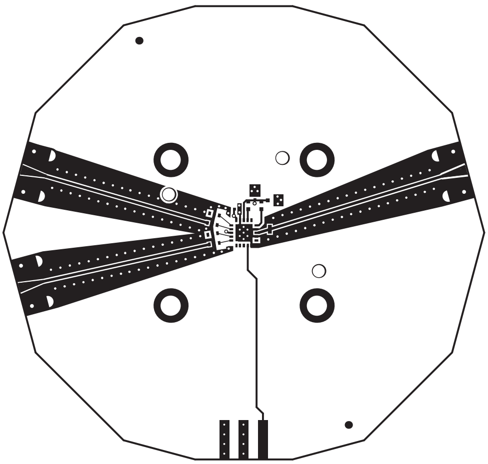
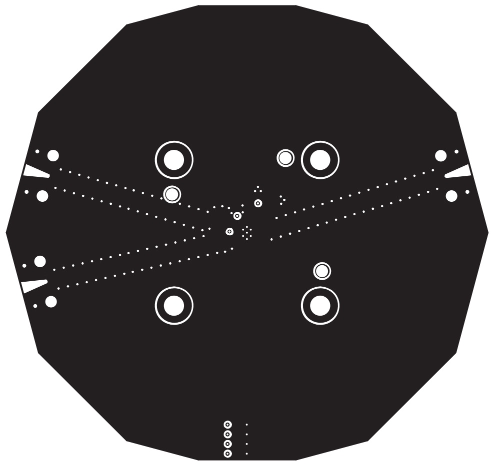
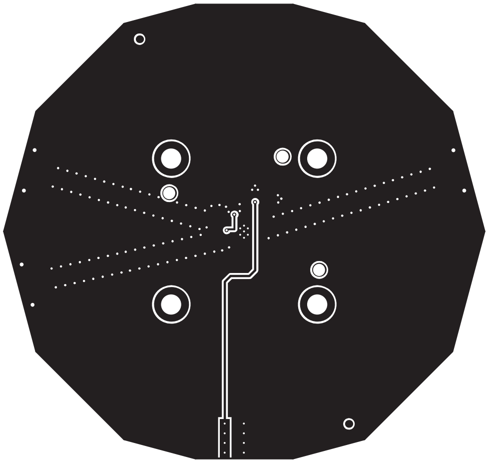
Evaluation Board Layout









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PCB Design Requirements

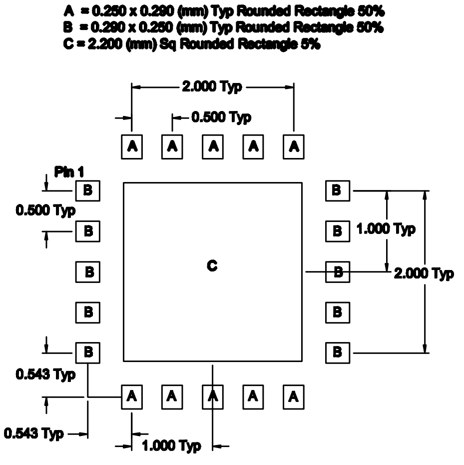
PCB Surface Finish

The PCB surface finish used for RFMD's qualification process is electroless nickel, immersion gold. Typical thickness is 3 µinch to 8 µinch gold over 180 µinch nickel.

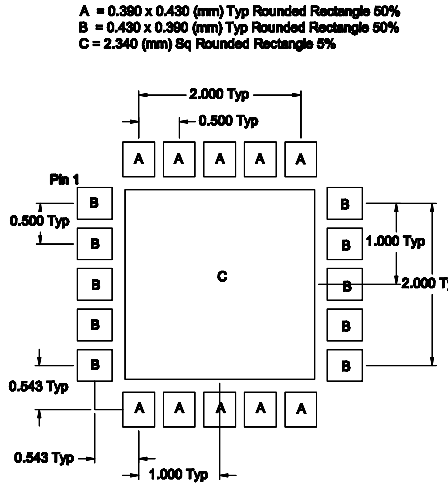
PCB Land Pattern Recommendation

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.

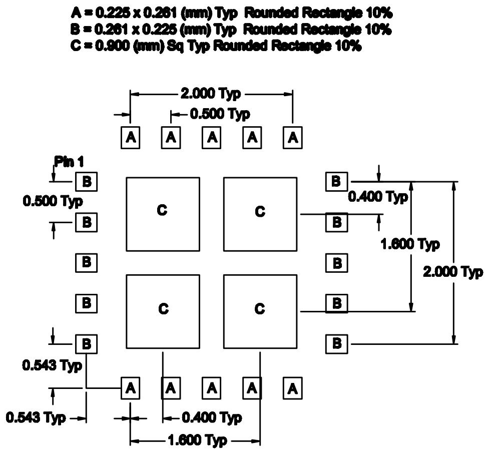
PCB Metal Land and Solder Mask Pattern



PCB METAL LAND PATTERN



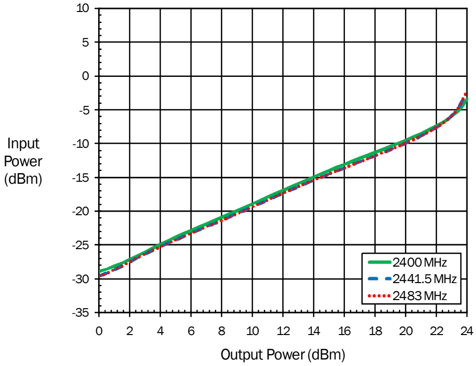
PCB SOLDER MASK PATTERN



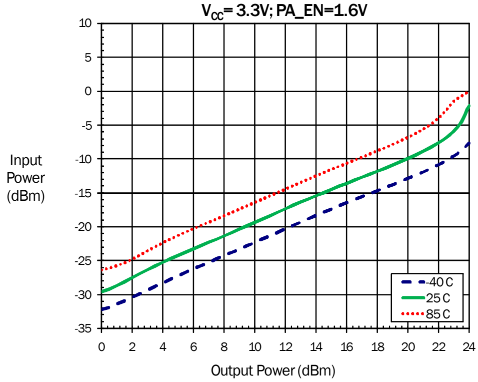
PCB STENCIL PATTERN

Thermal vias for center slug "C" should be incorporated into the PCB design. The number and size of thermal vias will depend on the application, the power dissipation, and this electrical requirements. Example of the number and size of vias can be found on the RFMD evaluation board layout.

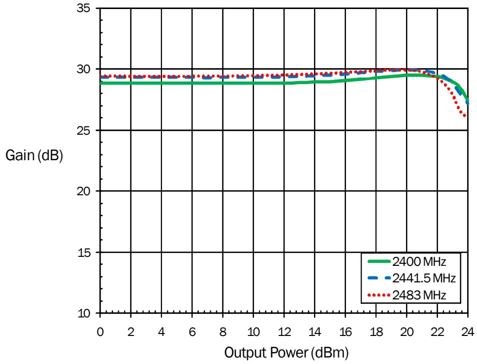
Input Power versus Output Power
V_{CC}=3.3V; PA_EN=1.6V



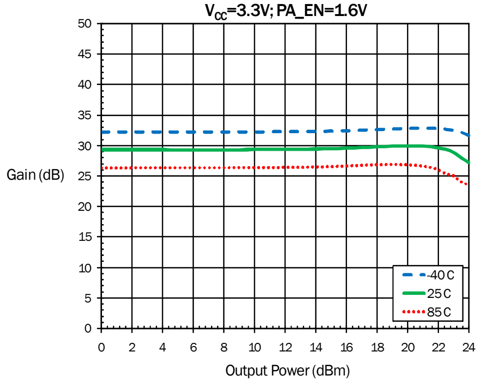
Input Power versus Output Power
(Over Temperature at 2441.5MHz)
V_{CC}= 3.3V; PA_EN=1.6V



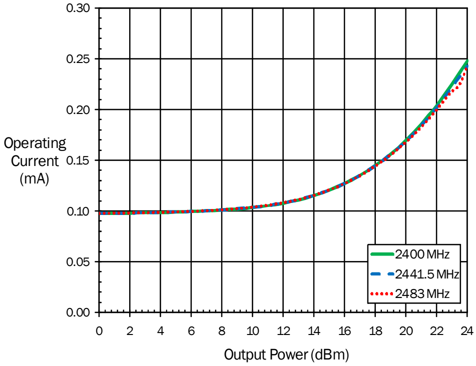
Gain versus Output Power
V_{CC}=3.3V; PA_EN=1.6V



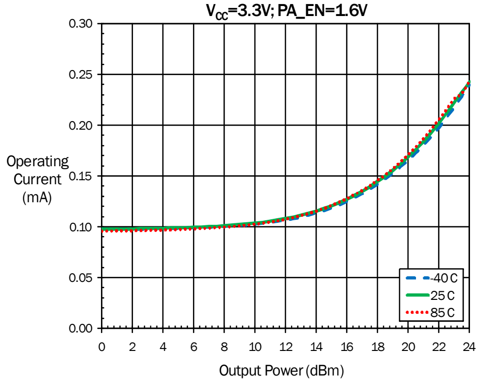
Gain versus Output Power
(Over Temperature at 2441.5 MHz)
V_{CC}=3.3V; PA_EN=1.6V

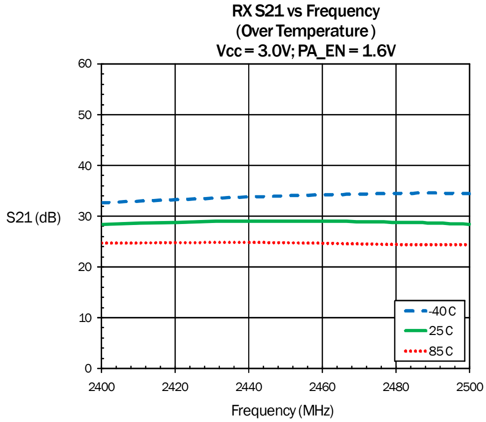


Operating Current vs Output Power
Vcc = 3.3V; PA_EN = 1.6V



Operating Current versus Output Power
(Over Temperature at 2441.5 MHz)
V_{CC}=3.3V; PA_EN=1.6V




RX S21 vs Frequency
(Over Temperature)
Vcc = 3.0V; PA_EN = 1.6V
S21 (dB)
60
50
40
30
20
10
0
2400
2420
2440
2460
2480
2500
Frequency (MHz)
-40 C
25 C
85 C