RF6525

3.0V TO 4.2V, 2.4GHz FRONT END MODULE

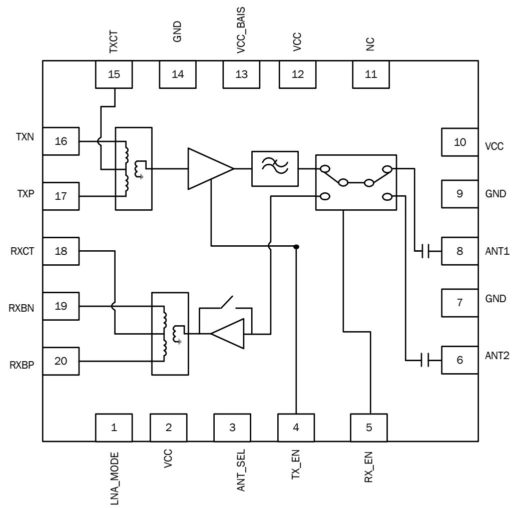
Package Style: QFN, 20-Pin, 3.5mmx3.5mmx0.5mm

Features

- TX Output Power: 22dBm
- RX Gain: 11.5dB
- RX NF: 2.5dB
- Integrated RF Front End Module with TX/RX balun, PA, Filter, LNA with Bypass Mode and DP2T Switch.
- Dual Differential Transceiver Interface.

Applications

- ZigBee® 802.15.4 Based Systems for Remote Monitoring and Control
- 2.4GHz ISM Band Applications
- Smart Meters for Energy Management



Functional Block Diagram

Product Description

The RF6525 integrates a complete solution in a single Front End Module (FEM) for ZigBee® applications in the 2.4GHz to 2.5GHz band. This FEM integrates the PA plus harmonic filter in the transmit path and the LNA with bypass mode in the receive side. It also integrates a diversity switch and provides balanced input and output signals for both the TX and RX paths respectively.

The RF6525 FEM is ideal for ZigBee® systems operating with a minimum output power of 20dBm and high efficiency requirements. On the receive path, the RX Chain provides 11.5dB of typical gain with only 7mA of current and excellent NF of 2.5dB. This FEM meets or exceeds the system requirements for ZigBee® applications operating in the 2.4GHz to 2.5GHz band. The device is provided in a 3.5mm x 3.5mm x 0.5mm, 20-pin QFN package.

Ordering Information

RF6525SQ	Standard 25 piece bag
RF6525SR	Standard 100 piece reel
RF6525TR13	Standard 2500 piece reel
RF6525PCK-410	Fully assembled evaluation board with 5 loose pieces

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 LNA (No Damage in High Gain Mode)	+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.

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 Min.	Specification Typ.	Specification Max.	Unit	Condition
Overall					Specifications must be met across supply voltage, control voltage, and temperature ranges unless otherwise noted. Typical conditions: T=25°C, V_{CC}=3.6V, TX_EN=High
Operating Frequency Range	2400		2483	MHz	
Operating Voltage (V_{CC})	3.0	3.6	4.2	V	
Leakage Current		0.5		uA	V_{CC}=3.6V, RF=OFF, TX_EN=Low, RX_EN=Low. LNA_EN, ANT_SEL, and LNA Mode=Low.
Transmit Parameters					
Frequency	2400		2483	MHz	
Input Return Loss		-13	-9.6	dB	Over all conditions for both Antenna 1 and Antenna 2
Amplitude Imbalance	-1		1	dB	
Phase Imbalance	-15		15	deg	
Output Return Loss		-14	-9.6	dB	Over all conditions for both Antenna 1 and Antenna 2
Gain	25	28		dB	At rated power and nominal conditions
Gain Variation	-1.5		+1.5	dB	Over temperature
Gain Flatness	-1		+1	dB	Over frequencies and voltage
Rated Output Power	20	22		dBm	
		19		dBm	V_{CC}=2.6V, V_{CC}_Bias=3.0V
Supply Current		200	230	mA	P_O=22dBm 802.15.4 OQPSK. Typical Conditions.
Supply Current		175	205	mA	P_O=20dBm 802.15.4 OQPSK.
Thermal Resistance		53		°C/W	V_{CC} = 3.6V, P_{OUT} = 22dBm, T_{REF} = 85°C
2nd Harmonic Level		-45	-42	dBm/MHz	Measured using standard 802.15.4 OQPSK modulation signal at P_{OUT}=20dBm over temperature, frequency, and voltage
3rd Harmonic Level		-45	-42	dBm/MHz	Measured using standard 802.15.4 OQPSK modulation signal at P_{OUT}=20dBm over temperature, frequency, and voltage
VSWR Stability and Load Mismatch Susceptibility	4:1				No spurs above -45dBm
VSWR No Damage	8:1				

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Transmit Parameters, cont.					
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 (LNA Mode)					
Frequency	2400		2483	MHz	
Gain	8	11.5	14	dB	From antenna to RX pin (entire RX path). (All conditions.)
Noise Figure		2.5	3.5	dB	From antenna to RX pin (entire RX path).
Current		8	12	mA	LNA + Switches
Input IP3	5	10		dBm	At nominal conditions
Gain Flatness	-0.7		0.7	dB	over frequency
Input Return Loss		10		dB	
Output Return Loss			8	dB	
Amplitude Imbalance	-1		1	dB	Differential RX Port
Phase Imbalance	-15		15	deg	On 180 degrees typical, differential RX Port
Current Sourced through RXCT Pin			1	mA	
Voltage Drop from RXCT Pin to RXP/RXN		0.05	0.1	V	
ByPass Mode					
Frequency	2400		2483	MHz	
Insertion Loss		5	7	dB	Entire RX path
Noise Figure		5		dB	Entire RX path
Current		5		uA	ANT1
		50		uA	ANT2
IIP3		18		dBm	Nominal
Gain Flatness	-0.1		0.1	dB	over frequency
Input Return Loss		15	12	dB	
Output Return Loss		9.5	8	dB	
Amplitude Imbalance	-1		1	dB	Differential RX Port
Phase Imbalance	-15		15	deg	On 180 degrees typical, differential RX Port
Current Sourced through RXCT Pin			1	mA	
Voltage Drop from RXCT Pin to RXP/RXN		0.05	0.1	V	
Antenna Switch					
RF-to-Control Isolation		50		dB	Measured at any control pin while in TX or RX mode.
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.
RF-to-RF Isolation	18	20		dB	Measured from TX port to RX port while in receive or transmit modes.
Switch Control Logic = HIGH	$=V_{CC}-0.3$		$=V_{CC}$	V	All Logic I/O's
Switch Control Logic = LOW	0.0		0.2	V	All Logic I/O's

Switch Control Current. Logic HIGH		2	5	µA	All Logic I/O's
Switch Control Current. Logic LOW		0.1		µA	All Logic I/O's
Antenna Select Switch Speed			1	uS	ANT1 or ANT2 path, TX or RX mode

Pin	Function	Description
1	LNA_MODE	Bypass enable pin. See logic table for operation.
2	VCC	Voltage Supply. An external 1uF capacitor might be needed for low frequency decoupling.
3	ANT_SEL	Control pin for Antenna select. See logic table for operation.
4	TX_EN	Enable voltage pin for the PA and Transmit switch. See logic table for operation.
5	RX_EN	Enable voltage pin for the LNA and Receive switch. See logic table for operation
6	ANT2	This is the common port (antenna). It is matched to 50Ω and DC-block is provided internally.
7	GND	Ground.
8	ANT1	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_BIAS	Voltage Supply. An external 1 uF capacitor might be needed for low frequency decoupling
14	GND	Ground.
15	TXCT	Center tap for passing thru DC voltage to TXN and TXP pins that connect to the TXVR SoIC.
16	TXN	100Ω single-ended, 200Ω differential.
17	TXP	100Ω single-ended, 200Ω differential.
18	RXCT	Center tap for passing thru DC voltage to RXBN and RXBP pins that connect to the TXVR SoIC.
19	RXBN	100Ω single-ended, 200Ω differential.
20	RXBP	100Ω single-ended, 200Ω differential.

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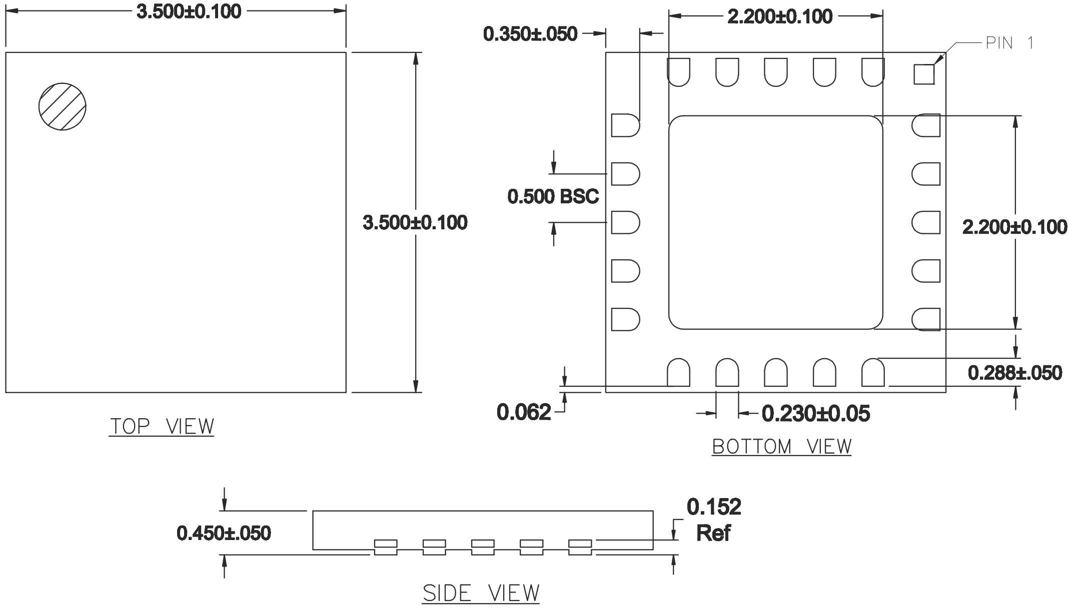
Package Drawing



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RF6525 Biasing Instructions

TX Mode

- With the RF source disabled, apply 3.3V to V_{CC} with other control set to 0V
- Set VTX=High, keeping VRX and LNA_MODE at 0V
- Apply 0V to ANT_SEL to select the ANT1 port, or 2.8V to select the ANT2 port
- 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 LNA Mode

- With the RF source disables, apply 3.3V to V_{CC} with other controls set to 0V
- Set VRX=High to RX Enable and LNA_MODE, keeping TX at 0V
- Apply 0V to ANT_SEL to select the ANT1 port, or 2.8V to select the ANT2 port
- V_{CC} current should rise to 7mA to 8mA
- Enable the RF source; V_{CC} current may increase a few mA depending on output power

RX Bypass Mode

- With the RF source disabled, apply 3.3V to V_{CC} with other controls set to 0V
- Set VRX=High, keeping TX and LNA_MODE at 0V
- Apply 0V to ANT_SEL to select the ANT1 port, or 2.8V to select the ANT2 port
- V_{CC} current should be in the uA range
- Enable the RF source; V_{CC} current should remain in the uA range

	Logic Table			
Mode	**TX_EN**	**RX_EN**	**LNA_MODE**	**ANT_SEL**
TX-ANT1	HIGH	LOW	LOW	LOW
TX_ANT2	HIGH	LOW	LOW	HIGH
RX-ANT1 LNA	LOW	HIGH	HIGH	LOW
RX-ANT1 BYP	LOW	HIGH	LOW	LOW
RX-ANT2LNA	LOW	HIGH	HIGH	HIGH
RX-ANT2 BYP	LOW	HIGH	LOW	HIGH
All OFF	LOW	LOW	LOW	LOW

Operating currents at nominal conditions

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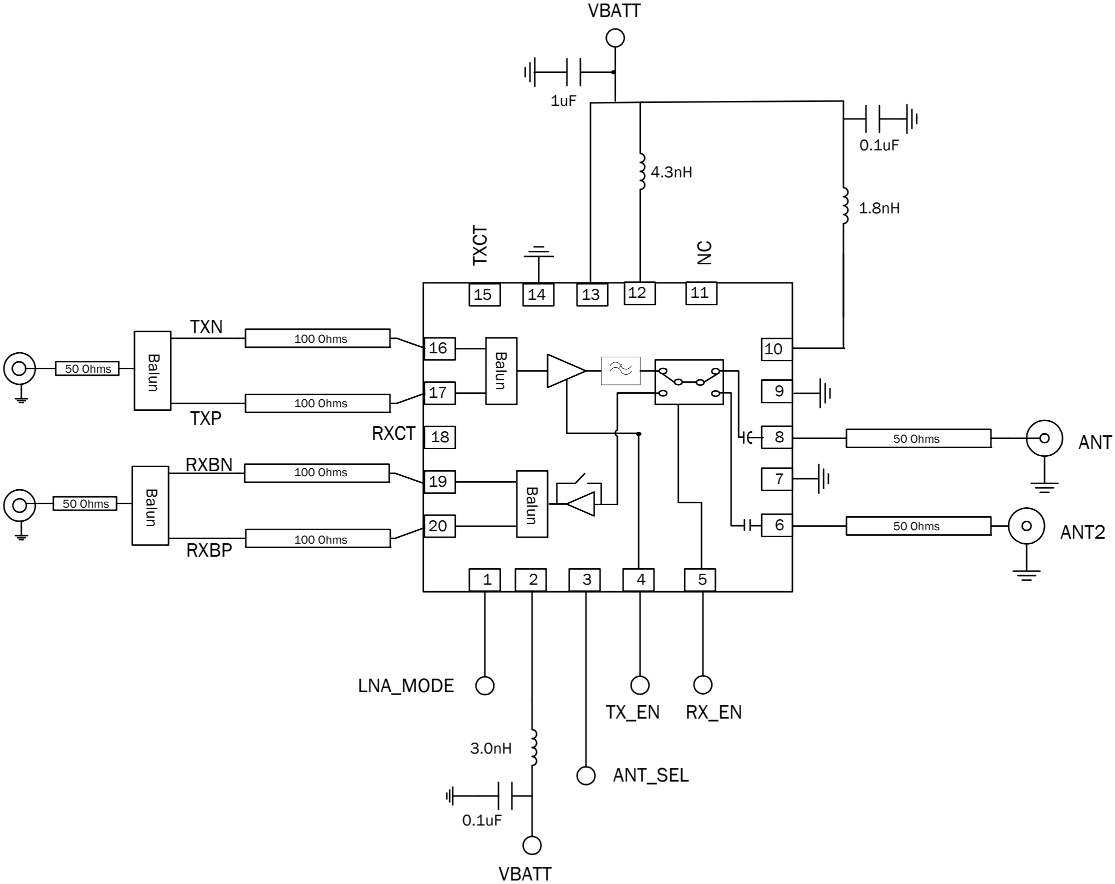
Evaluation Board Schematic



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PCB Design Requirements

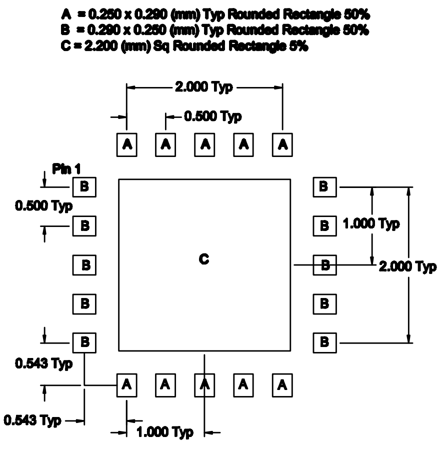
PCB Surface Finish

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.

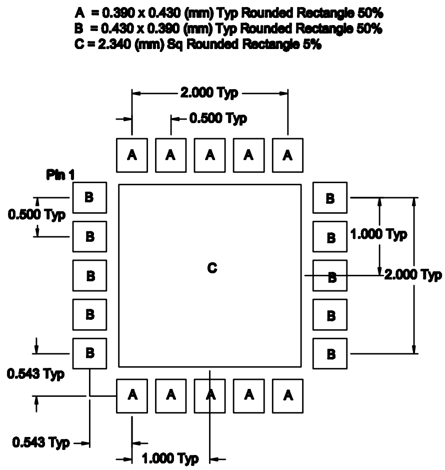
PCB Land Pattern Recommendation

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.

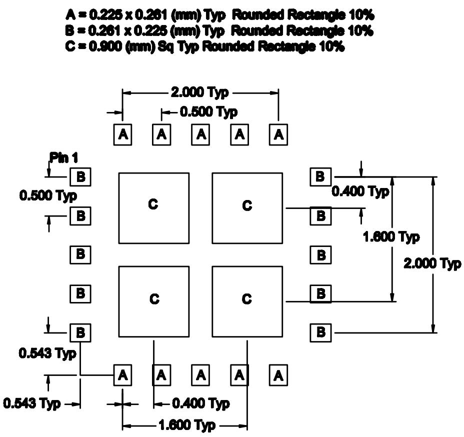
PCB Metal Land and Solder Mask Pattern



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.

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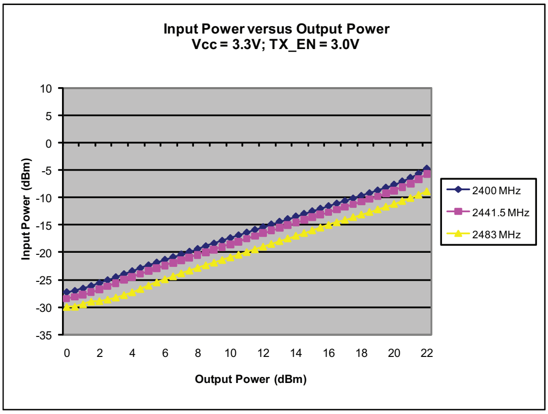
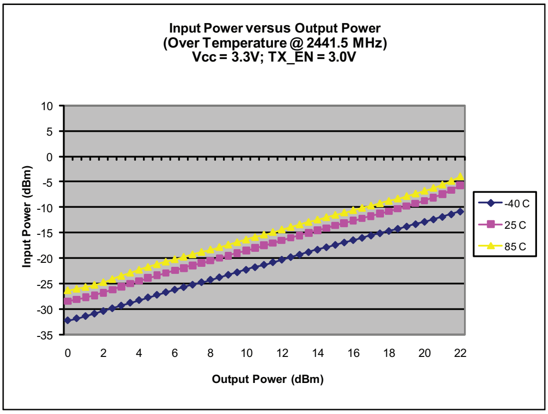
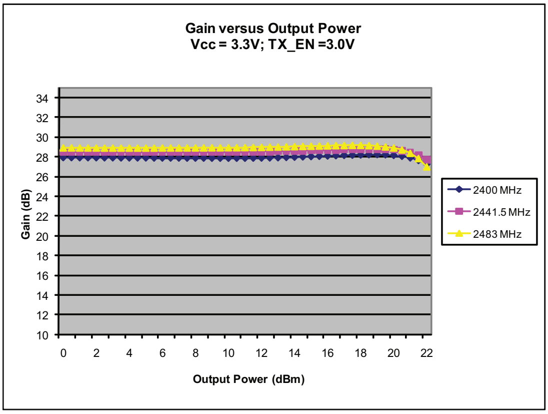
RF6525 2.4 GHz Front End Module

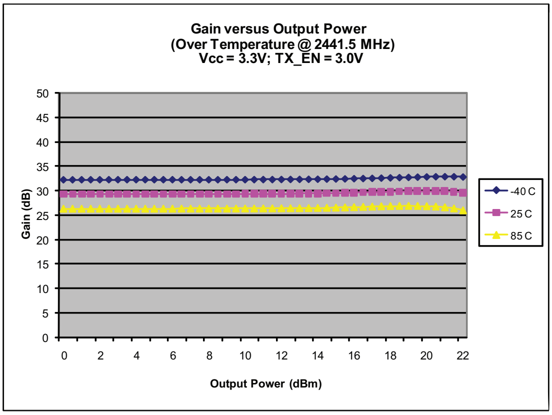
Input Power versus Output Power





Gain versus Output Power





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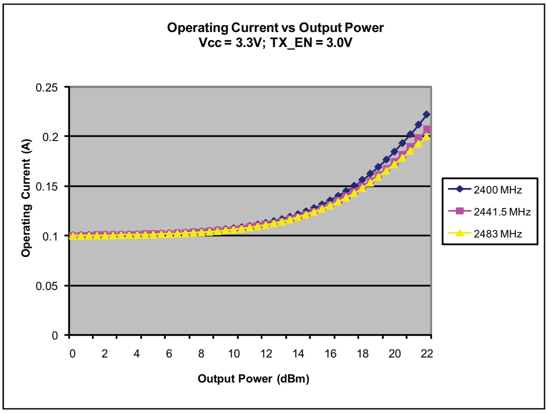
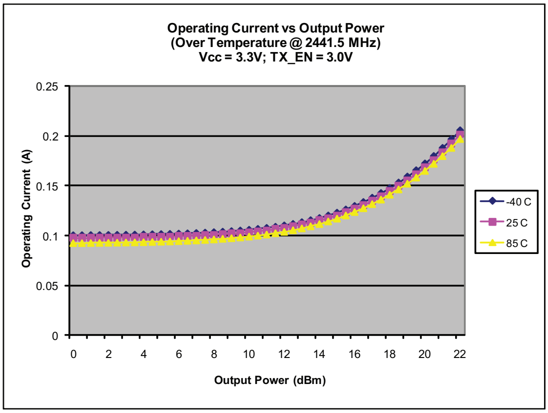
RF6525 2.4 GHz Front End Module

Operating Current versus Output Power





TX S21 versus Frequency