

## 2.4 GHz High-Linearity, WLAN Front-End Module

### FEATURES

- Input/output ports internally matched to 50 $\Omega$  and DC decoupled
- Package available
  - 16-contact X2QFN – 2.5mm x 2.5mm x 0.4mm
- All non-Pb (lead-free) devices are RoHS compliant

### Transmitter Chain

- Gain:
  - Typically 24 dB gain
- Dynamic linear output power:
  - Meets 802.11g OFDM ACPR requirement up to 21 dBm using 3.6V  $V_{CC}$  and 22.5 dBm using 5V  $V_{CC}$
  - 17 dBm using 3.6V, 18 dBm using 5.0V, at 3% EVM for 802.11g, 54 Mbps
  - 15 dBm using 3.6V, 16 dBm using 5.0V, at 1.75% dynamic EVM for 256 QAM, 40 MHz bandwidth
- Operating current
  - 150 mA @  $P_{OUT} = 17$  dBm for 802.11g, 3.6V
  - 130 mA @  $P_{OUT} = 15$  dBm for MCS9, 3.6V
- PA Control current,  $I_{PEN} < 3$  mA
- Idle current,  $I_{CO} : 90$  mA (3.6V  $V_{CC}$ )
- Low shut-down current:  $\sim 2$   $\mu$ A
- Power-up/down control
  - Turn on/off time (10%–90%) < 400 ns
- Limited variation over temperature
  - $\sim 1$  dB power variation between  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- Linear on-chip power detection
  - Load and temperature insensitive
  - $> 20$  dB dynamic range on-chip power detection

### Receiver Chain

- Gain: Typically 12 dB gain
- Noise figure: Typically 2.5 dB
- Receiver input P1dB: Typically -6 dBm
- LNA bypass loss: Typically 9 dB

### Bluetooth<sup>®</sup> Chain

- Loss: 1.6dB
- Output P1dB:  $> 25$  dBm

### APPLICATIONS

- WLAN (IEEE 802.11b/g/n/256 QAM)
- Home RF
- Cordless phones
- 2.4 GHz ISM wireless equipment

### 1.0 PRODUCT DESCRIPTION

SST12LF09 is a 2.4 GHz Front-end Module (FEM) designed in compliance with IEEE 802.11b/g/n and 256 QAM applications. Based on GaAs pHEMT/HBT technology, it combines a high-performance transmitter power amplifier (PA), a low-noise receiver amplifier (LNA) and an antenna Tx/Rx/BT switch (SP3T SW). The input/output RF ports are single-ended and internally matched to 50  $\Omega$ . These RF ports are DC decoupled, and require no DC-blocking capacitors or matching components. This helps reduce the system board Bill of Materials (BOM) cost.

There are two components to the FEM: the Transmitter (TX) chain and the Receiver (RX) chain.

The TX chain includes a high-efficiency PA based on the InGaP/GaAs HBT technology. The transmitter is optimized for high linearity, 802.11n and 256 QAM operation—typically providing 15 dBm with 1.75% dynamic EVM for 256 QAM, 40 MHz operation and 17 dBm at 3% for 802.11g, 54 Mbps operation at 3.6V. At 5V  $V_{CC}$ , the transmitter provides typically 17 dBm with 1.75% dynamic EVM for 256 QAM, 40 MHz operation and 18 dBm at 3% for 802.11g, 54 Mbps operation.

SST12LF09 has a transmitter on-chip, single-ended power detector that is stable over temperature and insensitive to output VSWR. It features a wide dynamic-range (20 dB) with dB-wise linear operation. The on-chip power detector provides a reliable solution to board-level power control.

The Rx chain provides typically 12 dB gain with 2.5 dB noise figure. With the LNA bypassed, the receiver loss is typically 9 dB.

SST12LF09 is offered in a 16-contact X2QFN package. See [Figure 3-1](#) for pin assignments and [Table 4-1](#) for pin descriptions.

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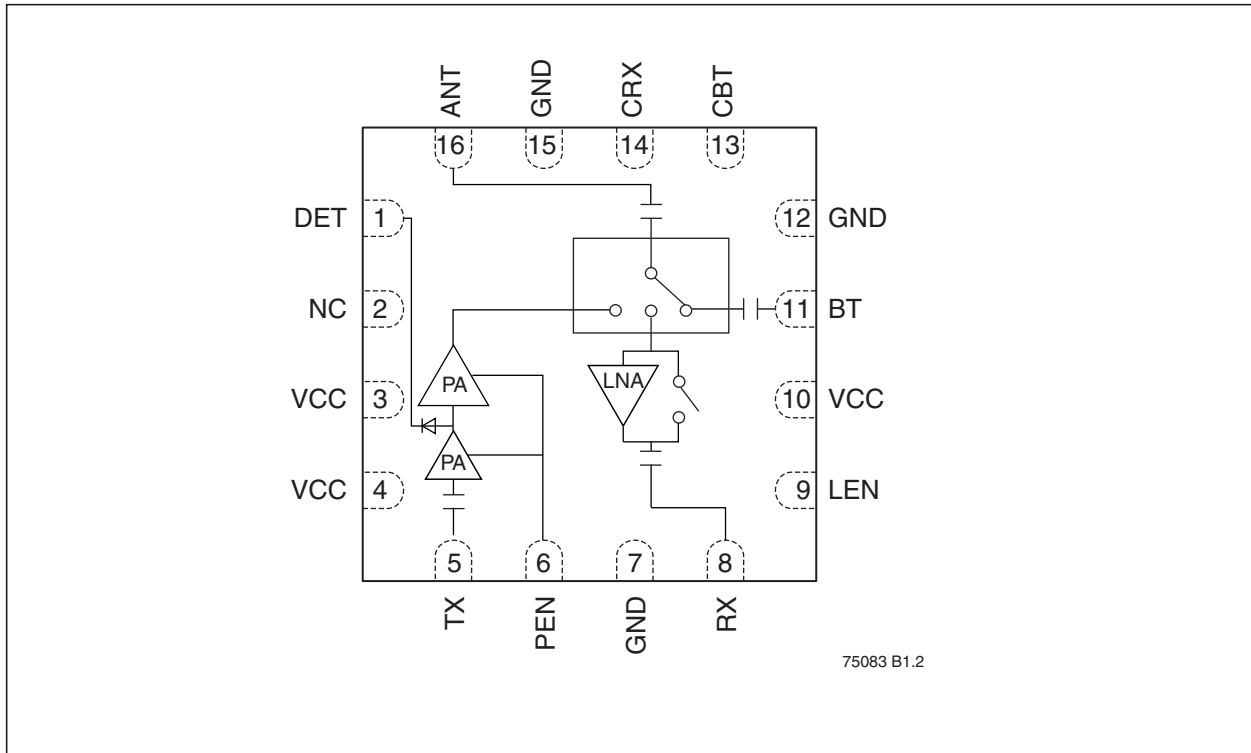
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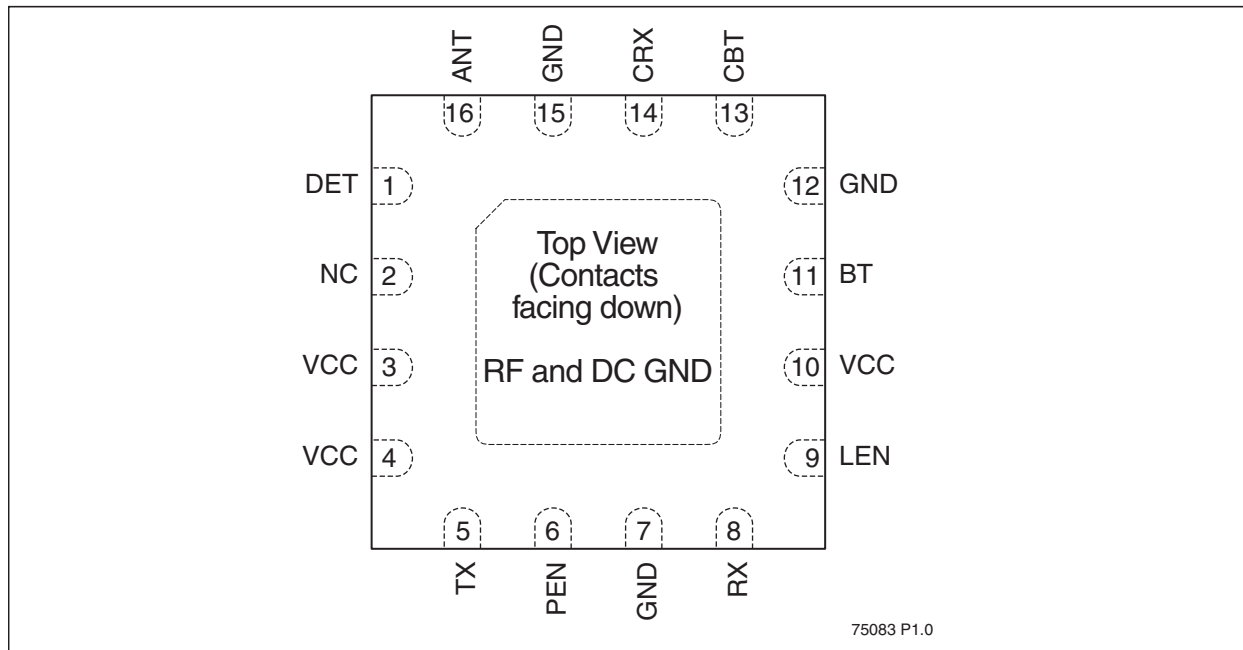
## 2.0 FUNCTIONAL BLOCKS

FIGURE 2-1: FUNCTIONAL BLOCK DIAGRAM



3.0 PIN ASSIGNMENTS

FIGURE 3-1: PIN ASSIGNMENTS FOR 16-CONTACT X2QFN



75083 P1.0

4.0 PIN DESCRIPTIONS

TABLE 4-1: PIN DESCRIPTION

Symbol	Pin No.	Pin Name	Type <sup>1</sup>	Function
DET	1		O	Detector output voltage ground
NC	2			No connect
VCC	3	Power Supply	PWR	Supply voltage
VCC	4	Power Supply	PWR	Supply voltage
TX	5		I	RF transmit input
PEN	6		I	PA enable
GND	7	Ground		Ground pad
RX	8		O	Rx output
LEN	9		I	LNA enable
VCC	10		PWR	Supply voltage
BT	11		I/O	Bluetooth RF port
GND	12	Ground		Ground pad
CBT	13		I	Bluetooth switch control
CRX	14		I	Receiver switch control voltage
GND	15	Ground		Ground Pad
ANT	16		I/O	Antenna

1. I=Input, O=Output

## 5.0 ELECTRICAL SPECIFICATIONS

The DC and RF specifications for the power amplifier are specified below. Refer to [Table 5-2](#) for the DC voltage and current specifications.

**Absolute Maximum Stress Ratings** (Applied conditions greater than those listed under “Absolute Maximum Stress Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this data sheet is not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.)

Tx input power to pin 5 (TX) . . . . .	+5 dBm
Rx input power to pin 16 (ANT with LNA ON) . . . . .	+5 dBm
Average Tx output power from pin 16 (ANT) <sup>1</sup> . . . . .	+26 dBm
Supply Voltage at pins 3 and 4 (V <sub>CC</sub> ) . . . . .	-0.3V to +5.5V
PA Enable Voltage to pin 6 (PEN) . . . . .	-0.3V to +3.6V
DC supply current (I <sub>CC</sub> ) <sup>2</sup> . . . . .	400 mA
Operating Temperature (T <sub>A</sub> ) . . . . .	-40°C to +85°C
Storage Temperature (T <sub>STG</sub> ) . . . . .	-40°C to +120°C
Maximum Junction Temperature (T <sub>J</sub> ) . . . . .	+150°C
Surface Mount Solder Reflow Temperature . . . . .	260°C for 10 seconds

1. Never measure with CW source. Pulsed single-tone source with <50% duty cycle is recommended. Exceeding the maximum rating of average output power could cause permanent damage to the device.
2. Measured with 100% duty cycle 54 Mbps 802.11g OFDM Signal

**TABLE 5-1: OPERATING RANGE**

Range	Ambient Temp	V <sub>CC</sub>
Extended	-40°C to +85°C	3.0-5.0V

**TABLE 5-2: DC ELECTRICAL CHARACTERISTICS AT 25°C FOR TX CHAIN**

Symbol	Parameter	Min.	Typ	Max.	Unit
V <sub>CC</sub>	Supply Voltage, V <sub>CC</sub>	3.0	3.6	5.0	V
I <sub>CC</sub>	Tx Idle current for V <sub>CC</sub> = 3.6V		90		mA
	Tx Idle current for V <sub>CC</sub> = 5.0V		95		mA
V <sub>PEN</sub>	Tx Enable Voltage	3.05	3.10	3.15	V
I <sub>CC</sub>	Tx Supply Current for 11g OFDM 54 Mbps signal: P <sub>OUT</sub> = 17 dBm at V <sub>CC</sub> = 3.6V P <sub>OUT</sub> = 18 dBm at V <sub>CC</sub> = 5.0V		150		mA
			160		mA
I <sub>DD</sub>	Rx Supply Current (with LNA ON)		9		mA

**TABLE 5-3: TX CHAIN RF CHARACTERISTICS AT  $V_{CC} = 3.6V$ , PEN=3.1V, 25°C**

Symbol	Parameter	Min.	Typ	Max.	Unit
$F_{L-U}$	Frequency range	2.4		2.5	GHz
Linearity,	Output Power with <3% EVM, 802.11g @ 54 Mbps OFDM		17		dBm
	Output Power level 1.75% Dynamic EVM, 256 QAM, 40 MHz		15		dBm
	Output Power level 2.5% Dynamic EVM, 802.11n, HT40		16		dBm
	Spectrum Mask compliance, IEEE802.11b		21		dBm
G	Gain	22	24		dB
$RL_{IN}$	Input return loss at TX port		14		dB
$V_{DET}$	Power detector output voltage at $P_{OUT}=5$ dBm, IEEE802.11g	0.25		0.35	V
	Power detector output voltage at $P_{OUT}= 20$ dBm,	0.55		0.65	V
2f, 3f, 4f, 5f	Harmonics at 17 dBm			-30	dBm/ MHz

**TABLE 5-4: TX CHAIN RF CHARACTERISTICS AT  $V_{CC} = 5.0V$ , PEN=3.1V, 25°C**

Symbol	Parameter	Min.	Typ	Max.	Unit
$F_{L-U}$	Frequency range	2.4		2.5	GHz
Linearity,	Output Power with <3% EVM, 802.11g @ 54 Mbps OFDM		18		dBm
	Output Power level 1.75% Dynamic EVM, 256 QAM, 40 MHz		16		dBm
	Output Power level 2.5% Dynamic EVM, 802.11n, HT40		17		dBm
	Spectrum Mask compliance, IEEE802.11b		22		dBm
G	Gain	22	24		dB
$RL_{IN}$	Input return loss at TX port		14		dB
$V_{DET}$	Power detector output voltage at $P_{OUT}=5$ dBm, IEEE802.11g	0.25		0.35	V
$V_{DET}$	Power detector output voltage at $P_{OUT}= 20$ dBm,	0.55		0.65	V
2f, 3f, 4f, 5f	Harmonics at 17 dBm			-30	dBm/ MHz

**TABLE 5-5: RX CHAIN RF CHARACTERISTICS AT  $V_{CC} = 3.6V-5V$ , LEN=3.1V, CRX = 3.1V, 25°C**

Symbol	Parameter	Min.	Typ	Max.	Unit
$F_{L-U}$	Frequency range	2.4		2.5	GHz
G	Gain, with LNA ON		12		dB
NF	Noise figure, with LNA ON		2.5		dB
IP1dB	Input P1dB, with LNA ON		-6		dBm
Loss	LNA bypass loss		9		dB
$RL_{IN}$	Input return loss at Antenna port with LNA		12		dB

**TABLE 5-6: BLUETOOTH CHAIN RF CHARACTERISTICS AT  $V_{CC} = 3.6V-5V$ , CBT=3.1V, 25°C**

Symbol	Parameter	Min.	Typ	Max.	Unit
$F_{L-U}$	Frequency range	2.4		2.5	GHz
L	Loss		1.6		dB
RL	Return Loss		8		dB

TABLE 5-7: CONTROL VOLTAGES<sup>1</sup>

Function	PEN	CRX	LEN	CBT
Transmit mode	3.1V	0	0	0
Bluetooth	0	0	0	3V
Receive mode, LNA on	0	3V	3V	0
Receive mode, LNA bypass	0	3V	0	0
OFF	0	0	0	0

1. No other operating modes are allowed

6.0 TYPICAL PERFORMANCE CHARACTERISTICS

6.1 Transmitter

Test Conditions:  $V_{CC} = 3.6V$ ,  $PEN = 3.10V$ ,  $LEN = 0V$ ,  $CRX = 0V$ ,  $CBT = 0V$ ,  $T_A = 25^\circ C$ , unless otherwise specified

FIGURE 6-1: S-PARAMETERS

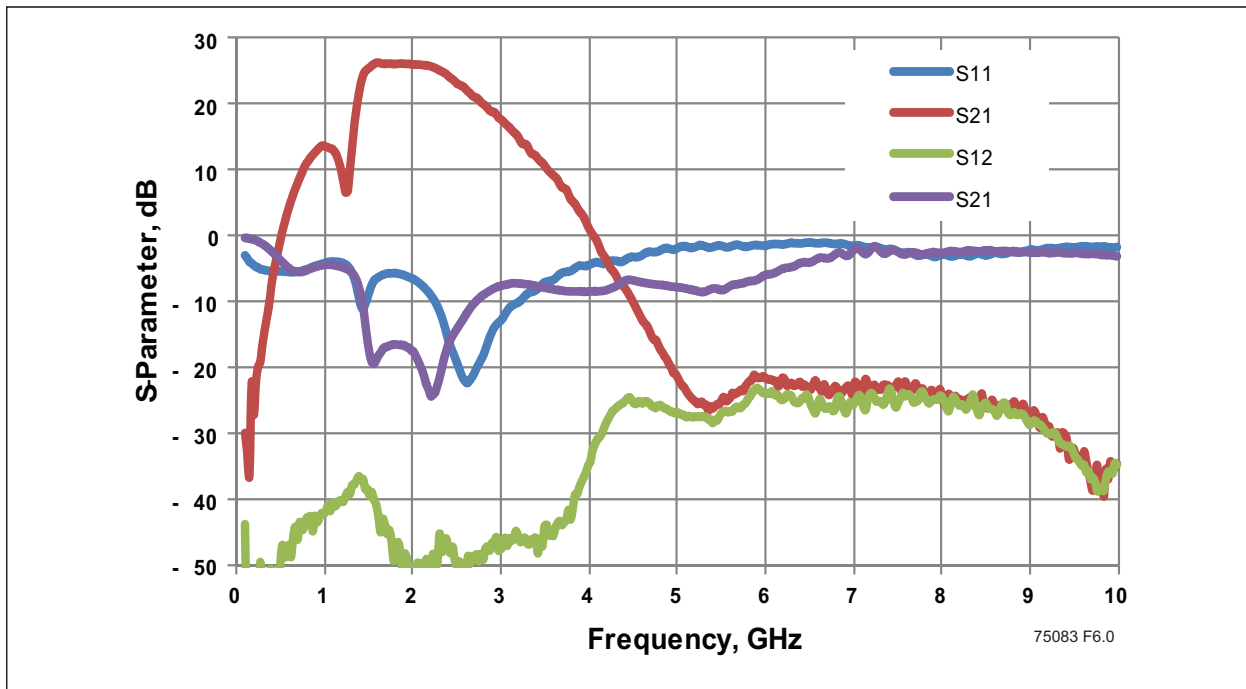
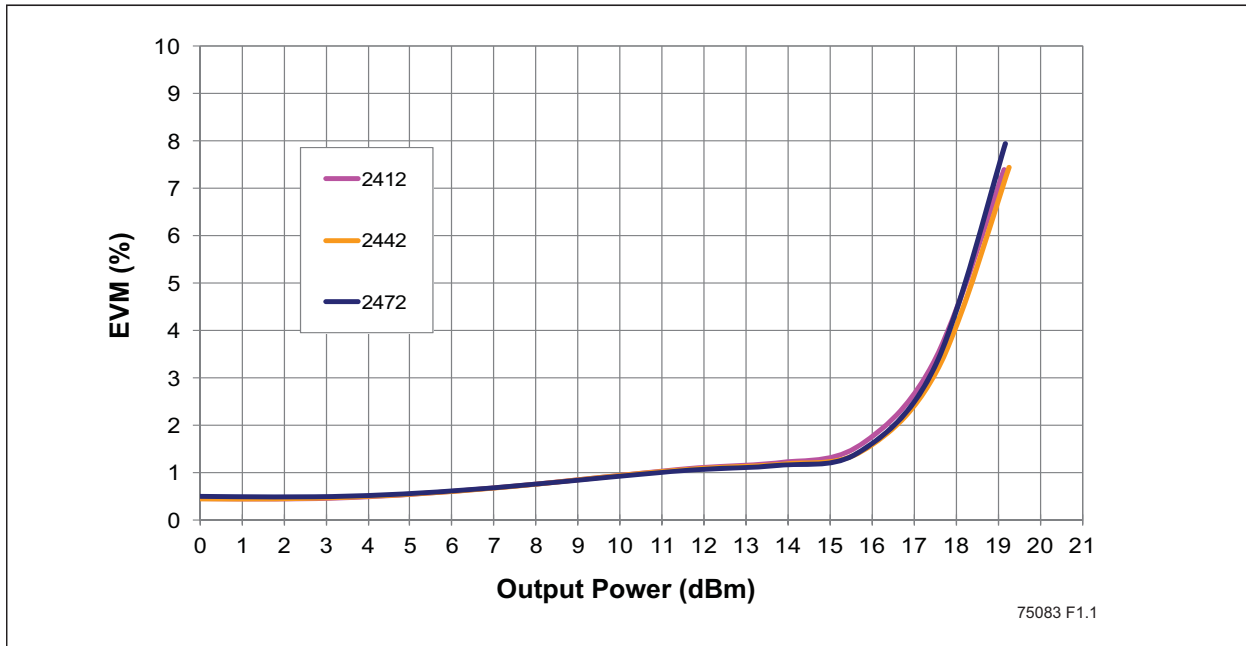
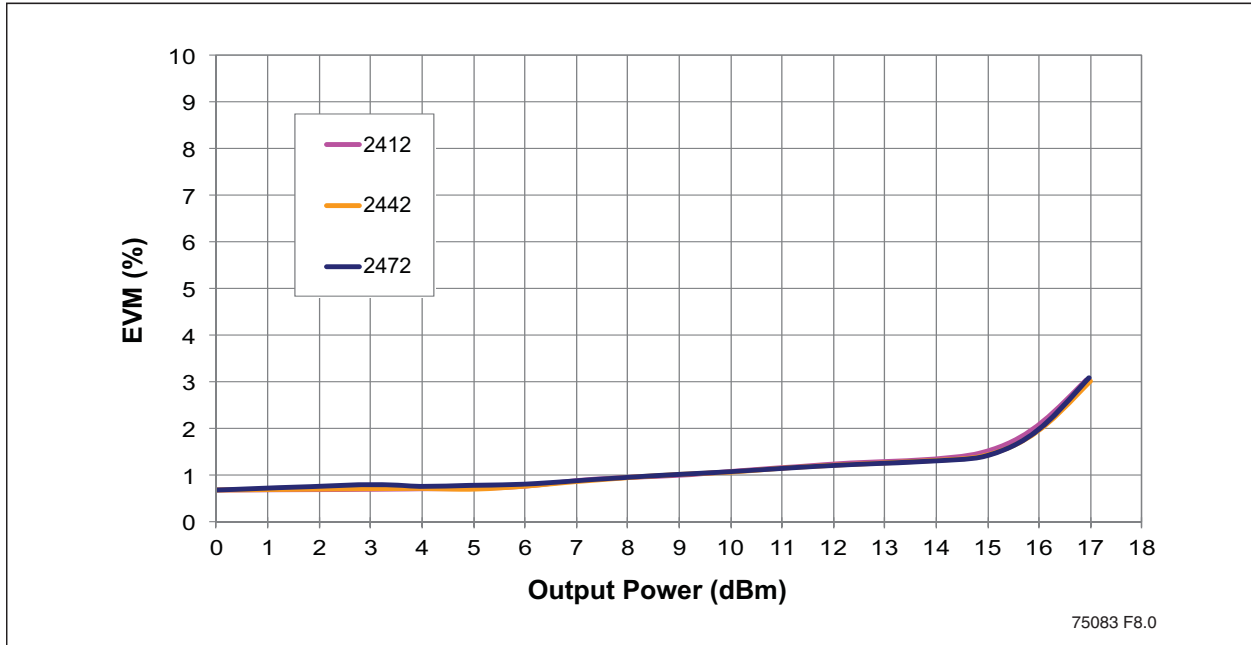


FIGURE 6-2: TRANSMITTER EVM VERSUS OUTPUT POWER MEASURED USING 802.11G WITH EQUALIZER TRAINING USING SEQUENCE ONLY





**FIGURE 6-3: TRANSMITTER DYNAMIC EVM VERSUS OUTPUT POWER MEASURED USING 256 QAM, 40 MHZ BANDWIDTH WITH EQUALIZER TRAINING USING SEQUENCE ONLY**



**FIGURE 6-4: GAIN VERSUS OUTPUT POWER**

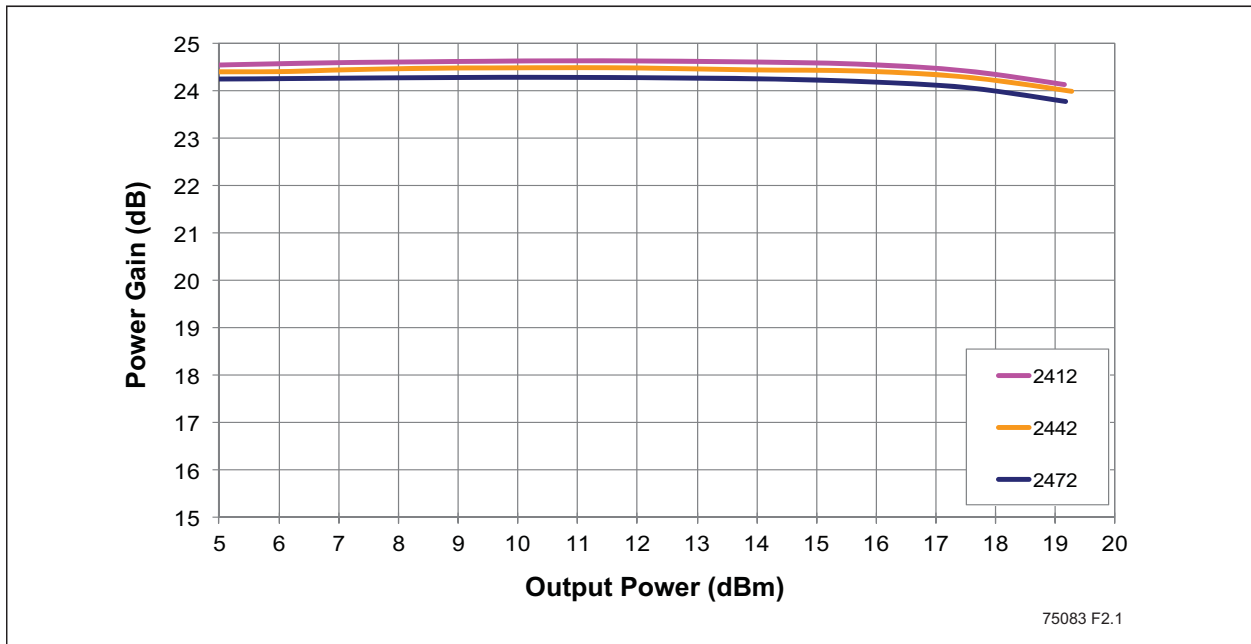


FIGURE 6-5: TRANSMITTER DC CURRENT VERSUS OUTPUT POWER

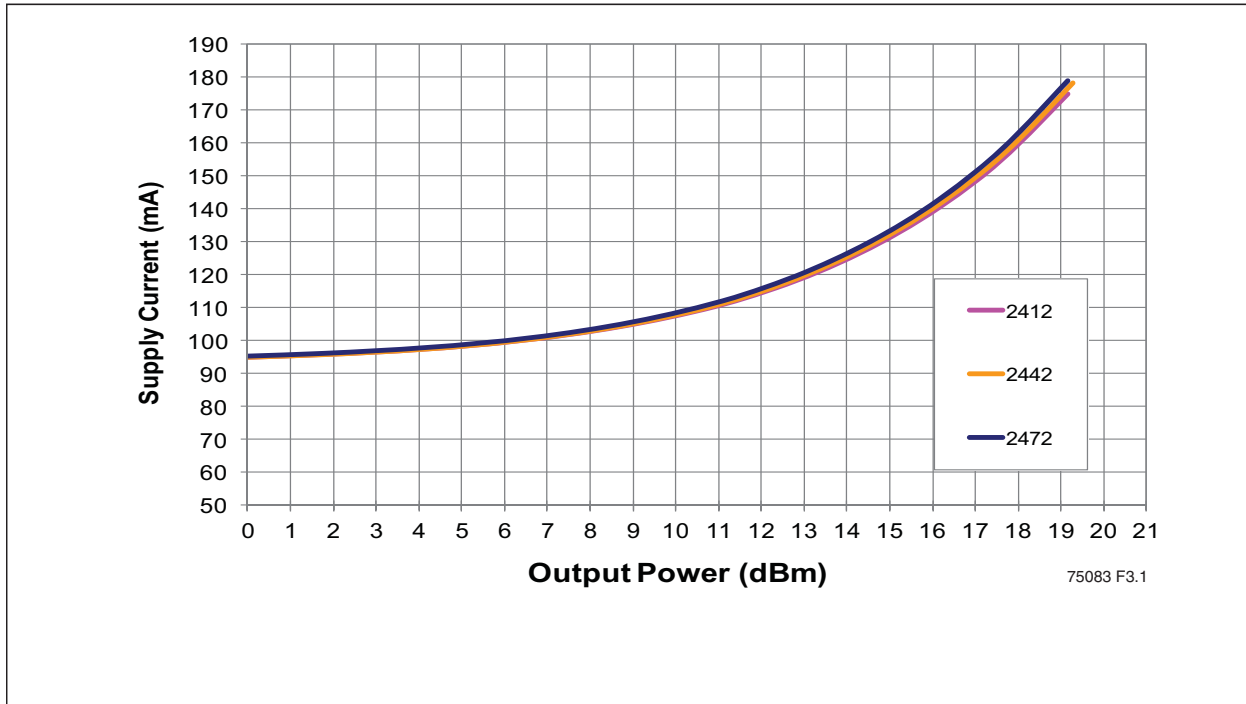
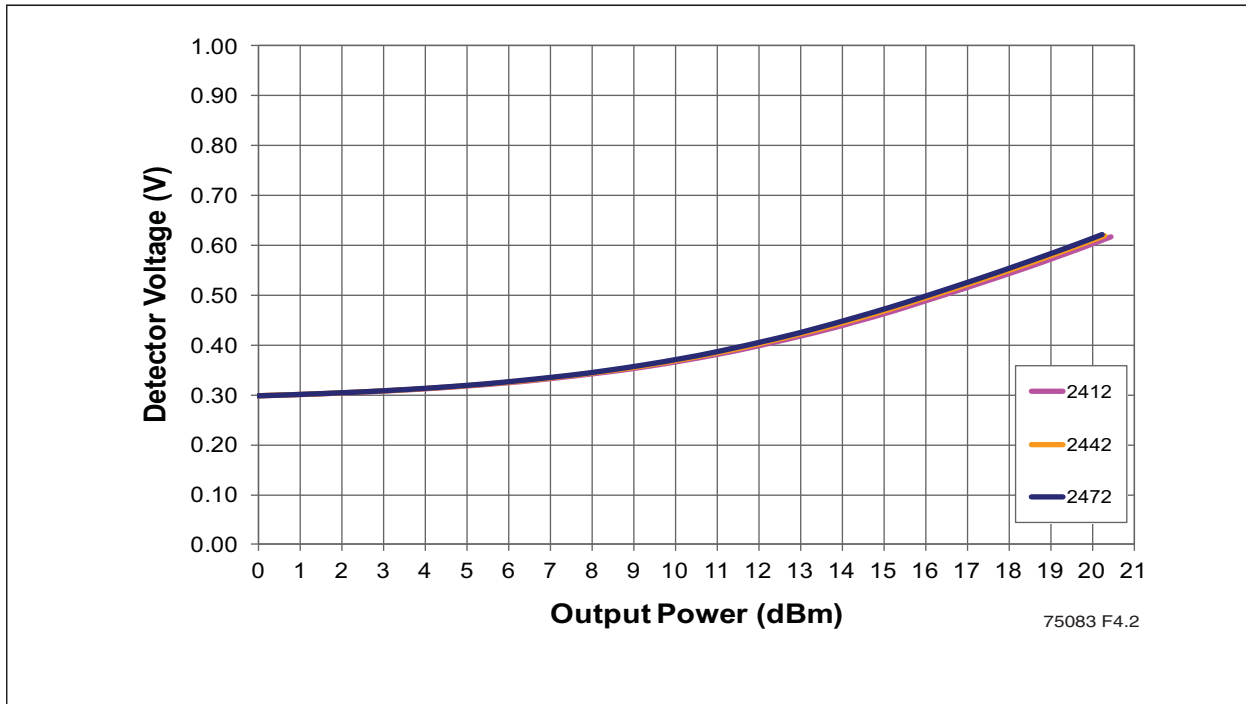


FIGURE 6-6: DETECTOR VOLTAGE VERSUS OUTPUT POWER



6.2 Receiver

Test Conditions:  $V_{CC} = 3.6V$ ,  $LEN = 3.3V$ ,  $CRX = 3.3V$ ,  $PEN = 0V$ ,  $CBT = 0V$ ,  $T_A = 25^{\circ}C$ , unless otherwise specified

FIGURE 6-7: RECEIVER S-PARAMETER

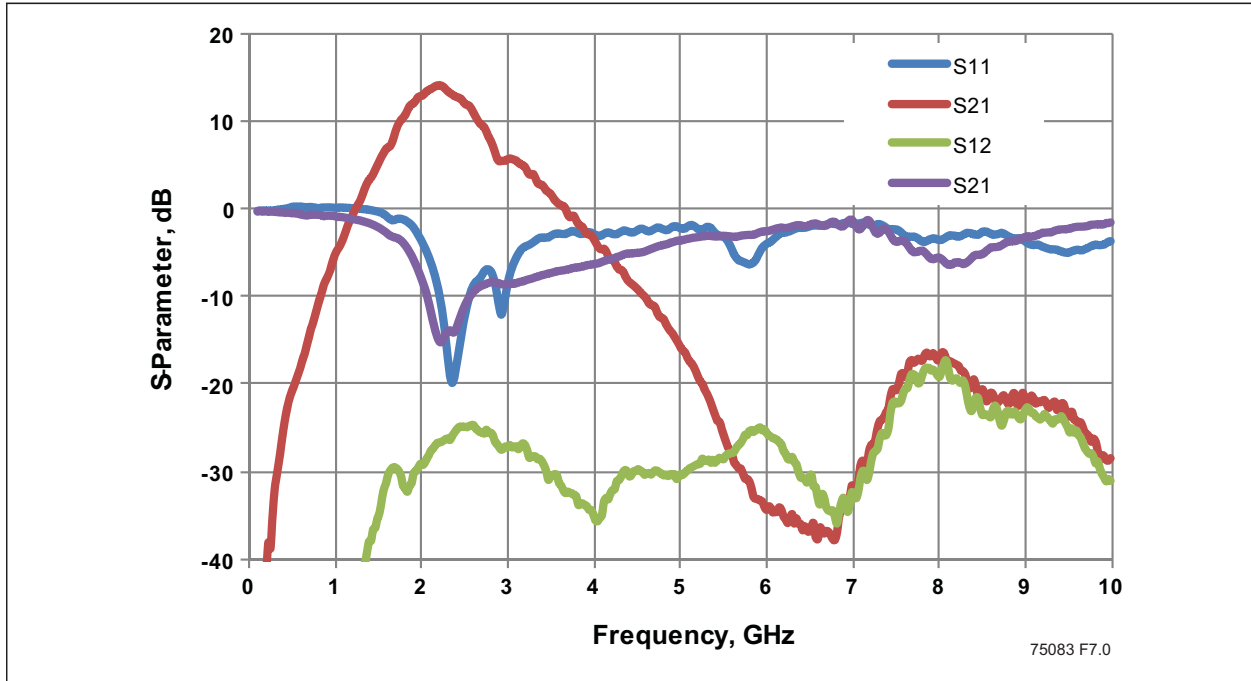
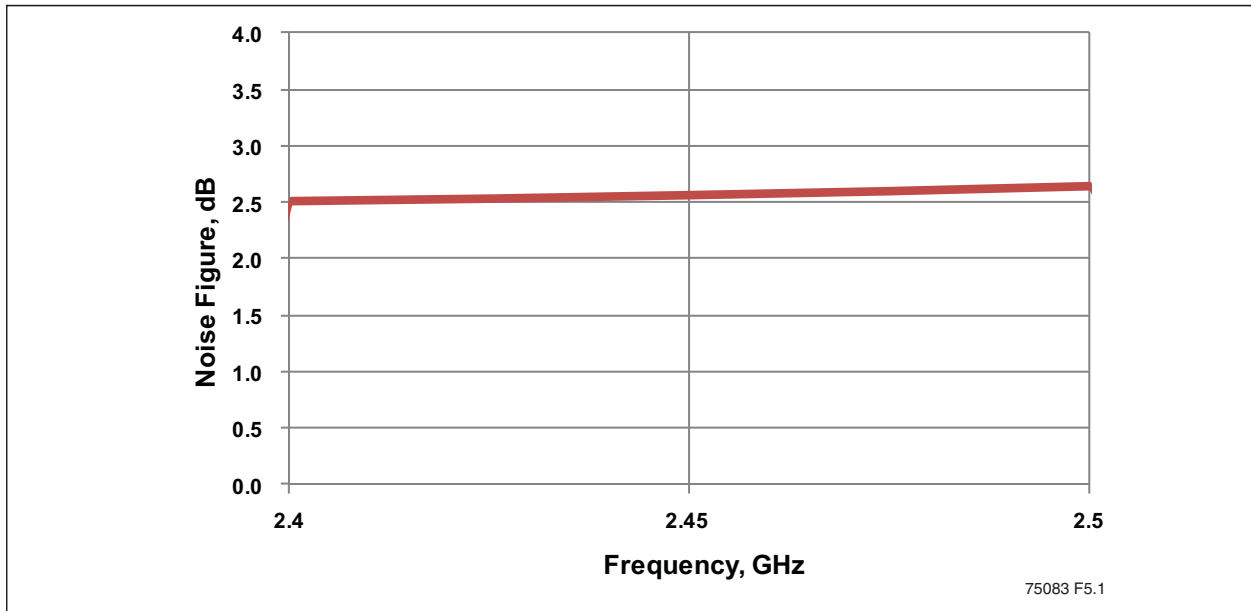
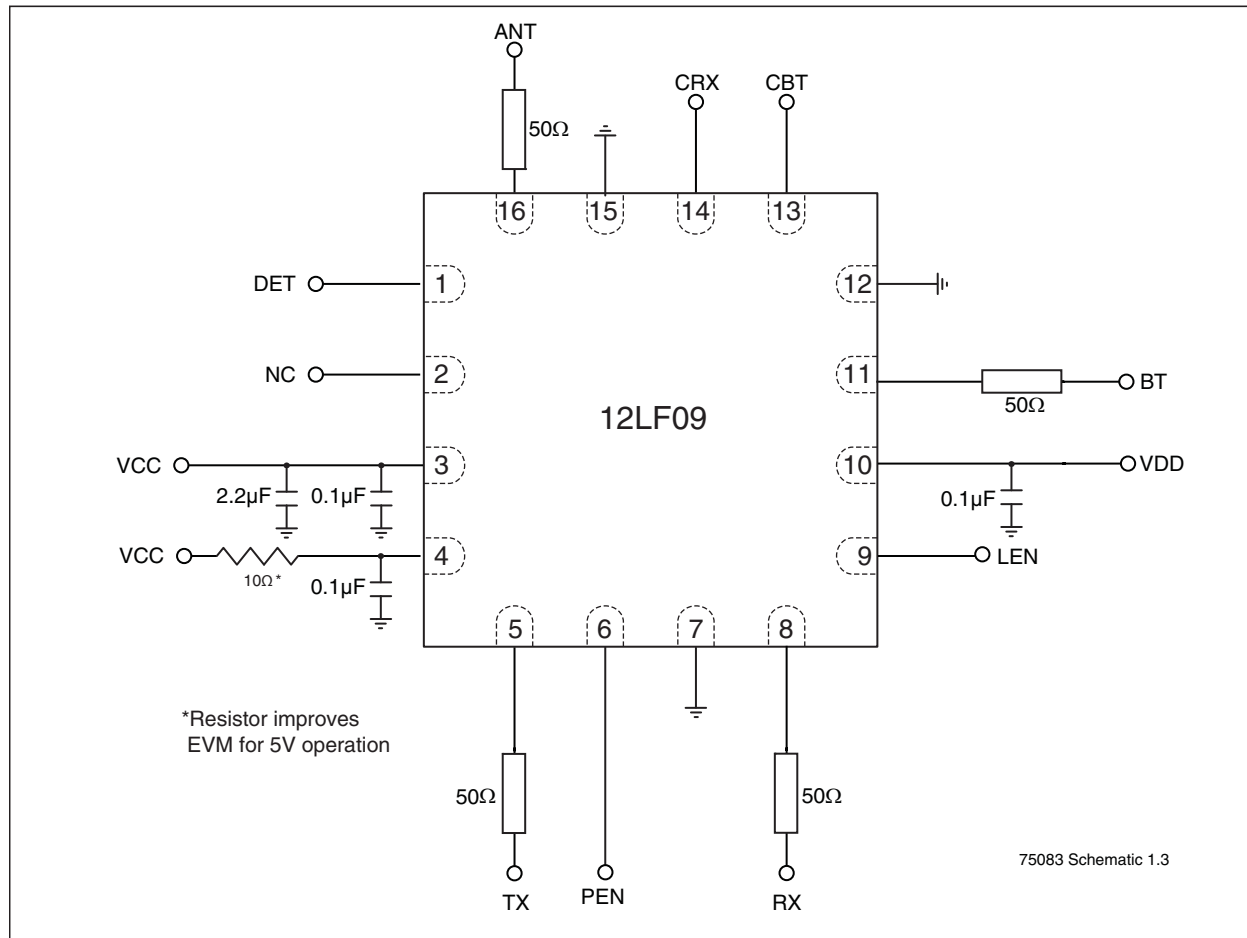


FIGURE 6-8: RECEIVER NOISE FIGURE



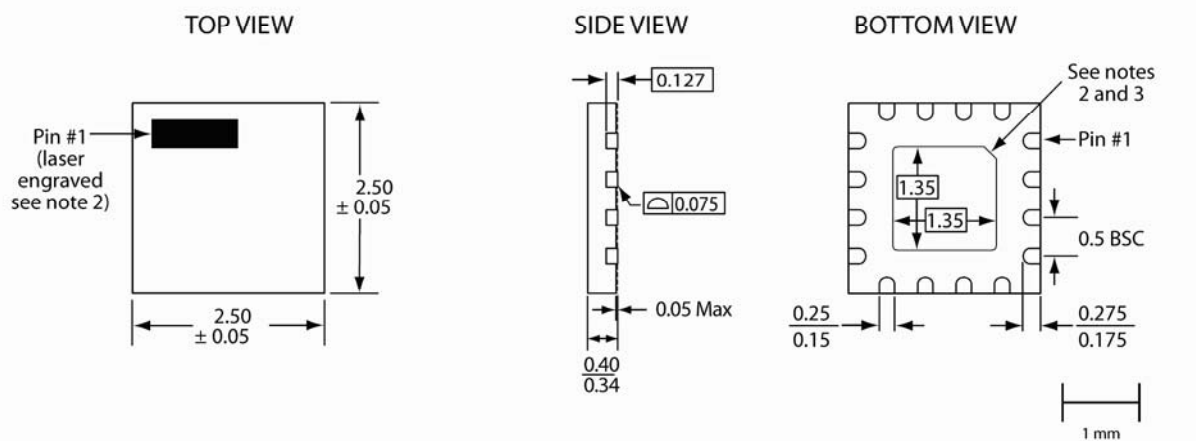
**FIGURE 6-9: TYPICAL SCHEMATIC**



## 7.0 PACKAGING DIAGRAMS

**16-Lead Super-Thin Quad Flatpack No-Leads (Q3CE/F) - 2.5x2.5 mm Body [X2QFN]**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

**Note:**

1. From the bottom view, the pin #1 indicator may be either a 45-degree chamfer or a half-circle notch.
2. The topside pin #1 indicator is laser engraved; its approximate shape and location is as shown.
3. The external paddle is electrically connected to the die back-side and to VSS.  
This paddle must be soldered to the PC board; it is required to connect this paddle to the VSS of the unit.  
Connection of this paddle to any other voltage potential will result in shorts and electrical malfunction of the device.
4. Untoleranced dimensions are nominal target dimensions.
5. All linear dimensions are in millimeters (max/min).

**TABLE 7-1: REVISION HISTORY**

<b>Revision</b>	<b>Description</b>	<b>Date</b>
A	<ul style="list-style-type: none"><li>• Initial release of data sheet</li></ul>	May 2013
B	<ul style="list-style-type: none"><li>• Revised “Features” on page 1</li><li>• Updated Tables 5-2, 5-3, 5-5, 5-6</li><li>• Updated Figure 6-6 on page 10 and Figure 6-9 on page 12</li><li>• Changed <math>V_{DD}</math> to <math>V_{CC}</math> throughout</li><li>• Updated Figure 2-1 on page 3</li></ul>	Dec 2013

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<u>PART NO.</u>	<u>XXX</u>	
Device	Package	
Device: SST12LF09		= 2.4 GHz High-Gain, High-Efficiency Front-end Module
Package: Q3CE		= X2QFN (2.5mm x 2.5mm), 0.4 max thickness 16-contact
Evaluation Kit Flag	K	= Evaluation Kit

**Valid Combinations:**  
SST12LF09-Q3CE  
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