SST12LF09

2.4 GHz High-Linearity, WLAN Front-End Module

FEATURES

- Input/output ports internally matched to 50Ω and DC decoupled
- Package available
  - 16-contact X2QFN – 2.5mm x 2.5mmx 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_{CQ}:90 mA (3.6V V_{CC})
- Low shut-down current: ~2 µA
- Power-up/down control
  - Turn on/off time (10%–90%) <400 ns
- Limited variation over temperature
  - ~1 dB power variation between -40°C to +85°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® 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 Ω. 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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An errata sheet, describing minor operational differences from the data sheet and recommended workarounds, may exist for current devices. As device/documentation issues become known to us, we will publish an errata sheet. The errata will specify the revision of silicon and revision of document to which it applies.

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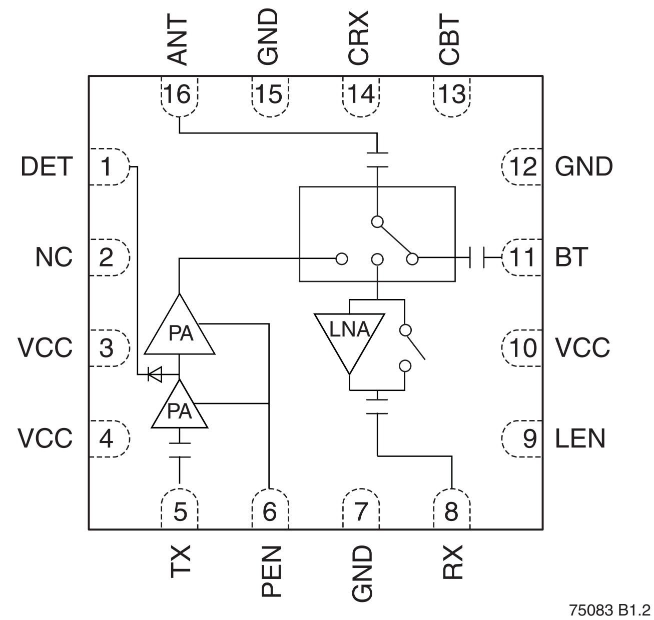
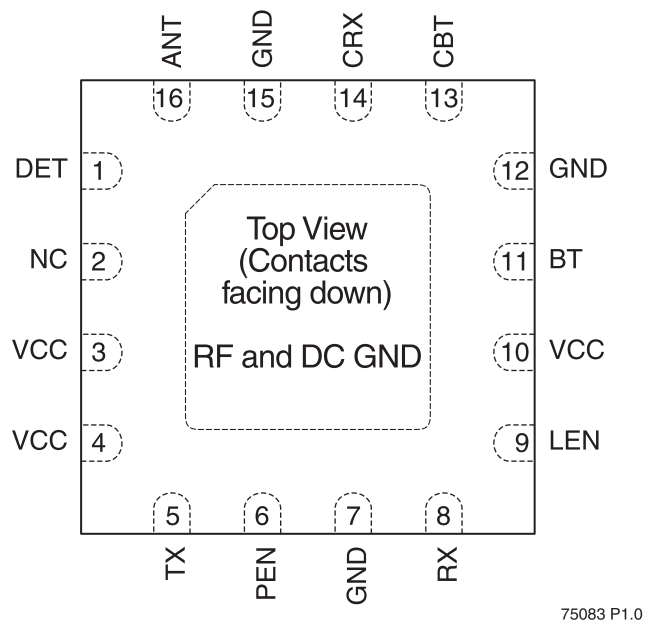
2.0 FUNCTIONAL BLOCKS

FIGURE 2-1: FUNCTIONAL BLOCK DIAGRAM



3.0 PIN ASSIGNMENTS

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



4.0 PIN DESCRIPTIONS

TABLE 4-1: PIN DESCRIPTION

Symbol	Pin No.	Pin Name	Type[1]	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)[1] . . . . +26 dBm
Supply Voltage at pins 3 and 4 (V_{CC}) . . . . -0.3V to +5.5V
PA Enable Voltage to pin 6 (PEN) . . . . -0.3V to +3.6V
DC supply current (I_{CC})[2] . . . . 400 mA
Operating Temperature (T_A) . . . . -40ºC to +85ºC
Storage Temperature (T_{STG}) . . . . -40ºC to +120ºC
Maximum Junction Temperature (T_J) . . . . +150ºC
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_{CC}
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_{CC}	Supply Voltage, V_{CC}	3.0	3.6	5.0	V
I_{CQ}	Tx Idle current for V_{CC} = 3.6V		90		mA
	Tx Idle current for V_{CC} = 5.0V		95		mA
V_{PEN}	Tx Enable Voltage	3.05	3.10	3.15	V
I_{CC}	Tx Supply Current for 11g OFDM 54 Mbps signal:				
	P_{OUT} = 17 dBm at V_{CC} = 3.6V		150		mA
	P_{OUT} = 18 dBm at V_{CC} = 5.0V		160		mA
I_{DD}	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[1]

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°C, unless otherwise specified

FIGURE 6-1: S-PARAMETERS

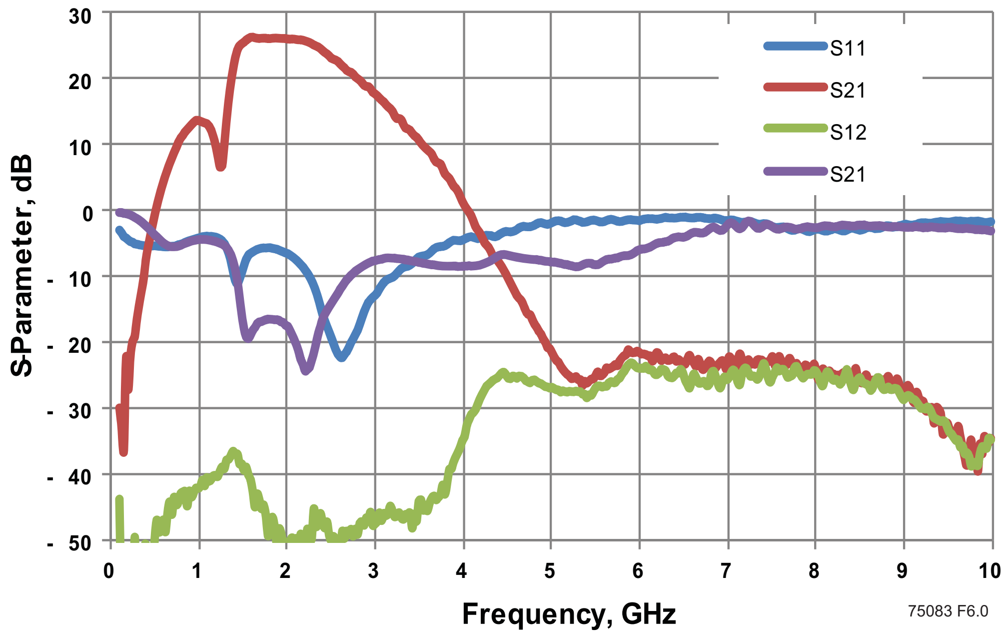


FIGURE 6-2: TRANSMITTER EVM VERSUS OUTPUT POWER MEASURED USING 802.11G WITH EQUALIZER TRAINING USING SEQUENCE ONLY

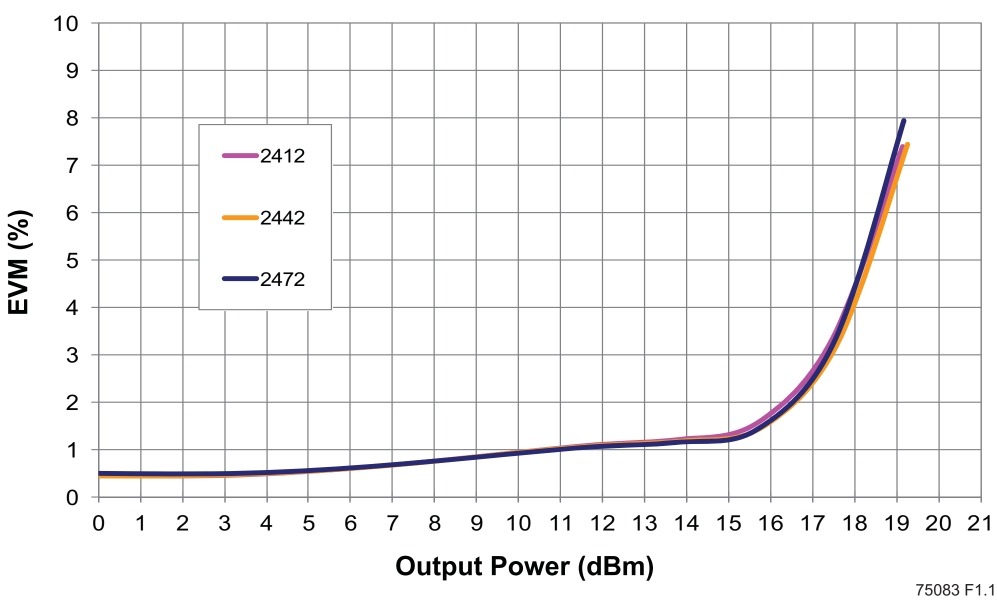


FIGURE 6-3: TRANSMITTER DYNAMIC EVM VERSUS OUTPUT POWER MEASURED USING 256 QAM, 40 MHZ BANDWIDTH WITH EQUALIZER TRAINING USING SEQUENCE ONLY

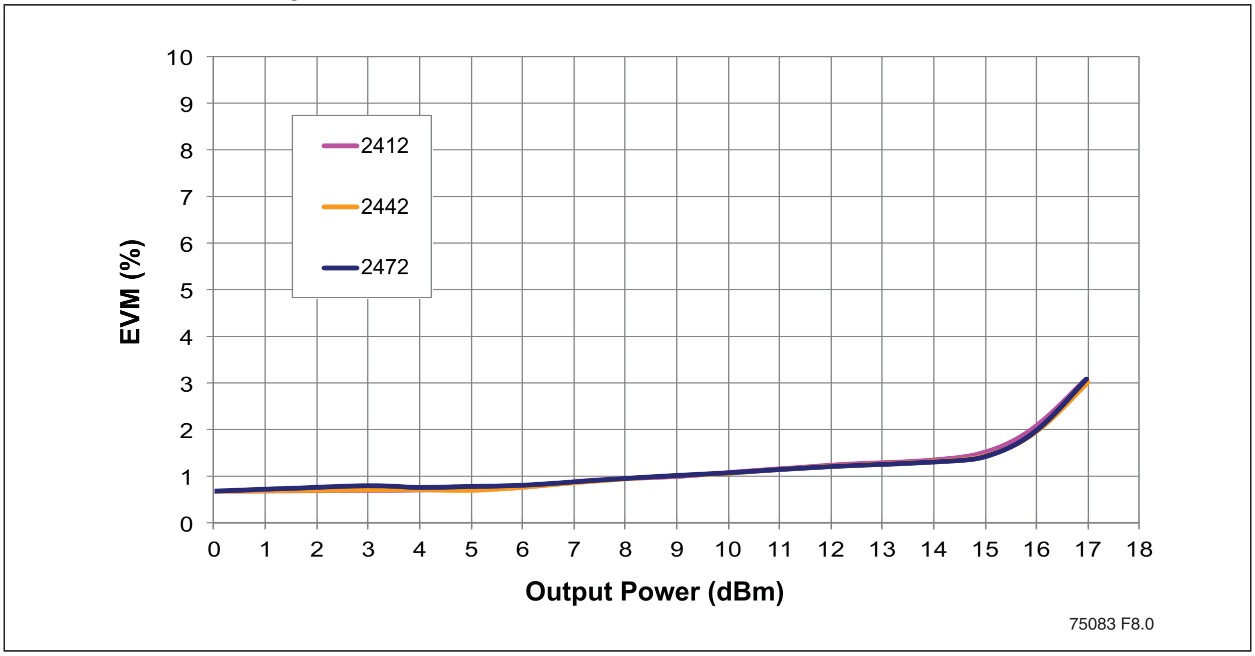


FIGURE 6-4: GAIN VERSUS OUTPUT POWER

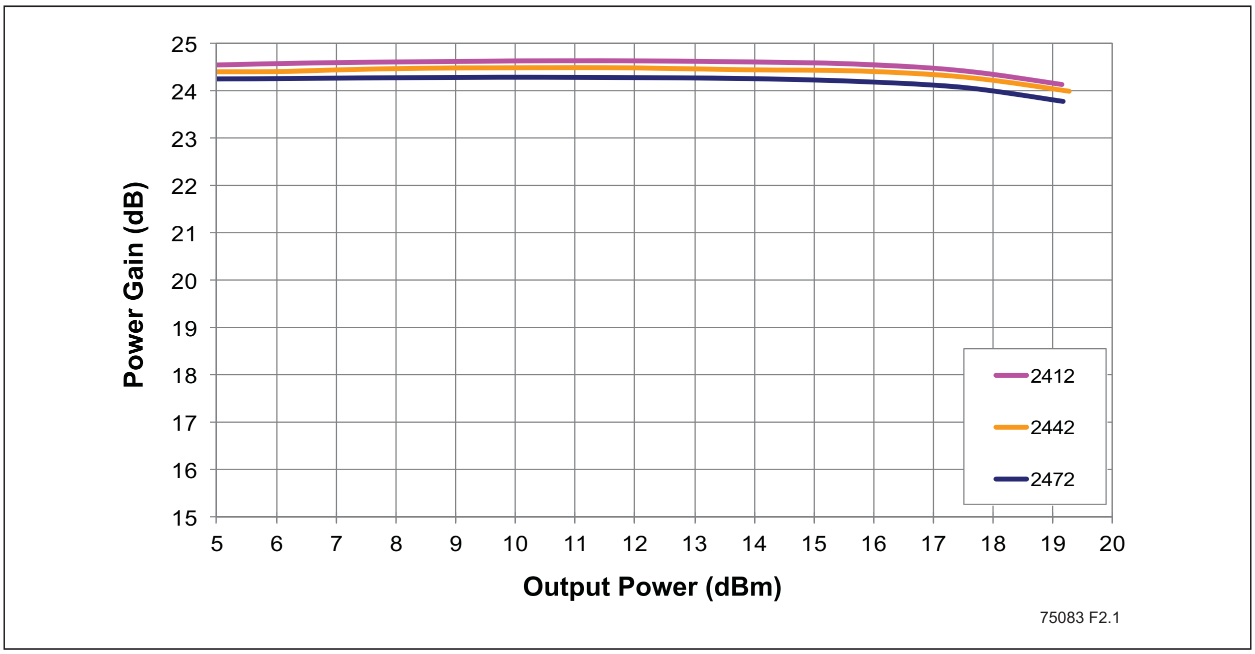


FIGURE 6-5: TRANSMITTER DC CURRENT VERSUS OUTPUT POWER

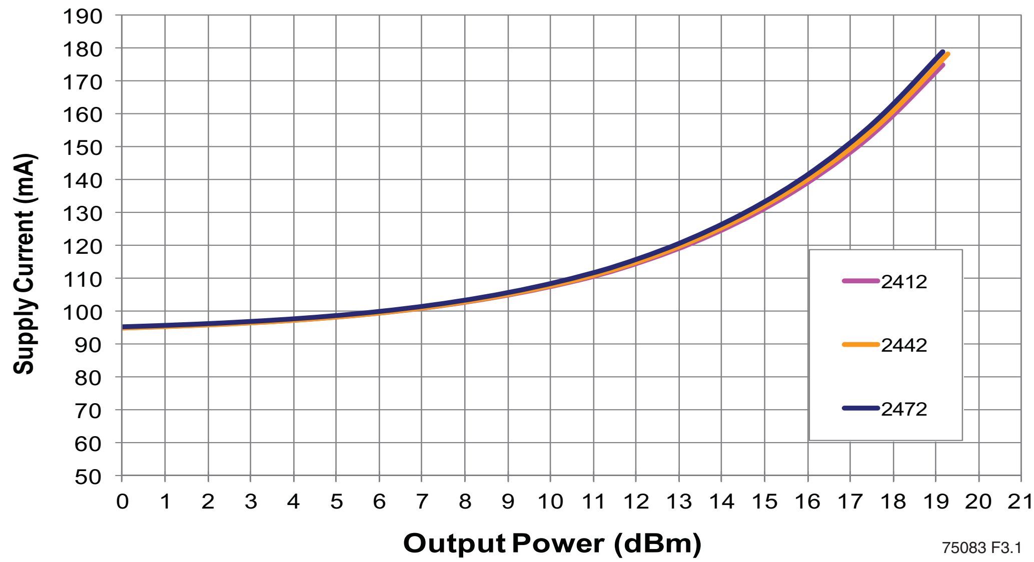
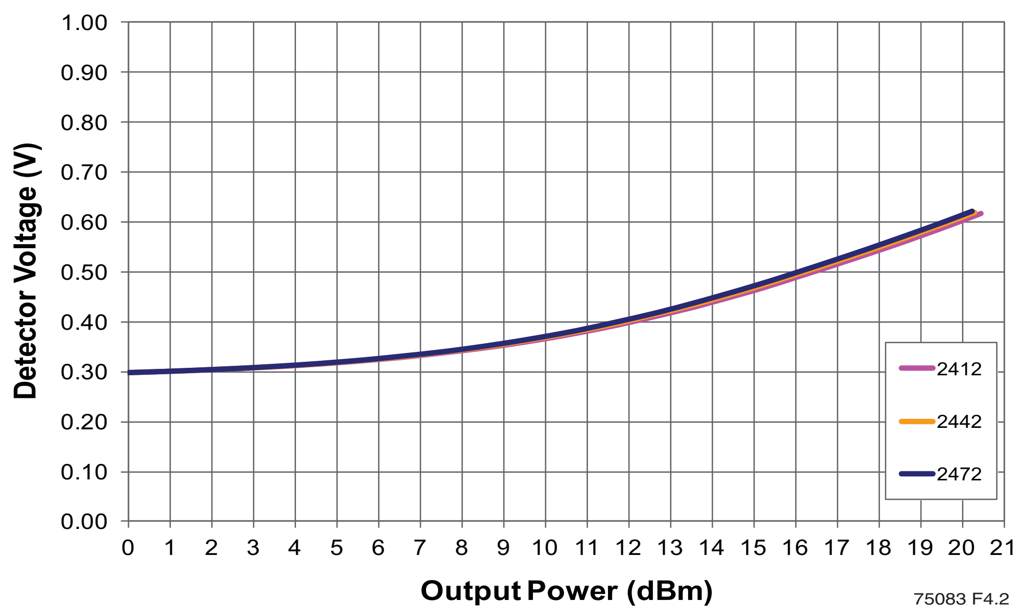


FIGURE 6-6: DETECTOR VOLTAGE VERSUS OUTPUT POWER



6.2 Receiver

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

FIGURE 6-7: RECEIVER S-PARAMETER

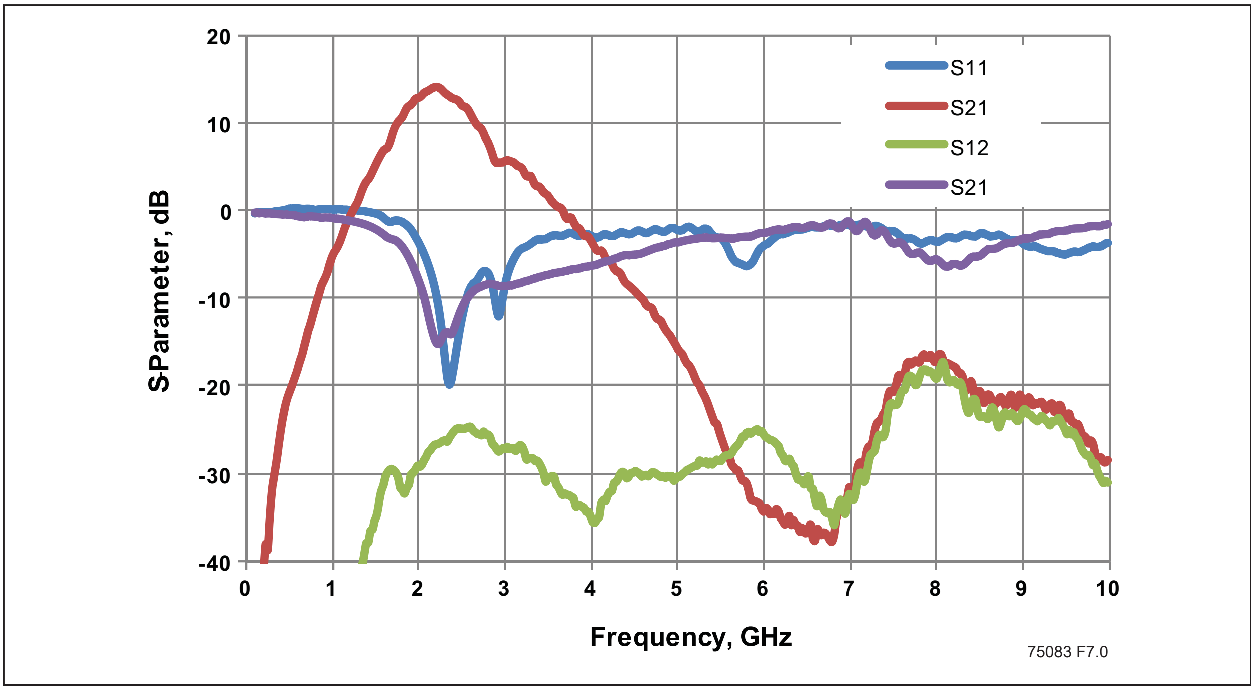
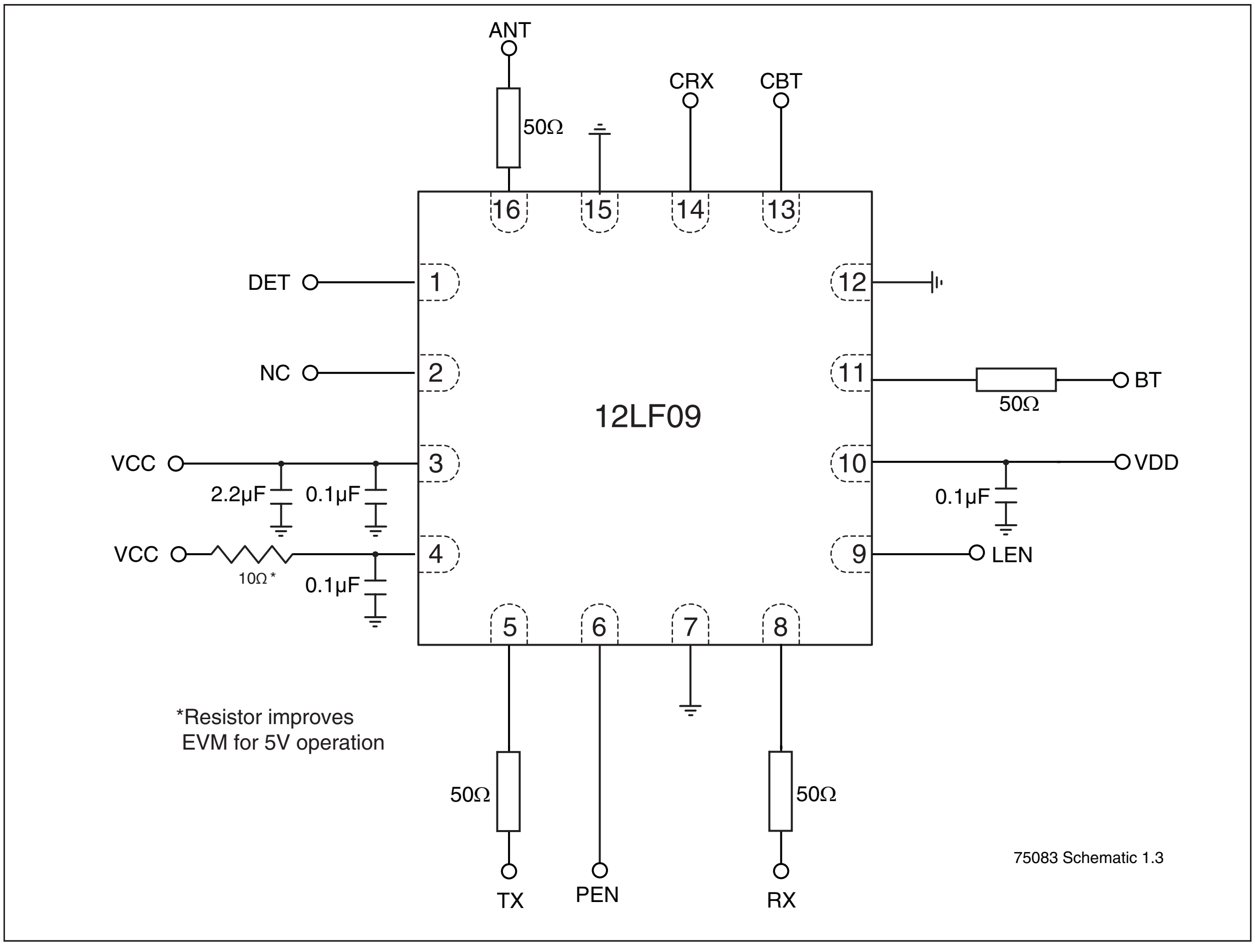


FIGURE 6-8: RECEIVER NOISE FIGURE

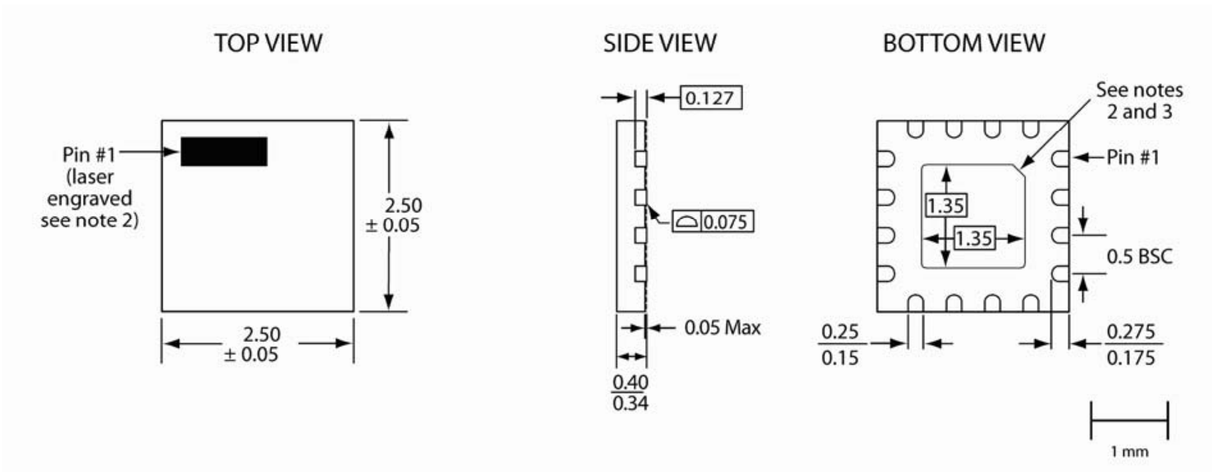
FIGURE 6-9: TYPICAL SCHEMATIC



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



16-x2qfn-2.5x2.5-Q3C-2.0

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).

Microchip Technology Drawing C04-14017A Sheet 1 of 1

TABLE 7-1: REVISION HISTORY

Revision	Description	Date
A	• Initial release of data sheet	May 2013
B	• Revised "Features" on page 1 • Updated Tables 5-2, 5-3, 5-5, 5-6 • Updated Figure 6-6 on page 10 and Figure 6-9 on page 12 • Changed V_{DD} to V_{CC} throughout • Updated Figure 2-1 on page 3	Dec 2013

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8.0 PRODUCT IDENTIFICATION SYSTEM

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PART NO.	XXX
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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