2.4 GHz WLAN High-Gain, High-Efficiency FEM

SST12LF02

Data Sheet

SST12LF02 is a 2.4 GHz Front-End Module (FEM) that combines a high-performance Power Amplifier (PA) and a single-pole, three-throw, antenna switch for Tx/Rx and Bluetooth® control. Designed in compliance with IEEE 802.11 b/g/n/256 QAM applications and based on GaAs PHEMT/HBT technology, the SST12LF02 operates within the frequency range of 2.4- 2.5 GHz at a very low DC-current consumption. The Transmitter chain has excellent linearity, typically 3% EVM up to 18 dBm output power, for 54 Mbps 802.11g operation while meeting 802.11g spectrum mask at 21 dBm. The transmitter will also provide 17 dBm with 11n, MCS7-HT40 modulation and 16 dBm with 256 QAM MCS9-HT40 modulation. SST12LF02 is offered in a 16-contact XQFN package.

Features

- **High gain:**
  - Typically 29 dB gain across 2.4–2.5 GHz over temperature 0°C to +85°C for Transmitter (TX) chain.
- **High linear output power:**
  - >24 dBm P1dB
    - Single-tone measurement
    - Please refer to “Absolute Maximum Stress Ratings” on page 6
  - Meets 802.11g OFDM ACPR requirement up to 21 dBm
  - ~3% EVM up to 18 dBm for 54 Mbps 802.11g signal
  - Meets 802.11b ACPR requirement up to 21 dBm
  - 2.5% EVM up to 17 dBm for 11n, MCS7-HT40
  - 1.8% EVM up to 16 dBm for 256 QAM MCS9-HT40
- **High power-added efficiency/Low operating current for 802.11b/g/n applications**
  - ~27%/160 mA @ P_{OUT} = 21 dBm for 802.11g
  - ~26%/165 mA @ P_{OUT} = 21 dBm for 802.11b
- **Low I_{REF} power-up/down control**
  - I_{REF} <2 mA
- **Low idle current**
  - ~65 mA I_{CQ} for 11g operation
  - ~80 mA I_{CQ} for 11n and 256 QAM operation
- **High-speed power-up/down**
  - Turn on/off time (10%- 90%) <100 ns
  - Typical power-up/down delay with driver delay included <200 ns
- **Low shut-down current (~2 µA)**
- **Limited variation over temperature**
  - ~1 dB gain/power variation between 0°C to +85°C
- **Excellent on-chip power detection**
  - >15 dB dynamic range on-chip power detection
- **Input/output ports matched to 50Ω internally and DC decoupled.**
- **Packages available**
  - 16-contact XQFN – 3mm x 3mm
- **All non-Pb (lead-free) devices are RoHS compliant**

Applications

- **WLAN (IEEE 802.11b/g/n)**
- **Cordless phones**
- **2.4 GHz ISM wireless equipment**

Product Description

SST12LF02 is a 2.4 GHz Front-end Module (FEM) designed in compliance with IEEE 802.11b/g/n applications. It combines a high-performance Power Amplifier (PA) and a switch. There are three components to the FEM: the Receiver (RX) chain, the Transmitter (TX) chain, and the Bluetooth® (BT) chain.

The TX chain includes a high-efficiency PA based on the InGaP/GaAs HBT technology. This chain typically provides 29 dB gain with 27% power-added efficiency (PAE) @ POUT = 21 dBm for 802.11g and 26% PAE @ POUT = 21 dBm for 802.11b

The TX chain has excellent linearity, typically ~3% added EVM at 18 dBm output power which is essential for 54 Mbps 802.11g operation while meeting 802.11g spectrum mask at 21dBm. The SST12LF02 transmitter will also provide up to 17 dBm for 11n, MCS7-HT40 modulation and up to 16 dBm for 256 QAM, MCS9-HT40 modulation.

SST12LF02 also features easy board-level usage along with high-speed power-up/down controls. Ultra-low reference current (total I_{REF} ~2 mA) makes SST12LF02 controllable by an on/off switching signal directly from the baseband chip. These features, coupled with low operating current, make the SST12LF02 ideal for the final stage power amplification in battery-powered 802.11b/g/n WLAN transmitter applications.

SST12LF02 has an excellent on-chip, single-ended power detector, which features wide-range (>15 dB) with dB-wise linearization. The excellent on-chip power detector provides a reliable solution to board-level power control.

The input/output RF ports are single-ended and fully matched to 50 Ω internally. 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.

The SST12LF02 is offered in a16-contact XQFN package. See Figure 2 for pin assignments and Table 1 for pin descriptions.

Functional Blocks

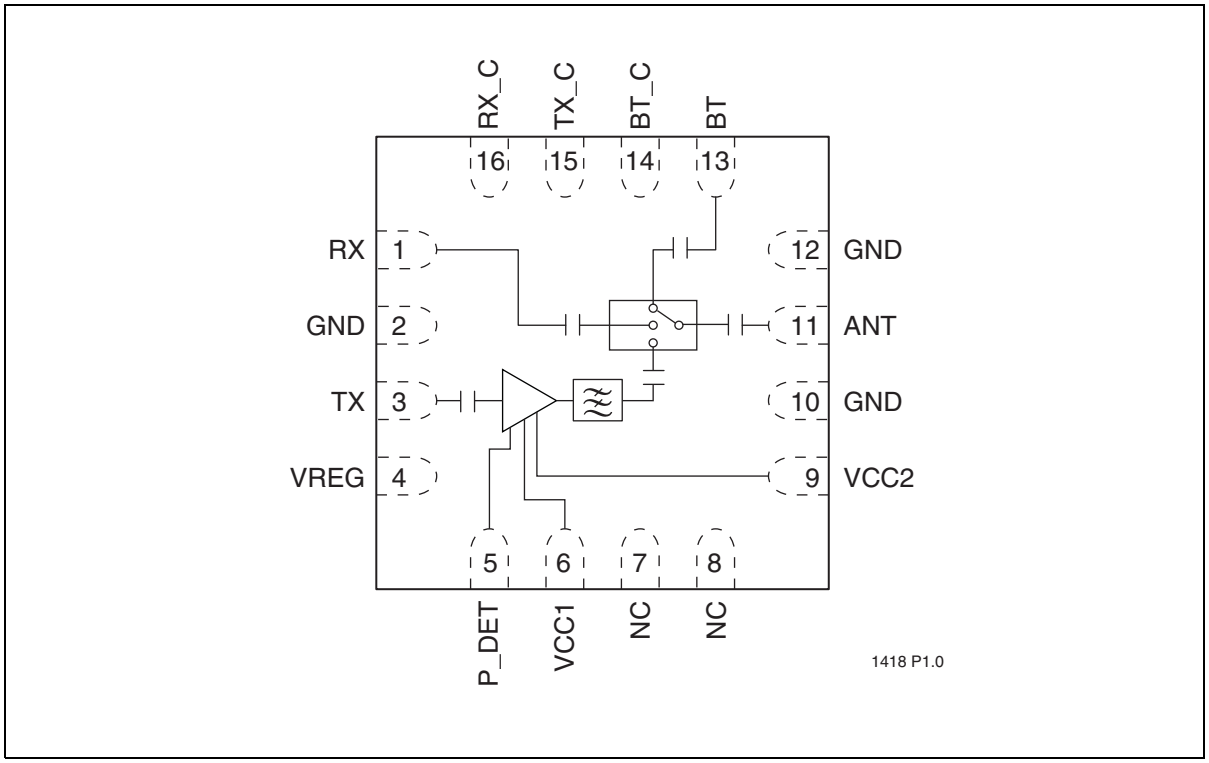

Figure 1: Functional Block Diagram

Pin Assignments

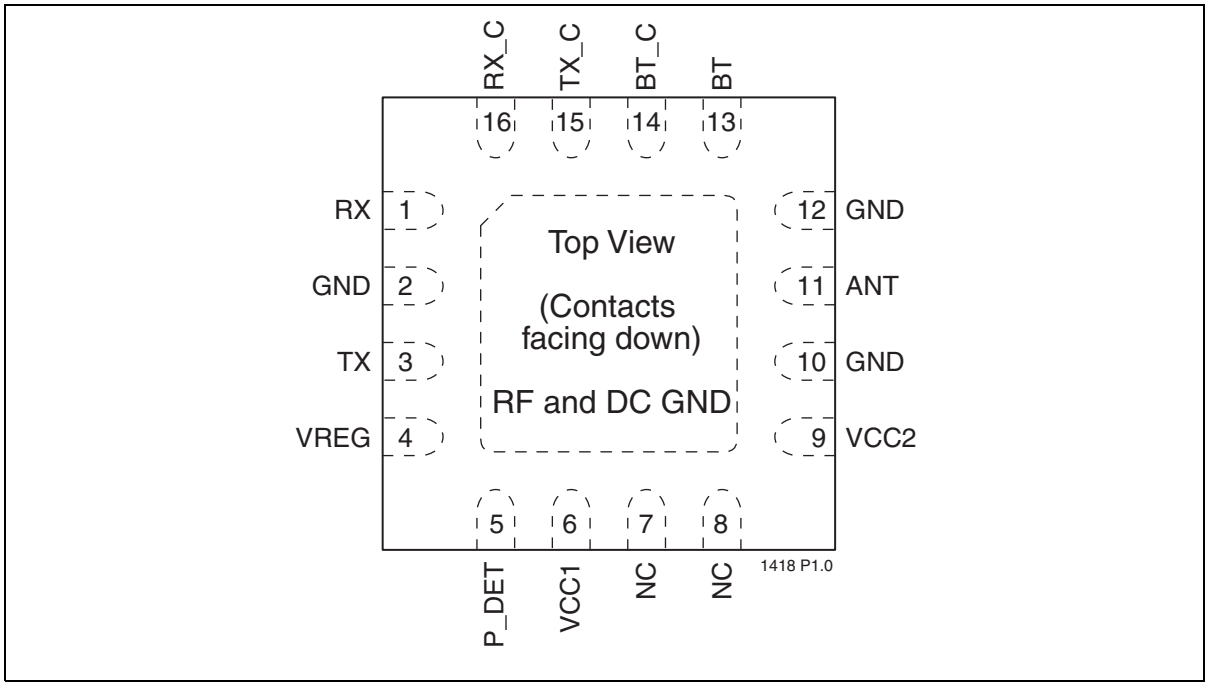

Figure 2: Pin Assignments for 16-contact XQFN

Pin Descriptions

Table 1: Pin Description

Symbol	Pin No.	Pin Name	Type[1]	Function
GND	0	Ground		Low inductance ground pad
RX	1		0	RF output for receive path, DC decoupled.
GND	2	Ground		Ground pad
TX	3		I	RF input for transmit path, DC decoupled
VREG	4		PWR	1st and 2nd stage idle current control
P_Det	5		O	On-chip power detector
VCC1	6	Power Supply	PWR	Power supply, 1st stage
NC	7	No Connection		Unconnected Pin
NC	8	No Connection		Unconnected Pin
VCC2	9	Power Supply	PWR	Power supply, 2nd stage
GND	10	Ground		Ground pad
ANT	11		I/O	RF input for receive path, and RF output for transmit path, DC decoupled
GND	12	Ground		Ground pad
BT	13		I/O	RF output for receive path, and RF input for transmit path, DC decoupled. Used for Bluetooth®
BT_C	14		PWR	Switch control pin for BT (bidirectional) path.
TX_C	15		PWR	Switch control pin for TX path
RX_C	16		PWR	Switch control pin for RX path

T1.0 75001

1. I=Input, O=Output

Electrical Specifications

The DC and RF specifications for the power amplifier are specified below. Refer to Table 3 for the DC voltage and current specifications. Refer to Figures 3 through 11 for the RF performance.

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.)

Input power to pin 3 (P_{IN}) . . . . . +5 dBm
Average output power from pin 11 (P_{OUT})[1] . . . . . +26 dBm
Supply Voltage at pins 6 and 9 (V_{CC}) . . . . . -0.3V to +4.0V
Reference voltage to pin 4 (V_{REF}) . . . . . -0.3V to +3.3V
DC supply current (I_{CC})[2] . . . . . 400 mA
Operating Temperature (T_A) . . . . . -40°C to +85°C
Storage Temperature (T_{STG}) . . . . . -40°C to +120°C
Maximum Junction Temperature (T_J) . . . . . +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 2: Operating Range

Range	Ambient Temp	V_{CC}
Extended	-20°C to +85°C	3.3V

Table 3: DC Electrical Characteristics at 25°C for TX Chain, 11g operation

Symbol	Parameter	Min.	Typ	Max.	Unit
V_{CC}	Supply Voltage at pins 6 and 9	3.0	3.3	3.6	V
I_{CQ}	Idle current. No RF input, PA biased for 18 dBm at 3% EVM		65		mA
V_{REG}	Reference Voltage	2.75	2.80	2.95	V
I_{CC}	Supply Current				
	for 11g OFDM 54 Mbps signal, P_{OUT} = 21 dBm		160		mA
	for 11b DSSS 1 Mbps signal, P_{OUT} = 21 dBm		165		mA

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Table 4: DC Electrical Characteristics at 25°C for TX Chain, 11n and 256 QAM operation

Symbol	Parameter	Min.	Typ	Max.	Unit
I_{CQ}	Idle current. No RF input, PA biased for 18 dBm at 3% EVM		80		mA
V_{REG}	Reference Voltage	2.90	2.95	3.00	V
I_{CC}	Supply Current				
	for 11n, MCS7, P_{OUT} = 17 dBm		120		mA
	for 256 QAM, MCS9 P_{OUT} = 16 dBm		110		mA

T4.1 75001

Table 5: RF Characteristics at 25°C for TX Chain, V_{CC}=3.3V, V_{REG}=2.80V

Symbol	Parameter	Min.	Typ	Max.	Unit	Test Condition
F_{L-U}	Frequency range	2412		2484	MHz	
G	Small signal gain	28	29		dB	TX and PA On
G_{VAR1}	Gain variation over band (2412–2484 MHz)			±0.5	dB	TX and PA On
G_{VAR2}	Gain ripple over channel (20 MHz)		0.2		dB	TX and PA On
P_{OUT}	Output power meets 11g OFDM 6 Mbps spectrum mask	20	21		dBm	TX and PA On
	Output power meets 11b DSSS 1 Mbps spectrum mask	20	21		dBm	TX and PA On
EVM	@ 18 dBm output power with 11g OFDM 54 Mbps signal		3		%	TX and PA On
	@ 17 dBm output power, MCS7-HT40		2.5		%	TX and PA On V_{REG}=2.95V
	@ 16 dBm output power, MCS9-HT40		1.8		%	TX and PA On V_{REG}=2.95V
2f, 3f, 4f, 5f	Harmonics at 22 dBm, without external filters			-35	dBc	TX and PA On
ISO1	Isolation (TX to RX)		-12		dB	TX and PA On
ISO2	Isolation (TX to BT)		-10		dB	TX and PA On
ISO3	Isolation (RX to TX)		-30		dB	TX and PA On
ISO4	Isolation (BT to TX)		-50		dB	TX and PA On

T5.0 75001

Table 6: RF Characteristics at 25°C for RX Chain

Symbol	Parameter	Min.	Typ	Max.	Unit	Test Condition
F_{L-U}	Frequency range	2412		2484	MHz	
IL	Insertion Loss (ANT to RX)[1]		0.5	0.8	dB	RX On
	Insertion Loss with BT enabled		4.5		dB	RX and BT On
RL	Return Loss			-10	dB	RX On
ISO1	Isolation (RX to BT) & (BT to RX)		-20		dB	RX On
ISO2	Isolation (RX to TX) & (TX to RX)		-30		dB	RX On

T6.0 75001

1. The evaluation board's loss is de-embedded and excluded from this number.

Table 7: RF Characteristics at 25°C for BT Chain

Symbol	Parameter	Min.	Typ	Max.	Unit	Test Condition
F_{L-U}	Frequency range	2412		2484	MHz	
IL	Insertion Loss (ANT to BT)[1]		0.5	0.8	dB	BT On
	Insertion Loss with RX enabled		3.8		dB	BT and RX On
RL	Return Loss			-10	dB	BT On
ISO1	Isolation (BT to RX) & (RX to BT)		-18		dB	BT On
ISO2	Isolation (BT to TX) & (TX to BT)		-48		dB	BT On

T7.0 75001

1. The evaluation board's loss is de-embedded and excluded from this number.

Table 8: Switch Control Logic[1]

RX_C	TX_C	BT_C	Mode
H	L	H	RX and BT
H	L	L	RX
L	H	L	TX
L	L	H	BT

T8.0 75001

1. For RX_C, TX_C, and BT_C, H = 3.3V and L = 0V.

Typical Performance Characteristics

Test Conditions: V_{CC} = 3.3V, T_A = 25°C, unless otherwise specified

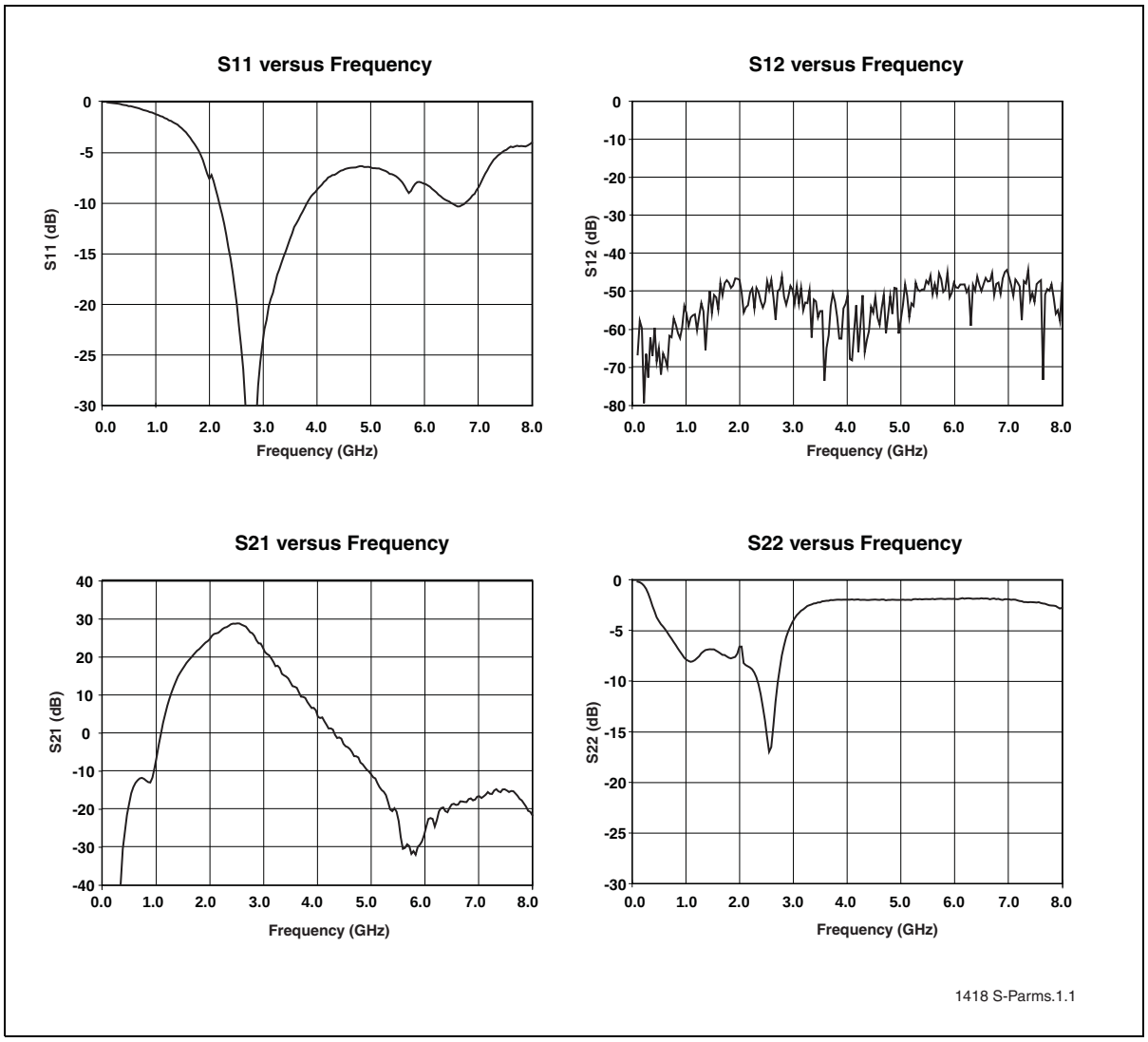


Figure 3: S-Parameters for TX Chain

Typical Performance Characteristics

Test Conditions: V_{CC} = 3.3V, T_A = 25°C, 54 Mbps 802.11g OFDM Signal

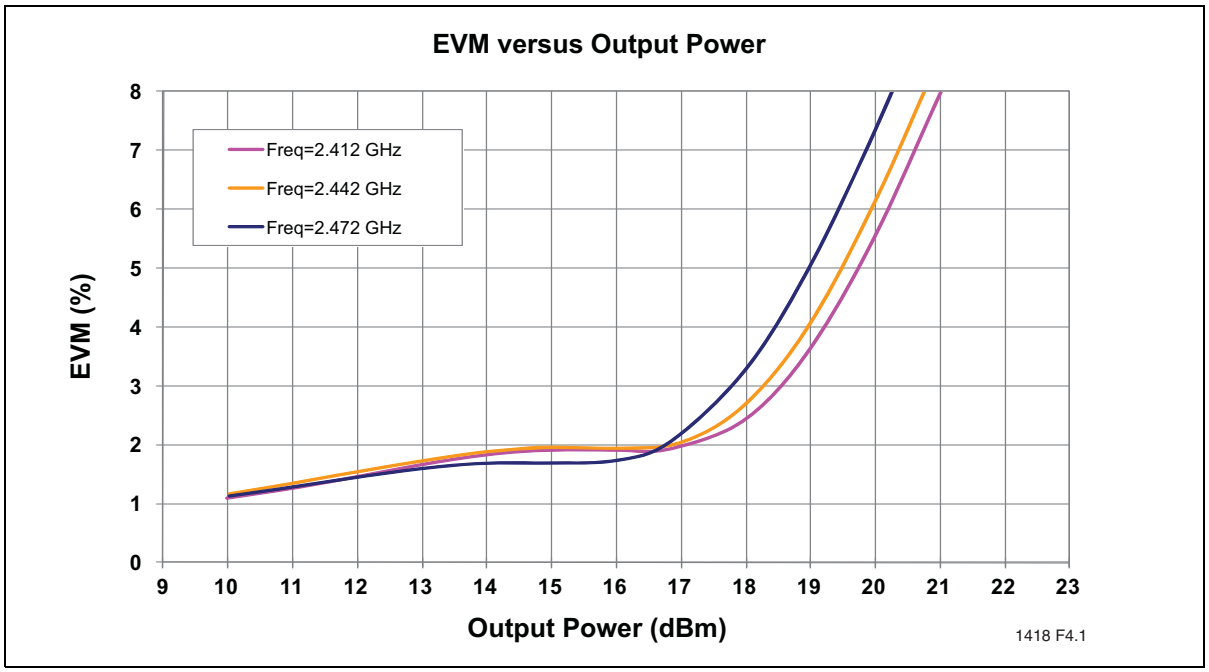


Figure 4: EVM versus Output Power measured with Equalizer training using Sequence only

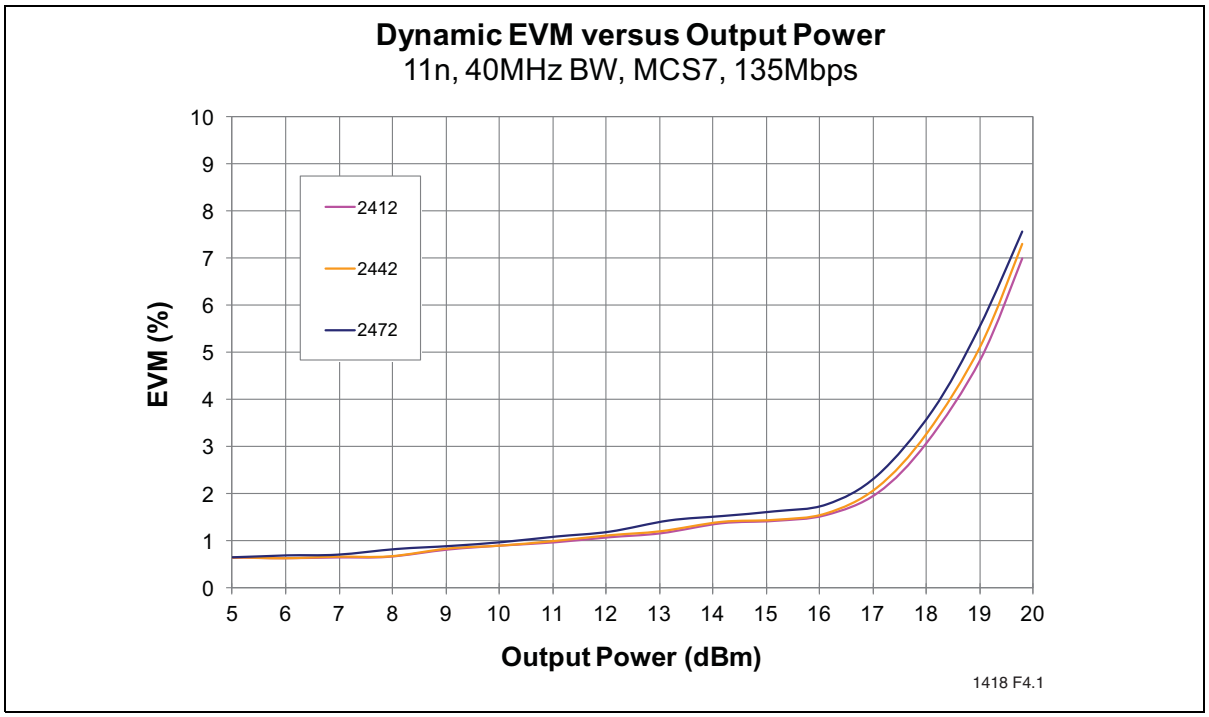


Figure 5: Dynamic EVM vs Output Power for MCS7-HT40 Modulation

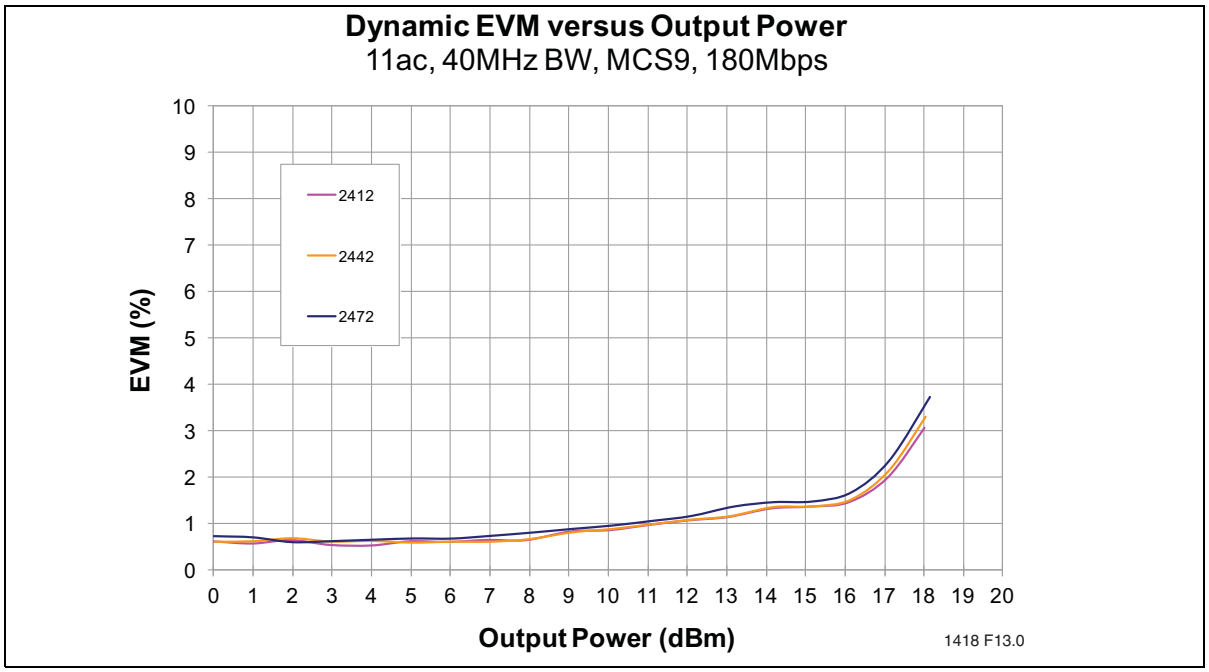


Figure 6: Dynamic EVM vs Output Power for MCS9-HT40 Modulation

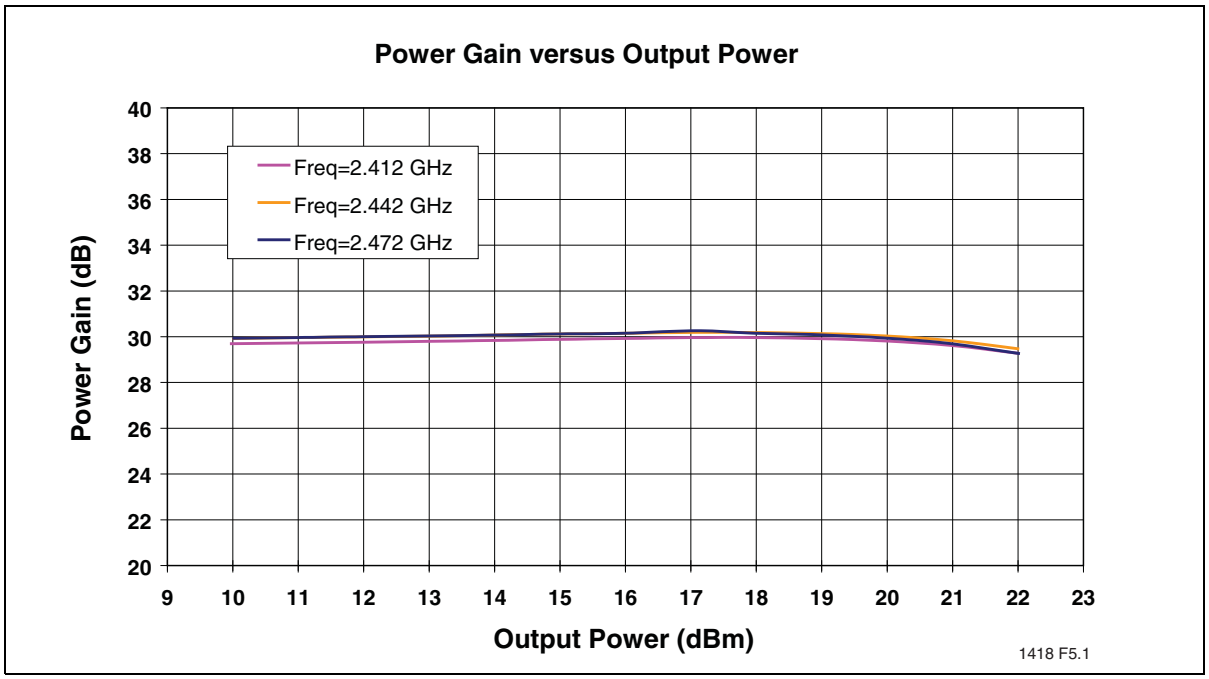


Figure 7: Power Gain versus Output Power

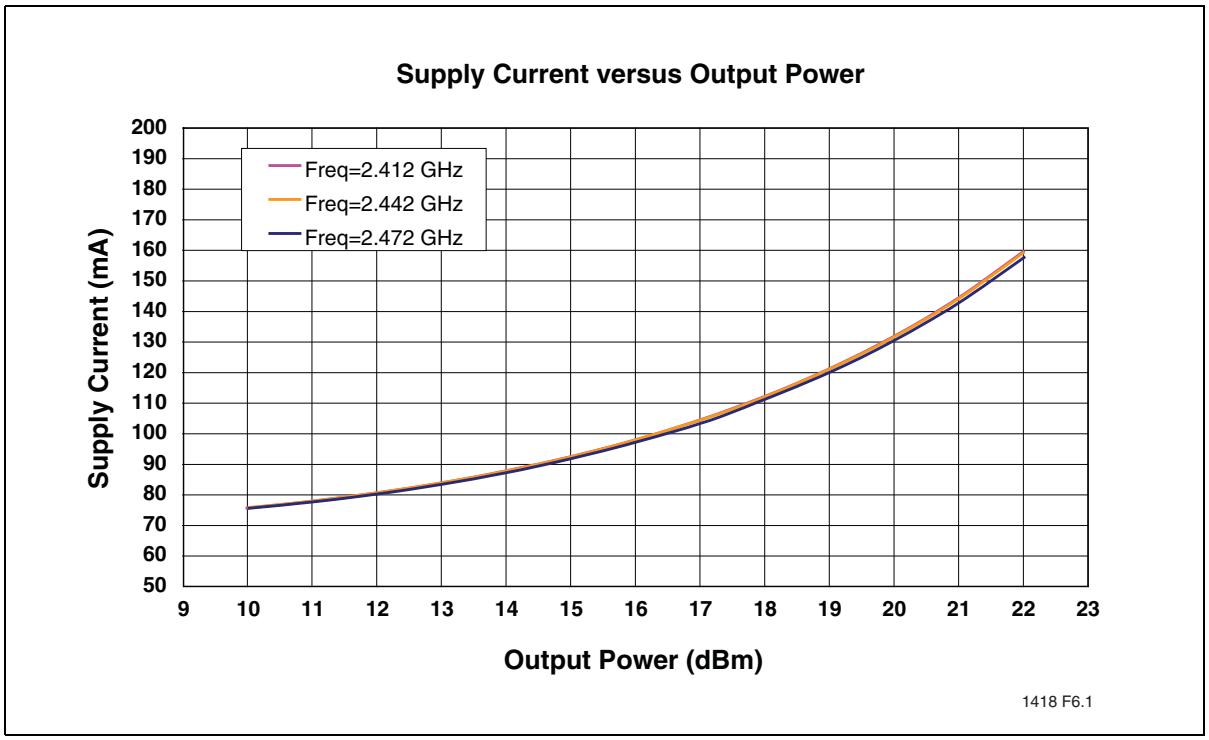


Figure 8: Total Current Consumption for 802.11g operation versus Output Power

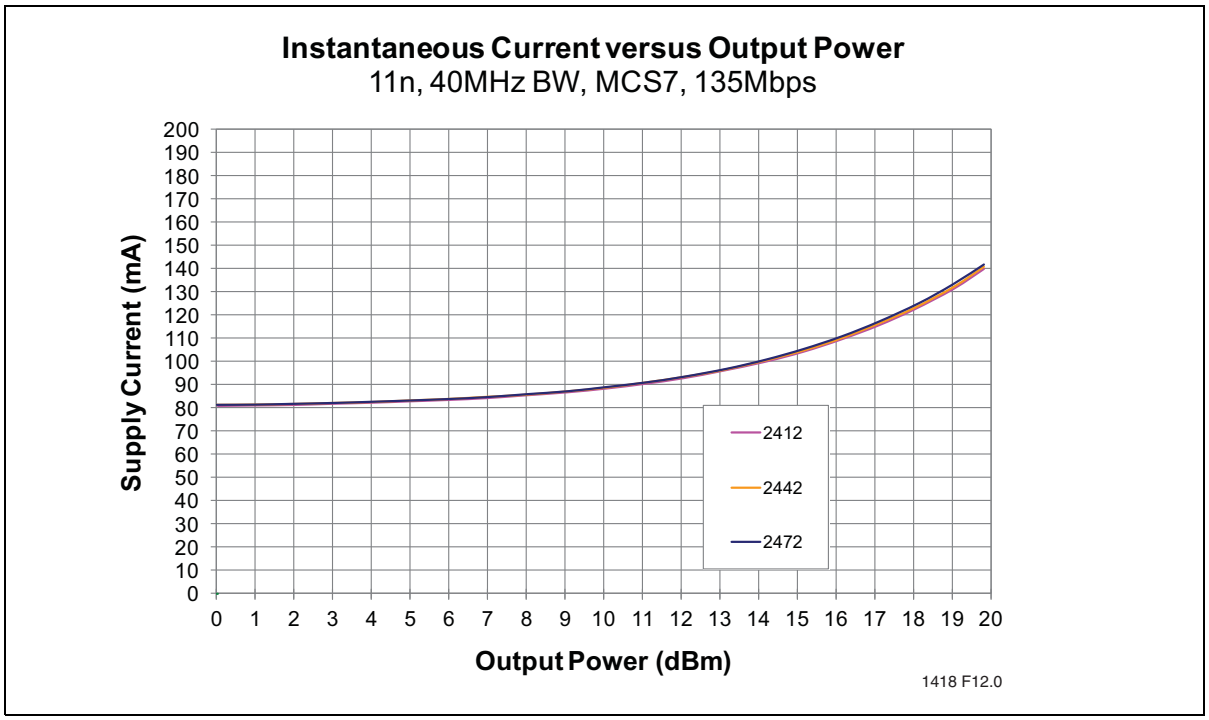


Figure 9: Total Current Consumption for 11n and 256 QAM Operations

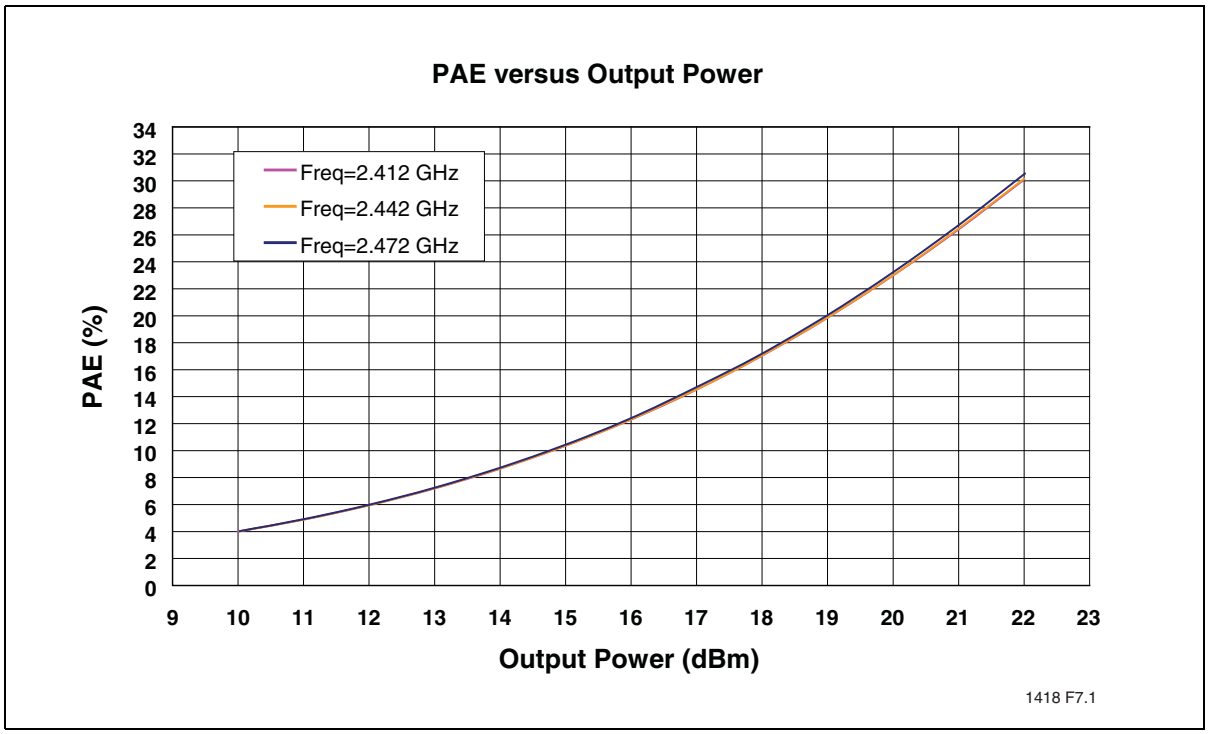


Figure 10: PAE versus Output Power

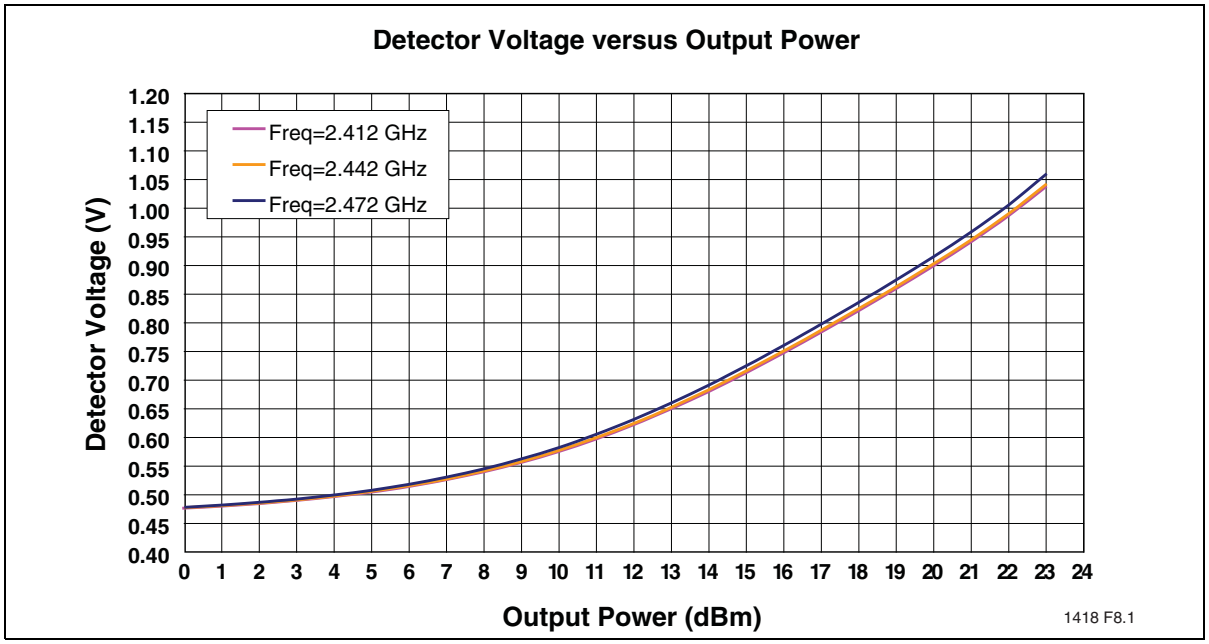


Figure 11: Detector Characteristics versus Output Power

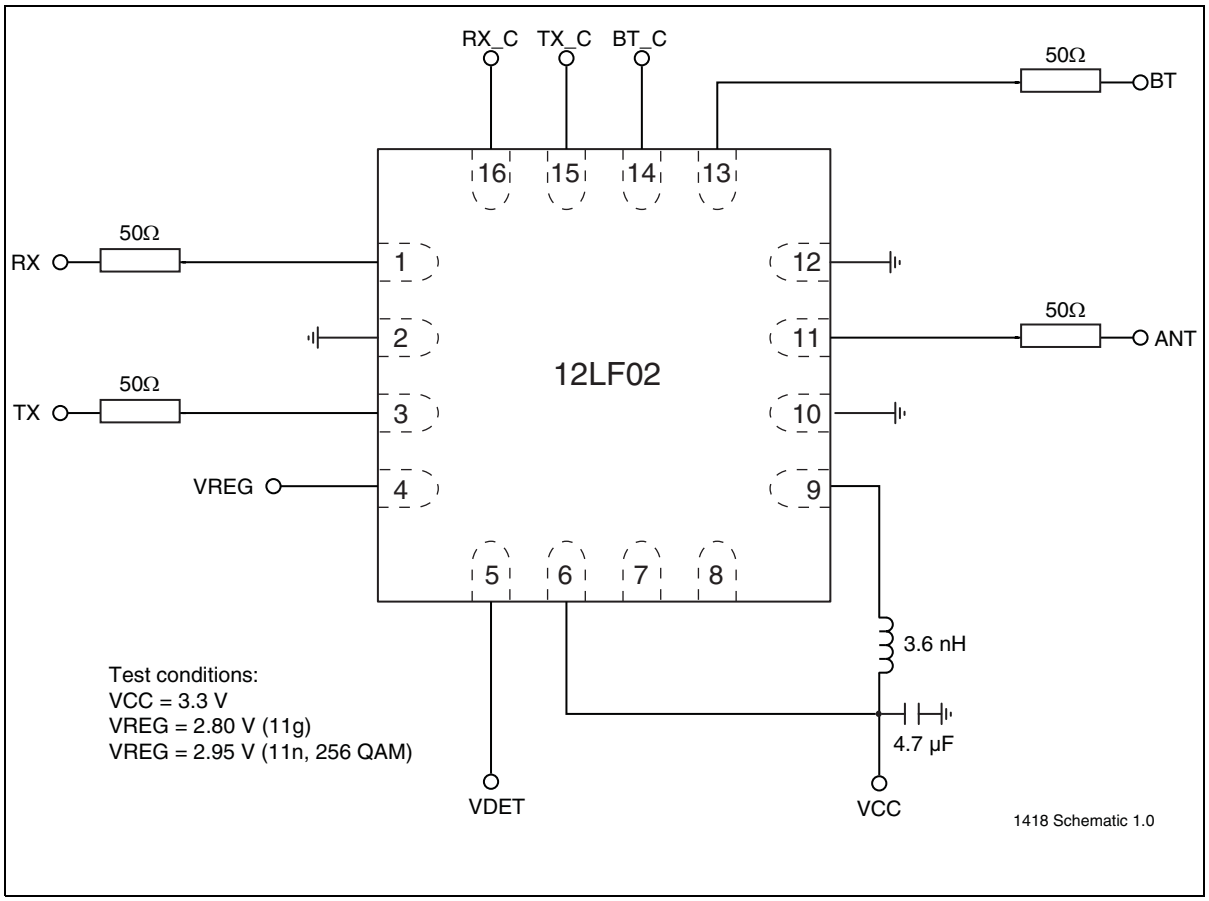
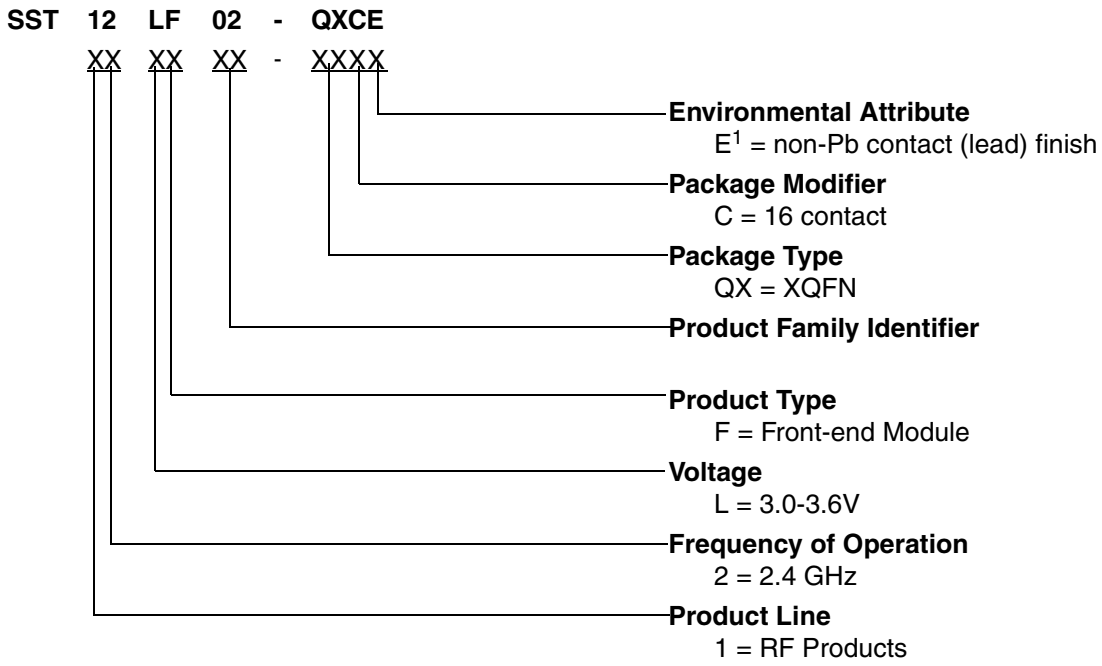


Figure 12: Typical Schematic for High-Efficiency 802.11b/g/n Applications

Product Ordering Information



1. Environmental suffix “E” denotes non-Pb solder. Non-Pb solder devices are “RoHS Compliant”.

Valid combinations for SST12LF02

SST12LF02-QXCE

SST12LF02 Evaluation Kits

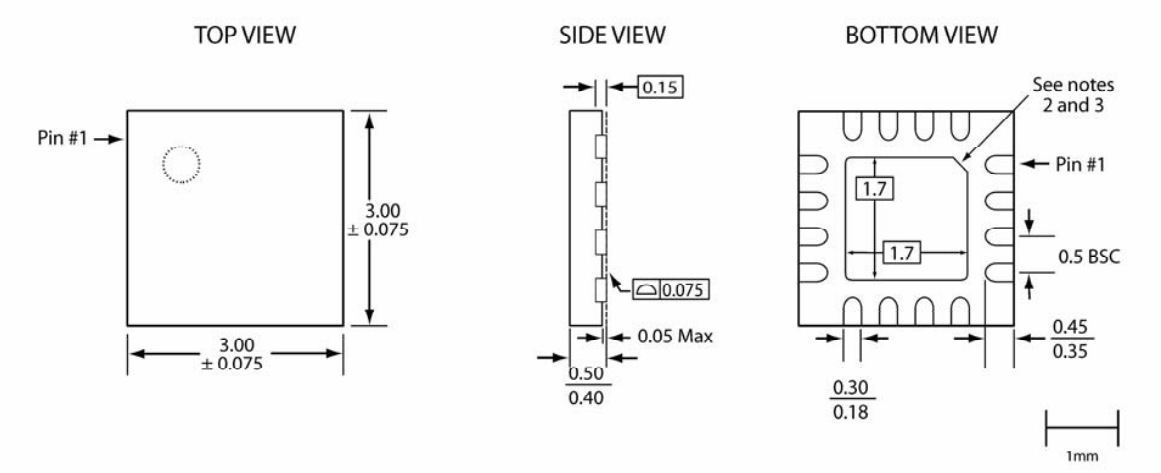
SST12LF02-QXCE-K

Note: Valid combinations are those products in mass production or will be in mass production. Consult your Microchip sales representative to confirm availability of valid combinations and to determine availability of new combinations.

Packaging Diagrams

16-Lead Extremely Thin Quad Flatpack No-Leads (QXCE/F) - 3x3 mm Body [XQFN]

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



16-xqfn-3x3-QXC-1.0

Note:
1. Complies with JEDEC JEP95 MO-248, variant XEED-4 except external paddle nominal dimensions.
2. From the bottom view, the pin #1 indicator may be either a 45-degree chamfer or a half-circle notch.
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 requiresd 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 C04-14018A Sheet 1 of 1

Table 9: Revision History

Revision	Description	Date
00	• Initial release of data sheet	Feb 2010
01	• Updated SST Address. • Revised WLAN information to include 802.11b/g/n. • Minor update to Table 4.	July 2010
02	• Updated “Features” on page 1 and Table 5 on page 7 • Applied new document format	Jan 2011
A	• Updated “Features” on page 1 • Removed a column from Table 3 on page 6 • Updated Figure 8 on page 12 • Released document under the letter revision system • Updated document from spec S71418 to DS-75001	Mar 2011
B	• This revision was never released	
C	• Updated “Features” on page 1 • Corrected voltage names from VRX, VTX, and VBT to RX_C, TX_C, BT_C • Updated Figure 4 and Table 5	Mar 2014
D	• Updated “Features” on page 1 • Added Figures 5, 4, and 9 • Added Table 4 on page 6 and revised Table 5 on page 7 • Edited Figure 12 on page 14	Jan 2015

ISBN:978-1-63276-995-4