A Microchip Technology Company

2.4 GHz High-Gain, High-Efficiency Front-end Module

SST12LF03

Data Sheet

The SST12LF03 is a completely integrated Front-End Module (FEM) for WLAN 802.11b/g/n and Bluetooth® systems. The SST12LF03 RF modules includes a PA, a LNA, and an antenna switch, making it ideal for WLAN/BT embedded applications where small size and high performance are required. Designed in compliance with IEEE 802.11 b/g/n applications and based on GaAs PHEMT/HBT technology, the SST12LF03 operates within the frequency range of 2.4- 2.5 GHz with a very low DC-current consumption. The Transmitter chain has excellent linearity, typically 3% added EVM up to 19 dBm output power for 54 Mbps 802.11g operation, while meeting 802.11b spectrum mask at 22 dBm. The receiver chain provides a low noise amplifier and has options for LNA bypass and simultaneous WLAN and Bluetooth operation.The SST12LF03 is offered in a 20-contact UQFN package.

Features

- **Input/output ports are matched to 50Ω internally and DC decoupled.**
- **Packages available**
  - 16-contact UQFN – 3mm x 3mm x 0.55mm
- **All non-Pb (lead-free) devices are RoHS compliant**

Transmitter Chain:

- **High gain:**
  - Typically 28 dB gain across 2.4–2.5 GHz over temperature -20°C to +85°C for Transmitter.
- **High linear output power:**
  - Meets 802.11g OFDM ACPR requirement up to 21 dBm
  - 3% added EVM up to 19 dBm for 54 Mbps 802.11g signal
  - Meets 802.11b ACPR requirement up to 22 dBm
- **High power-added efficiency/Low operating current for 802.11b/g/n applications**
  - ~25% @ P_{OUT} = 22 dBm for 802.11b/g
- **Low I_{REF} power-up/down control**
  - I_{REF} <2 mA
- **Low quiescent current**
  - ~55 mA I_{CQ}
- **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 power variation between -20°C to +85°C
  - ~2 dB gain variation between -20°C to +85°C
- **Linear on-chip power detector**
  - >20 dB dynamic range, temperature-stable, on-chip power detection

Receiver Chain:

- **LNA active gain:**
  - Typically 10 dB.
- **Low-noise receiver with LNA active**
  - 3.1 dB noise figure
  - >5dB P1dB
- **Low loss LNA bypass mode with simultaneous BT**
  - Typically 5.5 dB

Bluetooth Path:

- **Low-loss path:**
  - Typically 3dB.
- **Simultaneous BT/WLAN gain:**
  - 8 dB
- **Simultaneous BT/WLAN noise figure:**
  - 3.1 dB

Applications

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

Product Description

The SST12LF03 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 28 dB gain with 25% power-added efficiency (PAE) @ POUT = 22 dBm for 802.11g 802.11b

The TX chain has excellent linearity, typically ~3% added EVM at 19 dBm output power for 54 Mbps 802.11g operation, while meeting 802.11g spectrum mask at 22 dBm.

The SST12LF03 also features easy board-level usage along with high-speed power-up/down controls. Ultra-low reference current (total I_{REF} ~2 mA) makes the SST12LF03 controllable by an on/off switching signal directly from the baseband chip. These features, coupled with low operating current, make the SST12LF03 ideal for the final stage power amplification in battery-powered 802.11b/g/n WLAN transmitter applications.

The SST12LF03 has a linear on-chip, single-ended power detector, which features a temperature-stable and wide, linear dynamic range greater than 20 dB. The excellent on-chip power detector provides a reliable solution to board-level power control. In addition, the receiver path includes an LNA, has the option for simultaneous WLAN and Bluetooth operation, and an optional low-loss LNA bypass path. In WLAN operating mode, the receiver provides typically 10 dB gain and only 3.1 dB noise figure and >5 dB P1dB. Operating with simultaneous WLAN/BT, the receiver will provide both the WLAN and Bluetooth ports with 8 dB gain and only 3.1 dB noise figure. Operating in LNA bypass mode, both the RX and BT ports will have typically 5.5 dB loss.

All input/output RF ports are single-ended and internally matched to 50 Ω.. These RF ports are DC decoupled; no external DC-blocking capacitors or matching components are necessary. This helps reduce the system board Bill of Materials (BOM) cost.

The SST12LF03 is offered in a 20-contact UQFN package. See Figure 2 for pin assignments and Table 1 for pin descriptions.

Functional Blocks

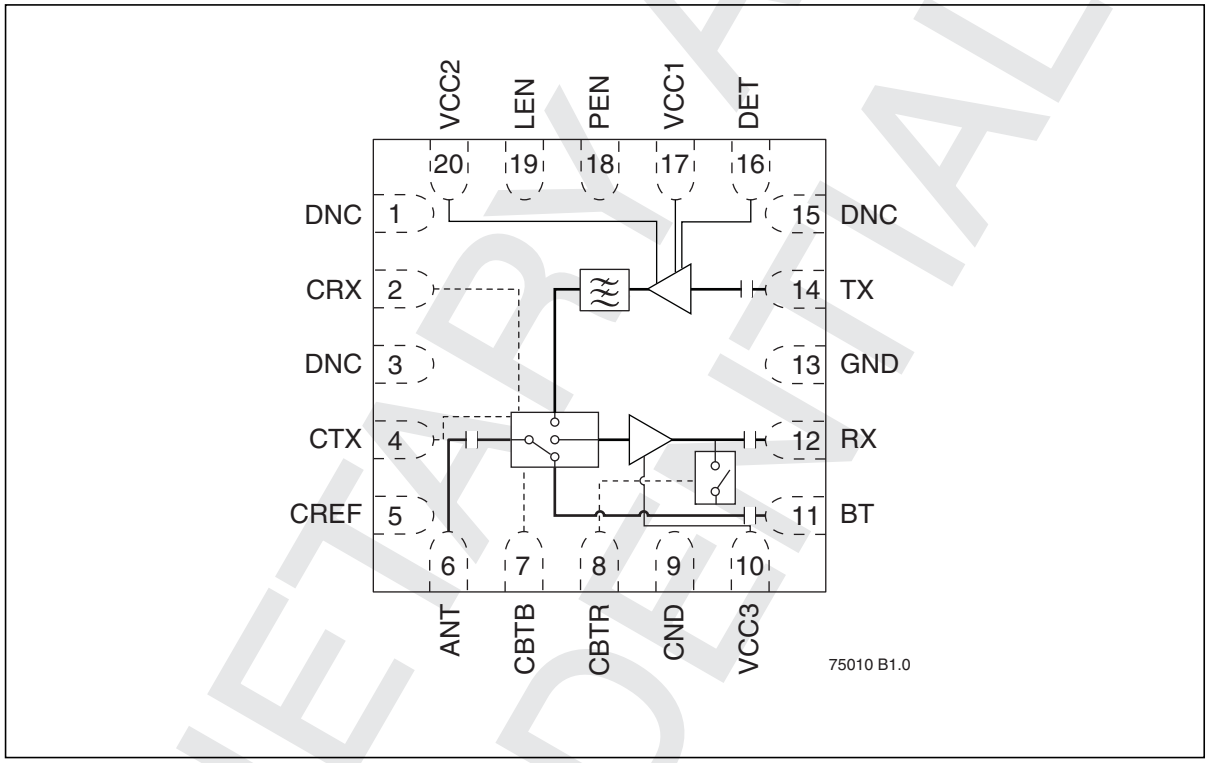


Figure 1: Functional Block Diagram

Pin Assignments

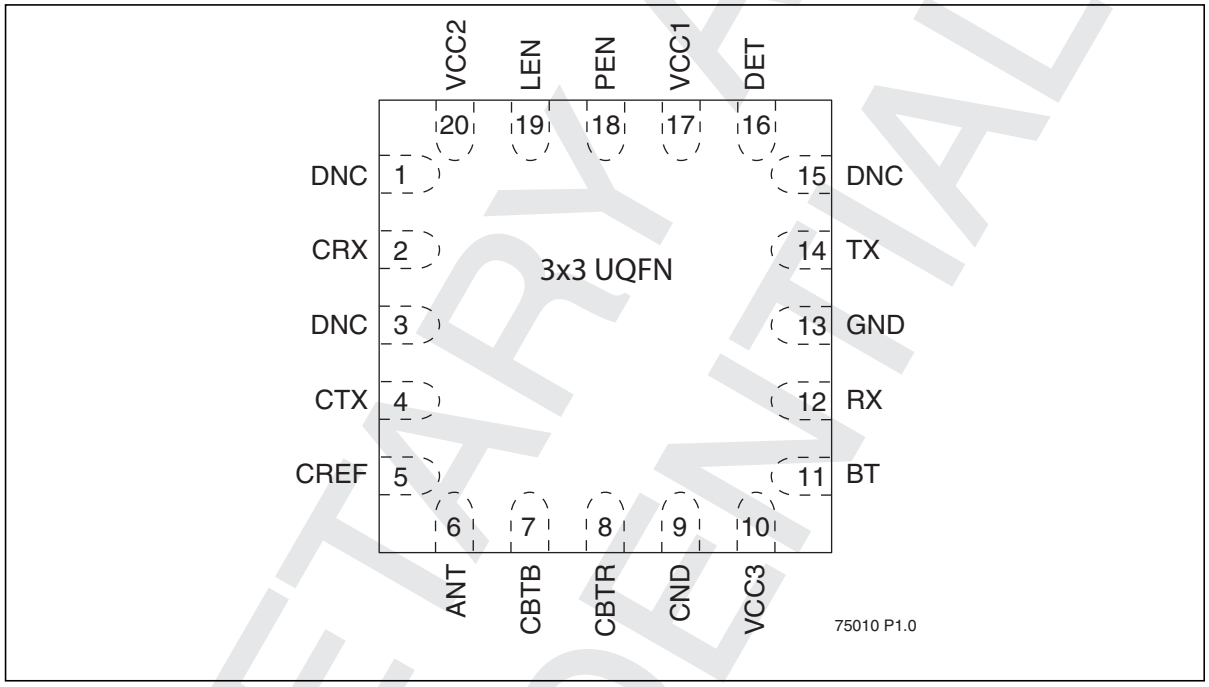


Figure 2: Pin Assignments for 20-contact UQFN

Pin Descriptions

Table 1: Pin Description

Symbol	Pin No.	Pin Name	Type[1]	Function
DNC	1	Do Not Connect		Do not connect to this pin
CRX	2			WLAN Receive Antenna Switch control
DNC	3	Do Not Connect		Do not connect to this pin
CTX	4	C_{TX}		WLAN Transmit Antenna Switch control
CREF	5	C_{REF}		Control pin reference high-level input
ANT	6	Antenna	I/O	Antenna port, AC coupled
CBTB	7	C_{BTB}		BT antenna switch control
CBTR	8	C_{BTR}		Switch control for simultaneous BT/RX
GND	9	Ground		Ground pin
VCC3	10	V_{CC3}	PWR	LNA power supply
BT	11			BT port, AC coupled
RX	12	R_X	I	WLAN receive port, AC coupled
GND	13	Ground		Ground pin
TX	14	T_X	O	WLAN transmit port, AC coupled
DNC	15	Do Not Connect		Do not connect to this pin
DET	16			WLAN transmit power detector
VCC1	17	V_{CC1}		WLAN power amplifier power supply #1
PEN	18			WLAN PA enable
LEN	19			LNA enable
VCC2	20	V_{CC2}	PWR	WLAN power amplifier power supply #2
Center	GND	Ground		Ground pin

T1.0 75010

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 9 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

Symbol	Parameter	Min.	Typ	Max.	Unit
V_{CC}	TX Supply Voltage at pins 6 and 9	3.0	3.3	4.2	V
I_{CQ}	TX Idle current for 802.11g to meet EVM ~3% @ 18 dBm		55		mA
V_{REG}	TX Reference Voltage	2.75	2.80	2.95	V
PEN	PA Enabled; PA Off			2.0	V
I_{CC}	TX Supply Current				
	for 11g OFDM 54 Mbps signal, P_{OUT} = 22 dBm		175		mA
	for 11b DSSS 1 Mbps signal, P_{OUT} = 22 dBm		185		mA
V_{DD}	LNA Supply Voltage at pin 10	3.0	3.3	4.2	V
I_{DD}	LNA Supply Current		10		mA
V_{CNTL}	Control Voltage logic high, CRX, CTX, CBTB, LEN	2.8	3.3	V_{CC}	V
	Control Voltage logic log	0		1.5	V

T3.1 75010

Table 4: TX Chain WLAN RF Characteristics

Symbol	Parameter	Min.	Typ	Max.	Unit	Test Condition
F_{L-U}	Frequency range	2412		2484	MHz	
G	Small signal gain	26	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	22		dBm	TX and PA On
	Output power meets 11b DSSS 1 Mbps spectrum mask	20	22		dBm	TX and PA On
Added EVM	@ 19 dBm output power with 11g OFDM 54 Mbps signal		3		%	TX and PA On
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

T4.0 75010

Table 5: RX Chain WLAN RF Characteristics

Symbol	Parameter	Min.	Typ	Max.	Unit	Test Condition
F_{L-U}	Frequency range	2412		2484	MHz	
G_{ON}	Gain with LNA on	10	12		dB	LEN=CRX=High PEN=CTX=CBTB=CBTR=Low
P1dB	Receiver 1 dB compression		5		dBm	LEN=CRX=High PEN=CTX=CBTB=CBTR=Low
G_{ONS}	Gain with LNA on and simultaneous BT	7	8		dB	LEN=CRX=High PEN=CTX=CBTB=Low
IL_S	Insertion loss with LNA bypassed to BT and RX simultaneous		5.5		dB	CBTB=CBTR=High PEN=CTX=CRX=LEN=Low
NF_{ON}	Noise figure with LNA on		3.1		dB	LEN=CRX=High PEN=CTX=CBTB=CBTR=Low
NF_{ONS}	Noise figure with LNA on and simultaneous BT		3.1		dB	LEN=CRX=High PEN=CTX=CBTB=Low
I_{DD}	Receiver supply current with LNA on		15		mA	LEN=High
ISO_{BT-RX}	Isolation BT to RX		17		dB	LEN=CRX=High PEN=CTX=CBTB=CBTR=Low
ISO_{BT-TX}	Isolation TX to RX with TX on		25		dB	LEN=CRX=High PEN=CTX=CBTB=CBTR=Low
RL_{ANT}	Receiver input return loss at the antenna with LNA on		12		dB	LEN=CRX=High PEN=CTX=CBTB=CBTR=Low
RL_{RX}	Receiver output return loss with WLAN only		12		dB	LEN=CRX=High PEN=CTX=CBTB=CBTR=Low
RX_{RXS}	Receiver output return loss with simultaneous WLAN/BT		10		dB	LEN=CRX=High PEN=CTX=CBTB=Low

T5.0 75010

Table 6: Bluetooth Chain RF Characteristics

Symbol	Parameter	Min.	Typ	Max.	Unit	Test Condition
F_{L-U}	Frequency range	2412		2484	MHz	
IL	Loss: antenna to BT		3	4	dB	CBTB=High LEN=PEN=CTX=CRX=CBTR=Low
IL_S	Loss: Antenna to BT and RX simultaneous		5.5			CBTB=High LEN=PEN=CTX=CRX=Low
G_{ONS}	Gain with LNA on and simultaneous BT	7	8		dB	LEN=CRX=CBTR=High PEN=CTX=CBTB=Low
NF_{ONS}	Noise figure with LNA on and simultaneous BT		3.1		dB	LEN=CRX=CBTR=High PEN=CTX=CBTB=Low
I_{DD}	Receiver supply current with LNA on		15		mA	LEN=High
RL_{ANT}	Receiver input return loss at the antenna with LNA on		12		dB	CBTB=High PEN=CTX=CBTR=LEN=CRX=Low
RL_{RX}	Receiver output return loss with WLAN only		12		dB	CBTB=High PEN=CTX=CBTR=LEN=CRX=Low
RX_{RXS}	Receiver output return loss with simultaneous WLAN/BT		8		dB	CBTB=CBTR=High PEN=CTX=LEN=CRX=Low

T6.0 75010

Table 7: Switch Control Logic

Mode	CTX	CRX	CBTB	CBTR	PEN	LEN
All Off	L	L	L	L	L	L
Bluetooth On	L	L	H	L	L	H
WLAN TX On	H	L	L	L	H	L
WLAN RX On	L	H	L	L	L	H
Simultaneous WLAN/BT Rx On WLAN: High gain, BT: Low gain	L	H	L	H	L	H
Simultaneous WLAN/BT Rx Off WLAN: Low gain, BT: Low gain	L	L	H	H	L	L
Simultaneous WLAN/BT Rx On WLAN: High gain, BT: High gain	L	H	H	L	L	H

T7.0 75010

Typical WLAN Transmitter Performance Characteristics

Test Conditions: V_{CC} = 3.3V, CTX=PEN=High, CRX = CBTB=CBTR=Low, T_A = 25°C, unless otherwise specified

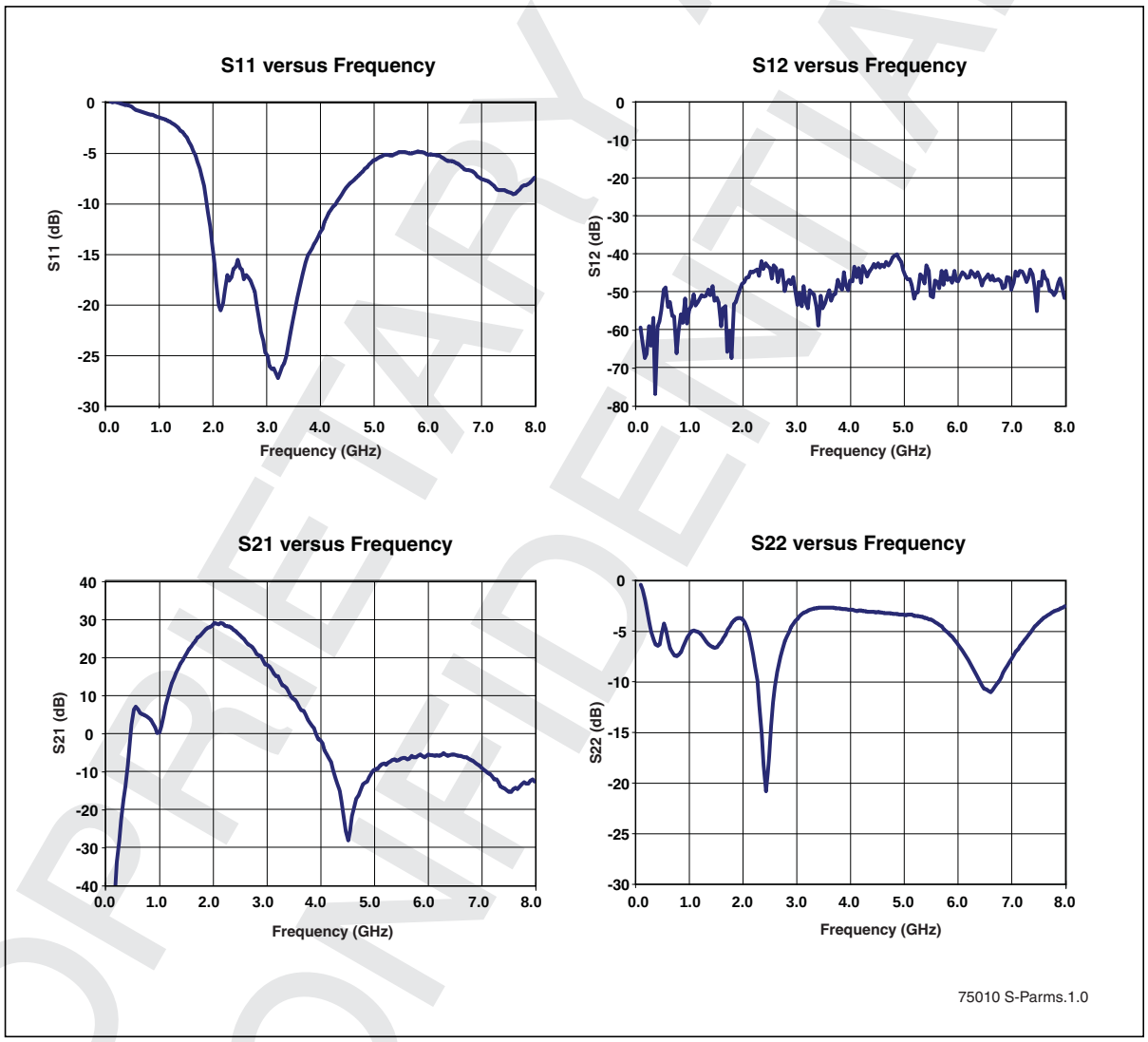


Figure 3: S-Parameters for WLAN Transmitter

Typical WLAN Transmitter Performance Characteristics

Test Conditions: V_{CC} = 3.3V, T_A = 25°C, 54 Mbps 802.11g OFDM Signal Equalizer Training Setting using Channel Estimation Sequence and Data

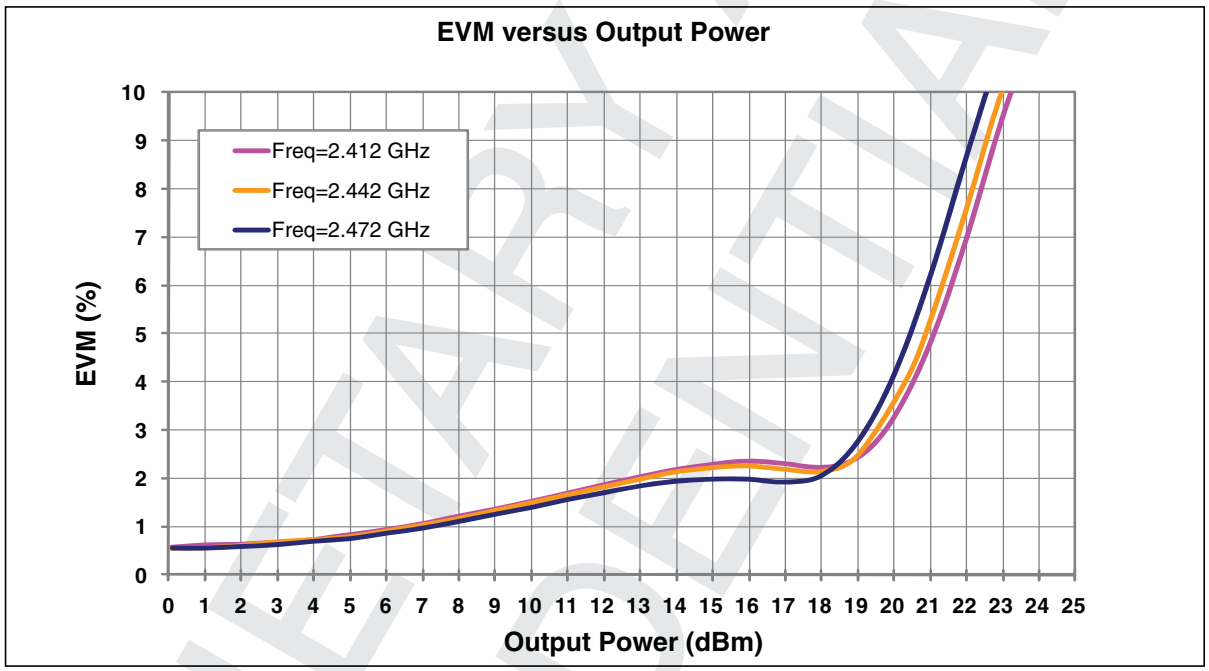


Figure 4: WLAN Tx EVM with 802.11g OFDM 54 Mbps

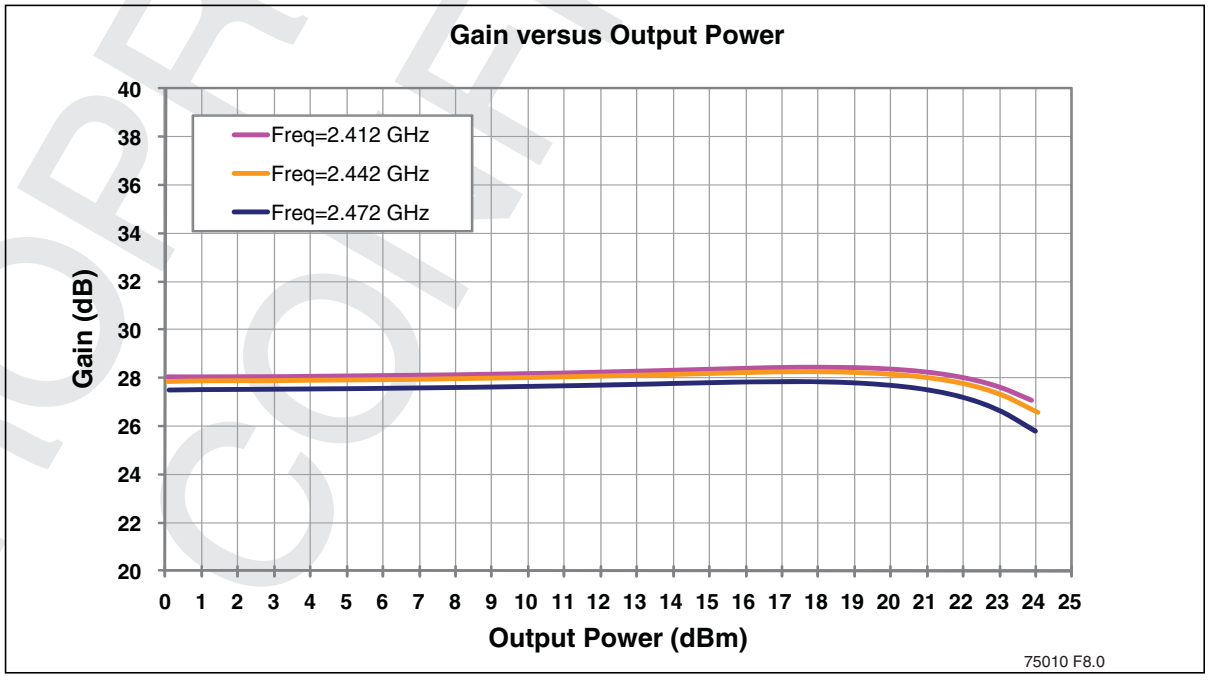


Figure 5: WLAN Tx Gain with 802.11g OFDM 54 Mbps

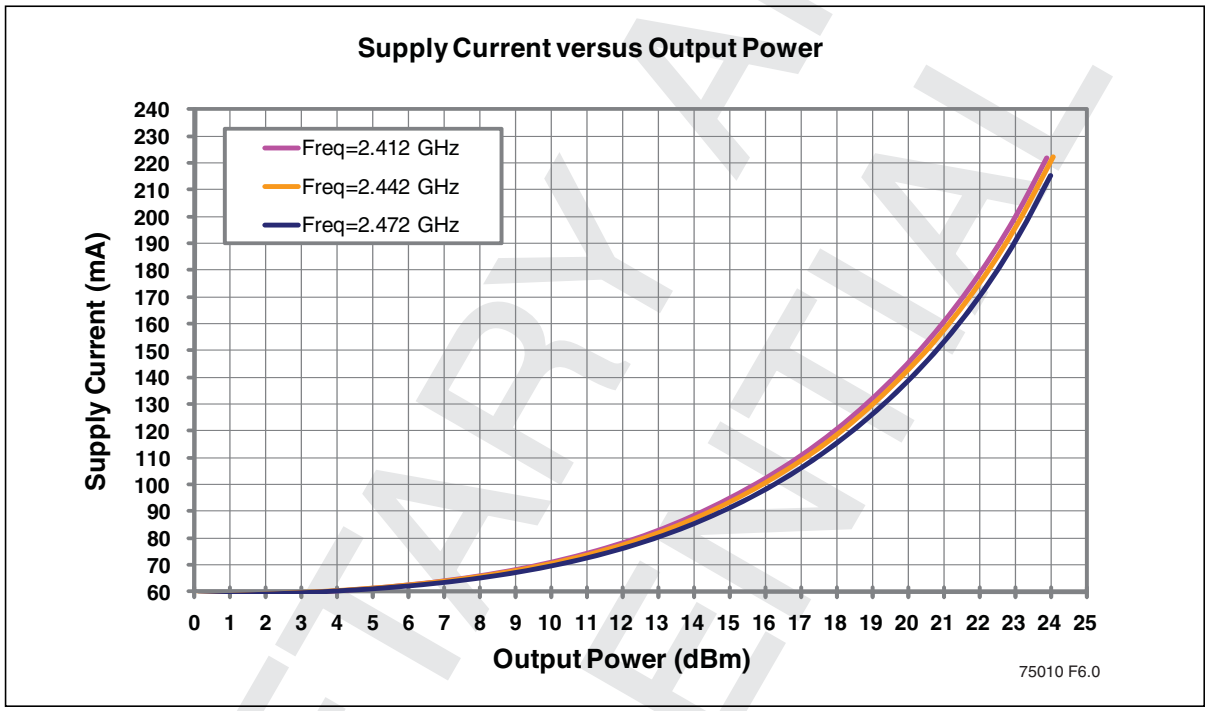


Figure 6: WLAN Tx Supply Current with 802.11g OFDM 54 Mbps

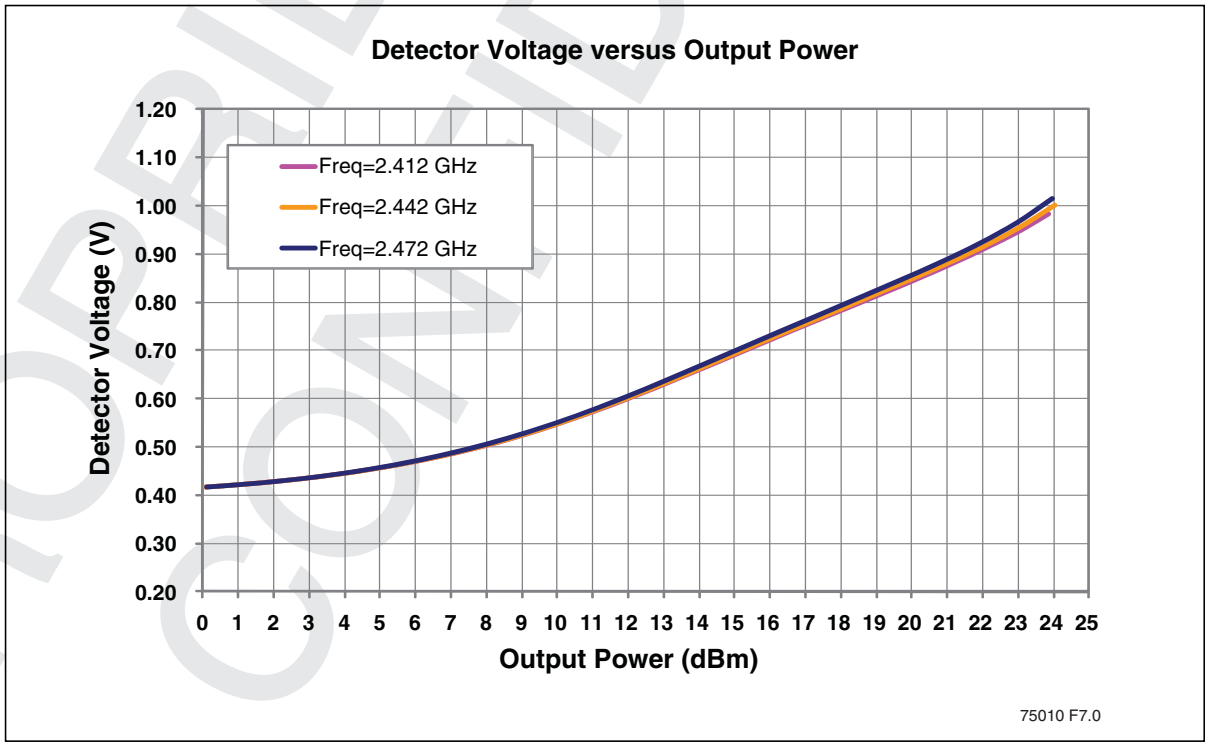


Figure 7: WLAN Tx Detector Voltage with 802.11g OFDM 54 Mbps

Typical WLAN Receiver Performance Characteristics

Test Conditions: V_{DD} = 3.3V, CRX=LEN=High, CTX = CBTB=CBTR=Low, T_A = 25°C, unless otherwise specified

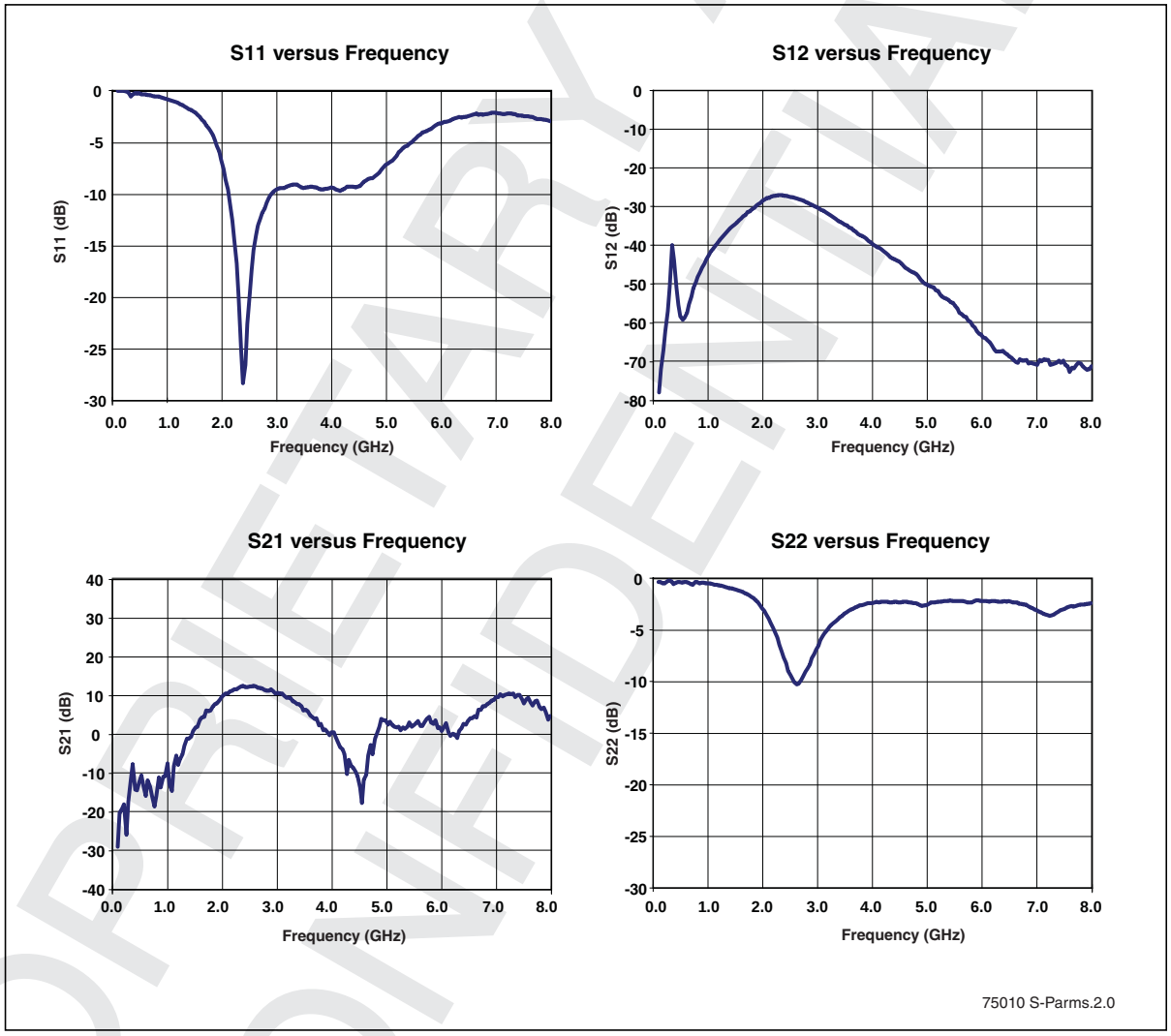


Figure 8: WLAN Receiver Gain

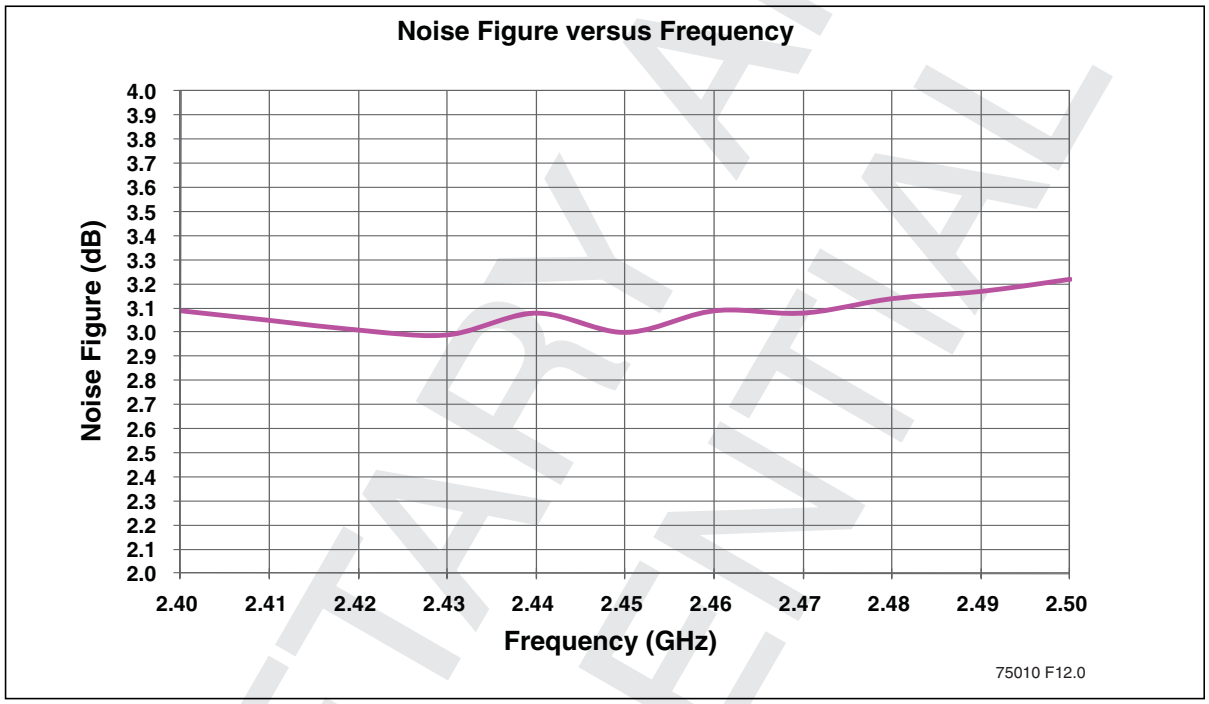


Figure 9: WLAN Rx Noise Figure

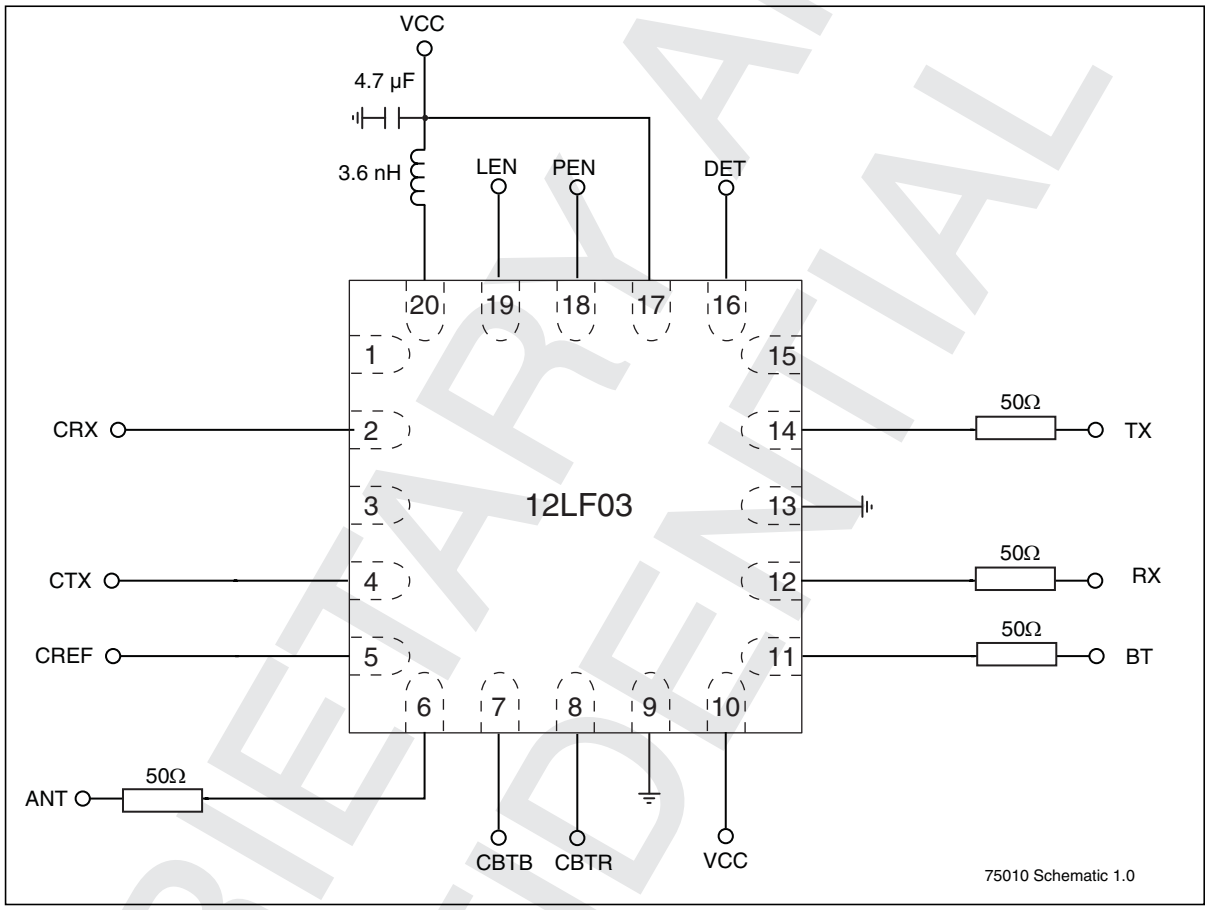
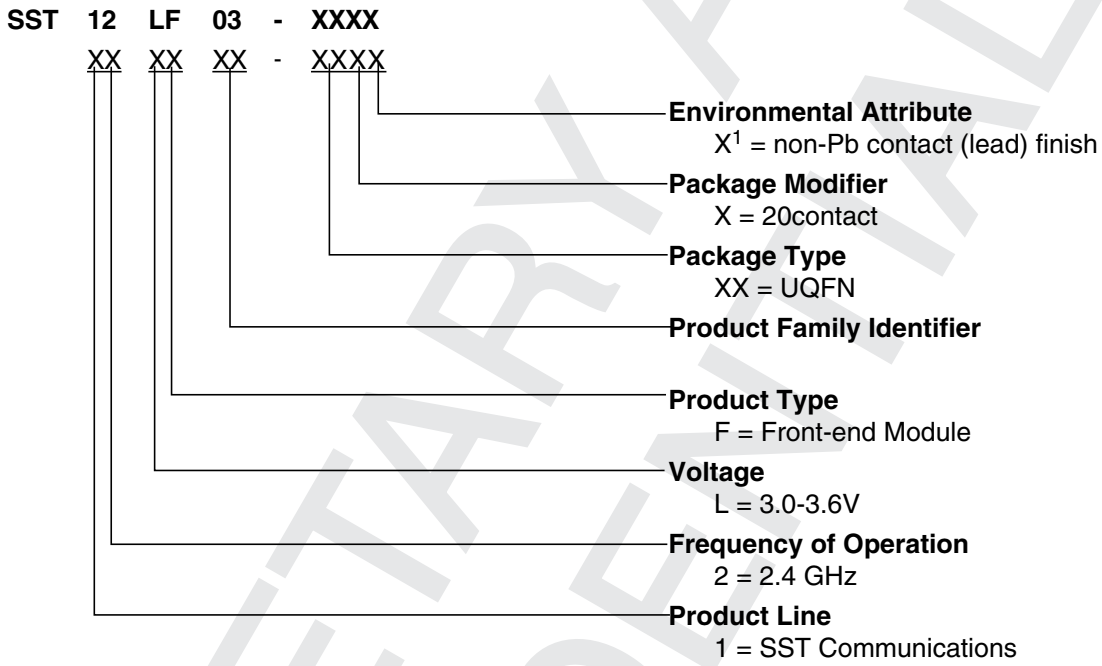


Figure 10: Typical Schematic for High-Efficiency 802.11b/g/n Applications

Product Ordering Information



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

Valid combinations for SST12LF03

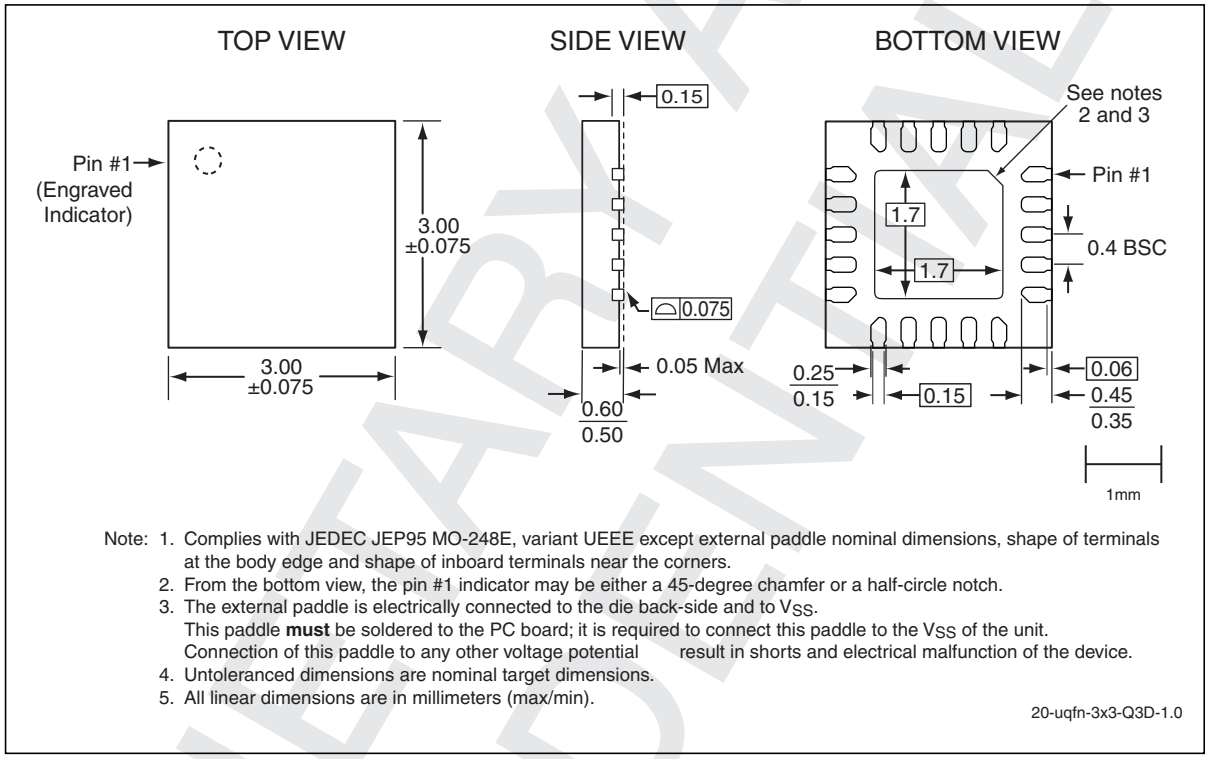
SST12LF03-XXXX

SST12LF03 Evaluation Kits

SST12LF03-XXXX-K

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

Packaging Diagrams



Note: 1. Complies with JEDEC JEP95 MO-248E, variant UEEE except external paddle nominal dimensions, shape of terminals at the body edge and shape of inboard terminals near the corners.
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 V_{SS}.
This paddle **must** be soldered to the PC board; it is required to connect this paddle to the V_{SS} of the unit.
Connection of this paddle to any other voltage potential 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).

20-uqfn-3x3-Q3D-1.0

Figure 11: 20-Contact Ultra-thin Qual Flat No-lead (UQFN)
SST Package Code: Q3D

Table 8: Revision History

Revision	Description	Date
00	• Initial release of data sheet	Jun 2011

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