Ultra-High Performance RF Narrowband Transceiver

Check for Samples: CC1125

1 Introduction

1.1 Features

- High-Performance, Single-Chip Transceiver
  - Adjacent Channel Selectivity: 67 dB at 6.25-kHz Offset
  - Blocking Performance: 104 dB at 10-MHz Offset
  - Excellent Receiver Sensitivity
    - –129 dBm at 300 bps
    - –123 dBm at 1.2 kbps
    - –110 dBm at 50 kbps
  - Very Low Phase Noise: –115 dBc/Hz at 10 kHz offset
- Suitable for Systems Targeting ETSI Category 1
- Separate 128-byte RX and TX FIFOs
- Support for seamless integration with the CC1190 device for increased range giving up to 3-dB improvement in sensitivity and up to +27 dBm output power
- High Spectral Efficiency (9.6 kbps in 12.5-kHz Channel in Compliance with FCC Narrowbanding Mandate)
- Power Supply
  - Wide Supply Voltage Range (2.0 V – 3.6 V)
  - Low Current Consumption:
    - RX: 2 mA in RX Sniff Mode
    - RX: 17 mA Peak Current in Low-Power Mode
    - RX: 26 mA Peak Current in High-Performance Mode
    - TX: 47 mA at +14 dBm
  - Power Down: 0.3 µA (0.5 µA with eWOR timer running)
- Programmable Output Power up to +16 dBm with 0.4-dB Step Size
- Automatic Output Power Ramping
- Configurable Data Rates: 0 to 200 kbps
- Supported Modulation Formats: 2-FSK, 2-GFSK, 4-FSK, 4-GFSK, MSK, OOK
- WaveMatch: Advanced Digital Signal Processing for Improved Sync Detect Performance
- RoHS-Compliant 5x5mm QFN 32 Package

1.2 Applications

- Social Alarms
- Narrowband Ultra-Low-Power Wireless Systems with Channel Spacing Down to 4 kHz
- 169-, 315-, 433-, 868-, 915-, 920-, 950-MHz ISM/SRD Band Systems
- Wireless Metering and Wireless Smart Grid (AMR and AMI)
- IEEE 802.15.4g Systems
- Home and Building Automation
- Wireless Alarm and Security Systems
- Industrial Monitoring and Control
- Wireless Healthcare Applications
- Wireless Sensor Networks and Active RFID
- Private Mobile Radio

1.3 Description

The CC1125 device is a fully integrated single-chip radio transceiver designed for high performance at very low-power and low-voltage operation in cost-effective wireless systems. All filters are integrated, thus removing the need for costly external SAW and IF filters. The device is mainly intended for the ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency bands at 164–192 MHz, 274–320 MHz, 410–480 MHz, and 820–960 MHz.

The CC1125 device provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication, and Wake-On-Radio. The main operating parameters of the CC1125 device can be controlled through an SPI interface. In a typical system, the CC1125 device will be used with a microcontroller and only a few external passive components.

Figure 1-1 shows pin names and locations for the CC1125 device.

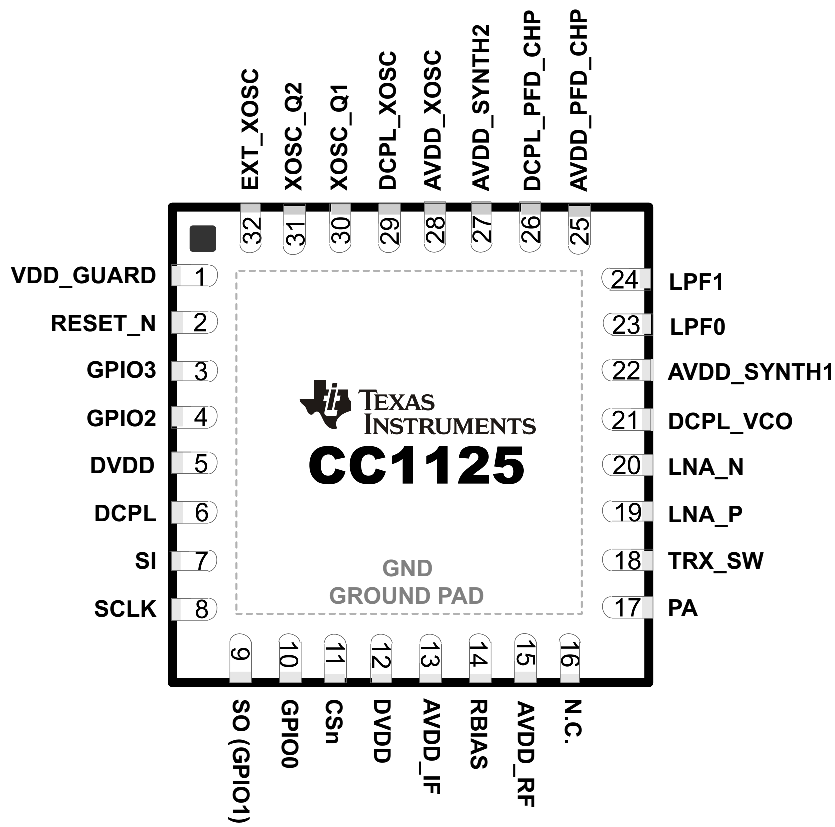


Figure 1-1. Package 5-mm × 5-mm QFN

1.4 Block Diagram

Figure 1-2 shows the system block diagram of the CC1125 device.

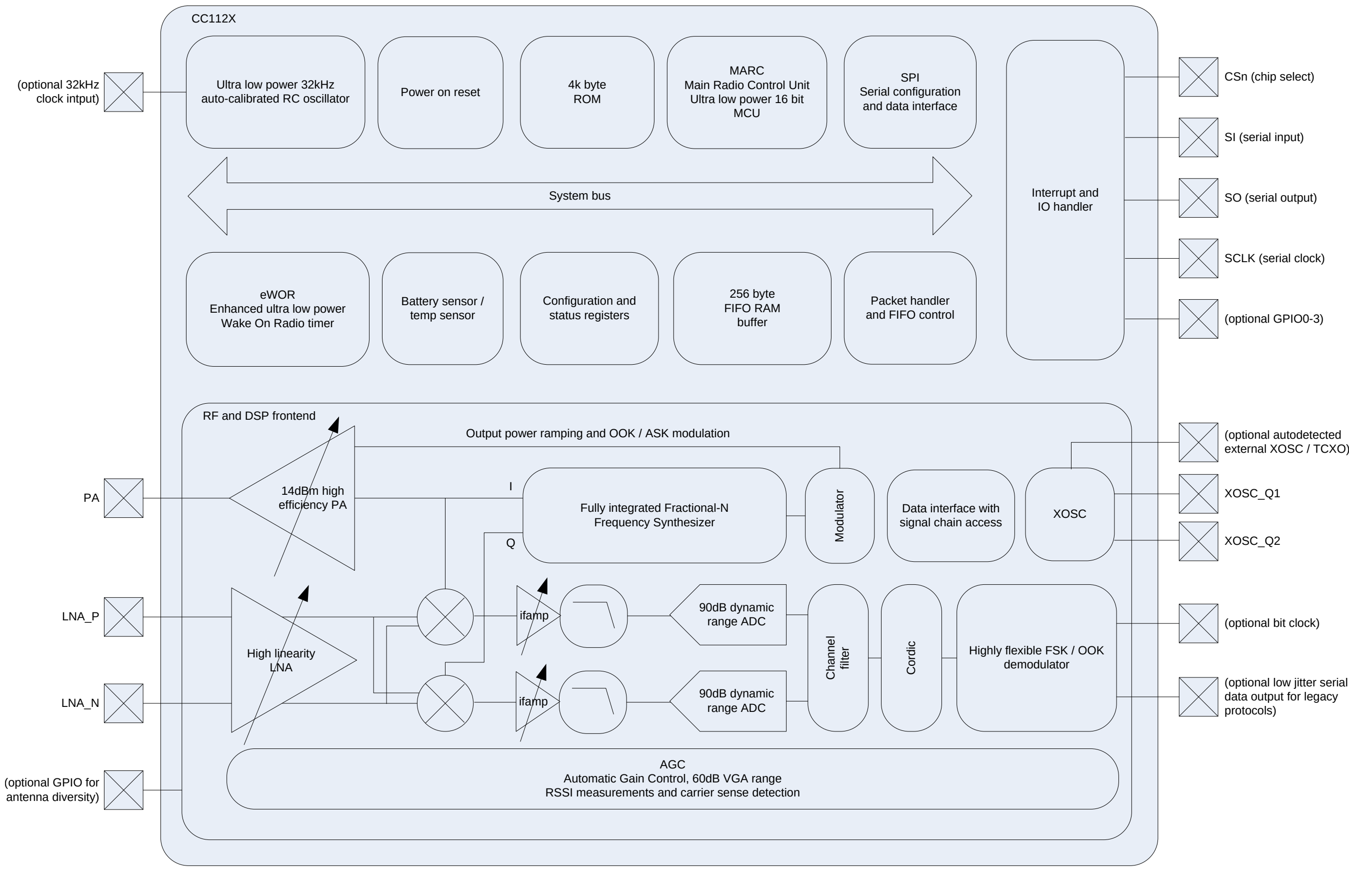


Figure 1-2. System Block Diagram

1.5 Regulations

Suitable for systems targeting compliance with:

- **Europe**: ETSI EN 300 220 category 1, ETSI EN 54-25, ETSI EN 300 113, and EN 301 166
- **US**: FCC CFR47 Part 15, 24, 90, 101
- **Japan**: ARIB RCR STD-T30, T-67, T-108

1.6 Peripherals and Support Functions

- Enhanced Wake-On-Radio (eWOR) functionality for automatic low-power receive polling
- Includes functions for antenna diversity support
- Support for retransmissions
- Support for auto-acknowledge of received packets
- TCXO support and control, also in power modes
- Automatic Clear Channel Assessment (CCA) for Listen-Before-Talk (LBT) systems
- Built-in coding gain support for increased range and robustness
- Digital RSSI measurement
- Temperature sensor

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

This data sheet revision history highlights the technical changes made to the SWRS120 device-specific data sheet.

Revision	Date	Description / Changes
SWRS120C	October 2013	Changed layout to TI data manual Added section on WaveMatch Added links to reference designs Added comment on DC path to VDD / GND required for PA / LNA pins
SWRS120B	March 2013	Added ARIB T-108 to list of regulations
		Added ETSI EN 301 166 to list of regulations
		Added optimum source / load impedance
		Added missing unit "dBm" in output power section
		Added temperature sensor data
		Clarified how the typical performance curves have been measured
		Corrected wrong deviation for 38.4 kbps sensitivity (was 50 kHz, corrected to 20 kHz)
		Pin CS_N renamed to CSn to comply with naming convention used in the user guide
		Updated typical frequency of low frequency RCOSC to show that it scales with the reference it is calibrated against (i.e. the high speed XOSC)
		Updated modulation format information in image rejection sections
		Stated which ETSI EN 300 220 receiver category that is suitable for low power mode
		Clarified under max ratings that I/O voltages should not exceed device supply voltage by more than 0.3 V
		Various minor spelling errors corrected
SWRS120	March 2012	Initial release

2 Device Characteristics

2.1 Electrical Specifications

All measurements performed on CC1120EM_868_915 rev.1.0.1, CC1120EM_955 rev.1.2.1, CC1120EM_420_470 rev.1.0.1 or CC1120EM_169 rev.1.2 (f_{xosc} = 32 MHz), and CC1125EM_868_915 rev.1.1.0, CC1125EM_420_470 rev.1.1.0, CC1125EM_169 rev.1.1.0, CC1125EM-Cat1-868 (f_{xosc} = 40 MHz)

2.2 Absolute Maximum Ratings

Parameter	Min	Typ	Max	Unit	Condition
Supply voltage (VDD) (all supply pins must have the same voltage)	–0.3		3.9	V	
Storage temperature range	–40		125	°C	
Solder reflow temperature			260	°C	According to IPC/JEDEC J-STD-020
ESD			2000	V	HBM
ESD			500	V	CDM
Input RF level			+10	dBm	
Voltage on any digital pin	–0.3		VDD+0.3 max 3.9	V	
Voltage on analog pins (including DCPL pins)	–0.3		2.0	V	

2.3 General Characteristics

Parameter	Min	Typ	Max	Unit	Condition
Voltage supply range	2.0		3.6	V	
Temperature range	–40		85	°C	

2.4 RF Characteristics

Parameter	Min	Typ	Max	Unit	Condition
Frequency bands	820		960	MHz	
	410		480	MHz	
	274		320	MHz	See SWRA398 for more information.
	164		192	MHz	
Frequency resolution		30		Hz	In 820–950 MHz band
		15		Hz	In 410–480 MHz band
		6		Hz	In 164–192 MHz band
Data rate	0		200	kbps	Packet mode
	0		100	kbps	Transparent mode
Data rate step size		1e-4		bps	

2.5 Regulatory Standards

Performance Mode	Frequency Band	Suitable for compliance with	Comments
High-performance mode	820–960 MHz	ARIB T-108 ARIB T-96 ETSI EN 300 220 category 1 ETSI EN 54-25 FCC PART 101 FCC PART 24 SUBMASK D FCC PART 15.247 FCC PART 15.249 FCC PART 90 MASK G FCC PART 90 MASK J	Performance also suitable for systems targeting maximum allowed output power in the respective bands, using a range extender such as the CC1190 device
	410–480 MHz	ARIB T-67 ARIB RCR STD-30 ETSI EN 301 166 ETSI EN 300 113 ETSI EN 300 220 category 1 FCC PART 90 MASK D FCC PART 90 MASK E FCC PART 90 MASK G	Performance also suitable for systems targeting maximum allowed output power in the respective bands, using a range extender
	164–192 MHz	ETSI EN 300 220 category 1 ETSI EN 301 166 ETSI EN 300 113 FCC PART 90 MASK C FCC PART 90 MASK D FCC PART 90 MASK E	Performance also suitable for systems targeting maximum allowed output power in the respective bands, using a range extender
Low-power mode	820–960 MHz	ETSI EN 300 220 category 2 FCC PART 15.247 FCC PART 15.249	
	410–480 MHz	ETSI EN 300 220 category 2	
	164–192 MHz	ETSI EN 300 220 category 2	

2.6 Current Consumption, Static Modes

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Power down with retention		0.3	1	µA	
		0.5		µA	Low-power RC oscillator running
XOFF mode		170		µA	Crystal oscillator / TCXO disabled
IDLE mode		1.3		mA	Clock running, system waiting with no radio activity

2.7 Current Consumption, Transmit Modes

2.7.1 950-MHz Band (High-Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
TX current consumption +10 dBm		37		mA	
TX current consumption 0 dBm		26		mA	

2.7.2 868-, 915-, and 920-MHz Bands (High-Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 40 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
TX current consumption +14 dBm		47		mA	
TX current consumption +10 dBm		38		mA	

2.7.3 434-MHz Band (High-Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 40 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
TX current consumption +15 dBm		51		mA	
TX current consumption +14 dBm		47		mA	
TX current consumption +10 dBm		36		mA	

2.7.4 169-MHz Band (High Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 40 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
TX current consumption +15 dBm		56		mA	
TX current consumption +14 dBm		52		mA	
TX current consumption +10 dBm		40		mA	

2.7.5 Low-Power Mode

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
TX current consumption +10 dBm		32		mA	

2.8 Current Consumption, Receive Modes

2.8.1 High-Performance Mode

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
RX wait for sync 1.2 kbps, 4-byte preamble 38.4 kbps, 4-byte preamble		 2 13.4		 mA mA	Using RX sniff mode, where the receiver wakes up at regular intervals to look for an incoming packet
RX peak current, f_{xosc} = 40 MHz 433-, 868-, 915-, and 920-MHz bands 169-MHz band		 26 27		 mA mA	Peak current consumption during packet reception at the sensitivity threshold
Average current consumption Check for data packet every 1 second using wake on radio		15		µA	50 kbps, 5-byte preamble, 40-kHz RC oscillator used as sleep timer

2.8.2 Low-Power Mode

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
RX peak current low-power RX mode 1.2 kbps		17		mA	Peak current consumption during packet reception at the sensitivity level

2.9 Receive Parameters

All RX measurements made at the antenna connector, to a bit error rate (BER) limit of 1%.

2.9.1 General Receive Parameters (High-Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Saturation		+10		dBm	
Digital channel filter programmable bandwidth					
f_{xosc} = 32 MHz	2.8		200	kHz	
f_{xosc} = 40 MHz	3.5		250	kHz	
IIP3, normal mode		–14		dBm	At maximum gain
IIP3, high linearity mode		–8		dBm	Using 6-dB gain reduction in front end
Datarate offset tolerance		±12		%	With carrier sense detection enabled and assuming 4-byte preamble
		±0.2		%	With carrier sense detection disabled
Spurious emissions					
1–13 GHz (VCO leakage at 3.5 GHz)		–56		dBm	Radiated emissions measured according to ETSI EN 300 220, fc = 869.5 MHz
30 MHz to 1 GHz		< –57		dBm	
Optimum source impedance					
868-, 915-, and 920-MHz bands		60 + j60 / 30 + j30		Ω	(Differential or single-ended RX configurations)
433-MHz band		100 + j60 / 50+ j30		Ω	
169-MHz band		140 + j40 / 70 + j20		Ω	

2.9.2 RX Performance in 950-MHz Band (High-Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Sensitivity Note: Sensitivity can be improved if the TX and RX matching networks are separated.		–120		dBm	1.2 kbps, DEV=4 kHz CHF=10 kHz(1)
		–107		dBm	50 kbps 2GFSK, DEV=25 kHz, CHF=100 kHz
		–100		dBm	200 kbps, DEV=83 kHz (outer symbols), CHF=200 kHz, 4GFSK(2)
Blocking and Selectivity 1.2 kbps 2-FSK, 12.5-kHz channel separation, 4-kHz deviation, 10-kHz channel filter		51		dB	± 12.5 kHz (adjacent channel)
		52		dB	± 25 kHz (alternate channel)
		73		dB	± 1 MHz
		76		dB	± 2 MHz
		81		dB	± 10 MHz
Blocking and Selectivity 50 kbps 2-GFSK, 200-kHz channel separation, 25-kHz deviation, 100-kHz channel filter (Same modulation format as 802.15.4g Mandatory Mode)		43		dB	± 200 kHz (adjacent channel)
		51		dB	± 400 kHz (alternate channel)
		62		dB	± 1 MHz
		65		dB	± 2 MHz
		71		dB	± 10 MHz
Blocking and Selectivity 200 kbps 4-GFSK, 83-kHz deviation (outer symbols), 200-kHz channel filter, zero IF		37		dB	± 200 kHz (adjacent channel)
		44		dB	± 400 kHz (alternate channel)
		55		dB	± 1 MHz
		58		dB	± 2 MHz
		64		dB	± 10 MHz

(1) DEV is short for deviation, CHF is short for channel filter bandwidth
(2) BT=0.5 is used in all GFSK measurements

2.9.3 RX Performance in 868-, 915-, and 920-MHz Bands (High-Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 32 MHz if nothing else stated if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Sensitivity		–129		dBm	300 bps, DEV=1 kHz CHF=3.8 kHz(1), f_{xosc} = 40 MHz
		–123		dBm	1.2 kbps, DEV=20 kHz CHF=50 kHz
		–114		dBm	4.8 kbps OOK
		–110		dBm	38.4 kbps, DEV=20 kHz CHF=100 kHz
		–110		dBm	50 kbps 2GFSK, DEV=25 kHz, CHF=100 kHz
		–103		dBm	200 kbps, DEV=83 kHz (outer symbols), CHF=200 kHz, 4GFSK
Blocking and Selectivity 0.3-kbps 2-FSK, 6.25-kHz channel separation, 1-kHz deviation, 3.8-kHz channel filter f_{xosc} = 40 MHz using TCXO		62		dB	± 6.25 kHz (adjacent channel)
		63		dB	± 12.5 kHz (alternate channel)
		83		dB	± 1 MHz
		87		dB	± 2 MHz
		91		dB	± 10 MHz
Blocking and Selectivity 1.2-kbps 2-FSK, 12.5-kHz channel separation, 4-kHz deviation, 10-kHz channel filter f_{xosc} = 40 MHz using TCXO		58		dB	+ 12.5 kHz (adjacent channel)
		58		dB	± 25 kHz (alternate channel)
		78		dB	± 1 MHz
		82		dB	± 2 MHz
		86		dB	± 10 MHz
Blocking and Selectivity 1.2-kbps 2-GFSK, 25-kHz channel separation, 4-kHz deviation, 16-kHz channel filter f_{xosc} = 40 MHz using TCXO Using external SAW filter for compliance with ETSI category 1		58		dB	± 25 kHz (alternate channel)
		77		dB	± 1 MHz
		106		dB	± 2 MHz
		101		dB	± 10 MHz
Blocking and Selectivity 38.4-kbps 2-GFSK, 100-kHz channel separation, 20-kHz deviation, 100-kHz channel filter		42		dB	± 100 kHz (adjacent channel)
		43		dB	± 200 kHz (alternate channel)
		62		dB	± 1 MHz
		66		dB	± 2 MHz
		74		dB	± 10 MHz
Blocking and Selectivity 50-kbps 2-GFSK, 200-kHz channel separation, 25-kHz deviation, 100-kHz channel filter (Same modulation format as 802.15.4g Mandatory Mode)		43		dB	± 200 kHz (adjacent channel)
		50		dB	± 400 kHz (alternate channel)
		61		dB	± 1 MHz
		65		dB	± 2 MHz
		74		dB	± 10 MHz
Blocking and Selectivity 200-kbps 4-GFSK, 83-kHz deviation (outer symbols), 200-kHz channel filter, zero IF		36		dB	± 200 kHz (adjacent channel)
		44		dB	± 400 kHz (alternate channel)
		55		dB	± 1 MHz
		59		dB	± 2 MHz
		67		dB	± 10 MHz
Image rejection (Image compensation enabled) f_{xosc} = 40 MHz using TCXO		58		dB	1.2 kbps, DEV=4 kHz CHF=10 kHz(1), image at -125 kHz

(1) DEV is short for deviation, CHF is short for channel filter bandwidth

2.9.4 RX Performance in 434-MHz Band (High-Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 32 MHz if nothing else stated if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Sensitivity		–129		dBm	300 bps, DEV=1 kHz, CHF=3.8 kHz(1) f_{xosc} = 40 MHz
		–123		dBm	1.2 kbps, DEV=4 kHz CHF=10 kHz(1)
		–109		dBm	50-kbps 2-GFSK, DEV=25 kHz, CHF=100 kHz(1)
		–116		dBm	1.2 kbps, DEV=20 kHz CHF=50 kHz(1)
Blocking and Selectivity 0.3-kbps 2-FSK, 6.25-kHz channel separation, 1-kHz deviation, 3.8-kHz channel filter f_{xosc} = 40 MHz using TCXO		65		dB	+ 6.25 kHz (adjacent channel)
		66		dB	+ 12.5 kHz (alternate channel)
		86		dB	± 1 MHz
		90		dB	± 2 MHz
		95		dB	± 10 MHz
Blocking and Selectivity 1.2-kbps 2-FSK, 12.5-kHz channel separation, 4-kHz deviation, 10-kHz channel filter f_{xosc} = 40 MHz using TCXO		60		dB	+ 12.5 kHz (adjacent channel)
		61		dB	± 25 kHz (alternate channel)
		80		dB	± 1 MHz
		85		dB	± 2 MHz
		91		dB	± 10 MHz
Blocking and Selectivity 38.4-kbps 2-GFSK, 100-kHz channel separation, 20-kHz deviation, 100-kHz channel filter		47		dB	+ 100 kHz (adjacent channel)
		50		dB	± 200 kHz (alternate channel)
		67		dB	± 1 MHz
		71		dB	± 2 MHz
		78		dB	± 10 MHz

(1) DEV is short for deviation, CHF is short for channel filter bandwidth

2.9.5 RX Performance in 169-MHz Band (High-Performance Mode)

T_A = 25°C, VDD = 3.0 V, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Sensitivity		–129		dBm	300 bps, DEV=1 kHz, CHF=3.8 kHz[1] f_{xosc} = 40 MHz
		–123		dBm	1.2 kbps, DEV=4 kHz CHF=10 kHz[1]
Blocking and Selectivity 0.3-kbps 2-FSK, 6.25-kHz channel separation, 1-kHz deviation, 3.8-kHz channel filter f_{xosc} = 40 MHz using TCXO		67		dB	± 6.25 kHz (adjacent channel)
		67		dB	+ 12.5 kHz (alternate channel)
		88		dB	± 1 MHz
		101		dB	–2 MHz
		104		dB	± 10 MHz
Blocking and Selectivity 1.2-kbps 2-FSK, 12.5-kHz channel separation, 4-kHz deviation, 10-kHz channel filter f_{xosc} = 40 MHz using TCXO		63		dB	± 12.5 kHz (adjacent channel)
		65		dB	± 25 kHz (alternate channel)
		82		dB	± 1 MHz
		86		dB	± 2 MHz
		93		dB	–10 MHz
Spurious Response Rejection 1.2-kbps 2-FSK, 12.5-kHz channel separation, 4-kHz deviation, 10-kHz channel filter		70		dB	
Image Rejection (Image compensation enabled)		66		dB	1.2 kbps, DEV=4 kHz CHF=10 kHz[1], image at –125 kHz

(1) DEV is short for deviation, CHF is short for channel filter bandwidth

2.9.6 RX Performance in Low-Power Mode

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Sensitivity		–111		dBm	1.2 kbps, DEV=4 kHz CHF=10 kHz[(1)]
		–99		dBm	38.4 kbps, DEV=50 kHz CHF=100 kHz[(1)]
		–99		dBm	50-kbps 2-GFSK, DEV=25 kHz, CHF=100 kHz[(1)]
Blocking and Selectivity 1.2-kbps 2-FSK, 12.5-kHz channel separation, 4-kHz deviation, 10-kHz channel filter		46		dB	± 12.5 kHz (adjacent channel)
		46		dB	± 25 kHz (alternate channel)
		73		dB	± 1 MHz
		78		dB	± 2 MHz
		79		dB	± 10 MHz
Blocking and Selectivity 1.2-kbps 2-FSK, 50-kHz channel separation, 20-kHz deviation, 50-kHz channel filter		43		dB	± 50 kHz (adjacent channel)
		45		dB	+ 100 kHz (alternate channel)
		71		dB	± 1 MHz
		74		dB	± 2 MHz
		75		dB	± 10 MHz
Blocking and Selectivity 38.4-kbps 2-GFSK, 100-kHz channel separation, 20-kHz deviation, 100-kHz channel filter		37		dB	+ 100 kHz (adjacent channel)
		43		dB	+ 200 kHz (alternate channel)
		58		dB	± 1 MHz
		62		dB	± 2 MHz
		64		dB	+ 10 MHz
Blocking and Selectivity 50-kbps 2-GFSK, 200-kHz channel separation, 25-kHz deviation, 100-kHz channel filter (Same modulation format as 802.15.4g Mandatory Mode)		43		dB	+ 200 kHz (adjacent channel)
		52		dB	+ 400 kHz (alternate channel)
		60		dB	± 1 MHz
		64		dB	± 2 MHz
		65		dB	± 10 MHz
Saturation		+10		dBm	

(1) DEV is short for deviation, CHF is short for channel filter bandwidth

2.10 Transmit Parameters

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Max output power		+12		dBm	At 950 MHz
		+14		dBm	At 915- and 920-MHz
		+15		dBm	At 915- and 920-MHz with VDD = 3.6 V
		+15		dBm	At 868 MHz
		+16		dBm	At 868 MHz with VDD = 3.6 V
		+15		dBm	At 433 MHz
		+16		dBm	At 433 MHz with VDD = 3.6 V
		+15		dBm	At 169 MHz
		+16		dBm	At 169 MHz with VDD = 3.6 V
Min output power		–11		dBm	Within fine step size range
		–40		dBm	Within coarse step size range
Output power step size		0.4		dB	Within fine step size range
Adjacent channel power		–75		dBc	4-GFSK 9.6 kbps in 12.5-kHz channel, measured in 100-Hz bandwidth at 434 MHz (FCC Part 90 Mask D compliant)
		–58		dBc	4-GFSK 9.6 kbps in 12.5-kHz channel, measured in 8.75-kHz bandwidth (ETSI 300 220 compliant)
		–61		dBc	2-GFSK 2.4 kbps in 12.5-kHz channel, 1.2-kHz deviation
Spurious emissions (not including harmonics)		< –60		dBm	
Harmonics					Transmission at +14 dBm (or maximum allowed in applicable band where this is less than +14 dBm) using TI reference design. Emissions measured according to ARIB T-96 in 950-MHz band, ETSI EN 300-220 in 169-, 433-, and 868-MHz bands and FCC part 15.247 in 450- and 915-MHz band. Fourth harmonic in 915-MHz band will require extra filtering to meet FCC requirements if transmitting for long intervals (>50-ms periods).
Second Harm, 169 MHz		–39		dBm	
Third Harm, 169 MHz		–58		dBm	
Second Harm, 433 MHz		–56		dBm	
Third Harm, 433 MHz		–51		dBm	
Second Harm, 450 MHz		–60		dBm	
Third Harm, 450 MHz		–45		dBm	
Second Harm, 868 MHz		–40		dBm	
Third Harm, 868 MHz		–42		dBm	
Second Harm, 915 MHz		56		dBuV/m	
Third Harm, 915 MHz		52		dBuV/m	
Fourth Harm, 915 MHz		60		dBuV/m	
Second Harm, 950 MHz		–58		dBm	
Third Harm, 950 MHz		–42		dBm	
Optimum load					
Impedance 868-, 915-, and 920-MHz bands		35 + j35		Ω	
433-MHz band		55 + j25		Ω	
169-MHz band		80 + j0		Ω	

2.11 PLL Parameters

2.11.1 High-Performance Mode

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz, f_{xosc} = 40 MHz using TCXO if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Phase noise in 950-MHz band f_{xosc} = 32 MHz		–100		dBc/Hz	± 10 kHz offset
		–103		dBc/Hz	± 100 kHz offset
		–123		dBc/Hz	± 1 MHz offset
Phase noise in 868-, 915-, 920-MHz bands		–101		dBc/Hz	± 10 kHz offset
		–102		dBc/Hz	± 100 kHz offset
		–124		dBc/Hz	± 1 MHz offset
Phase noise in 433-MHz band		–107		dBc/Hz	± 10 kHz offset
		–110		dBc/Hz	± 100 kHz offset
		–130		dBc/Hz	± 1 MHz offset
Phase noise in 169-MHz band		–115		dBc/Hz	± 10 kHz offset
		–115		dBc/Hz	± 100 kHz offset
		–135		dBc/Hz	± 1 MHz offset

2.11.2 Low-Power Mode

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Phase noise in 950-MHz band		–90		dBc/Hz	± 10 kHz offset
		–92		dBc/Hz	± 100 kHz offset
		–124		dBc/Hz	± 1 MHz offset
Phase noise in 868-, 915- , and 920-MHz bands		–95		dBc/Hz	± 10 kHz offset
		–95		dBc/Hz	± 100 kHz offset
		–124		dBc/Hz	± 1 MHz offset
Phase noise in 433-MHz band		–98		dBc/Hz	± 10 kHz offset
		–102		dBc/Hz	± 100 kHz offset
		–129		dBc/Hz	± 1 MHz offset
Phase noise in 169-MHz band		–106		dBc/Hz	± 10 kHz offset
		–110		dBc/Hz	± 100 kHz offset
		–136		dBc/Hz	± 1 MHz offset

2.12 Wake-up and Timing

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz, f_{xosc} = 32 MHz if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Powerdown to IDLE		0.4		ms	Depends on crystal
IDLE to RX/TX		166		µs	Calibration disabled
		461		µs	Calibration enabled
RX/TX turnaround		50		µs	
RX/TX to IDLE time		296		µs	Calibrate when leaving RX/TX enabled
		0		µs	Calibrate when leaving RX/TX disabled
Frequency synthesizer calibration		391		µs	When using SCAL strobe
Minimum required number of preamble bytes		0.5		bytes	Required for RF front-end gain settling only. Digital demodulation does not require preamble for settling.
Time from start RX until valid RSSI, including gain settling (function of channel bandwidth. Programmable for trade-off between speed and accuracy)		4.6		ms	12.5-kHz channels
		0.3		ms	200-kHz channels

2.13 High-Speed Crystal Oscillator

T_A = 25°C, VDD = 3.0 V if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Crystal frequency	32		44	MHz	Note: It is recommended that the crystal frequency is chosen so that the RF channel(s) are >1 MHz away from multiples of XOSC in TX and XOSC/2 in RX.
Load capacitance (C_L)		10		pF	
ESR		<50		Ω	
Start-up time		0.4		ms	Depends on crystal

2.14 High-Speed Clock Input (TCXO)

T_A = 25°C, VDD = 3.0 V if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Clock frequency	32		44	MHz	
Clock input amplitude (peak-to-peak)		>0.8		V	Should not exceed supply voltage

2.15 32-kHz Clock Input

T_A = 25°C, VDD = 3.0 V if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Clock frequency		32		kHz	
32-kHz clock input pin input high voltage	0.8×VDD			V	
32-kHz clock input pin input low voltage			0.2×VDD	V	

2.16 Low Speed RC Oscillator

T_A = 25°C, VDD = 3.0 V if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Frequency		32/40		kHz	After calibration (calibrated against the high-speed XOSC)
Frequency accuracy after calibration		±0.1		%	Relative to frequency reference (for example, 32-MHz crystal or TCXO)
Initial calibration time		1.6		ms	

2.17 I/O and Reset

T_A = 25°C, VDD = 3.0 V if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Logic input high voltage	0.8×VDD			V	
Logic input low voltage			0.2×VDD	V	
Logic output high voltage	0.8×VDD			V	At 4-mA output load or less
Logic output low voltage			0.2×VDD	V	
Power-on reset threshold		1.3		V	Voltage on DVDD pin

2.18 Temperature Sensor

T_A = 25°C, VDD = 3.0 V if nothing else stated

Parameter	Min	Typ	Max	Unit	Condition
Temperature sensor range	–40		85	°C	
Temperature coefficient		2.66		mV / °C	Change in sensor output voltage versus change in temperature
Typical output voltage		794		mV	Typical sensor output voltage at T_A = 25°C, VDD = 3.0 V
VDD coefficient		1.17		mV / V	Change in sensor output voltage versus change in VDD

The CC1125 device can be configured to provide a voltage proportional to temperature on GPIO1. The temperature can be estimated by measuring this voltage (see Section 2.18, *Temperature Sensor*). For more information, see the CC1125 user guide (SWRU295) for more information.

2.19 Typical Characteristics

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz if nothing else stated

All measurements performed on CC1120EM_868_915 rev.1.0.1, CC1120EM_955 rev.1.2.1, CC1120EM_420_470 rev.1.0.1 or CC1120EM_169 rev.1.2 (f_{xosc} = 32 MHz), and CC1125EM_868_915 rev.1.1.0, CC1125EM_420_470 rev.1.1.0, CC1125EM_169 rev.1.1.0, CC1125EM-Cat1-868 (f_{xosc} = 40 MHz)

Figure 2-16 was measured at the 50-Ω antenna connector.

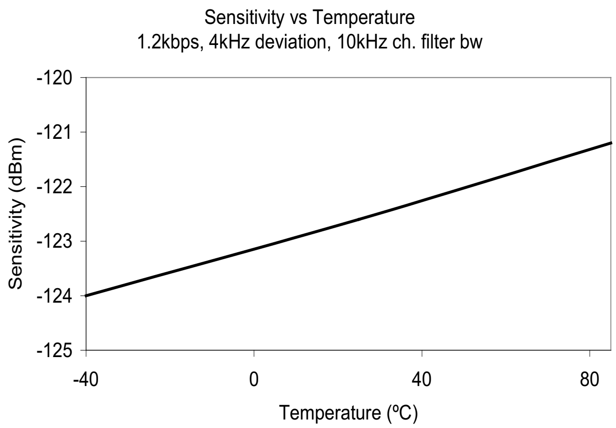


Figure 2-1.

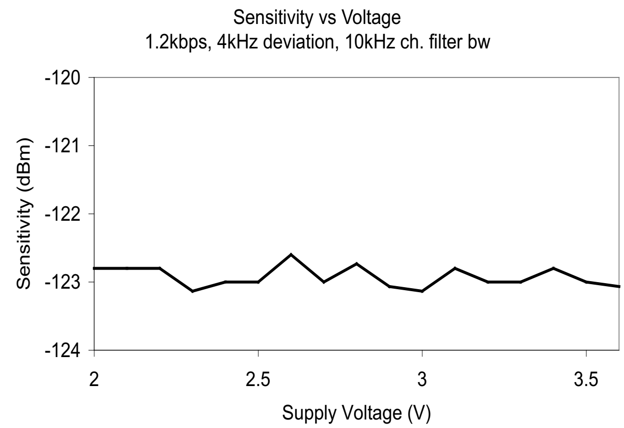


Figure 2-2.

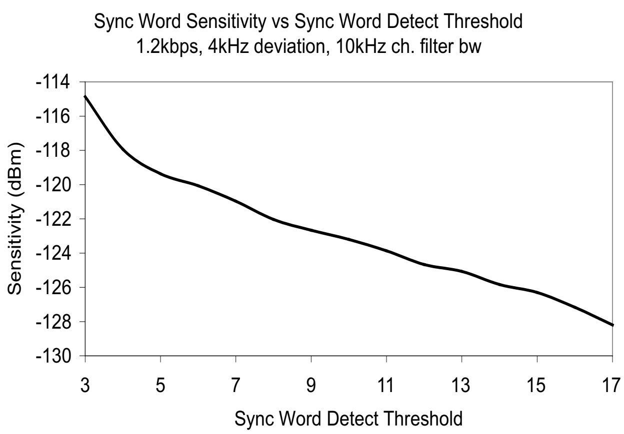


Figure 2-3.

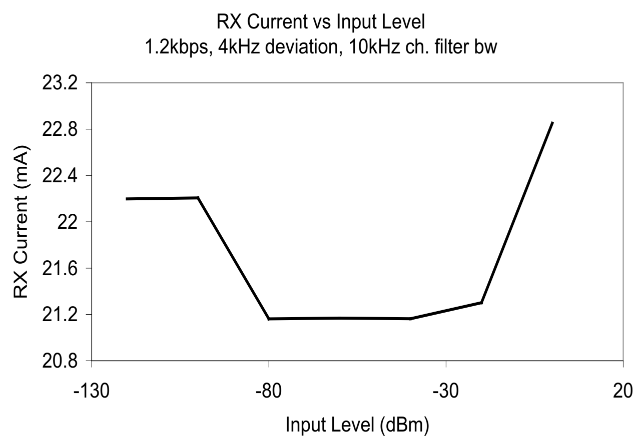


Figure 2-4.

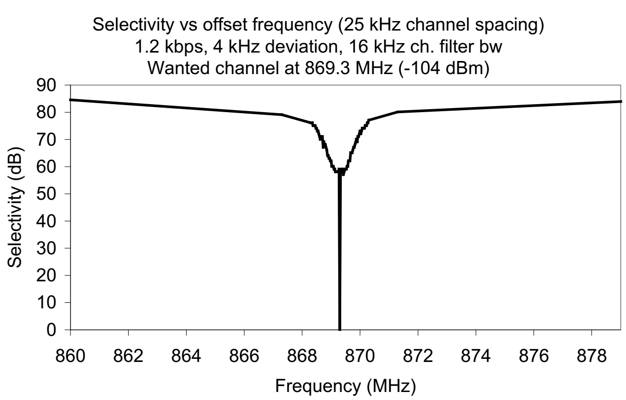
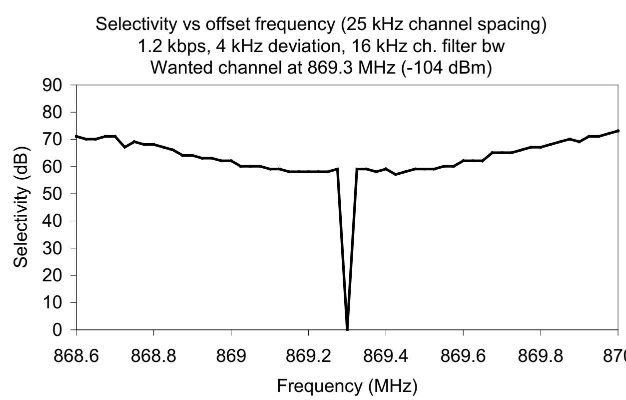


Figure 2-5.



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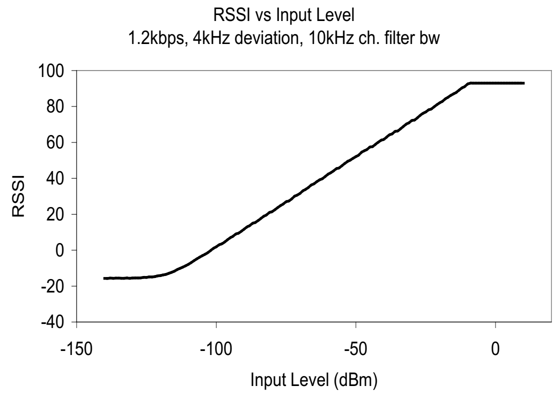

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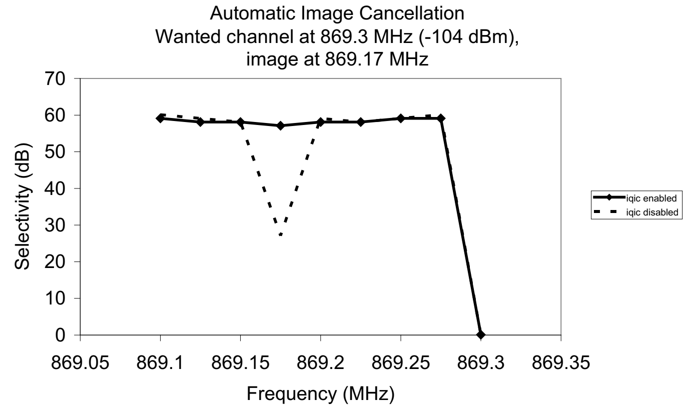


Figure 2-8.

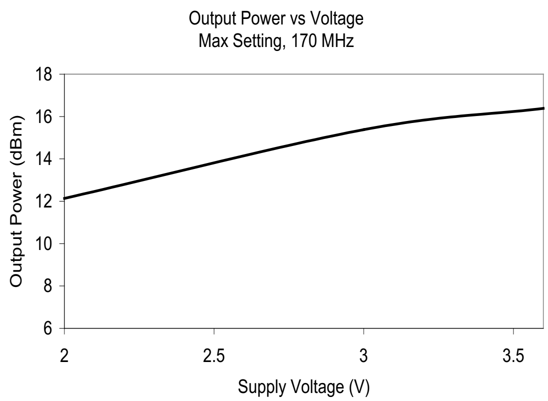


Figure 2-9.

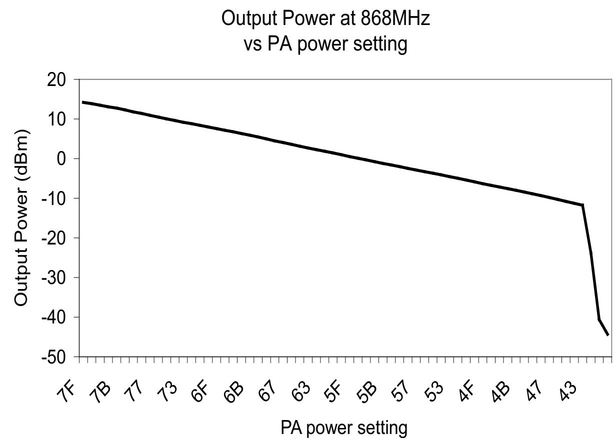


Figure 2-10.

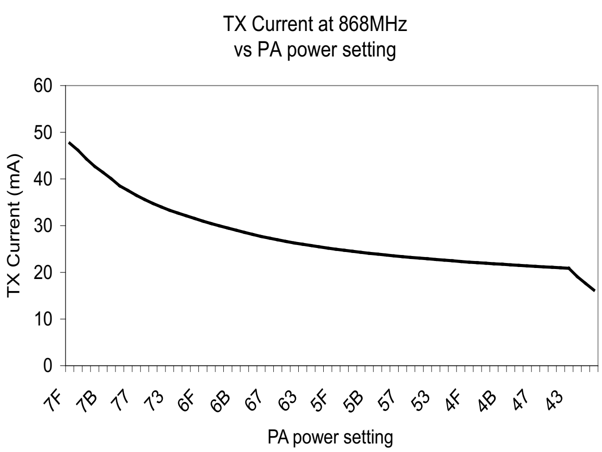


Figure 2-11.

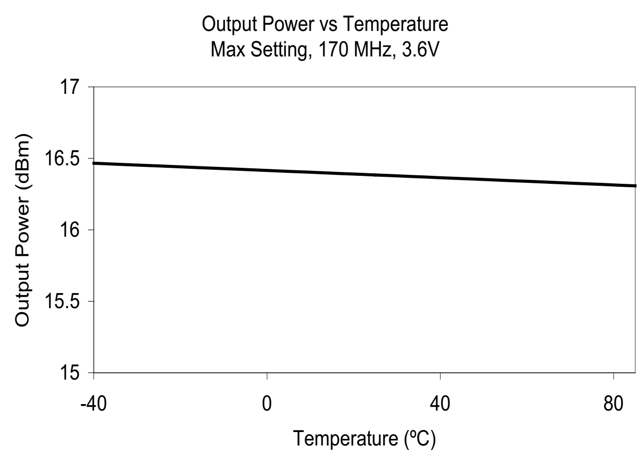


Figure 2-12.

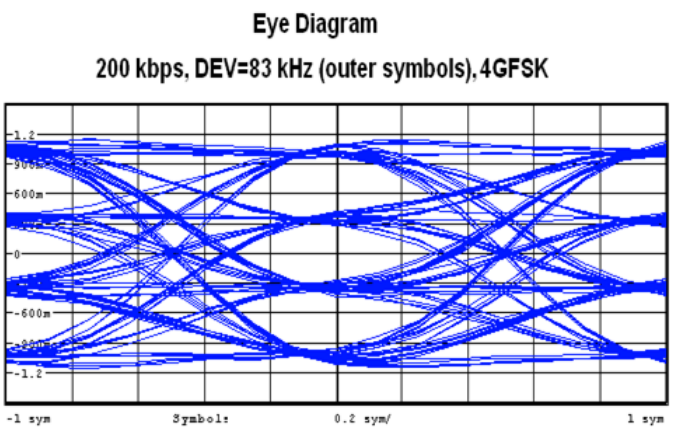


Figure 2-13.

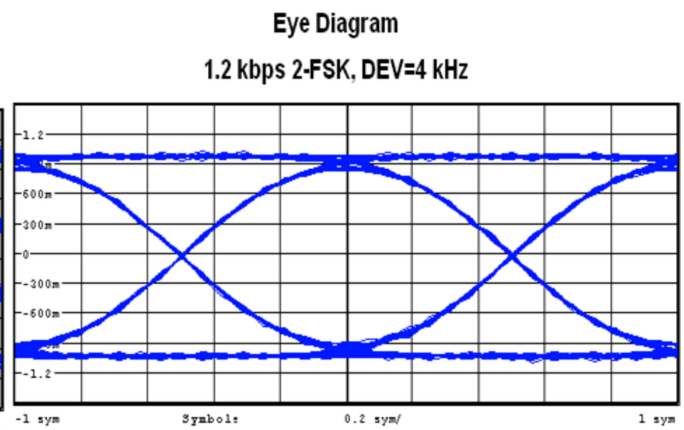


Figure 2-14.

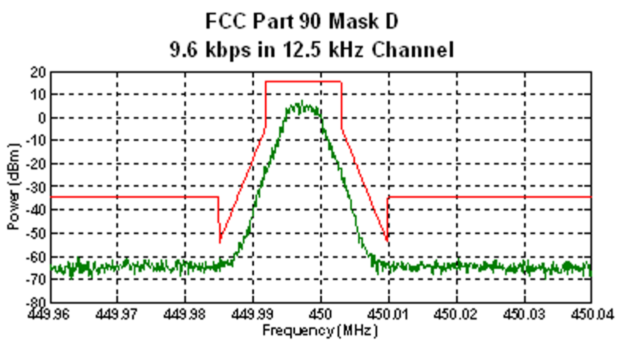


Figure 2-15.

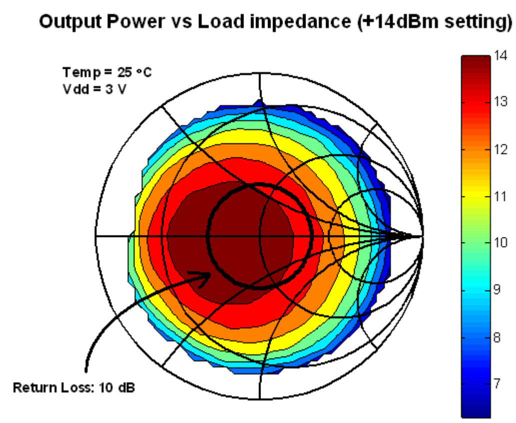


Figure 2-16.

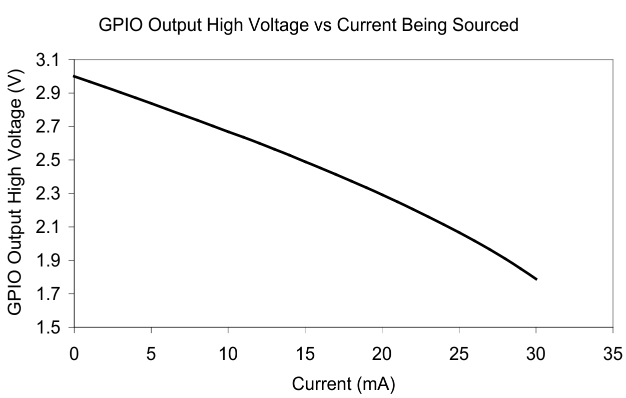


Figure 2-17.

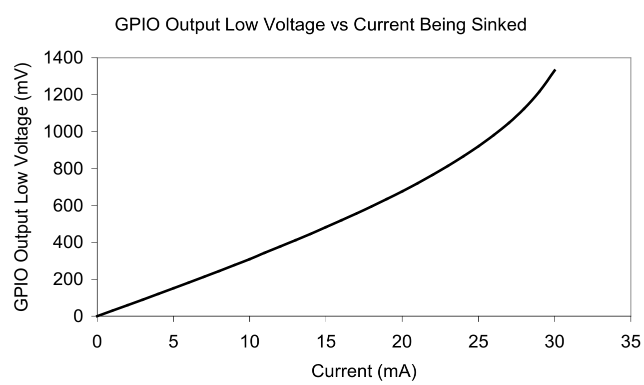


Figure 2-18.

3 Device Pins

3.1 Pin Configuration

The following table lists the pin-out configuration for the CC1125 device.

Pin No.	Pin Name	Type / Direction	Description
1	VDD_GUARD	Power	2.0–3.6 V VDD
2	RESET_N	Digital input	Asynchronous, active-low digital reset
3	GPIO3	Digital I/O	General-purpose I/O
4	GPIO2	Digital I/O	General-purpose I/O
5	DVDD	Power	2.0–3.6 VDD to internal digital regulator
6	DCPL	Power	Digital regulator output to external decoupling capacitor
7	SI	Digital input	Serial data in
8	SCLK	Digital input	Serial data clock
9	SO(GPIO1)	Digital I/O	Serial data out (general-purpose I/O)
10	GPIO0	Digital I/O	General-purpose I/O
11	CSn	Digital input	Active-low chip select
12	DVDD	Power	2.0–3.6 V VDD
13	AVDD_IF	Power	2.0–3.6 V VDD
14	RBIAS	Analog	External high-precision resistor
15	AVDD_RF	Power	2.0–3.6 V VDD
16	N.C.		Not connected
17	PA	Analog	Single-ended TX output (requires DC path to VDD)
18	TRX_SW	Analog	TX and RX switch. Connected internally to GND in TX and floating (high-impedance) in RX.
19	LNA_P	Analog	Differential RX input (requires DC path to GND)
20	LNA_N	Analog	Differential RX input (requires DC path to GND)
21	DCPL_VCO	Power	Pin for external decoupling of VCO supply regulator
22	AVDD_SYNTH1	Power	2.0–3.6 V VDD
23	LPF0	Analog	External loop filter components
24	LPF1	Analog	External loop filter components
25	AVDD_PFD_CHP	Power	2.0–3.6 V VDD
26	DCPL_PFD_CHP	Power	Pin for external decoupling of PFD and CHP regulator
27	AVDD_SYNTH2	Power	2.0–3.6 V VDD
28	AVDD_XOSC	Power	2.0–3.6 V VDD
29	DCPL_XOSC	Power	Pin for external decoupling of XOSC supply regulator
30	XOSC_Q1	Analog	Crystal oscillator pin 1 (must be grounded if a TCXO or other external clock connected to EXT_XOSC is used)
31	XOSC_Q2	Analog	Crystal oscillator pin 2 (must be left floating if a TCXO or other external clock connected to EXT_XOSC is used)
32	EXT_XOSC	Digital input	Pin for external clock input (must be grounded if a regular crystal connected to XOSC_Q1 and XOSC_Q2 is used)
–	GND	Ground pad	The ground pad must be connected to a solid ground plane.

4 Device Information

4.1 Block Diagram

Figure 4-1 shows the system block diagram of the CC1125 device.

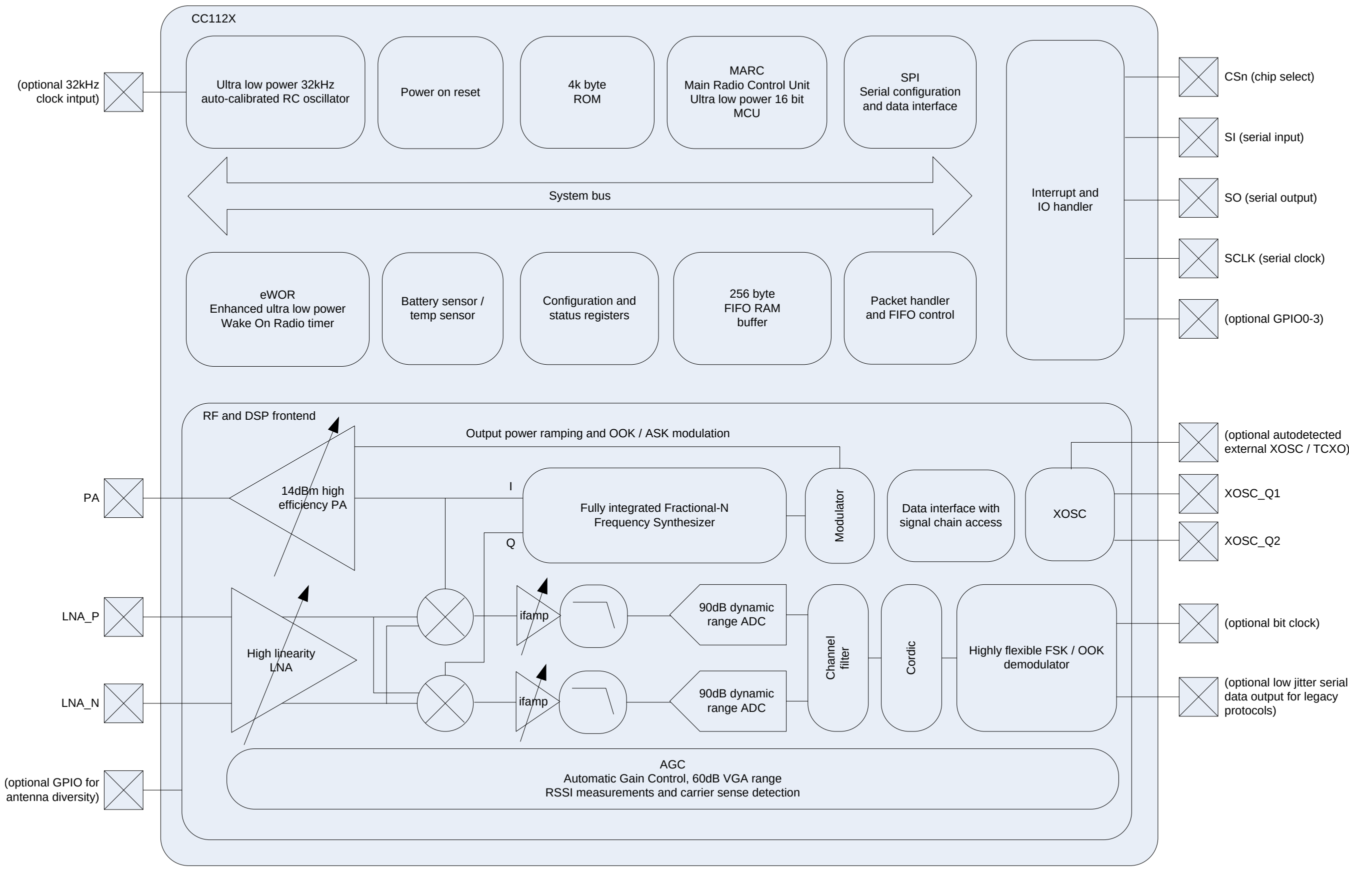


Figure 4-1. System Block Diagram

4.2 Frequency Synthesizer

At the center of the CC1125 device there is a fully integrated, fractional-N, ultra-high-performance frequency synthesizer. The frequency synthesizer is designed for excellent phase noise performance, providing very high selectivity and blocking performance. The system is designed to comply with the most stringent regulatory spectral masks at maximum transmit power.

Either a crystal can be connected to XOSC_Q1 and XOSC_Q2, or a TCXO can be connected to the EXT_XOSC input. The oscillator generates the reference frequency for the synthesizer, as well as clocks for the analog-to-digital (ADC) and the digital part. To reduce system cost, CC1125 device has high-accuracy frequency estimation and compensation registers to measure and compensate for crystal inaccuracies. This compensation enables the use of lower cost crystals. If a TCXO is used, the CC1125 device automatically turns on and off the TCXO when needed to support low-power modes and Wake-On-Radio operation.

4.3 Receiver

The CC1125 device features a highly flexible receiver. The received RF signal is amplified by the low-noise amplifier (LNA) and is down-converted in quadrature (I/Q) to the intermediate frequency (IF). At IF, the I/Q signals are digitized by the high dynamic-range ADCs.

An advanced automatic gain control (AGC) unit adjusts the front-end gain, and enables the CC1125 device to receive strong and weak signals, even in the presence of strong interferers. High-attenuation channels and data filtering enable reception with strong neighbor channel interferers. The I/Q signal is converted to a phase and magnitude signal to support the FSK and OOK modulation schemes.

NOTE

A novel I/Q compensation algorithm removes any problem of I/Q mismatch, thus avoiding time-consuming and costly I/Q image calibration steps.

4.4 Transmitter

The CC1125 transmitter is based on direct synthesis of the RF frequency (in-loop modulation). To use the spectrum effectively, the CC1125 device has extensive data filtering and shaping in TX mode to support high throughput data communication in narrowband channels. The modulator also controls power ramping to remove issues such as spectral splattering when driving external high-power RF amplifiers.

4.5 Radio Control and User Interface

The CC1125 digital control system is built around the main radio control (MARC), which is implemented using an internal high-performance, 16-bit ultra-low-power processor. MARC handles power modes, radio sequencing, and protocol timing.

A 4-wire SPI serial interface is used for configuration and data buffer access. The digital baseband includes support for channel configuration, packet handling, and data buffering. The host MCU can stay in power-down mode until a valid RF packet is received. This greatly reduces power consumption. When the host MCU receives a valid RF packet, it burst-reads the data. This reduces the required computing power.

The CC1125 radio control and user interface are based on the widely used CC1101 transceiver. This relationship enables an easy transition between the two platforms. The command strobes and the main radio states are the same for the two platforms.

For legacy formats, the CC1125 device also supports two serial modes.

- Synchronous serial mode: The CC1125 device performs bit synchronization and provides the MCU with a bit clock with associated data.
- Transparent mode: The CC1125 device outputs the digital baseband signal using a digital interpolation filter to eliminate jitter introduced by digital filtering and demodulation.

4.6 4.5 Enhanced Wake-On-Radio (eWOR)

eWOR, using a flexible integrated sleep timer, enables automatic receiver polling with no intervention from the MCU. When the CC1125 device enters RX mode, it listens and then returns to sleep if a valid RF packet is not received. The sleep interval and duty cycle can be configured to make a trade-off between network latency and power consumption. Incoming messages are time-stamped to simplify timer re-synchronization.

The eWOR timer runs off an ultra-low-power 32-kHz RC oscillator. To improve timing accuracy, the RC oscillator can be automatically calibrated to the RF crystal in configurable intervals.

4.7 Sniff Mode

The CC1125 device supports quick start up times, and requires few preamble bits. Sniff mode uses these conditions to dramatically reduce the current consumption while the receiver is waiting for data.

Because the CC1125 device can wake up and settle much faster than the duration of most preambles, it is not required to be in RX mode continuously while waiting for a packet to arrive. Instead, the enhanced Wake-On-Radio feature can be used to put the device into sleep mode periodically. By setting an appropriate sleep time, the CC1125 device can wake up and receive the packet when it arrives with no performance loss. This sequence removes the need for accurate timing synchronization between transmitter and receiver, and lets the user trade off current consumption between the transmitter and receiver.

For more information, see the sniff mode design note (SWRA428).

4.8 Antenna Diversity

Antenna diversity can increase performance in a multipath environment. An external antenna switch is required. The CC1201 device uses one of the GPIO pins to automatically control the switch. This device also supports differential output control signals typically used in RF switches.

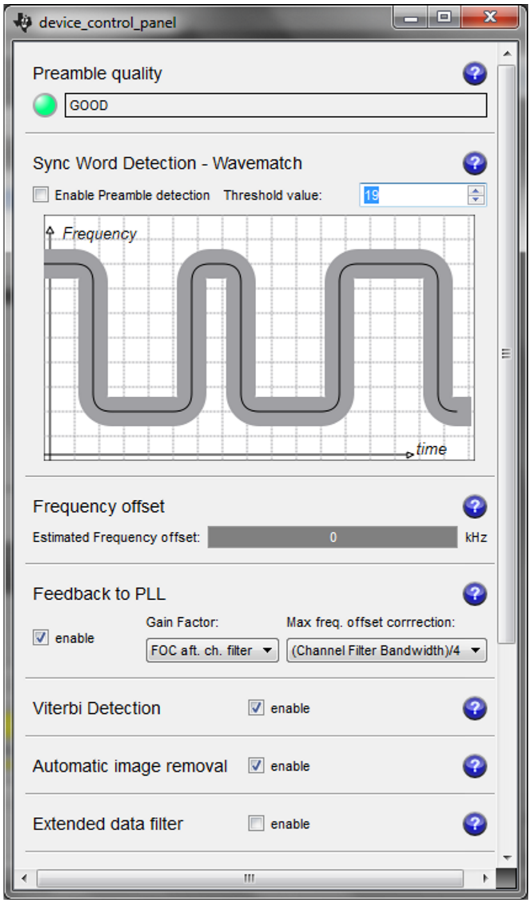
If antenna diversity is enabled, the GPIO alternates between high and low states until a valid RF input signal is detected. An optional acknowledge packet can be transmitted without changing the state of the GPIO.

An incoming RF signal can be validated by received signal strength or by using the automatic preamble detector. Using the automatic preamble detector ensures a more robust system and avoids the need to set a defined signal strength threshold (such a threshold sets the sensitivity limit of the system).

4.9 WaveMatch

Advanced capture logic locks onto the synchronization word and does not require preamble settling bytes. Therefore, receiver settling time is reduced to the settling time of the AGC, typically 4 bits.

The WaveMatch feature also greatly reduces false sync triggering on noise, further reducing the power consumption and improving sensitivity and reliability. The same logic can also be used as a high-performance preamble detector to reliably detect a valid preamble in the channel.



See SWRC046 for more information.

Figure 4-2. Receiver Configurator in SmartRF Studio

5 Typical Application Circuit

NOTE

This section is intended only as an introduction.

Very few external components are required for the operation of the CC1125 device. Figure 5-1 shows a typical application circuit. The board layout will greatly influence the RF performance of the CC1125 device. Figure 5-1 does not show decoupling capacitors for power pins.

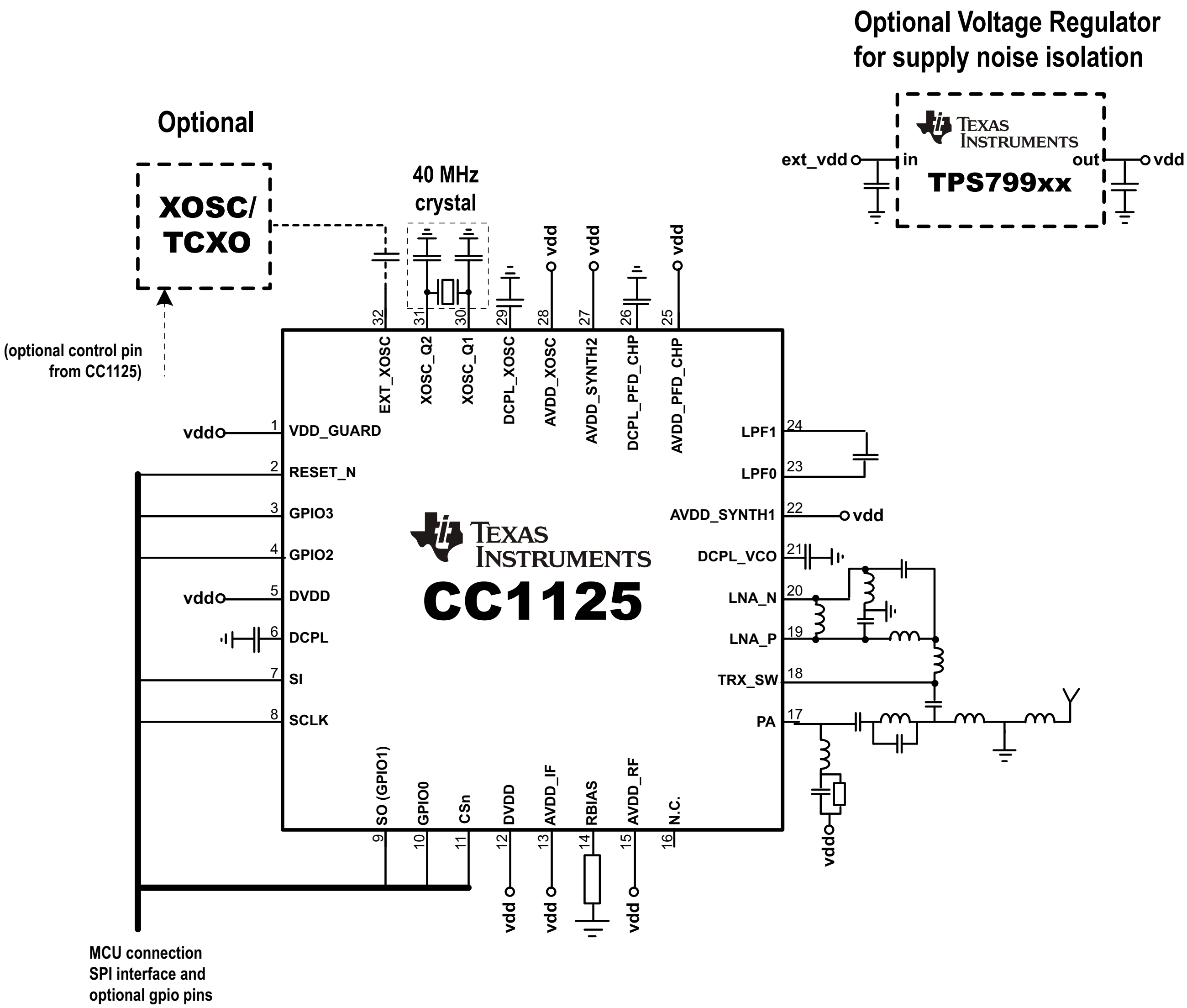


Figure 5-1. Typical Application Circuit

For more information, see the reference designs available for the CC1125 device:

- CC112x IPC 868- and 915-MHz 2-layer Reference Design (SWRR106)
- CC112x IPC 868- and 915-MHz 4-layer Reference Design (SWRR107)
- CC1125EM 169-MHz Reference Design (SWRR100)
- CC1125EM 420- to 470-MHz Reference Design (SWRR101)
- CC1121EM 868- to 915-MHz Reference Design (SWRR102)
- CC1120EM CAT1 868-MHz Reference Design (SWRR097).

6 Configuration Software

The CC1125 device can be configured using the SmartRF™ Studio software (SWRC046). The SmartRF Studio software is highly recommended for obtaining optimum register settings, and for evaluating performance and functionality.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CC1125RHBR	ACTIVE	VQFN	RHB	32	3000	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	CC1125	Samples
CC1125RHBT	ACTIVE	VQFN	RHB	32	250	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	CC1125	Samples
CC1125RHMR	NRND	VQFN	RHM	32	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CC1125	
CC1125RHMT	NRND	VQFN	RHM	32	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	CC1125	

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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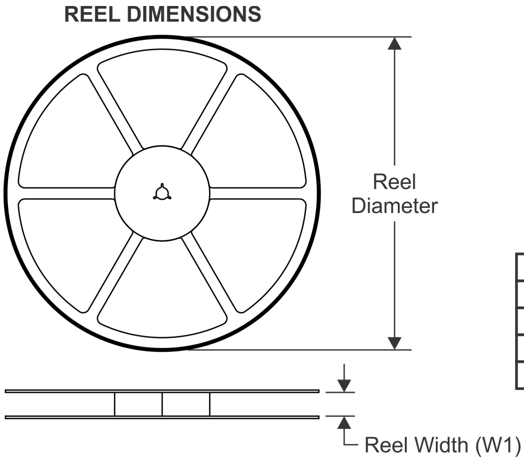
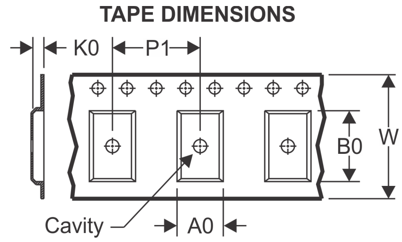
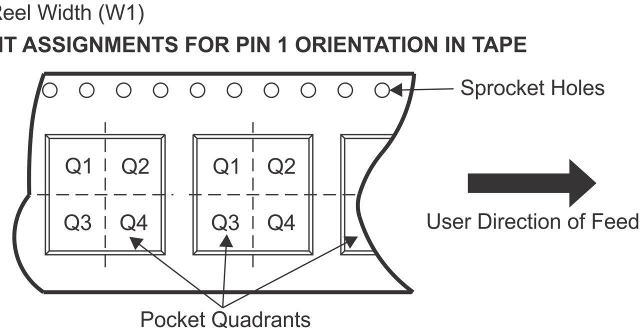
TAPE AND REEL INFORMATION





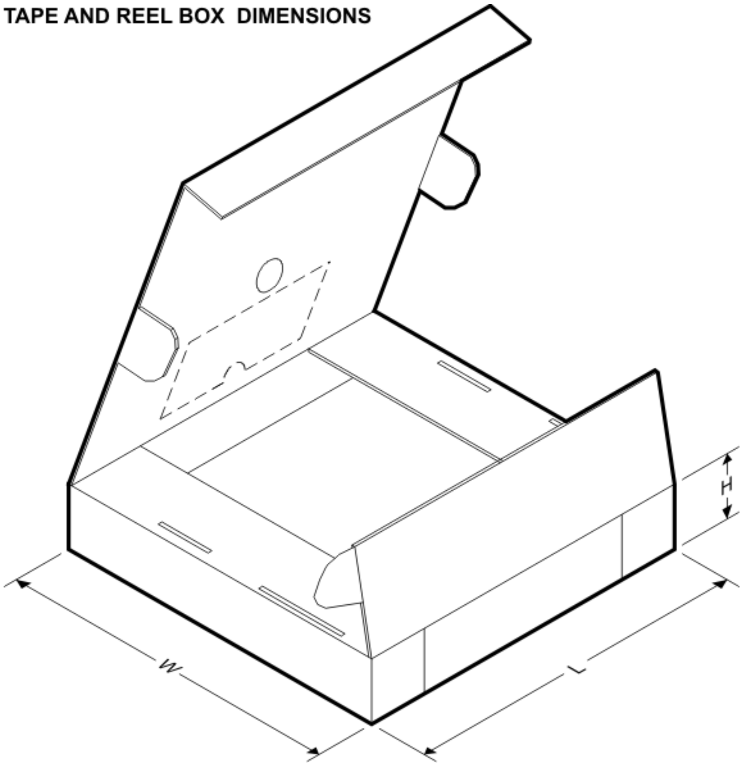
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CC1125RHBR	VQFN	RHB	32	3000	330.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2
CC1125RHBT	VQFN	RHB	32	250	180.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2

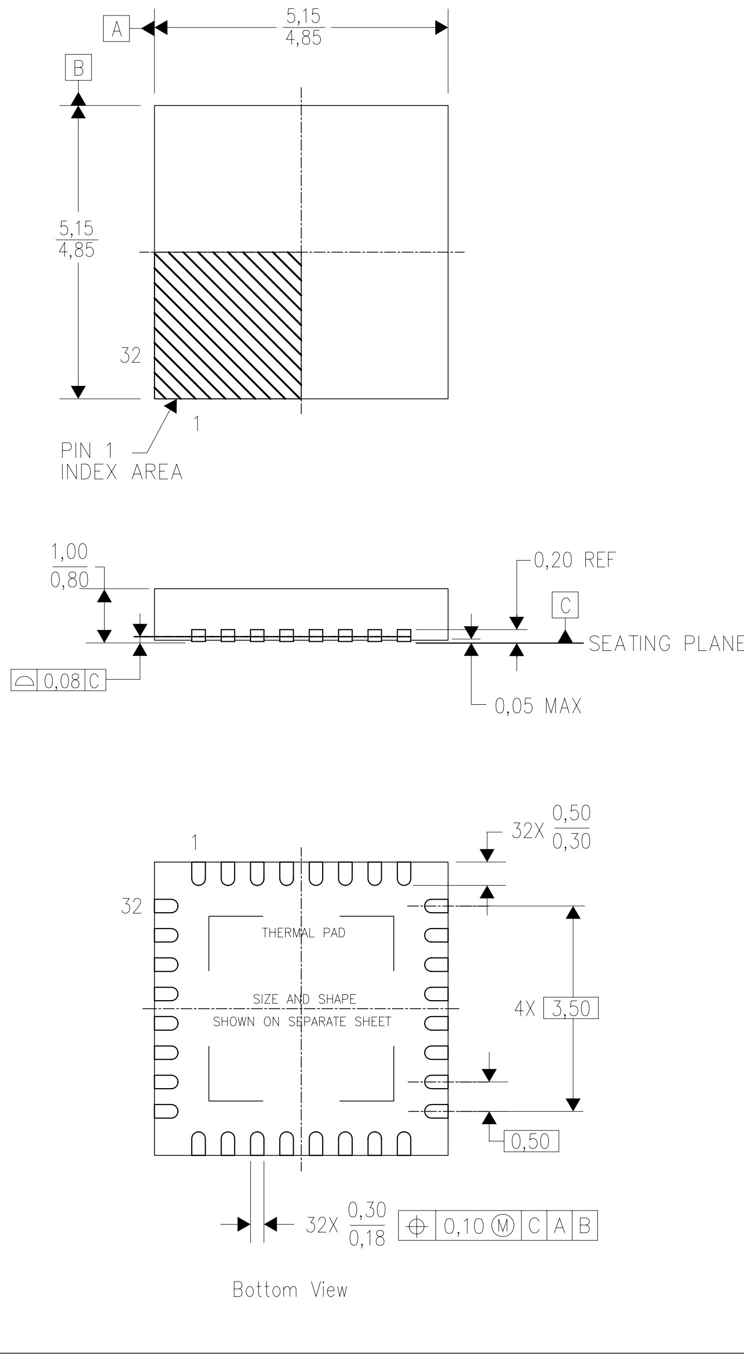
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CC1125RHBR	VQFN	RHB	32	3000	338.1	338.1	20.6
CC1125RHBT	VQFN	RHB	32	250	210.0	185.0	35.0

RHB (S–PVQFN–N32) PLASTIC QUAD FLATPACK NO–LEAD



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–Lead) Package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
F. Falls within JEDEC MO–220.

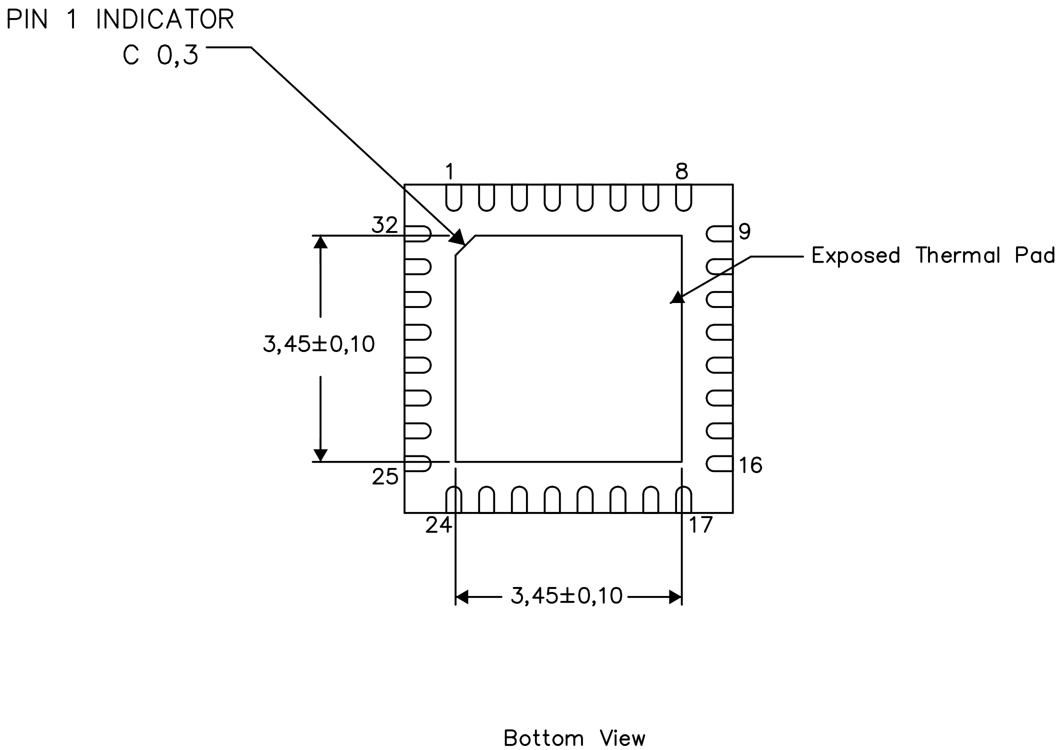
RHB (S-PVQFN-N32) PLASTIC QUAD FLATPACK NO-LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.

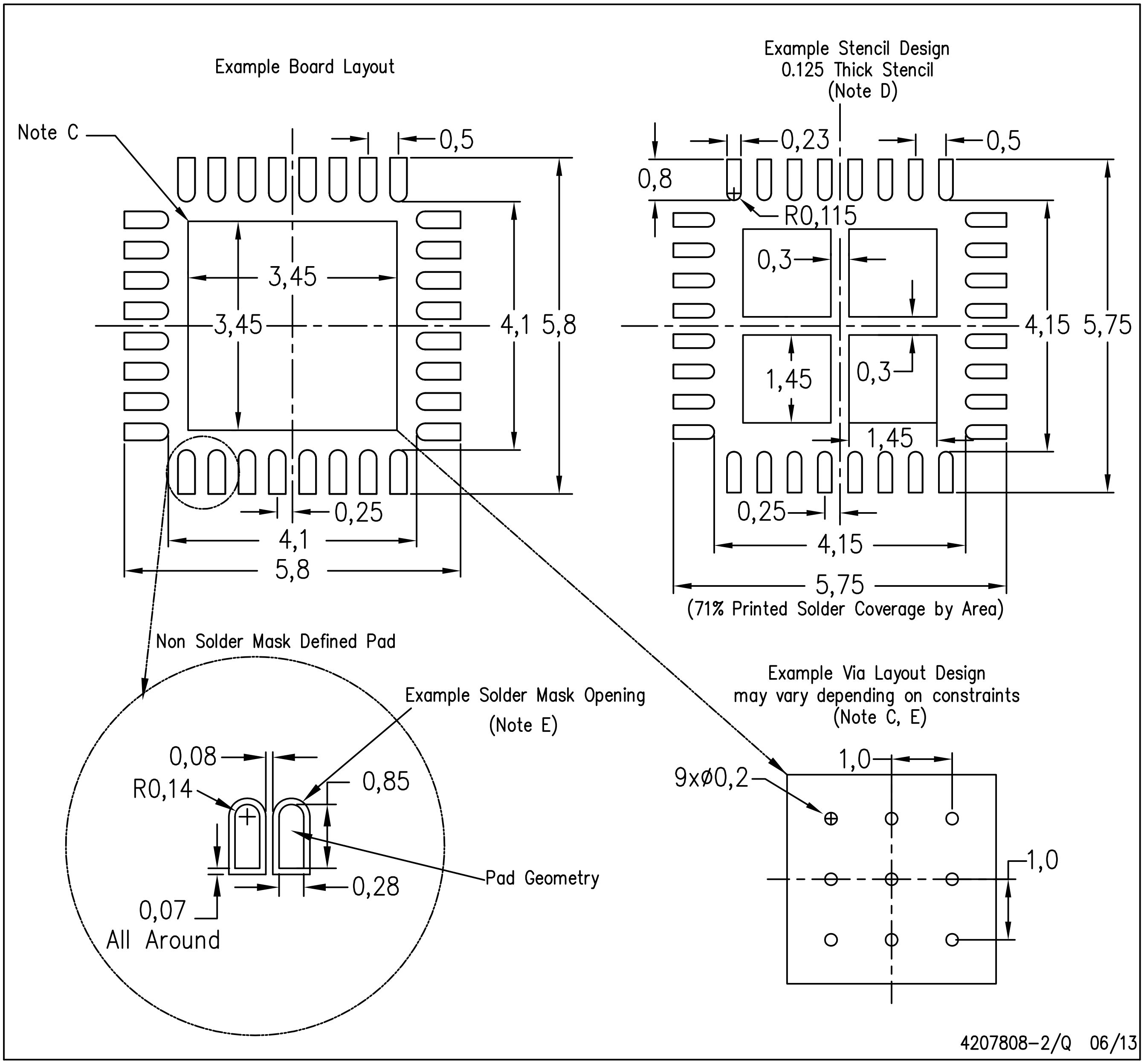


Exposed Thermal Pad Dimensions

4206356-2/Y 06/13

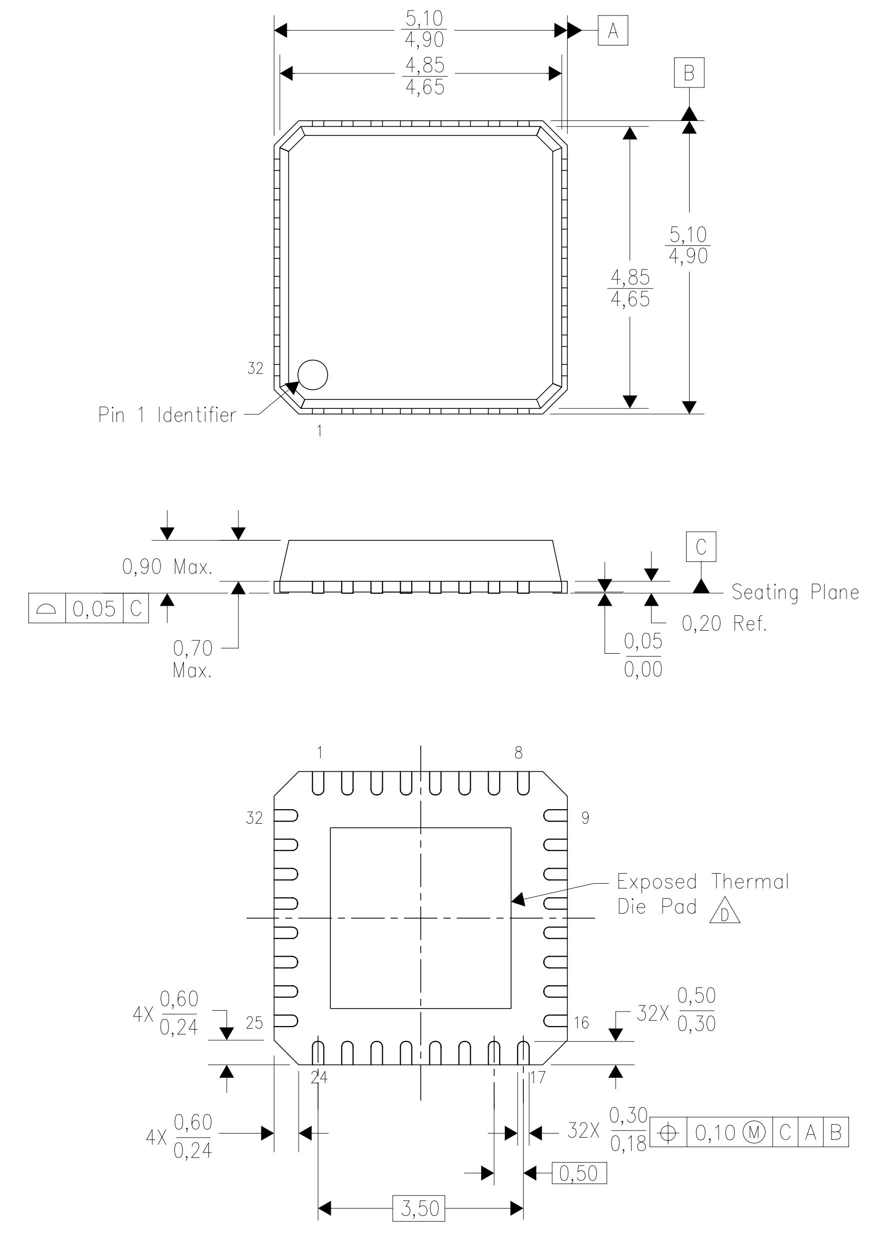
NOTE: A. All linear dimensions are in millimeters

RHB (S-PVQFN-N32) PLASTIC QUAD FLATPACK NO-LEAD



NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
- E. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

RHM (S-PVQFN-N32) PLASTIC QUAD FLATPACK NO-LEAD



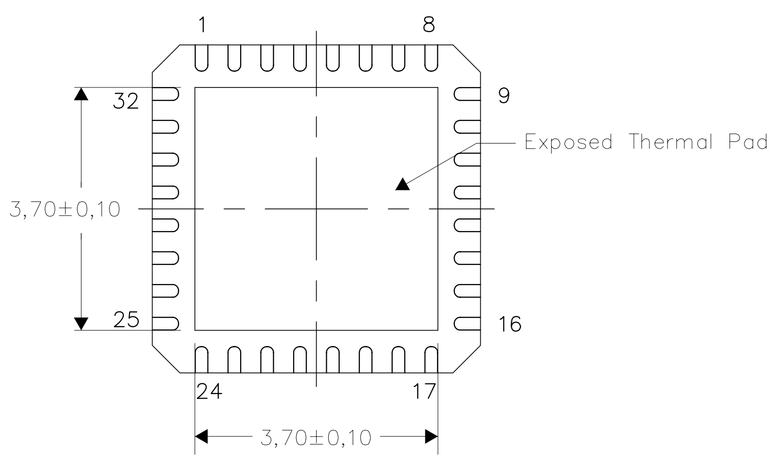
NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
- B. This drawing is subject to change without notice.
- C. QFN (Quad Flatpack No–Lead) Package configuration.
- D. The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.

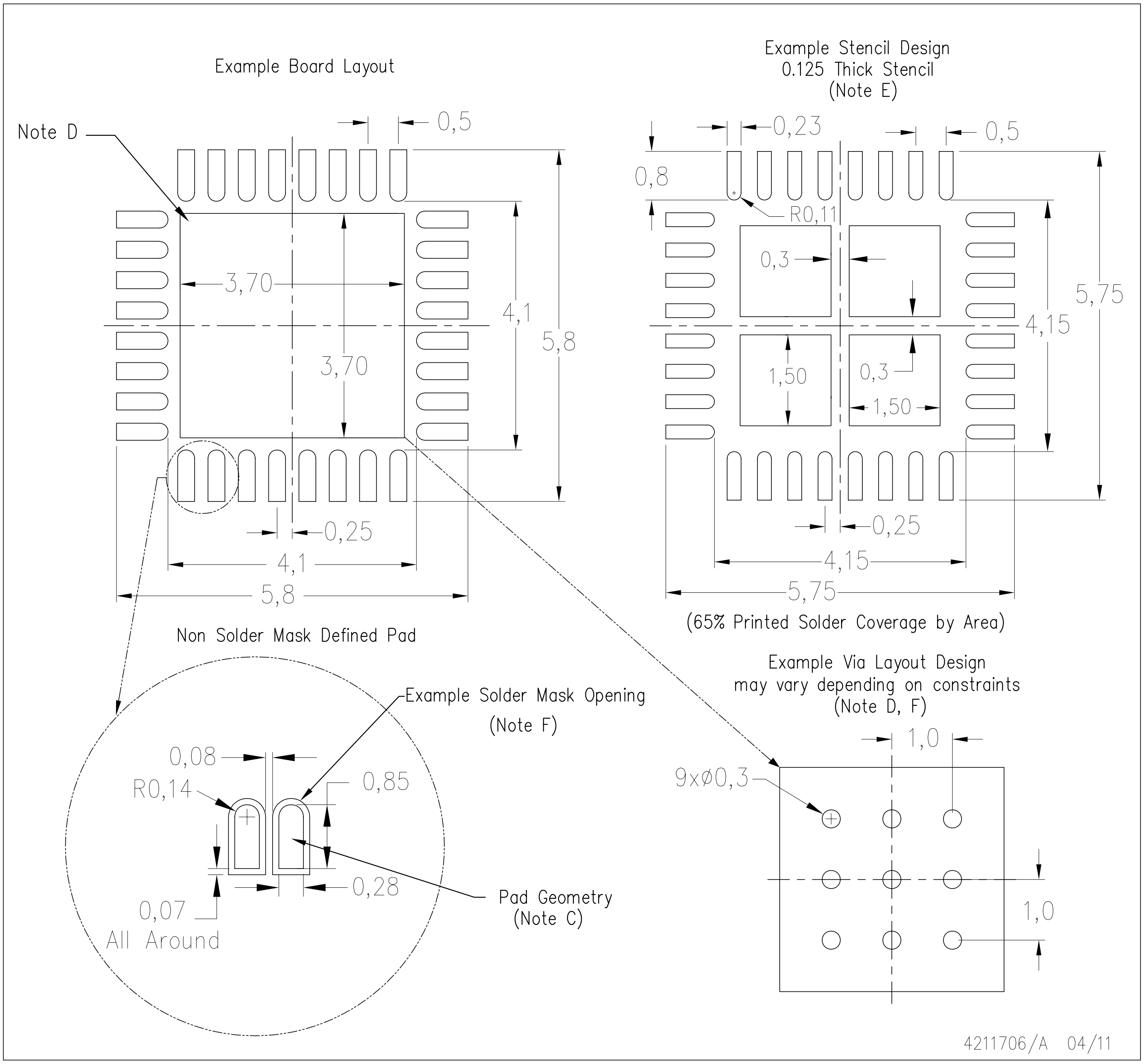


Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

RHM (S-PVQFN-N32) PLASTIC QUAD FLATPACK NO-LEAD



NOTES:

A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC-7351 is recommended for alternate designs.
D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http: //www.ti.com>.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
F. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

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