CC1175 High-Performance RF Transmitter for Narrowband Systems

1 Device Overview

1.1 Features

- High-Performance, Single-Chip Transmitter
  - Very Low Phase Noise: –111 dBc/Hz at 10-kHz Offset
- High Spectral Efficiency (9.6 kbps in 12.5-kHz Channel in Compliance With FCC Narrowbanding Mandate)
- 128-Byte TX FIFO
- Support for Seamless Integration With the CC1190 Device for Increased Range Giving up to +27-dBm Output Power
- Programmable Output Power up to +16 dBm With 0.4-dB Step Size
- Power Supply
  - Wide Supply Voltage Range (2.0 V to 3.6 V)
  - Low Current Consumption:
    - TX: 45 mA at +14 dBm
  - Power Down: 0.12 µA (0.5 µA With Timer Running)
- Automatic Output Power Ramping
- Configurable Data Rates: 0 to 200 kbps
- Supported Modulation Formats: 2-FSK, 2-GFSK, 4-FSK, 4-GFSK, MSK, OOK
- RoHS-Compliant 5-mm x 5-mm No-Lead QFN 32-Pin Package (RHB)
- Regulations – Suitable for Systems Targeting Compliance With
  - **Europe:** ETSI EN 300 220, ETSI EN 54-25
  - **US:** FCC CFR47 Part 15, FCC CFR47 Part 90, 24, and 101
  - **Japan:** ARIB RCR STD-T30, ARIB STD-T67, ARIB STD-T108
- Peripherals and Support Functions
  - TCXO Support and Control, also in Power Modes
  - Optional Coding Gain Feature for Increased Range and Robustness
  - Temperature Sensor

1.2 Applications

- One-way Narrowband Ultra-Low Power Wireless Systems With Channel Spacing Down to 6.25 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

1.3 Description

The CC1175 device is a fully integrated single-chip radio transmitter 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 CC1175 device provides extensive hardware support for packet handling, data buffering, and burst transmissions. The main operating parameters of the CC1175 device can be controlled through an SPI interface. In a typical system, the CC1175 device will be used with a microcontroller and only a few external passive components.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE
CC1175RHB	VQFN (32)	5.00 mm x 5.00 mm

(1) For more information, see Section 8, *Mechanical Packaging and Orderable Information*

1.4 Functional Block Diagram

Figure 1-1 shows the system block diagram of the CC1175 device.

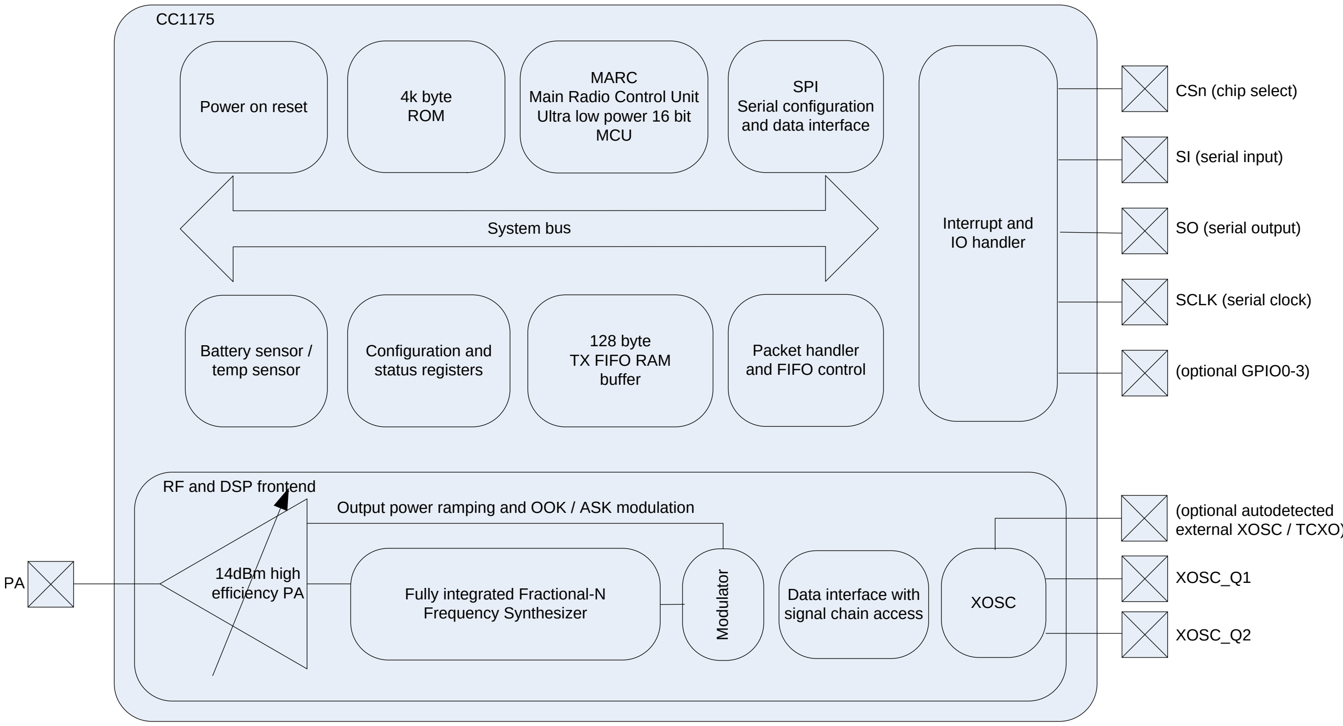

Figure 1-1. Functional Block Diagram

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2 Revision History

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

This data manual revision history highlights the changes made to the SWRS116E device-specific data manual to make it an SWRS116F revision.

Changes from Revision E (June 2014) to Revision F	Page
• Added Ambient to the temperature range condition and removed Tj from Temperature range	7
• Added data to TCXO table	13

3 Terminal Configuration and Functions

3.1 Pin Diagram

Figure 3-1 shows pin names and locations for the CC1175 device.

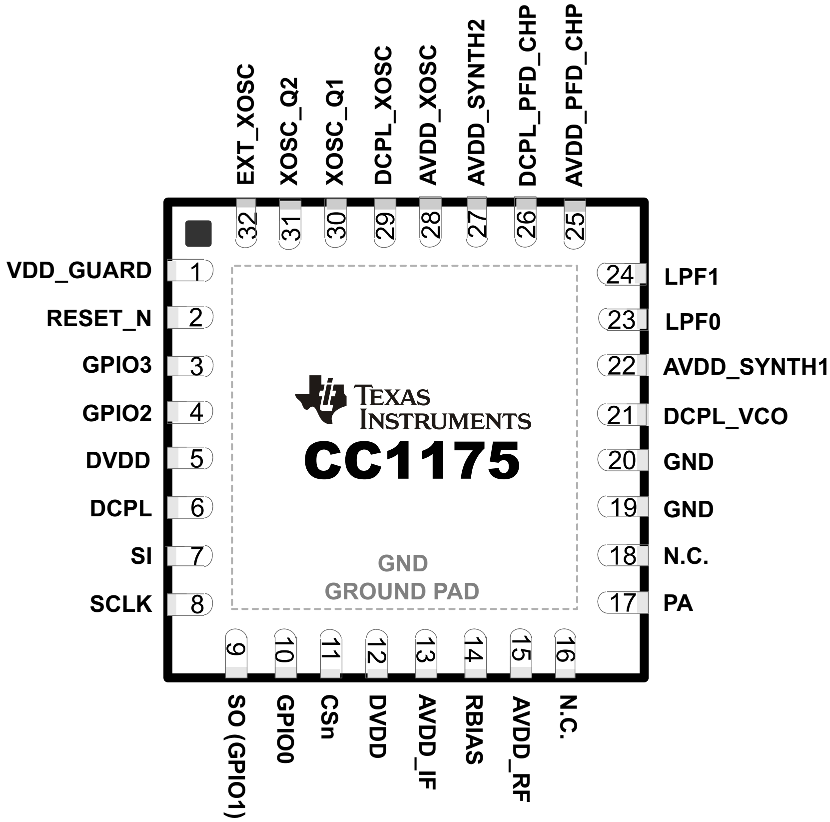


Figure 3-1. Package 5-mm × 5-mm QFN

3.2 Pin Configuration

The following table lists the pin-out configuration for the CC1175 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	N.C.		Not connected
19	GND1	Analog	Analog ground
20	GND0	Analog	Analog ground
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 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.

4.1 Absolute Maximum Ratings(1)(2)

PARAMETER	MIN	MAX	UNIT	CONDITION
Supply voltage (VDD, AVDD_x)	–0.3	3.9	V	All supply pins must have the same voltage
Voltage on any digital pin	–0.3	VDD+0.3	V	max 3.9
Voltage on analog pins (including DCPL pins)	–0.3	2.0	V	

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under general characteristics is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to V_{SS}, unless otherwise noted.

4.2 Handling Ratings

				MIN	MAX	UNIT
T_{stg}	Storage temperature range			–40	125	°C
V_{ESD}	Electrostatic discharge (ESD) performance:	Human body model (HBM), per ANSI/ESDA/JEDEC JS001(1)		–2	2	kV
		Charged device model (CDM), per JESD22-C101(2)	All pins	–500	500	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V HBM allows safe manufacturing with a standard ESD control process.

4.3 Recommended Operating Conditions (General Characteristics)

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
Voltage supply range	2.0		3.6	V	All supply pins must have the same voltage
Voltage on digital inputs	0		VDD	V	
Temperature range	–40		85	°C	Ambient

4.4 Thermal Resistance Characteristics for RHB Package

		°C/W(1)	AIR FLOW (m/s)(2)
$R\theta_{JC}$	Junction-to-case (top)	21.1	0.00
$R\theta_{JB}$	Junction-to-board	5.3	0.00
$R\theta_{JA}$	Junction-to-free air	31.3	0.00
Psi_{JT}	Junction-to-package top	0.2	0.00
Psi_{JB}	Junction-to-board	5.3	0.00
$R\theta_{JC}$	Junction-to-case (bottom)	0.8	0.00

(1) These values are based on a JEDEC-defined 2S2P system (with the exception of the Theta JC [$R\Theta_{JC}$] value, which is based on a JEDEC-defined 1S0P system) and will change based on environment as well as application. For more information, see these EIA/JEDEC standards:
- JESD51-2, *Integrated Circuits Thermal Test Method Environmental Conditions - Natural Convection (Still Air)*
- JESD51-3, *Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*
- JESD51-7, *High Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*
- JESD51-9, *Test Boards for Area Array Surface Mount Package Thermal Measurements*

Power dissipation of 40 mW and an ambient temperature of 25ºC is assumed.
(2) m/s = meters per second

4.5 RF Characteristics

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
Frequency bands	820		960	MHz	
	410		480	MHz	
	(273.3)		(320)	MHz	For more information, see SWRA398, *Using the CC112x/CC1175 at 274 to 320 MHz.*
	164		192	MHz	
	(205)		(240)	MHz	Contact TI for more information about the use of these frequency bands.
	(136.7)		(160)	MHz	
Frequency resolution		30		Hz	In 820– to 960–MHz band
		15		Hz	In 410– to 480–MHz band
		6		Hz	In 164– to 192–MHz band
Data rate	0		200	kbps	Packet mode
	0		100	kbps	Transparent mode
Data rate step size		1e-4		bps	

4.6 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 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 300 220 FCC Part 90 Mask D 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 FCC Part 90 Mask D	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 FCC Part 15.247 FCC Part 15.249	
	410–480 MHz	ETSI EN 300 220	
	164–192 MHz	ETSI EN 300 220	

4.7 Current Consumption, Static Modes

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
Power down with retention		0.12	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

4.8 Current Consumption, Transmit Modes

4.8.1 950-MHz Band (High-Performance Mode)

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
TX current consumption +10 dBm		37		mA	
TX current consumption 0 dBm		26		mA	

4.8.2 868-, 915-, and 920-MHz Bands (High-Performance Mode)

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
TX current consumption +14 dBm		45		mA	
TX current consumption +10 dBm		34		mA	

4.8.3 434-MHz Band (High-Performance Mode)

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
TX current consumption +15 dBm		50		mA	
TX current consumption +14 dBm		45		mA	
TX current consumption +10 dBm		34		mA	

4.8.4 169-MHz Band (High-Performance Mode)

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
TX current consumption +15 dBm		54		mA	
TX current consumption +14 dBm		49		mA	
TX current consumption +10 dBm		41		mA	

4.8.5 Low-Power Mode

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
TX current consumption +10 dBm		32		mA	

4.9 Transmit Parameters

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

4.10 PLL Parameters

4.10.1 High-Performance Mode

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
Phase noise in 950-MHz band		–99		dBc/Hz	± 10 kHz offset
		–99		dBc/Hz	± 100 kHz offset
		–123		dBc/Hz	± 1 MHz offset
Phase noise in 868-, 915-, and 920-MHz bands		–99		dBc/Hz	± 10 kHz offset
		–100		dBc/Hz	± 100 kHz offset
		–122		dBc/Hz	± 1 MHz offset
Phase noise in 433-MHz band		–106		dBc/Hz	± 10 kHz offset
		–107		dBc/Hz	± 100 kHz offset
		–127		dBc/Hz	± 1 MHz offset
Phase noise in 169-MHz band		–111		dBc/Hz	± 10 kHz offset
		–116		dBc/Hz	± 100 kHz offset
		–135		dBc/Hz	± 1 MHz offset

4.10.2 Low-Power Mode

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz if nothing else is 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- and 915-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

4.11 Wake-up and Timing

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
Powerdown to IDLE		0.4		ms	Depends on crystal
IDLE to TX		166		µs	Calibration disabled
		461		µs	Calibration enabled
TX to IDLE time		296		µs	Calibrate when leaving TX enabled
		0		µs	Calibrate when leaving TX disabled
Frequency synthesizer calibration		391		µs	When using SCAL strobe

4.12 High-Speed Crystal Oscillator

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
Crystal frequency	32		44	MHz	It is expected that there will be an increase in spurious emissions when the RF channel is close to multiples of XOSC in TX. We recommend that the level of spurious emissions be evaluated if the RF channel is closer than 1 MHz to multiples of XOSC in TX.
Load capacitance (C_L)		10		pF	
ESR			60	Ω	Simulated over operating conditions
Start-up time		0.4		ms	Depends on crystal

4.13 High-Speed Clock Input (TCXO)

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

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
Clock frequency	32		44	MHz	
TCXO with CMOS output					TCXO with CMOS output directly coupled to pin EXT_OSC
High input voltage	1.4		VDD	V	
Low input voltage	0		0.6	V	
Rise / Fall time			2	ns	
Clipped sine output Clock input amplitude (peak-to-peak)	0.8		1.5	V	TCXO clipped sine output connected to pin EXT_OSC through series capacitor

4.14 32-kHz Clock Input

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

4.15 Low-Speed RC Oscillator

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

4.16 I/O and Reset

T_A = 25°C, VDD = 3.0 V if nothing else is 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	At 4-mA output load or less
Power-on reset threshold		1.3		V	Voltage on DVDD pin

4.17 Temperature Sensor

T_A = 25°C, VDD = 3.0 V if nothing else is 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 CC1175 device can be configured to provide a voltage proportional to temperature on GPIO1. The temperature can be estimated by measuring this voltage (see Section 4.17). For more information, see the temperature sensor design note (SWRA415).

4.18 Typical Characteristics

T_A = 25°C, VDD = 3.0 V, f_c = 869.5 MHz if nothing else is 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 (fxosc = 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 (fxosc = 40 MHz).

Figure 4-6 was measured at the 50-Ω antenna connector.

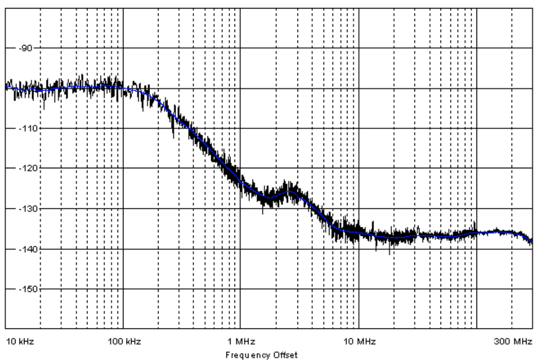


Figure 4-1. Phase Noise in 868-MHz Band

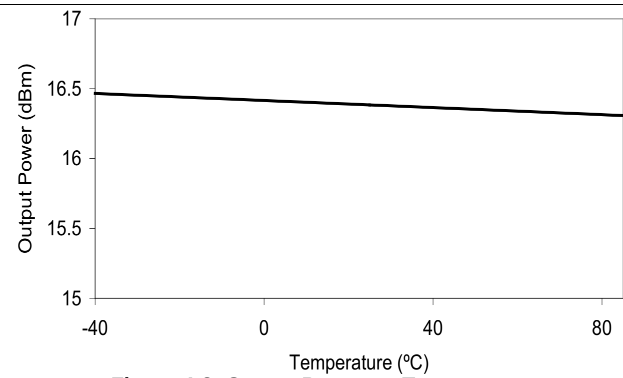


Figure 4-2. Output Power vs Temperature Max Setting, 170 MHz, 3.6 V

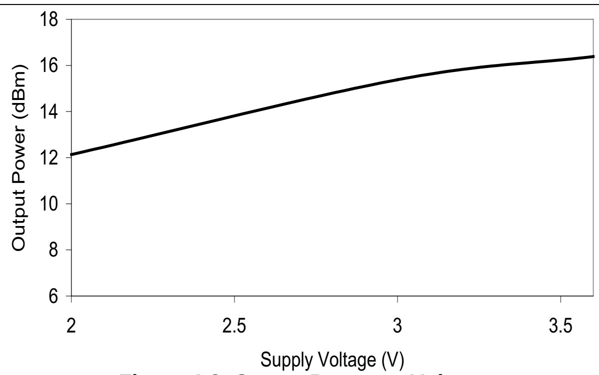


Figure 4-3. Output Power vs Voltage Max Setting, 170 MHz

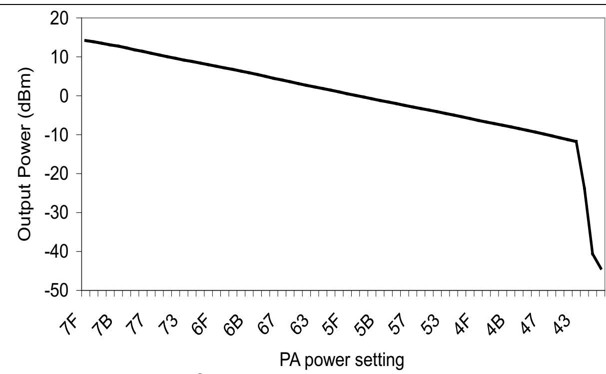


Figure 4-4. Output Power vs PA Power Setting

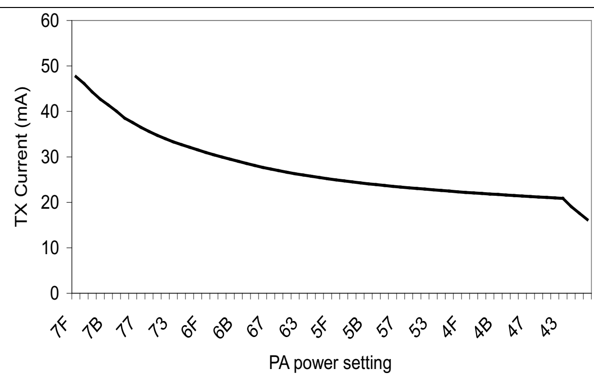


Figure 4-5. TX Current at 868 MHz vs PA Power Setting

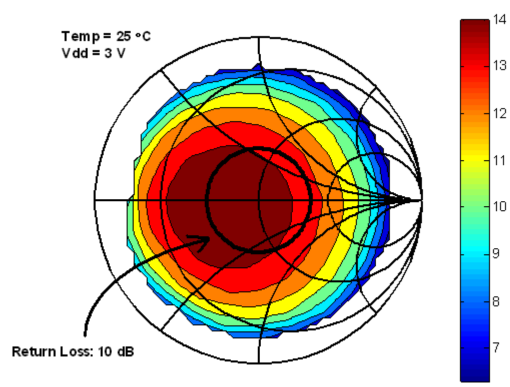
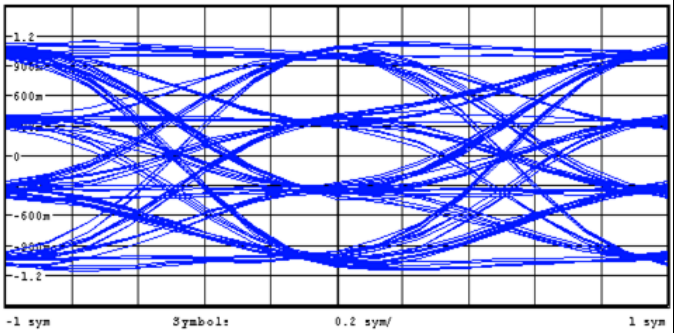
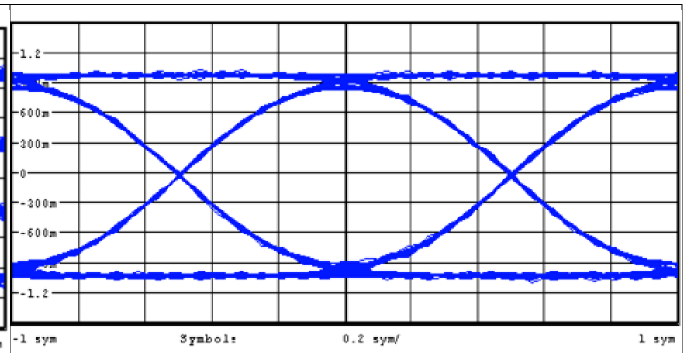


Figure 4-6. Output Power vs Load Impedance (+14-dBm Setting)

Typical Characteristics *(continued)*



200 kbps, DEV = 83 kHz (Outer Symbols), 4GFSK
Figure 4-7. Eye Diagram



1.2 kbps, 2-FSK, DEV = 4 kHz
Figure 4-8. Eye Diagram

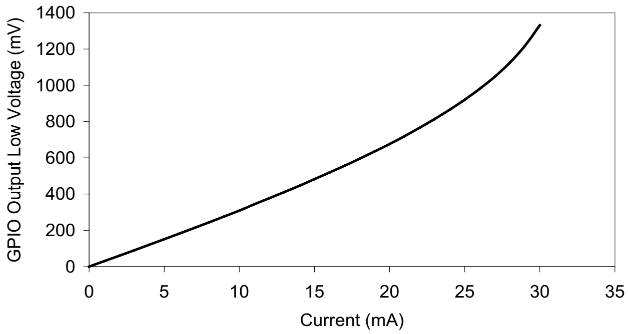


Figure 4-9. GPIO Output Low Voltage vs Current Being Sinked

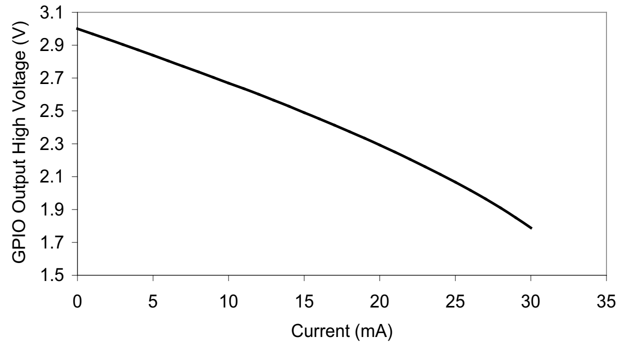
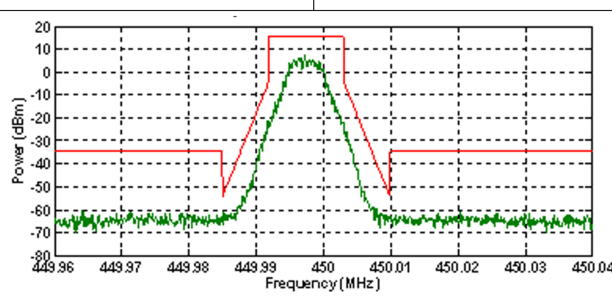


Figure 4-10. GPIO Output High Voltage vs Current Being Sourced



9.6 kbps in 12.5-kHz Channel
Figure 4-11. FCC Part 90 Mask D

5 Detailed Description

5.1 Block Diagram

Figure 5-1 shows the system block diagram of the CC1175 device.

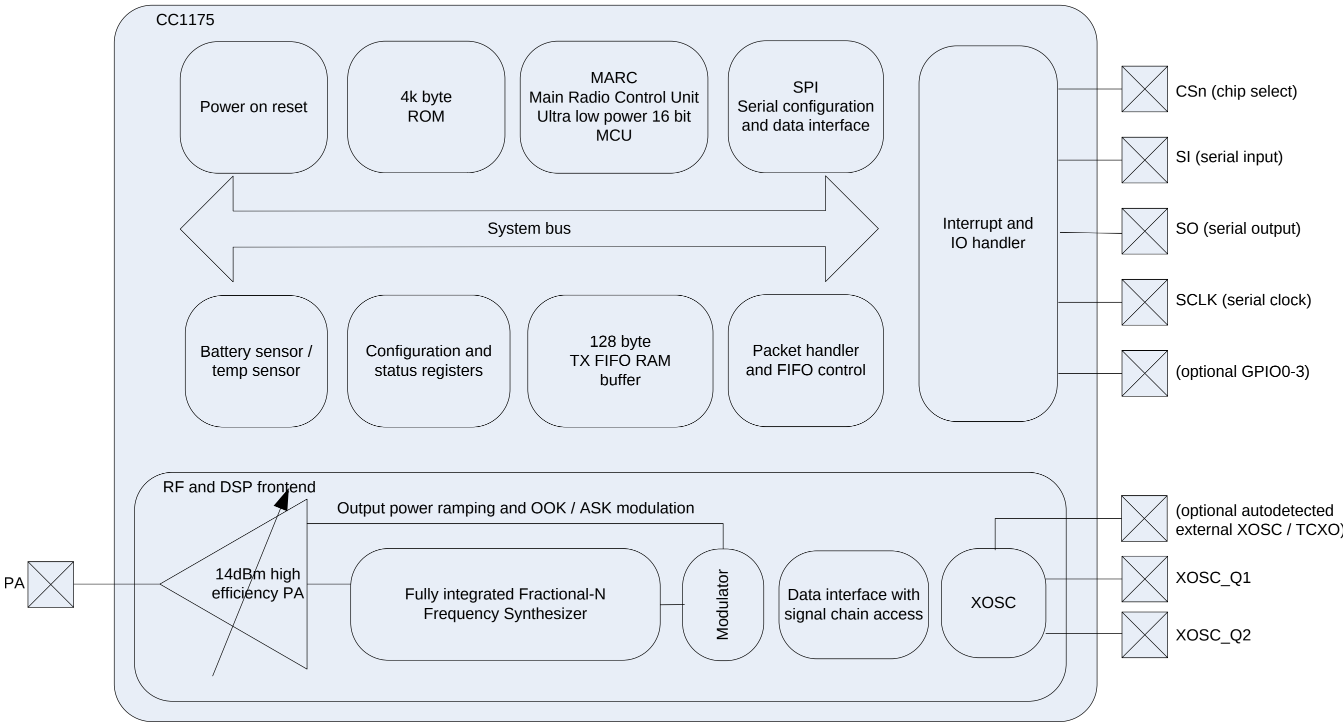


Figure 5-1. System Block Diagram

5.2 Frequency Synthesizer

At the center of the CC1175 device there is a fully integrated, fractional-N, ultra-high-performance frequency synthesizer. The frequency synthesizer is designed for excellent phase noise 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 digital part. If a TCXO is used, the CC1175 device automatically turns on and off the TCXO when needed to support low-power modes.

5.3 Transmitter

The CC1175 transmitter is based on direct synthesis of the RF frequency (in-loop modulation). To achieve effective spectrum usage, the CC1175 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.

The modulator also controls the PA power level to support on/off keying (OOK) and amplitude shift keying (ASK).

5.4 Radio Control and User Interface

The CC1175 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 CC1175 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 CC1175 device also supports two serial modes.

- Synchronous serial mode: The CC1175 device provides the MCU with a bit clock for sampling input data.
- Transparent mode: The CC1175 device samples the input pin at a configurable rate.

5.5 Low-Power and High-Performance Modes

The CC1175 device is highly configurable, enabling trade-offs between power and performance to be made based on the needs of the application. This data sheet describes two modes, low-power mode and high-performance mode, which represent configurations where the device is optimized for either power or performance.

6 Typical Application Circuit

NOTE

This section is intended only as an introduction.

Very few external components are required for the operation of the CC1175 device. Figure 6-1 shows a typical application circuit. The board layout will greatly influence the RF performance of the CC1175 device. Figure 6-1 does not show decoupling capacitors for power pins.

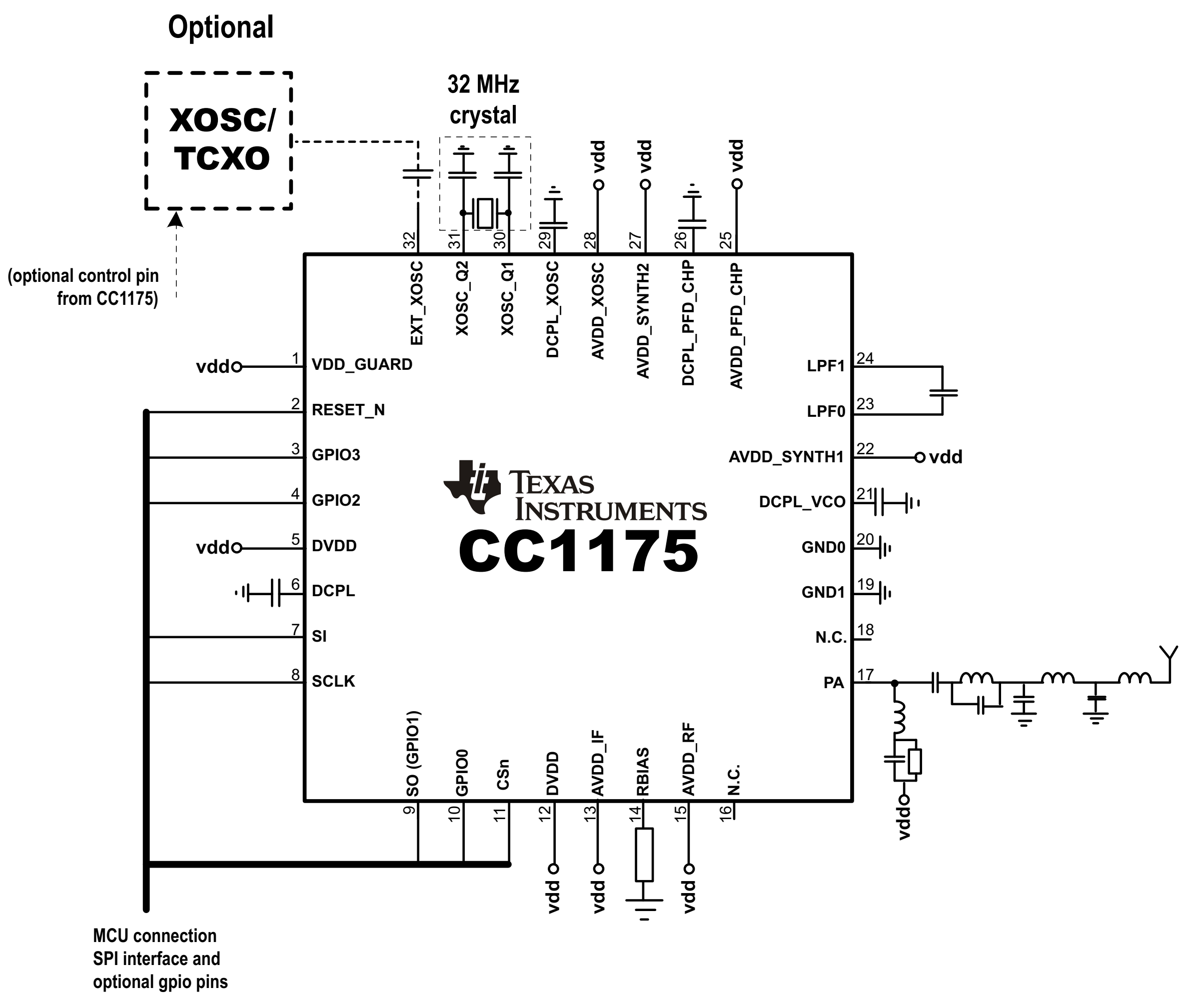


Figure 6-1. Typical Application Circuit

For more information, see the reference designs available for the CC1175 device in Section 7.2, *Documentation Support*.

7 Device and Documentation Support

7.1 Device Support

7.1.1 Development Support

7.1.1.1 Configuration Software

The CC1175 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.

7.1.2 Device and Development-Support Tool Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all microprocessors (MPUs) and support tools. Each device has one of three prefixes: X, P, or null (no prefix) (for example, CC1175). Texas Instruments recommends two of three possible prefix designators for its support tools: TMDX and TMDS. These prefixes represent evolutionary stages of product development from engineering prototypes (TMDX) through fully qualified production devices and tools (TMDS).

Device development evolutionary flow:

X Experimental device that is not necessarily representative of the final device's electrical specifications and may not use production assembly flow.

P Prototype device that is not necessarily the final silicon die and may not necessarily meet final electrical specifications.

null Production version of the silicon die that is fully qualified.

Support tool development evolutionary flow:

TMDX Development-support product that has not yet completed Texas Instruments internal qualification testing.

TMDS Fully qualified development-support product.

X and P devices and TMDX development-support tools are shipped against the following disclaimer:

"Developmental product is intended for internal evaluation purposes."

Production devices and TMDS development-support tools have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (X or P) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate still is undefined. Only qualified production devices are to be used.

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the package type (for example, RHB) and the temperature range (for example, blank is the default commercial temperature range) provides a legend for reading the complete device name for any CC1175 device.

For orderable part numbers of CC1175 devices in the QFN package types, see the Package Option Addendum of this document, the TI website (www.ti.com), or contact your TI sales representative.

7.2 Documentation Support

The following document supplements the CC1175 processor. Copies of these documents are available on the Internet at www.ti.com. *Tip:* Enter the literature number in the search box provided at www.ti.com.

SWRR093 CC1175EM 868- to 915-MHz Reference Design

7.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

TI Embedded Processors Wiki ***Texas Instruments Embedded Processors Wiki.*** Established to help developers get started with Embedded Processors from Texas Instruments and to foster innovation and growth of general knowledge about the hardware and software surrounding these devices.

7.4 Trademarks

SmartRF, E2E are trademarks of Texas Instruments.

7.5 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.6 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

8 Mechanical Packaging and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CC1175RHBR	ACTIVE	VQFN	RHB	32	3000	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	CC1175	Samples
CC1175RHBT	ACTIVE	VQFN	RHB	32	250	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	CC1175	Samples
CC1175RHMR	OBSOLETE	VQFN	RHM	32		TBD	Call TI	Call TI	-40 to 85	CC1175	

(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.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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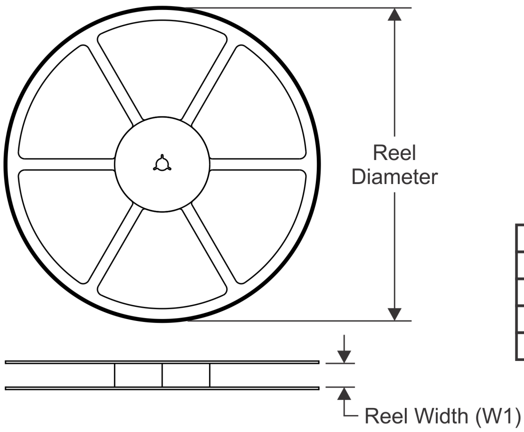
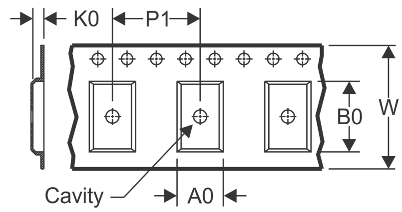
TAPE AND REEL INFORMATION

REEL DIMENSIONS

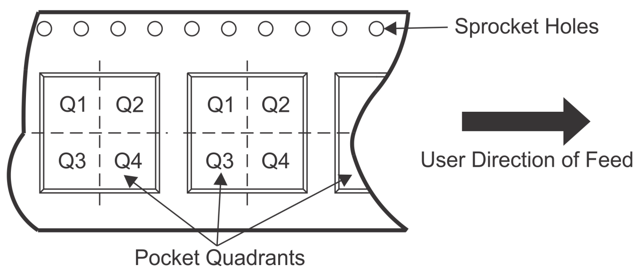


TAPE DIMENSIONS



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

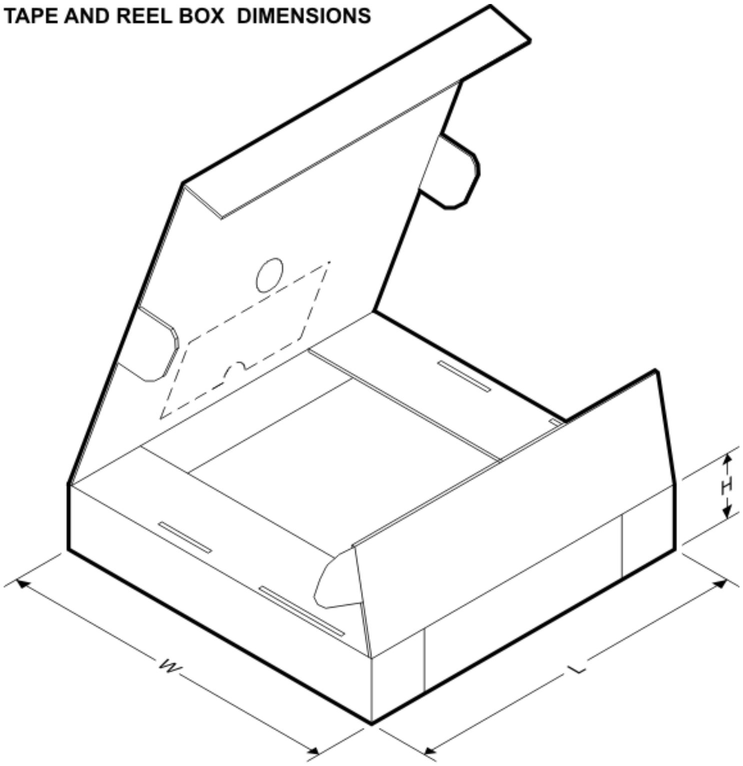
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
CC1175RHBR	VQFN	RHB	32	3000	330.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2
CC1175RHBT	VQFN	RHB	32	250	180.0	12.4	5.3	5.3	1.5	8.0	12.0	Q2

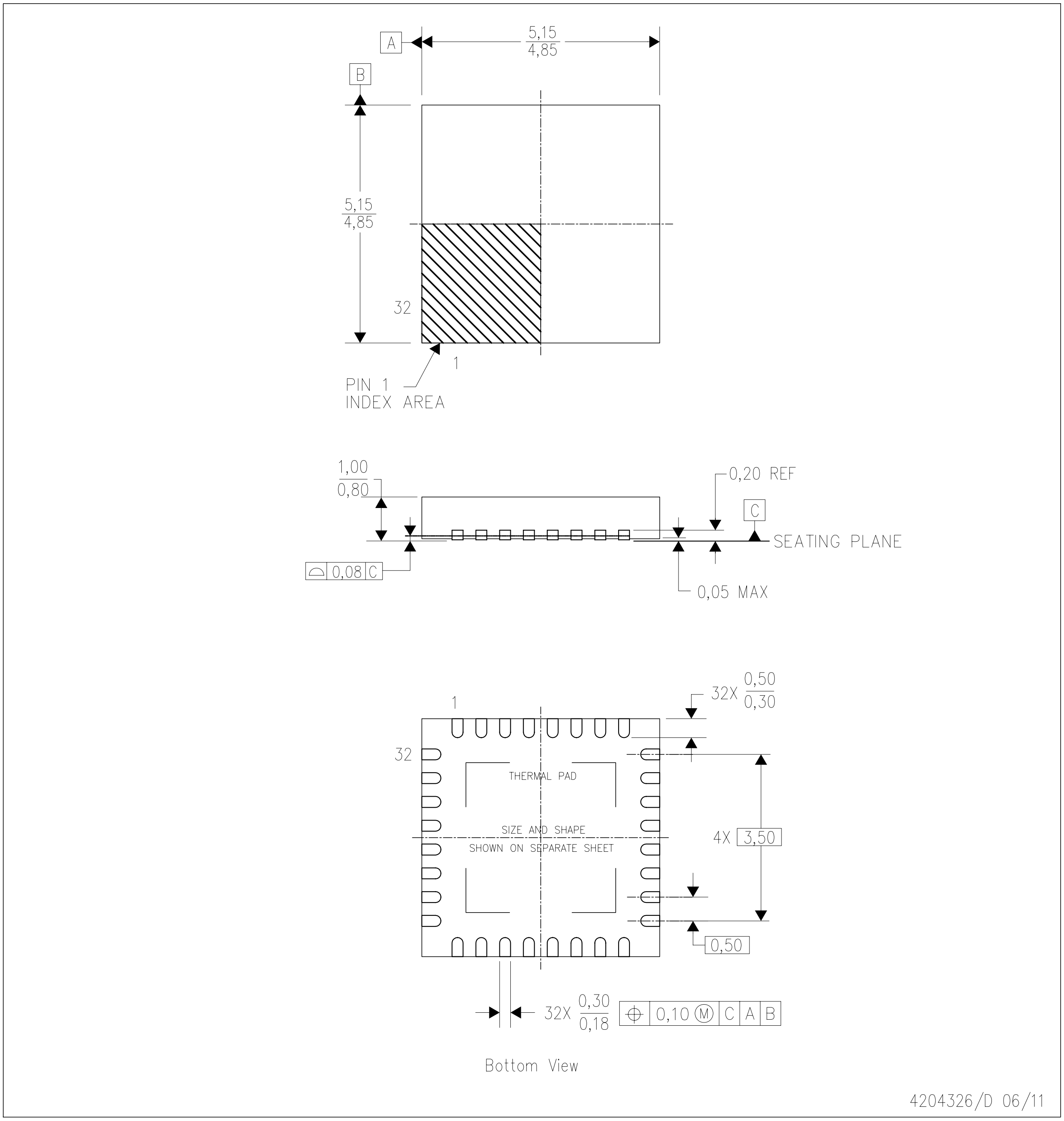
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CC1175RHBR	VQFN	RHB	32	3000	338.1	338.1	20.6
CC1175RHBT	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.

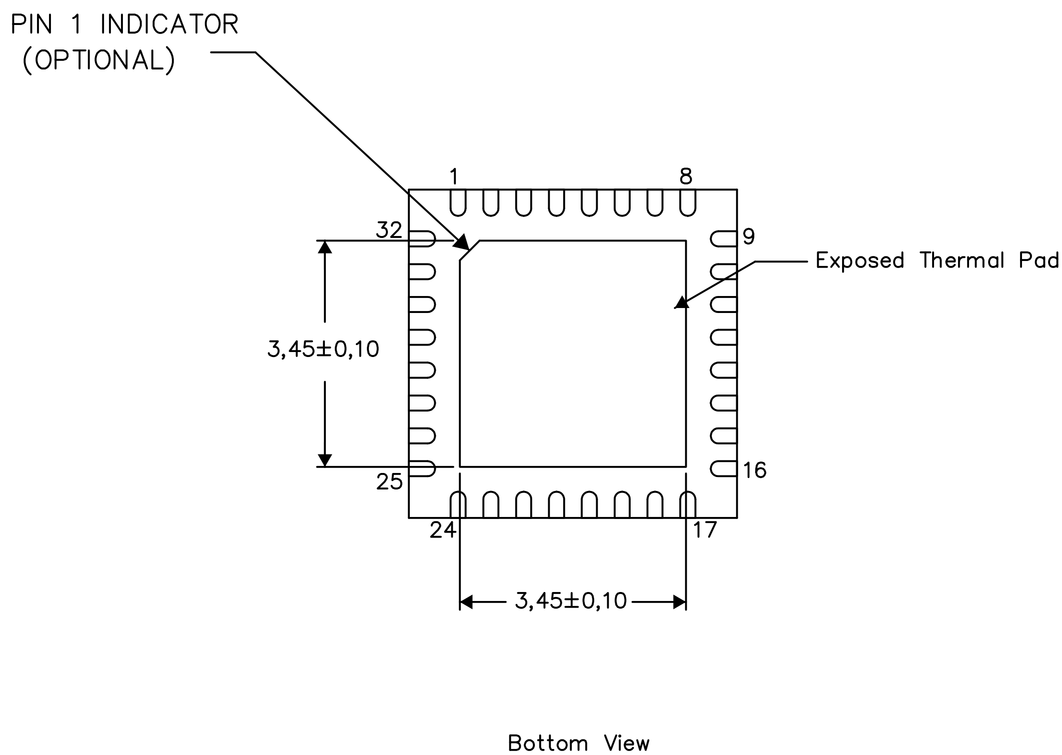
RHB (S-PVQFN-N32) PLASTIC QUAD FLATPACK NO-LEAD

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.

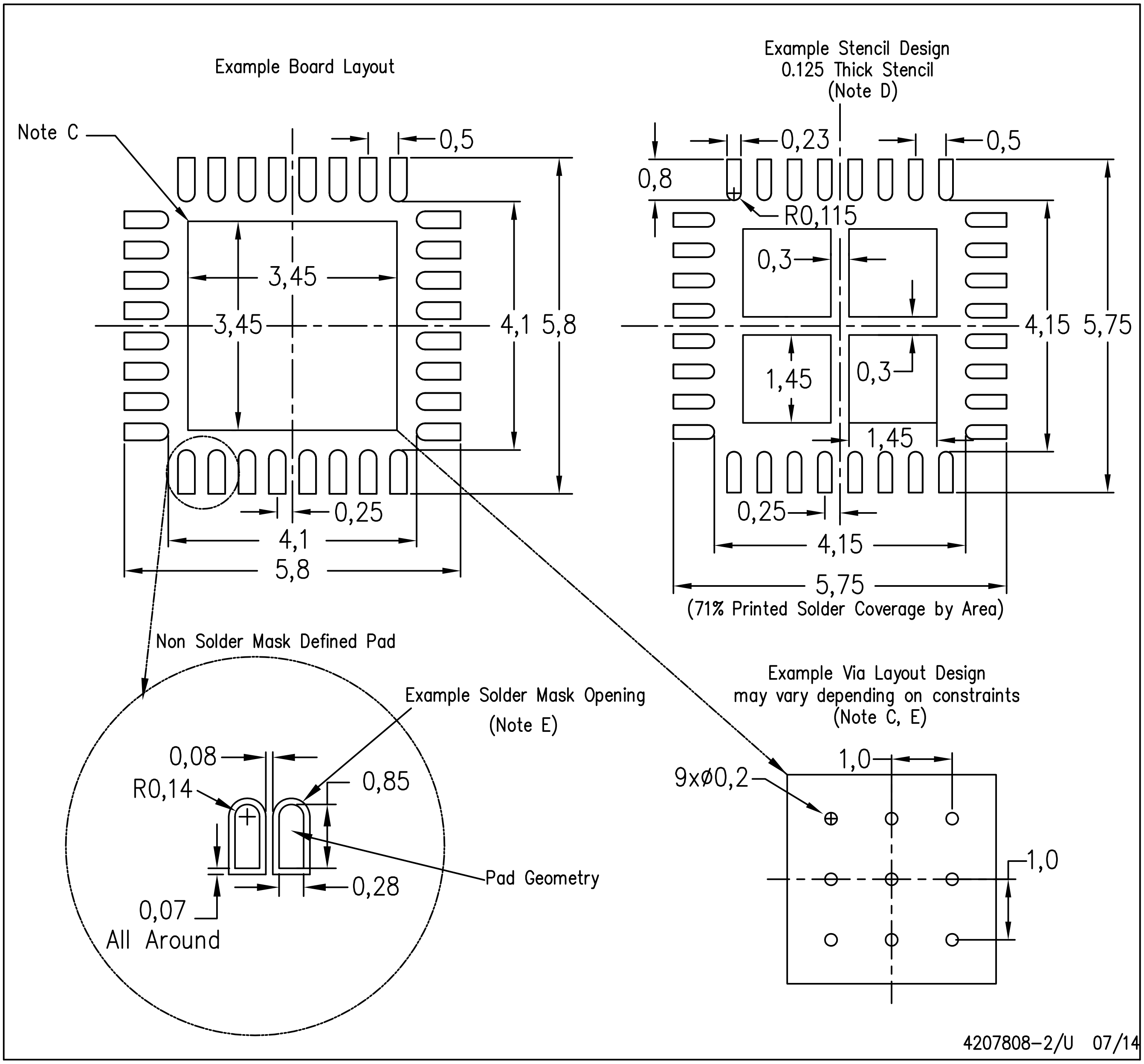


Exposed Thermal Pad Dimensions

4206356-2/AB 07/14

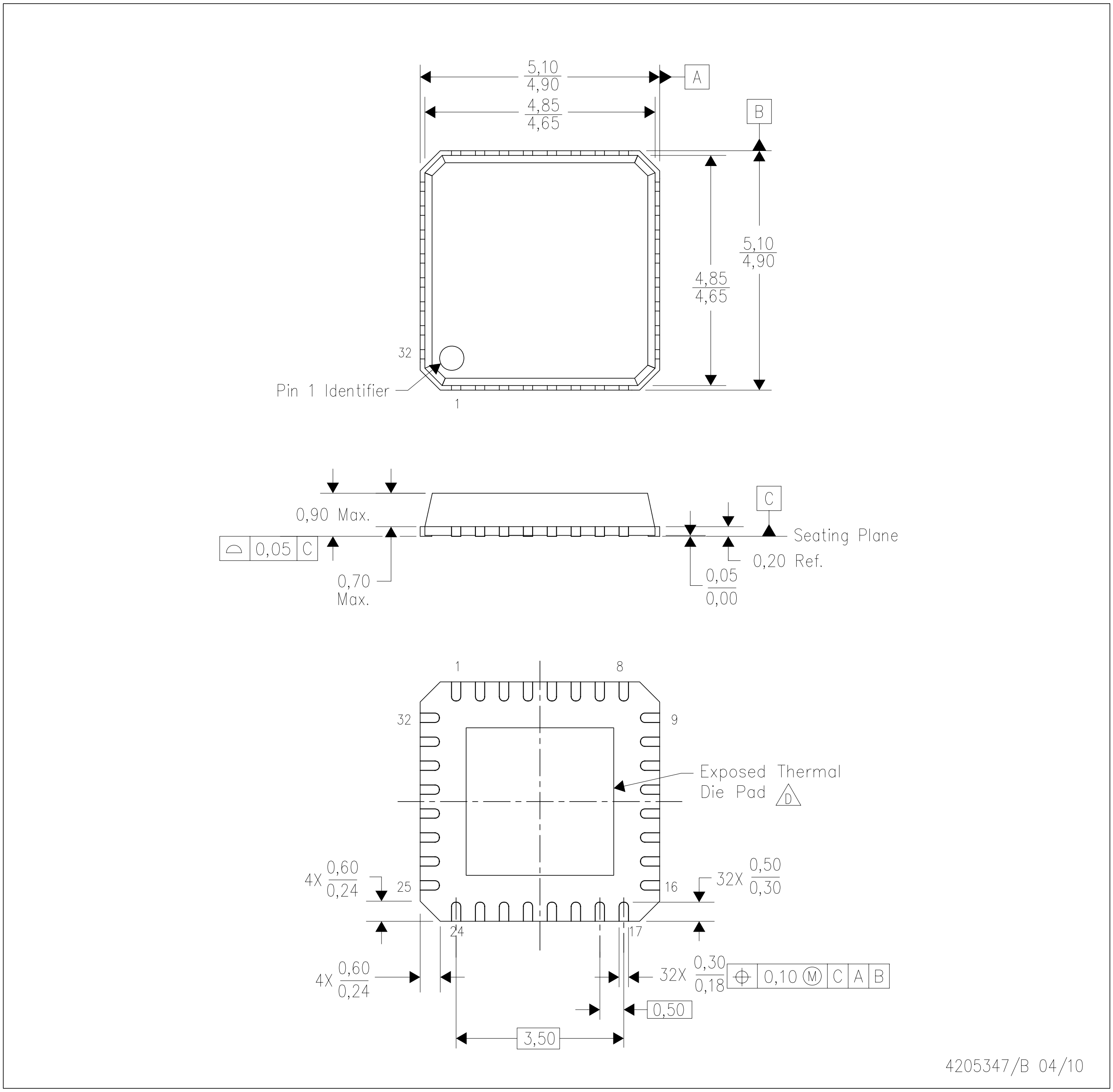
NOTE: A. All linear dimensions are in millimeters

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 any larger diameter 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.

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