System-on-Chip for 2.4 GHz ZigBee®/ IEEE 802.15.4 with Location Engine

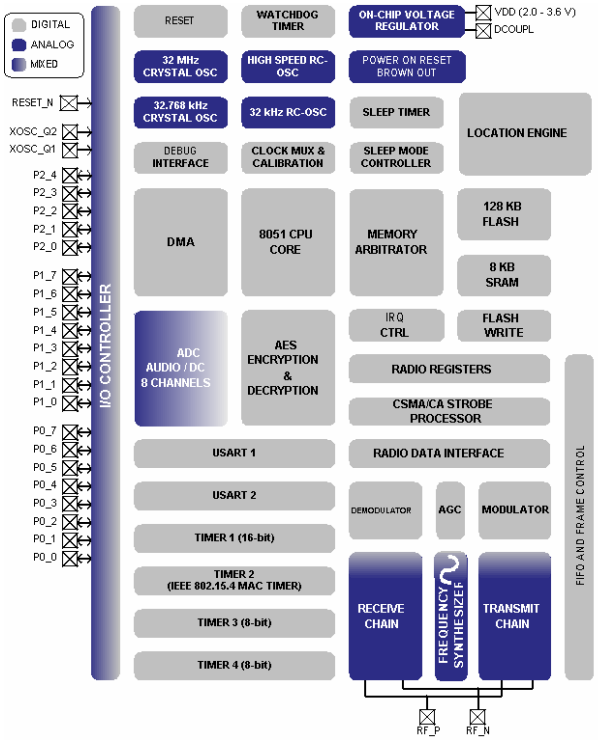
Applications

- *ZigBee® systems*
- *2.4 GHz IEEE 802.15.4 systems*
- *Home/building automation*
- *Industrial Control and Monitoring*
- *Low power wireless sensor networks*
- *Access Control*
- *PC peripherals*
- *Set-top boxes and remote controls*
- *Consumer Electronics*
- *Container/Vehicle Tracking*
- *Active RFID*
- *Inventory Control*

Product Description

The ***CC2431*** is a true System-On-Chip (SOC) for wireless sensor networking ZigBee®/IEEE 802.15.4 solutions. The chip includes a location detection hardware module that can be used in so-called blind nodes (i.e. nodes with unknown location) to receive signals from nodes with known location's. Based on this the location engine calculates an estimate of a blind node's position. The ***CC2431*** enables ZigBee® nodes to be built with very low total bill-of-material costs. The ***CC2431*** combines the excellent performance of the leading ***CC2420*** RF transceiver with an industry-standard enhanced 8051 MCU, 128 KB flash memory, 8 KB RAM and many other powerful features. Combined with the industry leading ZigBee® protocol stack (Z-Stack™) from Texas Instruments, the ***CC2431*** provides the market's most competitive ZigBee® solution.

The ***CC2431*** is highly suited for systems where ultra low power consumption is required. This is achieved by various operating modes. Short transition times between these modes further ensure low power consumption.



Key Features

- Location Engine calculates the location of a node in a network
- High performance and low power 8051 microcontroller core.
- 2.4 GHz IEEE 802.15.4 compliant RF transceiver (industry leading ***CC2420*** radio core).
- ZigBee® protocol stack (Z-Stack™) from Texas Instruments includes support for ***CC2431*** 's location engine.
- Excellent receiver sensitivity and robustness to interferers
- 128 KB in-system programmable flash
- 8 KB RAM, 4 KB with data retention in all power modes
- Powerful DMA functionality
- Very few external components
- Only a single crystal needed for mesh network systems
- Low current consumption (RX: 27 mA, TX: 27 mA, microcontroller running at 32 MHz)
- Only 0.5µA current consumption in power-down mode, where external interrupts or the RTC can wake up the system
- 0.3 µA current consumption in power-down mode, where external interrupts can wake up the system
- Very fast transition times from low-power modes to active mode enables ultra low average power consumption in low duty-cycle systems
- CSMA/CA hardware support
- Wide supply voltage range (2.0 V – 3.6 V)
- Digital RSSI/ LQI support
- Battery monitor and temperature sensor
- ADC with up to eight inputs and configurable resolution
- 128-bit AES security coprocessor

Key Features (continued)

- Two powerful USARTs with support for several serial protocols.
- Hardware debug support
- Watchdog timer
- One IEEE 802.15.4 MAC Timer, one general 16-bit timer and two 8-bit timers
- RoHS compliant 7x7 mm QLP48 package
- 21 general I/O pins, two with 20 mA sink/source capability
- Powerful and flexible development tools available

Note:

The CC2431 and the CC2430 are pin compatible, and the MCU and RF parts of the CC2430-F128 are identical to the CC2431 except the Location Engine. This data sheet complements the CC2430 data sheet with a description of the Location Engine. For complete information about the CC2431, please refer to the CC2430 data sheet in addition to this data sheet. The CC2430 data sheet can be found here:

http://focus.ti.com/lit/ds/symlink/cc2430.pdf

Table Of Contents

1 Register conventions

Each RF register is described in a separate table. The table heading is given in the following format:

REGISTER NAME (XDATA Address)

In the register descriptions, each register bit is shown with a symbol indicating the access mode of the register bit. The register values are always given in binary notation unless prefixed by '0x' which indicates hexadecimal notation.

Table 1: Register bit conventions

Symbol	Access Mode
R/W	Read/write
R	Read only
R0	Read as 0
R1	Read as 1
W	Write only
W0	Write as 0
W1	Write as 1
H0	Hardware clear
H1	Hardware set

2 Location Engine

The Location Engine is used to estimate the position of nodes in an ad-hoc wireless network. Reference nodes exist with known coordinates, typically because they are part of an installed infrastructure. Other nodes are *blind nodes*, whose coordinates need to be estimated. These blind nodes are often mobile and attached to assets that need to be tracked.

The Location Engine implements a distributed computation algorithm that uses received signal strength indicator (RSSI) values from known reference nodes. Performing location calculations at the node level reduces network traffic and communication delays otherwise present in a centralized computation approach.

The Location Engine has the following main features:

- 3 to 16 reference nodes can be used for the location estimation algorithm
- Location estimate with readout resolution of 0.25 meters (note: The accuracy of the location estimate will depend on several factors described below).
- Time to estimate node location is 50 µs to 13 ms
- Location range 64 x 64 meters
- Runs location estimation with minimum CPU usage

To achieve the best possible accuracy one should use antennas that have near-isotropic radiation characteristics. The location error depends on signal environment, deployment pattern of reference nodes and the density of reference nodes in a given area. In general, having more reference nodes available improves the accuracy of the location estimation.

2.1 Location Engine Operation

This section describes the basic steps required to obtain location estimates from the Location Engine.

The Location Engine requires a set of three to 16 reference coordinates to be input together with a set of measured parameters. The output from the Location Engine consists of a pair of estimated location coordinates.

Before any input data is written, the Location Engine must be enabled by writing a 1 to the enable bit, `LOCENG.EN`. When the Location Engine is not in use, writing a 0 to `LOCENG.EN` will reduce the power consumption of the CC2431 by gating off the Engine's clock signal.

Figure 1 shows the basic operation of the Location Engine.

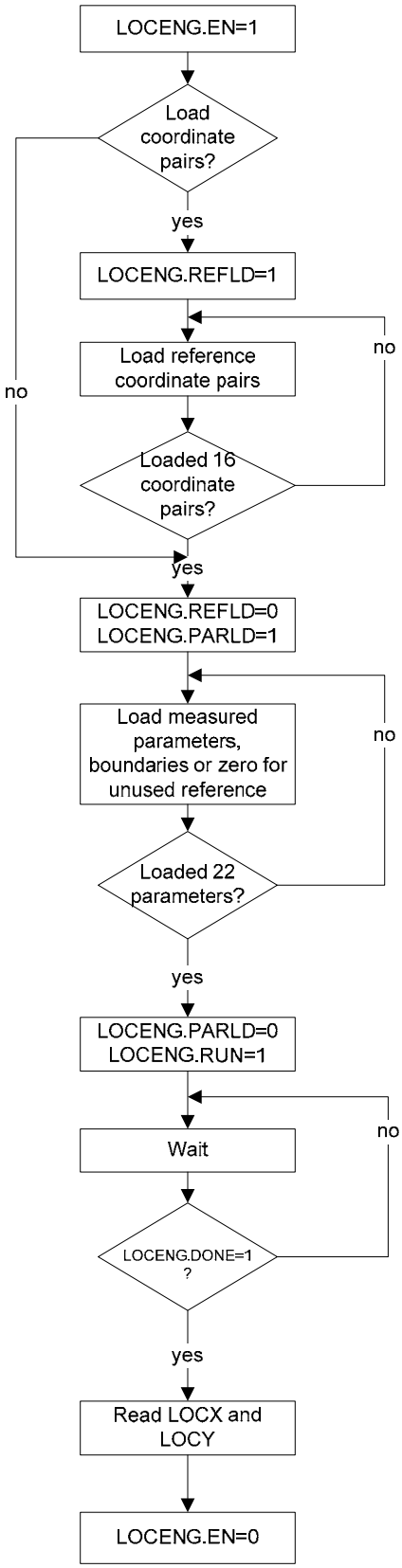


Figure 1: Location Engine Operation

2.1.1 Reference Coordinates

The Location Engine requires a set of between three and 16 reference coordinates [x0, y0, x1, y1, …, x15, y15] to be input. The reference coordinates express each reference nodes position in meters, as unsigned values in the interval [0, 63.75] meters. The finest possible readout resolution is 0.25 meter. The format used is fixed-point data with the two LSBs representing the fractional part and the remaining six bits representing the integer part, thus e.g. 63.75 is represented as 0xFF.

Reference coordinates are loaded into the RF register REFCOORD. Before writing to REFCOORD, a 1 must be written to the register bit LOCENG.REFLD to indicate that a set of reference coordinates are being written. Once the coordinate load process commences (LOCENG.REFLD =1), 16 coordinate pairs must always be written. However, it is possible for the Location Engine to use less than 16 reference coordinates, by marking certain reference coordinates as unused. Zeros shall be used to fill the unused reference coordinate slots, and they will be interpreted as unused when 0.0 is loaded as the RSSI value for those reference coordinates.

The reference coordinates are written in the order [x0, y0, x1, y1, …, x15, y15] to the register REFCOORD. After all coordinates have been written, a 0 is written to the register bit LOCENG.REFLD.

2.1.2 Measured Parameters

After the reference coordinates have been written, a set of measured parameters must be input to the Location Engine. These parameters consist of two radio parameters: Four search boundary coordinates and 16 RSSI values. The radio parameters are the values *A* and *n*. These radio parameters are used in the Engine's algorithm used to find the estimated location. The parameters *A* and *n* can be adjusted to describe the propagation environment in which a network of devices will operate.

2.1.2.1 Parameter Definitions

The measured parameters are described in this section together with how these should be estimated.

2.1.2.1.1 Parameter A

The radio parameter *A* is defined as the absolute value of the average power in dBm received at a close-in reference distance of one meter from the transmitter, assuming an omni-directional radiation pattern. For example, if the mean received power at one meter is -40 dBm, the parameter *A* is specified as 40.

The Engine expects the parameter *A* to be in the range [30.0, 50.0] with precision 0.5. The parameter A is given as an unsigned fixed-point value where the LSB bit is the fractional bit and the remaining bits are the integer part. A typical value for *A* is 40.0.

2.1.2.1.2 Parameter n

The radio parameter *n* is defined as the path loss exponent that describes the rate at which the signal power decays with increasing distance from the transmitter. This decay is proportional to d^n where *d* is the distance between transmitter and receiver.

The actual parameter *n* value written to the Location Engine is an integer index value selected from a lookup table shown in Table 2.

As an example, in the case when the value *n*=2.98 is found from measurements, the closest available value of *n* in the lookup table is 3.00, corresponding to index 13. Therefore, the integer value 13 is used for the parameter *n* written to the Location Engine.

Refer to section 2.1.2.1.3 in order to find the value for *n* to be used.

Table 2: n parameter lookup table

n index	*n*	*n index*	*n*
0	1.000	16	3.375
1	1.250	17	3.500
2	1.500	18	3.625
3	1.750	19	3.750
4	1.875	20	3.875
5	2.000	21	4.000
6	2.125	22	4.125
7	2.250	23	4.250
8	2.375	24	4.375
9	2.500	25	4.500
10	2.625	26	4.625
11	2.750	27	5.000
12	2.875	28	5.500
13	3.000	29	6.000
14	3.125	30	7.000
15	3.250	31	8.000

The parameter *n* is written to the Location Engine as an integer index in the range [0, 31] as the index is given as an integer value with no fractional bits, e.g. the value *n* = 7 is loaded as 00000111. The typical value for *n* depends on the environment.

2.1.2.1.3 Parameter Estimation

The parameters *A* and *n* can be estimated empirically by collecting RSSI data (and therefore path loss data) for which the distances between the transmitting and receiving devices are known. Figure 2 is a scatter plot of abs(RSSI) data versus log distance in meters. A least-squares best-fit line is used to glean the specific values of *A* and *n* for the environment in which the data were measured:

- *A* is the y-intercept of the line, and
- *n* is the slope of the line

The data in Figure 2 give *A*=42.4 and *n*=2.98 for that environment. Note that the plot in this example does not show the actual y-intercept i.e. the point on the line where x=0.

The value of *A* loaded into the engine in this case would by 42.5. The value of *n* loaded into the engine, is seen to be 13 from Table 2.

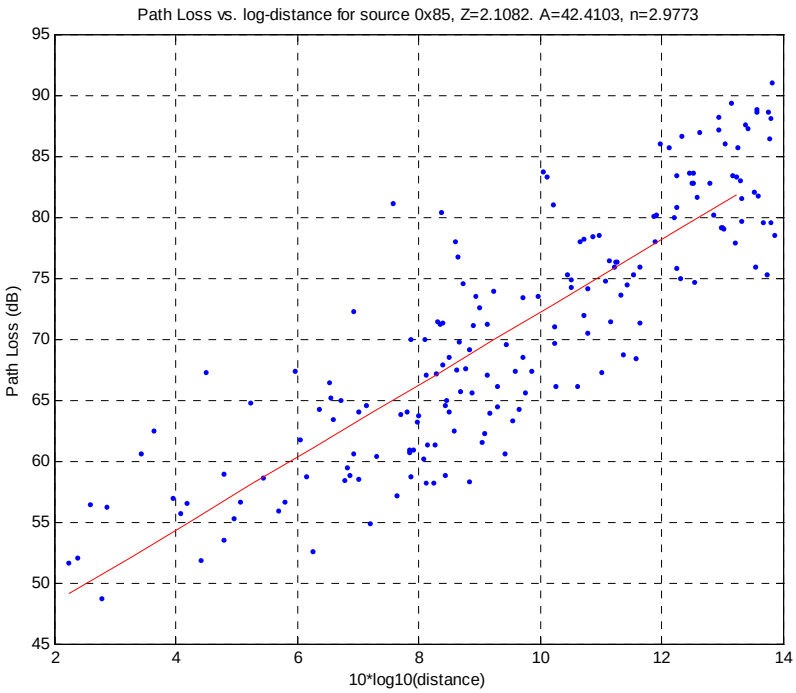


Figure 2: Path loss vs. log distance

2.1.2.1.4 Search Boundary Coordinates

It is possible to reduce error and estimation time by setting search boundaries for the estimated location X and Y coordinates. The maximum area that can be considered is with X and Y in the interval [0.0, 63.75] meters.

Assume that the Location Engine search is to be limited to include only the rectangular area bounded by the coordinates [x_{min}, y_{min}] and [x_{max}, y_{max}].

Four search boundary parameters are entered in the following order:

$$x_{min}, x_{delta}, y_{min}, y_{delta}$$

where:

$x_{delta} = x_{max} - x_{min}$

$y_{delta} = y_{max} - y_{min}$

Note that even when it is chosen to search in the whole possible search space, these coordinates must be entered as the coordinates for the whole space, i.e. the following values: 0.0, 63.75, 0.0, 63.75.

If some input parameters are omitted the Location Engine will not estimate correctly.

2.1.2.1.5 RSSI Values

The RSSI values are the RSSI measurements corresponding to the set of reference coordinates. The RSSI values are within the interval [-40 dBm, -95 dBm] with precision 0.5 dBm. The negative sign is removed in the value written. As an example, in the case where the value RSSI = -50.35 dB, this would be written into the location engine as 50.5.

Note that a value of 0.0 must be written as RSSI value for unused reference coordinates, if less than 16 reference nodes are used. The engine will not function correctly if only some of the parameters are loaded.

2.1.2.2 Loading Parameters

All measured parameters described in the previous sections are loaded into the RF register MEASPARM. Before writing to MEASPARM, a 1 must be written to the register bit LOCENG.PARLD to indicate that a set of measured parameters are being written. Once the parameter load process commences

(LOCENG.PARLD =1), all 22 parameters must be written.

The measured parameters must be written in the order [A, n, x_{min}, x_{delta}, y_{min}, y_{delta}, $rssi_0$, $rssi_1$, …, $rssi_{15}$] to the MEASPARM register. Once the parameter load process commences (LOCENG.PARLD =1) it must be completed with all 22 parameters. Included in these are the 16 RSSI values which must be all written, so any unused slots must be written as zeros. After all 22 parameters have been written, a 0 must be written to the register bit LOCENG.PARLD.

2.1.3 Location Estimation

The estimated location coordinates are given in meters in the interval [0.0, 63.75] with resolution 0.25 m. The data format uses the LSB bit as the fractional part.

When reference coordinates and measured parameters have been loaded, the location estimate is calculated by writing 1 to the LOCENG.RUN register bit. The estimated coordinates can be read from the LOCX and LOCY registers when LOCENG.DONE is set to 1. The time until estimated coordinates can be read varies with the search boundary parameters, from 50 µs to 13 ms (with 32 MHz system clock) after LOCENG.RUN was set to 1. The Location Engine does not produce any interrupt requests.

The value of the X coordinate estimate given by LOCX includes an offset value which must be removed to obtain the actual X coordinate. The offset removal must be performed after reading the LOCX register, to obtain the actual X value as follows:

$$X = (X_{LOCX} - x_{min} + 1) \% (x_{delta} + 1) + x_{min}$$

Where X_{LOCX} is the value read from register LOCX, and x_{min} and x_{delta} are the boundary parameters used as inputs to limit the search as described in section 2.1.2.1.4. Notice that the Y coordinate read LOCY from can be used directly.

The estimated coordinates remain valid in the LOCX and LOCY registers until new results have been calculated or until a reset.

Note that LOCENG.EN must be 1 during operation of the Location Engine.

2.2 Location Engine Register

This section describes the RF registers associated with the Location Engine. These registers are:

- LOCENG - Location Engine control and status
- REFCOORD - Reference coordinates input
- MEASPARM - Measured parameters input
- LOCX - Location estimate X coordinate
- LOCY - Location estimate Y coordinate

The RF registers reside in XDATA memory space. Table 3 gives an overview of register addresses while the remaining tables in this section describe each register in detail. Refer also to section 1 for Register conventions.

For the remaining RF registers refer to the CC2430 Data Sheet.

Table 3 : Overview of Location Engine RF registers

XDATA Address	Register name	Description
0xDF55	REFCOORD	Reference coordinates input
0xDF56	MEASPARM	Measured parameters input
0xDF57	LOCENG	Location Engine control and status
0xDF58	LOCX	Location estimate X coordinate
0xDF59	LOCY	Location estimate Y coordinate
0xDF60	CHVER	Chip Version
0xDF61	CHIPID	Chip Identification

REFCOORD (0xDF55)

Bit	Name	Reset	R/W	Description
7:0	REFCOORD	0	R/W	Location Engine reference coordinate [x0, y0, x1, y1, … x15, y15]

MEASPARM (0xDF56)

Bit	Name	Reset	R/W	Description
7:0	MEASPARM	0	R/W	Location Engine measured parameters of channel and reference nodes [A, n, x_{min}, x_{delta}, y_{min}, y_{delta}, $rssi_0$, $rssi_1$, …, $rssi_{15}$]

LOCENG (0xDF57)

Bit	Name	Reset	R/W	Description
7:5	-	00	R0	Reserved, read as 0.
4	EN	0	R/W	Enable location engine 0 Disable location engine 1 Enable location engine
3	DONE	0	R	Estimation completed. After 1 has been written to RUN, this bit is cleared and then set to 1 when the estimated data is ready.
2	PARLD	0	R/W	Load parameters. This bit shall be written as 1 before the set of parameters are written to MEASPARM. Write 0 to this bit after the last parameter has been written.
1	REFLD	0	R/W	Load reference coordinates. This bit shall be written as 1 before the set of coordinates are written to REFCOORD. Write 0 to this bit after the last coordinate has been written.
0	RUN	0	R0W1	Location estimate start. This bit shall be written as 1 when desired coordinates and parameters have been written to REFCOORD and MEASPARM registers. Estimation process starts when 1 is written to this bit. Always read as 0.

LOCX (0xDF58)

Bit	Name	Reset	R/W	Description
7:0	LOCX	00h	R	Location estimate X coordinate with offset.

LOCY (0xDF59)

Bit	Name	Reset	R/W	Description
7:0	LOCY	00h	R	Location estimate Y coordinate.

CHVER (0xDF60)

Bit	Name	Reset	R/W	Description
7:0	VERSION[7:0]	0x03	R	Chip revision number. The current die revision is as follows: 0x04 : Die revision E The current number in VERSION[7:0] may not be consistent with past or future die revisions of this product

CHIPID (0xDF61)

Bit	Name	Reset	R/W	Description
7:0	CHIPID[7:0]	0x89	R	Chip identification number. Always read as 0x89.

3 Ordering Information

Table 4: Ordering Information

Ordering part number	Description	MOQ
CC2431RTC	CC2431, QLP48 package, RoHS compliant Pb-free assembly, trays with 260 pcs per tray, 128 Kbytes in-system programmable flash memory, System-on-chip RF transceiver.	260
CC2431RTCR	CC2431, QLP48 package, RoHS compliant Pb-free assembly, T&R with 2500 pcs per reel, 128 Kbytes in-system programmable flash memory, System-on-chip RF transceiver.	2500
CC2431ZRTC	CC2431, QLP48 package, RoHS compliant Pb-free assembly, trays with 260 pcs per tray, 128 Kbytes in-system programmable flash memory, System-on-chip RF transceiver, including royalty for using TI's ZigBee® Software Stack, Z-Stack™, in an end product	260
CC2431ZRTCR	CC2431, QLP48 package, RoHS compliant Pb-free assembly, T&R with 2500 pcs per reel, 128 Kbytes in-system programmable flash memory, System-on-chip RF transceiver, including royalty for using TI's ZigBee® Software Stack, Z-Stack™, in an end product	2500
CC2431DK	CC2431 Development Kit	1
CC2431ZDK	CC2431 ZigBee® Development Kit	1
CC2431EMK	CC2431 Evaluation Module Kit	1

MOQ = Minimum Order Quantity T&R = tape and reel

4 General Information

4.1 Document History

Table 5: Document History

Revision	Date	Description/Changes
2.01	2007-05-30	First data sheet for released product. Preliminary data sheets exist for engineering samples and pre-production prototype devices, but these data sheets are not complete and may be incorrect in some aspects compared with the released product.

5 Address Information

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Gaustadalléen 21
N-0349 Oslo
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Tel: +47 22 95 85 44
Fax: +47 22 95 85 46
Web site: http://www.ti.com/lpw

6 TI Worldwide Technical Support

Internet

TI Semiconductor Product Information Center Home Page:	support.ti.com
TI Semiconductor KnowledgeBase Home Page:	support.ti.com/sc/knowledgebase

Product Information Centers

Americas

Phone:	+1(972) 644-5580
Fax:	+1(972) 927-6377
Internet/Email:	support.ti.com/sc/pic/americas.htm

Europe, Middle East and Africa

Phone:	
Belgium (English)	+32 (0) 27 45 54 32
Finland (English)	+358 (0) 9 25173948
France	+33 (0) 1 30 70 11 64
Germany	+49 (0) 8161 80 33 11
Israel (English)	180 949 0107
Italy	800 79 11 37
Netherlands (English)	+31 (0) 546 87 95 45
Russia	+7 (0) 95 363 4824
Spain	+34 902 35 40 28
Sweden (English)	+46 (0) 8587 555 22
United Kingdom	+44 (0) 1604 66 33 99
Fax:	+49 (0) 8161 80 2045
Internet:	support.ti.com/sc/pic/euro.htm

Japan

Fax	International	+81-3-3344-5317
	Domestic	0120-81-0036
Internet/Email	International	support.ti.com/sc/pic/japan.htm
	Domestic	www.tij.co.jp/pic

Asia

Phone	International	+886-2-23786800
	Domestic	Toll-Free Number
	Australia	1-800-999-084
	China	800-820-8682
	Hong Kong	800-96-5941
	India	+91-80-51381665 (Toll)
	Indonesia	001-803-8861-1006
	Korea	080-551-2804
	Malaysia	1-800-80-3973
	New Zealand	0800-446-934
	Philippines	1-800-765-7404
	Singapore	800-886-1028
	Taiwan	0800-006800
	Thailand	001-800-886-0010
Fax		+886-2-2378-6808
Email		tiasia@ti.com or ti-china@ti.com
Internet		support.ti.com/sc/pic/asia.htm

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
CC2431RTC	NRND	Production	VQFN (RTC) | 48	260 | JEDEC TRAY (10+1)	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2431
CC2431ZRTC	NRND	Production	VQFN (RTC) | 48	260 | JEDEC TRAY (10+1)	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2431
CC2431ZRTC.B	NRND	Production	VQFN (RTC) | 48	260 | JEDEC TRAY (10+1)	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2431

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

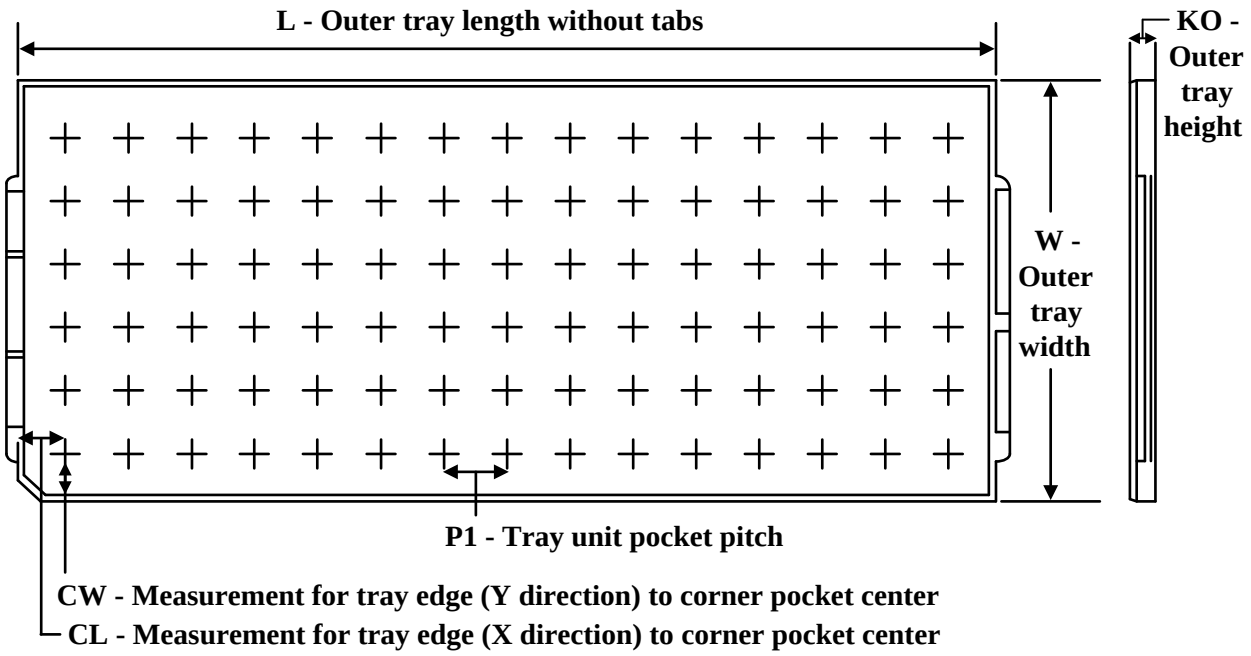
(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TRAY



Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
CC2431RTC	RTC	VQFNP	48	260	26 x 10	150	322.6	135.9	7620	11.8	10	10.35
CC2431ZRTC	RTC	VQFNP	48	260	26 x 10	150	322.6	135.9	7620	11.8	10	10.35
CC2431ZRTC.B	RTC	VQFNP	48	260	26 x 10	150	322.6	135.9	7620	11.8	10	10.35

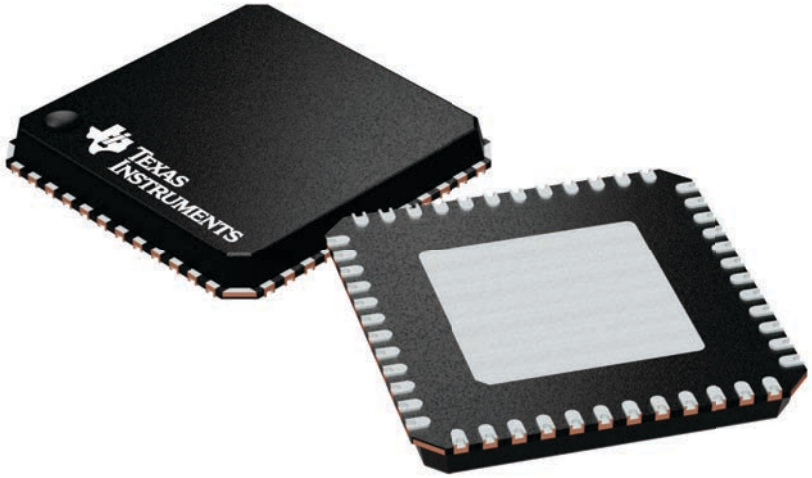
GENERIC PACKAGE VIEW

RTC 48

VQFNP - 0.9 mm max height

7 x 7, 0.5 mm pitch

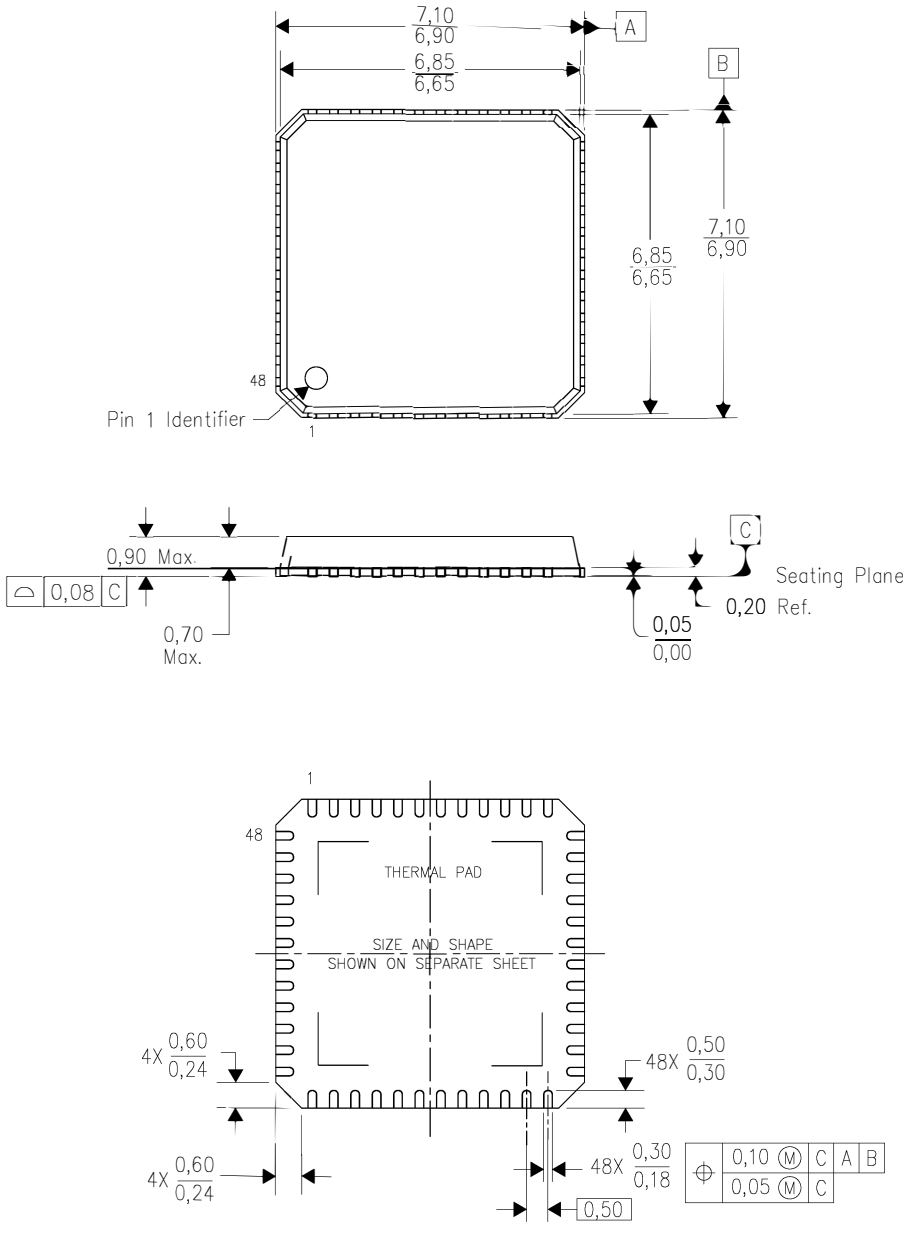
PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4224601/A

RTC (S–PVQFN–N48) 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.

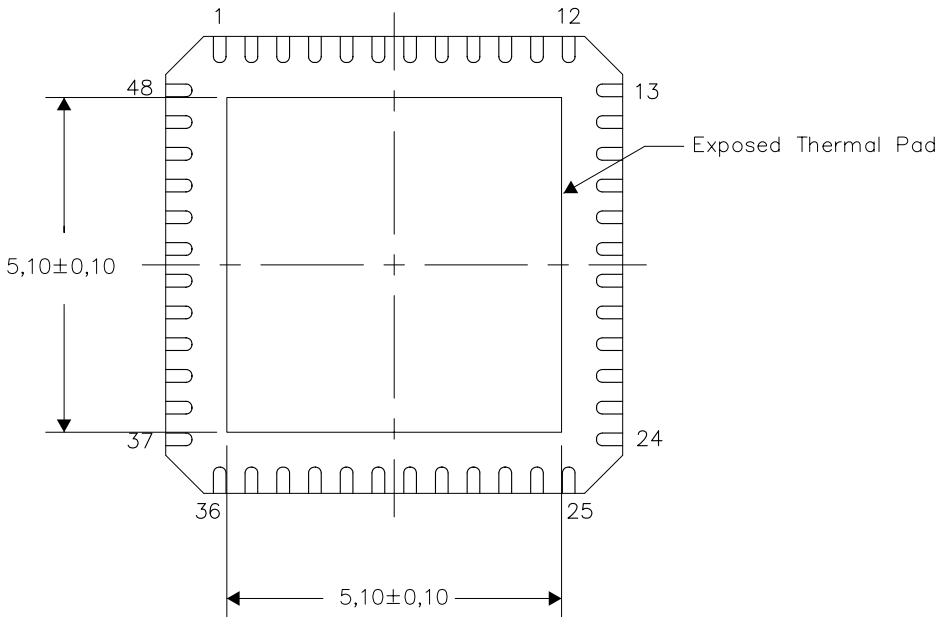
RTC (S–PVQFN–N48) PLASTIC QUAD FLATPACK NO–LEAD

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.



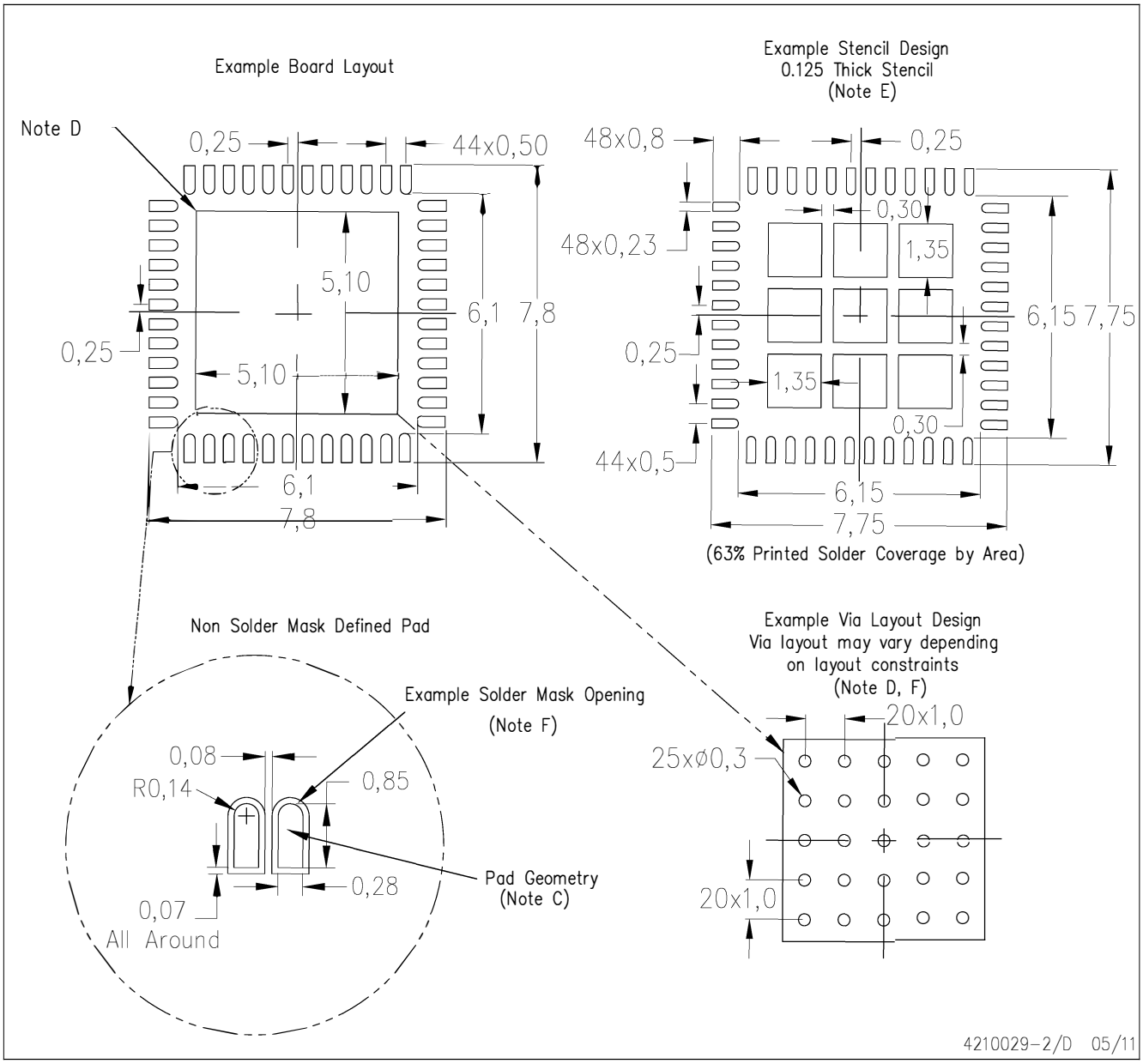
Bottom View

Exposed Thermal Pad Dimensions

4206337–2/H 01/11

NOTE: All linear dimensions are in millimeters

RTC (S–PVQFN–N48) 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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