Panasonic

PAN1326C

Bluetooth Basic Data Rate and Low Energy Module

Product Specification

Rev. 1.2

Wireless Modules

Overview

Panasonic's new PAN1326C is a Host Controlled Interface (HCI) Bluetooth RF module that brings Texas Instrument's seventh generation Bluetooth core integrated circuit, the CC2564C, to an easy-to-use module format. The PAN1326C is Bluetooth 4.2 compliant and it offers best-in-class RF performance with about twice the range of other Bluetooth Low Energy solutions. Panasonic's tiny footprint technology has produced a module of only 85.5 mm². The module is designed to accommodate PCBs pad pitch of 1.3 mm and as few as two layers for easy implementation and manufacturing. The module has been designed to be 100 percent pin-compatible with previous generations of Texas Instrument's based Bluetooth HCI modules.

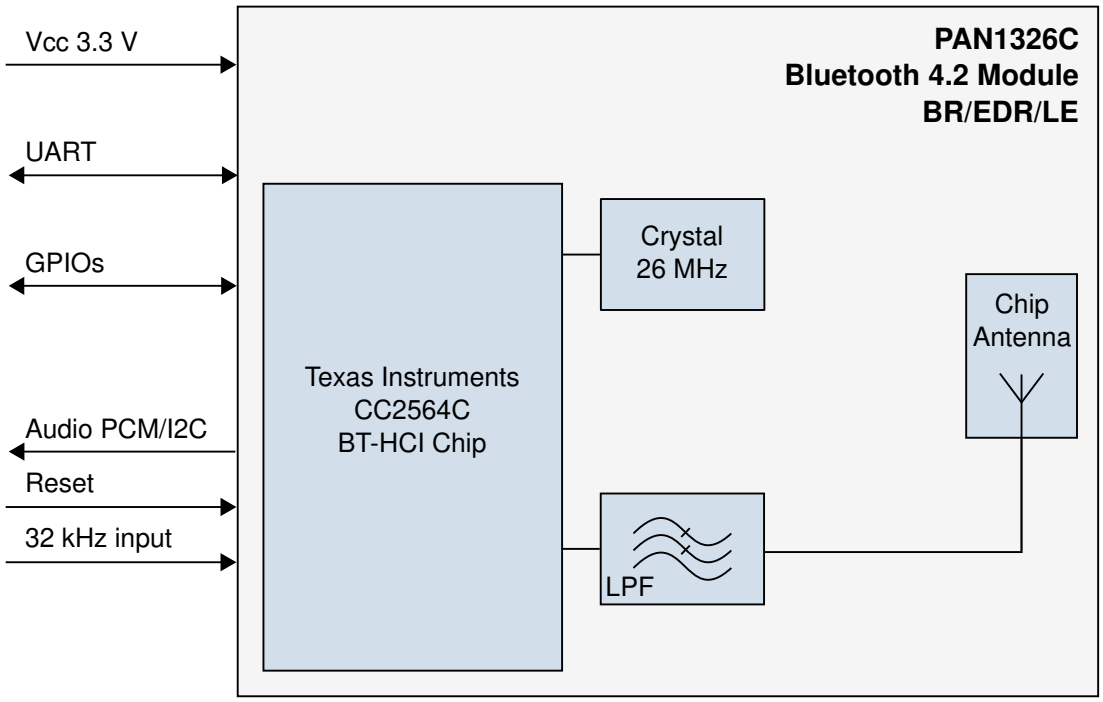
Features

- Bluetooth-4.2-compliant up to the HCI layer
- Best-in-class Bluetooth RF performance (Tx, Rx sensitivity, blocking)
- Dimensions: 9.0 mm x 9.5 mm x 1.8 mm
- Based upon TI's CC2564C
- Interfaces: UART, GPIO, PCM

Characteristics

- Bluetooth 4.2
- Receiver sensitivity -93 dBm
- Output power 11.5 dBm
- Power supply 1.7 V to 4.8 V
- Power consumption Tx 40 mA
- Power consumption Rx 20 mA
- Sleep mode 135 µA
- Operating temperature range -45 ºC to +85 ºC

Block Diagram



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This Product Specification does not lodge the claim to be complete and free of mistakes.

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If Engineering Samples are delivered to the customer, these samples have the status “Engineering Samples”. This means that the design of this product is not yet concluded. Engineering Samples may be partially or fully functional, and they may differ from the published Product Specification.

Engineering Samples are not qualified and they are not to be used for reliability testing or series production.

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- Deviation or lapse in function of the Engineering Sample,
- Improper use of the Engineering Sample.

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Table of Contents

1 About This Document

1.1 Purpose and Audience

This Product Specification provides details on the functional, operational, and electrical characteristics of the Panasonic PAN1326C module. It is intended for hardware design, application, and Original Equipment Manufacturer (OEM) engineers. The product is referred to as “the PAN1326C” or “the module” within this document.

1.2 Revision History

Revision	Date	Modifications/Remarks
1.0	01.11.2017	1st version
1.1	01.02.2018	Added Bluetooth QDIDs.
1.2	10.08.2018	Update layout and editorial changes.

1.3 Use of Symbols

Symbol	Description
	**Note** Indicates important information for the proper use of the product. Non-observance can lead to errors.
	**Attention** Indicates important notes that, if not observed, can put the product’s functionality at risk.
⇨ [chapter number] [chapter title]	**Cross reference** Indicates cross references within the document. **Example:** Description of the symbols used in this document ⇨ 1.3 Use of Symbols.

1.4 Related Documents

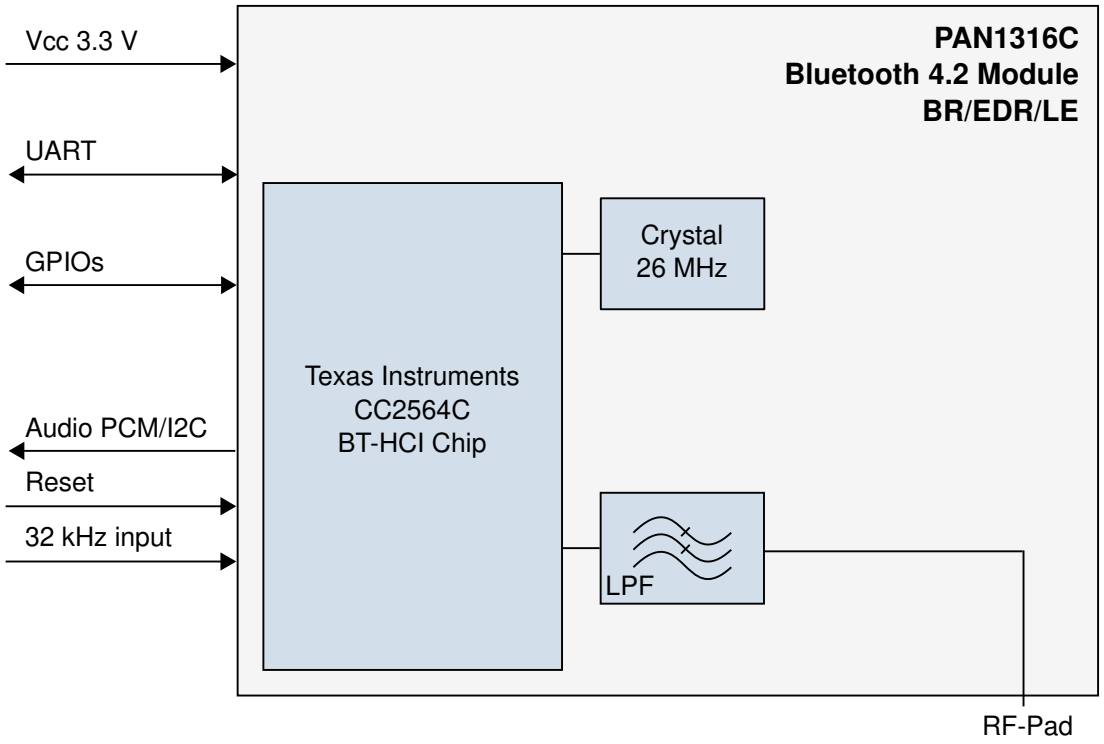
Please refer to the Panasonic website for related documents ⇨ 6.2.2 Product Information.

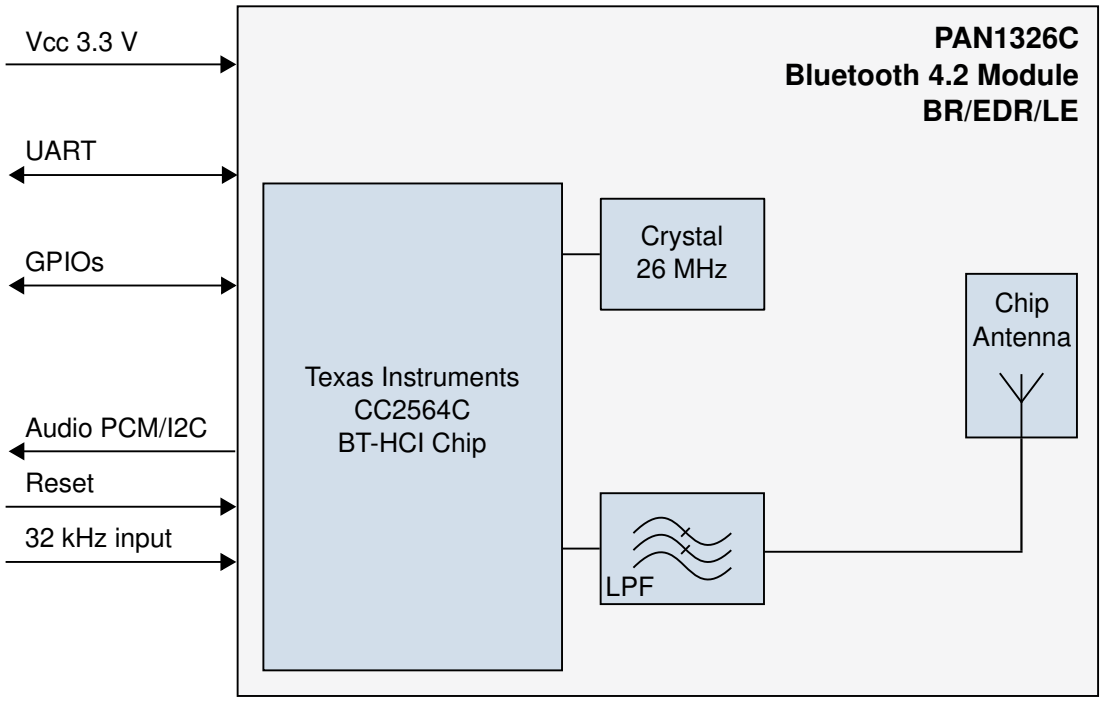
2 Overview

Panasonic's new PAN1326C is a Host Controlled Interface (HCI) Bluetooth RF module that brings Texas Instrument's seventh generation Bluetooth core integrated circuit, the CC2564, to an easy-to-use module format. The PAN1326C is Bluetooth-4.2-compliant and it offers best in class RF performance with about twice the range of other Bluetooth Low Energy solutions. Panasonic's tiny footprint technology has produced a module of only 85.5 mm². The module is designed to accommodate PCBs pad pitch of 1.3 mm and as few as two layers for easy implementation and manufacturing. The module has been designed to be 100 percent pin-compatible with previous generations of Texas Instruments-based Bluetooth HCI modules.

Please refer to the Panasonic website for related documents ⇨ 6.2.2 Product Information.
Further information on the variants and versions ⇨ 6.1 Ordering Information.

2.1 Block Diagram





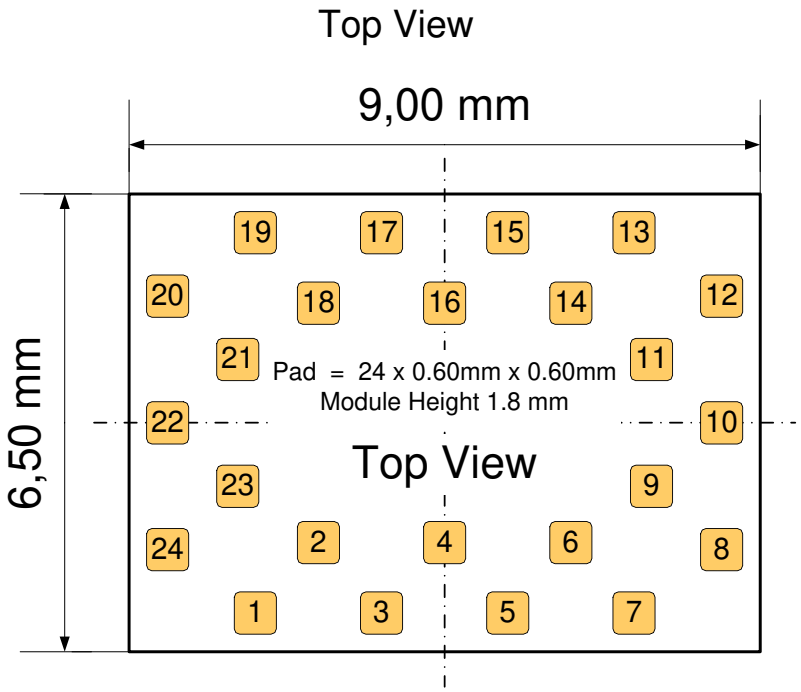
The Slow Clock 32.768 kHz is mandatory, otherwise the module does not start up⇨ 2.4 Clock Inputs.

The IO are 1.8 V driven and might need external level shifter and LDO. The MLDO_OUT PIN can not be used as reference due to RF internal connection.

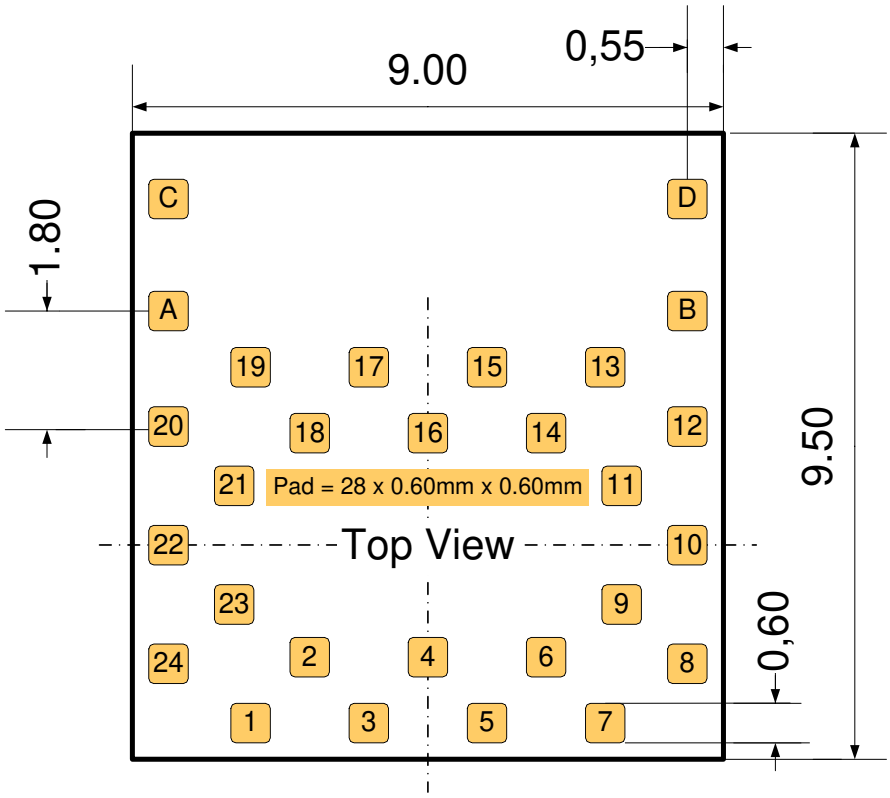
The total capacity will not exceed 2.8 µF and the total inductance will not exceed 0 nH. There are no voltage multiplying or voltage boosting circuits.

2.2 Pin Configuration

Pin Assignment PAN1316C



PIN Assignment PAN1326C



Pin Functions

No	Pin Name	Pull at Reset	Def. Dir. [1]	I/O Type [2]	Description	
1	GND				Connect to Ground	
2	TX_DBG	PU	O	2 mA	Logger output	
3	HCI_CTS	PU	I	8 mA	HCI UART clear-to-send	
4	HCI_RTS	PU	O	8 mA	HCI UART request-to-send	
5	HCI_RX	PU	I	8 mA	HCI UART data receive	
6	HCI_TX	PU	O	8 mA	HCI UART data transmit	
7	AUD_FSYNC	PD	IO	4 mA	PCM frame synchronisation (NC if not used)	FailSafe[3]
8	SLOW_CLK_IN		I		32.768-kHz clock in	Fail Safe
9	NC		IO		Not connected	
10	MLDO_OUT		O		Main LDO output (1.8 V nom.)	
11	CL1.5_LDO_IN		I		PA LDO input	
12	GND				Connect to Ground	
13	RF		IO		Bluetooth RF IO	
14	GND				Connect to Ground	
15	MLDO_IN		I		Main LDO input	
16	nSHUTD	PD	I		Shutdown input (active low)	
17	AUD_OUT	PD	O	4 mA	PCM data output. (NC if not used)	Fail Safe
18	AUD_IN	PD	I	4 mA	PCM data input. (NC if not used)	Fail Safe
19	AUD_CLK	PD	IO	HY, 4 mA	PCM clock. (NC if not used)	Fail Safe
20	GND				Connect to Ground	
21	NC				EEPROM I²C SDA (Internal)	
22	VDD_IO		PI		I/O power supply 1.8 V Nom	
23	NC				EEPROM I²C SCL (Internal)	
24	NC		IO		Not connected	
A	GND				Connect to Ground	
B	GND				Connect to Ground	
C	GND				Connect to Ground	
D	GND				Connect to Ground	

[1] I=input; O=output; IO=bidirectional; P=power; PU=pulled up; PD=pulled down

[2] I/O Type: Digital I/O cells. HY=input hysteresis, current=typ. output current

[3] No signals are allowed on the IO pins if no VDD_IO (Pin 22) power supplied, except pin 7, 8, 17-19.

For RF conducted measurements either use the PAN1323ETU or de-solder the antenna and solder an antenna connector to the hot pin.

Pin Description

No	Pin Name	Pull at Reset	Def. Dir. [4]	I/O Type [5]	Description
5	HCI_RX	PU	I	8 mA	HCI UART data receive
6	HCI_TX	PU	O	8 mA	HCI UART data transmit
4	HCI_RTS	PU	O	8 mA	HCI UART request-to-send
3	HCI_CTS	PU	I	8 mA	HCI UART clear-to-send
7	AUD_FYSNC	PD	IO	4 mA	PCM frame synchronisation (NC if not used) Fail safe
19	AUD_CLK	PD	IO	HY, 4 mS	PCM clock (NC if not used) Fail safe
18	AUD_IN	PD	I	4 mA	PCM data input (NC if not used) Fail safe
17	AUD_OUT	PD	O	4 mA	PCM data output (NC if not used) Fail safe
2	TX_DBG	PU	O	2 mA	Logger output OPTION: nTX_DBG - logger out (low=1)
8	SLOW_CLK_IN		I		32.768 kHz clock in Fail safe
13	RF		IO		Bluetooth RF IO (not connected with antenna)
16	nSHUTD	PD	I		Shutdown input (active low)
22	VDD_IO		PI		I/O power supply 1.8 V Nom
15	MLDO_IN		I		Main LDO input Connect directly to battery or to a pre-regulated 1.8 V supply
10	MLDO_OUT		O		Main LDO output (1.8 V nom.) Can not be used as 1.8 V supply due to internal connection to the RF part
11	CL1.5_LDO_IN		I		PA LDO input Connect directly to battery or to a pre-regulated 1.8 V supply
1	GND		P		Connect to Ground
12	GND		P		Connect to Ground
14	GND		P		Connect to Ground
20	GND		P		Connect to Ground
23	NC	PU/PD	I	HY, 4 mA	EEPROM I²C SCL (Internal)
21	NC	PU/PD	IO	HY, 4 mA	EEPROM I²C IRQ (Internal)

[4] I=input; O=output; IO=bidirectional; P=power; PU=pulled up; PD=pulled down

[5] I/O Type: Digital I/O cells. HY=input hysteresis, current=typ. output current

HCI_CTS is an input signal to the CC2564C device:

- When HCI_CTS is low, then CC2564C is allowed to send data to Host device.
- When HCI_CTS is high, then CC2564C is not allowed to send data to Host device.

2.3 Device Power Supply

The PAN1326C Bluetooth radio solution is intended to work in devices with a limited power budget such as cellular phones, headsets, hand-held PC's and other battery-operated devices. One of the main differentiators of the PAN1326C is its power management – it is ability to draw as little current as possible.

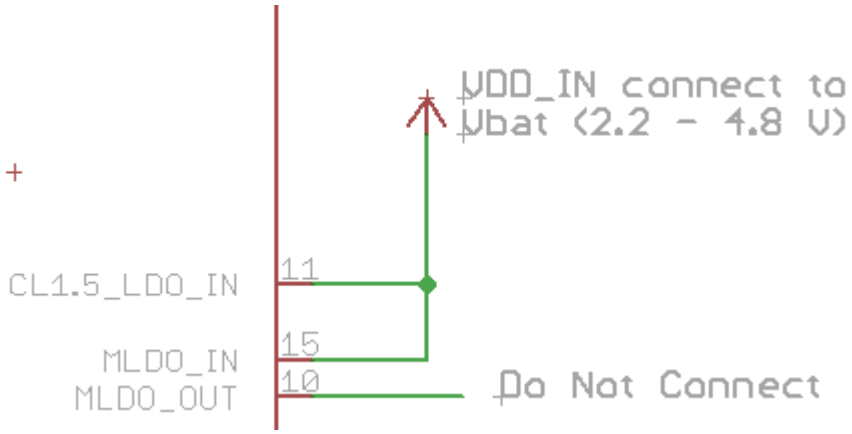
The PAN1326C device requires two kinds of power sources:

1. Main power supply for the Bluetooth - VDD_IN=VBAT
2. Power source for the 1.8 V I/O ring - VDD_IO

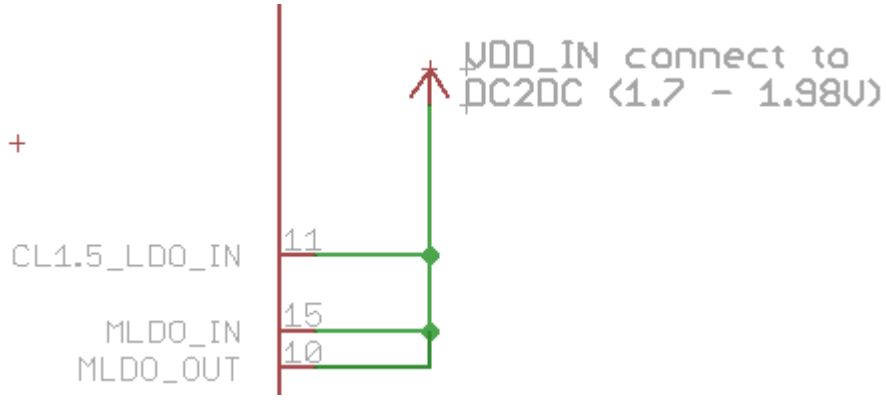
The PAN1326C includes several on-chip voltage regulators for increased noise immunity. The PAN1326C can be connected either directly to the battery or to an external 1.8 V DC to DC converter.

Three ways to supply power

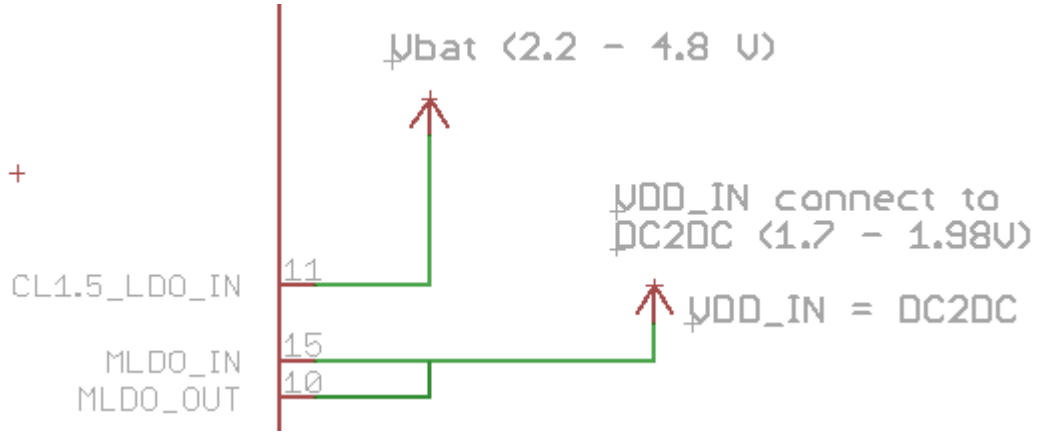
1. Full-V_{BAT} system (Maximum RF output power, but not optimum system power):



2. Full-DC2DC system (Lower RF output power, but optimum system power):



3. Mixed DC2DC-V_{BAT} system (Maximum RF output power and optimum system power, but requires routing of $V_{BAT)}$:



2.4 Clock Inputs

The Slow Clock is always supplied from an external source. It is connected to the SLOW_CLK_IN pin number 8 and can be a digital signal with peak to peak of 0 V - 1.8 V.

The Slow Clock's frequency accuracy must be 32.768 kHz 250 ppm for Bluetooth usage (according to the Bluetooth specification).

The Slow Clock 32.768 kHz is mandatory to start the internal controller; otherwise the module does not start up.

2.5 Bluetooth Features

- Bluetooth 4.2 compliant up to the HCI layer
- Up to seven active devices
- Scatternet: up to three piconets simultaneously, one as master and two as slaves
- Up to two Synchronous Connection Oriented (SCO) links on the same piconet
- Support for All Voice Air-Coding - Continuously Variable Slope Delta (CVSD), A-law, µ-law, modified Subband Coding (mSBC), and transparent (uncoded)
- Assisted mode for HFP 1.6 Wideband Speech (WBS) profile or A2DP profile to reduce host processing and power
- Support of multiple Bluetooth profiles with enhanced QoS
- Multiple sniff instances tightly coupled to achieve minimum power consumption
- Independent buffering for Low Energy allows large numbers of multiple connections without affecting BR or EDR performance
- Built-in coexistence and prioritization handling for BR, EDR, and Low Energy
- Capabilities of link layer topology Scatternet - can act concurrently as peripheral and central
- Network support for up to 10 devices
- Time line optimization algorithms to achieve maximum channel utilization

2.6 Interfaces

2.6.1 Host Controller Interface (HCI)

The CC2564C incorporates one UART module dedicated to the host controller interface (HCI) transport layer. The HCI interface transports commands, events, ACL, and synchronous data between the Bluetooth device and it is host using HCI data packets.

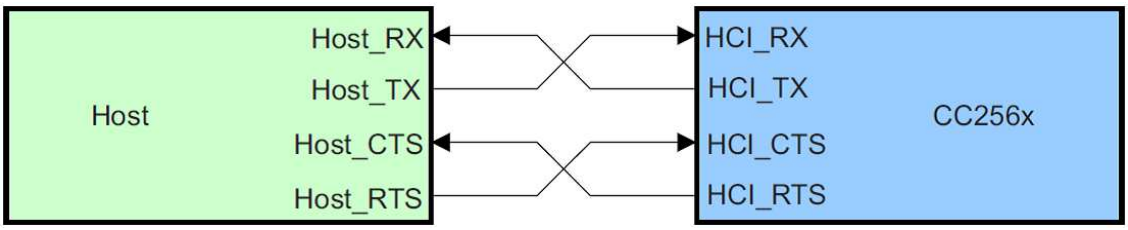
The UART module supports H4 (4-wires) protocol with maximum baud rate of 4 Mbps for all fast clock frequencies.

After power up the baud rate is set for 115.2 kbps, irrespective of fast clock frequency. The baud rate can thereafter be changed with a vendor specific command. The CC2564C responds with a Command Complete Event (still at 115.2 kbps), after which the baud rate change takes place. HCI hardware includes the following features:

- Receiver detection of break, idle, framing, FIFO overflow, and parity error conditions
- Transmitter underflow detection
- CTS/RTS hardware flow control

The interface includes four signals: TXD, RXD, CTS, and RTS. Flow control between the host and the CC2564C is byte-wise by hardware.

Flow control is obtained by the following:



When the UART RX buffer of the CC2564C passes the “flow control” threshold, it will set the UART_RTS signal high to stop transmission from the host.

When the UART_CTS signal is set high, the CC2564C will stop it is transmission on the interface. In case HCI_CTS is set high in the middle of transmitting a byte, the CC2564C will finish transmitting the byte and stop the transmission.

2.6.2 Audio/Voice CODEC Interface

The codec interface is a fully-dedicated programmable serial port that provides the logic to interface to several kinds of PCM or I2S codec’s. PAN1326C supports all voice coding schemes required by Bluetooth specification - Log PCM (A-Law or µ-Law) and Linear (CVSD). In addition, module also supports transparent scheme:

- Two voice channels
- Master/slave modes
- µ-Law, A-Law, Linear, Transparent coding schemes
- Long and short frames
- Different data sizes, order, and positions.
- High rate PCM interface for EDR
- Enlarged interface options to support a wider variety of codecs
- PCM bus sharing

2.6.2.1 PCM Hardware Interface

The PCM interface is one implementation of the codec interface. It contains the following four lines:

- Clock: configurable direction (input or output)
- Frame synchronisation: configurable direction (input or output)
- Data In: Input
- Data Out: Output/3-state

The Bluetooth device can be either the master of the interface where it generates the clock and the frame synchronisation signals, or slave where it receives these two signals. The PCM interface is fully configured by a vendor specific command.

For slave mode, clock input frequencies of up to 16 MHz are supported. At clock rates above 12 MHz, the maximum data burst size is 32 bits. For master mode, the CC2564C can generate any clock frequency between 64 kHz and 6 MHz.

When the I2S bus is used in an application, it is recommended adding a low pass filter (series resistor and capacitor to GND) to the bus for better noise suppression. Connecting the host µController/DSP directly with the module's I2S interface is not recommended.

The suggested low pass filter component values are:
470 pF
120 Ω

2.6.2.2 Data Format

The data format is fully configurable:

- The data length can be from 8 bits to 320 bits, in 1 bit increments, when working with two channels, or up to 640 bits when using one channel. The Data length can be set independently for each channel.
- The data position within a frame is also configurable in with 1 clock (bit) resolution and can be set independently (relative to the edge of the frame synchronisation signal) for each channel.
- The Data_In and Data_Out bit order can be configured independently. For example; Data_In can start with the MSB while Data_Out starts with LSB. Each channel is separately configurable. The inverse bit order (that is, LSB first) is supported only for sample sizes up to 24 bits.
- It is not necessary for the data in and data out size to be the same length.
- The Data_Out line is configured to "high-Z" output between data words. Data_Out can also be set for permanent high-Z, irrespective of data out. This allows the CC2564C to be a bus slave in a multi-slave PCM environment. At power up, Data Out is configured as "high-Z".

2.6.2.3 Frame Idle Period

The codec interface has the capability for frame idle periods, where the PCM clock can "take a break" and become "0" at the end of the PCM frame, after all data has been transferred.

The CC2564C supports frame idle periods both as master and slave of the PCM bus.

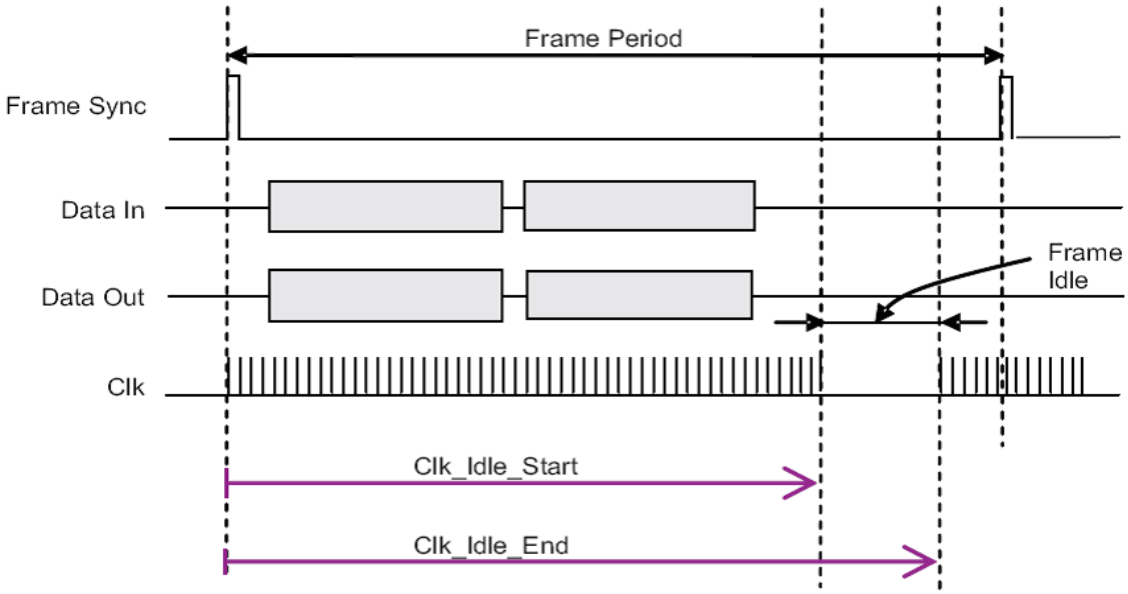
When CC2564C is the master of the interface, the frame idle period is configurable. There are two configurable parameters:

- Clk_Idle_Start - Indicates the number of PCM clock cycles from the beginning of the frame until the beginning of the idle period. After Clk_Idle_Start clock cycles, the clock will become "0".
- Clk_Idle_End - Indicates the time from the beginning of the frame till the end of the idle period. This time is given in multiples of PCM clock periods.

The delta between Clk_Idle_Start and Clk_Idle_End is the clock idle period.

For example, for PCM clock rate=1 MHz, frame synchronisation period=10 kHz, Clk_Idle_Start=60, Clk_Idle_End=90.

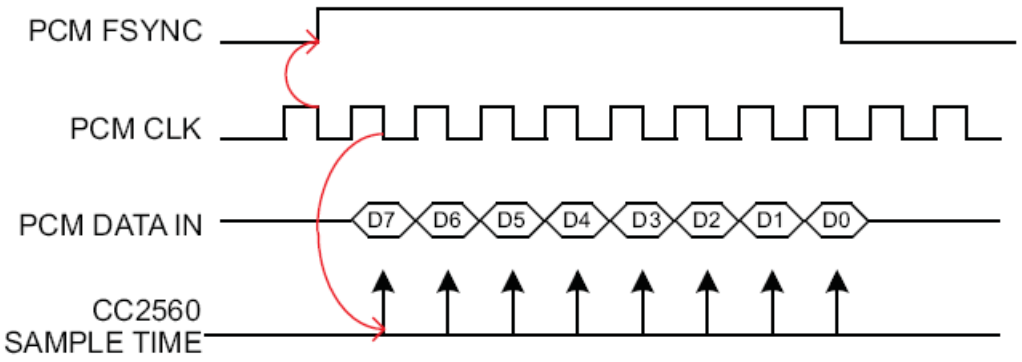
Between each two frame synchronisations there are 70 clock cycles (instead of 100). The clock idle period starts 60 clock cycles after the beginning of the frame, and lasts 90 – 60=30 clock cycles. This means that the idle period ends 100 – 90=10 clock cycles before the end of the frame. The data transmission must end prior to the beginning of the idle period.



2.6.2.4 Clock-Edge Operation

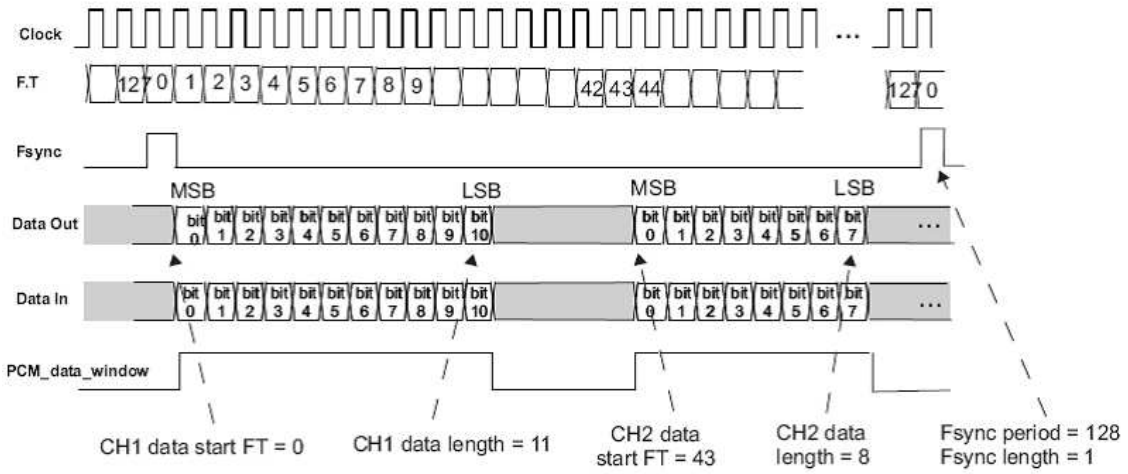
The codec interface of the CC2564C can work on the rising or the falling edge of the clock. It also has the ability to sample the frame synchronisation and the data at inversed polarity.

This is the operation of a falling-edge-clock type of codec. The codec is the master of the PCM bus. The frame synchronisation signal is updated (by the codec) on the falling clock edge and therefore shall be sampled (by the CC2564C) on the next rising clock. The data from the codec is sampled (by the CC2564C) on the clock falling edge.



2.6.2.5 Two-Channel PCM Bus Example

In below figure, a 2-channel PCM bus is shown where the two channels have different word sizes and arbitrary positions in the bus frame. (FT stands for Frame Timer)



2.6.2.6 Audio Encoding

The CC2564C codec interface can use one of four audio-coding patterns:

- A-Law (8 bit)
- μ-Law (8 bit)
- Linear (8 bit or 16 bit)

2.6.2.7 Improved Algorithm For Lost Packets

The CC2564C features an improved algorithm for improving voice quality when received voice data packets are lost. There are two options:

- Repeat the last sample – possible only for sample sizes up to 24 bits. For sample sizes >24 bits, the last byte is repeated.
- Repeat a configurable sample of 8 bits to 24 bits (depends on the real sample size), in order to simulate silence (or anything else) in the PCM bus. The configured sample will be written in a specific register for each channel.

The choice between those two options is configurable separately for each channel.

2.6.2.8 Bluetooth/PCM Clock Mismatch Handling

In Bluetooth RX, the CC2564C receives RF voice packets and writes these to the codec I/F. If the CC2564C receives data faster than the codec I/F output allows, an overflow will occur. In this case, the Bluetooth has two possible behaviour modes: “allow overflow” and “don’t allow overflow”.

- If overflow is allowed, the Bluetooth will continue receiving data and will overwrite any data not yet sent to the codec.
- If overflow is not allowed, RF voice packets received when buffer is full will be discarded.

2.6.2.9 Bluetooth Inter-IC Sound (I2S)

The CC2564C can be configured as an Inter-IC Sound (I2S) serial interface to an I2S codec device. In this mode, the CC2564C audio codec interface is configured as a bi-directional, full-duplex interface, with two time slots per frame: Time slot 0 is used for the left channel audio data and time slot 1 for the right channel audio data. Each time slot is configurable up to 40 serial clock cycles in length and the frame is configurable up to 80 serial clock cycles in length.

Do not connect the microcontroller/DSP directly to the module's PCM interface.

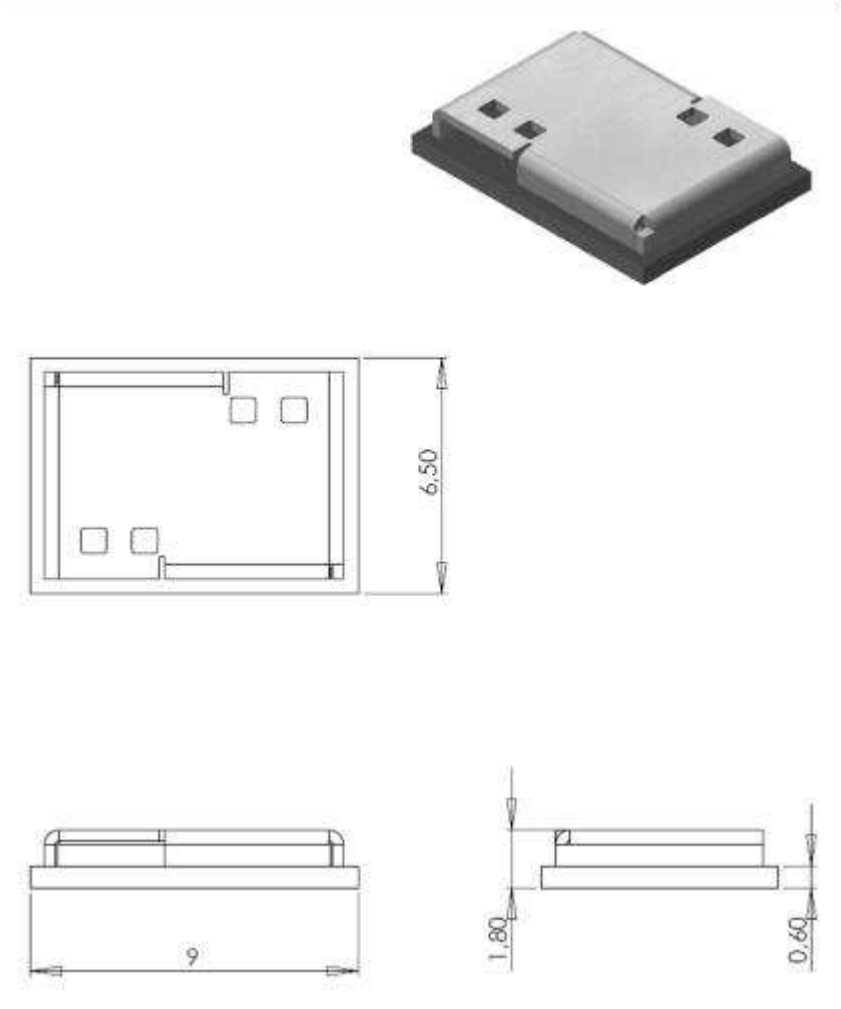
It is recommended to use a simple RC low pass filter to improve noise suppression.

3 Detailed Description

3.1 Dimensions

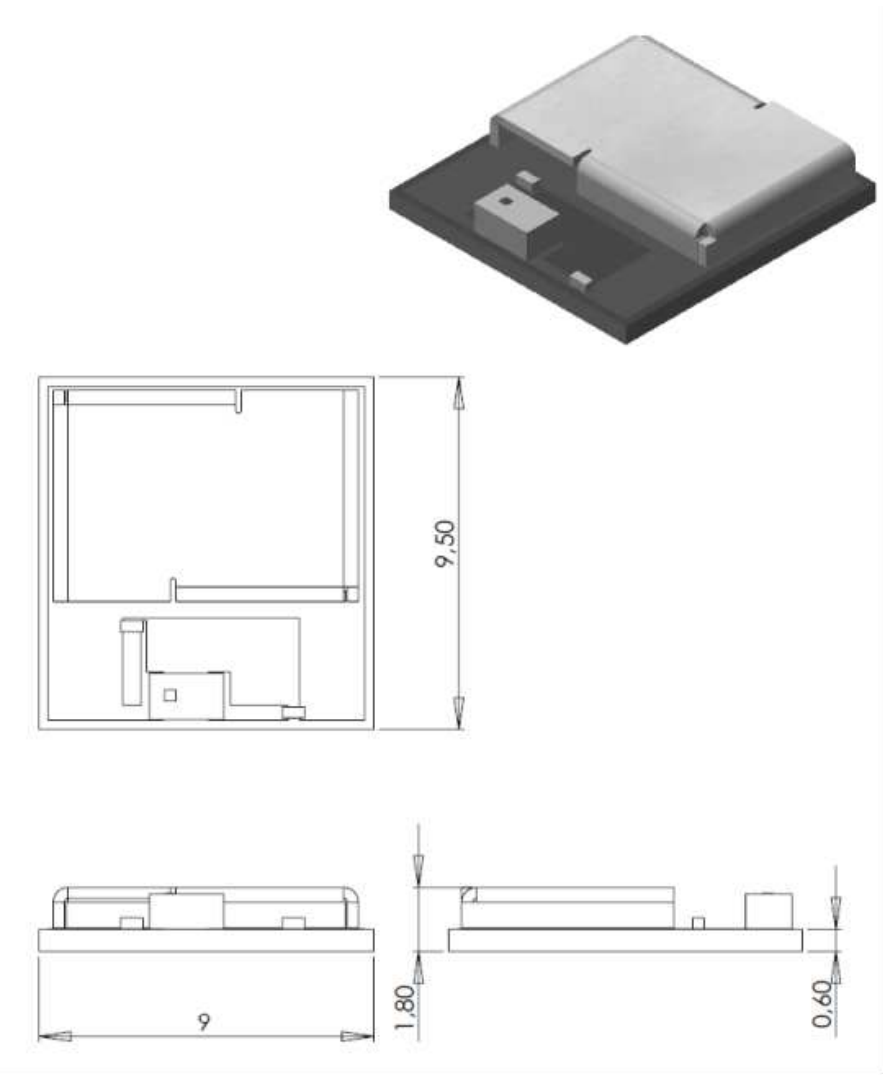
All dimensions are in millimeters.

3.1.1 PAN1316C Module Drawing



No.	Item	Dimension	Tolerance	Remark
1	Width	6.50	± 0.30	
2	Length	9.00	± 0.30	
3	Height	1.80	± 0.20	With case

3.1.2 PAN1326C Module Drawing

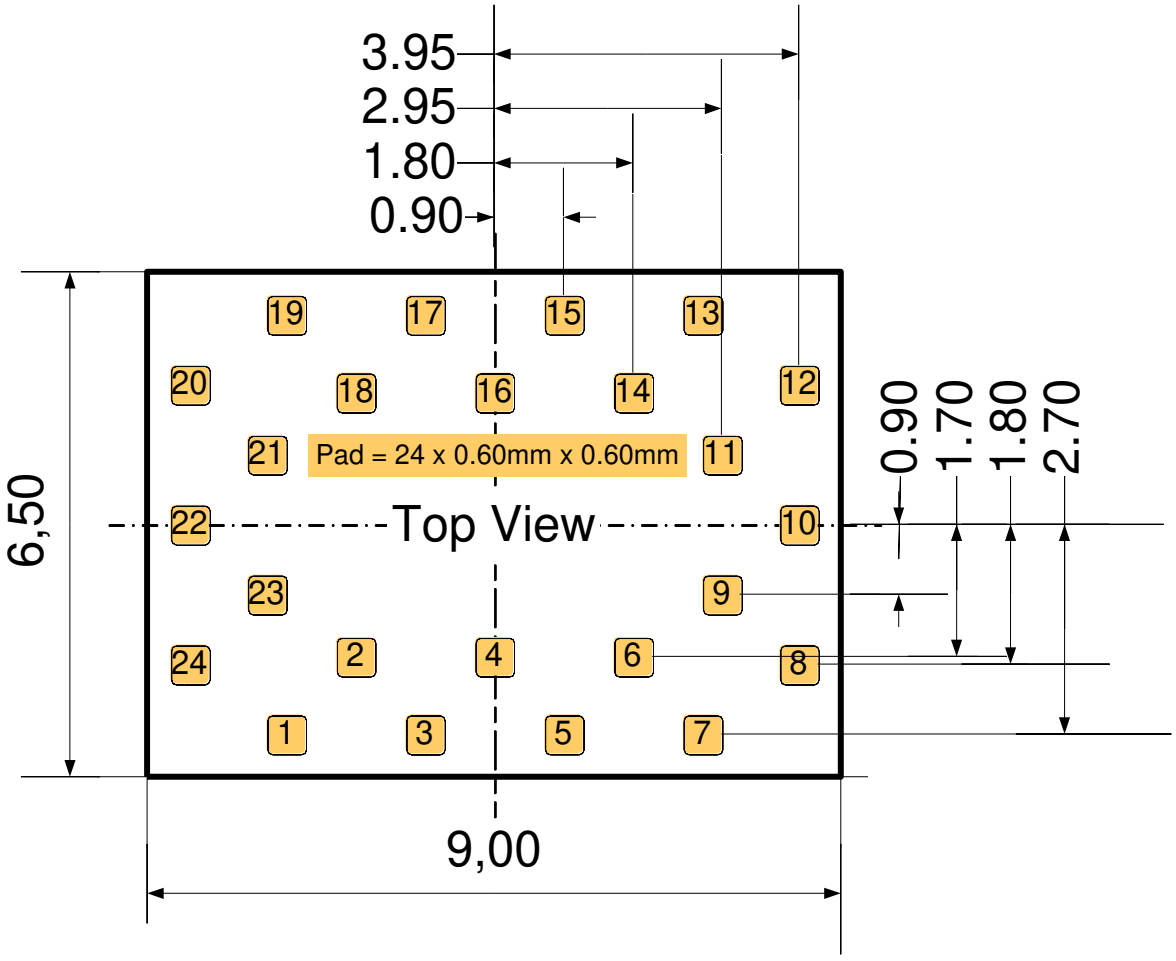


No.	Item	Dimension	Tolerance	Remark
1	Width	9.50	± 0.30	
2	Length	9.00	± 0.30	
3	Height	1.80	± 0.20	With case

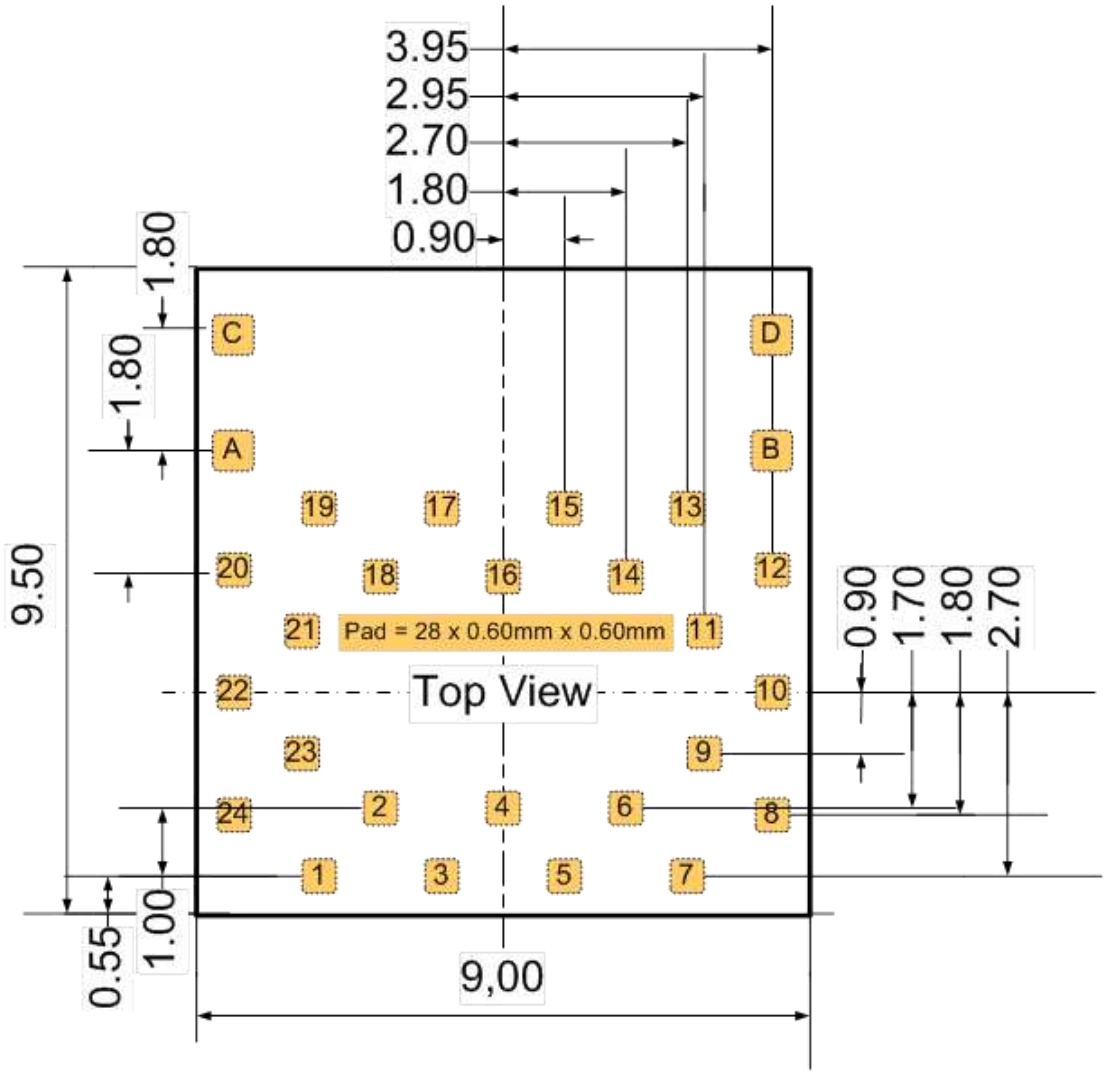
3.2 Footprint

- The outer dimensions have a tolerance of ±0.2 mm.
- The layout is symmetric to center.
- The inner pins (2, 4, 6, 9, 11, 14, 16, 18, 21, and 23) are shifted to the center by 1 mm.

3.2.1 Footprint – PAN1316C Without Antenna



3.2.2 Footprint – PAN1326C With Antenna

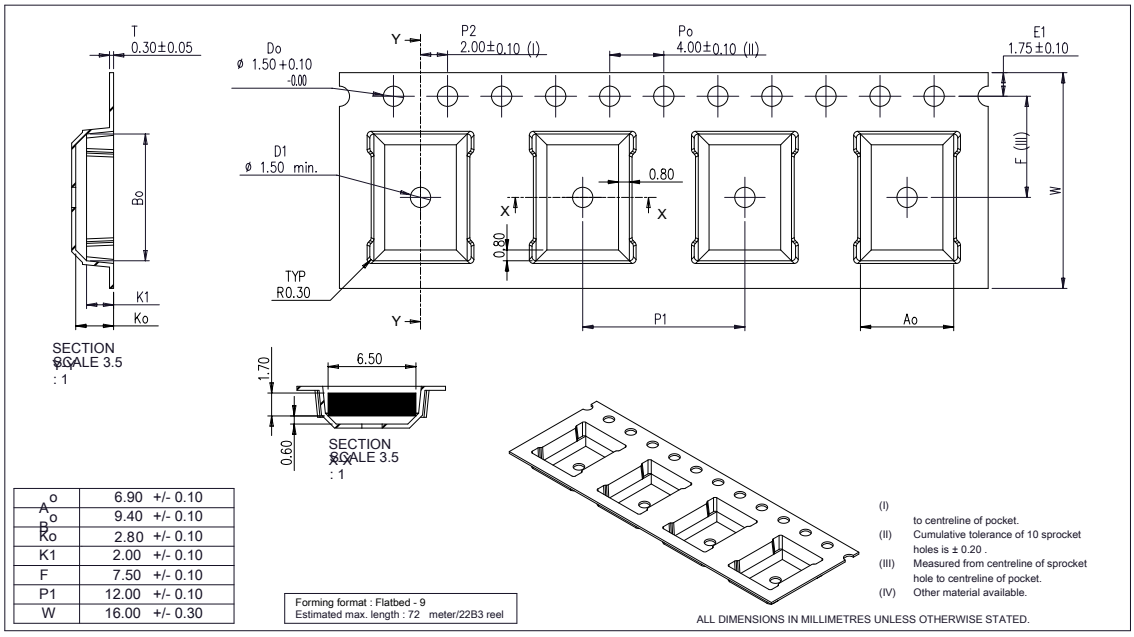


3.3 Packaging

The product is a mass production status product and will be delivered in the package described below.

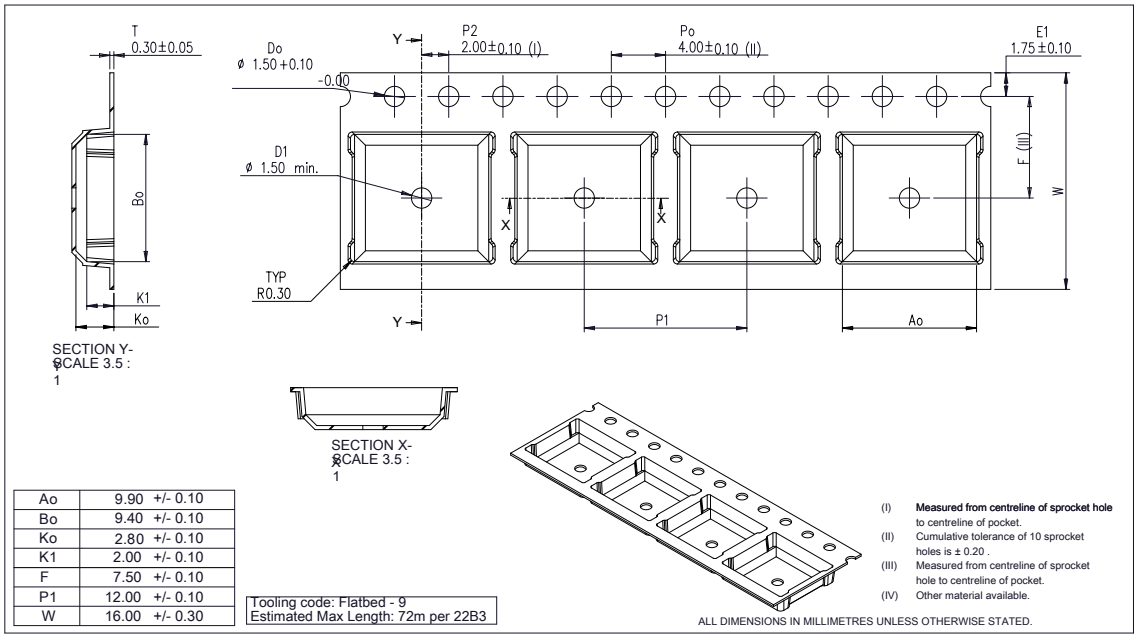
3.3.1 Tape Dimensions

3.3.1.1 PAN1316C Without Antenna



Ao	6.90 +/- 0.10
Bo	9.40 +/- 0.10
Ko	2.80 +/- 0.10
K1	2.00 +/- 0.10
F	7.50 +/- 0.10
P1	12.00 +/- 0.10
W	16.00 +/- 0.30

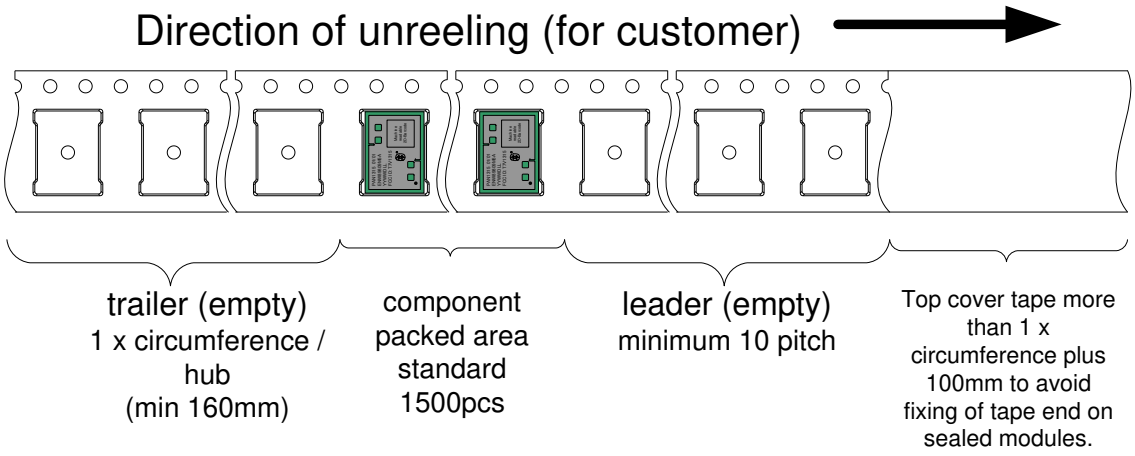
3.3.1.2 PAN1326C With Antenna



Ao	9.90 +/- 0.10
Bo	9.40 +/- 0.10
Ko	2.80 +/- 0.10
K1	2.00 +/- 0.10
F	7.50 +/- 0.10
P1	12.00 +/- 0.10
W	16.00 +/- 0.30

3.3.2 Packing in Tape

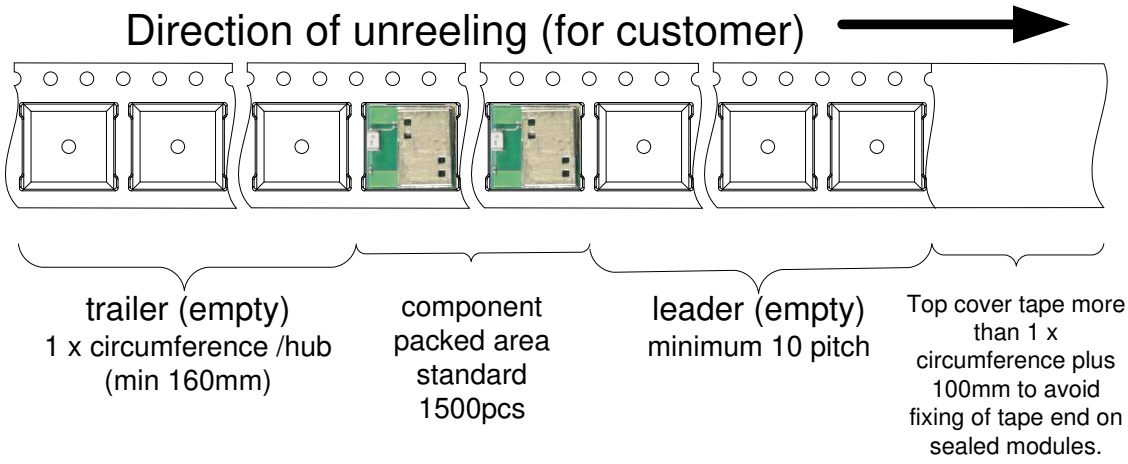
3.3.2.1 PAN1316C Without Antenna



Empty spaces in the component packed area shall be less than two per reel and those spaces shall not be consecutive.

The top cover tape shall not be found on reel holes and it shall not stick out from the reel.

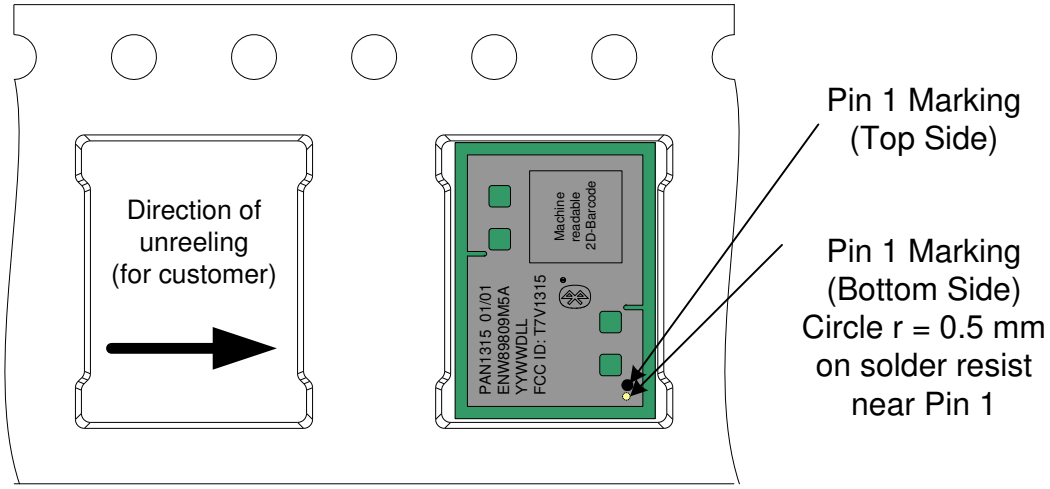
3.3.2.2 PAN1326C With Antenna



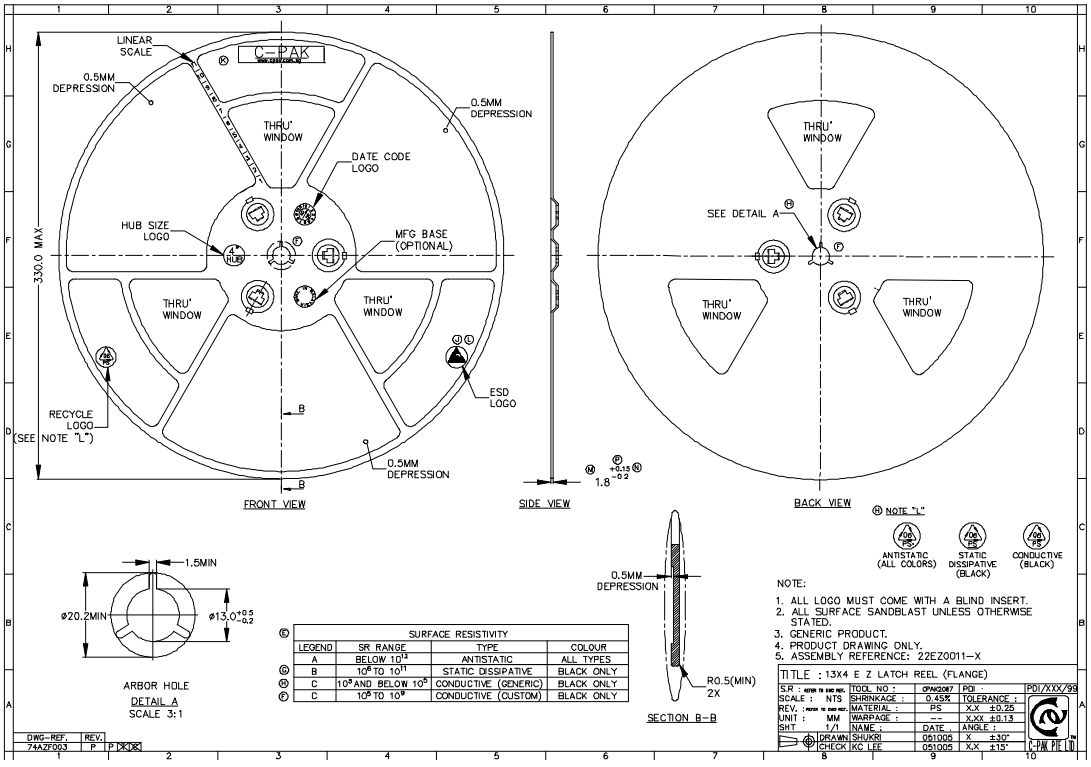
Empty spaces in the component packed area shall be less than two per reel and those spaces shall not be consecutive.

The top cover tape shall not be found on reel holes and it shall not stick out from the reel.

3.3.3 Component Direction

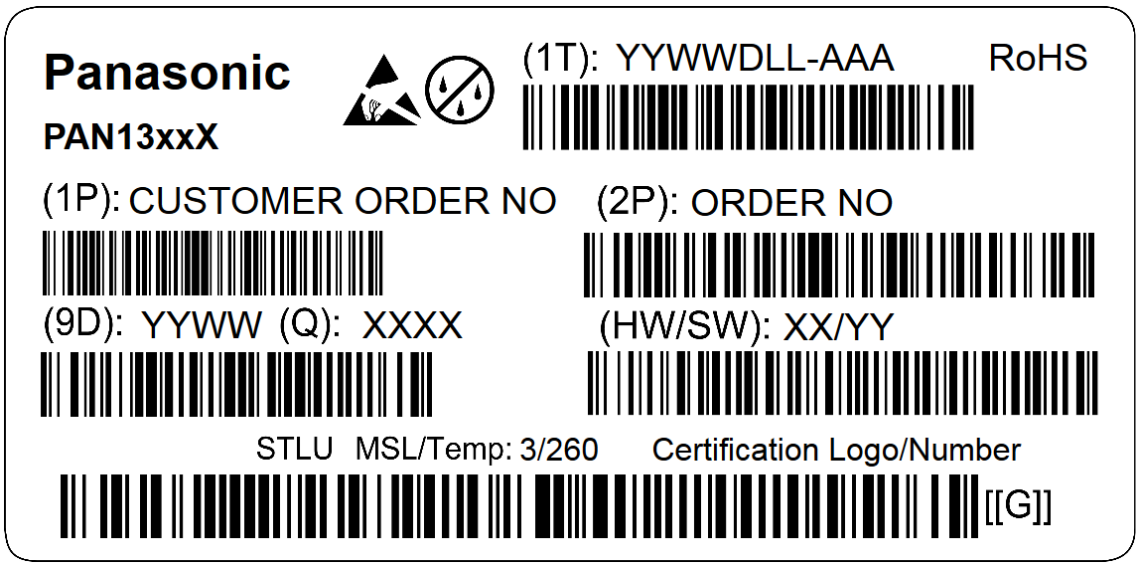


3.3.4 Reel Dimension



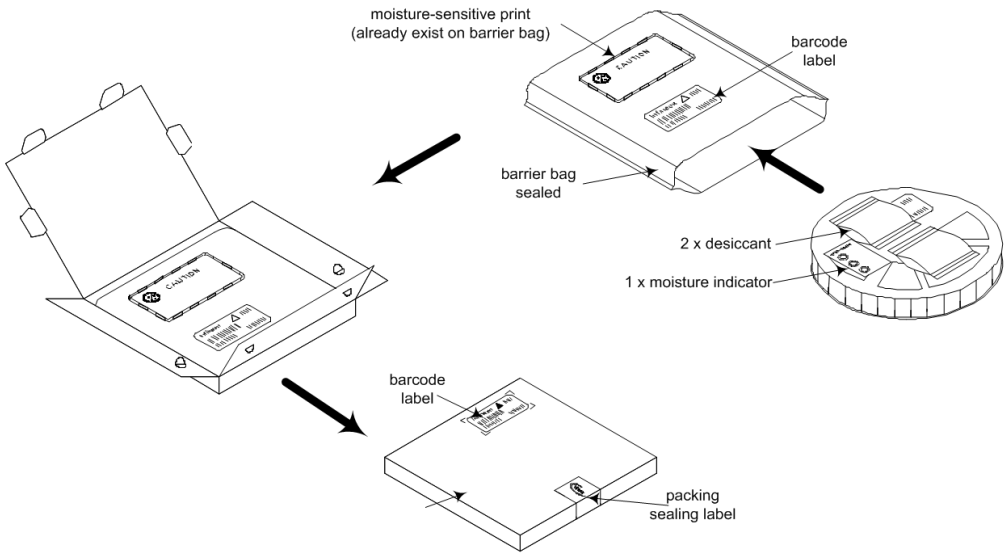
3.3.5 Package Label

Example



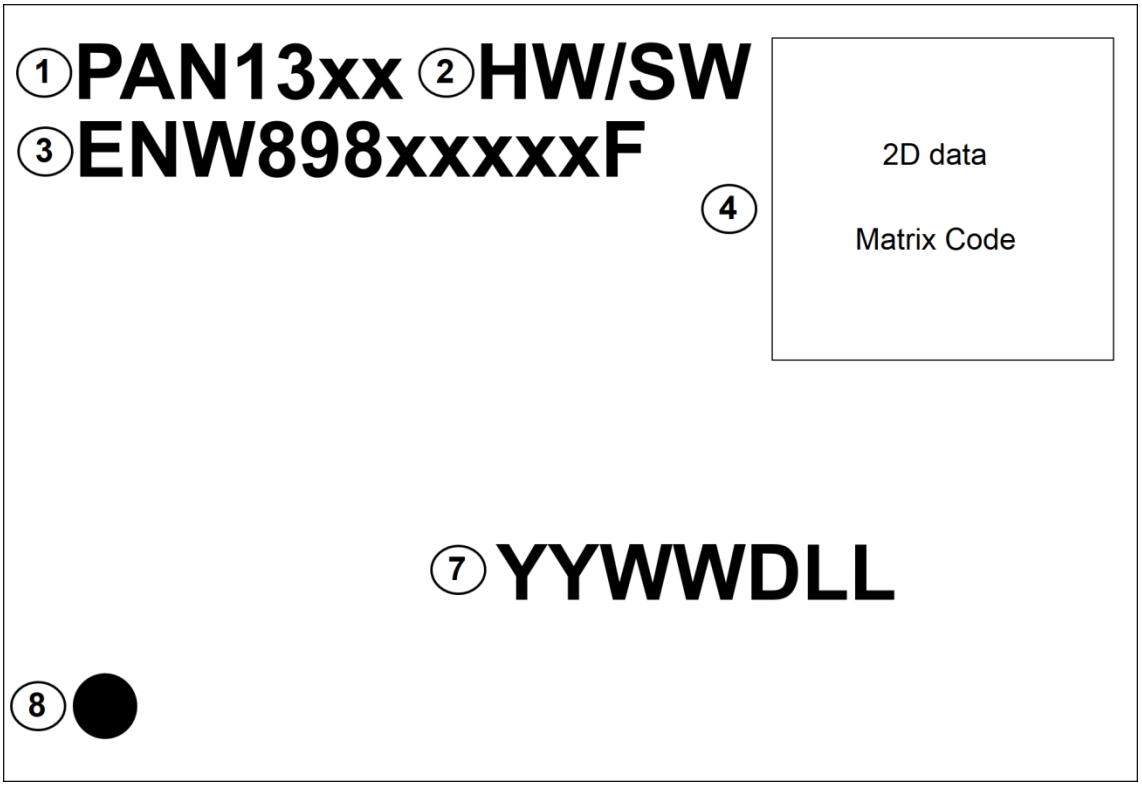
(1T)	Lot code
(1P)	Customer order number, if applicable
(2P)	Order number
(9D)	Date code
(Q)	Quantity
(HW/SW)	Hardware/software version

3.3.6 Total Package



3.4 Case Marking

Example



1	Brand name
2	Hardware/software version
3	Order number
4	2D Data Matrix Code
7	Lot code
8	Marking for Pin 1

4 Specification

All specifications are over temperature and process, unless indicated otherwise.

4.1 Default Test Conditions

Temperature:	25 ± 10 °C
Humidity:	40 to 85 % RH
Supply Voltage:	3.3 V

4.2 Absolute Maximum Ratings

The maximum ratings may not be exceeded under any circumstances, not even momentarily or individually, as permanent damage to the module may result.

All parameters are measured as follows unless stated otherwise: VDD_IN [6]=3.3 V, VDD_IO=1.8 V.

No	See[7]	Min.	Max.	Unit
Ratings Over Operating Free-Air Temperature Range				
1	VDD_IN	-0.5	5.5	V
2	VDDIO_1.8 V	-0.5	2.145	V
3	Input voltage to RF (Pin 13)	-0.5	2.1	V
4	Operating ambient temperature range	-40	85[8]	°C
5	Storage temperature range	-40	125	°C
6	ESD: Human Body Model (HBM). JEDEC 22-A114		500	V

[6] VDD_IN is supplied to MLDO_IN (Pin 15) and CL1.5_LDO_IN (Pin 11); other options are described in⇨ 2.3 Device Power Supply.

[7] 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 “recommended operating conditions” is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

[8] Older generation parts, which are not recommended for new designs, will support a temperature range -20 to 70. See ⇨ 6.1 Ordering Information for details.

4.3 Recommended Operating Conditions

The maximum ratings may not be exceeded under any circumstances, not even momentarily or individually, as permanent damage to the module may result.

Symbol	Parameter	Condition	Min.	Max.	Unit
VDD_IN	Power supply voltage [9]		1.7	4.8	V
VDD_IO	IO power supply voltage		1.62	1.92	V
V_{IH}	High-level input voltage	Default	0.65 x VDD_IO	VDD_IO	V
V_{IL}	Low-level input voltage	Default	0	0.35 x VDD_IO	V
Tr/Tf	IO Input rise/fall times, 10 % to 90 % [10]		1	10	ns
	Maximum ripple on VDD_IN (Sine wave) for 1.8 V (DC2DC) mode	0 MHz to 0.1 MHz		60	mVp-p
		0.1 MHz to 0.5 MHz		50	
		0.5 MHz to 2.5 MHz		30	
		2.5 MHz to 3.0 MHz		15	
		> 3.0 MHz		5	
	Voltage dips on VDD_IN (V_{BAT}) (duration=577 µs to 2.31 ms, period=4.6 m)			400	mV
	Maximum ambient operating temperature [11][12]		-40	85	°C

[9] Excluding 1.98 < VDD_IN < 2.2 V range is not allowed.

[10] Asynchronous mode.

[11] The device can be reliably operated for seven years at $T_{ambient}$ of 85 °C, assuming 25 percent active mode and 75 percent sleep mode (15 400 cumulative active power-on hours).

[12] The device can be reliably operated for seven years at $T_{ambient}$ of 85 °C, assuming 25 percent active mode and 75 percent sleep mode (15 400 cumulative active power-on-hours).

4.4 Current Consumption

No	Characteristics	Min. 25 °C	Typ. 25 °C	Max. 25 °C	Min. -40 °C	Typ. -40 °C	Max. -40 °C	Min. +85 °C	Typ. +85 °C	Max. +85 °C	Unit
2	Current consumption in Deep Sleep Mode		40	105						700	µA
3	Total IO current consumption for Active Mode			1			1			1	mA
4	Current consumption during transmit DH5 full throughput		40								mA
1	Current consumption in Shutdown Mode		1	3						7	µA

4.5 nSHUTD Requirements

Symbol	Parameter	Min.	Max.	Unit
V_{IH}	Operation mode level [13]	1.42	1.98	V
V_{IL}	Shutdown mode level	0	0.4	V
	Minimum time for nSHUT_DOWN low to reset the device	5		ms
Tr/Tf	Rise/fall times		20	µs

4.6 External Digital Slow Clock Requirements

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
	Input Slow Clock frequency			32 768		Hz
	Input Slow Clock accuracy (Initial + temp + aging)	Bluetooth			±250	Ppm
Tr/Tf	Input transition time Tr/Tf – 10 % to 90 %				100	Ns
	Frequency input duty cycle		15	50	85	%
	Phase noise	at 1 kHz			-125	dBc/Hz
	Jitter	Integrated over 300 Hz to 15 000 Hz			1	Hz
V_{IH}	Slow Clock input voltage limits	Square wave, DC coupled	0.65 x VDD_IO		VDD_IO	V peak

[13] Internal pull down retains shut down mode when no external signal is applied to this pin.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V_{IL}	Slow Clock input voltage limits	Square wave, DC coupled	0		0.35 x VDD_IO	V peak
	Input impedance		1			MΩ
	Input capacitance				5	pF

4.7 Bluetooth

Bluetooth Receiver – In-Band Signals

Characteristics	Condition		Min.	Typ.	Max.	Unit
Operation frequency range			2 402		2 480	MHz
Channel spacing				1		MHz
Input impedance				50		Ω
Sensitivity, Dirty Tx on[14]	GFSK, BER=0.1 %		-91.5	-95		dBm
	π/4-DQPSK, BER=0.01 %		-90.5	-94.5		
	8DPSK, BER=0.01 %		-81	-87.5		
BER error floor at sensitivity +10 dB, dirty TX off	π/4-DQPSK		1E–6	1E–7		
	8DPSK		1E–6			
Maximum usable input power	GFSK, BER=0.1 %		-5			dBm
	π/4-DQPSK, BER=0.1 %		-10			
	8DPSK, BER=0.1 %		-10			
Intermodulation characteristics	Level of interferers (for n=3, 4, and 5)		-36	-30		dBm
C/I performance[15]	GFSK, cochannel					dB
Image=–1 MHz	EDR, cochannel	π/4-DQPSK		9.5	11	
		8DPSK		16.5	20	
	GFSK, adjacent ±1 MHz			-10	-5	
	EDR, adjacent ±1 MHz, (image)	π/4-DQPSK		-10	-5	
		8DPSK		-5	-1	
	GFSK, adjacent +2 MHz			-38	-35	
	EDR, adjacent, +2 MHz	π/4-DQPSK		-38	-35	
		8DPSK		-38	-30	
	GFSK, adjacent –2 MHz			-28	-20	
	EDR, adjacent –2 MHz	π/4-DQPSK		-28	-20	
		8DPSK		-22	-13	
	GFSK, adjacent ≥ |±3| MHz			-45	-43	

[14] Sensitivity degradation up to 3 dB may occur for minimum and typical values where the Bluetooth frequency is a harmonic of the fast clock.

[15] Numbers show ratio of desired signal to interfering signal. Smaller numbers indicate better C/I performance.

Characteristics	Condition		Min.	Typ.	Max.	Unit
	EDR, adjacent ≥ |±3| MHz	π/4-DQPSK		-45	-43	
		8DPSK		-44	-36	
RF return loss				-10		dB
RX mode LO leakage	Frf=(received RF – 0.6 MHz)			-63	-58	dBm

Bluetooth Receiver – General Blocking

Characteristics	Condition	Min.	Typ.	Unit
Blocking performance over full range, according to Bluetooth specification[16]	30 to 2 000		-6	MHz
	2 000 to 2 399		-6	MHz
	2 484 to 3 000		-6	MHz
	3 to 12.75		-6	GHz

Bluetooth Transmitter – GFSK

Characteristics		Min.	Typ.	Max	Unit
Maximum RF output power[17]	VDD_IN=VBAT		12		dBm
	VDD_IN=external regulator to 1.8 V		10		
Power variation over Bluetooth band		-1		1	dB
Gain control range			30		dB
Power control step			5		dB
Adjacent channel power |M–N|=2			-45		dBm
Adjacent channel power |M–N|>2			-50		dBm

[16] Exceptions are taken out of the total 24 allowed in the Bluetooth specification.

[17] To modify maximum output power, use an HCI VS command.

Bluetooth Transmitter – EDR

Characteristics			Min.	Typ.	Max	Unit
EDR output power[18]	π/4-DQPSK	VDD_IN=VBAT		5.5		dBm
		VDD_IN=external regulator to 1.8 V				
	8DPSK	VDD_IN=VBAT				
		VDD_IN=external regulator to 1.8 V				
EDR relative power			-2		1	dB
Power variation over Bluetooth band			-1		1	dB
Gain control range				30		dB
Power control step				5		dB
Adjacent channel power |M–N|=1				-36		dBc
Adjacent channel power |M–N|=2				-30		dBm
Adjacent channel power |M–N|>2				-42		dBm

Bluetooth Modulation – GFSK

Characteristics		Condition		Min.	Typ.	Max.	Unit
	–20 dB bandwidth	GFSK			925		kHz
F1 avg	Modulation characteristics	Δf1avg	Mod data=4 1 s, 4 0 s: 111100001111...		165		kHz
F2 max		Δf2max ≥ limit for at least 99.9 % of all Δf2max	Mod data=1010101...		130		kHz
		Δf2avg, Δf1avg			88		%
	Absolute carrier frequency drift	DH1		-25		25	kHz
		DH3 and DH5		-35		35	
	Drift rate					15	kHz/50 µs
	Initial carrier frequency tolerance			-75		75	kHz

Bluetooth low energy Transceiver, Out-Of-Band and Spurious Emissions

Characteristics	Condition	Min.	Typ.	Max.	Unit
Second harmonic	Measured at maximum output power		-14	-2	dBm
Third harmonic			-10	-6	
Fourth harmonics			-19	-11	

[18] To modify maximum output power, use an NCI VS command.

Bluetooth low energy Receiver – In-Band Signals

Characteristics	Condition	Min.	Typ.	Max.	Unit
Operation frequency range		2 402		2 480	MHz
Channel spacing			2		MHz
Input impedance			50		Ω
Sensitivity, Dirty Tx on[19]	PER=30.8 %; dirty TX on		-96		dBm
Maximum usable input power	GMSK, PER=30.8 %	-5			
Intermodulation characteristics	Level of interferers (for n=3, 4, 5)		-30		dBm
C/I performance[20]	GMSK, cochannel		8		dB
Image=–1 MHz	GMSK, adjacent ±1 MHz		-5		
	GMSK, adjacent ±2 MHz		-45		
	GMSK, adjacent -2 MHz		-22		
	GMSK, adjacent ≥ |±3| MHz		-47		
RX mode LO leakage	Frf=(received RF – 0.6 MHz)		-63		dBm

Bluetooth low energy Receiver—General Blocking

Characteristics	Condition	Min.	Typ.	Max.	Unit
Blocking performance over full range, according to Bluetooth low energy specification[21]	30 to 2 000 MHz		–15		dBm
	2 000 to 2 399 MHz		–15		
	2 484 to 3 000 MHz		–15		
	3 to 12.75 GHz		–15		

Bluetooth low energy Transmitter

Characteristics		Min.	Typ.	Max.	Unit
RF output power	VDD_IN=VBAT		12		dBm
	VDD_IN=External regulator to 1.8 V		10		
Power variation over Bluetooth low energy band				1	dB
Adjacent channel power |M-N|=2			-45		dBm
Adjacent channel power |M-N|>2			-50		dBm

[19] Sensitivity degradation up to 3 dB may occur where the Bluetooth low energy frequency is a harmonic of the fast clock.

[20] Numbers show wanted signal-to-interfering signal ratio. Smaller numbers indicate better C/I performance.

[21] Exceptions are taken out of the total 10 allowed in the Bluetooth low energy specification.

Bluetooth low energy Modulation

Characteristics		Condition		Min.	Typ.	Max.	Unit
Δf1 avg	Modulation characteristics	Δf1avg	Mod data=4 1 s, 4 0 s: 1111000011110000...	240	250	260	kHz
Δf2 max		Δf2max ≥ limit for at least 99.9 % of all Δf2max	Mod data=1010101...	185	210		kHz
		Δf2avg, Δf1avg		0.85	0.9		
	Absolute carrier frequency drift			-25		25	kHz
	Drift rate					15	kHz/50 ms
	Initial carrier frequency tolerance			-75		75	kHz

No	Parameter	Min.	Typ.	Max.	Unit
1	Average Power Hopping DH5	4	11,3	20	dBm
2	Average Power: Ch0	4	11,4	20	dBm
3	Peak Power: Ch0		11,6	23	dBm
4	Average Power: Ch39	4	11,3	20	dBm
5	Peak Power: Ch39		11,6	23	dBm
6	Average Power: Ch78	4	11,3	20	dBm
7	Peak Power: Ch78		11,5	23	dBm
8	Max. Frequency Tolerance: Ch0	-75	-2.6	75	kHz
9	Max. Frequency Tolerance: Ch39	-75	-2.2	75	kHz
10	Max. Frequency Tolerance: Ch78	-75	-2.1	75	kHz
11	Max. Drift: Ch0_DH1	-25	3.6	25	kHz
12	Max. Drift: Ch0_DH3	-40	3.7	40	kHz
13	Max. Drift: Ch0_DH5	-40	4.0	40	kHz
14	Max. Drift Rate: Ch0_DH1	-20	-2.6	20	kHz
15	Max. Drift Rate: Ch0_DH3	-20	-3.2	20	kHz

No	Parameter	Min.	Typ.	Max.	Unit
16	Max. Drift Rate: Ch0_DH5	-20	-3.3	20	kHz
17	Max. Drift: Ch39_DH1	-25	4.0	25	kHz
18	Max. Drift: Ch39_DH3	-40	4.3	40	kHz
19	Max. Drift: Ch39_DH5	-40	4.3	40	kHz
20	Max. Drift Rate: Ch39_DH1	-20	-3.1	20	kHz
21	Max. Drift Rate: Ch39_DH3	-20	-3.6	20	kHz
22	Max. Drift Rate: Ch39_DH5	-20	-3.7	20	kHz
23	Max. Drift: Ch78_DH1	-25	4.1	25	kHz
24	Max. Drift: Ch78_DH3	-40	4.5	40	kHz
25	Max. Drift: Ch78_DH5	-40	4.4	40	kHz
26	Max. Drift Rate: Ch78_DH1	-20	-3.4	20	kHz
27	Max. Drift Rate: Ch78_DH3	-20	-3.9	20	kHz
28	Max. Drift Rate: Ch78_DH5	-20	-4.1	20	kHz
29	Delta F1 Avg: Ch0	140	159.5	175	kHz
30	Delta F2 Max.: Ch0	99.9	100.0		%
31	Delta F2 Avg/Delta F1 Avg: Ch0	0.8	0.9		
32	Delta F1 Avg: Ch39	140	159.8	175	kHz
33	Delta F2 Max.: Ch39	99.9	100.0		%
34	Delta F2 Avg/Delta F1 Avg: Ch39	0.8	0.9		
35	Delta F1 Avg: Ch78	140	159.1	175	kHz
36	Delta F2 Max.: Ch78	99.9	100.0		%
37	Delta F2 Avg/Delta F1 Avg: Ch78	0.8	0.9		
45	Sensitivity	-81	-93.0		
46	f(H)-f(L): Ch0		918.4	1 000	kHz
47	f(H)-f(L): Ch39		918.3	1 000	kHz

No	Parameter	Min.	Typ.	Max.	Unit
48	f(H)-f(L): Ch78		918.2	1 000	kHz
49	ACPower -3: Ch3		-51.5	-40	dBm
50	ACPower -2: Ch3		-50.4	-40	dBm
51	ACPower -1: Ch3		-18.5		dBm
52	ACPower Center: Ch3	4	6,8	20	dBm
53	ACPower +1: Ch3		-19.2		dBm
54	ACPower +2: Ch3		-50.7	-40	dBm
55	ACPower +3: Ch3		-53.3	-40	dBm
56	ACPower -3: Ch39		-51.6	-40	dBm
57	ACPower -2: Ch39		-50.7	-40	dBm
58	ACPower -1: Ch39		-19.0		dBm
59	ACPower Center: Ch39	4	6,3	20	dBm
60	ACPower +1: Ch39		-19.7		dBm
61	ACPower +2: Ch39		-50.9	-40	dBm
62	ACPower +3: Ch39		-53.2	-40	dBm
63	ACPower -3: Ch75		-51.7	-40	dBm
64	ACPower -2: Ch75		-50.7	-40	dBm
65	ACPower -1: Ch75		-19.2		dBm
66	ACPower Center: Ch75	4	5,8	20	dBm
67	ACPower +1: Ch75		-20.0		dBm
68	ACPower +2: Ch75		-51.0	-40	dBm
69	ACPower +3: Ch75		-53.4	-40	dBm
70	omega i 2-DH5: Ch0	-75	-4.7	75	kHz
71	omega o + omega i 2-DH5: Ch0	-75	-6.0	75	kHz
72	omega o 2-DH5: Ch0	-10	-1.5	10	kHz

No	Parameter	Min.	Typ.	Max.	Unit
73	DEVM RMS 2-DH5: Ch0		0.0	0.2	%
74	DEVM Peak 2-DH5: Ch0		0.1	0.35	%
75	DEVM 99 % 2-DH5: Ch0	99	100.0		%
76	omega i 3-DH5: Ch0	-75	-3.7	75	kHz
77	omega o + omega i 3-DH5: Ch0	-75	-5.8	75	kHz
78	omega o 3-DH5: Ch0	-10	-2.6	10	kHz
79	DEVM RMS 3-DH5: Ch0		0.0	0.13	%
80	DEVM Peak 3-DH5: Ch0		0.1	0.25	%
81	DEVM 99 % 3-DH5: Ch0	99	100.0		%
82	omega i 2-DH5: Ch39	-75	-4.8	75	kHz
83	omega o + omega i 2-DH5: Ch39	-75	-6.1	75	kHz
84	omega o 2-DH5: Ch39	-10	-1.4	10	kHz
85	DEVM RMS 2-DH5: Ch39		0.0	0.2	%
86	DEVM Peak 2-DH5: Ch39		0.1	0.35	%
87	DEVM 99 % 2-DH5: Ch39	99	100.0		%
88	omega i 3-DH5: Ch39	-75	-3.8	75	kHz
89	omega o + omega i 3-DH5: Ch39	-75	-5.9	75	kHz
90	omega o 3-DH5: Ch39	-10	-2.6	10	kHz
91	DEVM RMS 3-DH5: Ch39		0.0	0.13	%
92	DEVM Peak 3-DH5: Ch39		0.1	0.25	%
93	DEVM 99% 3-DH5: Ch39	99	100.0		%
94	omega i 2-DH5: Ch78	-75	-4.9	75	kHz
95	omega o + omega i 2-DH5: Ch78	-75	-6.2	75	kHz
96	omega o 2-DH5: Ch78	-10	-1.4	10	kHz
97	DEVM RMS 2-DH5: Ch78		0.0	0.2	%

No	Parameter	Min.	Typ.	Max.	Unit
98	DEVM Peak 2-DH5: Ch78		0.1	0.35	%
99	DEVM 99 % 2-DH5: Ch78	99	100.0		%
100	omega i 3-DH5: Ch78	-75	-3.8	75	kHz
101	omega o + omega i 3-DH5: Ch78	-75	-6.0	75	kHz
102	omega o 3-DH5: Ch78	-10	-2.7	10	kHz
103	DEVM RMS 3-DH5: Ch78		0.0	0.13	%
104	DEVM Peak 3-DH5: Ch78		0.1	0.25	%
105	DEVM 99 % 3-DH5: Ch78	99	100.0		%

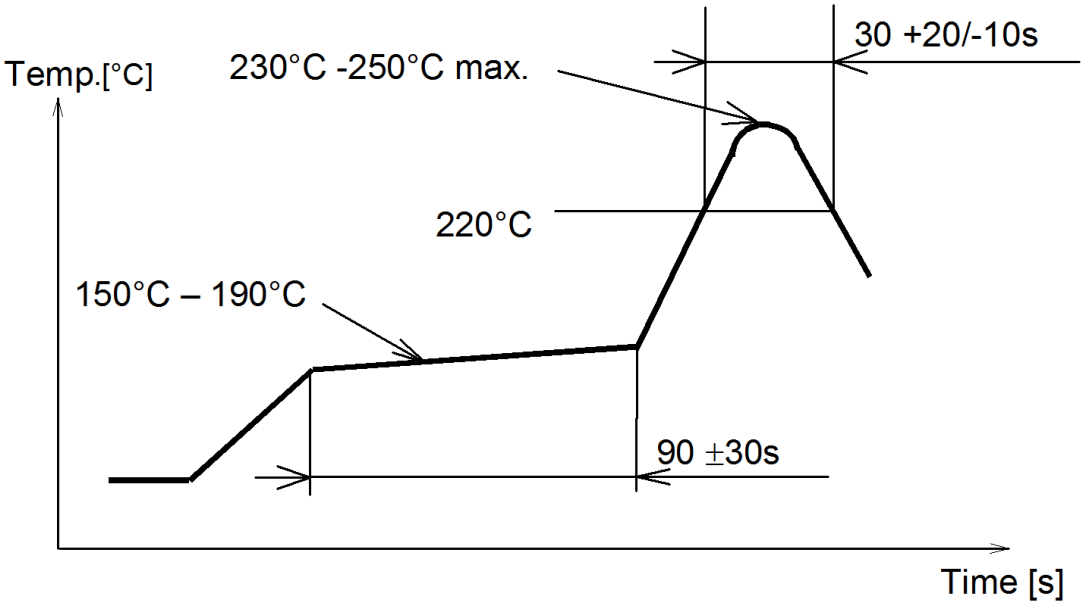
4.8 Reliability Tests

The measurement should be done after the test device has been exposed to room temperature and humidity for one hour.

No.	Item	Limit	Condition
1	Vibration test	Electrical parameter should be in specification	• Freq.: 10~50 Hz; Amplitude: 1.5 mm; 20 min./cycle, 1 hrs. each of XYZ axis • Freq.: 30~100 Hz, 6 G; 20min./cycle, 1 hrs. each of XYZ axis
2	Shock test	See above	Dropped onto hard wood from a height of 50 cm for 3 times
3	Heat cycle test	See above	-40 °C for 30 min. and +85 °C for 30 min.; each temperature 300 cycles
4	Moisture test	See above	+60 °C, 90 % RH, 300 h
5	Low temperature test	See above	-40 °C, 300 h
6	High temperature test	See above	+85 °C, 300 h

4.9 Recommended Soldering Profile

- Reflow permissible cycle: 2
- Opposite side reflow is prohibited due to module weight
- More than 75 percent of the soldering area shall be coated by solder
- The soldering profiles should be adhered to in order to prevent electrical or mechanical damage
- Soldering profile assumes lead-free soldering



5 Cautions

Failure to follow the guidelines set forth in this document may result in degrading of the product's functions and damage to the product.

5.1 Design Notes

1. Follow the conditions written in this specification, especially the control signals of this module.
2. The supply voltage must be free of AC ripple voltage (for example from a battery or a low noise regulator output). For noisy supply voltages, provide a decoupling circuit (for example a ferrite in series connection and a bypass capacitor to ground of at least 47 µF directly at the module).
3. This product should not be mechanically stressed when installed.
4. Keep this product away from heat. Heat is the major cause of decreasing the life of these products.
5. Avoid assembly and use of the target equipment in conditions where the product's temperature may exceed the maximum tolerance.
6. The supply voltage should not be exceedingly high or reversed. It should not carry noise and/or spikes.
7. Keep this product away from other high frequency circuits.
8. Refer to the recommended pattern when designing a board.

5.2 Installation Notes

1. Reflow soldering is possible twice based on the conditions set forth in ⇨ 4.9 Recommended Soldering Profile. Set up the temperature at the soldering portion of this product according to this reflow profile.
2. Carefully position the products so that their heat will not burn into printed circuit boards or affect the other components that are susceptible to heat.
3. Carefully locate these products so that their temperatures will not increase due to the effects of heat generated by neighboring components.
4. If a vinyl-covered wire comes into contact with the products, then the cover will melt and generate toxic gas, damaging the insulation. Never allow contact between the cover and these products to occur.
5. This product should not be mechanically stressed or vibrated when reflowed.
6. To repair the board by hand soldering, follow the conditions set forth in this chapter.
7. Do not wash this product.
8. Pressing on parts of the metal cover or fastening objects to the metal will cause damage to the unit.

5.3 Usage Condition Notes

1. Take measures to protect the unit against static electricity.
   If pulses or other transient loads (a large load applied in a short time) are applied to the products, check and evaluate their operation befor assembly on the final products.
2. Do not use dropped products.
3. Do not touch, damage or soil the pins.
4. Follow the recommended condition ratings about the power supply applied to this product.
5. Electrode peeling strength: Do not add pressure of more than 4.9 N when soldered on PCB.
6. Pressing on parts of the metal cover or fastening objects to the metal cover will cause damage.
7. These products are intended for general purpose and standard use in general electronic equipment, such as home appliances, office equipment, information, and communication equipment.

5.4 Storage Notes

1. The module should not be stressed mechanically during storage.
2. Do not store these products in the following conditions or the performance characteristics of the product, such as RF performance will be adversely affected:

– Storage in salty air or in an environment with a high concentration of corrosive gas, such as Cl2, H2S, NH3, SO2, or NOX,
– Storage in direct sunlight,
– Storage in an environment where the temperature may be outside the range of 5 °C to 35 °C, or where the humidity may be outside the 45 to 85 percent range,
– Storage of the products for more than one year after the date of delivery storage period: Please check the adhesive strength of the embossed tape and soldering after six months of storage.

3. Keep this product away from water, poisonous gas, and corrosive gas.
4. This product should not be stressed or shocked when transported.
5. Follow the specification when stacking packed crates (maximum 10).

5.5 Safety Cautions

These specifications are intended to preserve the quality assurance of products and individual components.

Before use, check and evaluate the operation when mounted on your products. Abide by these specifications without deviation when using the products. These products may short-circuit. If electrical shocks, smoke, fire, and/or accidents involving human life are anticipated when a short circuit occurs, provide the following failsafe functions as a minimum:

1. Ensure the safety of the whole system by installing a protection circuit and a protection device.
2. Ensure the safety of the whole system by installing a redundant circuit or another system to prevent a single fault causing an unsafe status.

5.6 Other Cautions

1. Do not use the products for other purposes than those listed.
2. Be sure to provide an appropriate fail-safe function on your product to prevent any additional damage that may be caused by the abnormal function or the failure of the product.
3. This product has been manufactured without any ozone chemical controlled under the Montreal Protocol.
4. These products are not intended for uses other than under the special conditions shown below. Before using these products under such special conditions, carefully check their performance and reliability under the said special conditions to determine whether or not they can be used in such a manner:

– In liquid, such as water, salt water, oil, alkali, or organic solvent, or in places where liquid may splash,
– In direct sunlight, outdoors, or in a dusty environment,
– In an environment where condensation occurs,
– In an environment with a high concentration of harmful gas (for example salty air, HCl, Cl2, SO2, H2S, NH3, and NOX).

5. If an abnormal voltage is applied due to a problem occurring in other components or circuits, replace these products with new products because they may not be able to provide normal performance even if their electronic characteristics and appearances appear satisfactory.

Please refer to the Panasonic website for for further information
⇨ 6.2.2 Product Information.

5.7 Bluetooth Declaration

PAN1326C QDID: 39329

https://launchstudio.bluetooth.com/ListingDetails/5045

TI Host-Stack: QDID: 69887

https://launchstudio.bluetooth.com/ListingDetails/23810

TI Profile Stack: QDID: 69886

https://launchstudio.bluetooth.com/ListingDetails/23811

5.8 Life Support Policy

This Panasonic Industrial Devices Europe GmbH product is not designed for use in life support appliances, devices, or systems where malfunction can reasonably be expected to result in a significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect it is safety or effectiveness.

Panasonic customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Panasonic Industrial Devices Europe GmbH for any damages resulting.

5.9 Restricted End Use

This Panasonic Industrial Devices Europe GmbH product is not designed for any restricted activity that supports the development, production, handling usage, maintenance, storage, inventory or proliferation of any weapons or military use.

Transfer, export, re-export, usage or reselling of this product to any destination, end user or any end use prohibited by the European Union, United States or any other applicable law is strictly prohibited.

6 Appendix

6.1 Ordering Information

Variants and Versions

Order Number	Brand Name	Description	MOQ [22]
ENW89823C4KF	PAN1316C	Bluetooth Basic Data Rate and Low Energy Module w/o antenna	1 500
ENW89823A4KF[23]	PAN1326C	Bluetooth Basic Data Rate and Low Energy Module w/ antenna	1 500

[22] Abbreviation for Minimum Order Quantity (MOQ). The default MOQ for mass production is 1 500 pieces, fewer only on customer demand. Samples for evaluation can be delivered at any quantity via the distribution channels.

[23] Samples are available on customer demand.

6.2 Contact Details

6.2.1 Contact Us

Please contact your local Panasonic Sales office for details on additional product options and services:

For Panasonic Sales assistance in the **EU**, visit
https://eu.industrial.panasonic.com/about-us/contact-us
Email: wireless@eu.panasonic.com

For Panasonic Sales assistance in **North America**, visit the Panasonic "Sales & Support" website to find assistance near you at
https://na.industrial.panasonic.com/distributors

Please visit the **Panasonic Wireless Technical Forum** to submit a question at
https://forum.na.industrial.panasonic.com

6.2.2 Product Information

Please refer to the Panasonic Wireless Connectivity website for further information on our products and related documents:

For complete Panasonic product details in the **EU**, visit
http://pideu.panasonic.de/products/wireless-modules.html

For complete Panasonic product details in **North America**, visit
http://www.panasonic.com/rfmodules