Product Specification

Applicant / Manufacturer Hardware	Panasonic Industrial Devices Europe GmbH Zeppelinstrasse 19 21337 Lüneburg Germany
Applicant / Manufacturer Software	Refer to chapter 22 / 26.5 for information regarding software versions
Software Version	Refer to chapter 22 / 26.5 for information regarding software versions

By purchase of any of products described in this document the customer accepts the document's validity and declares their agreement and understanding of its contents and recommendations. Panasonic reserves the right to make changes as required without notification.

Power Electronics R&D Center Wireless Connectivity Panasonic Industrial Devices Europe GmbH	APPROVED genehmigt	CHECKED geprüft	DESIGNED erstellt

TABLE OF CONTENTS

1. SCOPE OF THIS DOCUMENT

This product specification applies to Panasonic's Wi-Fi IEEE 802.11 b/g/n full embedded module with series name PAN9320.

2. HISTORY FOR THIS DOCUMENT

Revision	Date	Modification / Remarks
0.1	22.04.2015	1st preliminary version

3. DATA SHEET STATUS

This data sheet contains the PRELIMINARY specification. Supplementary data will be published at a later date.

Panasonic reserves the right to make changes at any time without notice.

Consult the most recently issued data sheet before initiating or completing a design.

4. RELATED DOCUMENTS

Search these homepages for documentation updates.

[1] PAN9320 Software-Guide
http://pideu.panasonic.de/produkte/Funkmodule.html

[2] Semiconductor Datasheet
88MC200 from Marvell®
88W8782 from Marvell®

[3] Application Note Land Grid Array
http://www.pideu.panasonic.de/pdf/184ext.pdf

[4] REACH and RoHS Certificate
http://pideu.panasonic.de/files/Documents/WM_Documents/PAN9320/WM-REACH_and_RoHS_directive.pdf

5.   KEY FEATURES

- Surface Mount Type 29.0 x 13.5 x 2.6 mm³
- Wireless Local Area Network (WLAN) module with integrated MCU and Radio (SoC)
- Operating in the 2.4GHz ISM band
- Supports IEEE 802.11
  - ➢ IEEE 802.11b/g payload data rates
  - ➢ IEEE 802.11n high throughput data rates
  - ➢ IEEE 802.11i security standards WEP, TKIP, AES-CCMP and AES-CMAC
  - ➢ IEEE 802.11e Quality of Service (QoS)
- Coexistence Interface for external co-located 2.4GHz radios (e.g. Bluetooth)
- Tx power up to +18 dBm (IEEE 802.11b)
- High Rx sensitivity
  - ➢ -98dBm (IEEE 802.11b DSSS 1Mbps)
  - ➢ -76dBm (IEEE 802.11g OFDM 54Mbps)
  - ➢ -74dBm (IEEE 802.11n MCS7 HT20 65Mbps)
  - ➢ -71dBm (IEEE 802.11n MCS7 HT40 135Mbps)
- Marvell® 88W8782 WLAN System-on-Chip (SoC) and 88MC200 (MCU) inside
- Integrated flash for customer web contents and configuration file 1,5MByte (extentable)
- High performance low power CPU core
- Internal crystal oscillators for Radio (40MHz) and MCU (32MHz)
- 2 UART interfaces (Command, Data)
- Integrated shielding to resist EMI
- Manufactured in conformance with RoHS

6.   APPLICATIONS FOR THE MODULE

All Embedded Wireless Applications

- White goods
- Home Automation
- Internet of Things
- Fitness Equipment
- Lighting Control
- M2M Communication
- Printer
- Smart Meters
- Media Player
- Sensors
- POS Terminal
- Patient Monitors

7.   WIRELESS LOCAL AREA NETWORK

Wireless Local Area Network (WLAN) is a local radio network defined in part by the IEEE 802.11 family of standards. The IEEE 802.11 is an international standard describing the wireless network. The standard defines the lower layers of the OSI model for wireless communication with the Physical Layer (PHY) and the Data Link Layer (DLL) with its two sub-layers Logical Link Control (LLC) and Media Access Control (MAC), making it possible to use any protocol over a IEEE 802.11 wireless network as an Ethernet network. Basically WLAN networks use two operating modes for connecting station computers (STA) equipped with a wireless network adapter. The first one is the infrastructure mode where the wireless clients are connected via one or more access points (AP) to a wired network. In this case the network is configured with the same Service Set Identifier (SSID) network name in order to communicate. The second one is the ad-hoc mode where wireless clients are connected without any access point to the internet.

WLAN devices typically have a higher transmit power to cover a radio range about 100m. Furthermore WLAN is commonly used to transmit high throughput data using Orthogonal Frequency Division Multiplexing

(OFDM) modulation. The Carrier Sense Multiple Access with Collosion Avoidance (CSMA/CA) mechanism enables the parallel access of more than one device to the media of a IEEE 802.11 network. By implementation of security mechanisms like Adavanced Encryption Standard (AES) with Counter Mode CBC-MAC Protocol (CCMP) or Cipher-Based Message Authentication Code (CMAC) and Wired Equivalent Privacy (WEP) with Temporal Key Integrity Protocol (TKIP) the network is supporting the security standard IEEE 802.11i. Video, voice and multimedia applications are supported by the IEEE 802.11e Quality of Service amendment.

8.   DESCRIPTION FOR THE MODULE

The PAN9320 series is a 2.4GHz ISM band wireless radio module for implementing WLAN functionality into various electronic devices. A block diagram can be found in chapter 14.

The PAN9320 series is a cost-effective, low-power consumption, system-on-chip (SoC) solution for WLAN applications. It enables wireless network adapters and cards to be built with low total bill-of-material costs. The PAN9320 series combines an excellent 802.11 wireless radio, baseband processor, medium access controller, encryption unit, CPU, boot ROM with patching capability, internal SRAM, in-system programmable flash memory and many other powerful supporting features and peripherals. The PAN9320 is suitable for wireless network systems based on WLAN IEEE 802.11 b/g/n 2.4GHz where small form factor, highly integration, high throughput data rates and low RF expertise are required.

The PAN9320 includes integrated firmware consisting of TCP/IP-stack on 802.11 MAC with various application features.

The Driver-Firmware Interface handles all 802.11 MAC management tasks by converting standard 802.3 Ethernet frames to the SoC firmware to transmit over the wireless link as 802.11 frames and processes the received 802.11 frames and converts them into 802.3 Ethernet frames before forwarding them to the host driver. The HOST driver is seperated in three modules. The Standard Ethernet driver, the 802.11 Extensions and the Hardware Interface Driver. The 802.11 Extensions module extends the Standard Ethernet driver in order to view and control the state of the WLAN adapter. The Hardware Interface Driver controls the hardware interface on the HOST side. Additonally the software package from Marvell[®] consists of various applications, demonstrations and utilities.

Refer to [1] PAN9320 Software-Guide and chapter 27 Ordering Information.

Please contact your local sales office for further details on additional options and services:

www.panasonic.com/rfmodules for the US,

http://industrial.panasonic.com/eu/i/29606/wireless_modules/wireless_modules.html for EU

or write an e-mail to wireless@eu.panasonic.com.

9. DETAILED DESCRIPTION

9.1. PAN9320 TERMINAL LAYOUT

Top View, Application PCB

Top View
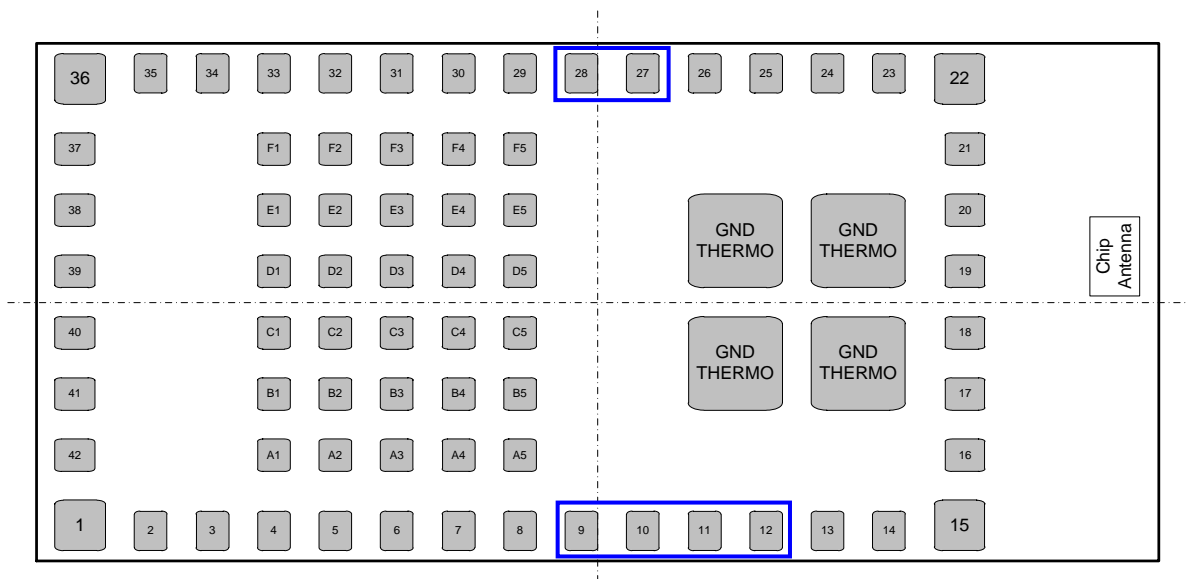
9.2. COMMON TERMINAL PIN-CONFIGURATION

No	Pin Name	Pin Type	Description
1	GND	Ground Pin	Connect to Ground
2	GPIO44[1]	Digital I/O	Digital I/O #44
3	GPIO45[1]	Digital I/O	Digital I/O #45
4	USB AVDD 33	Power	Don't connect, only for internal purpose
5	USB DP	Analog I/O	Don't connect, only for internal purpose
6	USB DM	Analog I/O	Don't connect, only for internal purpose
7	3.3V	Power	3.0V – 3.6V power supply connection
8	3.3V	Power	3.0V – 3.6V power supply connection
9	UART1 CTS	Digital In	CTSn for UART1
10	UART1 RTS	Digital Out	RTSn for UART 1
11	UART1 TXD	Digital Out	TXD for UART1
12	UART1 RXD	Digital In	RXD for UART1
13	QSPI CS2	Digital Out	Chip Select for external QSPI Flash Memory (option)
14	GND	Ground Pin	Connect to Ground
15	GND	Ground Pin	Connect to Ground
16	NC	NC	NC
17	GND	Ground Pin	Connect to Ground
18	GND	Ground Pin	Connect to Ground
19	GND	Ground Pin	Connect to Ground
20	GND	Ground Pin	Connect to Ground
21	GND	Ground Pin	Connect to Ground
22	GND	Ground Pin	Connect to Ground

[1] All GPIO's are initial set to output with low level

No	Pin Name	Pin Type	Description
23	GND	Ground Pin	Connect to Ground
24	GND	Ground Pin	Connect to Ground
25	GND	Ground Pin	Connect to Ground
26	W STAT LED	Digital Out	Connect to WiFi-Status LED
27	UART0 TXD	Digital Out	TXD for UART0
28	UART0 RXD	Digital In	RXD for UART0
29	GPIO4[1]	Digital I/O	Digital I/O #4
30	GPIO5[1]	Digital I/O	Digital I/O #5
31	GPIO6[1]	Digital I/O	Digital I/O #6
32	GPIO7[1]	Digital I/O	Digital I/O #7
33	STAT LED1	Digital Out	Connect to Microcontroller-Status LED, active low
34	STAT LED2	Digital Out	Connect to IP-Connectivity LED active low
35	STAT LED3	Digital Out	Connect to Error LED active low
36	GND	Ground Pin	Connect to Ground
37	RESETn	Digital In	Resetn, active low
38	WAKE UP0	Digital In	Wake up signal for MCU, active high
39	BOOT	Digital In	Boot option, High level: boot from internal flash, Low level: boot over UART[2]
40	GPIO28[1]	Digital I/O	Digital I/O #28
41	MCU READY	Digital Out	Connect to Ready-LED, active high
42	FACTORY RESET	Digital In	Factory reset, active high
A1	SD DAT3	Digital I/O	Don't connect, only for internal purpose
A2	SD DAT2	Digital I/O	Don't connect, only for internal purpose
A3	SD DAT1	Digital I/O	Don't connect, only for internal purpose
A4	SD DAT0	Digital I/O	Don't connect, only for internal purpose
A5	SD CMD	Digital I/O	Don't connect, only for internal purpose
B1	SD CLK	Digital Out	Don't connect, only for internal purpose
B2	BT FREQ	Input Signal	Information BT using channel which overlaps WLAN channel or not
B3	BT GRANTN	Output Signal	Indicate permission to transmit, low BT can transmit
B4	BT REQ	Input Signal	BT device request access to medium
B5	BT STATE	Input Signal	Information BT_REQ priority (1- or 2-bit) and direction BT RX/TX
C1	NC		Don't connect, only for internal purpose
C2	NC		Don't connect, only for internal purpose
C3	WAKE UP1	Digital In	Don't connect, only for internal purpose
C4	QSPI CLK	Digital Out	Clock for QSPI
C5	QSPI D3	Digital I/O	Data3 for QSPI
D1	TDI	Digital In	TDI for JTAG
D2	TRSTn	Digital In	TRSTn for JTAG
D3	NC		Don't connect, only for internal purpose
D4	QSPI D0	Digital I/O	Data0 for QSPI
D5	QSPI D1	Digital I/O	Data1 for QSPI
E1	TDO	Digital Out	TDO for JTAG
E2	TCK	Digital Out	TCK for JTAG
E3	TMS	Digital I/O	TMS for JTAG
E4	QSPI D2	Digital I/O	Data2 for QSPI
E5	QSPI CS	Digital Out	Chip select for internal QSPI Flash Memory
F1	W PDn	Digital In	Don't connect, only for internal purpose
F2	W RESETn	Input Signal	Don't connect, only for internal purpose
F3	GND	Ground Pin	Connect to Ground
F4	GND	Ground Pin	Connect to Ground
F5	GND	Ground Pin	Connect to Ground

[2] Connect the Boot-Pin over a 100 Ohm resistor to Vcc or GND

10. GENERAL FEATURES

- Surface Mount Type 29,0 x 13.5 x 2.66 mm³
- Wireless Local Area Network (WLAN) module with integrated MCU and Radio (SoC)
- Integrated embedded stack, interfaces Telnet, http, Ajax, Jason, others
- Wireless Update of Radio Driver and MCU Firmware with integrated bootloader
- Integrated flash for customer web contents up to 1.5MByte
- Evaluation and Development software for Windows
- Getting started Tutorials, Libraries, APIs
- Easy to use Evaluation Board for quick development and reduced time to market
- Supports IEEE 802.11 b/g/n and security standards WEP, WPA, WPA2
- Tx power up to +18 dBm (IEEE 802.11b)
- High Rx sensitivity -98 dBm (IEEE 802.11b DSSS 1Mbps)
- Marvell® 88W8782 WLAN System-on-Chip (SoC) and 88MC200 (MCU) inside
- High performance low power CPU core
- Two Internal crystal oscillator 32MHz and 40MHz
- Programming over JTAG
- HOST communication interfaces UART0 (Command) and UART1 (Data tunnel)
- Integrated shielding to resist EMI

11. HOST INTERFACES

11.1. UART0 INTERFACE (COMMAND)

- 2-wire data transfer (RX, TX)
- Programmable baud rate (110bps to 1.5 Mbps)
- Data format (LSB first)
- Data bit: (5-8 bit)
- Parity bit: (0-4 bit)
- Stop bit: (1-2 bit)

11.2. UART1 INTERFACE (DATA)

- 4-wire data transfer (RX, TX, RTS, CTS)
- Programmable baud rate (110bps to 1.5 Mbps)
- Data format (LSB first)
- Data bit: (5-8 bit)
- Parity bit: (0-4 bit)
- Stop bit: (1-2 bit)

12. PERIPHERAL BUS INTERFACE

- Embedded WLAN SoC with following features:
  - Clocked Serial Unit (CSU)
    - 3-Wire, 4-Wire (3W4W) Interface
    - 2-Wire Serial Interface (TWSI)
    - 1-Wire Serial Interface

  - General-Purpose I/O (GPIO) Interface
    - User-defined GPIOs, I/O configured to either input or output
    - GPIOs independently controlled
    - GPIO1 with LED output functionality
      - ❖ LED Pulse Stretching to observe short duration of status events
      - ❖ Two software controlled blink rates to indicate events

13. WLAN FEATURES

13.1. IEEE 802.11 / STANDARDS

- 802.11 data rates 1 and 2 Mbps (DSSS)
- 802.11b data rates 5.5 and 11 Mbps (CCK)
- 802.11g data rates 6, 9, 12, 18, 24, 36, 48 and 54 Mbps (OFDM)
- 802.11b/g performance enhancements
- 802.11n compliant with maximum data rates up to 72 Mbps (20 MHz channel) and 150 Mbps (40 MHz channel)
- 802.11d international roaming
- 802.11i enhanced security (WEP, WPA, WPA2)
- 802.11k radio resource measurement[3]
- 802.11r fast hand-off for AP roaming[3]
- 802.11w protected management frames[3]
- Support clients (stations) implementing IEEE Power Save mode

13.2. WLAN MAC

- Ad-Hoc[3] and Infrastructure Modes
- RTS/CTS for operation und DCF
- Hardware filtering of 32 multicast addresses and duplicate frame detection for up to 32 unicast addresses
- WLAN SoC with Tx and Rx FIFO for maximum throughput
- Open System and Shared Key Authentication services
- A-MPDU Rx (de-aggregation) and Tx (aggregation)
- 20/40 MHz channel coexistence
- Reduced Inter-Frame Spacing (RIFS) bursting
- Management Information Base (MIB) counter
- Radio resource measurement counters
- Block acknowledgement with 802.11n extensions
- Transmit beamformer support
- Transmit rate adaptation
- Transmit power control
- Long and short preamble generation on a frame-by-frame basis for 802.11b frames
- Marvell® Mobile Hotspot technology (MMH)

13.3. WLAN BASEBAND

- 802.11n 1x1 SISO (WLAN SoC with SISO RF radio)
- Backward compatibility with legacy 802.11b/g technology
- PHY data rates up to 150 Mbps (802.11n - MCS7)
- 20 MHz bandwidth/channel, 40 MHz bandwidth/channel, upper/lower 20 MHz bandwidth in 40 MHz channel and 20 MHz duplicate legacy bandwidth in 40 MHz channel mode operation
- Modulation and Coding Scheme MCS 0 ~ 7 and MCS 32 (duplicate 6 Mbps)
- Radio resource measurement
- Optional 802.11n SISO features:
  - ➢ 20/40 MHz coexistence
  - ➢ 1-stream Space-Time-Block-Coding (STBC) reception
  - ➢ Short Guard Interval
  - ➢ RIFS on receive path
  - ➢ Beamformer function and hardware acceleration
  - ➢ Greenfield Tx/Rx

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[3] Hardware supported, not implemented in the software stack

13.4. WLAN RADIO

- 20 and 40 MHz channel bandwidth
- Embedded WLAN SoC with following features:
  - Direct conversion radio (no SAW filter)
  - 2.4GHz Tx/Rx switch, Power Amplifier (PA) and Low Noise Amplifier (LNA) path
  - Gain selectable LNAs with optimized noise figure and power consumption
  - Power Amplifiers with power control
  - Closed loop power control (0.5 dB step increments)
  - Optimized Tx gain distribution for linearity and noise performance
  - Fine channel step with AFC (adaptive frequency control)

13.5. WLAN ENCRYPTION

- Embedded WLAN SoC with following features:
  - WEP 64-bit and 128-bit encryption with hardware TKIP processing (WPA)
  - AES-CCMP hardware implementation as part of 802.11i security standard (WPA2)
  - Enhanced AES engine performance
  - AES-Cipher-Based Message Authentication Code (CMAC) as part of the 802.11w security standard[3]

14. PAN9320 BLOCK DIAGRAM
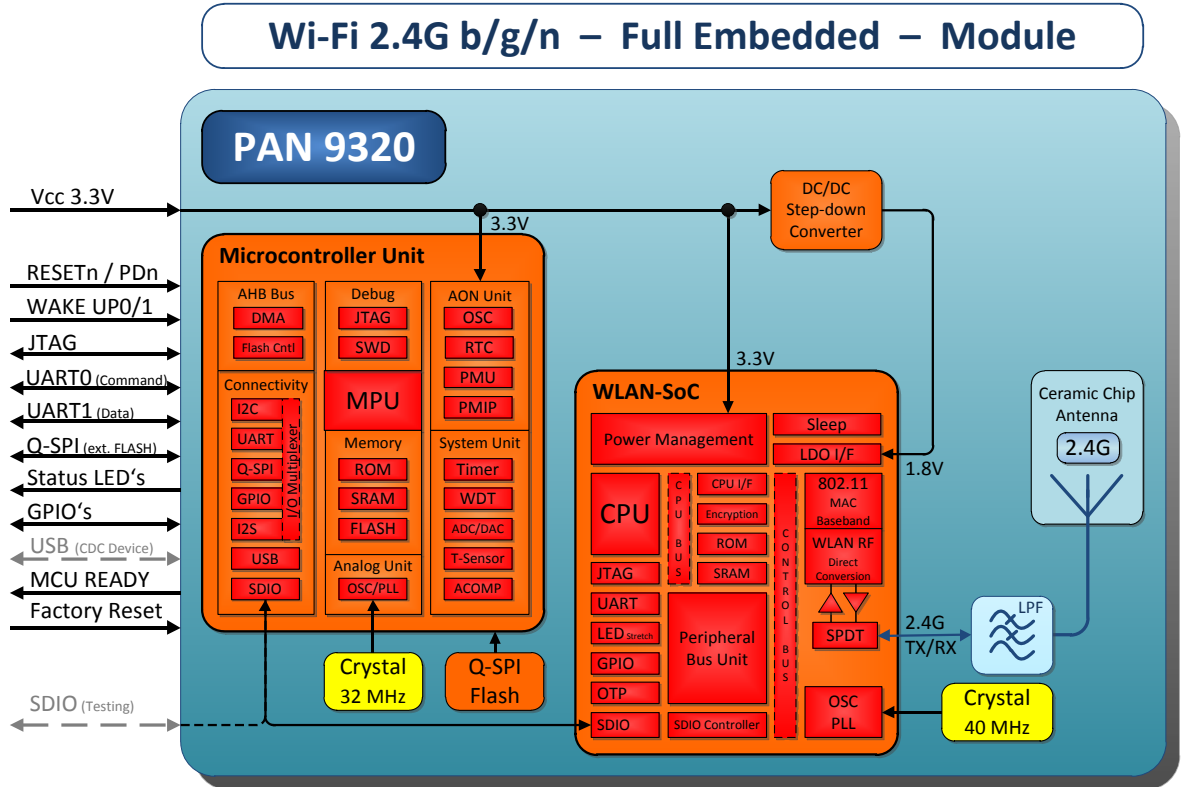
15. KEY PARTS LIST

Part Name	Material
P.W.Board	Glass cloth epoxide resin with gold plating
Casing	Material: C7521, thickness 0.30mm
IC (WLAN-SoC)	88W8782 (Marvell®, www.marvell.com)
IC (Microcontroller Unit)	88MC200 (Marvell®, www.marvell.com)

16. TEST CONDITIONS

Measurements shall be made under operating free-air temperature range unless otherwise specified.

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

17. GENERAL REQUIREMENTS AND OPERATION

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

17.1. ABSOLUTE MAXIMUM RATINGS

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

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
T_{STOR}	Storage temperature		-40		+85	°C
V_{ESD}	ESD robustness	All pads, according to human-body model, JEDEC STD 22, method A114			1000	V
		According to charged-device model, JEDEC STD 22, method C101			500	V
P_{RF}	RF input level				+20	dBm
V_{DDMAX}	Maximum voltage	Maximum power supply voltage from any pin with respect to V_{SS} (GND)	-0.3		3.6	V
V_{DIG}	Voltage on any digital pins	GPIOs, PDn, RESETn, Coex I/F	-0.3		V_{DDMAX}	V

17.2. RECOMMENDED OPERATING CONDITIONS

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

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
T_A	Ambient operating temperature range	Extendet grade	-30		+70	°C
V_{DD}	3V3 Supply voltage[4]	Voltage on pins 7, 8 (3.3V) I/O supply voltage internally connected to V_{DD}	3.0	3.3	3.6	V

17.3. DIGITAL PIN CHARACTERISTICS

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{IH}	High level input voltage[5]	3.3V Operation ($V_{IO} = V_{DD}$)	$0.7V_{DD}$		$V_{DD}+0.3$	V
V_{IL}	Low level input voltage[5]	3.3V Operation ($V_{IO} = V_{DD}$)	-0.3		$0.3V_{DD}$	V
I_{OH} @ V_{DD}-0.4V	High level output current[5]	3.3V Operation ($V_{IO} = V_{DD}$)	4			mA
I_{OL} @ 0.4V	Low level output current[5]	3.3V Operation ($V_{IO} = V_{DD}$)	4			mA

[4] The supply current must be limited to max. 1A

[5] The capacitive load should not be larger than 50 pF for all I/O's when using the default driver strength settings. Generally, large capacitance loads increase the overall current consumption.

17.4. ELECTRICAL CHARACERISTICS

The current consumption depends on the user scenario and the setup and timing in the power modes. Assume V_{DD} = 3.3V, T_{amb} = 25°C if nothing else stated

17.4.1. Current consumption

Symbol	Parameter Current Consumption	Condition	Min.	Typ.	Max.	Units
I_{TX}	Active Transmit [6]	P_{TX} = +18 dBm for 802.11b @ 11 Mbps		430		mA
		P_{TX} = +15 dBm for 802.11g @ 54 Mbps		370		mA
		P_{TX} = +13 dBm for 802.11n (20MHz) @ 65 Mbps		350		mA
I_{RX}	Active Receive [7]	802.11b @ 11 Mbps		160		mA
		802.11g @ 54 Mbps		165		mA
		802.11n @ 65 Mbps		170		mA
I_{RXIdle}	Receive Idle [8]	Passive receive state, ready to receive packets, but no active decoding		160		mA
$I_{IEEE-PSM}$	IEEE 802.11 PS	Radio in "IEEE PS DTIM 1" mode		tbd		mA
$I_{Shut-off}$	Shut-off mode	MCU and Radio in Power Safe mode		tbd		mA

17.5. INTERNAL OPERATING FREQUENCIES

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$f_{SYSCLK1}$	CPU/System/Encryption clock speed	Refers to clock speed of WLAN SoC			128	MHz
$f_{SYSCLK2}$	CPU/System clock speed	Refers to clock speed of MCU			200	MHz
$f_{REFCLK1}$	WLAN SoC Crystal fundamental frequency	Frequency tolerance < ±10 ppm over operating temperature and process		40		MHz
$f_{REFCLK2}$	Microcontroller Crystal fundamental frequency	Frequency tolerance < ±10 ppm over operating temperature and process		32		MHz

[6] Peak values for specified output power level and data rate with UDP traffic between the AP and Device (STA).

[7] Peak values for specified data rate with UDP traffic between the AP and Device (STA)..

[8] The device is powered on and is ready to receive packets, but is not actively decoding.
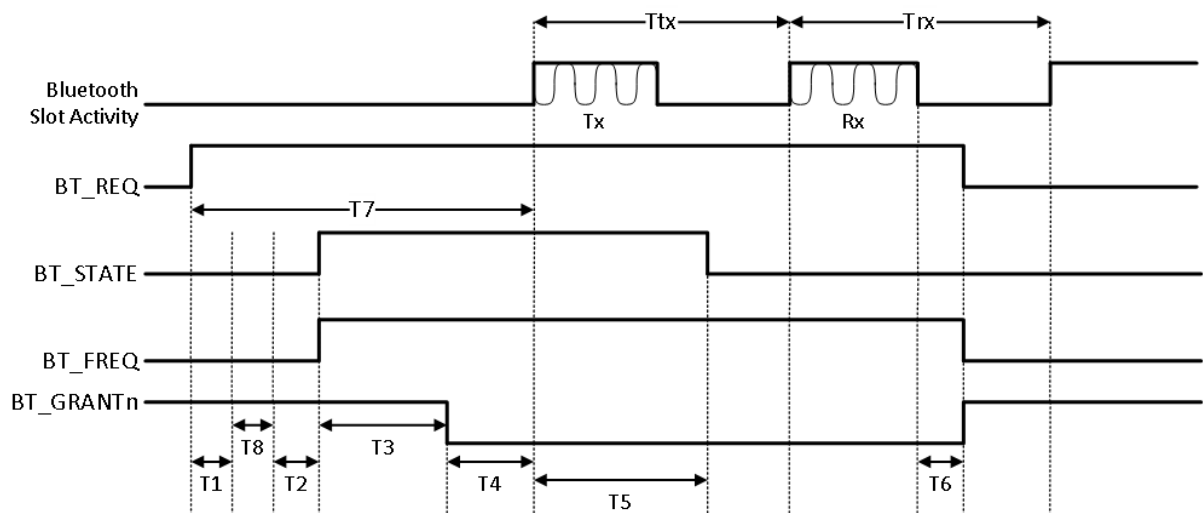
17.6. COEXISTENCE INTERFACE SPECIFICATION

The Coexistence Interface pins are powered from the VIO voltage supply internally connected to V_{DD} = 3.3V. See Chapter 17.3 Digital Pin Characteristics for DC specification.

17.6.1. Marvell® 3/4-Wire Timing Data

Symbol	Parameter	Min.	Typ.	Max.	Units
T1	Priority[0] info is valid in BT_STATE on and after T1 from BT_REQ rise.	0	1	100	µs
T2	TxRx Info is valid in BT_STATE on and after T2. The BT_STATE must hold until there is any change of direction in the next slots.	2	19	100	µs
T3	Time from TxRx Info valid to BCA grant decision (T3 = T7 – T4 – T2 – T8 – T1).	2	40	594	µs
T4	BT_GRANTn needs to be valid T4 time before the upcoming slot. BT_GRANTn indicates Tx grant, and may also indicate Rx grant. Once a slot is granted, the subsequent slots are also granted unless there is a change in direction from Rx to Tx. Rx to Tx change always re-arbitrates.	2	80	594	µs
T5	TxRx Info for the next slot is valid on and after T5 to the start of the next slot. If direction remains the same for the next slot, then BT_STATE must not change during the current slot. If the direction changes for the next slot, the BT_STATE must change only after the last bit of Bluetooth data is transferred; otherwise the transfer may be disrupted.	5	40	600	µs
T6	The BT_REQ signal de-asserts T6 time after last bit of Bluetooth data is transferred.	0	15	25	µs
T7	Time from BT_REQ rise to first Bluetooth slot boundary. Bluetooth slot boundary is marked by first bit of Bluetooth data.	8	150	600	µs
T8	Optional Priority[1] information is valid in BT_STAT on and after T8. This time parameter only exists if BCA is configured for 2-bit priority on same BT_STATE pin. Otherwise, the start of T2 would come after T1.	2	10	100	µs
Ttx	Slot time (fixed fpr Bluetooth)		625		µs
Trx	Slot time (fixed fpr Bluetooth)		625		µs

17.6.2. WL_ACTIVE 2/3/4-Wire Timing Data

Symbol	Parameter	Min.	Typ.	Max.	Units
T1	• If WLAN can be stopped, WL_ACTIVE will de-asser prior to Bluetooth slot start (T1 < T2) • If the Bluetooth device samples WL_ACTIVE before starting priority transfer, WL_ACTIVE needs to de-assert earlier than the sampling time.	0		499	µs
T2	Time from BT_PRIORITY rise to start of Bluetooth activity.	20	50	499	µs
T3	Time from end of Bluetooth activity to BT_PRIORITY fall.	0	0	499	µs
T4	Slot time (fixed fpr Bluetooth)		625		µs
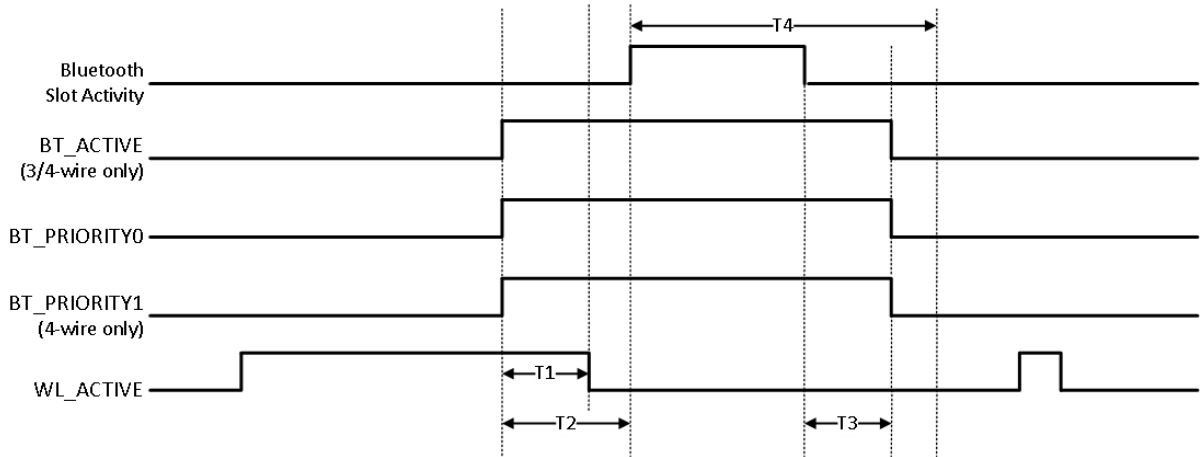
17.7. HOST INTERFACE SPECIFICATION

17.7.1. UART0 Interface (Command)

UART0 Interface bus signals:

Module Pin No	Signal Name	Description
27	TXD for UART0	Transmit data output
28	RXD for UART0	Receive data input

Protocol

Item	Range	Default	Comment
Baudrate	300 ~ 1528000	115200	
Data Bits	5 ~ 8 (LSB first)	8	LSB first
Parity Bits	0 ~ 4	0	
Stop Bit	1 / 1,5 / 2	1	

Initial setting:
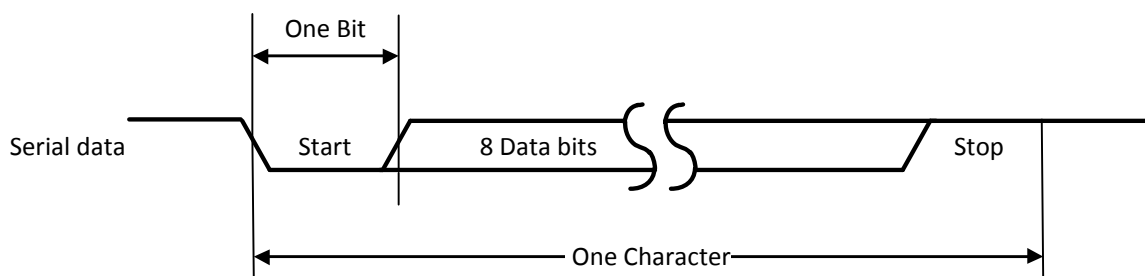
17.7.2. UART1 Interface (Data)

UART1 Interface bus signals

Module Pin No	Signal Name	Description
9	CTS for UART1	Clear to send
10	RTS for UART1	Request to send
11	TXD for UART1	Transmit data output
12	RXD for UART1	Receive data input

Protokol

Item	Range	Default	Comment
Baudrate	300 ~ 1528000	115200	
Data Bits	5 ~ 8 (LSB first)	8	LSB first
Parity Bits	0 ~ 4	0	
Stop Bit	1 / 1,5 / 2	1	

18. RF ELECTRICAL CHARACTERISTICS

18.1. WLAN RADIO SPECIFICATION

Parameter	Operation mode				Specification
Standard Conformance	IEEE 802.11 / IEEE 802.11b				
	IEEE 802.11g				
	IEEE 802.11n				
Modulation	IEEE 802.11b				DSSS / CCK
	IEEE 802.11g				OFDM
	IEEE 802.11n				OFDM @ MCS0~7 and MCS32 (duplicate 6 Mbps)
Physical layer data rates	IEEE 802.11				1, 2 Mbps @ DSSS
	IEEE 802.11b				5.5, 11 Mbps @ DSSS / CCK
Supported data rates	IEEE 802.11g				6, 9, 12, 18, 24, 36, 48, 54 Mbps
	IEEE 802.11n	MCS0~7	HT20	LGI	6.5, 13, 19.5, 26, 39, 52, 58.5, 65 Mbps
				SGI	7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65, 72.2 Mbps
			HT40	LGI	13.5, 27, 40.5, 54, 81, 108, 121.5, 135 Mbps
				SGI	15, 30, 45, 60, 90, 120, 135, 150 Mbps
Supported bandwidth	IEEE 802.11n				20, 40 MHz (BW)
Supported channel mode operation	IEEE 802.11n				20 MHz BW / channel, 40 MHz BW / channel, upper / lower 20 MHz BW @ 40 MHz channel, 20 MHz duplicate legacy BW @ 40 MHz channel
Supported Guard Interval	IEEE 802.11n				400 ns (SGI), 800 ns (LGI)
Supported channel 2.4GHz	IEEE 802.11g	North America			1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
		Europe			1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
		Spain			10, 11
		France			10, 11, 12, 13
		Japan MMK			1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
	IEEE 802.11n	North America			1-5, 2-6, 3-7, 4-8, 5-9, 6-10, 7-11
		Europe			
		Spain			
		France			
		Japan MMK			-

18.2. WLAN RF CHARACTERISTICS

18.2.1. RF Characteristics for IEEE 802.11b

Assume V_{DD} = 3.3V, T_{amb} = 25°C if nothing else stated
50 Ohm terminal load connected to the RF connector

Parameter	Condition	Min.	Typ.	Max.	Units
RF frequency range		2400		2483.5	MHz
Carrier frequency tolerance		-25		+25	ppm
Transmit output power		+16	+18	+20	dBm
Spectrum mask	f_C ± 11 MHz			-30	dBr
	f_C ± 22 MHz			-50	
Power-on / Power-down ramp				2	µs
RF Carrier suppression				-15	dB
Error Vector Magnitude (EVM)	Peak			35	%
Minimum Receive Sensitivity	1 Mbps (DSSS)	FER ≤ 8%		-98	-86	dBm
	2 Mbps (DSSS)	FER ≤ 8%		-95	-83	dBm
	5.5 Mbps (CCK)	FER ≤ 8%		-91	-79	dBm
	11 Mbps (CCK)	FER ≤ 8%		-88	-76	dBm
Maximum Input Level		FER ≤ 8%	-10			dBm
Adjacent Channel Rejection		FER ≤ 8%	35			dB

18.2.2. RF Characteristics for IEEE 802.11g

Assume V_{DD} = 3.3V, T_{amb} = 25°C if nothing else stated
50 Ohm terminal load connected to the RF connector

Parameter		Condition	Min.	Typ.	Max.	Units
RF frequency range			2400		2483.5	MHz
Carrier frequency tolerance			-25		+25	ppm
Transmit output power	6 Mbps ~ 36 Mbps		+14	+16	+18	dBm
	48 Mbps ~ 54 Mbps		+13	+15	+17	dBm
Spectrum mask	f_C ± 11 MHz				-20	dBr
	f_C ± 20 MHz				-28	dBr
	f_C ± 30 MHz				-40	dBr
Transmitter center frequency leakage					-15	dB
Transmitter Spectral Flatness			-2		+2	dB
Constellation Error (EVM)	BPSK, CR 1/2 (6 Mbps)				-5	dB
	BPSK, CR 3/4 (9 Mbps)				-8	dB
	QPSK, CR 1/2 (12 Mbps)				-10	dB
	QPSK, CR 3/4 (18 Mbps)				-13	dB
	16-QAM, CR 1/2 (24 Mbps)				-16	dB
	16-QAM, CR 3/4 (36 Mbps)				-19	dB
	64-QAM, CR 2/3 (48 Mbps)				-22	dB
	64-QAM, CR 3/4 (54 Mbps)				-25	dB
Minimum Receive Sensitivity	BPSK, CR 1/2 (6 Mbps)	PER ≤ 10%		-93	-82	dBm
	BPSK, CR 3/4 (9 Mbps)	PER ≤ 10%		-92	-81	dBm
	QPSK, CR 1/2 (12 Mbps)	PER ≤ 10%		-90	-79	dBm
	QPSK, CR 3/4 (18 Mbps)	PER ≤ 10%		-88	-77	dBm
	16-QAM, CR 1/2 (24 Mbps)	PER ≤ 10%		-85	-74	dBm
	16-QAM, CR 3/4 (36 Mbps)	PER ≤ 10%		-81	-70	dBm
	64-QAM, CR 2/3 (48 Mbps)	PER ≤ 10%		-77	-66	dBm
	64-QAM, CR 3/4 (54 Mbps)	PER ≤ 10%		-76	-65	dBm
Maximum Input Level		PER ≤ 10%			-20	dBm
Adjacent channel rejection	BPSK, CR 1/2 (6 Mbps)	PER ≤ 10%	16			dB
	64-QAM, CR 3/4 (54 Mbps)	PER ≤ 10%	-1			dB

18.2.3. RF Characteristics for IEEE 802.11n (BW 20 MHz)

Assume V_{DD} = 3.3V, T_{amb} = 25°C if nothing else stated
50 Ohm terminal load connected to the RF connector

Parameter	Condition	Min.	Typ.	Max.	Units
RF frequency range		2400		2483.5	MHz
Carrier frequency tolerance		-25		+25	ppm
Transmit output power	MCS0 ~ MCS2	13	15	17	dBm
	MCS3 ~ MCS4	12	14	16	dBm
	MCS5 ~ MCS7	11	13	15	dBm
Spectrum mask	f_C ± 11 MHz			-20	dBr
	f_C ± 20 MHz			-28	dBr
	f_C ± 30 MHz			-45	dBr
Transmitter center frequency leakage				-15	dB
Transmitter Spectral Flatness		-2		+2	dB
Constellation Error (EVM)	BPSK, CR 1/2 (MCS0)			-5	dB
	QPSK, CR 1/2 (MCS1)			-10	dB
	QPSK, CR 3/4 (MCS2)			-13	dB
	16-QAM, CR 1/2 (MCS3)			-16	dB
	16-QAM, CR 3/4 (MCS4)			-19	dB
	64-QAM, CR 2/3 (MCS5)			-22	dB
	64-QAM, CR 3/4 (MCS6)			-25	dB
	64-QAM, CR 5/6 (MCS7)			-27	dB
Minimum Receive Sensitivity [9]	6.5 Mbps (MCS0)	PER ≤ 10%	-92	-82	dBm
	13 Mbps (MCS1)	PER ≤ 10%	-89	-79	dBm
	19.5 Mbps (MCS2)	PER ≤ 10%	-87	-77	dBm
	26 Mbps (MCS3)	PER ≤ 10%	-84	-74	dBm
	39 Mbps (MCS4)	PER ≤ 10%	-80	-70	dBm
	52 Mbps (MCS5)	PER ≤ 10%	-76	-66	dBm
	58.5 Mbps (MCS6)	PER ≤ 10%	-75	-65	dBm
	65 Mbps (MCS7)	PER ≤ 10%	-74	-64	dBm
Maximum Input Level		PER ≤ 10%		-20	dBm
Adjacent channel rejection [10]	65 Mbps (MCS7)	PER ≤ 10%	-2		dB

[9] The Minimum Sensitivity levels apply only to non-STBC modes, MCS 0~7, 800 ns LGI and BCC.

[10] The Adjacent Channel Rejection levels apply only to non-STBC modes, MCS 0~7, 800 ns LGI and BCC.

18.2.4. RF Characteristics for IEEE 802.11n (BW 40 MHz)

Assume V_{DD} = 3.3V, T_{amb} = 25°C if nothing else stated
50 Ohm terminal load connected to the RF connector

Parameter		Condition	Min.	Typ.	Max.	Units
RF frequency range			2400		2483.5	MHz
Carrier frequency tolerance			-25		+25	ppm
Transmit output power	MCS0 ~ MCS2		11	13	15	dBm
	MCS3 ~ MCS4		10	12	14	dBm
	MCS5 ~ MCS7		9	11	13	dBm
Spectrum mask	f_C ± 21 MHz				-20	dBr
	f_C ± 40 MHz				-28	dBr
	f_C ± 60 MHz				-45	dBr
Transmitter center frequency leakage					-15	dB
Transmitter Spectral Flatness			-2		+2	dB
Constellation Error (EVM)	BPSK, CR 1/2 (MCS0)				-5	dB
	QPSK, CR 1/2 (MCS1)				-10	dB
	QPSK, CR 3/4 (MCS2)				-13	dB
	16-QAM, CR 1/2 (MCS3)				-16	dB
	16-QAM, CR 3/4 (MCS4)				-19	dB
	64-QAM, CR 2/3 (MCS5)				-22	dB
	64-QAM, CR 3/4 (MCS6)				-25	dB
	64-QAM, CR 5/6 (MCS7)				-27	dB
Minimum Receive Sensitivity [9]	13.5 Mbps (MCS0)	PER ≤ 10%		-89	-79	dBm
	27 Mbps (MCS1)	PER ≤ 10%		-86	-76	dBm
	40.5 Mbps (MCS2)	PER ≤ 10%		-84	-74	dBm
	54 Mbps (MCS3)	PER ≤ 10%		-81	-71	dBm
	81 Mbps (MCS4)	PER ≤ 10%		-77	-67	dBm
	108 Mbps (MCS5)	PER ≤ 10%		-73	-63	dBm
	121.5 Mbps (MCS6)	PER ≤ 10%		-72	-62	dBm
	135 Mbps (MCS7)	PER ≤ 10%		-71	-61	dBm
Maximum Input Level		PER ≤ 10%			-20	dBm
Adjacent channel rejection [10]	135 Mbps (MCS7)	PER ≤ 10%	-2			dB

19. SOLDERING TEMPERATURE-TIME PROFILE (FOR REFLOW SOLDERING)

19.1. FOR LEAD SOLDER

Recommended temp. profile for reflow soldering

10 ±1s

30 +20/-10s

235°C max.

220 ±5°C

200°C

150 ±10°C

90 ±30s

Temp.[°C]

Time [s]
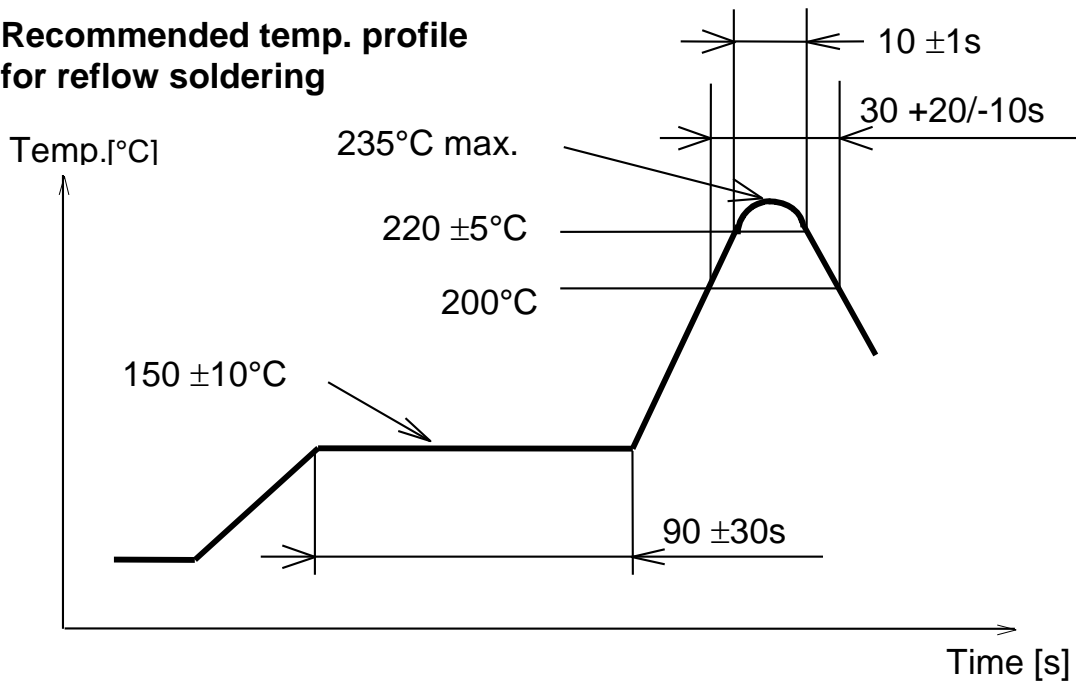
19.2. FOR LEADFREE SOLDER

Our used temp. profile for reflow soldering

30 +20/-10s

230°C -250°C max.

220°C

150°C – 190°C

90 ±30s

Temp.[°C]

Time [s]
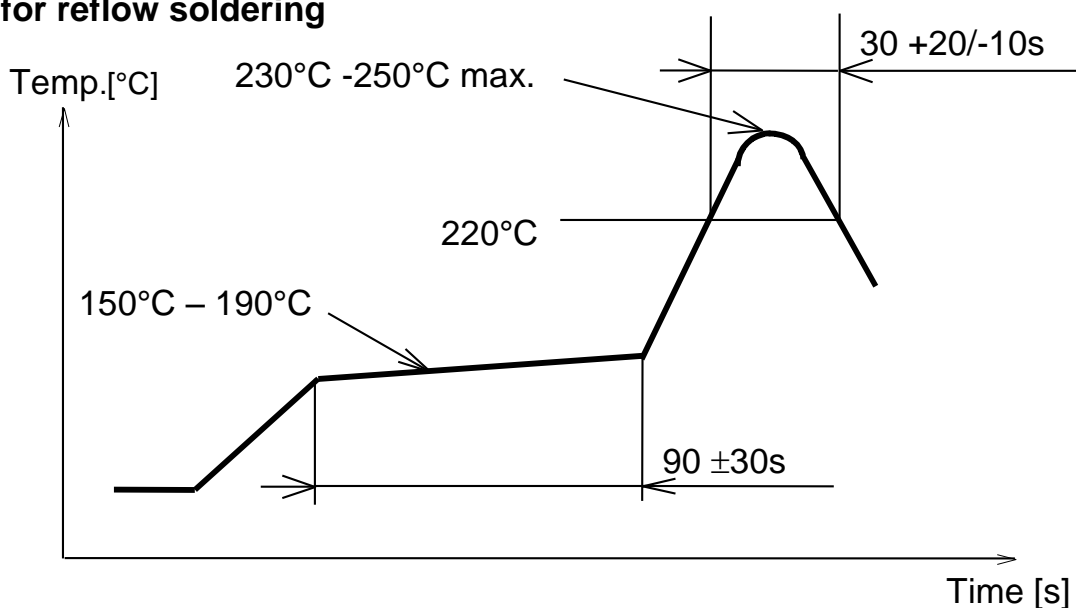
Reflow permissible cycle: 2
Opposite side reflow is prohibited due to module weight.

20. PAN9320 MODULE DIMENSION

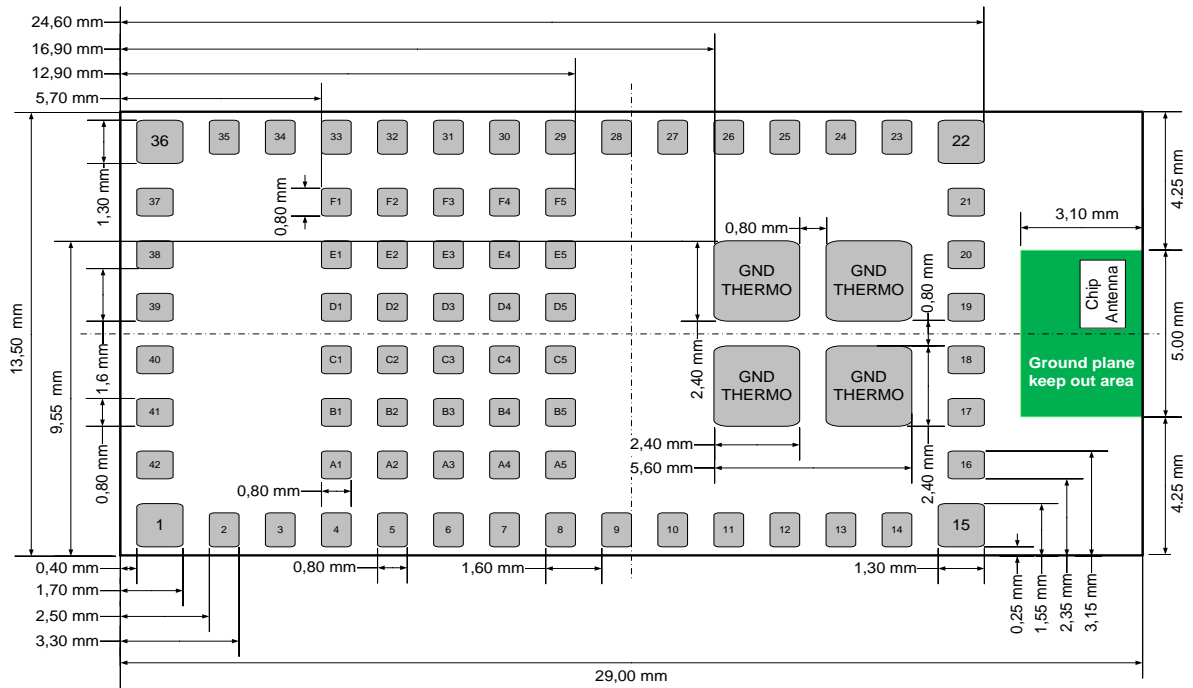| No.	Item	Dimension	Tolerance	Remark
1	Width	13.50	± 0.30	
2	Length	29.00	± 0.30	
3	Height	2.66	± 0.20	with case
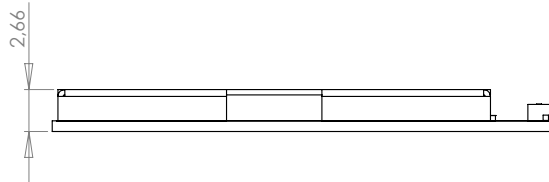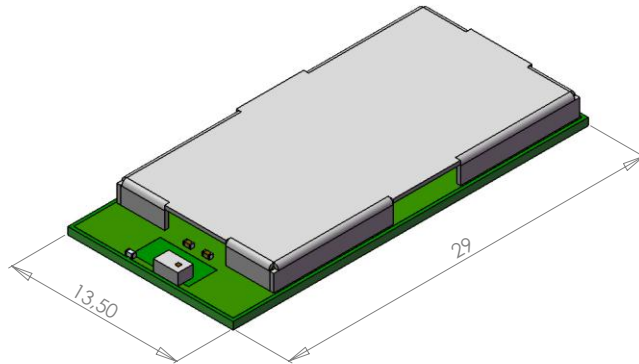
21. PAN9320 FOOTPRINT OF THE MODULE

All dimensions are in millimeters.
The outer dimensions have a tolerance of $\pm$ 0.3mm.

Top view, Application PCB

Top View

22. CASE MARKING (EXAMPLE FOR PAN9320)

No.	Remark
1	PAN9320 (Model Name), see chapter 27 Ordering Information
2	Hardware/Software version
3	Part Number, see Ordering Information, chapter 27 Ordering Information
4	Lot code: YearYear, WeekWeek, Day, LotLot
5	Serial Number (8 digits)
6	WLAN MAC address (12 digits)
7	FCC ID, refer to chapter 29.1 (tbd)
8	IC Canada, refer to chapter 29.2 (tbd)
9	Marking for Pin 1 (Circle 0,15 mm)
10	2D-Code, for internal usage only and can be change without any notice

23. MECHANICAL REQUIREMENTS

No.	Item	Limit	Condition
1	Solderability	More than 75% of the soldering area shall be coated by solder	Reflow soldering with recommendable temperature profile
2	Resistance to soldering heat	It shall be satisfied electrical requirements and not be mechanical damage	See chapter 19.2

24. RELIABILITY TESTS

The measurement should be done after being exposed to room temperature and humidity for 1 hour.

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

25. 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.

25.1. 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 47uF 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 products' 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.

25.2.　INSTALLATION NOTES

(1)　Reflow soldering is possible twice based on the conditions in chapter 15.
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)　Refer to the recommended pattern when designing a board.

(9)　Pressing on parts of the metal cover or fastening objects to the metal will cause damage to the unit.

(10)　For more details on LGA (Land Grid Array) soldering processes refer to the application note.

25.3.　USAGE CONDITIONS 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 4.9N 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.

25.4.　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 Cl_2, H_2S, NH_3, SO_2, or NO_X
- Storage in direct sunlight
- Storage in an environment where the temperature may be outside the range of 5°C to 35°C range, or where the humidity may be outside the 45 to 85% 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 6 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 (max. 10).

25.5. 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, then 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.
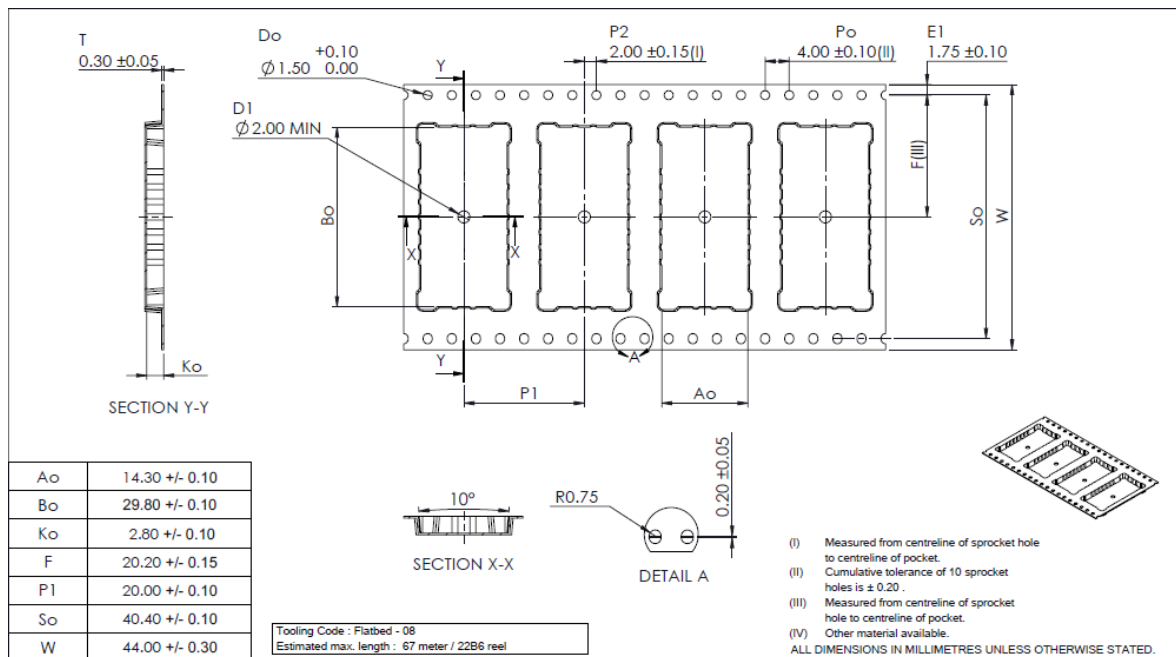
25.6. OTHER CAUTIONS

(1) This specification sheet is copyrighted. Do not disclose it to a third party.

(2) Do not use the products for other purposes than those listed.

(3) Be sure to provide an appropriate fail-safe function on your product to prevent an additional damage that may be caused by the abnormal function or the failure of the product.

(4) This product has been manufactured without any ozone chemical controlled under the Montreal Protocol.

(5) These products are not intended for other uses, other than under the special conditions shown below. Before using these products under such special conditions, check their performance and reliability under the said special conditions carefully 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 (e.g. salty air, HCl, Cl2, SO2, H2S, NH3, and NOX)

(6) 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.

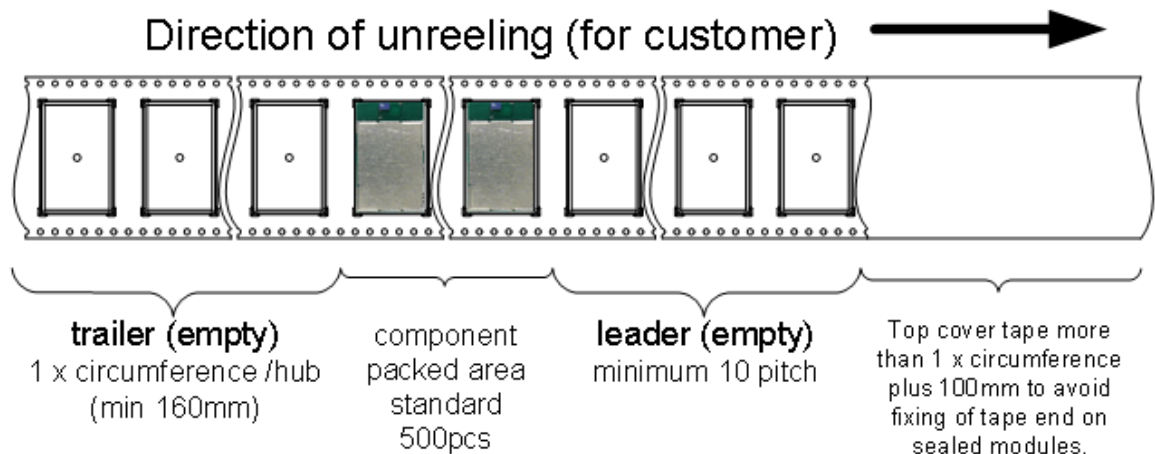(7) When you have any question or uncertainty, contact Panasonic.

26. PACKAGING

Mass production status product -- as indicated in Chapter 3 -- will be delivered in the package described below.

26.1. PAN9320 TAPE DIMENSION

Ao	14.30 +/- 0.10
Bo	29.80 +/- 0.10
Ko	2.80 +/- 0.10
F	20.20 +/- 0.15
P1	20.00 +/- 0.10
So	40.40 +/- 0.10
W	44.00 +/- 0.30

Tooling Code : Flatbed - 08
Estimated max. length : 67 meter / 22B6 reel

(I)   Measured from centreline of sprocket hole to centreline of pocket.
(II)   Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV)   Other material available.
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

26.2. PACKING IN TAPE

Direction of unreeling (for customer)

trailer (empty)
1 x circumference /hub
(min 160mm)

component
packed area
standard
500pcs

leader (empty)
minimum 10 pitch

Top cover tape more
than 1 x circumference
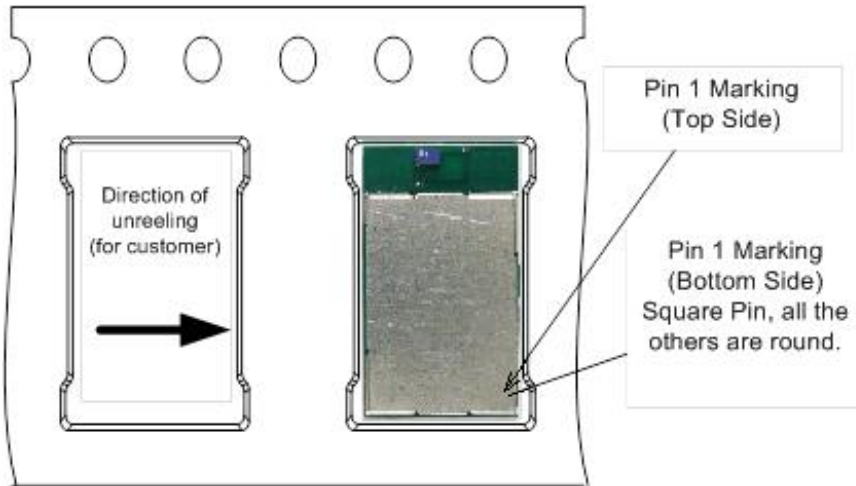plus 100mm to avoid
fixing of tape end on
sealed modules.

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

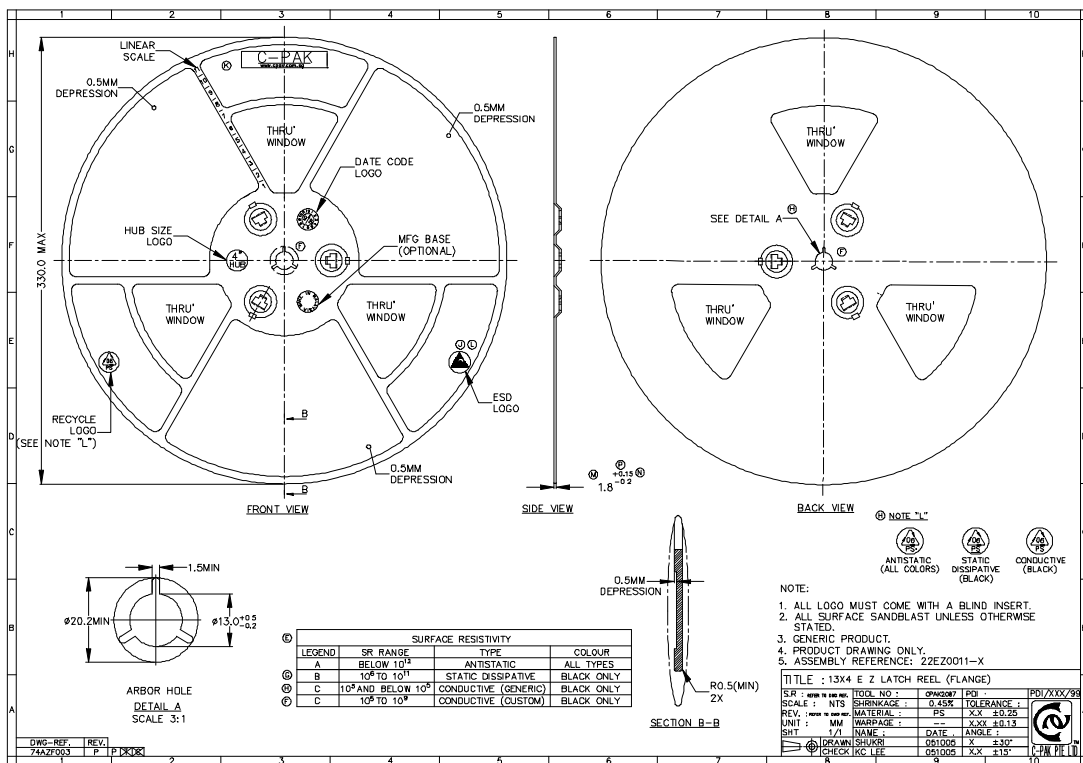Top cover tape shall not be found on reel holes and shall not stick out from reel.

26.3. COMPONENT DIRECTION

26.4. REEL DIMENSION

26.5. LABEL FOR PACKAGE

The picture shows an example from similar product.
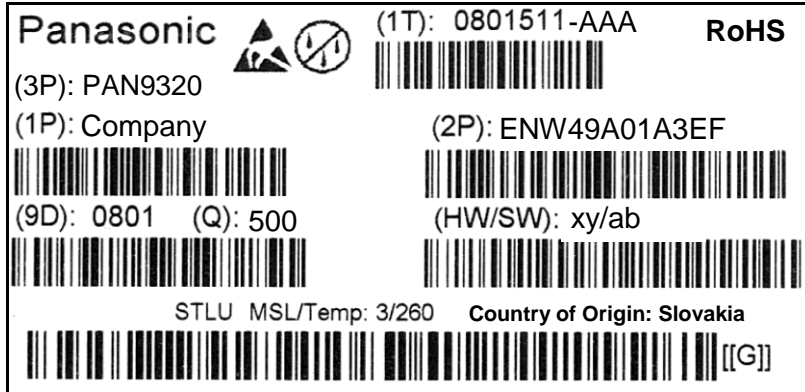
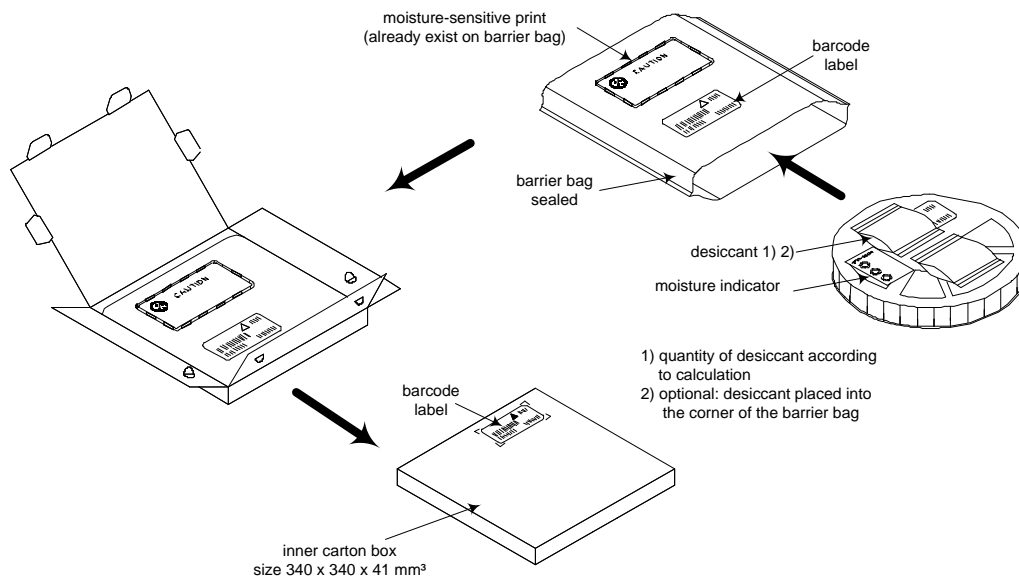| (1T)	Lot code [YYWWDLL-AAA]		Example from above:
	YY	year	printed 08
	WW	normal calendar week	printed 01
	D	day	printed 5 (Friday)
	L	line identifier, if more as one	printed 1
	L	lot identifier per day	printed 1
	AAA	number of the reel (example 001, 002,…, 999)	printed 001
(1P)	Customer Order Code, if any, otherwise company name will be printed		
(2P)	Panasonic Order Code: ENW49A01x3EF (see chapter 27 Ordering Information)		
(3P)	Model type, (see chapter 27 Ordering Information)		
(9D)	Date code as [YYWW]		
(Q)	Quantity [XXXX], variable max. 500		
(HW/SW)	Hardware/Software Release		

26.6. TOTAL PACKAGE

moisture-sensitive print
(already exist on barrier bag)

barcode label

barrier bag sealed

desiccant 1) 2)

moisture indicator

1) quantity of desiccant according to calculation
2) optional: desiccant placed into the corner of the barrier bag

barcode label

inner carton box
size 340 x 340 x 41 mm³

27. ORDERING INFORMATION

Ordering part number	Model type	Description	MOQ [1]
ENW49A01A3EF	PAN9320	WLAN IEEE 802.11 b/g/n 2.4GHz Full Embedded Module with ceramic chip-antenna	500

The PAN9320 will be delivered with a preinstalled embedded Web-Stack, see [1] PAN9320 Software-Guide

Notes:

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

28. ROHS DECLARATION

Declaration of environmental compatibility for supplied products:

Hereby we declare to our best present knowledge based on declaration of our suppliers that this product does not contain the following substances which are banned by Directive 2002/95/EC (RoHS) or contains a maximum concentration of 0.1% by weight in homogeneous materials for

- Lead and lead compounds
- Mercury and mercury compounds
- Chromium (VI)
- PBB (polybrominated biphenyl) category
- PBDE (polybrominated biphenyl ether) category

And a maximum concentration of 0.01% by weight in homogeneous materials for

- Cadmium and cadmium compounds

29. REGULATORY INFORMATION

29.1. FCC FOR US

Under preparation

29.2. INDUSTRY CANADA CERTIFICATION

Under preparation

29.3. EUROPEAN R&TTE DECLARATION OF CONFORMITY

Under preparation

30. GENERAL INFORMATION

© Panasonic Industrial Devices Europe GmbH 2015.
All rights reserved.
This product description does not lodge the claim to be complete and free of mistakes.
Please contact the related product manager in every case.

If ES samples are delivered to the customer, these samples have the status Engineering Samples. This means, the design of this product is not yet concluded. Engineering Samples may be partially or fully functional, and there may be differences to be published Data Sheet.
Engineering Samples are not qualified and are not to be used for reliability testing or series production.

Disclaimer:
Customer acknowledges that samples may deviate from the Data Sheet and may bear defects due to their status of development and the lack of qualification mentioned above.
Panasonic rejects any liability or product warranty for Engineering Samples. In particular, Panasonic disclaims liability for damages caused by

- the use of the Engineering Sample other than for Evaluation Purposes, particularly the installation or integration in another product to be sold by Customer,
- deviation or lapse in function of Engineering Sample,
- improper use of Engineering Samples.

Panasonic Industrial Devices Europe GmbH disclaimes any liability for consequential and incidental damages. In case of any questions, please contact your local sales partner or the related product manager.

31. 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 its safety or effectiveness. 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.