Product Specification

Applicant / Manufacturer Hardware	Panasonic Industrial Devices Europe GmbH Zeppelinstrasse 19 21337 Lüneburg Germany
Applicant / Manufacturer Software	Please refer to chapter 30 / 30.1 Information regarding Software Versions
Software Version	Please refer to chapter 30 / 30.1 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.

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1. SCOPE OF THIS DOCUMENT

This product specification applies to Panasonic's Wi-Fi IEEE 802.11 b/g/n radio module with model names PAN9020U, PAN9010U, PAN9020S and PAN9010S.

2. HISTORY FOR THIS DOCUMENT

Revision	Date	Modification / Remarks
0.1	May 2014	1st preliminary version
0.2	May 2014	- Add Host Interface specification for USB 2.0 and SDIO (19.8 Host Interface Specification)
0.3	July 2014	- Change order of chapters, move 3. Data Sheet Status, 4. Related Documents, 9. Difference PAN9020U (USB) to PAN9020S (SDIO and 10. Difference PAN9020 to PAN9010, restructure chapter numbers - Add contents of 802.11n - Supported data rates (20.1 WLAN Radio Specification) - Change parameter information of EVM and Minimum Receiver Sensitivity (20.2.2 / 20.2.3 / 20.2.4)
0.4	October 2014	- Adapt Active Transmit Current (19.4.1) - Add Transmit output power vs datarate and Carrier Frequency Tolerance at RF Characteristics for 802.11g (20.2.2) and 802.11n BW 20/40 MHz (20.2.3 / 20.2.4) - Update comments at sub-chapters of Regulatory Information (32.) - Adapt list of standards at European R&TTE Declaration of Conformity (32.3)
1.0	January 2015	- Adapt Case-marking information regarding FCC / IC certification (24)
1.1	January 2015	- Adapt specification based on change of model name PAN9020U/10U and PAN9020S/10S
1.2	July 2015	- SDIO specific Terminal Pin Configuration (11.4) - take out SPI mode - Case-marking information regarding FCC / IC certification (24) - Regulatory Information for FCC US (32.1 / 32.1.1 ~ 32.1.6)

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 in order to improve design and supply the best possible product.

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

4. RELATED DOCUMENTS

For an update, please search in the suitable homepage.

[1] PAN9020U and PAN9020S Reference-Guide

[2] Semiconductor Datasheet
88W8782U 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-REACH_and_RoHS_directive.pdf

5. KEY FEATURES

- Surface Mount Type 22.75 x 13.5 x 2.4 mm³
- Wireless Local Area Network (WLAN) Technology
- 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 AES-CCMP, WEP, TKIP, AES-CMAC and WAPI
  - 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 CCK) and +15 dBm (IEEE 802.11g ODFM)
- 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) solution inside
- High performance low power CPU core
- Two powerful independent DMA channels
- Power Management Unit with internal or external Sleep Clock (for Power Save Mode)
- Internal crystal oscillator (40MHz)
- USB2.0 or SDIO interface
- Integrated shielding to resist EMI
- Manufactured in conformance with RoHS

6. APPLICATIONS FOR THE MODULE

All Embedded Wireless Applications

- Imaging Platform
- Gaming Platform
- Consumer Electronic
- Portable Application
- Health & Fitness
- Smart Energy
- Printer, Digital Picture Frame
- Game Console
- TV, Media Player
- PC, Tablet, eBook
- Home Gateways, Medical devices
- Thermostat, Control panels

7. WIRELESS LOCAL AREA NETWORK

Wireless Local Area Network (WLAN) is indicating a local radio network meant as a part of the standard IEEE 802.11 family. 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). It makes it possible to use any protocol over a IEEE 802.11 wireless network as used at an Ethernet network. Basically WLAN networks using 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 upon other the Orthogonal Frequency Division Multiplexing (OFDM) modulation technique. 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 PAN9020 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 16.

The PAN9020 series is a cost-effective, low-power operation, 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 PAN9020 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 low-power operation supporting deep sleep and standby modes by using the on-board power management unit. The PAN9020/10 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.

Panasonic offers the software package supporting various Fedora Core Kernel versions. It includes the WLAN SoC Firmware binary that powers the WLAN SoC for client (STA), micro access point (uAP) and Ad-hoc mode (Wi-Fi direct) applications. In addition it includes the HOST Driver-Firmware Interface (API) which represents the interface between the host driver and SoC firmware.

The Driver-Firmware Interface handles all 802.11 MAC management tasks by converting standard 802.3 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 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. Furtheron the software package from Marvell® consists of various applications, demonstrations and utilities.

Refer to [1] PAN9020U and PAN9020S Reference-Guide and chapter 30 Ordering Information.

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

http://na.industrial.panasonic.com/products/wireless-connectivity for the US,

http://eu.industrial.panasonic.com/products/wireless-connectivity for EU

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

9. DIFFERENCE PAN9020U (USB) TO PAN9020S (SDIO)

Both the PAN9020U (USB) and PAN9020S (SDIO) are refered to the PAN9020 series in this document.

The PAN9020U is pin-compatible with the PAN9020S, with the exception that USB is the hardware communication interface on the PAN9020U and SDIO is the hardware communication interface on the PAN9020S. The PAN9020S does not have the USB interface found on the PAN9020U.
The RF performance on both PAN9020U and PAN9020S are the same.

Additional details, which have an impact on the module can be found in the datasheets from Marvell®.

88W8782U from Marvell®

88W8782 from Marvell®

10. DIFFERENCE PAN9020 TO PAN9010

The PAN9010 is the non antenna version with bottom pad where the PAN9020 is the version with antenna.

11. DETAILED DESCRIPTION

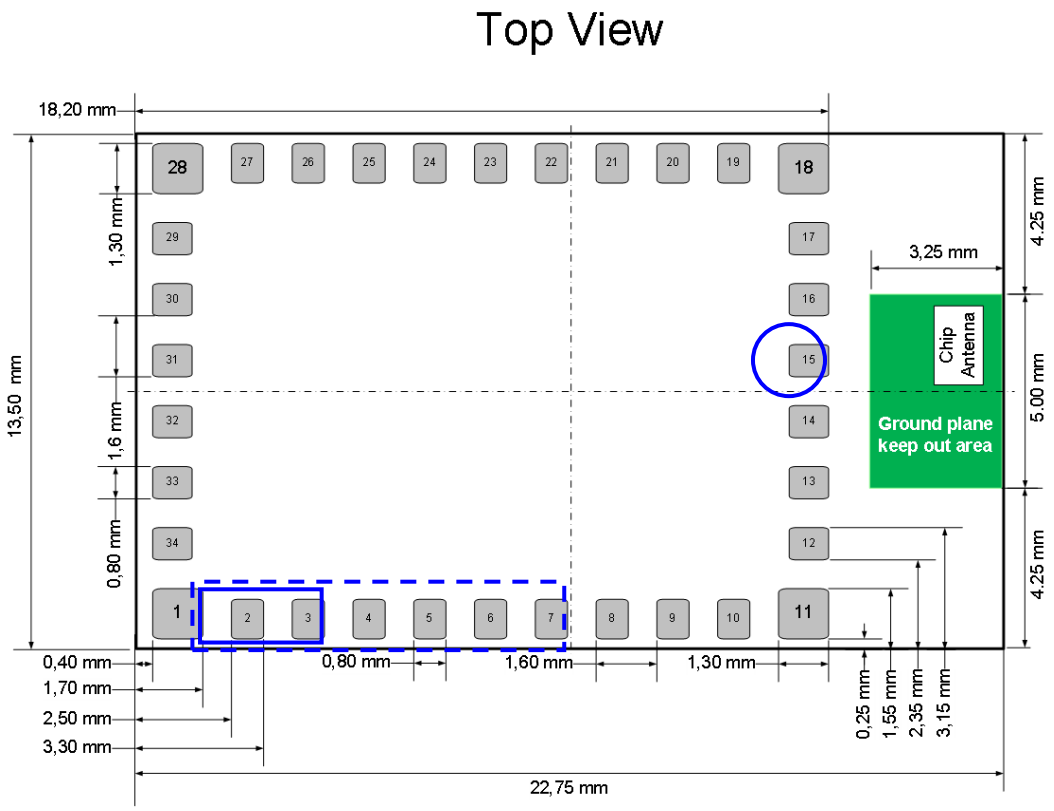
11.1. PAN9020 / PAN9010 TERMINAL LAYOUT

PAN9020U USB pins are marked with a blue rectangular box.

PAN9020S SDIO pins are marked with a blue dashed rectangular box.

PAN9010U and PAN9010S antenna pin is marked with a blue circle.

Top View, Application PCB



11.2. PAN9020 / PAN9010 COMMON TERMINAL PIN-CONFIGURATION

No	Pin Name	Pin Type	Description
1	GND	Ground Pin	Connect to Ground
2-7	…	…	… for USB see chapter 0 and for SDIO see chapter 11.4
8	GND	Ground Pin	Connect to Ground
9	PDn	Input Signal	Power down, active-low
10	GPIO[5]	Digital I/O	Port 5 – optional GPIO or W1_CNTL for PMD programming I/F control
11	GND	Ground Pin	Connect to Ground
12	GND	Ground Pin	Connect to Ground
13	GND	Ground Pin	Connect to Ground
14	GND	Ground Pin	Connect to Ground
15	NC	NC	… for PAN9010 see chapter 11.5
16	GND	Ground Pin	Connect to Ground
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	RESETn	Input Signal	Reset, active-low
22	GND	Ground Pin	Connect to Ground
23	GPIO[0]	Digital I/O	Port 0 – GPIO
24	GPIO[1]	Digital Output	Port 1 – LED output with 10mA drive capability
25	GPIO[2]	Digital I/O	Port 2 – optional GPIO or SoC-to-Host wake-up
26	GPIO[3]	Digital I/O	Port 3 – optional GPIO or external sleep clock 32.768 KHz input
27	GPIO[4]	Digital I/O	Port 4 – optional GPIO or Host-to-SoC wake-up (for USB used internally)
28	GND	Ground Pin	Connect to Ground
29	BT_FREQ	Input Signal	Information BT using channel which overlaps WLAN channel or not
30	BT_GRANTn	Output Signal	Indicate permission to transmit, low BT can transmit
31	BT_REQ	Input Signal	BT device request access to medium
32	BT_STATE	Input Signal	Information BT_REQ priority (1- or 2-bit) and direction BT RX/TX
33	3.3V	Power	3.0V – 3.6V power supply connection
34	3.3V	Power	3.0V – 3.6V power supply connection

11.3. PAN9020U / PAN9010U USB SPECIFIC TERMINAL PIN-CONFIGURATION

No	Pin Name	Pin Type	Description
2	USB_DMNS	D-	USB Bus Data Minus
3	USB_DPLS	D+	USB Bus Data Plus
4-7	NC (4x)	NC	Do not connect (4x)

11.4. PAN9020S / PAN9010S SDIO SPECIFIC TERMINAL PIN-CONFIGURATION

No	Pin Name	Pin Type	Description	
			4-bit mode	1-bit mode
2	SD_CMD	Digital I/O	-	Command Line
3	SD_DAT[0]	Digital I/O	Data Line bit [0]	Data Line
4	SD_DAT[1]	Digital I/O	Data Line bit [1]	Interrupt
5	SD_DAT[2]	Digital I/O	Data Line bit [2] or … Read Wait (optional)	
6	SD_DAT[3]	Digital I/O	Data Line bit [3]	Not used
7	SD_CLK	Digital I/O	Clock	Clock

11.5. PAN9010U / PAN9010S RF-TERMINAL PIN-CONFIGURATION

No	Pin Name	Pin Type	Description
15	RF	RF Port	50Ω bottom pad

12. GENERAL FEATURES

- Embedded WLAN SoC with following features:
  - Integrated CPU with maximum clock speed of 128 MHz
  - Single-chip integration of 802.11 wireless radio, baseband, MAC, CPU, memory and HOST interface
  - SRAM for Tx frame queues and Rx data buffer
  - Boot ROM and ROM patching capability
  - Independent 2-Channel Direct Memory Access (DMA)
  - Low power operation supporting deep sleep and stand-by modes
  - Optional power management with external sleep clock for near zero deep sleep
- Optional embedded EEPROM for storing e.g. serial number

13. HOST INTERFACES

13.1. PAN9020U / PAN9010U USB VARIANT

- USB 2.0 Interface
  - Compliant with the Universal Serial Bus Specification, Revision 2.0
  - Allows HOST controller using USB cable bus and USB 2.0 device interface
  - High/full speed operation with (480/12 Mbps)
  - Suspend / host resume / device resume (remote wake-up)
  - USB 2.0 device interface with integrated level shifter for 3.3V signal level

13.2. PAN9020S / PAN9010S SDIO VARIANT

- SDIO Interface
  - Conforms to the industry SDIO Full-Speed card specification
  - Supports SPI, 1-bit SDIO and 4-bit SDIO transfer modes at the full clock range

14. 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

15. WLAN FEATURES

15.1. 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
- 802.11r fast hand-off for AP roaming
- 802.11w protected management frames
- Fully supports clients (stations) implementing IEEE Power Save mode
- Wi-Fi Direct connectivity

15.2. WLAN MAC

- Ad-Hoc 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 beamformee 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)

15.3. 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
  - Beamformee function and hardware acceleration
  - Greenfield Tx/Rx

15.4. WLAN RADIO

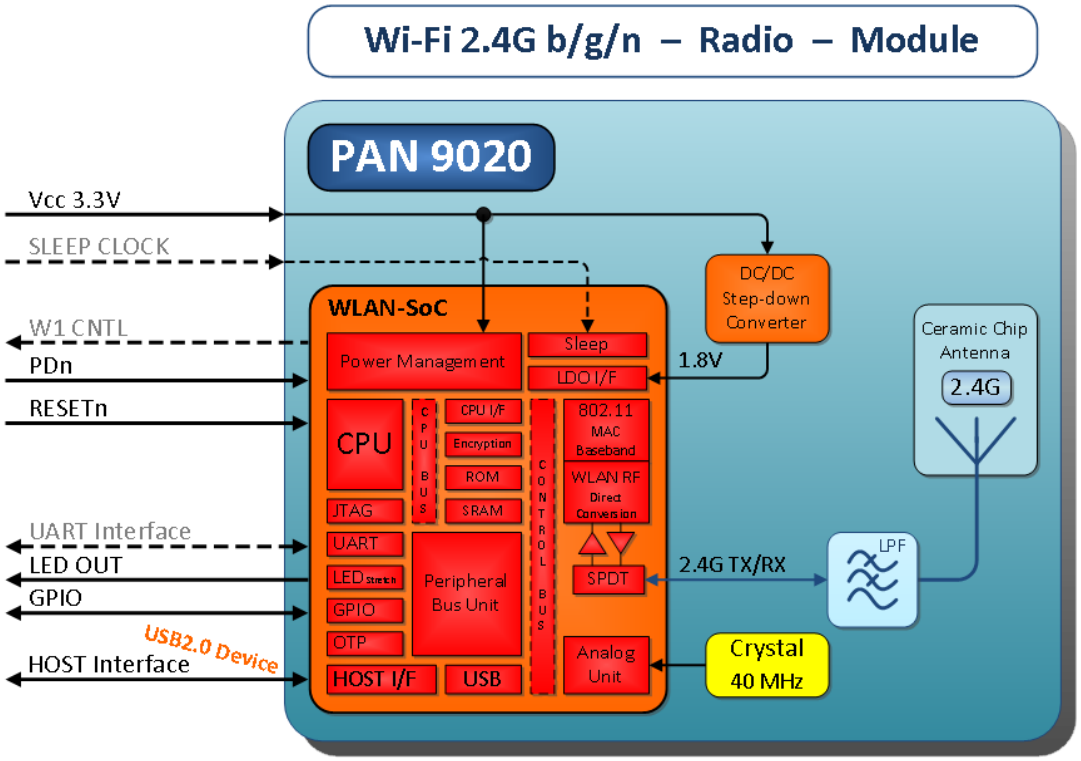
- 20 and 40 MHz channel bandwidth
- Embedded WLAN SoC with following features:
  - Direct conversion radio (no SAW filter)
  - 2.4GHz Tx/Rx switch, Power Amplifier (PA) and Low Noise Amplifier (LNA) path
  - Gain selectable LNAs with optimized noise figure and power consumption
  - Power Amplifiers with power control
  - Closed/Open 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)

15.5. WLAN ENCRYPTION

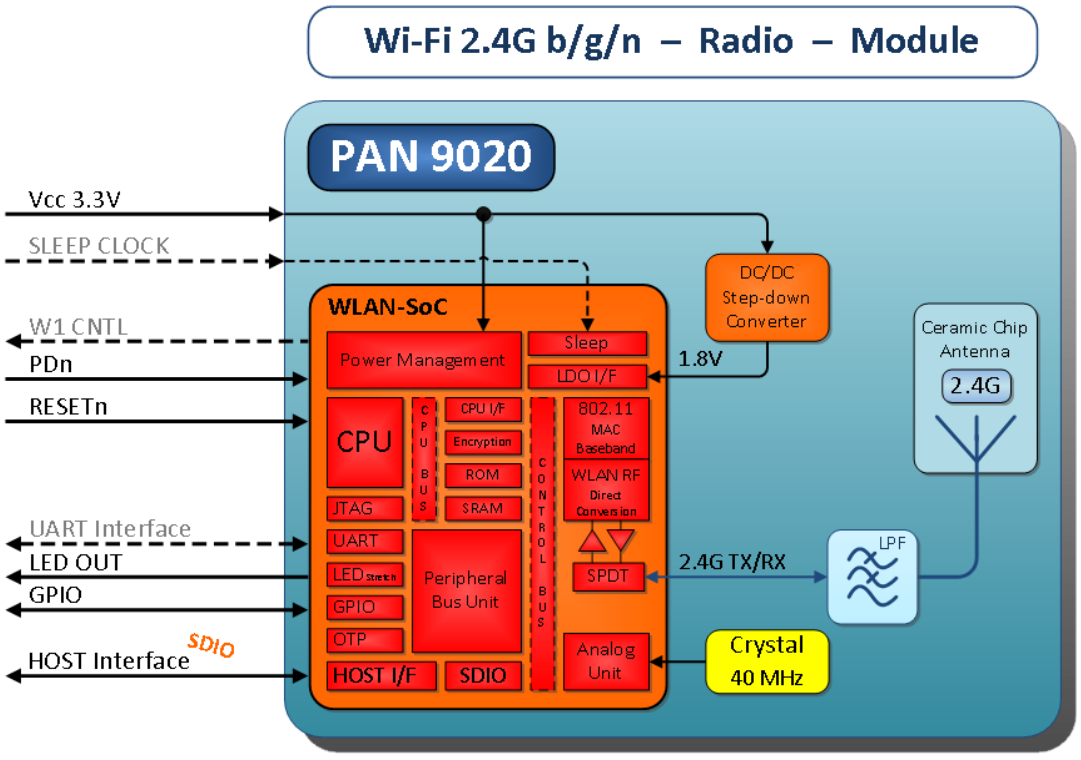
- Embedded WLAN SoC with following features:
  - WEP 64-bit and 128-bit encryption with hardware TKIP processing (WPA)
  - AES-CCMP hardware implementation as part of 802.11i security standard (WPA2)
  - Enhanced AES engine performance
  - AES-Chipher-Based Message Authentication Code (CMAC) as part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

16. PAN9020U / PAN9010U BLOCK DIAGRAM

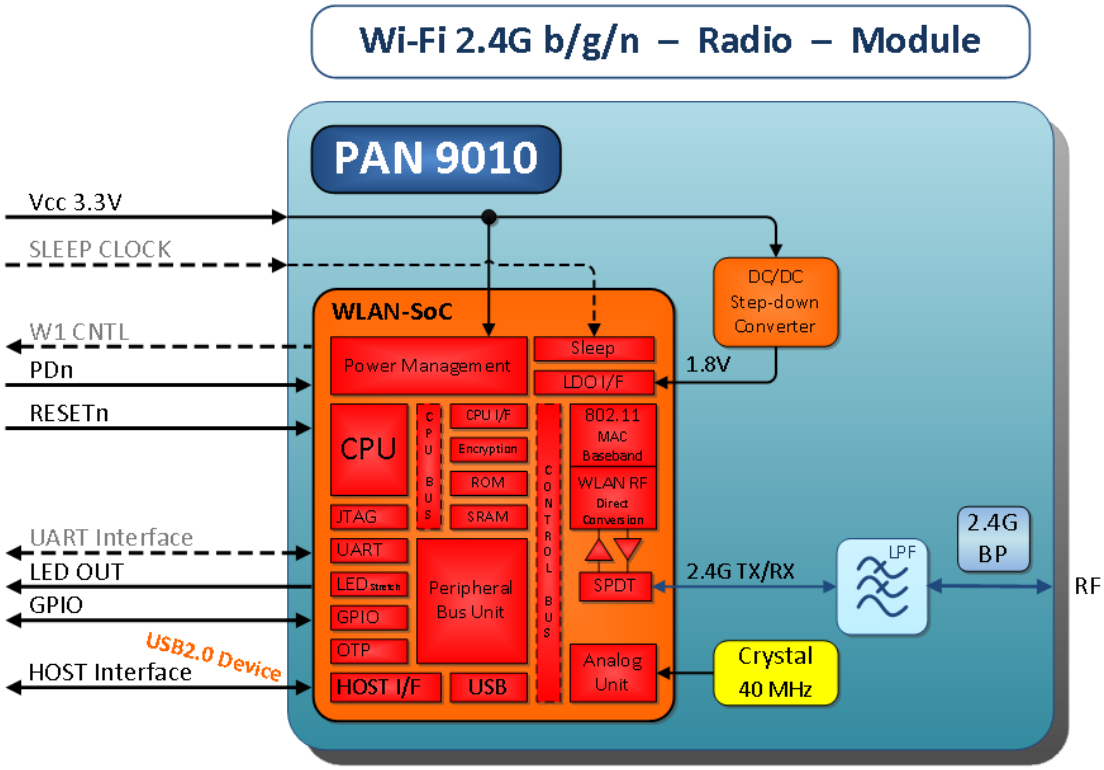
16.1. PAN9020U USB VARIANT



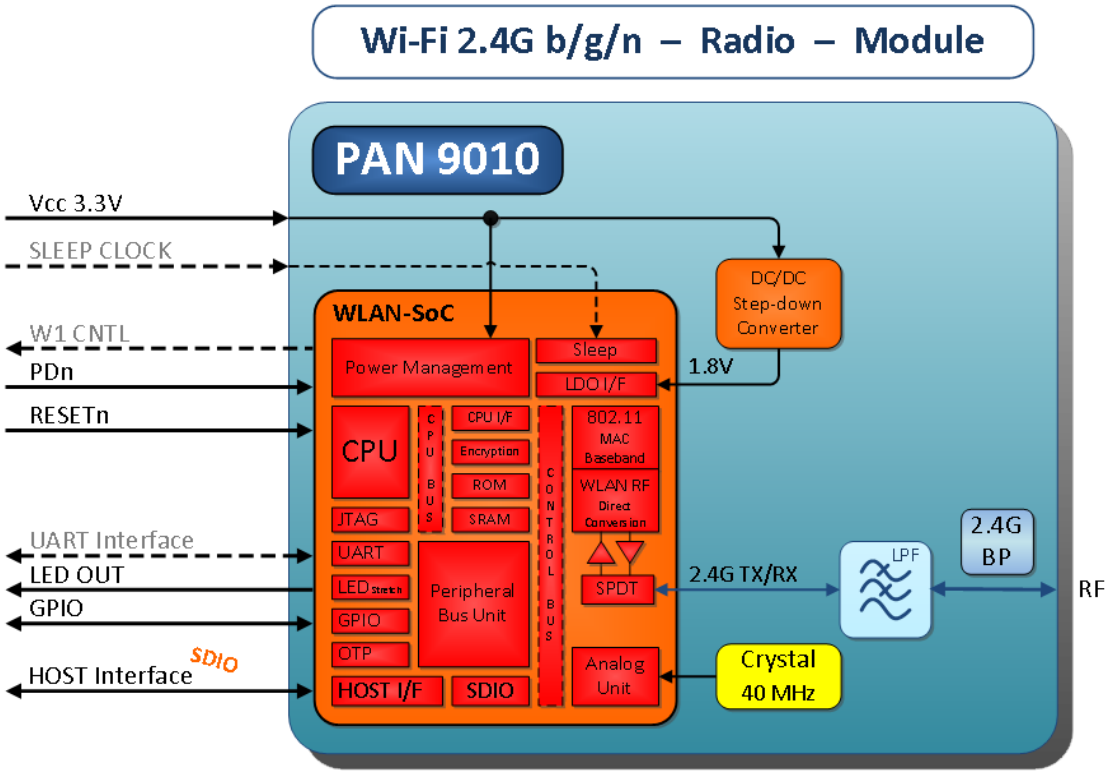
16.2. PAN9020S SDIO VARIANT



16.3. PAN9010U USB VARIANT



16.4. PAN9010S SDIO VARIANT



17. KEY PARTS LIST

Part Name	Material
P.W.Board	Glass cloth epoxide resin with gold plating
Casing	Material: C7521 or ZSNC S1S8 8/8, thickness 0.30mm
IC part name	88W8782 (Marvell®, www.marvell.com)

18. 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

19. GENERAL REQUIREMENTS AND OPERATION

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

19.1. 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		+125	°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		3.9	V
V_{DIG}	Voltage on any digital pins	GPIOs, PDn, RESETn, Coex I/F	-0.3		V_{DDMAX}	V

19.2. 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	Commercial grade	0		+70	°C
V_{DD}	3V3 Supply voltage[1]	Voltage on pins 33, 34 (3.3V) I/O supply voltage internally connected to V_{DD}	3.0	3.3	3.6	V

19.3. DIGITAL PIN CHARACTERISTICS

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{IH}	High level input voltage[2]	3.3V Operation ($V_{IO} = V_{DD}$)	$0.7V_{DD}$		$V_{DD}+0.3$	V
V_{IL}	Low level input voltage[2]	3.3V Operation ($V_{IO} = V_{DD}$)	-0.3		$0.3V_{DD}$	V
V_{HYS}	Input hysteresis voltage[2]	3.3V Operation ($V_{IO} = V_{DD}$)	200			mV
V_{OH}	High level output voltage[2]	3.3V Operation ($V_{IO} = V_{DD}$)	$V_{DD} – 0.4$			V
V_{OL}	Low level output voltage[2]	3.3V Operation ($V_{IO} = V_{DD}$)			0.4	V

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

[2] 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.

19.4. 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

19.4.1. Current consumption PAN9020U / PAN9010U USB Variant

Symbol	Parameter Current Consumption	Condition	Min.	Typ.	Max.	Units
I_{TX}	Active Transmit [3]	P_{TX} = +18 dBm for 802.11b @ 11 Mbps		400		mA
		P_{TX} = +15 dBm for 802.11g @ 54 Mbps		340		mA
		P_{TX} = +13 dBm for 802.11n (20MHz) @ 65 Mbps		320		mA
I_{RX}	Active Receive [4]	802.11b @ 11 Mbps		105		mA
		802.11g @ 54 Mbps		110		mA
		802.11n @ 65 Mbps		115		mA
I_{RXIdle}	Receive Idle [5]	Passive receive state, ready to receive packets, but no active decoding		100		mA
I_{PDn}	Power Down [6]	Grounding of PDn pin		350		µA
$I_{USBSusp}$	USB Suspend [7]	Low-power device automatically enters a suspend state after 3ms of no bus activity		450		µA
$I_{DeepSleep}$	Deep Sleep [8]	Low-power state used in sleep state		200		µA

19.4.2. Current consumption PAN9020S / PAN9010S SDIO Variant

Symbol	Parameter Current consumption	Condition	Min.	Typ.	Max.	Units
I_{TX}	Active Transmit [3]	P_{TX} = +18 dBm for 802.11b @ 11 Mbps		390		mA
		P_{TX} = +15 dBm for 802.11g @ 54 Mbps		330		mA
		P_{TX} = +13 dBm for 802.11n (20MHz) @ 65 Mbps		315		mA
I_{RX}	Active Receive [4]	802.11b @ 11 Mbps		65		mA
		802.11g @ 54 Mbps		70		mA
		802.11n @ 65 Mbps		75		mA
I_{RXIdle}	Receive Idle [5]	Passive receive state, ready to receive packets, but no active decoding		60		mA
I_{PDn}	Power Down [6]	Grounding of PDn pin		100		µA
$I_{DeepSleep}$	Deep Sleep [8]	Low-power state used in sleep state		150		µA

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

[4] Peak values for specified data rate with UDP traffic between the AP and DUT.

[5] The device is powered on, had the firmware download and is ready to receive packets, but is not actively decoding.

[6] Power Down state can be achieved by grounding the PDn pin. All internal clocks are shut down, the registers and memory are not maintained. Upon exiting power down mode, a rest is automatically performed and a firmware re-download is required.

[7] USB Suspend Mode is valid only for PAN9020U and PAN9010U. The low-power device automatically enters a suspend state after 3ms of no bus activity.

[8] It is a low-power mode used in the deep sleep state of power save mode. In this case the external reference clock and many WLAN SoC specific blocks are switched-off. Only an internal slow sleep clock is used to maintain register and memory states.

19.5. INTERNAL OPERATING FREQUENCIES

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
f_{SYSCLK}	CPU/System/Encryption clock speed	Refers to clock speed of WLAN SoC			128	MHz
f_{REFCLK}	Crystal fundamental frequency	Frequency tolerance < ±10 ppm over operating temperature and process		40		MHz

19.6. EXTERNAL SLEEP CLOCK REQUIREMENTS

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$f_{SLEEPCLK}$	Sleep Clock frequency [9]	CMOS input clock signal type, ±250 ppm over temperature, aging and process		32.768		kHz
V_{IH}	High level input voltage		0.8		1.98	V
V_{IL}	Low level input voltage		0.0		0.25	V
PN	Phase Noise	Phase Noise requirement @ 100 kHz		-125		dBc/Hz
J_C	Cycle Jitter			1.5		ns (RMS)
SR	Slew rate limit (10-90%)				100	ns
DC	Duty cycle tolerance		20		80	%

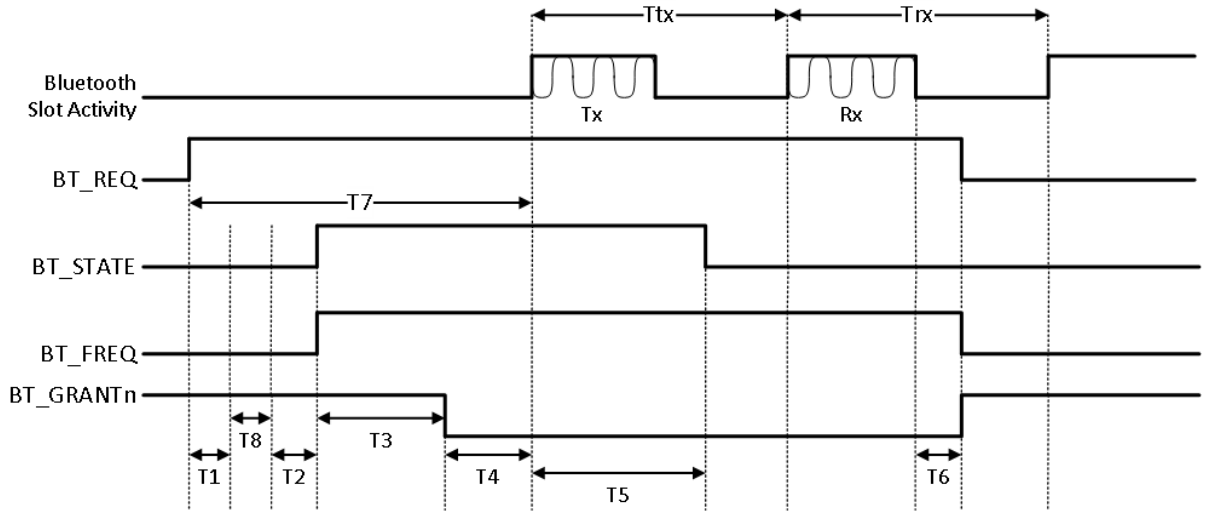
[9] Need to provide external sleep clock when low power operation mode near zero deep sleep is necessary. The external sleep clock is not necessary for normal power modes.

19.7. COEXISTENCE INTERFACE SPECIFICATION

The Coexistence Interface pins are powered from the VIO voltage supply internally connected to V_{DD} = 3.3V. See Chapter 19.3 Digital Pin Characteristics for DC specification.

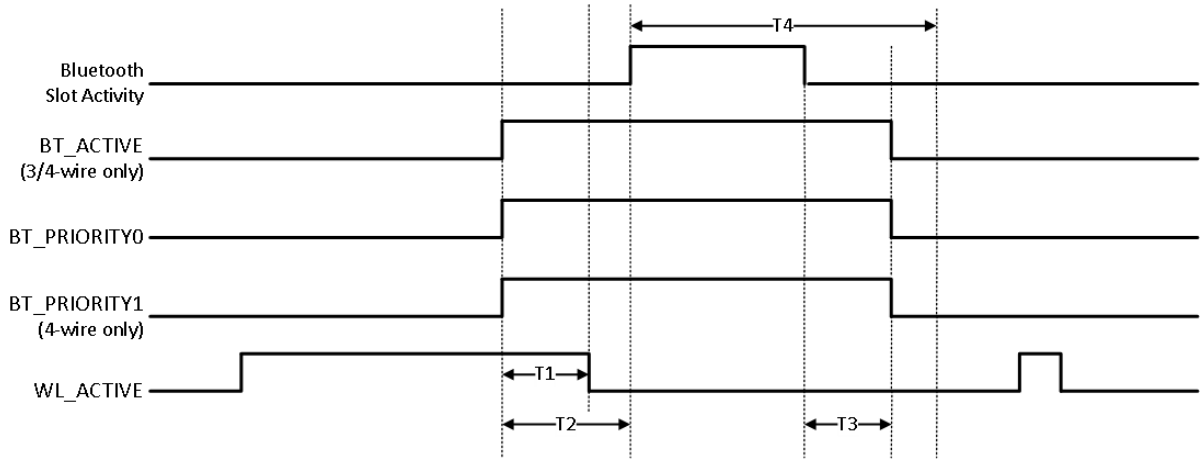
19.7.1. Marvell® 3/4-Wire Timing Data

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



19.7.2. 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



19.8. HOST INTERFACE SPECIFICATION

19.8.1. USB 2.0 Interface (PAN9020U / PAN9010U)

The USB 2.0 Host Interface pins are powered internally from the V_{DD} = 3.3V. It supports the high / full speed operation (480 / 12 Mbps) depending on the USB bus termination. The default mode is high speed operation.

19.8.1.1. Common Electrical Characteristics

Symbol	*Parameter*	*Condition*	*Min.*	*Typ.*	*Max.*	*Units*
Input Levels for Low / Full Speed						
V_{IH}	Input high voltage (driven)		2.0			V
V_{IHZ}	Input high voltage (floating)		2.7		3.6	V
V_{IL}	Input low voltage				0.8	V
V_{DI}	Differential input sensitivity		0.2			V
V_{CM}	Differential common mode range		0.8		2.5	V
Input Levels for High Speed						
V_{HSSQ}	High-speed squelch detection threshold (differential signal amplitude)		100		150	mV
V_{HSDSC}	High-speed disconnect detection threshold (differential signal amplitude)		525		625	mV
---	High-speed differential input signaling levels	Specified by eye pattern templates; see Section 7.1.7.2 in the USB 2.0 specification				
V_{HSCM}	High-speed data signaling common mode voltage range		-50		500	mV
Output Levels for Low / Full Speed						
V_{OL}	Output low voltage		0.0		0.3	V
V_{OH}	Output high voltage (driven)		2.8		3.6	V
V_{OSE1}	Output SE1 voltage		0.8			V
V_{CRS}	Output signal crossover voltage		1.3		2.0	V
Outpu Levels for High Speed						
V_{HSOI}	High-speed idle level		-10		10	mV
V_{HSOH}	High-speed data signaling high		360		440	mV
V_{HSOL}	High-speed data signaling low		-10		10	mV
V_{CHIRPJ}	Chirp J level (differential voltage)		700		1100	mV
V_{CHIRPK}	Chirp K level (differential voltage)		-900		-500	mV

17.8.1.1 Common Electrical Characteristics (continued)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
Decoupling Capacitance						
C_{RPB}	Upstream facing port bypass capacitance		1		10	µF
Input Capacitance for Low / Full Speed						
C_{INUB}	Upstream facing port capacitance (without cable)				100	pF
C_{EDGE}	Transceiver edge rate control capacitance				75	pF
Input Impedance for High Speed						
---	TDR specification for high-speed termination	Differential impedance	80		100	Ω
Terminations						
R_{PUI}	Bus pull-up resistor on upstream port (idles bus)		0.900		1.575	kΩ
R_{PUA}	Bus pull-up resistor on upstream port (receiving)		1.425		3.090	kΩ
Z_{INP}	Input impedance exclusive of pull-up / pull-down (for low / full speed)		300			kΩ
V_{TERM}	Termination voltage for upstream facing port pull-up resistor (R_{PU})		3.0		3.6	V
Terminations in High Speed						
V_{HSTERM}	Termination voltage in high speed		-10		10	mV

19.8.1.2. High Speed Source Electrical Characteristics

Symbol	*Parameter*	*Condition*	*Min.*	*Typ.*	*Max.*	*Units*
Driver Characteristics						
T_{HSR}	Rise Time (10% - 90%)		500			ps
T_{HSF}	Fall Time (10% - 90%)		500			ps
---	Driver waveform requirements	Specified by eye pattern templates; see Section 7.1.2 in the USB 2.0 specification				
Z_{HSDRV}	Driver output resistance (which also serves as high speed termination)		40.5		49.5	Ω
Clock Timings						
T_{HSDRAT}	High speed data rate		479.76		480.24	Mbps
T_{HSFRAM}	Microframe interval		124.9375		125.0625	µs
T_{HSRFI}	Consecutive microframe interval difference				4 high-speed bit times	
High Speed Data Timings						
---	Data source jitter	Specified by eye pattern templates; see Section 7.1.2.2 in the USB 2.0 specification				
---	Receiver jitter tolerance	Specified by eye pattern templates; see Section 7.1.2.2 in the USB 2.0 specification				

19.8.1.3. Full Speed Source Electrical Characteristics

Symbol	*Parameter*	*Condition*	*Min.*	*Typ.*	*Max.*	*Units*
Driver Characteristics						
T_{FR}	Rise Time		4		20	ns
T_{FF}	Fall Time		4		20	ns
T_{FRFM}	Differential rise and fall time matching	T_{FR} / T_{FF}	90		111.11	%
Clock Timings						
$T_{FDRATHS}$	Full speed data rate	Average bit rate	11.994		12.006	Mbps
T_{FDRATE}	Frame interval		0.9995		1.0005	µs
T_{HSRFI}	Consecutive frame interval difference	No clock adjustment			42	ms
Full Speed Data Timings						
T_{DJ1}	Source Jitter total to next transition (including frequency tolerance)		-3.5		3.5	ns
T_{DJ2}	Source Jitter total to paired transitions (including frequency tolerance)		-4		4	ns
T_{FDEOP}	Source Jitter for differential transition to SE0 transition		-2		5	ns
T_{JR1}	Receiver Jitter to next transition		-18.5		18.5	ns
T_{JR2}	Receiver Jitter to paired transition		-9		9	ns
T_{FEOPT}	Source SE0 interval of EOP		160		175	ns
T_{FEOPR}	Receiver SE0 interval of EOP		82			ns
T_{FST}	Width of SE0 interval during differential transition				14	ns

19.8.1.4. Device Event Timings

Symbol	*Parameter*	*Condition*	*Min.*	*Typ.*	*Max.*	*Units*
T_{SIGATT}	Time from internal power good device pulling D+/D- beyond V_{IHZ} (min) (signaling attach)				100	ms
T_{ATTDB}	Debounce interval provided by USB system software after attach				100	ms
T_{2SUSP}	Maximum time a device can draw power > suspend power when bus is continuously in idle state				10	ms
$T_{SUSAVGI}$	Maximum duration of suspend averaging interval				1	s
T_{WTRSM}	Period of idle bus before device can initiate resum	Device must be remote-wake-up enabled	5			ms
T_{DRSMUP}	Duration of driving resume upstream		1		15	ms
T_{RSMCY}	Resume recovery time	Provided by USB system software	10			ms
$T_{RSTRCYI}$	Reset recovery time				10	ms
T_{IPD}	Inter-packet delay (for low/full speed)		2			bit times
$T_{RSPIPD1}$	Inter-packet delay for device response with detachable cable for low/full speed				6.5	bit times
$T_{RSPIPD2}$	Inter-packet delay for device response with captive cable for low/full speed				7.5	bit times
$T_{DSETADDR}$	SetAddress() completion time				50	ms

17.8.1.4 Device Event Timings (continued)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$T_{DRQCMPLTND}$	Time to complete standard request with no data				50	ms
$T_{DRETDATA1}$	Time to deliver first and subsequent (except last) data for standard request				500	ms
$T_{DRETDATAN}$	Time to deliver last data for standard request				50	ms
$T_{HSRSPIPD2}$	Inter-packet delay for device response with captive cable (high speed)				192 bit times + 52ns	ms
Reset Handshake Protocol						
$F_{FILTSE0}$	Time for which a suspended high speed capable device must see a continuous SE0 before beginning the high speed detection handshake		2.5			µs
$T_{WTRSTFS}$	Time for which high speed capable device operating in non-suspended full speed must wait after start of SE0 before beginning the high speed detection handshake		2.5		3000	µs
T_{WTREV}	Time for which high speed capable device operating in high speed must wait after start of SE0 before reverting to full speed		3.0		3.125	ms
$T_{WTRSTHS}$	Time for which a device must wait after reverting to full speed before sampling the bus state for SE0 and beginning the high speed detection handshake		100		875	µs
T_{UCH}	Minimum duration of a Chirp K from a high speed capable device within the reset protocol		1.0			ms
T_{UCHEND}	Time after start of SE0 by which a high speed capable device is required to have completed its Chirp K within the reset protocol				7.01	ms
T_{WTHS}	Time after end of upstream chirp at which device enters the high speed default state if downstream chirp is detected				500	µs
T_{WTFS}	Time after end of upstream chirp at which device reverts to full speed default state if no downstream chirp is detected		1.0		2.5	ms

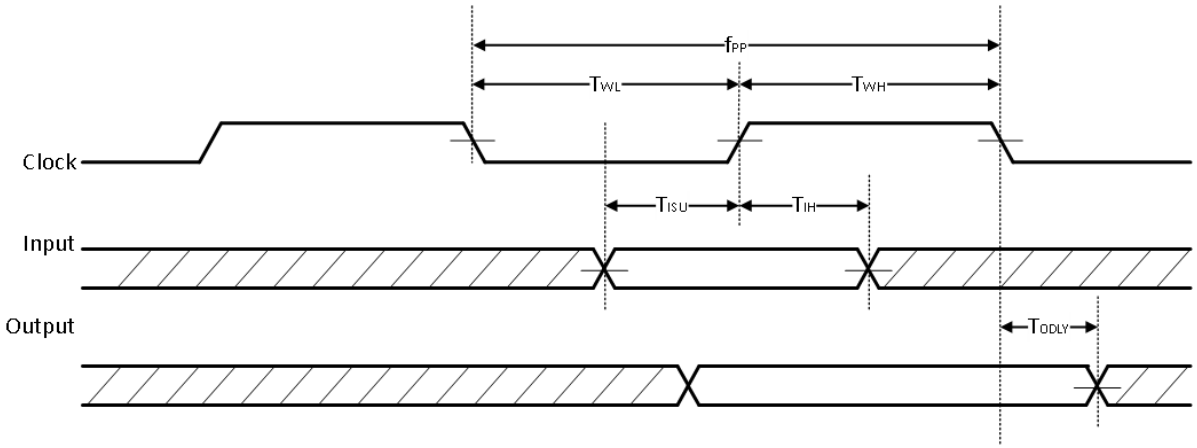
19.8.2. SDIO Interface (PAN9020S / PAN9010S)

The SDIO Host Interface pins are powered from the VIO voltage supply internally connected to V_{DD} = 3.3V. See Chapter 19.3 Digital Pin Characteristics for DC specification. The SDIO electrical specifications are identical for the 1-bit SDIO and 4-bit SDIO modes.

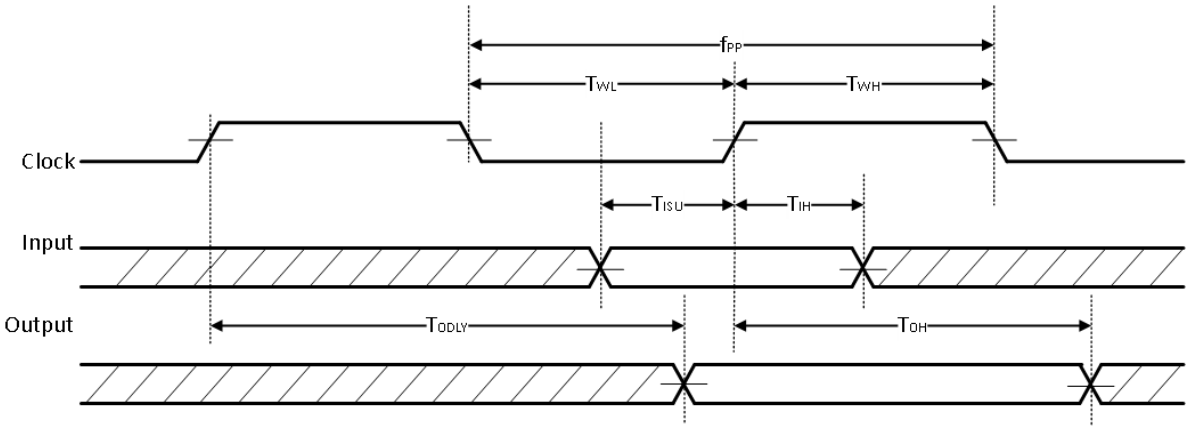
19.8.2.1. SDIO Timing Data

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
f_{PP}	Clock frequency	Normal	0		25	MHz
		High Speed	0		50	MHz
T_{WL}	Clock low time	Normal	10			ns
		High Speed	7			ns
T_{WH}	Clock high time	Normal	10			ns
		High Speed	7			ns
T_{ISU}	Input setup time	Normal	5			ns
		High Speed	6			ns
T_{IH}	Input hold time	Normal	5			ns
		High Speed	2			ns
T_{ODLY}	Output delay time				7.33	ns
T_{OH}	Output hold time	High Speed	2.5			ns

19.8.2.2. SDIO Protocol Timing – Normal Mode



19.8.2.3. SDIO Protocol Timing – High Speed Mode



19.9. PERIPHERAL INTERFACE SPECIFICATION

19.9.1. GPIO

The GPIO pins are powered from the VIO voltage supply internally connected to V_{DD} = 3.3V. See Chapter 19.3 Digital Pin Characteristics for DC specification.

GPIO Function	GPIO Pin					
General Purpose	GPIO[0]	GPIO[1]	GPIO[2]	GPIO[3]	GPIO[4]	GPIO[5]
Input	YES	YES	YES	YES	YES	YES
Output	YES	YES	YES	YES	YES	YES
Function by firmware (USB)		LED Mode	SoC-to-Host wake-up	external sleep clock input	Used internally	W1_CNTL
Function by firmware (SDIO)		LED Mode	SoC-to-Host wake-up	external sleep clock input	Host-to-SoC wake-up	W1_CNTL
LED Output	NO	YES	NO	NO	NO	NO

The basic function of the GPIOs are set by firmware default, but can be reconfigured by software.

19.9.1. LED Mode of GPIO[1]

The GPIO pin for LED Mode is powered from the VIO voltage supply internally connected to V_{DD} = 3.3V. See Chapter 19.3 Digital Pin Characteristics for DC specification.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{OH}	Switching current high	Tristate on pin (requires pull-up on board)	Tristate when driving high			mA
I_{OL}	Switching current low	@ 0.4V		10		mA

The LED Mode is independently selectable for the GPIO[1].

20. RF ELECTRICAL CHARACTERISTICS

20.1. 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 [10]	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			-

[10] The supported channels are defined by setting of country code

20.2. WLAN RF CHARACTERISTICS

20.2.1. 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

20.2.2. 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

20.2.3. 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 [11]	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 [12]	65 Mbps (MCS7)	PER ≤ 10%	-2			dB

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

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

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

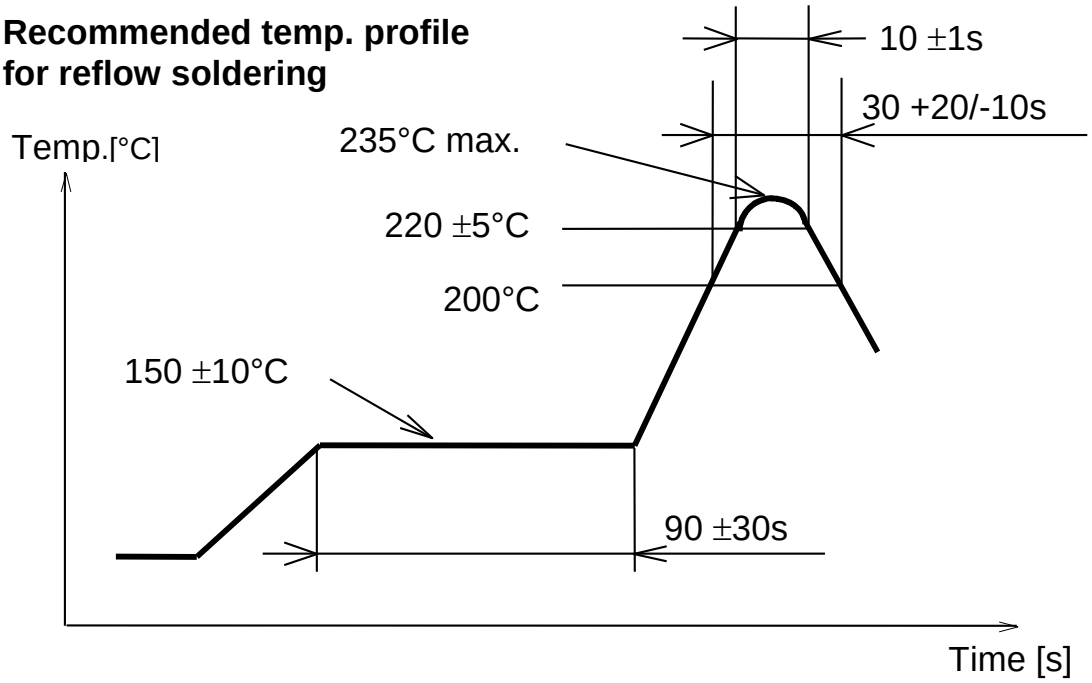
Assume V_{DD} = 3.3V, T_{amb} = 25°C if nothing else stated
50 Ohm terminal load connected to the RF connector

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 [11]	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 [12]	135 Mbps (MCS7)	PER ≤ 10%	-2			dB

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

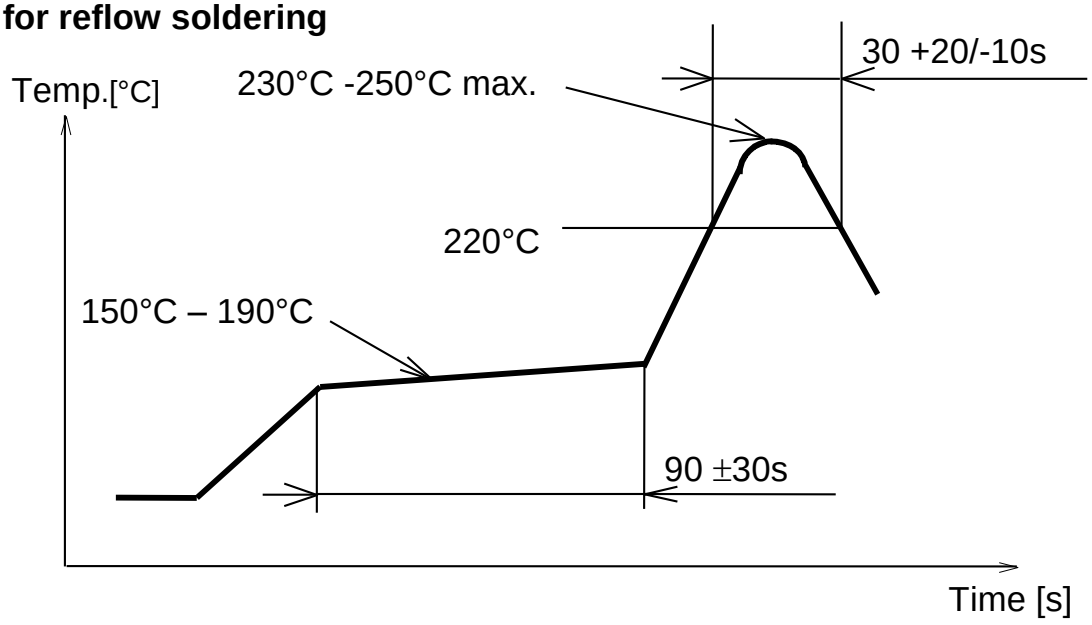
21.1. FOR LEAD SOLDER

Recommended temp. profile for reflow soldering



21.2. FOR LEADFREE SOLDER

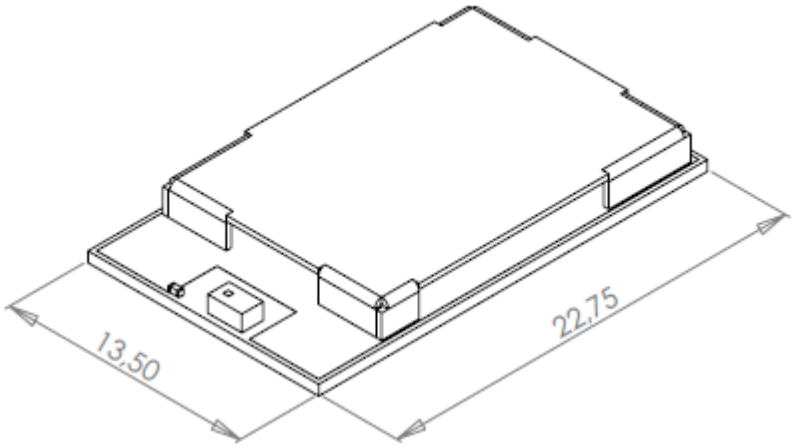
Our used temp. profile for reflow soldering

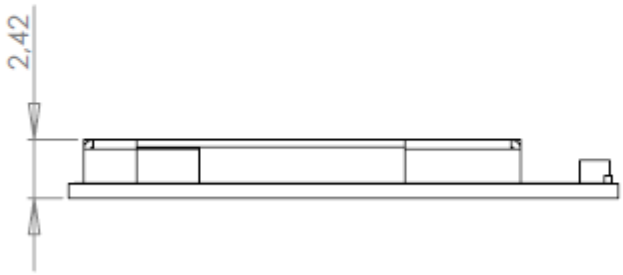


Reflow permissible cycle: 2
Opposite side reflow is prohibited due to module weight.

22. PAN9020 / PAN9010 MODULE DIMENSION

No.	Item	Dimension	Tolerance	Remark
1	Width	13.50	± 0.30	
2	Length	22.75	± 0.30	
3	Height	2.42	± 0.20	with case

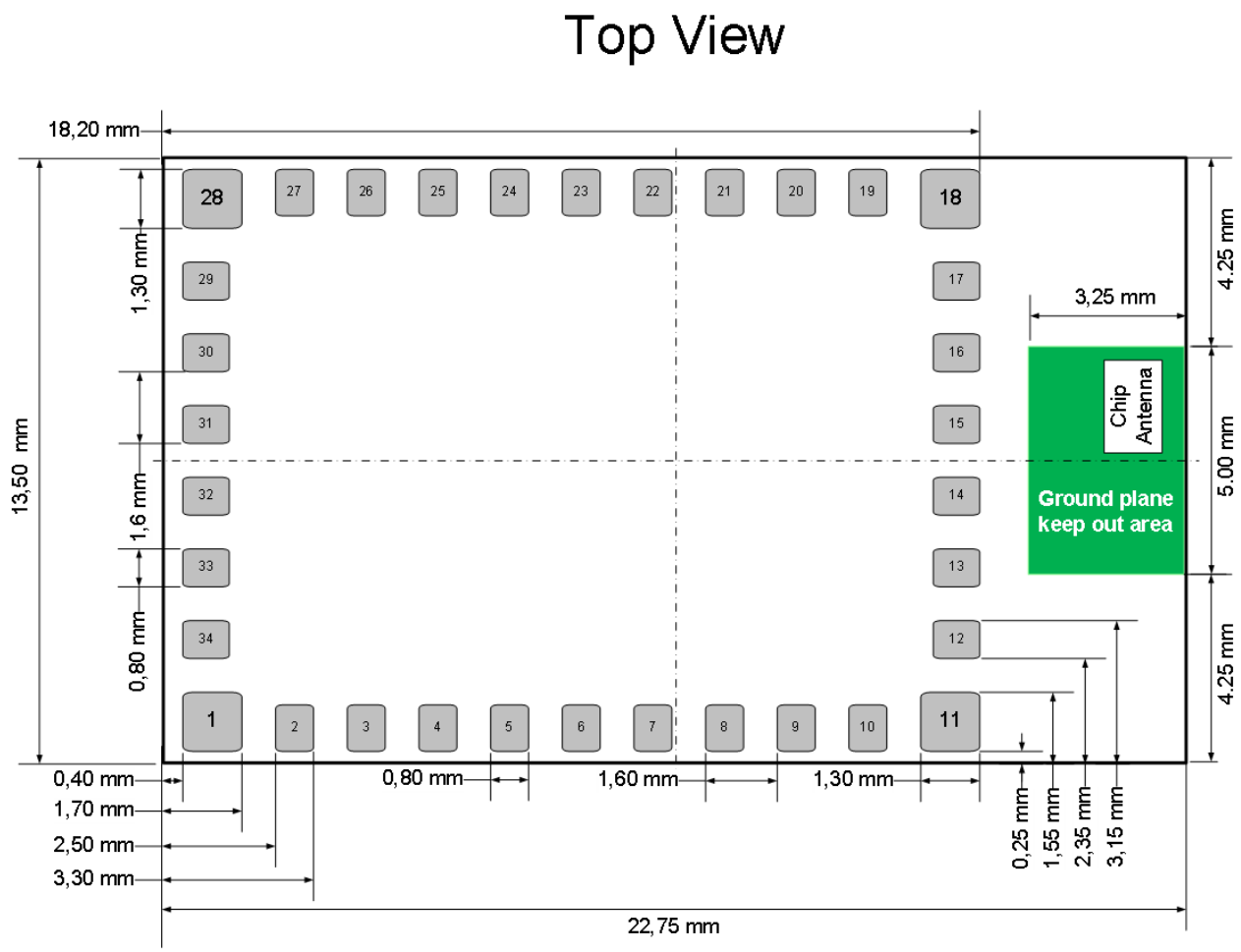




23. PAN9020 / PAN9010 FOOTPRINT OF THE MODULE

All dimensions are in millimeters.
The outer dimensions have a tolerance of ± 0.3mm.

Top view, Application PCB



24. CASE MARKING (EXAMPLE FOR PAN9020U)

No.	Remark
1	Marking for Pin 1 (Circle 0,15 mm)
2	2D-Code, for internal usage only and can be change without any notice
3	Marking definition see below

24.1. MARKING DESCRIPTION

P	A	N	9	0	x	0	y		H	W	/	S	W		E	S
E	N	W	4	9	8	0	y	x	1	J	F					
Y	Y	W	W	D	L	L										
S	N	S	N	S	N	S	N									
M	A	C	M	A	C	M	A	C	M	A	C					
I	C	:		2	1	6	Q	-	9	0	2	0	y			

24.2. DETAILED MARKING DEFINITION

(1) Pin1 marking

(2) 2D code (Serial number)

(3) Marking:

- PAN90x0y (Model Name), HW/SW (Hardware/Software version)
  - y = U → USB, y = S → SDIO
  - x = 2 → ceramic chip-antenna (PAN9020), x = 1 → 50 Ohm bottom pad (PAN9010)
- ES (Engineering Sample marking)
- ENW4980yx1JF (Part Number, refer to chapter 30 Ordering Information)
  - y = 1 → USB, y = 2 → SDIO
  - x = A → ceramic chip-antenna (PAN9020), x = C → 50 Ohm bottom pad (PAN9010)
- Lot code (YearYear, WeekWeek, Day, LotLot)
- Serial Number (8 digits)
- WLAN MAC address (12 digits)
- IC Canada (refer to chaper 32 Regulatory Information)
  - y = U → USB, y = S → SDIO

Note: For available Versions, refer to [1] PAN9020U and PAN9020S Reference-Guide. and chapter 30 Ordering Information.

25. 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 21.2

26. DEVELOPMENT OF APPLICATIONS

For development support please refer to [1] PAN9020U and PAN9020S Reference-Guide.

27. 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

28. 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.

28.1. DESIGN NOTES

(1) Follow the conditions written in this specification, especially the control signals of this module.
(2) The supply voltage has to 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.

28.2. 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.

28.3. 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.

28.4. 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 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).

28.5. 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.

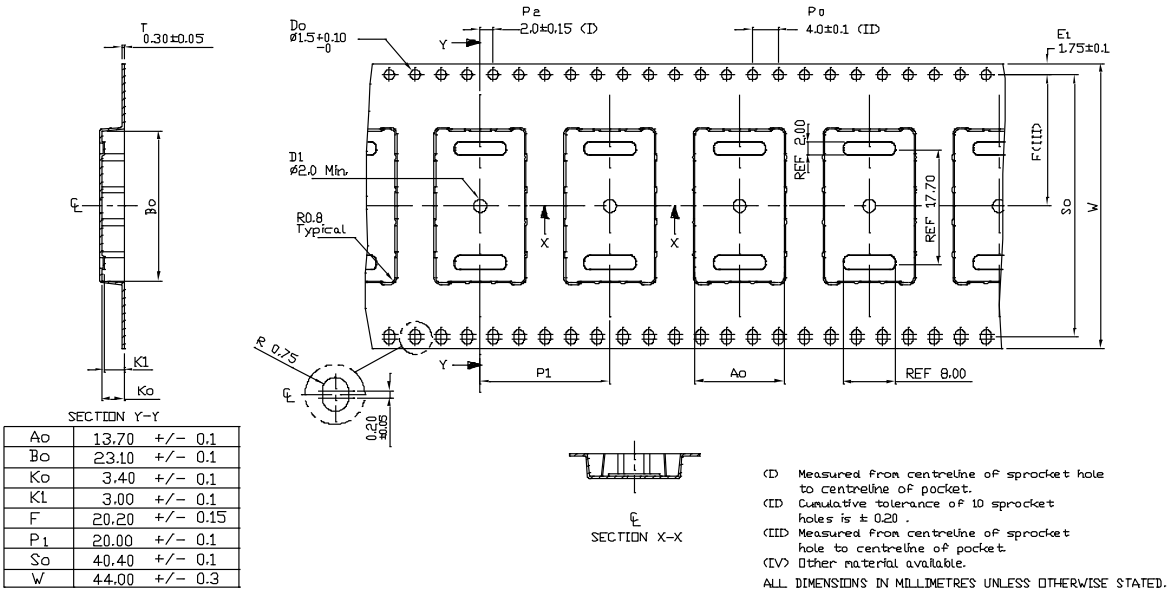
28.6. OTHER CAUTIONS

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

29. PACKAGING

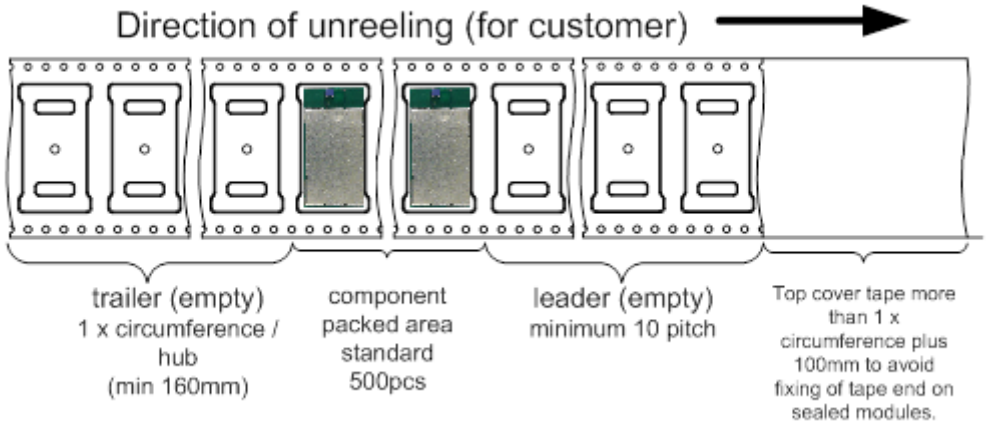
If the product has mass production status, indicated in chapter 3, we will deliver the module in the package which are described below.

29.1. PAN9020 / PAN9010 TAPE DIMENSION



Ao	13.70	+/− 0.1
Bo	23.10	+/− 0.1
Ko	3.40	+/− 0.1
K1	3.00	+/− 0.1
F	20.20	+/− 0.15
P1	20.00	+/− 0.1
So	40.40	+/− 0.1
W	44.00	+/− 0.3

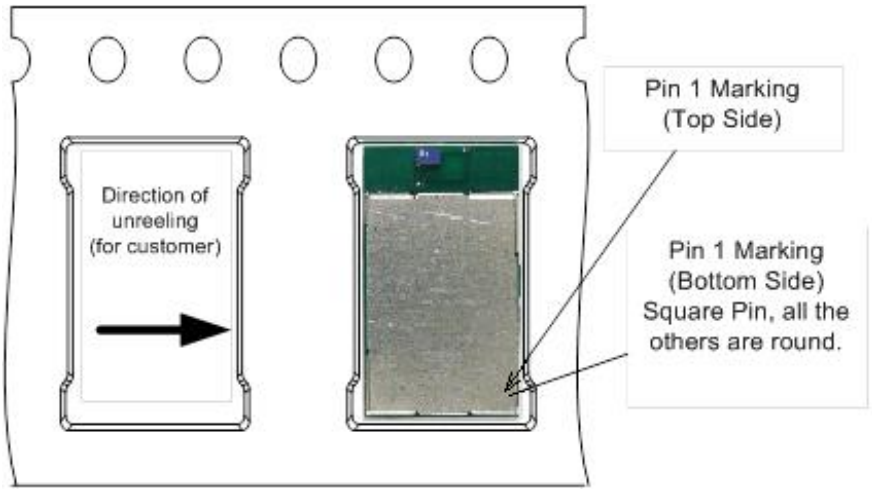
29.2. PACKING IN TAPE



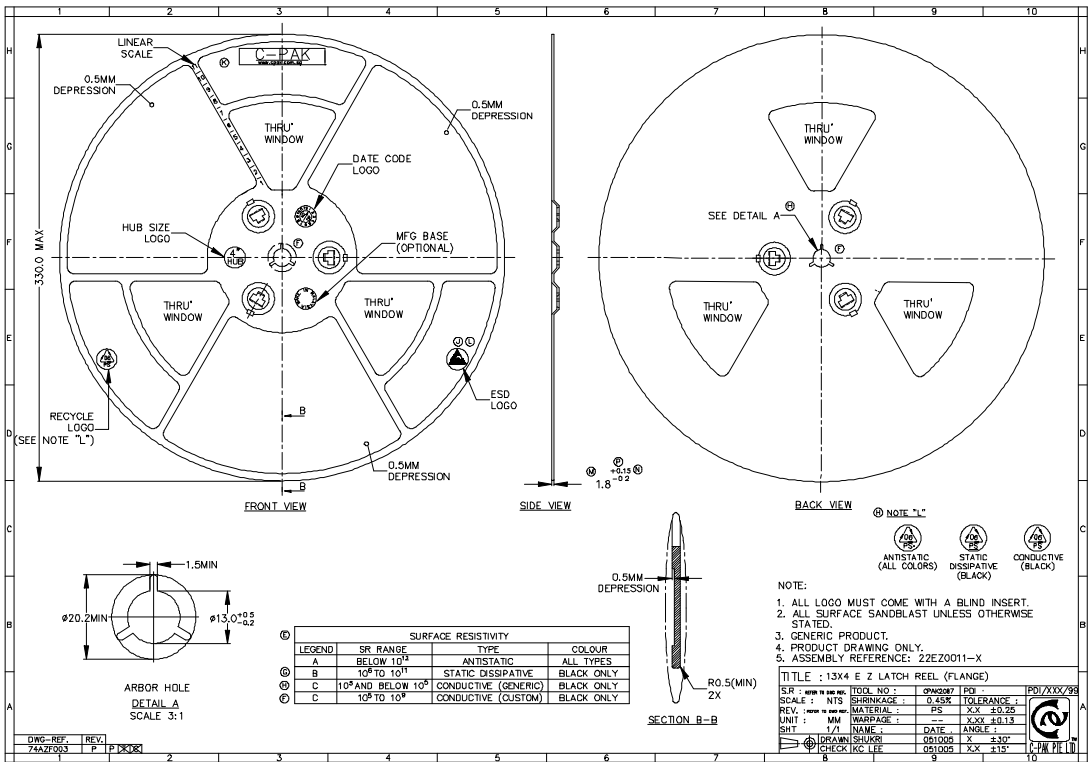
Empty spaces in component packed area shall be less than two per reel and those spaces shall not be consecutive.

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

29.3. COMPONENT DIRECTION

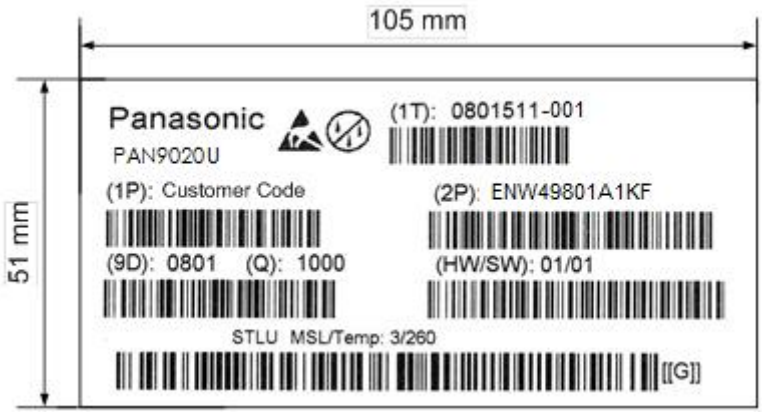


29.4. REEL DIMENSION



29.5. 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: ENW49801x1J

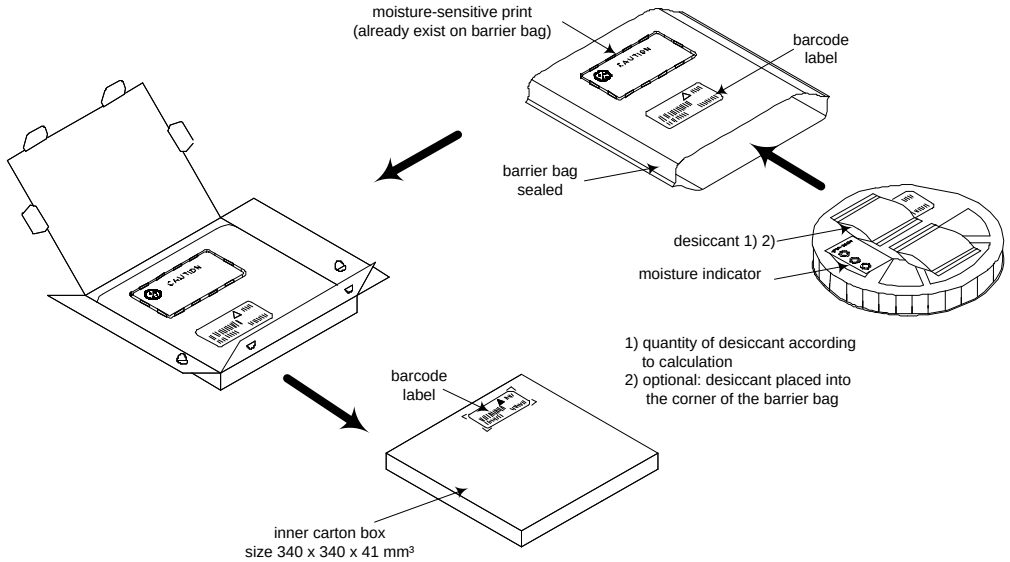
(9D) Date code as [YYWW]

(Q) Quantity [XXXX], variable max. 500

(HW/SW) Hardware /Software Release

Hardware	01	Indicates the HW revision.
Software	01	Indicates the SW revision.

29.6. TOTAL PACKAGE



30. ORDERING INFORMATION

Ordering part number	Description	MOQ (1)
ENW49801A1JF	PAN9020U WLAN IEEE 802.11 b/g/n 2.4GHz Radio Module with USB2.0 HOST Interface, ceramic chip-antenna	500
ENW49802A1JF	PAN9020S WLAN IEEE 802.11 b/g/n 2.4GHz Radio Module with SDIO HOST Interface, ceramic chip-antenna	500
ENW49801C1JF	PAN9010U WLAN IEEE 802.11 b/g/n 2.4GHz Radio Module with USB2.0 HOST Interface, with 50Ω bottom pad	500
ENW49802C1JF	PAN9010S WLAN IEEE 802.11 b/g/n 2.4GHz Radio Module with SDIO HOST Interface, with 50Ω bottom pad	500

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.

30.1. INFORMATION REGARDING SOFTWARE VERSIONS

ENW49801/02A**1**JF / ENW49801/02C**1**JF:

The modules will be delivered without any WLAN Firmware but including calibration data.

The WLAN SoC Firmware and HOST Driver-Firmware Interface software modules taking place on the customers HOST processor and need to be programmed on their own production process.

For details refer to the reference guide.

31. 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

32. REGULATORY INFORMATION

32.1. FCC FOR US

32.1.1. FCC Notice

The model PAN9020U / PAN9020S, including the ceramic antenna (ENW49801A1JF and ENW49802A1JF) and the model PAN9010U / PAN9010S SMD type (ENW49801C1JF and ENW49802C1JF), including with the antennas, which are listed in 32.1.5, complies with Part 15 of the FCC Rules.

32.1.2. Caution

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help

32.1.3. Labeling Requirements

The Original Equipment Manufacturer (OEM) must ensure that FCC labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate FCC identifier for this.

32.1.4. Antenna Warning

The related part numbers for these device are ENW49801C1JF and ENW49802C1JF (PAN9010U / PAN9010S with SMD pad). For details, see the Chapter 30. Ordering Information. These devices are tested with a standard SMA connector and with the antenna listed below. When integrated in the OEMs product, these fixed antennas require installation preventing end-users from replacing them. Any antenna must be tested to comply with FCC Section 15.203 for unique antenna connectors and Section 15.247 for emissions. PAN9020U and PAN9020S were tested with antenna mentioned in chapter 32.1.5.

32.1.5. Antenna of PAN9020U and PAN9020S

Item	Part Number	Manufacturer	Frequency Band	Type	Gain (dBi)
1	ANT2012LL13R2400A	Yageo	2.4GHz	Chip-Antenna	+0.8

32.1.6. RF Exposure PAN9020U and PAN9020S

To comply with FCC RF Exposure requirements, the Original Equipment Manufacturer (OEM) must ensure that the antenna in the previous table must be installed.

The preceding statement must be included as a CAUTION statement in manuals for products operating with the antennas in the previous table to alert users on FCC RF Exposure compliance.

Any notification to the end user of installation or removal instructions about the integrated radio module is not allowed.

The radiated output power of PAN9020U / PAN9020S with mounted ceramic chip antenna are far below the FCC radio frequency exposure limits. Nevertheless, the PAN9020U and PAN9020S shall be used in such a manner that the potential for human contact during normal operation is minimized.

End users may not be provided with the module installation instructions. OEM integrators and end users must be provided with transmitter operating conditions for satisfying RF exposure compliance.

32.2. INDUSTRY CANADA CERTIFICATION

PAN9020U and PAN9020S are licensed to meet the regulatory requirements of Industry Canada (IC),

License for USB version: **IC: 216Q-9020U**

License for SDIO version: **IC: 216Q-9020S**

Manufacturers of mobile, fixed or portable devices incorporating this module are advised to clarify any regulatory questions and ensure compliance for SAR and/or RF exposure limits. Users can obtain Canadian information on RF exposure and compliance from www.ic.gc.ca.

This device has been designed to operate with the antennas listed in Table 20 above, having a maximum gain of 0.8 dBi. Antennas not included in this list or having a gain greater than 0.8 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. The antenna used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

32.2.1. IC Notice

The device PAN9020U / PAN9020S, for details refer to Chapter 30, including the antennas, which are listed in 32.1.5, complies with Canada RSS-GEN Rules. The device meets the requirements for modular transmitter approval as detailed in RSS-GEN.

Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) This device must accept any interference received, including interference that may cause undesired operation.

32.2.2. Labeling Requirements

The Original Equipment Manufacturer (OEM) must ensure that IC labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Panasonic IC identifier for this product as well as the IC

Notice above. The IC identifier are: **216Q-9020U** for USB version and **216Q-9020S** for SDIO version.

This IC identifier is valid for all PAN9020U and PAN9020S, for details, see the Chapter 30. Ordering Information.

In any case the end product must be labelled exterior with
"Contains IC: 216Q-9020U" for USB version
"Contains IC: 216Q-9020S" for SDIO version.

Les fabricants d'équipements (OEM) doivent s'assurer que les obligations d'étiquetage du produit final sont remplies. Ces obligations incluent une étiquette clairement visible à l'extérieur de l'emballage externe, comportant l'identifiant IC du module Panasonic inclus, ainsi que la notification ci-dessus.

Les identifiants IC sont: IC: 216Q-9020U (pour USB version)

Les identifiants IC sont: IC: 216Q-9020S (pour SDIO version)

Ces identifiants sont valides pour tous les PAN9020U / PAN9020S (Chapter 30. Ordering Information). Dans tous les cas les produits finaux doivent indiquer sur leur emballage externe une des mentions suivantes:

"Contient IC: 216Q-9020U" (pour USB version)

"Contient IC: 216Q-9020S" (pour SDIO version)

32.3. EUROPEAN R&TTE DECLARATION OF CONFORMITY

All modules described in this data sheet comply to the standards according R&TTE article:

3.1a Safety/Health:
EN60950-1:2006+A11:2009+A1:2010+A12:2011+AC:2011+A2:2013
EN62311:2008
EN62479:2010

3.1b EMC: EN 301 489-1 V1.8.1:2008-04
EN 301 489-17 V2.2.1:2012-09

3.2 Radio: EN 300 328 V1.8.1:2012-06

As a result of the conformity assessment procedure described in Annex III of the Directive 1999/5/EC, the end-customer equipment should be labelled as follows:

CE

The end-customer has to assure that the device has a distance of more than 20cm from the human body under all circumstances.

The end-customer equipment must meet the actual Safety/Health requirements according R&TTE.

PAN9020U / PAN9020S and their model versions in the specified reference design can be used in the following countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Netherland, the United Kingdom, Switzerland, and Norway.

33. 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 we deliver ES samples 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.

34. 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.