Panasonic
INDUSTRY

PAN9520

Embedded Wi-Fi Module

Product Specification

Rev. 1.0

Wireless Connectivity

Overview

The PAN9520 is a 2.4 GHz ISM band Wi-Fi embedded module based on Espressif ESP32-S2, which includes a wireless radio and a MCU for easy integration of Wi-Fi connectivity into various electronic devices.

Features

- Embedded 2.4 GHz Wi-Fi 802.11 b/g/n module
- Xtensa® single-core 32-bit LX7 microprocessor, up to 240 MHz
- Chip internal 128 kB ROM, 320 kB SRAM, and 16 kB low power SRAM
- Integrated QSPI Flash and PSRAM (a variety of memory densities are available)
- Ultra-Low Power (ULP) co-processor usable in deep sleep mode
- All security features required for WPA2 and WPA3 personal
- Espressif Integrated Development Framework (ESP-IDF) with a multitude of examples available for software development
- Supports 20 MHz and 40 MHz bandwidths in 2.4 GHz band with data rates up to 150 Mbps
- Simultaneous support for Infrastructure Station, SoftAP, and promiscuous modes
- 802.11mc Fine Time Measurement (FTM)
- 36× programmable GPIOs with a rich set of alternative functionalities:
  - 2× 12-bit SAR ADCs, up to 20 channels
  - 2× 8-bit DAC
  - 14× touch sensing IOs
  - 4× SPI (2× available for general purpose)
  - 1× I²S
  - 2× I²C
  - 2× UART
  - RMT (Tx/Rx)
  - LED PWM, up to 8 channels
  - 1× full-speed USB OTG
  - 1× DVP 8/16 camera interface (I²S resources used)
  - 1× LCD interface (SPI2 resources used)
  - 1× LCD interface (I²S resources used)

Characteristics

- Surface Mount Type (SMT): 24 mm × 13 mm × 3.1 mm
- Tx power: up to 19.5 dBm at IEEE 802.11b 1 Mbps
- Rx sensitivity: -97 dBm at IEEE 802.11b 1 Mbps
- Power supply: 3 V to 3.6 V
- Current consumption 260 mA Tx (average at 11b, 11 Mbps), 76 mA Rx (40 MHz channel), 310 mA Tx peak
- Deep sleep mode: <100 µA typical power consumption (RTC timer only and VDD_SPI disconnected)
- Wide temperature range from -40 °C to 85 °C

Block Diagram

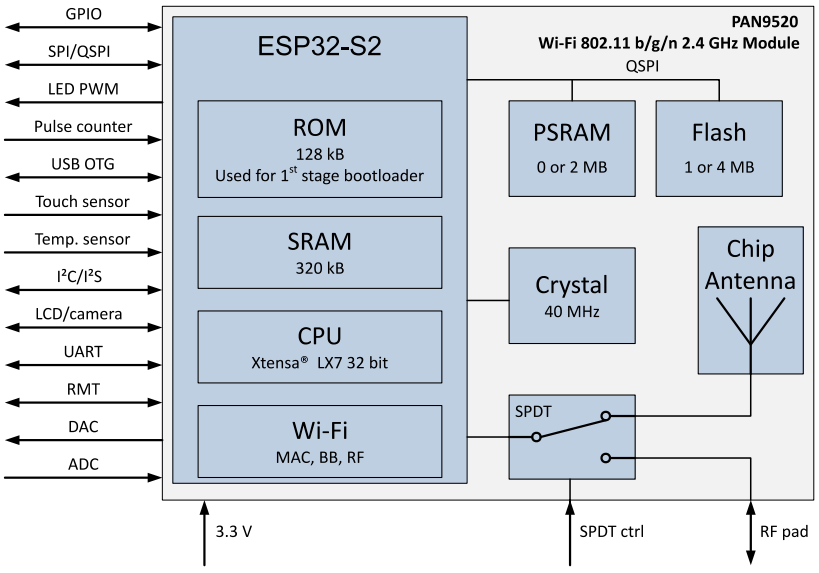

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Table of Contents

1 About This Document

1.1 Purpose and Audience

This Product Specification provides details on the functional, operational, and electrical characteristics of the Panasonic PAN9520 module. It is intended for hardware design, application, and Original Equipment Manufacturers (OEM) engineers.

The product is referred to as “the PAN9520” or “the module” within this document.

1.2 Revision History

Revision	Date	Modifications/Remarks
1.0	2021-06-02	First version

1.3 Use of Symbols

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

1.4 Related Documents

For related documents please refer to the Panasonic website ⇨ 7.2.2 Product Information.

2 Overview

The PAN9520 is a 2.4 GHz 802.11 b/g/n embedded Wi-Fi module based on Espressif's ESP32-S2 that includes the powerful Xtensa® 32-bit LX7 CPU. An integrated chip antenna and QSPI memory enable the module to be used in a variety of stand-alone or host-controlled applications. The integrated crystal ensures connection performance over full temperature range and lifetime. The integrated crystal ensures connection performance over full temperature range and lifetime. Although the PAN9520 is one of the smallest modules on the market, this offers a rich set of peripherals like full-speed USB OTG, SPI, UART, I²C, and many more[1].

The PAN9520 combines a high-performance CPU, high-sensitivity wireless radio, baseband (BB) processor, Medium Access Controller (MAC), encryption unit, ROM bootloader, chip-internal SRAM, and module-internal QSPI flash and PSRAM. Features as CCMP, TKIP, WAPI, WEP, BIP, and an AES[2] accelerator enable the usage of secure data connections.

Parallel support of access point and station mode allows easy setup of simultaneous Wi-Fi connections from the module to smart devices and home network routers.

With the Espressif Integrated Development Framework (ESP-IDF), software can be developed for a wide range of applications. At the same time, a huge number of software examples can be used as starting point for the development.

Please note that the ESP-IDF is provided by Espressif Systems. Always use the latest updates https://github.com/espressif/esp-idf.

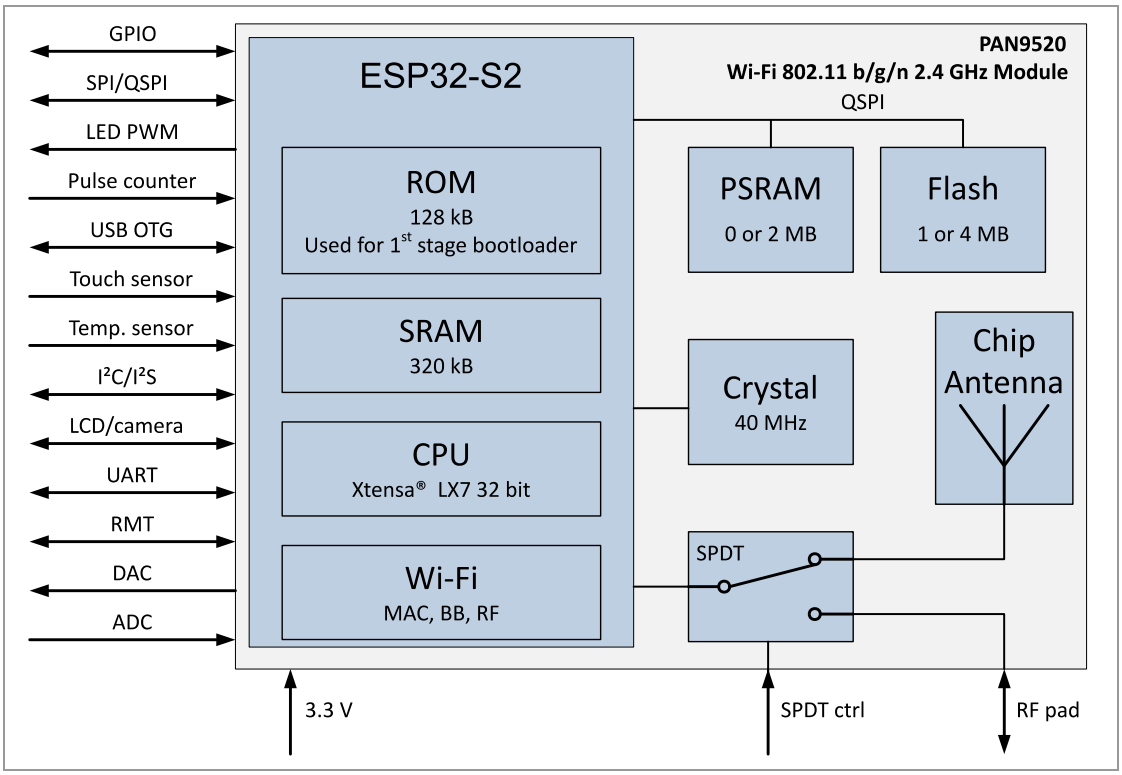
For related documents please refer to ⇨ 7.2.2 Product Information.

For further information on the variants and versions please refer to ⇨ 7.1 Ordering Information.

[1] Compared to modules offering similar feature sets.

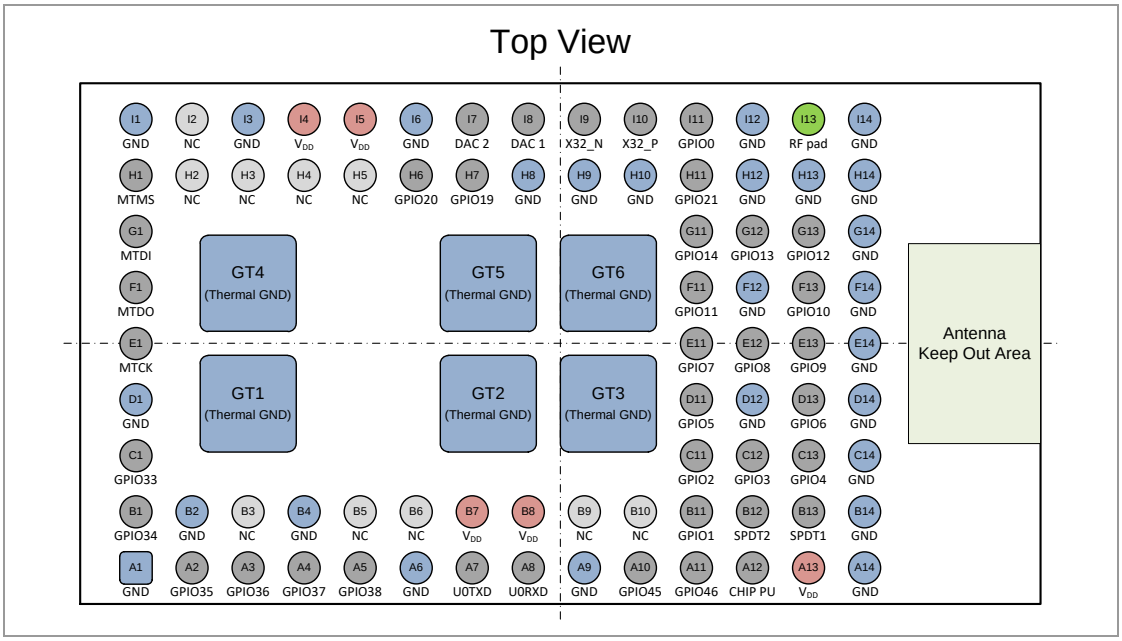
[2] Counter Mode with CBC-MAC Protocol (CCMP); Temporary Key Integrity Protocol (TKIP); WLAN Authentication and Privacy Infrastructure (WAPI); Wired Equivalent Privacy (WEP); Broadcast/Multitask Integrity Protocol (BIP); Advanced Encryption Standard (AES)

2.1 Block Diagram



2.2 Pin Configuration

Pin Assignment



Pin Functions

No.	Pin Name	Pin Type	Description
A1	GND	Ground Pin	Connect to ground
A2	GPIO35	Digital I/O	SPIIO6, GPIO35, FSPID
A3	GPIO36	Digital I/O	SPIIO7, GPIO36, FSPICLK
A4	GPIO37	Digital I/O	SPIDQS, GPIO37, FSPIQ
A5	GPIO38	Digital I/O	GPIO38, FSPIWP
A6	GND	GND	Connect to ground
A7	U0TXD	Digital I/O	U0TXD (can be used for programming), GPIO43, CLK_OUT1
A8	U0RXD	Digital I/O	U0RXD (can be used for programming), GPIO44, CLK_OUT2
A9	GND	GND	Connect to ground
A10	GPIO45	Digital I/O	GPIO45 (and strapping pin to control V_{DD_SPI}) **Note**: Do not connect or pull down at boot up ⇨ 4.3.5 Strapping Pins.
A11	GPI(O)46	Digital Input	GPI(O)46 (and strapping pin for print control) **Note**: For details please refer to ⇨ 4.3.5 Strapping Pins.

No.	Pin Name	Pin Type	Description
A12	CHIP PU	Chip enable	High: Enables the ESP32-S2 Wi-Fi chip Low: Disables the ESP32-S2 Wi-Fi chip **Note**: Do not leave the pin CHIP_PU floating and please refer to ⇨ 4.3.4 Power up Sequence and Reset.
A13	V_{DD}	PWR Pin	Connect to 3.3 V
A14	GND	Ground Pin	Connect to ground
B1	GPIO34	Digital I/O	SPIIO5, GPIO34, FSPICS0
B2	GND	Ground Pin	Connect to ground
B3	NC	NC	Do not connect
B4	GND	Ground Pin	Connect to ground
B5	NC	NC	Do not connect
B6	NC	NC	Do not connect
B7	V_{DD}	Supply Pin	Connect to 3.3 V
B8	V_{DD}	Supply Pin	Connect to 3.3 V
B9	NC	NC	Do not connect
B10	NC	NC	Do not connect
B11	GPIO1	Digital I/O	RTC_GPIO1, GPIO1, TOUCH1, ADC1_CH0
B12	SPDT2	Digital Input	SPDT control pin: Configures if the antenna or RF pad is fed **Note**: Do not connect or pull up to connect the internal antenna ⇨ 4.3.2 Module Selectable RF In/Output.
B13	SPDT1	Digital Input	SPDT control pin: Configures if the antenna or RF pad is fed **Note**: Do not connect or pull down to connect the internal antenna ⇨ 4.3.2 Module Selectable RF In/Output.
B14	GND	Ground Pin	Connect to ground
C1	GPIO33	Digital I/O	SPIIO4, GPIO33, FSPIHD
C11	GPIO2	Digital I/O Analog	RTC_GPIO2, GPIO2, TOUCH2, ADC1_CH1
C12	GPIO3	Digital I/O Analog	RTC_GPIO3, GPIO3, TOUCH3, ADC1_CH2
C13	GPIO4	Digital I/O Analog	RTC_GPIO4, GPIO4, TOUCH4, ADC1_CH3
C14	GND	Ground Pin	Connect to ground
D1	GND	Ground Pin	Connect to ground
D11	GPIO5	Digital I/O Analog	RTC_GPIO5, GPIO5, TOUCH5, ADC1_CH4
D12	GND	Ground Pin	Connect to ground

No.	Pin Name	Pin Type	Description
D13	GPIO6	Digital I/O Analog	RTC_GPIO6, GPIO6, TOUCH6, ADC1_CH5
D14	GND	Ground Pin	Connect to ground
E1	MTCK	Digital I/O	MTCK, GPIO39, CLK_OUT3
E11	GPIO7	Digital I/O Analog	RTC_GPIO7, GPIO7, TOUCH7, ADC1_CH6
E12	GPIO8	Digital I/O Analog	RTC_GPIO8, GPIO8, TOUCH8, ADC1_CH7
E13	GPIO9	Digital I/O Analog	RTC_GPIO9, GPIO9, TOUCH9, ADC1_CH8, FSPIHD
E14	GND	Ground Pin	Connect to ground
F1	MTDO	Digital I/O	MTDO, GPIO40, CLK_OUT2
F11	GPIO11	Digital I/O Analog	RTC_GPIO11, GPIO11, TOUCH11, ADC2_CH0, FSPID, FSPIIO5
F12	GND	Ground Pin	Connect to ground
F13	GPIO10	Digital I/O Analog	RTC_GPIO10, GPIO10, TOUCH10, ADC1_CH9, FSPICS0, FSPIIO4
F14	GND	Ground Pin	Connect to ground
G1	MTDI	Digital I/O	MTDI, GPIO41, CLK_OUT1
G11	GPIO14	Digital I/O	RTC_GPIO14, GPIO14, TOUCH14, ADC2_CH3, FSPIWP, FSPIDQS
G12	GPIO13	Digital I/O Analog	RTC_GPIO13, GPIO13, TOUCH13, ADC2_CH2, FSPIQ, FSPIIO7
G13	GPIO12	Digital I/O Analog	RTC_GPIO12, GPIO12, TOUCH12, ADC2_CH1, FSPICLK, FSPIIO6
G14	GND	Ground Pin	Connect to ground
H1	MTMS	NC	MTMS, GPIO42
H2	NC	NC	Do not connect
H3	NC	NC	Do not connect
H4	NC	NC	Do not connect
H5	NC	NC	Do not connect
H6	GPIO20	Digital I/O Analog	RTC_GPIO20, GPIO20, U1CTS, ADC2_CH9, CLK_OUT1, USB_D+
H7	GPIO19	Digital I/O Analog	RTC_GPIO19, GPIO19, U1RTS, ADC2_CH8, CLK_OUT2, USB_D-

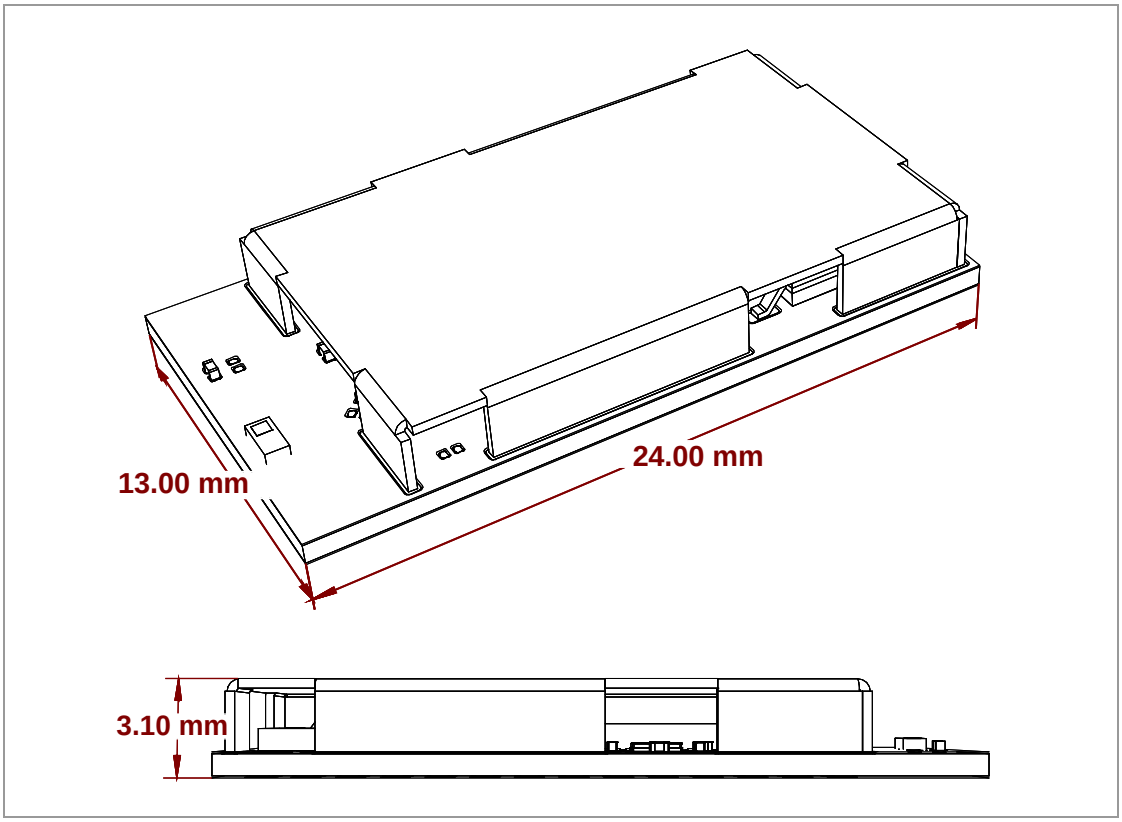
No.	Pin Name	Pin Type	Description
H8	GND	Ground Pin	Connect to ground
H9	GND	Ground Pin	Connect to ground
H10	GND	Ground Pin	Connect to ground
H11	GPIO21	Digital I/O	RTC_GPIO21, GPIO21
H12	GND	Ground Pin	Connect to ground
H13	GND	Ground Pin	Connect to ground
H14	GND	Ground Pin	Connect to ground
I1	GND	Ground Pin	Connect to ground
I2	NC	NC	Do not connect
I3	GND	Ground Pin	Connect to ground
I4	V_{DD}	Supply Pin	Connect to 3.3 V
I5	V_{DD}	Supply Pin	Connect to 3.3 V
I6	GND	Ground Pin	Connect to ground
I7	DAC 2	Digital I/O Analog	RTC_GPIO18, GPIO18, U1RXD, ADC2_CH7, DAC_2, CLK_OUT3
I8	DAC 1	Digital I/O Analog	RTC_GPIO17, GPIO17, U1TXD, ADC2_CH6, DAC_1
I9	XTAL_32K_N	Digital I/O Analog	RTC_GPIO16, GPIO16, U0CTS, ADC2_CH5, XTAL_32K_N
I10	XTAL_32K_P	Digital I/O Analog	RTC_GPIO15, GPIO15, U0RTS, ADC2_CH4, XTAL_32K_P
I11	GPIO0	Digital I/O	RTC_GPIO0, GPIO0 (strapping pin to configure boot or download mode) **Note**: Do not connect or pull high for boot mode ⇨ 4.3.5 Strapping Pins.
I12	GND	Ground Pin	Connect to ground
I13	RF pad	RF I/O	The RF signal can be routed to this pin by setting SPDT1 to a low and SPDT2 to a high level.
I14	GND	Ground Pin	Connect to ground
GT1	Thermal GND	Ground Pin	Connect to ground for heat dissipation
GT2	Thermal GND	Ground Pin	Connect to ground for heat dissipation
GT3	Thermal GND	Ground Pin	Connect to ground for heat dissipation
GT4	Thermal GND	Ground Pin	Connect to ground for heat dissipation
GT5	Thermal GND	Ground Pin	Connect to ground for heat dissipation
GT6	Thermal GND	Ground Pin	Connect to ground for heat dissipation

2.3 WLAN Features

Type	Features
IEEE 802.11/Standards	• 802.11 data rates: 1 Mbps and 2 Mbps (DSSS) • 802.11b data rates: 5.5 Mbps and 11 Mbps (CCK) • 802.11g data rates: 6, 9, 12, 18, 24, 36, 48, and 54 Mbps (OFDM) • 802.11n compliant with maximum data rates: up to 72 Mbps (20 MHz channel) and 150 Mbps (40 MHz channel) • 802.11n MCS32 (HT duplicate) • 802.11mc Fine Time Measurement (FTM) • Supports clients (stations) implementing IEEE Power Save mode • Wi-Fi direct connectivity
WLAN MAC	• Simultaneous Soft-AP and Infrastructure Station modes • Distributed Control Function (DCF) • Request to Send (RTS) and Clear to Send (CTS) and immediate Block Acknowledgement (BA or Block ACK) • 4× virtual Wi-Fi interfaces • Fragmentation and defragmentation • Aggregated Mac Protocol Data Unit (A-MPDU) for Rx and Tx • Aggregated Mac Service Data Unit (A-MSDU) for Rx • Transmission Opportunity (TXOP) • Wi-Fi Multimedia (WMM) • CCMP, TKIP, WAPI, WEP, BIP • Automatic beacon monitoring/hardware Time Synchronization Function (TSF)
WLAN Baseband and Radio	• 802.11n 1x1 SISO (WLAN SoC with SISO RF radio) • PHY data rates: up to 150 Mbps • Short guard interval (0.4 µs) • 20 MHz and 40 MHz bandwidth/channel • Modulation and Coding Scheme MCS 0~7 • Radio resource measurement • Space Time Block Coding (STBC) with one spatial stream reception • MCS32 (HT duplicate) • Automatic Gain Control (AGC) • Direct conversion radio (no need for external SAW filter)
WLAN Encryption	• Embedded WLAN Radio SoC with the following features: • Advanced Encryption Standard (AES) – 128/192/256 bit (hardware accelerated) • Counter Mode with CBC-MAC Protocol (CCMP) • Temporary Key Integrity Protocol (TKIP) • WLAN Authentication and Privacy Infrastructure (WAPI) • Wired Equivalent Privacy (WEP) • Broadcast/Multitask Integrity Protocol (BIP)

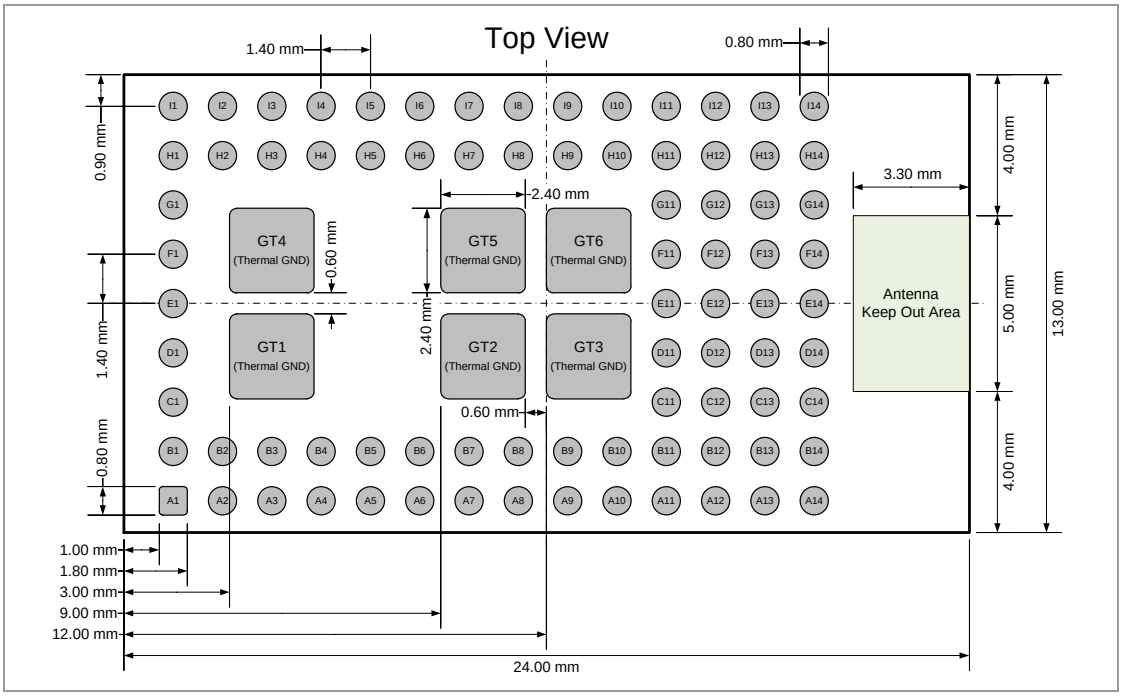
3 Detailed Description

3.1 Dimensions



No.	Item	Dimension (mm)	Tolerance (mm)	Remark
1	Width	13.00	±0.35	
2	Length	24.00	±0.35	
3	Height	3.10	±0.20	With case

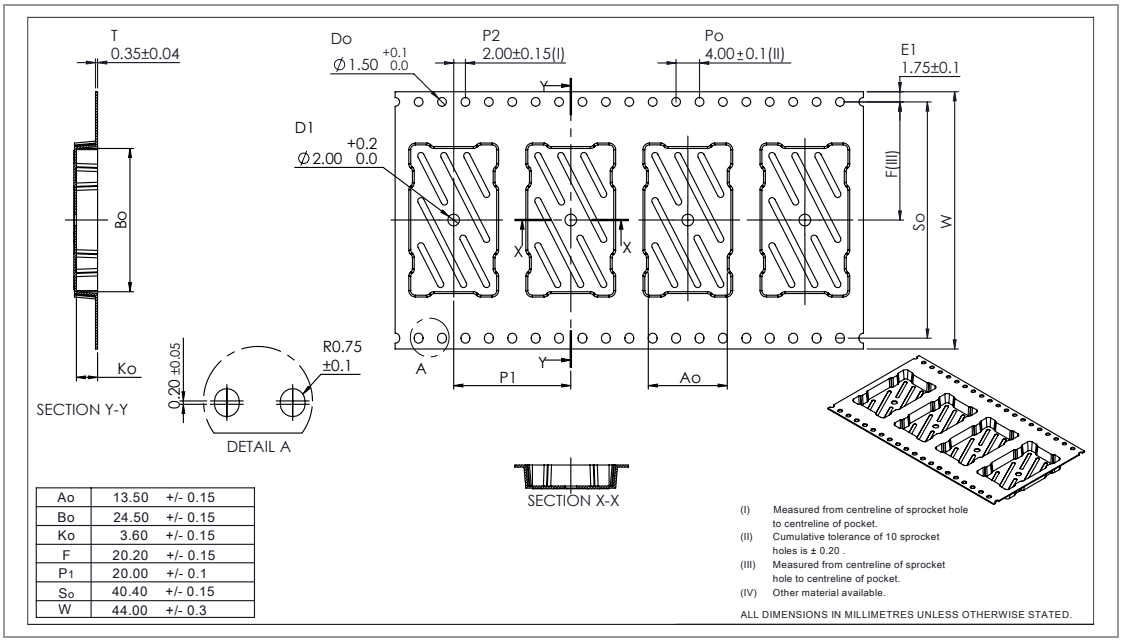
3.2 Footprint



3.3 Packaging

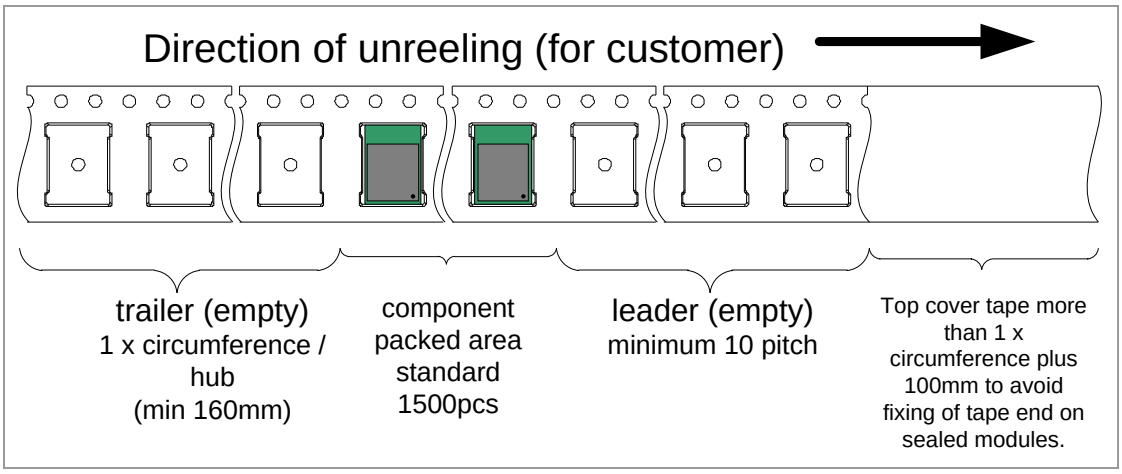
The module is a mass production status product and will be delivered in the package described below.

3.3.1 Tape Dimensions



Ao	13.50	+/- 0.15
Bo	24.50	+/- 0.15
Ko	3.60	+/- 0.15
F	20.20	+/- 0.15
P_1	20.00	+/- 0.1
S_o	40.40	+/- 0.15
W	44.00	+/- 0.3

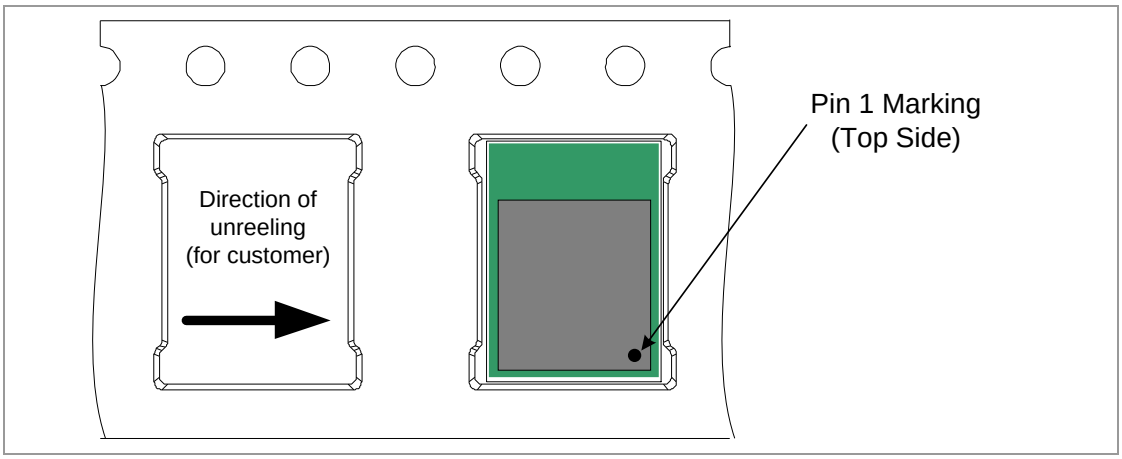
3.3.2 Packing in Tape



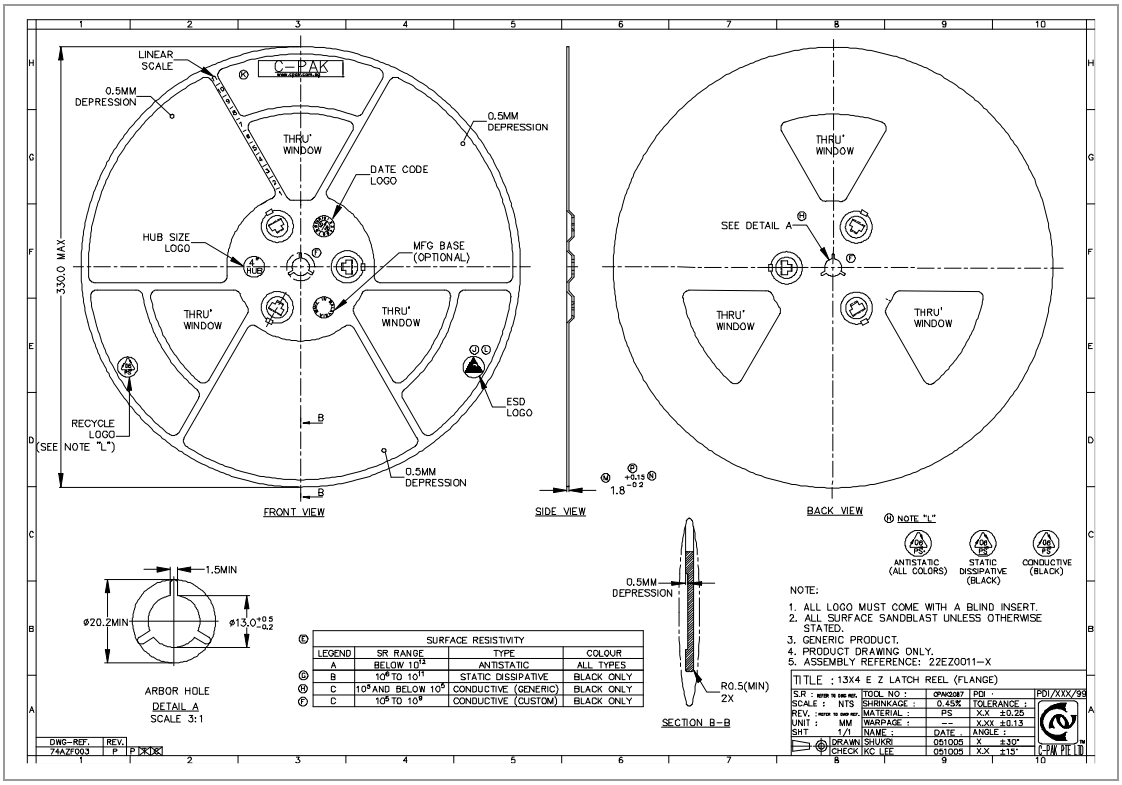
Empty spaces in the component packed area shall be less than two per reel and those spaces shall not be consecutive.

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

3.3.3 Component Direction

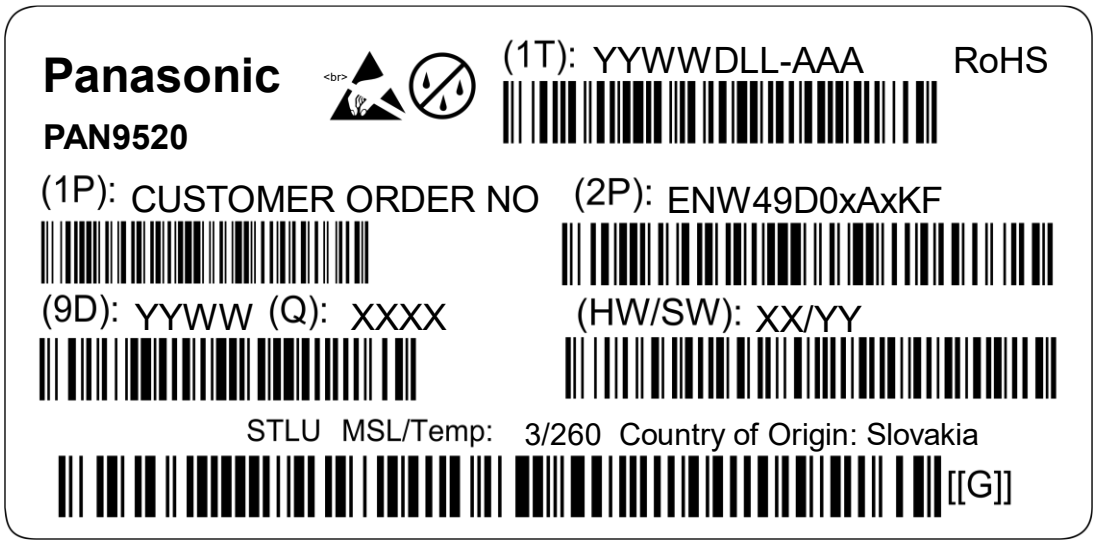


3.3.4 Reel Dimension



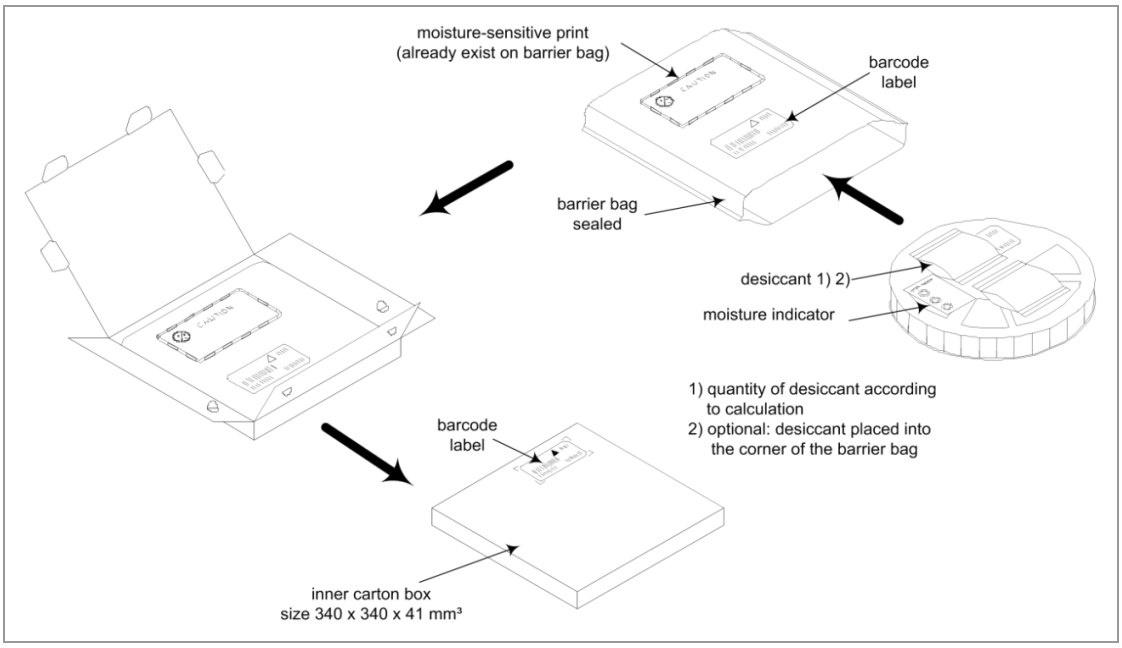
3.3.5 Package Label

Example:



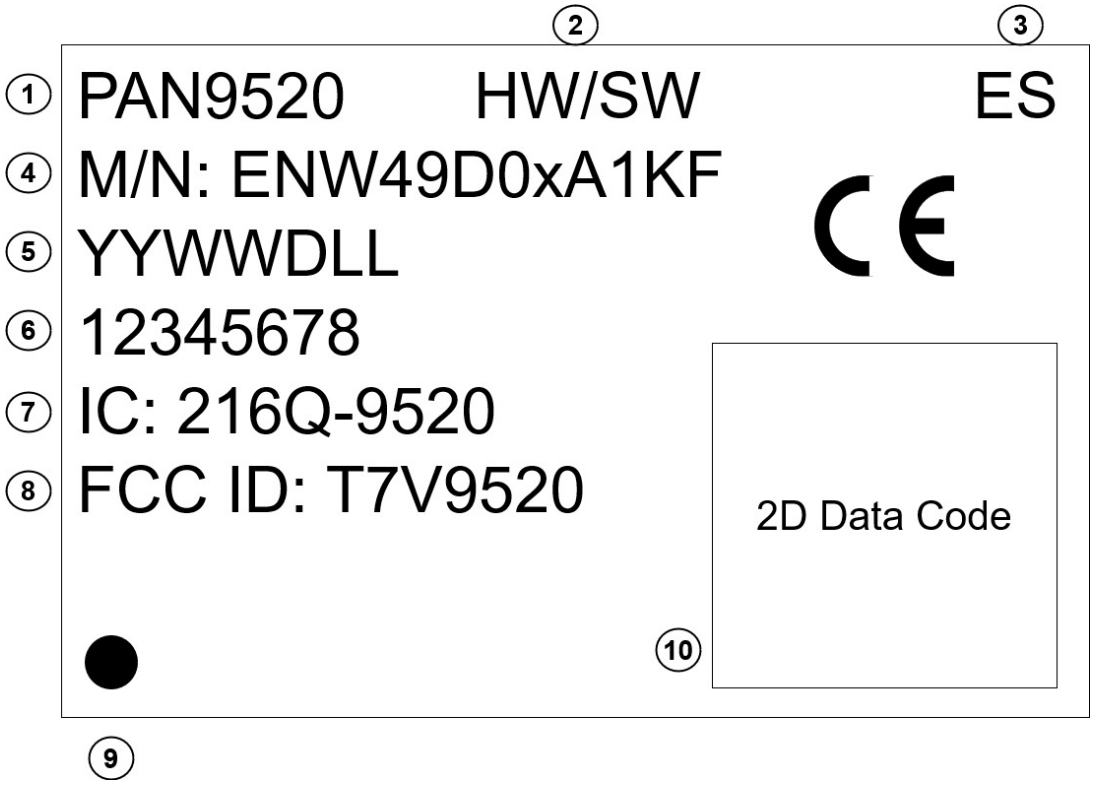
(1T)	Lot code
(1P)	Customer order number, if applicable
(2P)	Order number
(9D)	Date code
(Q)	Quantity
(HW/SW)	Hardware/software version

3.3.6 Total Package



3.4 Case Marking

Example:



1	Brand name
2	Hardware/software version
3	Engineering Sample (optional)
4	Model Name/ENW number
5	Lot code
6	Serial number
7	IC Canada
8	FCC ID
9	Marking for Pin 1
10	2D barcode, for internal usage only

4 Specification

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

4.1 Default Test Conditions

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

4.2 Absolute Maximum Ratings

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

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
T_{STOR}	Storage Temperature		-40		85	°C
V_{ESD}	ESD Robustness	All pads, according to human body model (HBM), JEDEC STD 22, method A114			1 000	V
		According to charged device model (CDM), JEDEC STD 22, method C101			500	V
PRF	RF Input Level	11b, 1 Mbps			5	dBm
		11b, 11 Mbps			5	dBm
		11g, 6 Mbps			5	dBm
		11g, 54 Mbps			0	dBm
		11n, HT20, MCS0			5	dBm
		11n, HT20, MCS7			0	dBm
		11n, HT40, MCS0			5	dBm
		11n, HT40, MCS7			0	dBm
$V_{DD\ MAX}$	Maximum Voltage	Maximum power supply voltage from any pin with respect to V_{SS} (GND)	-0.3		3.6	V

4.3 Recommended Operating Conditions

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

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
T_A	Ambient Operating Temperature Range	Industrial grade	-40		85	°C
V_{DD}			3	3.3	3.6	V

4.3.1 Digital Pin Characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V_{IH}	High Level Input Voltage	3.3 V operation (V_{IO}=V_{DD})	0.75 V_{DD}		V_{DD} + 0.3	V
V_{IL}	Low Level Input Voltage	3.3 V operation (V_{IO}=V_{DD})	-0.3		0.25 V_{DD}	V
I_{IH}	High Level Input Current				50	nA
I_{IL}	Low Level Input Current				50	nA
V_{OH}	High Level Output Voltage	Measured on high-impedance load	0.8 V_{DD}			V
V_{OL}	Low Level Output Voltage	Measured on high-impedance load			0.1 V_{DD}	
I_{OH} at V_{OH} >= 2.64 V	High Level Output Current	3.3 V operation (V_{IO}=V_{DD}), Pin is current source		40		mA
I_{OL} at 0.495 V	Low Level Output Current	3.3 V operation (V_{IO}=V_{DD}); Pin is current sink		28		mA
RPU	Internal Pull-Up Resistance	Except pins SPDT1 and SPDT2		45		kΩ
RPD	Internal Pull-Down Resistance	Except pins SPDT1 and SPDT2		45		kΩ
VIH_nRST	Chip Reset Release Voltage	CHIP_PU (pin A12) = nRST pin	0.75 V_{DD}		V_{DD} + 0.3	V
VIL_nRST	Chip Reset Voltage	CHIP_PU (pin A12) = nRST pin	-0.3		0.25 V_{DD}	V

4.3.2 Module Selectable RF In/Output

The module's RF-output can be switched between the on-board ceramic chip antenna and the 50 Ω RF-pad (pin I13) output by adjusting the voltage level on pin B12 (SPDT2) and pin B13 (SPDT1). If pin B12 and pin B13 are not connected (NC), the on-board ceramic chip antenna will be fed. This default configuration is applied by internal 100 kΩ pull-resistors.

RF In/Output	Pin B12 (SPDT2)	Pin B13 (SPDT1)
On-board ceramic chip antenna output	NC or 3 V to 3.6 V (typ. 3.3 V)	NC or GND (0 V)
Module 50 Ω RF-pad (pin I13)	GND (0 V)	3 V to 3.6 V (typ. 3.3 V)

4.3.3 Internal Operating Frequencies

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
fSYSCLK1	CPU/System/ Encryption Clock Speed				240	MHz
fREFCLK1	WLAN/MCU Crystal Fundamental Frequency	Frequency tolerance < ±25 ppm over operating temperature and process		40		MHz

4.3.4 Power up Sequence and Reset

Pull-Resistors on strapping Pins are needed at Power-up

Please note that the default boot settings that are applied by ESP32-S2 internal pull resistors, do not work when the module is powered up.

Permanent pull resistors may be needed in the end product!

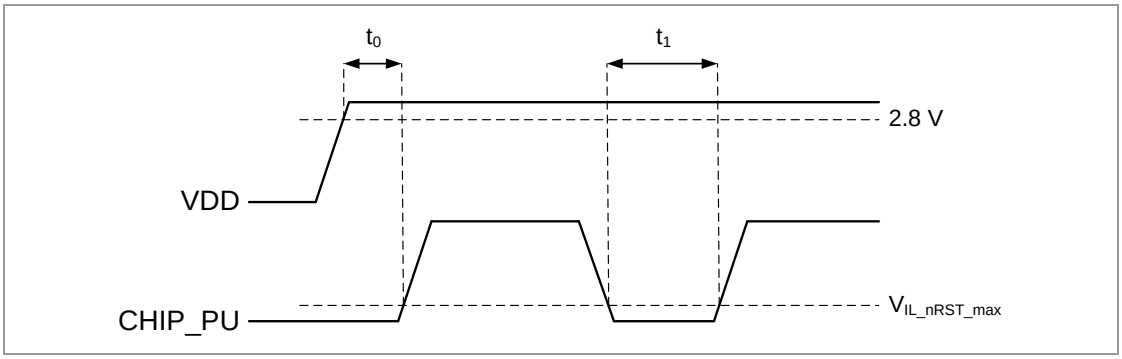
Please follow the described power up sequence, when powering the device.

Make sure that the reset signal is active (CHIP_PU = low), when the module is powered. After the supply voltage V_{DD} has risen to a level of 2.8 V and the time t_0 has passed, the reset signal can be activated (voltage on CHIP_PU >= $V_{IL\_nRST\_max}$ = 0.25 V_{DD}).

If the device is active, this can be reset by activating the reset signal (CHIP_PU = low → CHIP_PU = high).

Please note that CHIP_PU must be low (voltage below $V_{IL\_nRST\_max}$) for at least t_1 to reset the chip.

For specifications of V_{IL_nRST} please refer to ⇨ 4.3.1 Digital Pin Characteristics.



Parameter	Condition	Min.	Typ.	Max.	Unit
t_0	Time period from power up until CHIP_PU activated	0.5			ms
t_1	Time period, in which the reset signal must be active (CHIP_PU low) to reset the device.	0.5			ms

4.3.5 Strapping Pins

Pull-Resistors on strapping Pins needed at Power-up

Please note that the default settings that are applied by ESP32-S2 internal pull resistors, do not work when the module is powered up.

Permanent pull resistors may be needed in the end product!

Three pins of the PAN9520 are evaluated at boot-up to set up the module's mode and behavior. These pins are called "strapping pins". This section explains their function in more detail.

The three mentioned strapping pins are GPIO0, GPIO45, and GPIO46. Their voltage level is captured during each reset and boot-up caused by one of the following sources: power-on-reset, RTC watchdog reset, brownout reset, analog super watchdog reset, and crystal clock glitch detection reset. The detected level of each strapping pin is written to the register GPIO_STRAPPING as zero (low level) or one (high level). The captured values are kept until the next reset. After boot-up, all strapping bits are available in the register GPIO_STRAPPING (read only) and thus the strapping pins can be used as usual pins.

Each strapping pin level can be set-up by applying an external voltage from a different I/O or a pull-resistor. Besides, weak chip-internal pull-resistors determine the default level of the pins at boot-up caused by a reset. Please note that the pull-resistors are activated too late if the module's power supply is switched on. Therefore, the module will start in download mode when the module is connected to the power supply and if no external pull resistors are used.

In the following, the strapping functionality and default level is described for each of the three pins.

GPIO0

GPIO0 determines, if the device does a normal boot and runs an application or if it enters the download mode, in which data can be written to the QSPI flash. Per default, the pin is set to “1” by a weak chip-internal pull-up resistor. This makes the device entering the usual boot mode. Applying a zero (low level) to the pin at boot-up makes the device entering the download mode.

GPIO45

Be aware that GPIO45 must be left open or pulled down at boot-up. Applying a high-level voltage causes malfunction of the PAN9520 device.

GPIO45 determines the voltage of the QSPI Flash and PSRAM. The mounted QSPI memories expect a voltage of 3.3 V. This is applied, if GPIO45 is set to a low level at boot-up. This is done by a chip-internal weak pull-down resistor. Therefore, the pin must be left open or pulled to ground at boot-up. A high level on GPIO45 at boot-up causes malfunction of the PAN9520 module.

Please note that the functionality of GPIO45 can be disabled by setting the eFuse bit VDD_SPI_FORCE (OTP) to “1”. In this case, the voltage is defined by the eFuse bit VDD_SPI_TIEH (OTP).

GPIO46

Be aware that applying a high level to GPIO46 will trigger unexpected behavior, if GPIO0 is set to a low level (download mode).

The pre-installed first stage bootloader of the ESP32-S2 can print several information, when running. The values of eFuse UART_PRINT_CONTROL (OTP) and GPIO46 determine if this functionality is enabled. The different configurations are explained in the following:

Value of UART_PRINT_CONTROL	Value of GPIO46	Print Setting
0	-	Printing during boot-up is enabled.
1	0	Printing during boot-up is enabled.
	1	Printing during boot-up is disabled.
2	0	Printing during boot-up is disabled.
	1	Printing during boot-up is enabled.
3	-	Printing during boot-up is disabled.

The value of UART_PRINT_CONTROL is zero at delivery of the module. Therefore, the level on GPIO46 at boot-up has not any effect if the device is in boot mode (GPIO0=low). Anyway, if the device is started in download mode (GPIO=high), the level on GPIO46 must be a low level.

Please note that the chip-internal weak pull-down resistor makes the strapping bit to be low, if the pin is left open.

Summary

The following table summarizes the description that has been made previously:

Pin	Default	Level during boot	Description
GPIO0	Pull-up (one)	Low (zero)	Download mode (Flash memory can be written)
		High (one)	Boot mode (device continues booting an application)
GPIO45	Pull-down (zero)	Low (zero)	QSPI memory is powered by 3.3 V
		High (one)	QSPI memory is powered by 1.8 V (not allowed)
GPIO46	Pull-down (zero)	Low (zero)	Please see the previous table (GPIO46).
		High (one)	Please see the previous table (GPIO46) (not allowed in download mode).

4.4 Current Consumption

The current consumption depends on the user scenario and on the setup and timing in the power modes.

Assume V_{DD}=3.3 V, T_{amb}=25 °C, if nothing else stated.

Parameter	Condition	Min.	Typ.	Max.	Unit
Active Transmit	802.11b, 20 MHz, 1 Mbps at 19.5 dBm		255		mA
	802.11b, 20 MHz, 11 Mbps at 19.5 dBm		260		mA
	802.11g, 20 MHz, 54 Mbps at 15 dBm		187		mA
	802.11n, 20 MHz, MCS7 at 13 dBm		175		mA
	802.11n, 40 MHz, MCS7 at 13 dBm		180		mA
Active Receive	802.11bgn, 20 MHz		73		mA
	802.11n, 40 MHz		76		mA
Modem-sleep (IEEE power save mode)	CPU at 80 MHz		12		mA

Parameter	Condition	Min.	Typ.	Max.	Unit
Light-sleep	ENW49D01A1KF with SPI Flash and PSRAM powered		1.1		mA
	ENW49D02A1KF with SPI Flash powered		0.95		mA
Deep-sleep	RTC timer only		26		µA
Disabled	CHIP PU (A12) is set to low level		5		µA

4.5 RF Electrical Characteristics

4.5.1 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 at MCS0~7
Physical Layer Data Rates	IEEE 802.11				1 and 2 Mbps at DSSS
	IEEE 802.11b				5.5 and 11 Mbps at 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, and 65 Mbps
				SGI	7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65, and 72.2 Mbps
			HT40	LGI	13.5, 27, 40.5, 54, 81, 108, 121.5, and 135 Mbps
				SGI	15, 30, 45, 60, 90, 120, 135, and 150 Mbps
Supported Bandwidth (BW)	IEEE 802.11n				20 MHz (HT20), 40 MHz (HT40)
Supported Guard Interval	IEEE 802.11n				400 ns (SGI), 800 ns (LGI)
Supported Channel 2.4 GHz[3]	IEEE 802.11 b/g/n		North America (US)		1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
			Canada (CA)		1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
			Europe (EU)		1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

[3] To comply with the relevant regulatory requirements, please refer to the “PAN9520 Module Integration Guide”.

4.5.2 WLAN RF Characteristics

4.5.2.1 IEEE 802.11b (RF Characteristics)

Assume V_{DD}=3.3 V, T_{amb}=25 °C, if nothing else stated.

50 Ω terminal load connected to the RF connector.

Parameter		Condition	Min.	Typ.	Max.	Unit
RF Frequency Range			2 400		2 483.5	MHz
Carrier Frequency Tolerance			-25		+25	ppm
Transmit Output Power				+18[4]	+19.5	dBm
Spectrum Mask	fC±11 MHz				-30	dBr
	fC±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)	PER ≤ 10 %		-97	-86	dBm
	2 Mbps (DSSS)	PER ≤ 10 %		-94	-83	dBm
	5.5 Mbps (CCK)	PER ≤ 10 %		-92	-79	dBm
	11 Mbps (CCK)	PER ≤ 10 %		-88	-76	dBm
Maximum Input Level					5	dBm
Adjacent Channel Rejection		PER ≤ 8 %	35			dB

4.5.2.2 IEEE 802.11g (RF Characteristics)

Assume V_{DD}=3.3 V, T_{amb}=25 °C, if nothing else stated.

50 Ω terminal load connected to the RF connector.

Parameter		Condition	Min.	Typ.	Max.	Unit
RF Frequency Range			2 400		2 483.5	MHz
Carrier Frequency Tolerance			-25		+25	ppm

[4] The output power must be limited by following the instructions of the module integration guide to keep the modular approval valid. The power limit depends on the region the end production is operated in.

Parameter		Condition	Min.	Typ.	Max.	Unit
Transmit Output Power	6 Mbps~18 Mbps			+16[5]	+18	dBm
	24 Mbps~36 Mbps			+16[5]	+17	dBm
	48 Mbps			+16[5]	+16	dBm
	54 Mbps			+15[5]	+15	dBm
Spectrum Mask	fC±11 MHz				-20	dBr
	fC±20 MHz				-28	dBr
	fC±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 %		-92	-82	dBm
	BPSK, CR 3/4 (9 Mbps)	PER ≤ 10 %		-91	-81	dBm
	QPSK, CR 1/2 (12 Mbps)	PER ≤ 10 %		-89	-79	dBm
	QPSK, CR 3/4 (18 Mbps)	PER ≤ 10 %		-87	-77	dBm
	16-QAM, CR 1/2 (24 Mbps)	PER ≤ 10 %		-84	-74	dBm
	16-QAM, CR 3/4 (36 Mbps)	PER ≤ 10 %		-80	-70	dBm
	64-QAM, CR 2/3 (48 Mbps)	PER ≤ 10 %		-76	-66	dBm
	64-QAM, CR 3/4 (54 Mbps)	PER ≤ 10 %		-74	-65	dBm
Maximum Input Level	BPSK, CR 1/2 (6 Mbps)				5	dBm
	64-QAM, CR 3/4 (54 Mbps)				0	dBm
Adjacent Channel Rejection	BPSK, CR 1/2 (6 Mbps)	PER ≤ 10 %	16	31		dB
	64-QAM, CR 3/4 (54 Mbps)	PER ≤ 10 %	-1	14		dB

4.5.2.3 IEEE 802.11n: BW 20 MHz (RF Characteristics)

Assume V_{DD}=3.3 V, T_{amb}=25 °C, if nothing else stated.

50 Ω terminal load connected to the RF connector.

[5] The output power must be limited by following the instructions of the module integration guide to keep the modular approval valid. The power limit depends on the region the end production is operated in.

Parameter		Condition	Min.	Typ.	Max.	Unit
RF Frequency Range			2 400		2 483.5	MHz
Carrier Frequency Tolerance			-25		+25	ppm
Transmit Output Power	MCS0~MCS2			+16[6]	+18	dBm
	MCS3~MCS4			+16[6]	+17	dBm
	MCS5			+16[6]	+16	dBm
	MCS6			+15[6]	+15	dBm
	MCS7			+13[6]	+13.5	dBm
Spectrum Mask	fC±11 MHz				-20	dBr
	fC±20 MHz				-28	dBr
	fC±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[7]	6.5 Mbps (MCS0)	PER ≤ 10 %		-92	-82	dBm
	13 Mbps (MCS1)	PER ≤ 10 %		-88	-79	dBm
	19.5 Mbps (MCS2)	PER ≤ 10 %		-85	-77	dBm
	26 Mbps (MCS3)	PER ≤ 10 %		-83	-74	dBm
	39 Mbps (MCS4)	PER ≤ 10 %		-79	-70	dBm
	52 Mbps (MCS5)	PER ≤ 10 %		-75	-66	dBm
	58.5 Mbps (MCS6)	PER ≤ 10 %		-74	-65	dBm
	65 Mbps (MCS7)	PER ≤ 10 %		-72	-64	dBm
Maximum Input Level	6.5 Mbps (MCS7)				5	dBm
	65 Mbps (MCS7)				0	dBm
Adjacent Channel Rejection[8]	6.5 Mbps (MCS7)	PER ≤ 10 %	-2	31		dB
	65 Mbps (MCS7)	PER ≤ 10 %	-2	13		dB

[6] The output power must be limited by following the instructions of the module integration guide to keep the modular approval valid. The power limit depends on the region the end production is operated in.

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

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

4.5.2.4 IEEE 802.11n: BW 40 MHz (RF Characteristics)

Assume V_{DD}=3.3 V, T_{amb}=25 °C, if nothing else stated.

50 Ω terminal load connected to the RF connector.

Parameter		Condition	Min.	Typ.	Max.	Unit
RF Frequency Range			2 400		2 483.5	MHz
Carrier Frequency Tolerance			-25		+25	ppm
Transmit Output Power	MCS0~MCS2			+16[9]	+18	dBm
	MCS3~MCS4			+16[6]	+17	dBm
	MCS5			+16[6]	+16	
	MCS6			+15[6]	+15	
	MCS7			+13[6]	+13.5	
Spectrum Mask	fC±21 MHz				-20	dBr
	fC±40MHz				-28	dBr
	fC±60 MHz				-45	dBr
Transmitter Center Frequency Leakage					-20	dB
Transmitter Spectral Flatness			-4		+4	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[10]	13.5 Mbps (MCS0)	PER ≤ 10 %		-89	-79	dBm
	27 Mbps (MCS1)	PER ≤ 10 %		-86	-76	dBm
	40.5 Mbps (MCS2)	PER ≤ 10 %		-83	-74	dBm
	54 Mbps (MCS3)	PER ≤ 10 %		-80	-71	dBm
	81 Mbps (MCS4)	PER ≤ 10 %		-76	-67	dBm
	108 Mbps (MCS5)	PER ≤ 10 %		-72	-63	dBm
	121.5 Mbps (MCS6)	PER ≤ 10 %		-71	-62	dBm

[9] The output power must be limited by following the instructions of the module integration guide to keep the modular approval valid. The power limit depends on the region the end production is operated in.

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

Parameter		Condition	Min.	Typ.	Max.	Unit
	135 Mbps (MCS7)	PER ≤ 10 %		-69	-61	dBm
Maximum Input Level	13.5 Mbps (MCS0)				5	dBm
	135 Mbps (MCS7)				0	dBm
Adjacent Channel Rejection[11]	13.5 Mbps (MCS0)	PER ≤ 10 %	-2	19		dB
	135 Mbps (MCS7)	PER ≤ 10 %	-2	8		dB

4.6 Reliability Tests

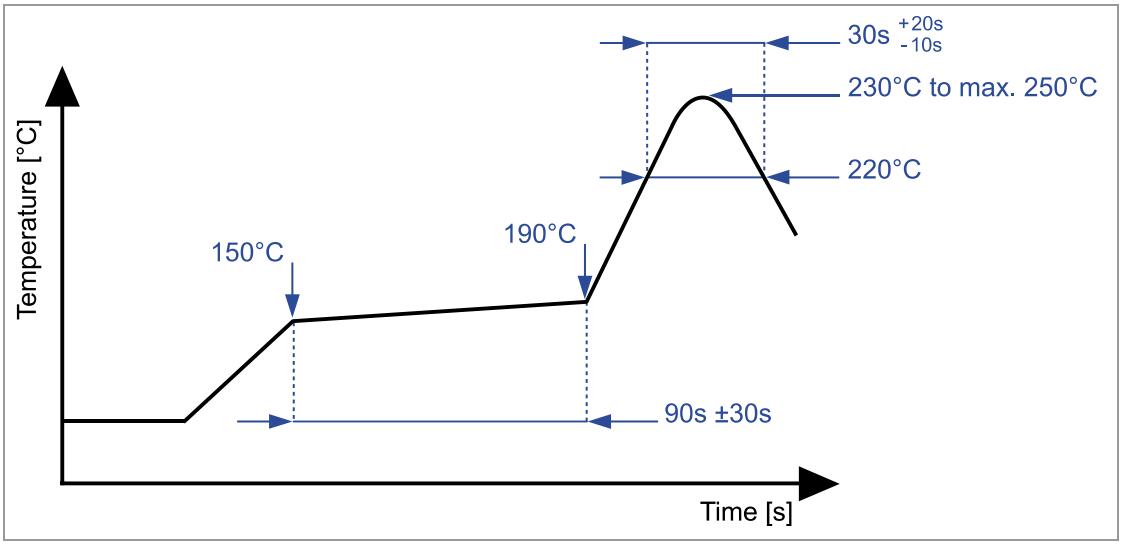
The measurement should be done after the test device has been exposed to room temperature and humidity for one hour.

No.	Item	Limit	Condition
1	Vibration test	Electrical parameters are in specification	Acc.: 17 G to 50 G, Freq. = 20 – 2 000 Hz - 20 Hz, Sweep Duration = 8 min, Total Duration = 20 hrs./axis
2	Shock test		Dropped onto concrete from a height of 1 m for 3 times (each side)
3	Heat shock cycle test		-40 °C and +85 °C for 300 cycles each 30 min.
4	Temperature humidity bias test (THB)		+85 °C, 85 % RH, 500 h
5	Low temperature storage test (LTST)		-40 °C, 300 h
6	High temperature storage test (HTST)		+85 °C, 300 h

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

4.7 Recommended Soldering Profile

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



5 Cautions

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

5.1 Design Notes

1. Follow the conditions written in this specification, especially the control signals of this module.
2. The supply voltage should abide by the maximum ratings (⇨ 4.2 Absolute Maximum Ratings).
3. The supply voltage must be free of AC ripple voltage (for example from a battery or a low noise regulator output). For noisy supply voltages, provide a decoupling circuit (for example a ferrite in series connection and a bypass capacitor to ground of at least 47 µF directly at the module).
4. This module should not be mechanically stressed when installed.
5. Keep this module away from heat. Heat is the major cause of decreasing the life time of these modules.
6. Avoid assembly and use of the target equipment in conditions where the module temperature may exceed the maximum tolerance.
7. Keep this module away from other high frequency circuits.
8. Refer to the recommended pattern when designing a board.

5.2 Installation Notes

1. Reflow soldering is possible twice based on the conditions set forth in ⇨ 4.7 Recommended Soldering Profile. Set up the temperature at the soldering portion of this module according to this reflow profile.
2. Carefully position the module so that the heat will not burn into printed circuit boards or affect other components that are susceptible to heat.
3. Carefully locate the module, to avoid an increased temperature caused by heat generated by neighboring components.
4. If a vinyl-covered wire comes into contact with the module, the wire cover will melt and generate toxic gas, damaging the insulation. Never allow contact between a vinyl cover and these modules to occur.
5. This module should not be mechanically stressed or vibrated when reflowed.
6. To repair the board by hand soldering, follow the conditions set forth in this chapter.
7. Do not wash this product.
8. Pressing on parts of the metal cover or fastening objects to the metal will cause damage to the module.

5.3 Usage Condition Notes

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

5.4 Storage Notes

1. The module should not be stressed mechanically during storage.
2. Do not store these modules in the following conditions or the performance characteristics of the module, 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, or where the humidity may be outside the 45 % to 85 % range,
   - Storage of the modules 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 module away from water, poisonous gas, and corrosive gas.
4. This module should not be stressed or shocked when transported.
5. Follow the specification when stacking packed crates (max. 10).

5.5 Safety Cautions

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

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

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

5.6 Other Cautions

1. Do not use the module for other purposes than those listed in section ⇨ 5.3 Usage Condition Notes.
2. Be sure to provide an appropriate fail-safe function on your product to prevent any additional damage that may be caused by the abnormal function or the failure of the module.
3. This module has been manufactured without any ozone chemical controlled under the Montreal Protocol.
4. These modules are not intended for use under the special conditions shown below. Before using these modules under such special conditions, carefully check their performance and reliability under the said special conditions to determine whether or not they can be used in such a manner:
   - In liquid, such as water, salt water, oil, alkali, or organic solvent, or in places where liquid may splash,
   - In direct sunlight, outdoors, or in a dusty environment,
   - In an environment where condensation occurs,
   - In an environment with a high concentration of harmful gas (e. g. salty air, HCl, Cl2, SO2, H2S, NH3, and NOX).
5. If an abnormal voltage is applied due to a problem occurring in other components or circuits, replace these modules with new modules, because they may not be able to provide normal performance even if their electronic characteristics and appearances appear satisfactory.

For further information please refer to the Panasonic website ⇨ 7.2.2 Product Information.

5.7 Restricted Use

5.7.1 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.

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

5.7.2 Restricted End Use

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

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

6 Regulatory and Certification Information

6.1 General Certification Information

For further certification requests for other radio software please contact Panasonic ⇨ 7.2 Contact Details.

6.2 Federal Communications Commission (FCC) for US

6.2.1 FCC Notice

The PAN9520, including the ceramic antenna (ENW49D01A1KF and ENW49D02A1KF) and the antennas, which are listed in ⇨ 6.2.5 Approved Antenna List, complies with Part 15 of the FCC Rules.

The device meets the requirements for modular transmitter approval as detailed in FCC public Notice DA00-1407. The transmitter 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.

6.2.2 Caution

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Panasonic Industrial Devices Europe GmbH may void the user's authority to operate the equipment.

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.

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.

6.2.3 Label Requirements

The OEM must ensure that FCC labelling requirements are met. This includes a clearly visible label (laser marking) on the outside of the OEM enclosure specifying the appropriate Panasonic FCC identifier for this product as well as the FCC Notice above.

The FCC identifier is **FCC ID: T7V9520**

This FCC identifier is valid for the PAN9520. The end product must in any case be labelled on the exterior with:

“Contains FCC ID: T7V9520”.

6.2.4 Antenna Warning

This antenna warning refers to the test device with the model number ENW49D01A1KF and ENW49D02A1KF in bottom pad mode ⇨ Module Selectable RF In/Output.

The device is tested with a standard SMA connector and with the antenna listed below. When integrated into the OEM’s product, these fixed antennas require installation preventing end users from replacing them with non-approved antennas. Any antenna not in the following table must be tested to comply with FCC Section 15.203 for unique antenna connectors and with Section 15.247 for emissions. The FCC identifier for the device with the antenna listed in ⇨ 6.2.5 Approved Antenna List is the same (**FCC ID: T7V9520**).

6.2.5 Approved Antenna List

Item	Part Number	Manufacturer	Type	Polarization	Frequency Band	Gain (dBi)	
						Min	Peak
1	ANT016008LCS2442MA1	TDK	Chip Antenna	Linear	2.400 GHz to 2.484 GHz	-46.1	1.6

6.2.6 RF Exposure

To comply with FCC RF Exposure requirements, the OEM must ensure that only antennas from the Approved Antenna List are installed ⇨ 6.2.5 Approved Antenna List.

The preceding statement must be included as a caution statement in manuals for products operating with the approved 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 the PAN9520 with a mounted ceramic chip antenna (**FCC ID: T7V9520**) are fulfilled for mobile configuration. The installation of the module is restricted to mobile host devices. The PAN9520 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.

6.2.7 Integration Instructions

This chapter gives integration instructions for host product manufacturers according to “KDB 996369 D03 OEM Manual v01”.

Section	Topic and Comment	
2.2	**List of applicable FCC rules**	
	47 CFR Section	Part 15C
	Frequency Band (MHz)	2 400 to 2 483.5
	Systems	Digital Transmission Systems operating within the 2 400 MHz to 2 483.5 MHz Band
	Reference/Requirement	15.247(a)(2), 15.247(b)(1), 15.207, 15.247(d), 15.247(e)
	Complied Module M/N	ENW49D01A1KF, ENW49D02A1KF
2.3	**Summarize the specific operational use conditions**	
	Please refer to ⇨ 5 Cautions, ⇨ 5.3 Usage Condition Notes, and ⇨ 6.2.5 Approved Antenna List.	
2.4	**Limited module procedures**	
	Not applicable, the module has a single-modular transmitter approval.	

2.5	**Trace antenna designs**
	Not applicable, the module has a ceramic chip antenna. For guidance regarding the PCB layout requirements for module integration refer to the “Module Integration Guide” ⇨ 7.2.2 Product Information.
2.6	**RF exposure considerations**
	Mobile application, the end customer has to assure that the device has a distance of more than 20 cm from the human body under all circumstances.
2.7	**Antennas**
	Please refer to ⇨ 6.2.4 Antenna Warning and ⇨ 6.2.5 Approved Antenna List.
2.8	**Label and compliance information**
	Please refer to ⇨ 6.2.3 Label Requirements.
2.9	**Information on test modes and additional testing requirements**
	The documents for integration guidance and compliance testing are available here ⇨ 7.2.2 Product Information.
2.10	**Additional testing, Part 15 Subpart B disclaimer**
	The single-modular transmitter is FCC authorized for the specific rule parts listed at ⇨ List of applicable FCC rules. The host product manufacturer needs to also consider the FCC requirements for certified modular transmitter being used in the host product and maintain documentation on how the host product with the certified modular transmitter complies with the FCC rules. Host product manufacturers are responsible to follow the integration guidance and to perform a limited set of transmitter module verification testing, to ensure the end product is in compliance with the FCC rules. Also host product manufacturers are responsible for all additional equipment authorization and testing for technical requirements not covered by the module grant (e.g., unintentional radiator Part 15 Subpart B requirements, or transmitters used in the host that are not certified modules).

6.3 Innovation, Science, and Economic Development (ISED) for Canada

English

The PAN9520 is licensed to meet the regulatory requirements of ISED.

License ID: **IC: 216Q-9520**

HVIN: **ENW49D01A1KF**

ENW49D02A1KF

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 ⇨ 6.2.5 Approved Antenna List, having a maximum gain of 1.6 dBi for 2.4 GHz. Antennas not included in this list or having a gain greater than 1.6 dBi for 2.4 GHz 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.

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

If the end customer application intends to use the PAN9520 in a distance smaller 20 cm from the human body, SAR evaluation has to be repeated by the OEM.

The end customer equipment must meet the actual Safety/Health requirements according to ISED.

French

PAN9520 est garanti conforme aux dispositions règlementaires d'Industry Canada (ISED).

License: **IC: 216Q-9520**

HVIN: **ENW49D01A1KF**

ENW49D02A1KF

Il est recommandé aux fabricants d'appareils fixes, mobiles ou portables de consulter la réglementation en vigueur et de vérifier la conformité de leurs produits relativement aux limites d'exposition aux rayonnements radiofréquence ainsi qu'au débit d'absorption spécifique maximum autorisé.

Des informations pour les utilisateurs sur la réglementation Canadienne concernant l'exposition aux rayonnements RF sont disponibles sur le site www.ic.gc.ca.

Ce produit a été développé pour fonctionner spécifiquement avec les antennes listées dans le tableau ⇨ 6.2.5 Approved Antenna List, présentant un gain maximum de 1.6 dBi pour 2.4 GHz. Des antennes autres que celles listées ici, ou présentant un gain supérieur à 1.6 dBi pour 2.4 GHz ne doivent en aucune circonstance être utilises en combinaison avec ce produit.

L'impédance des antennes compatibles est 50 Ohm. L'antenne utilisée avec ce produit ne doit ni être située à proximité d'une autre antenne ou d'un autre émetteur, ni être utilisée conjointement avec une autre antenne ou un autre émetteur.

Le client final doit s'assurer que l'appareil se trouve en toutes circonstances à une distance de plus de 20 cm du corps humain.

Si le client final envisage une application nécessitant d'utiliser le PAN9520 à une distance inférieure à 20 cm du corps humain, alors le FEO doit répéter l'évaluation DAS.

L'équipement du client final doit répondre aux exigences actuelles de sécurité et de santé selon l'ISED.

6.3.1 Radio Standards Specification RSS-247 Issue 2

The Radio Standards Specification RSS-247, Issue 2, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices, replaces RSS-247, Issue 1, dated May 2015. It sets out certification requirements for radio apparatus operating in the bands 2 400 MHz to 2 483.5 MHz and 5 725 MHz to 5 850 MHz employing frequency hopping, digital modulation and/or a combination (hybrid) of both techniques. It also includes license exempt local area network (LE-LAN) devices operating in the bands 5 150 MHz to 5 250 MHz, 5 250 MHz to 5 350 MHz, 5 470 MHz to 5 725 MHz and 5 725 MHz to 5 850 MHz as specified in SP-5 150 MHz.

6.3.1.1 General

Equipment covered by the standard RSS-247 is classified as Category I equipment. Either a technical acceptance certificate (TAC) issued by the Certification and Engineering Bureau of Innovation, Science and Economic Development Canada (ISED) or a certificate issued by a certification body (CB) is required.

6.3.1.2 Certification Requirements

RSS-247 shall be used in conjunction with RSS-Gen, General Requirements for Compliance of Radio Apparatus, for general specifications and information relevant to the equipment for which this standard applies. Equipment certified under the standard is required to comply with the provisions in RSS‑Gen with respect to emissions falling within restricted frequency bands. These restricted frequency bands are listed in RSS‑Gen.

6.3.1.3 Measurement Method

In addition to the requirements in RSS-Gen and the requirements of the standard RSS-247, the method for measuring DTS devices is provided in ANSI C63.10.

6.3.1.4 FHS and DTS operating in the bands 2 400 MHz to 2 483.5 MHz

This section applies to frequency hopping systems (FHSs) in the bands 2 400 MHz to 2 483.5 MHz and 5 725 MHz to 5 850 MHz and digital transmission systems (DTSs) in the band 2 400 MHz to 2 483.5 MHz. Systems in these bands can be frequency hopping, digital transmission and/or a combination (hybrid) of both types. The digital transmission technology of DTSs or hybrid systems operating in the band 5 725 MHz to 5 850 MHz shall comply with the requirement in section Technical requirements for license-exempt local area network devices and digital transmission systems operating in the 5 GHz band.

RSS-247 Section	5.2
Frequency Band (MHz)	2 400 to 2 483.5
Systems	Digital Transmission Systems
Systems out of Scope	-
Requirements	The minimum 6 dB bandwidth shall be 500 kHz. The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. The maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W.
Complied Module M/N	ENW49D01A1KF, ENW49D02A1KF

RSS-247 Section	5.4
Frequency Band (MHz)	2 400 to 2 483.5
Systems	FHSs operating in the band 2 400 to 2 483.5 MHz. DTSs employing digital modulation techniques operating in the band 2 400 MHz to 2 483.5 MHz.
Systems out of Scope	FHSs operating in the band 902 MHz to 928 MHz and 5 725 MHz to 5 850 MHz. DTSs employing digital modulation techniques operating in the bands 902 MHz to 928 MHz. Fixed point-to-point systems in the bands 2 400 MHz to 2 483.5 MHz and 5 725 MHz to 5 850 MHz. Transmitters operating in the band 2 400 MHz to 2 483.5 MHz, may employ antenna systems that emit multiple directional beams simultaneously or sequentially.
Requirements	Transmitter Output Power: The maximum peak conducted output power shall not exceed 1 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W. For DTSs employing digital modulation techniques operating in the band 2 400 MHz to 2 483.5 MHz, the maximum peak conducted output power shall not exceed W. The e.i.r.p. shall not exceed 4 W.
Complied Module M/N	ENW49D01A1KF, ENW49D02A1KF

RSS-247 Section	5.5
Frequency Band (MHz)	2 400 to 2 483.5
System	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating.
System out of Scope	-
Requirements	Unwanted Emissions: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.
Complied Module M/N	ENW49D01A1KF, ENW49D02A1KF

6.3.2 IC Notice

English

The device PAN9520 and versions (⇨ 7.1 Ordering Information), including the antennas (⇨ 6.2.5 Approved Antenna List), comply 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 inference received, including interference that may cause undesired operation.

French

Le présent appareil PAN9520 (⇨ 7.1 Ordering Information), les antennes y compris (⇨ 6.2.5 Approved Antenna List), est conforme aux CNR-Gen d'ISDE applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage, et
2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

6.3.3 Labeling Requirements

English

Labeling Requirements

The 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 is: **IC: 216Q-9520**

These IC identifiers are valid for all PAN9520 modules ⇨ 7.1 Ordering Information. In any case, the end product must be labelled on the exterior with:

“Contains IC: 216Q-9520”.

French

Obligations d'étiquetage

Les fabricants d'équipements d'origine (FEO) – en anglais Original Equipment Manufacturer (OEM) – doivent s'assurer que les obligations d'étiquetage IC 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.

L' identifiant IC est: **IC: 216Q-9520**

Ces identifiants sont valide pour tous les modules PAN9520 ⇨ 7.1 Ordering Information. Dans tous les cas les produits finaux doivent indiquer sur leur emballage externe la mention suivante:

"Contient IC: 216Q-9520".

6.4 European Conformity According to RED (2014/53/EU)

The PAN9520 modules with model number ENW49D01A1KF and ENW49D02A1KF comply with the standards according to the following LVD (2014/35/EU), EMC-D (2014/30/EU) together with RED (2014/53/EU) articles:

3.1a Safety/Health:	EN 62368-1:2014
	EN 62311:2008
3.1b EMC:	EN 301 489-1 V2.1.1:2017-02
	EN 301 489-17 V3.1.1:2017-02
3.2 Radio:	EN 300 328 V2.2.2:2019-07
	EN 301 893 V2.1.1:2017-05
	EN 300 440 V2.1.1:2017-03

The RED EU Type Examination Certificate No. **T818887N-01** issued by the Notified Body 0682 can be used for the OEM end product conformity assessment. If a Notified Body has been contracted for the end product conformity assessment, it should be noted that this EU Type Examination Certificate should be used for conformance assessment.

As a result of the conformity assessment procedure described in 2014/53/EU Directive, 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 5 cm from the human body under all circumstances.

If the end customer application intends to use the PAN9520 in a distance smaller 5 cm from the human body, SAR evaluation has to be repeated by the OEM.

The end customer equipment must meet the actual Safety/Health requirements according to RED.

PAN9520 and its model versions in the specified reference design can be used in all countries of the European Economic Area (Member States of the EU, European Free Trade Association States [Iceland, Liechtenstein, and Norway]), Monaco, San Marino, Andorra, and Turkey.

6.4.1 Radio Equipment Directive

The Radio Equipment Directive 2014/53/EU (RED) establishes a regulatory framework for placing radio equipment on the market. It ensures a Single Market for radio equipment by setting essential requirements for safety and health, electromagnetic compatibility, and the efficient use of the radio spectrum.

The RED aligned the previous Directive, the Radio and Telecommunication Terminal Equipment Directive 1999/5/EC (R&TTED), with the new legislative framework for the marketing of products. The RED is applicable as of 2016-06-13. It included a one-year transitional period, which ended on 2017-06-12 (Article 48). On 2017-06-20, the Commission Implementing Regulation (EU) 2017/1354 was adopted. This specifies how to present the information provided for in Article 10(10) of Directive 2014/53/EU.

Article 10(10) RED

In cases of restrictions on putting into service or of requirements for authorisation of use, information available on the packaging shall allow the identification of the Member States or the geographical area within a Member State where restrictions on putting into service or requirements for authorisation of use exist. Such information shall be completed in the instructions accompanying the radio equipment. The Commission may adopt implementing acts specifying how to present that information. Those implementing acts shall be adopted in accordance with the advisory procedure referred to in Article 45(2).

- **Class 1:**
  Radio equipment that can be operated without any restriction in EU, EEA, and EFTA. According to Article 8(1)b of the RED, it is clarified that no national radio interfaces specifications are required to be notified under RED;
- **Class 2:**
  Radio equipment subject to restrictions in one or more EU, EEA, and EFTA countries where:
  - The technical parameters are not harmonised through EU, EEA, and EFTA;
  - The technical parameters are harmonised through EU, EEA, and EFTA, and do not fall in above class 1 definition.

Radio equipment class means a class identifying particular categories of radio equipment which, under this Directive, are considered similar and those radio interfaces for which the radio equipment is designed.

Article 8 RED

Notification of radio interface specifications and assignment of radio equipment classes 1:

1) Member States shall notify, in accordance with the procedure set out in Directive 98/34/EC, the radio interfaces which they intend to regulate except:
   a) The radio interfaces which fully and without any deviation comply with the Commission decisions on the harmonised use of radio spectrum adopted pursuant to Decision No. 676/2002/EC; and
   b) The radio interfaces which, in accordance with implementing acts adopted pursuant to paragraph 2 of this Article, correspond to radio equipment which can be put into service and used without restrictions within the Union.

2) The Commission shall adopt implementing acts establishing the equivalence between notified radio interfaces and assigning a radio equipment class, details of which shall be published in the Official Journal of the European Union. Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 45(3).

The Radio Interface Specifications Templates are provided for information in the EFIS database for applications which use is in harmonised radio spectrum, however with restrictions.

6.4.2 Equipment Classes

The PAN9520 is a radio module classified as class-1 or class-2 radio equipment depending on the frequency band in which it can operate. This equipment class is passed on the end-product which integrates the module.

Class 1

Class 1 radio equipment can be placed on the market and put into service without restrictions according to Article 1(3) of Commission Decision 2000/299/EC (Version 2018-01).

This radio module is defined as Class 1 radio equipment when it is restricted to operate in the following frequency bands:

Sub-class of Class 1	Application/Reference	Frequency Band (MHz)	Transmit Power/Power Density
22	Wideband Data Transmission Systems EN 300 328	2 400 to 2 483.5	100 mW e.i.r.p and 100 mW/100 kHz e.i.r.p. density applies when frequency hopping modulation is used, 10 mW/MHz e.i.r.p. density applies when other types of modulation are used.
54	Wireless Access Systems including Radio Local Area Networks (WAS/RLANs) EN 301 893	5 470 to 5 725	1 W mean e.i.r.p., 50 mW/MHz mean e.i.r.p. density in any 1 MHz band.
43	Non-Specific Short Range Devices EN 300 440	5 725 to 5 875	25 mW e.i.r.p.

Class 2

Class 2 radio equipment are restricted in accordance with Article 1(3) of Commission Decision 2000/299/EC1 if the equipment falls within the scope of Class 2.

The usage of PAN9520 module in a vehicular environment cannot be considered as **indoor use**.

This radio module is also defined as Class 2 radio equipment when it is restricted to operate in the following frequency bands:

Sub-class of Class 2	Application/Reference	Frequency Band (MHz)	Transmit Power/Power Density
H01	Wireless Access Systems including Radio Local Area Networks (WAS/RLANs) **Restricted to indoor use** EN 301 893	5 150 to 5 350	Max. 200 mW mean e.i.r.p. and max. 10 mW/MHz mean e.i.r.p. density in any 1 MHz band.

6.5 RoHS and REACH Declaration

The latest declaration of environmental compatibility (Restriction of Hazardous Substances, RoHS and Registration, Evaluation, Authorisation and Restriction of Chemicals, REACH) for supplied products can be found on the Panasonic website in the “Downloads” section of the respective product ⇨ 7.2.2 Product Information.

7 Appendix

7.1 Ordering Information

Variants and Versions

Order Number	Brand Name	Description	MOQ [12]
ENW49D01A1KF[13]	PAN9520	Embedded Wi-Fi Module with 4 MB QSPI Flash and 2 MB QSPI PSRAM	500
ENW49D02A1KF[13]	PAN9520	Embedded Wi-Fi Module with 1 MB QSPI Flash and no QSPI PSRAM	500

[12] Abbreviation for Minimum Order Quantity (MOQ). The default 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.

[13] Samples are available on customer demand.

7.2 Contact Details

7.2.1 Contact Us

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

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

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

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

7.2.2 Product Information

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

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

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