

PAN9520

Embedded Wi-Fi Module

Module Integration Guide

Rev. 1.0



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

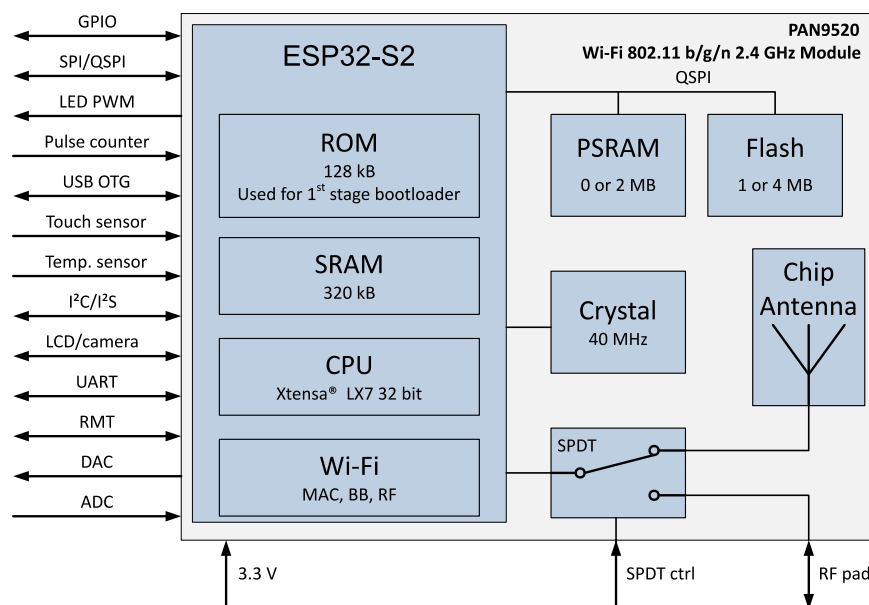
- Embedded 2.4 GHz Wi-Fi 802.11 b/g/n module
- Xtensa® single-core 32-bit LX7 microprocessor, up to 240 MHz
- Chip internal 128 kB ROM, 320 kB SRAM, and 16 kB low power SRAM
- Integrated QSPI Flash and PSRAM (a variety of memory densities are available)
- Ultra-Low Power (ULP) co-processor usable in 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)

- 36x 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 (2x 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 of -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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1 About This Document

1.1 Purpose and Audience

This Module Integration Guide is intended to support the easy integration of the PAN9520 into a product and to ensure the compliance with regulatory requirements.

This guide gives an overview about the hardware design requirements. It is intended for hardware design, application, and Original Equipment Manufacturers (OEM) engineers.

Please read this guide carefully to assure the compliance of your product to regulatory.

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

1.2 Revision History

Revision	Date	Modifications/Remarks
1.0	31.05.2021	Initial 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.
	Tip Indicates useful information designed to facilitate working with the module and software.
⇒ [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.
✓	Requirement Indicates a requirement that must be met before the corresponding tasks can be completed.
→	Result Indicates the result of a task or the result of a series of tasks.

Symbol	Description
This font	GUI text Indicates fixed terms and text of the graphical user interface. Example: Click Save .
Menu > Menu item	Path Indicates a path, e.g. to access a dialog. Example: In the menu, select File > Setup page .
This font	File names, messages, user input Indicates file names or messages and information displayed on the screen or to be selected or entered by the user. Examples: pan1760.c contains the actual module initialization. The message Failed to save your data is displayed. Enter the value Product 123.
Key	Key Indicates a key on the keyboard, e.g. F10 .

1.4 Related Documents

For related documents please refer to the Panasonic website ⇒ [8.2 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. 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 more¹.

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 AES² 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>.

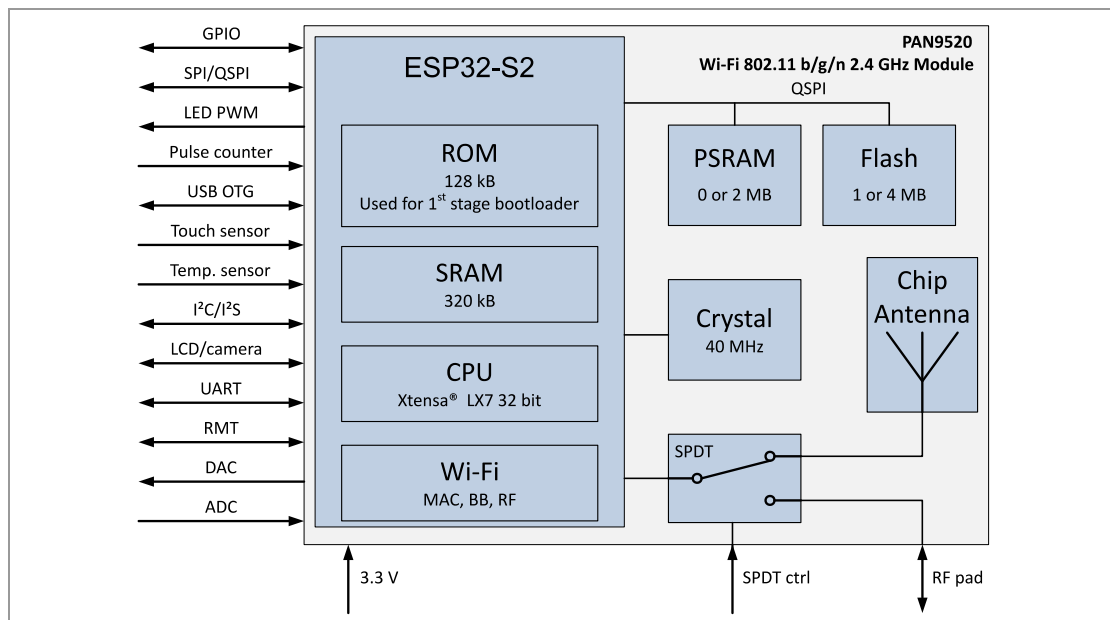
For related documents please refer to ➔ [8.2 Product Information](#).

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)

3 PAN9520 Module

3.1 Block Diagram

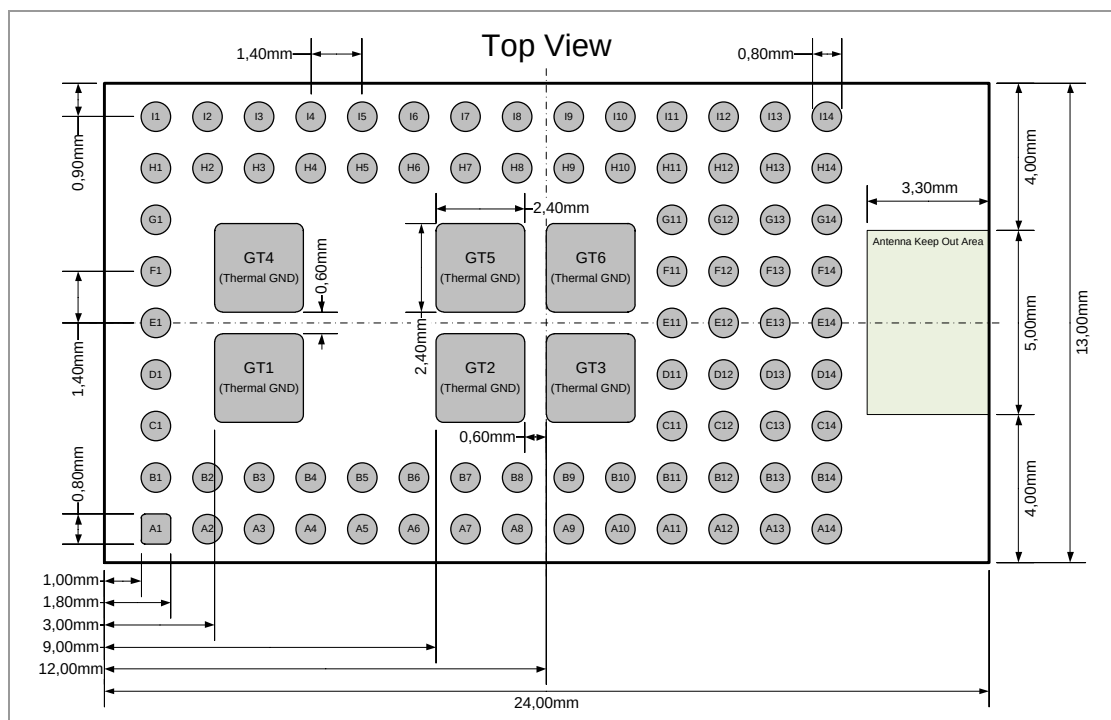


3.2 Footprint



The dimensions are in millimeters.

The outer dimensions have a tolerance of ± 0.35 mm.



3.3 Placement



Antenna “Keep out Area”

Do not place any ground plane under the marked restricted antenna area in any layer! This would be affecting the performance of the chip antenna in a critical manner.



Impact of Placement on the Antenna Radiation Pattern

The placement of the module, surrounding material, and customer components has an impact on the radiation pattern of the antenna.



The recommendation for the ground plane is based on a FR4 4-Layer PCB.

The following requirements must be met:

- ✓ Keep this product away from heat. Heat is the major cause of decreasing the life of these products.
- ✓ Keep this product away from other high frequency circuits.

The antenna requires a cutout area of 5 mm x 3.3 mm under the PAN9520 module. This “Keep out Area” shall be located in every layer under the module antenna. Note for example the “Keep out Area” in all four layers of the PAN9520 evaluation board.

It is recommended to verify the perfect position of the module in the target application before fixing the design.



All dimensions are in millimeters.

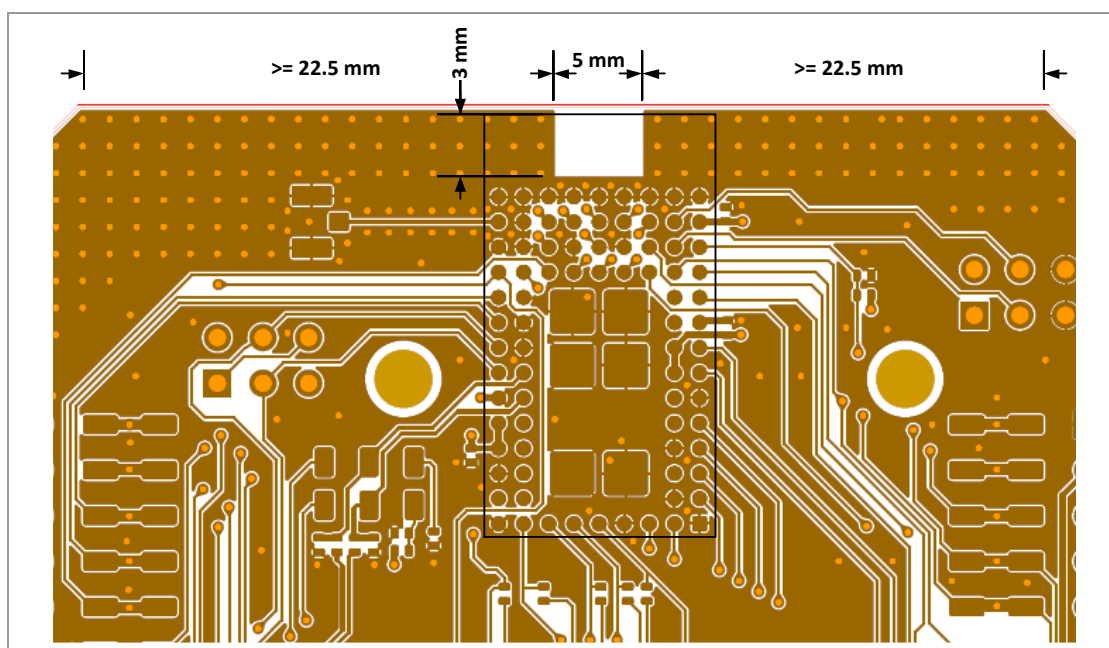


Use a ground plane in the area surrounding the module wherever possible.

Recommended antenna/module placement:

- Place the module at the edge of the mother PCB with the antenna pointing towards the outside
- Align the module at the center of this edge
- Provide 22.5 mm ground planes next to the antenna’s keep-out-area (both sides; top and bottom plane)
- Don’t place any copper on any layer in the antenna’s keep out area (5 mm x 3 mm)
- Extend the keep-out-area towards the mother PCB’s edge, if needed

Antenna Placement Recommendation



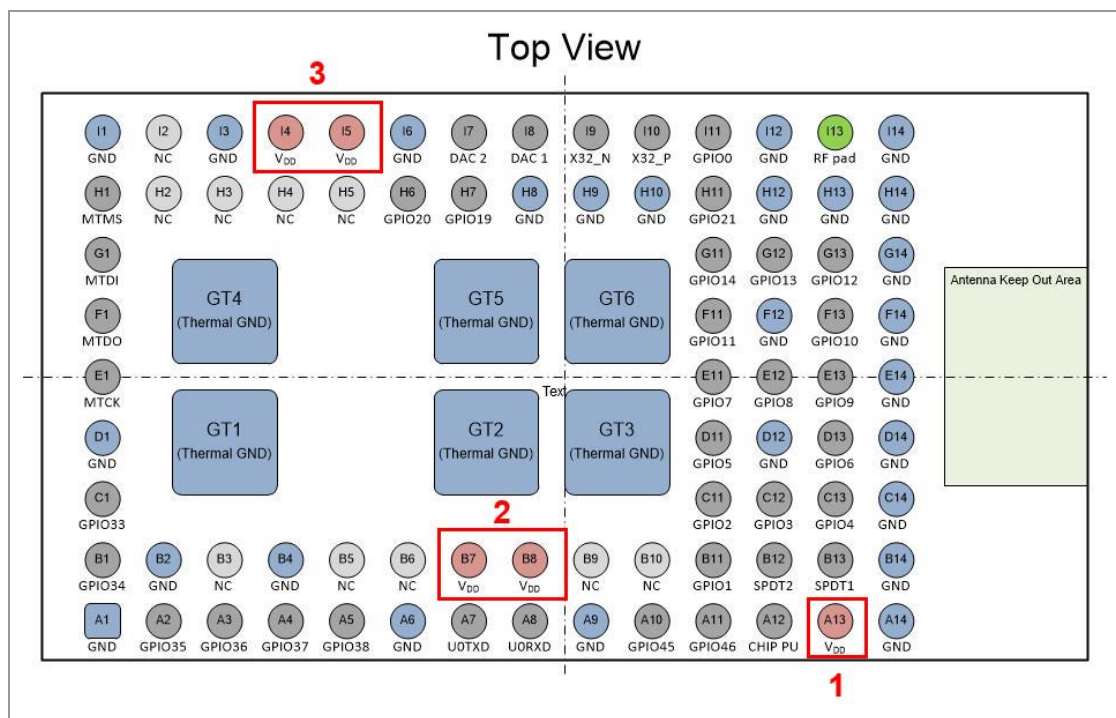
4 Power Supply

The following conditions must be met:

- ✓ The supply voltage must be free of AC ripple voltage (for example from a battery or a low noise regulator output). On the PAN9520 ETU, 10 μ F decoupling capacitors on each supply terminal are used for this purpose. If there is much noise on the power delivery network, a filter network can be used instead.
- ✓ Decoupling capacitors/networks should be placed close to the module to reduce inductive effects.
- ✓ The supply voltage should not be exceedingly high or reversed. It should not carry noise and/or spikes.

4.1 Power Terminals

There are three power terminals on the PAN9520. All are connected to the same 3.3V power net on the module. Although the module could be powered via one terminal only, it is recommended to use all terminals for distributing the currents. This will lead to a smaller voltage drop and thus a better power integrity. Moreover, the supply's return currents will also be distributed, which reduces the galvanic coupling from the power net to signals and vice versa. The power terminals are indicated by red rectangles in the figure below.



5 RF Path Design

5.1 External Antenna



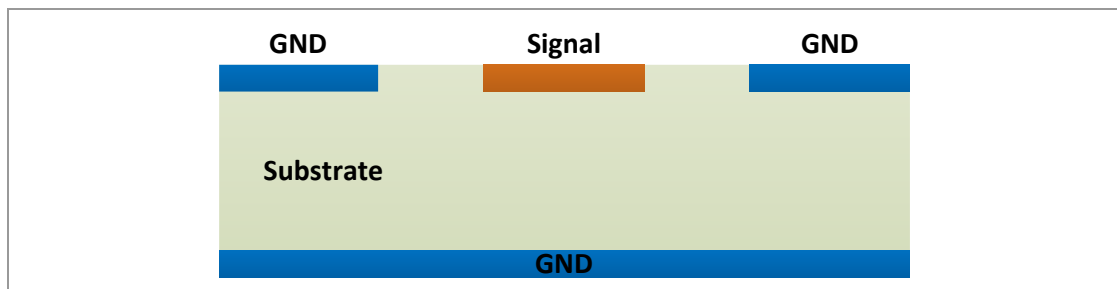
Antenna Warning

The PAN9520's modular approval is only valid if the on-board antenna is used. Other antennas have not been certified. OEMs must test the compliance of the product by themselves, if other antennas are used in the end product.

The PAN9520 module has a 50 Ω RF pin (SMD pad). Connect an external antenna directly or via a connector (e.g. U.FL) with RF trace to this RF pin. This RF trace shall be matched to 50 Ω
⇒ [5.2 RF Trace](#).

5.2 RF Trace

Ensure that the RF trace's impedance is close to 50 Ω . It is recommended to use a Coplanar Waveguide with Ground (CPWG) as RF trace. The impedance is related to the trace width, the distances of the trace to the ground layers and the material of the PCB.

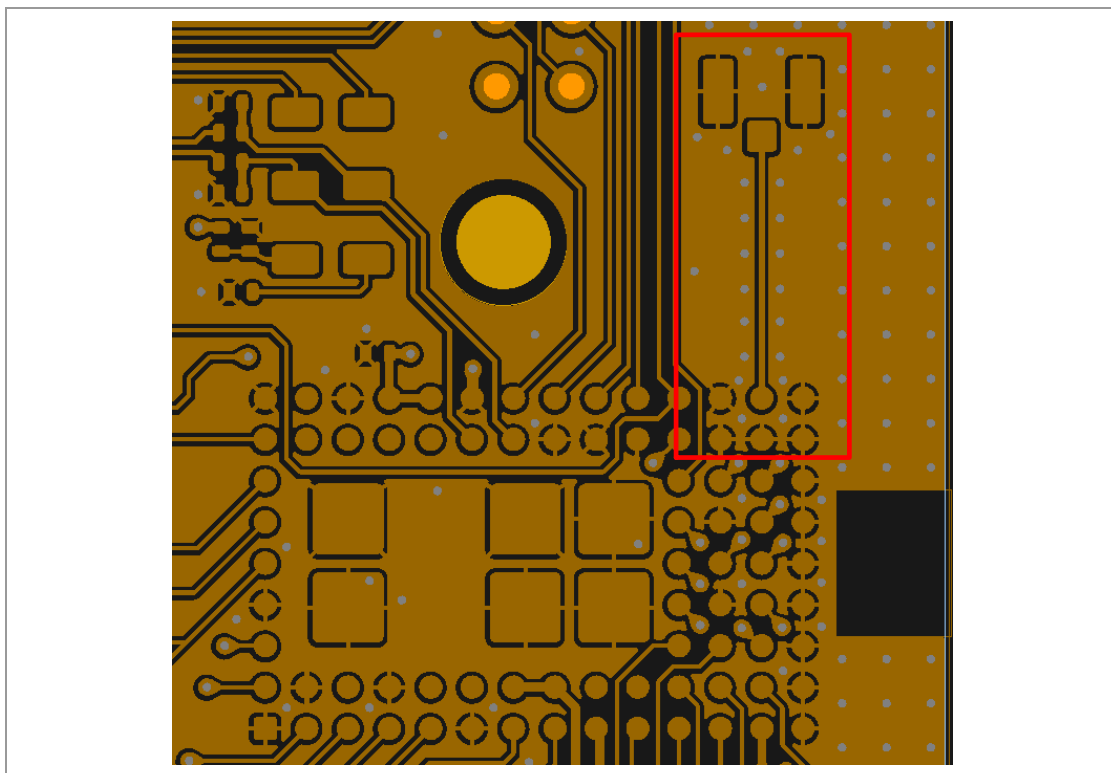


The following design recommendation shall be met:

- ✓ Trace impedance of 50 Ω
- ✓ Trace length shall not exceed 2 cm
- ✓ Via fence around the trace
- ✓ Crossing no other lines (power supply, interfaces or clock traces)

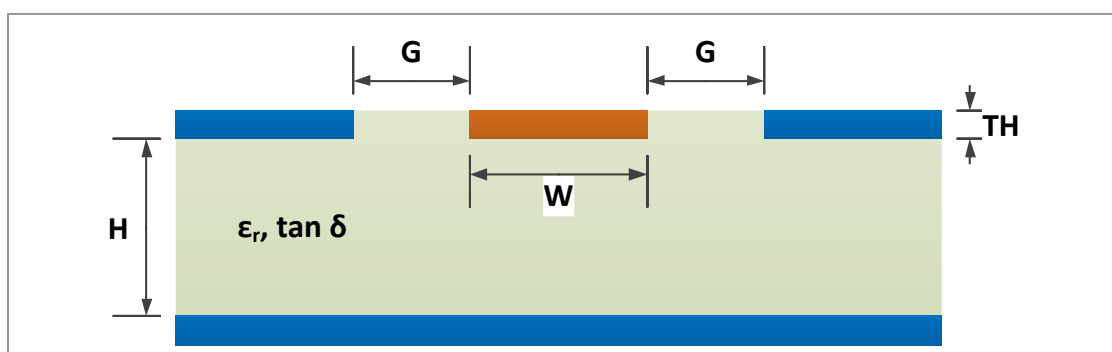
5.2.1 Example RF Trace of the PAN9520 ETU

On the PAN9520 ETU (ENW49D01AZKF), the module's RF pad is connected to an U.F.L. connector. As an example, this RF trace is described in the following. The trace is shown in the figure below (red marking). It can be observed that it is surrounded by a via fence as recommended. A critical point is the transition from the module to the mother PCB. Further simulations of the transition and the RF paths help to determine e.g. the positions of ground vias around the RF pad.



The dimensions of the used RF path are listed below:

Trace width	W	$= 178 \mu\text{m}$
Gap to GND	G	$= 156 \mu\text{m}$
Copper thickness	TH	$= 35 \mu\text{m}$
Height of substrate	H	$= 127 \mu\text{m}$
Relative permittivity	ϵ_r	$= 4.2$
Loss tangent	$\tan \delta$	$= 0.021$



6 Regulatory and Certification Information

6.1 Integration Measures for a Valid Approval

The modular approval of the PAN9520 is only valid if the OEM satisfies several requirements. These affect mainly the output power and the limitation of the operating channel range. This section describes how both can be controlled and what are the measures for a valid modular approval.



The PAN9520 is distributed without software and to OEMs only. The OEM is responsible for using a software that complies with the local regulations.

PAN9520 evaluation tools must be distributed to OEMs only.

6.1.1 Limiting the Channel Range and Setting the Country Code

The range of channels, on which the PAN9520 can operate, has to be limited according to the location of the module (or end product). The modular approval is only valid, if the OEM applies the needed limitations in the developed software. This section describes how the required limitations can be implemented.



Depending on the region the PAN9520 is operating in, the range of channels must be limited accordingly. The OEM is responsible for implementing a software that fulfills this requirement. Channels must be limited to following ranges:

FCC (USA): Channels 1 to 11

IC (Canada): Channels 1 to 11

RED (EU): Channels 1 to 13



The country code and channel limitations must not be changeable in the end product / application.

6.1.1.1 Country Code Setting with ESP-IDF

The Espressif Integrated Development Framework (ESP-IDF) is the official software development kit (SDK) for the ESP32-S2 IC used on the PAN9520. This contains a function called `esp_wifi_set_country` that can be used for setting the country code and limiting the channel range. The function returns an error code of type `esp_err_t`. A pointer to a variable of

type `wifi_country_t` is needed as input. When the function is called, the settings of the linked input variable (`*country`) are stored to the module's flash memory.

```
esp_err_t esp_wifi_set_country(const wifi_country_t *country)
```

⇒ https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32s2/api-reference/network/esp_wifi.html?highlight=esp_wifi_set_country#_CPPv420esp_wifi_set_countryPK14wifi_country_t

The linked variable (type `wifi_country_t`) is a structure that contains all needed settings, which are listed below.

Structure of type `wifi_country_t`

Name	Type	Example Settings	Description
<code>cc</code> ³	<code>char array (3 bytes)</code>	<code>cc[0-2] = ['D', 'E', ' ']</code> <code>cc[0-2] = ['U', 'S', ' ']</code> <code>cc[0-2] = ['C', 'A', ' ']</code> <code>cc[0-2] = ['E', 'U', ' ']</code>	This array of three characters contains the two-digit country code (ISO/IEC3166-1) and an environmental setting (byte 3). Example codes are given for Germany (DE), USA (US), Canada (CA) and the European Union (EU).
<code>schan</code>	<code>uint8_t</code>	1	Index of first channel of the allowed range.
<code>nchan</code>	<code>uint8_t</code>	11	Number of channels in the allowed range. The index of the last channel in the range is <code>schan + nchan - 1</code>
<code>max_tx_power</code>	<code>int8_t</code>	56	Maximum Tx power in steps of 0.25 dBm (valid values 8 to 78 $\pm$ 2 to 19.5 dBm)
<code>policy</code> ⁴	<code>wifi_country_policy_t</code>	WIFI_COUNTRY_POLICY_MANUAL	Setting, if the configured country code is always used, or if the module adapts to the AP configuration (if it is station). Details are given in the following.

WIFI_COUNTRY_POLICY_AUTO

If the PAN9520 is configured as station, the used country code setting is adapted to the one of the access point (AP), to which the station is connected. Please note that not only the country code itself is changed, but also the channel range.

After the station has been disconnected from the AP, the country code setting is reset to the configured one.

If the module is in station mode, not connected to an AP and performs a scan, this scans actively on channels `schan` to `min{(schan + nchan - 1), 11}` of the configured country code setting. The remaining channels `schan + nchan` to 14 (or 12 to 14 if `schan + nchan` $\geq$ 12) are scanned passively. This ensures that regulations are not violated, even if the configured country code doesn't match the location of the device. Please note that hidden SSIDs on channels 12 to 14 can never be found, if `WIFI_COUNTRY_POLICY_AUTO` is used.

If the module is in station mode, connected to an AP and performs a scan, the module uses the country code settings of the AP. Hence, an active scan is performed on `schan` to `(schan +`

³ Entries zero and one contain the alpha-2 country code specified by ISO3166. A list of codes can be found on <https://www.iso.org/obp/ui/#search/code/>. Please note that there are also reserved codes that don't represent a country but are valid as well. An example would be EU for the European union.

⁴ The setting "policy" is of another custom datatype called `wifi_country_policy_t`. Variables of this type are enumerations with two valid numbers. The numbers are represented by following macros:

nchan -1) of the AP's country code settings and a passive scan is performed on the remaining channels.

If the module is set to station/AP coexistence mode, the configured country code settings are used as long as the device hasn't been connected to another AP. If the device is connected to another AP, the country code settings of the AP are used (also for the module's AP).

If the module is configured as AP, this setting hasn't any effect and the configured country code settings are always used.

Please see ⇒ <https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32/api-guides/wifi.html#wi-fi-country-code> for further details (accessed on 31.03.2021).

WIFI_COUNTRY_POLICY_MANUAL

If this setting is used, the configured country code settings are used in any case. Only channels in the valid range can be scanned actively.

Please see ⇒ <https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32/api-guides/wifi.html#wi-fi-country-code> for further details (accessed on 31.03.2021).

Example 1 (US, Manual Policy)

If the module shall be e.g. only operated in the USA, the country code could be set accordingly and the policy setting can be set to `WIFI_COUNTRY_POLICY_MANUAL` for ensuring that the device cannot operate on prohibited channels in any case. A related application could be a product that operates as AP and is sold in the US. Related example C code is given below.

```
#include "exmpl_error_check.h"
#include "esp_wifi.h"

esp_err_t error_code;
wifi_country_t cc_us_manual = {{'U', 'S', ' '}, 1, 11, 78, WIFI_COUNTRY_POLICY_MANUAL};
wifi_country_t* cc_us_manual_pt = &cc_us_manual;

error_code = wifi_set_country(cc_us_manual_pt);

check_error_code(error_code);
```

Example 2 (EU, Automatic Policy)

In this example, the country code is set to EU and channels 1 to 13 are enabled. The maximum output power is limited to 16 dBm (see next chapter for details) and the policy is set to `WIFI_COUNTRY_POLICY_AUTO`. This could be applicable for a product that acts as station and is sold in the EU. If the device is operated in a non-EU region, the country code will be adapted to the one of local APs. If the device is not connected to any AP, active scans will be only performed on channels 1 to 11. Channels 12 to 14 are scanned passively.

```
#include "exmpl_error_check.h"
#include "esp_wifi.h"

esp_err_t error_code;
wifi_country_t cc_eu_auto = {{'E', 'U', ' '}, 1, 13, 64, WIFI_COUNTRY_POLICY_AUTO};
wifi_country_t* cc_eu_auto_pt = &cc_eu_auto;

error_code = wifi_set_country(cc_eu_auto_pt);

check_error_code(error_code);
```

Further Reading

“Wi-Fi Country Code” general description: ⇒ <https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32/api-guides/wifi.html#wi-fi-country-code>

Function `esp_wifi_set_country`: ⇒ https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32/api-reference/network/esp_wifi.html#_CPPv420esp_wifi_set_countryPK14wifi_country_t

Data type `wifi_country_t`: ⇒ https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32/api-reference/network/esp_wifi.html#_CPPv414wifi_country_t

6.1.1.2 Country Code Setting with ESP32-S2 AT Firmware

Instead of developing an embedded software for the PAN9520, an AT firmware provided by Espressif can be used. This is based on the ESP-IDF and is available as source code or precompiled binary. This section explains how the country code settings can be applied, if the AT firmware is used.

There are two commands related to the country code setting. These are `AT+CWOUNTRY?`, which will query the current country code information, and `AT+CWOUNTRY`, which will set the country code configuration and store it into flash. The input parameters are similar to those used in ESP-IDF (see section ⇒ 6.1.1.1) and are only explained briefly in the following.

```
AT+ CWOUNTRY=<country_policy>,<country_code>,<start_channel>,<total_channel_count>
Function: Sets the Wi-Fi country code information.
```

⇒ https://docs.espressif.com/projects/esp-at/en/release-v2.1.0.0/esp32s2/AT_Command_Set/Wi-Fi_AT_Commands.html#at-cwcountry-configures-the-wi-fi-country-code

country_policy

0: Identical to `WIFI_COUNTRY_POLICY_AUTO` option in ESP-IDF

1: Identical to `WIFI_COUNTRY_POLICY_MANUAL` option in ESP-IDF

country_code

String of variable length (maximum 3) containing the country code. Please note that quotation marks must be used to identify the parameter as string. Similar to `cc[0-2]` in ESP-IDF.

start_channel

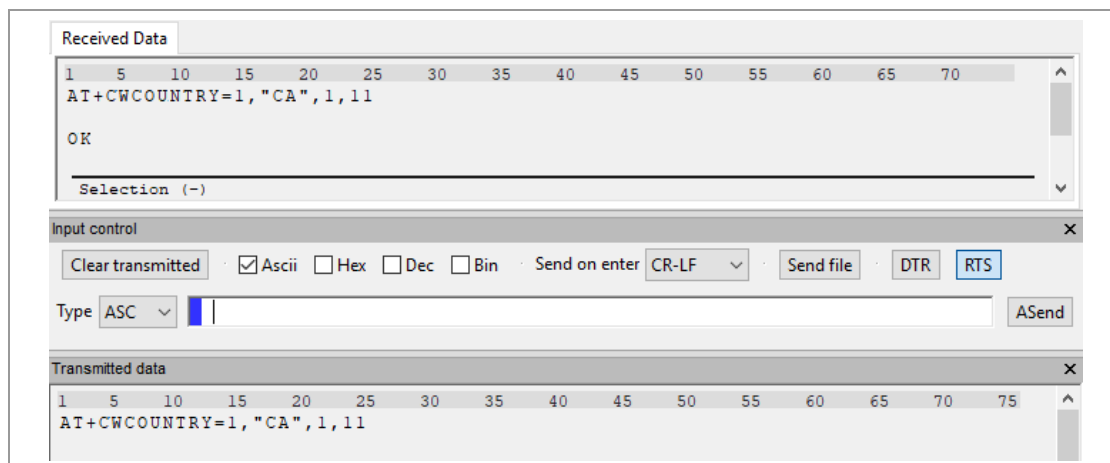
Index of first channel allowed to use. Identical to `schan` in ESP-IDF.

total_channel_count

Number of channels that can be used. The index of the last channel is `start_channel + total_channel_count - 1`. Identical to `nchan` in ESP-IDF.

Example (Canada, Manual Policy)

This example illustrates the configuration via AT commands. The country code has been chosen to be CA for Canada and the range of allowed channels are set to 1 to 11 accordingly. The device shall always use the configured country code settings, which causes the parameter country_policy to be one. Following figure shows the related serial communication.



Further Reading

AT command description: ➔ https://docs.espressif.com/projects/esp-at/en/release-v2.1.0.0_esp32s2/AT_Command_Set/Wi-Fi_AT_Commands.html#at-cwcountry-configures-the-wi-fi-country-code

6.1.2 Limiting the Output Power

For a valid modular approval, the radiated power must not exceed certain limits. These can be summarized as follows:

RED (Europe)

Standard	Affected Channels	Power Limit
802.11b	1 to 13	14 dBm
802.11g & 802.11n	1 to 13 (20 MHz) 3 to 11 (40 MHz)	16 dBm

FCC (USA) and IC (Canada)

Standard	Affected Channels	Power Limit
802.11b	1 to 11	18 dBm
802.11g & 802.11n	3 to 9 (20 MHz)	16 dBm
802.11g & 802.11n	1, 2, 10 and 11 (20 MHz)	13 dBm
802.11n	All 40 MHz channels	11 dBm

All limits have been determined using the module's integrated chip antenna. For limiting the power, there are several options that are explained in this section. These are:

1. Using a `phy_init_data` binary (stored into a corelated partition) to limit the power for each channel and modulation (ESP-IDF and AT firmware).
2. Editing and using the `phy_init_data` implemented in the user application's source code (ESP-IDF).



Please note that the power limits documented in this chapter must not be exceeded in the end product to keep the modular approval valid. Examples that fulfill this requirement are documented in the following sections.



Please note that it is not recommended to use functions like `esp_wifi_set_max_tx_power`, because the device could transmit with restricted output power settings before the function is called.

6.1.2.1 Using `phy_init_data` Binary

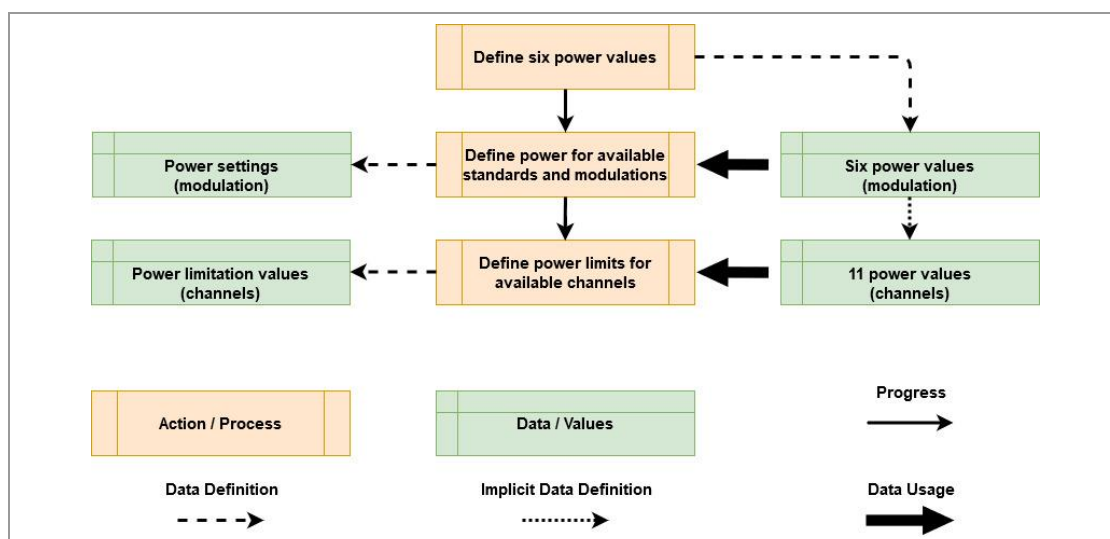
The physical (PHY) layer is controlled by a PHY init data set. This can be defined in the application source code or it can be stored into a separate partition of the module's Flash memory. This section explains how the data is composed, how it can be stored and how the user application can be configured to use the data stored in the partition.

Binaries for applying settings that comply with the RED or FCC / IC regulations are provided by Panasonic. If a related partition is reserved in the partition table and the setting `CONFIG_ESP32_PHY_INIT_DATA_IN_PARTITION` in the project configurations is set to "y", the data can be flashed and is then used by the hardware.

Phy Init Data Structure

The data is composed of 128 bytes that configure the device's PHY layer. The data that is flashed into the corresponding partition contains 16 more bytes. Eight at the beginning and eight at the end. Byte positions stated in this section are relative to start of the stored data (binary data). Six power values can be stored and used for configuration. Power settings can be defined for different data rates (=> standards and modulations). Additionally, the maximum power can be configured for each channel. Details are given below or in ➔ https://www.espressif.com/sites/default/files/documentation/esp32_phy_init_bin_parameter_configuration_guide_en.pdf.

Following figure illustrates an example process for configuring/editing the phy init data. This consists mainly of three steps: Defining six power values, setting up the power for each available standard and modulation and defining power limits for each available channel.



Power Values

Beginning with the first step of the example configuration process, six power values are defined. They are stored in bytes 52 to 57 (0x34 to 0x39) of the binary data and are called `txpwr_qdb_0` to `txpwr_qdb_5`. A value written to such a byte correlates to $4 \times [\text{power in dBm}]$. The following table shows values of the recommended binary files (for RED and FCC/IC).

Name	Byte Position in Binary	Value		Resulting Power	
		RED	FCC / IC	RED	FCC / IC
<code>txpwr_qdb_0</code>	52 (0x34)	56 (0x38)	72 (0x48)	14 dBm	18 dBm
<code>txpwr_qdb_1</code>	53 (0x35)	64 (0x40)	64 (0x40)	16 dBm	16 dBm
<code>txpwr_qdb_2</code>	54 (0x36)	60 (0x3C)	60 (0x3C)	15 dBm	15 dBm
<code>txpwr_qdb_3</code>	55 (0x37)	56 (0x38)	56 (0x38)	14 dBm	14 dBm
<code>txpwr_qdb_4</code>	56 (0x38)	56 (0x38)	52 (0x34)	14 dBm	13 dBm
<code>txpwr_qdb_5</code>	57 (0x39)	52 (0x34)	48 (0x30)	13 dBm	12 dBm

Configuring the values `txpwr_qdb_0` to `txpwr_qdb_5` also defines 11 imaginary power levels. These are called TX Power Limit and depend on the defined values as follows.

Name	Power in dBm Depending on Conf. Values	Resulting Power	
		RED	FCC / IC
TX Power Limit 0	<code>txpwr_qdb_0 / 4</code>	14 dBm	18 dBm
TX Power Limit 1	<code>txpwr_qdb_1 / 4</code>	16 dBm	16 dBm
TX Power Limit 2	<code>txpwr_qdb_2 / 4</code>	15 dBm	15 dBm
TX Power Limit 3	<code>txpwr_qdb_3 / 4</code>	14 dBm	14 dBm
TX Power Limit 4	<code>txpwr_qdb_4 / 4</code>	14 dBm	13 dBm
TX Power Limit 5	<code>txpwr_qdb_5 / 4</code>	13 dBm	12 dBm
TX Power Limit 6	<code>(txpwr_qdb_5 / 4) - 1</code>	12 dBm	11 dBm
TX Power Limit 7	<code>(txpwr_qdb_5 / 4) - 2</code>	11 dBm	10 dBm
TX Power Limit 8	<code>(txpwr_qdb_5 / 4) - 3</code>	10 dBm	9 dBm
TX Power Limit 9	<code>(txpwr_qdb_5 / 4) - 4</code>	9 dBm	8 dBm
TX Power Limit 10	<code>(txpwr_qdb_5 / 4) - 5</code>	8 dBm	7 dBm

Power Levels for Modulations and Standards

The second configuration step defines power levels for each standard and modulation, whereas the modulation of standards b and g is defined by the related data rates. There are 11 bytes for applying the configuration with some configurations merged to one byte. Bytes `txpwr_index_0` to `txpwr_index_7` are stored at byte positions 58 to 65 and correspond to standards 802.11g and 802.11n. The power is defined by the index of the desired power value `txpwr_qdb`.

For configuring the power levels of standard 802.11b, there are two possibilities. The first is to set byte `txpwr_index_11b_en` at byte position 66 to zero. This makes `txpwr_qdb_0` to be used for all 802.11b data rates. If the byte `txpwr_index_11b_en` is set to one, `txpwr_index_11b_0` and `txpwr_index_11b_1` define the maximum power levels, which is the second option.

Configurations that fulfill the requirements for a valid modular approval are given in the following table. The configuration requires the power values to be configured as described in the previous section.

Name	Byte Position in Binary	Affected Data Rate / MCS	txpwr_qdb Index		Resulting Power	
			RED	FCC / IC	RED	FCC / IC
txpwr_index_0	58 (0x3A)	11g: 6 & 9 Mbit/s 11n: MCS 0	0x01	0x01	16 dBm	16 dBm
txpwr_index_1	59 (0x3B)	11g: 12 Mbit/s 11n: MCS 1	0x01	0x01	16 dBm	16 dBm
txpwr_index_2	60 (0x3C)	11g: 18 Mbit/s 11n: MCS 2	0x01	0x01	16 dBm	16 dBm
txpwr_index_3	61 (0x3D)	11g: 24 Mbit/s 11n: MCS 3	0x01	0x01	16 dBm	16 dBm
txpwr_index_4	62 (0x3E)	11g: 36 Mbit/s 11n: MCS 4	0x01	0x01	16 dBm	16 dBm
txpwr_index_5	63 (0x3F)	11g: 48 Mbit/s 11n: MCS 5	0x02	0x02	15 dBm	15 dBm
txpwr_index_6	64 (0x40)	11g: 54 Mbit/s 11n: MCS 6	0x03	0x03	14 dBm	14 dBm
txpwr_index_7	65 (0x41)	11n: MCS 7	0x05	0x04	13 dBm	13 dBm
txpwr_index_11b_en ⁵	66 (0x42)	11b	0x00	0x00	14 dBm	18 dBm
txpwr_index_11b_0 ⁵	67 (0x43)	11b: 1 & 2 Mbit/s	0x00	0x00	N/A	N/A
txpwr_index_11b_1 ⁵	68 (0x44)	11b: 5.5 & 11 Mbit/s	0x00	0x00	N/A	N/A

Power Limits for Channels

The third configuration step defines power limits for each channel. If the power configured for a certain standard and modulation exceeds the limit of the current channel, the power is reduced to the one of the limit. The first byte (at position 69) of this configuration (`fcc_enable`) determines if the limits are applied. If the byte's value is zero, settings made in bytes `mpwr_cbw20_chan1` to `mpwr_cbw40_chan11` are ignored. In contrast, they are applied, if `fcc_enable` is two.

⁵ txpwr_index_11b_en determines, if txpwr_qdb_0 is used for all 11b data rates (value = 0), or if configurations txpwr_index_11b_0 and txpwr_index_11b_1 are used (value = 1).

Bytes `mpwr_cbw20_chan1` to `mpwr_cbw20_chan11` are stored at byte positions 70 to 83 and configure the power limits for the 20 MHz channels. Each of these bytes is separated into two nibbles: bit[3:0] (low nibble) and bit[7:4] (high nibble). The low nibble configures the limit for standards 802.11g and 802.11n. The high nibble configures the limit for standard 802.11b. By selecting the index of the desired TX Power Limit for a nibble, the configuration is made.

The limits of the 40 MHz channels are configured by bytes `mpwr_cbw40_chan3_4` to `mpwr_cbw40_chan11`. Because 40 MHz channels can be only used with the 802.11n standard, the bytes' nibbles do not correspond to standards. Instead, each nibble is used for one channel. Thus, each configuration byte contains the setting for two channels. The low nibble (bit[3:0]) configures the lower channel and the high nibble (bit[7:4]) configures the higher channel.

An example configuration that complies with the FCC/IC regulations is given in the table below (channels limits are not needed for RED). Unused channels have been configured with the lowest TX Power Limit value.



Because byte nibbles are used for configuration, the hexadecimal representation is quite convenient. Each nibble is represented by a digit in the range 0x0 to 0xA (0 to 10 in decimal system).

Name	Byte Position in Binary	Notes	TX Power Limit Index		Resulting Power FCC / IC
			RED	FCC / IC	
<code>fcc_enable</code>	69 (0x45)	0: Disable limits 1: N/A 2: Enable limits	0x00	0x02	Power limits are enabled
<code>mpwr_cbw20_chan1</code>	70 (0x46)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x04	11g/n: 13 dBm 11b: 18dBm
<code>mpwr_cbw20_chan2</code>	71 (0x47)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x04	11g/n: 13 dBm 11b: 18dBm
<code>mpwr_cbw20_chan3</code>	72 (0x48)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x01	11g/n: 16 dBm 11b: 18dBm
<code>mpwr_cbw20_chan4</code>	73 (0x49)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x01	11g/n: 16 dBm 11b: 18dBm
<code>mpwr_cbw20_chan5</code>	74 (0x4A)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x01	11g/n: 16 dBm 11b: 18dBm
<code>mpwr_cbw20_chan6</code>	75 (0x4B)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x01	11g/n: 16 dBm 11b: 18dBm
<code>mpwr_cbw20_chan7</code>	76 (0x4C)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x01	11g/n: 16 dBm 11b: 18dBm

Name	Byte Position in Binary	Notes	TX Power Limit Index		Resulting Power FCC / IC
			RED	FCC / IC	
mpwr_cbw20_chan8	77 (0x4D)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x01	11g/n: 16 dBm 11b: 18dBm
mpwr_cbw20_chan9	78 (0x4E)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x01	11g/n: 16 dBm 11b: 18dBm
mpwr_cbw20_chan10	79 (0x4F)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x04	11g/n: 13 dBm 11b: 18dBm
mpwr_cbw20_chan11	80 (0x50)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0x04	11g/n: 13 dBm 11b: 18dBm
mpwr_cbw20_chan12	81 (0x51)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0xAA	11g/n: 7 dBm 11b: 7 dBm
mpwr_cbw20_chan13	82 (0x52)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0xAA	11g/n: 7 dBm 11b: 7 dBm
mpwr_cbw20_chan14	83 (0x53)	Bit[3:0]: 11g/n Bit[7:4]: 11b	N/A	0xAA	11g/n: 7 dBm 11b: 7 dBm
mpwr_cbw40_chan3_4	84 (0x54)	Bit[3:0]: ch 3 Bit[7:4]: ch 4	N/A	0x66	Ch 3: 11 dBm Ch 4: 11 dBm
mpwr_cbw40_chan5_6	85 (0x55)	Bit[3:0]: ch 5 Bit[7:4]: ch 6	N/A	0x66	Ch5: 11 dBm Ch6: 11 dBm
mpwr_cbw40_chan7_8	86 (0x56)	Bit[3:0]: ch 7 Bit[7:4]: ch 8	N/A	0x66	Ch7: 11 dBm Ch8: 11 dBm
mpwr_cbw40_chan9_10	87 (0x57)	Bit[3:0]: ch 9 Bit[7:4]: ch 10	N/A	0xA6	Ch9: 16 dBm Ch10: 7 dBm
mpwr_cbw40_chan11	88 (0x58)	Bit[3:0]: ch 11 Bit[7:4]: N/A	N/A	0xAA	Ch11: 7 dBm

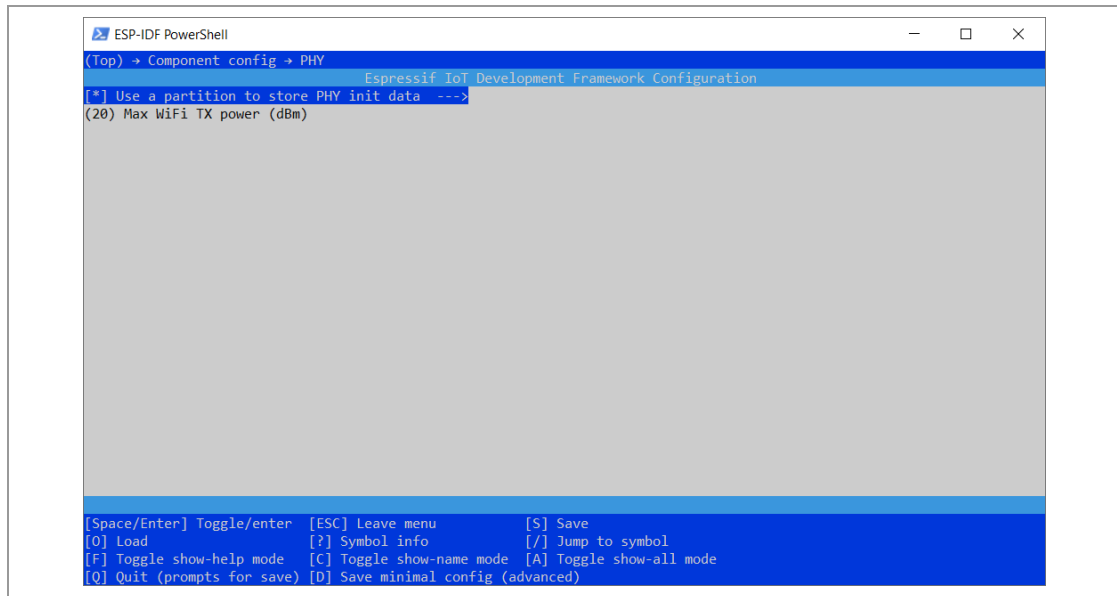
Editing Binary Files

It is recommended to use the binary files provided by Panasonic. Anyway, the files can be edited as long as they do not exceed the limits given at the beginning of section ⇒ 6.1.2.

Therefore, an editor that can represent the binary data as hexadecimal values is recommended (e.g. HxD).

Enabling the Usage of a Phy Init Data Binary

Per default the PAN9520 will use the phy init data defined by the source code. If a binary file shall be used, a small setting must be applied in the project configuration before the project is compiled. The project configuration can be changed by using the command `idf.py menuconfig` in the ESP-IDF command line tool. After opening the menu, the setting can be applied under: Component config > PHY.



This setting will make the PAN9520 use the phy init data binary. Moreover, the default partition table will include a corresponding partition at address 0x8000, to which the binary must be flashed. Please see the ESP-IDF documentation for details: ⇨

<https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32s2/api-reference/kconfig.html?highlight=support%20multiple%20phy#config-esp32-phy-init-data-in-partition> (accessed on 30.04.2021).

Using a Binary with Multiple Phy Init Data Sets

It is also possible to create a binary that contains phy init data sets for several regions. The binary data is then selected depending on the used country code. Please see the ESP-IDF documentation for details: ⇨ <https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32s2/api-reference/kconfig.html?highlight=support%20multiple%20phy#config-esp32-support-multiple-phy-init-data-bin> (accessed on 30.04.2021).

Further Reading

Phy init data documentation: ⇨

https://www.espressif.com/sites/default/files/documentation/esp32_phy_init_bin_parameter_configuration_guide_en.pdf (accessed on 30.04.2021)

PHY project configuration: ⇨ <https://docs.espressif.com/projects/esp-idf/en/v4.2/esp32s2/api-reference/kconfig.html?highlight=support%20multiple%20phy#phy> (accessed on 30.04.2021)

6.1.2.2 Editing the Phy Init Data in the Source Code

Per default, the phy init data set defined in the source code is used by the PAN9520. Therefore, adapting this data is also an option to comply with the regulations. The data can be found in the ESP-IDF folder: `[ESP-IDF] > components > esp_wifi > esp32s2 > include > phy_init_data.h`. The structure `phy_init_data` of type `phy_init_data_t` contains the configuration bytes. These are the same as described in section [⇒ 6.1.2.1 Using phy_init_data Binary](#), but the eight start and end bytes are missing. Therefore, the byte enumeration is decreased by eight. You can find code examples for RED (EU) and FCC / IC (USA and Canada) below.

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```

        0xf4,
        0xf8,
        0xf8,
        0xf0,
        0xf0,
        0xf0,
        0xe0,
        0xe0,
        0xe0,
        0x18,
        0x18,
        0x18,

/* Start of Power Value Definitions */
        56,                // byte 44 (byte 52 in binary)
        56,                // byte 45 (byte 53 in binary)
        56,                // byte 46 (byte 54 in binary)
        56,                // byte 47 (byte 55 in binary)
        56,                // byte 48 (byte 56 in binary)
        52,                // byte 49 (byte 57 in binary)

/* Start of Power Settings (Modulation) */
        0,                // byte 50 (byte 58 in binary)
        0,                // byte 51 (byte 59 in binary)
        0,                // byte 52 (byte 60 in binary)
        0,                // byte 53 (byte 61 in binary)
        0,                // byte 54 (byte 62 in binary)
        0,                // byte 55 (byte 63 in binary)
        0,                // byte 56 (byte 64 in binary)
        5,                // byte 57 (byte 65 in binary)
        0,                // byte 58 (byte 66 in binary)
        0,                // byte 59 (byte 67 in binary)
        0,                // byte 60 (byte 68 in binary)

/* Start of Power Limit Settings (Channels) */
        0,                // byte 61 (byte 69 in binary)
        0,                // byte 62 (byte 70 in binary)

```

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```
0,  
0,  
0,  
0,  
0,  
0,  
0,  
}  
};
```

Phy Init Data for RED (above)

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```

    0xf4,
    0xf8,
    0xf8,
    0xf0,
    0xf0,
    0xf0,
    0xe0,
    0xe0,
    0xe0,
    0x18,
    0x18,
    0x18,

/* Start of Power Value Definitions */
    72,                // byte 44 (byte 52 in binary)
    64,                // byte 45 (byte 53 in binary)
    60,                // byte 46 (byte 54 in binary)
    56,                // byte 47 (byte 55 in binary)
    52,                // byte 48 (byte 56 in binary)
    48,                // byte 49 (byte 57 in binary)

/* Start of Power Settings (Modulation) */
    1,                // byte 50 (byte 58 in binary)
    1,                // byte 51 (byte 59 in binary)
    1,                // byte 52 (byte 60 in binary)
    1,                // byte 53 (byte 61 in binary)
    1,                // byte 54 (byte 62 in binary)
    2,                // byte 55 (byte 63 in binary)
    3,                // byte 56 (byte 64 in binary)
    4,                // byte 57 (byte 65 in binary)
    0,                // byte 58 (byte 66 in binary)
    0,                // byte 59 (byte 67 in binary)
    0,                // byte 60 (byte 68 in binary)

/* Start of Power Limit Settings (Channels) */
    2,                // byte 61 (byte 69 in binary)
    0x04,            // byte 62 (byte 70 in binary)

```

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```

    0,
    0,
    0,
    0,
    0,
    0,
    0,
    0,
} };

```

Phy Init Data for FCC / IC (above)

6.2 General Certification Information



For further certification requests for other radio software please contact Panasonic ⇒ [8 Contact Details](#).

6.3 Federal Communications Commission (FCC) for US

6.3.1 FCC Statement

The following FCC statement has to be printed in the OEM end product user information:



This device complies with part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

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.

6.3.2 Caution

The following FCC caution has to be printed in the OEM end product user information:



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.

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.

6.3.3 Label Requirements

The following labelling requirements have to be implemented on the OEM end product:



The 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 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"

Due to the PAN9520 model size, the FCC identifier is displayed in the installation instruction only and it cannot be displayed readable on the module's label due to the limited size.

6.3.4 Antenna Warning

The following Antenna has to be followed by the OEM:

This antenna warning refers to the device with the model number PAN9520.

The device is tested with a integrated 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.

6.3.5 Approved Antenna List

Item	Part Number	Manufacturer	Frequency Band	Type	Max. Gain (dBi)
1	ANT016008LCS2442MA1	TDK	2.4 GHz	Chip Antenna	1.6

6.3.6 RF Exposure



To comply with FCC RF Exposure requirements, the OEM must ensure that only antennas from the Approved Antenna List are installed ⇒ [6.3.5 Approved Antenna List](#).

The preceding statement must be included as a “CAUTION” statement in manuals for products operating with the approved antennas 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 antenna (**FCC ID: T7V9520**) is below the FCC radio frequency exposure limits. Nevertheless, 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.



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 done by the OEM.

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

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

The following IC rules have to be followed by end product OEM's:

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 Approved Antenna List, having a maximum gain of 1.6 dBi. Antennas not included in this list or having a gain greater than 1.6 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 without the need of re-assessment of conformity by ISED.

Due to the model size, the IC identifier is displayed in the installation instruction and on the package label only. It cannot be displayed readable on the module's label due to the limited size.



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 done by the OEM.

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

French

PAN9520 est garanti conforme aux dispositions réglementaires 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 Approved Antenna List, présentant un gain maximum de 1.6 dBi. Des antennes autres que celles listées ici, ou présentant un gain supérieur à 1.6 dBi ne doivent en aucune circonstance être utilisées 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.

En raison de la taille du produit, l'identifiant IC est fourni dans le manuel d'installation.



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 faire l'évaluation DAS.

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

6.4.1 IC Notice

The following IC notice has to be printed in English and French in the OEM end product user information:

English



The device PAN9520, including the integrated antenna mentioned in ⇒ [6.3.5 Approved Antenna List](#), 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.

French



Le présent appareil PAN9520, les antennes y compris ⇒ [6.3.5 Approved Antenna List](#) est conforme aux CNR-Gen d'Industrie Canada 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.

6.4.2 Labeling Requirements

The following IC labelling requirements have to be followed by end product OEM's:

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**

This IC identifier is valid for the PAN9520 module. 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**

Cet identifiant est valide pour module PAN9520. Dans tous les cas les produits finaux doivent indiquer sur leur emballage externe la mention suivante:

"Contient IC: 216Q-9520"

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



All modules described in this Module Integration Guide comply with the standards according to the following LVD (2014/35/EU), EMC-D (2014/30/EU) together with RED (2014/53/EU) articles.

Standards

- The end product OEM has to re-assess the conformity of the end product to EU regulations, but can use the PAN9520 RED pre-assessment to shorten this procedure.
- The RED EU Type Examination Certificate No. **T818887N-01** issued by the Notified Body 0682 can be used for the OEM end product conformance 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 OEM end product conformity assessment procedure described in 2014/53/EU Directive and other applicable EU directives, the end customer equipment should be labelled as follows:



The requirements for CE marking are described in regulation (EU) No. 765/2008 Annex II.



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, Norway]), Monaco, San Marino, Andorra, and Turkey.

7 Restricted Use

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.

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.

8 Contact Details

8.1 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>

8.2 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>