

PAN9028

Wi-Fi Dual Band 2.4 GHz/5 GHz and Bluetooth® Module Module Integration Guide

Rev. 0.2



Overview

The PAN9028 is a 2.4 GHz/5 GHz ISM band Wi-Fi and Bluetooth radio module, which includes a wireless radio and a power management IC for easy integration of Wi-Fi and Bluetooth connectivity into various electronic devices.

Features

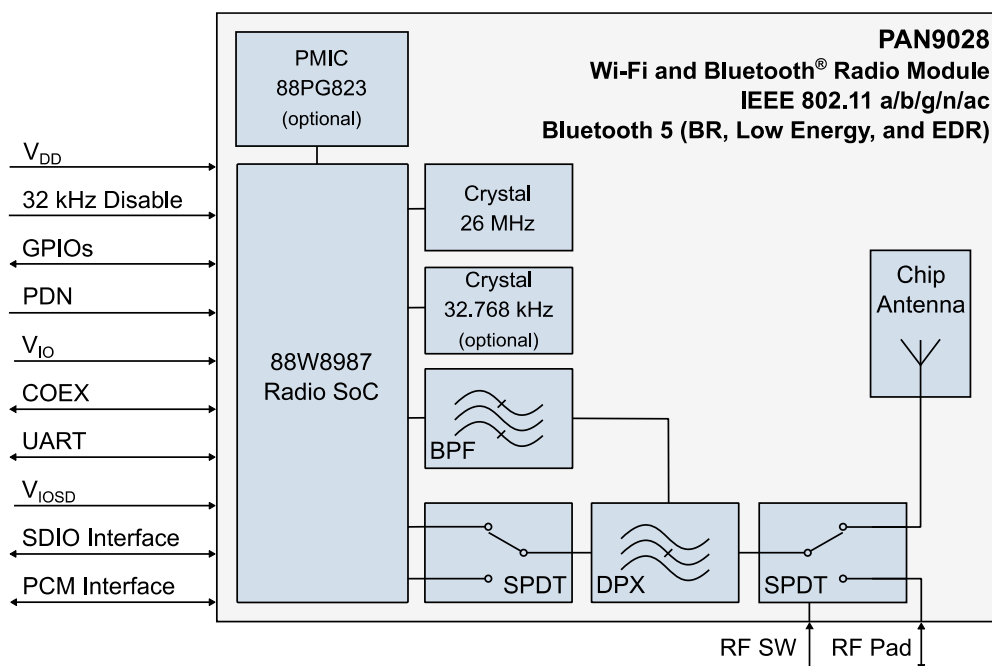
- Dual band 2.4 GHz/5 GHz 802.11 a/b/g/n/ac Wi-Fi and Bluetooth combo module
- Supports 802.11i security standards through AES, CCMP, and more security mechanism
- 802.11e Quality of Service is supported for multimedia application
- IEEE 802.11ac (Wave 2), 1x1 spatial stream with data rates up to 433 Mbps (MCS9, 80 MHz channel bandwidth)
- IEEE 802.11ac MU-MIMO beamformee
- Bluetooth 5 (includes Low Energy)
- Dual simultaneous and independent WLAN and Bluetooth operation
- Dynamic Rapid Channel Switching (DRCS) for simultaneous operation in 2.4 GHz and 5 GHz bands
- Indoor location and navigation with IEEE 802.11mc

- Power management with sleep clock
- Coexistence interface for arbitration of co-located WLAN, Bluetooth, or mobile wireless system (e.g. LTE or ZigBee®)
- Generic interfaces include SDIO 3.0 and high speed UART for host processor connection
- Software driver Linux®

Characteristics

- Surface Mount Type (SMT)
24 mm × 12 mm × 2.8 mm
- NXP® 88W8987 WLAN 2.4 GHz/5 GHz and Bluetooth single-chip solution inside
- Single power supply: 3.3 V with Marvell® 88PG823 Power Management IC (optional)
- Tx power: 16 dBm at 802.11b
- Rx sensitivity: -97 dBm at 802.11b DSSS 1 Mbps
- IEEE 802.11ac 20 MHz, 40 MHz, 80 MHz channel bandwidth
- Long and Short Guard Interval support
- Current consumption Wi-Fi typical 320 mA (at Tx) and 70 mA (at Rx)
- SDIO 1 bit or 4 bit
- Wide temperature range of -30 °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 PAN9028 into a product and to ensure the compliance with regulatory requirements.

This guide gives an overview about the hardware design requirements by providing a reference design, which is the evaluation board of the PAN9028.




It is intended for hardware design and Original Equipment Manufacturers (OEM) engineers.

The product is referred to as “the PAN9028” or “the module” within this document.

1.2 Revision History

Revision	Date	Modifications/Remarks
0.1	2018-05-08	First preliminary version
0.2	2021-03-15	Changed SDIO stick to mSD stick. New design. Updated formatting. Changed document type and structure (“Design Guide” into “Module Integration Guide”). Corrected current consumption. Corrected cutout area. Updated chapter “Power Supply”. Removed chapter “Power Configuration Examples for ENWF940[x]A1EF”. Updated chapter “Placement”. Updated picture “Solder Mask Layout”. Updated chapter “Functional Blocks”.

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.

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

1.4 Related Documents

For related documents please refer to the Panasonic website ⇒ [11.2 Product Information](#).

2 Overview

The PAN9028 is a dual band 2.4 GHz and 5 GHz 802.11 a/b/g/n/ac Wi-Fi radio module with integrated Bluetooth BR/EDR/Low Energy (LE), specifically designed for highly integrated and cost-effective applications. The simultaneous and independent operation of the two standards enables very high data rates (802.11ac) and low-power operation (Bluetooth LE). Integrated power management, a fast dual-core CPU, 802.11i security standard support, and high-speed data interfaces deliver the performance for the speed, reliability, and quality requirements of next generation products. Tx power calibration data, Wi-Fi, and Bluetooth system parameters are pre-stored on the One Time Programmable memory of the PAN9028 during production at Panasonic. This simplifies passing the certification process for PAN9028 customers. Furthermore, the module reduces design, test, and calibration effort resulting in reduced time-to-market compared to discrete solutions.

Integrating Wi-Fi and Bluetooth wireless connectivity allows high throughput applications for industrial devices and appliances. The combination of Wi-Fi and Bluetooth provides the highest flexibility for connectivity.

This Module Integration Guide applies to the PAN9028 WLAN/Bluetooth combo module and the PAN9028 mSDIO Adapter development platform.

This document is structured into two main parts:

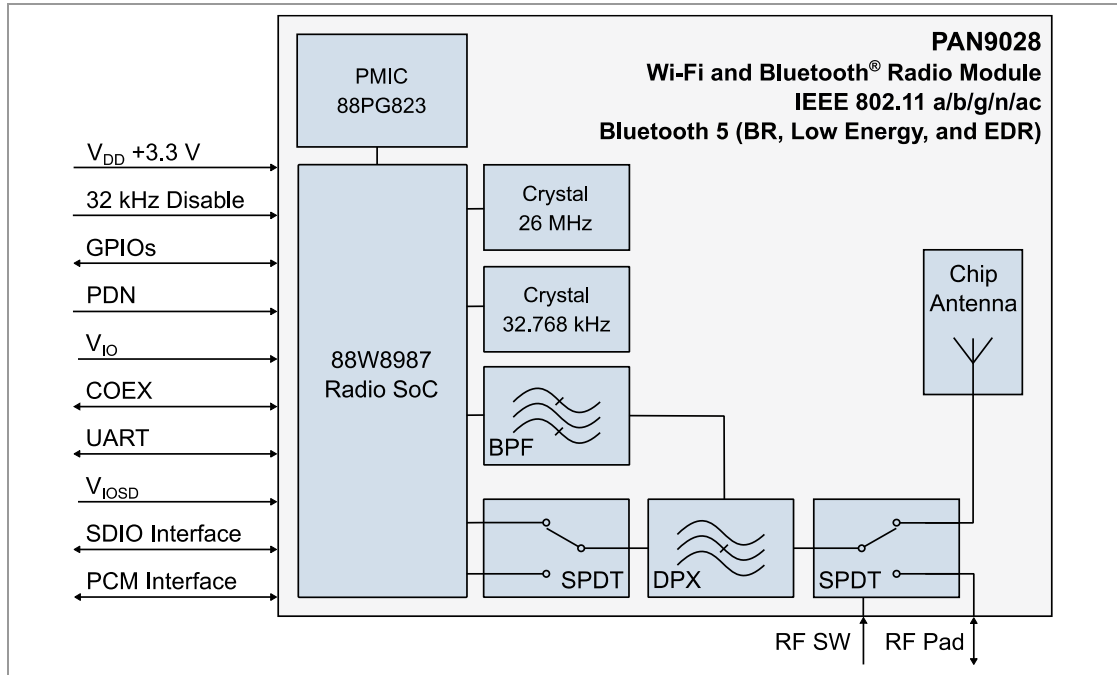
- The hardware integration of the PAN9028 module.
- The PAN9028 mSDIO Adapter as an example for the module integration.

For related documents please refer to [⇒ 11.2 Product Information](#).

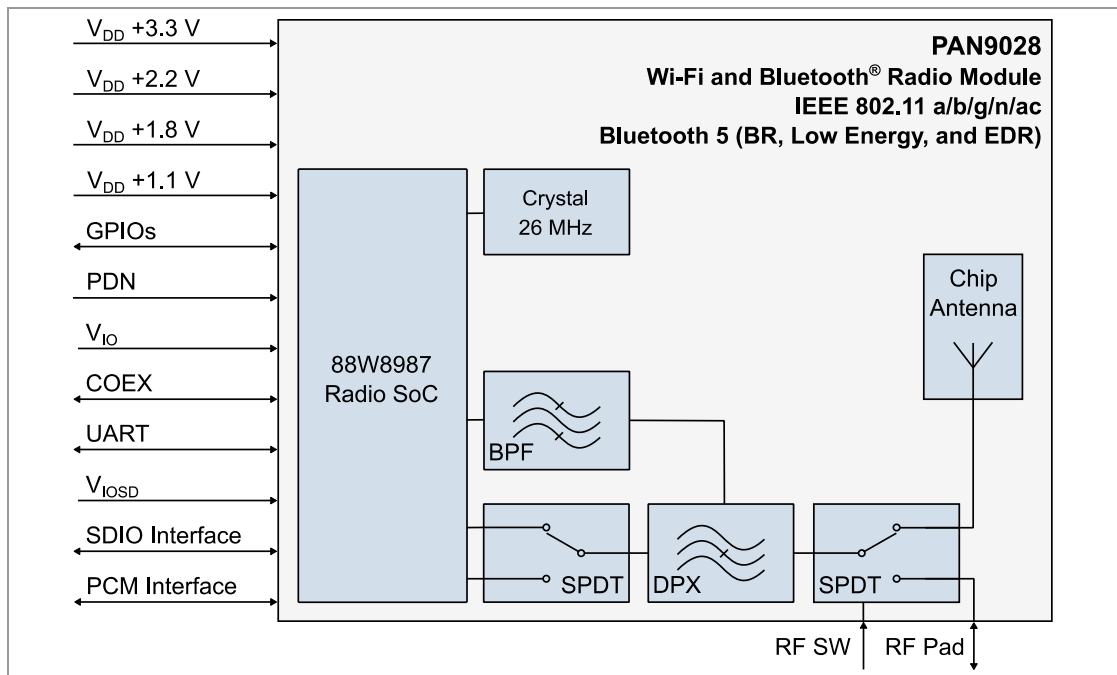
3 PAN9028 Module

3.1 Block Diagram

For Module Variant ENWF940[x]A1EF:



For Module Variant ENWF940[x]A2EF:



3.2 Land Pattern

For Module Variant ENWF940[x]A1EF:

Top View

	1	2	3	4	5	6	7	8	9	10	11	12			
G	VOUT 2.2V	VOUT 2.2V	VIO	VOUT 1.8V	SD_CLK	SD_CMD	SD_DAT0	SD_DAT1	SD_DAT2	SD_DAT3	GND	RF	G		
F	GND	VDD 3.3V	VDD 3.3V	VIO_SD	GPIO	GPIO	GPIO	GPIO	GPIO	GPIO	GND	GND	F		
E	GPIO	EP 1			EP 2		DNC	EP 1			EP 2		GND	GND	E
D	PG2						CONFIG HOST[0]						GND	GND	D
C	PGLDO						CONFIG AUTO REF DET						GND	GND	C
B	PG1	GPIO	32 kHz Stand-by	GPIO	PDN	UART	UART	UART	GPIO	GPIO	RF_SW1	GND	B		
A	GND	EN PMIC	VOUT 1.1 V	GPIO	DNC	UART	UART	UART	DNC	GPIO	RF_SW2	GND	A		
	1	2	3	4	5	6	7	8	9	10	11	12			

For Module Variant ENWF940[x]A2EF:

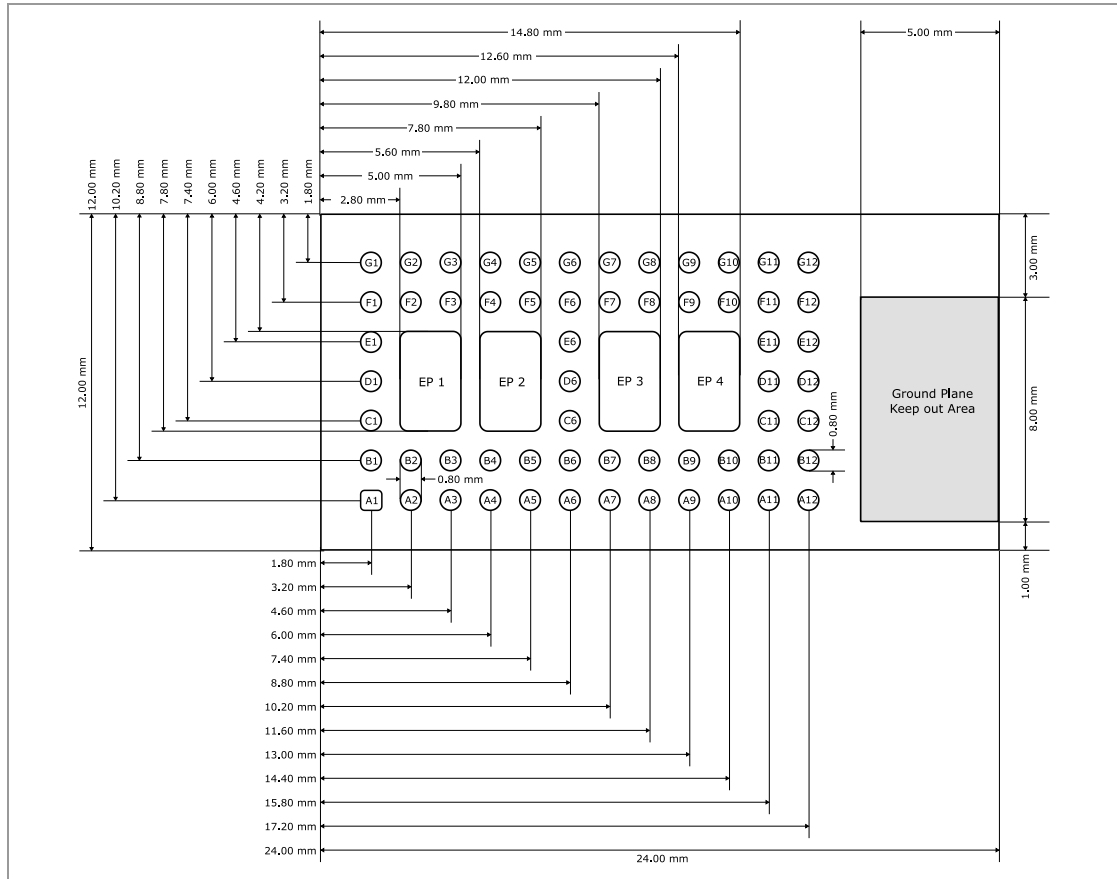
Top View

	1	2	3	4	5	6	7	8	9	10	11	12			
G	VDD 2.2V	VDD 2.2V	VIO	VDD 1.8V	SD_CLK	SD_CMD	SD_DAT0	SD_DAT1	SD_DAT2	SD_DAT3	GND	RF	G		
F	GND	VDD 3.3V	VDD 3.3V	VIO_SD	GPIO	GPIO	GPIO	GPIO	GPIO	GPIO	GND	GND	F		
E	GPIO	EP 1			EP 2		DNC	EP 1			EP 2		GND	GND	E
D	DNC						CONFIG HOST[0]						GND	GND	D
C	DNC						CONFIG AUTO REF DET						GND	GND	C
B	DNC	GPIO	DNC	GPIO	PDN	UART	UART	UART	GPIO	GPIO	RF_SW1	GND	B		
A	GND	DNC	VDD 1.1 V	GPIO	DNC	UART	UART	UART	DNC	GPIO	RF_SW2	GND	A		
	1	2	3	4	5	6	7	8	9	10	11	12			

3.3 Footprint



The outer dimensions have a tolerance of ± 0.35 mm.

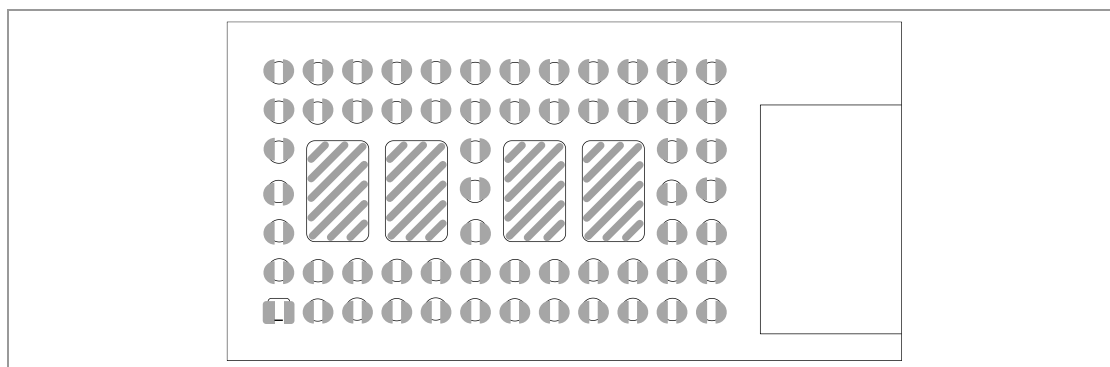


3.4 Solder Mask

It is recommended to use the following layout for the soldering mask to reduce voids on the thermal pads. Use the dimensions:

- ✓ The Resist Mask should be 50 μm bigger than the pad size (\Rightarrow 3.3 Footprint).
- ✓ The Solder Mask should be 50 μm smaller than the pad size (\Rightarrow 3.3 Footprint); they are separated in two semi circles with 300 μm distance and a shifting about 150 μm .

Layout



3.5 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 8 mm x 5 mm under the PAN9028 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 PAN9028 evaluation board.

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

Antenna Placement Recommendation



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

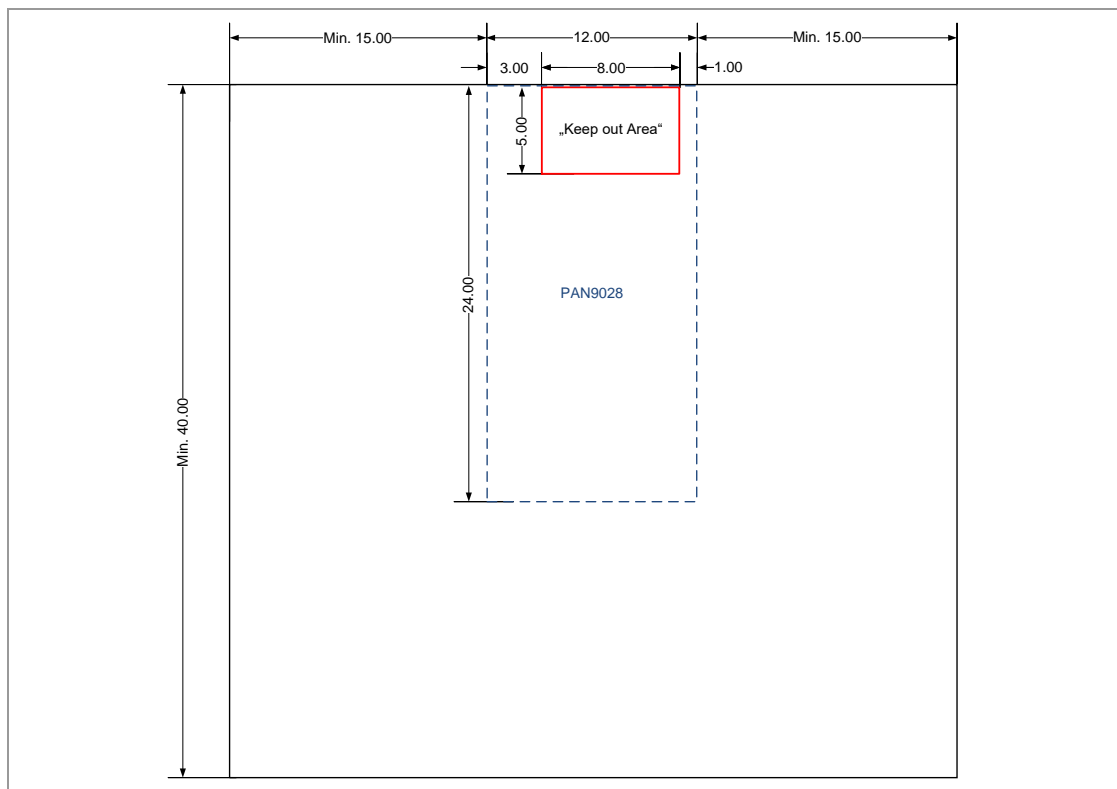


All dimensions are in millimeters.

It is recommended to place the module:

- In the center (horizontal) of mother PCB.
- At the edge (horizontal) of mother PCB.

Top View



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). 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).
- ✓ The supply voltage should not be exceedingly high or reversed. It should not carry noise and/or spikes.



ENWF940[x]A1EF: The V_{OUT1V1} , V_{OUT1V8} and V_{OUT2V2} power supply pins are only for internal purpose. Do not use them to power external circuits.



Take care to follow correct power-up sequence of module which is specified in PAN9028 product specification.

5 RF Path

5.1 External Antenna



Antenna Warning

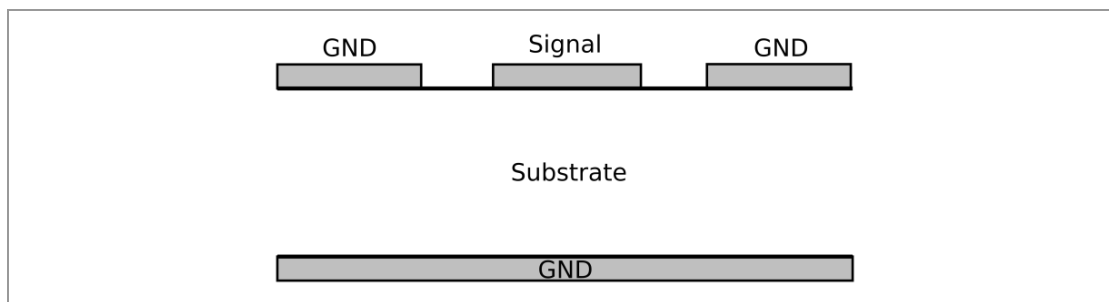
The PAN9028 is tested with a standard U.FL connector and with the antenna listed in the regulatory and certification chapter of the “PAN9028 Product Specification”. When integrated into the OEM's product, these fixed antennas require installation preventing end users from replacing them with non-approved antennas.

Any antenna not in the regulatory and certification chapter of the “PAN9028 Product Specification” must be tested to comply with FCC Section 15.203 for unique antenna connectors and with Section 15.247 for emissions.

The PAN9028 module has a 50 ohm 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 ohm ⇒ [5.2 RF Trace](#).

5.2 RF Trace

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

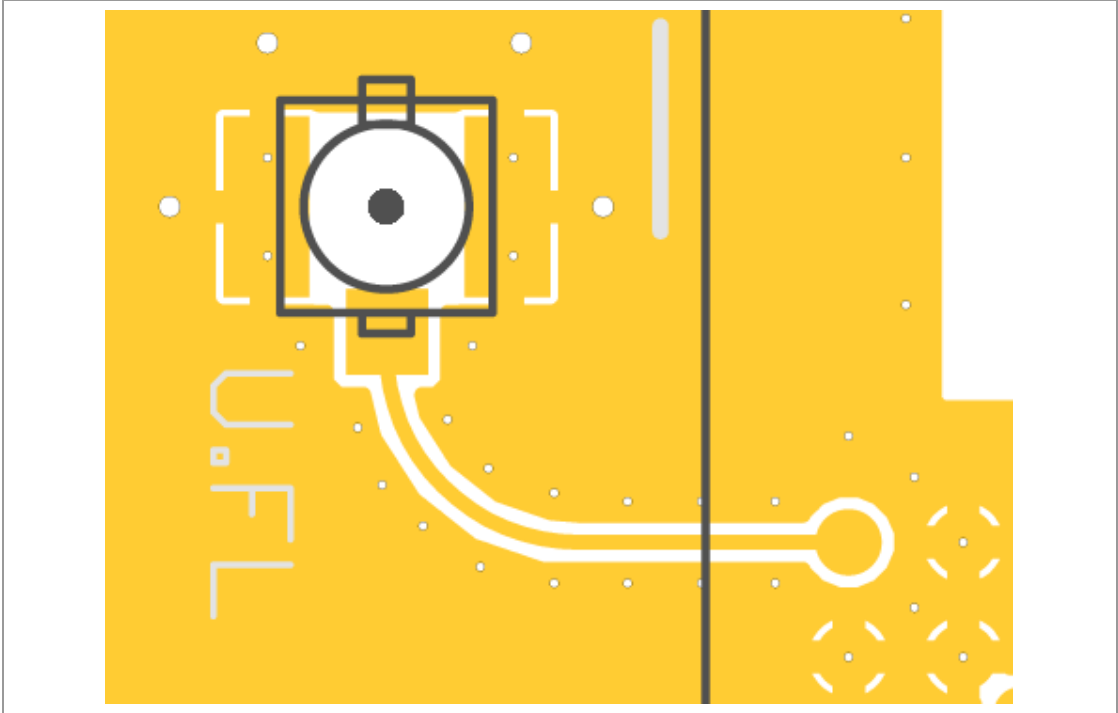
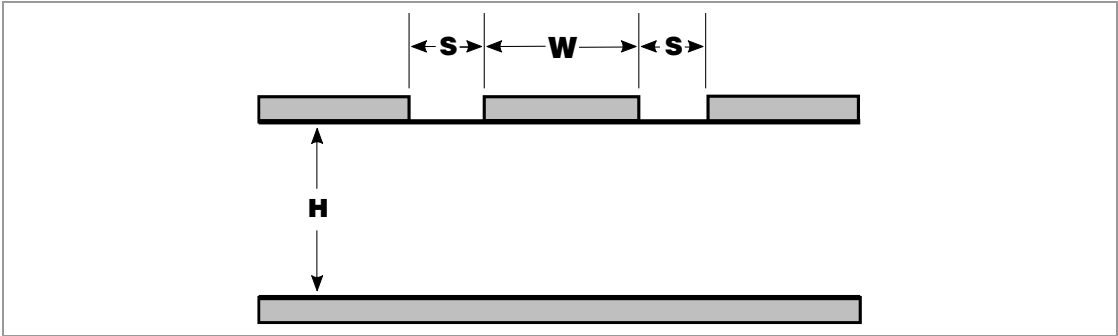


The following design recommendation shall be met:

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

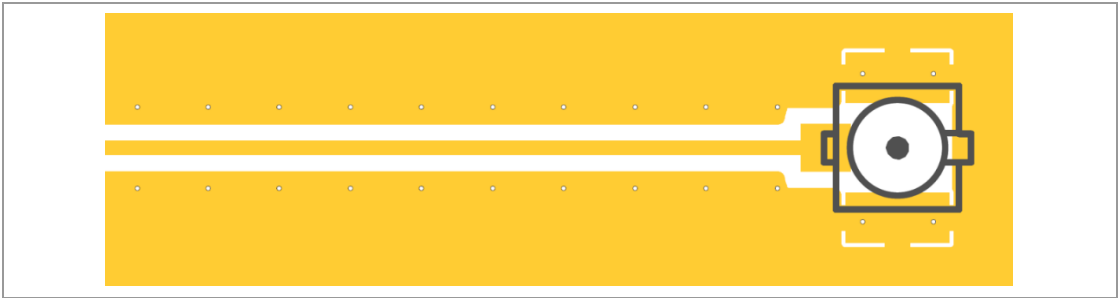
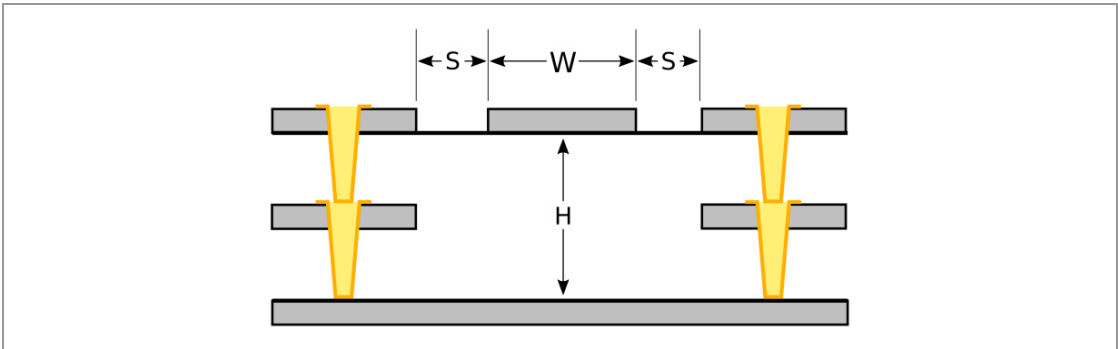
Example 1: 50 ohm Coplanar Waveguide with Ground on mSDIO Adapter

Trace width	$W = 180 \mu\text{m}$
Trace distance to ground	$S = 150 \mu\text{m}$
Substrate thickness	$H = 80 \mu\text{m}$
Effective permittivity	$\epsilon_r = 3.9$
Loss tangent	$\tan \delta = 0.015$



Example 2: 50 ohm Coplanar Waveguide with Ground and Micro Vias

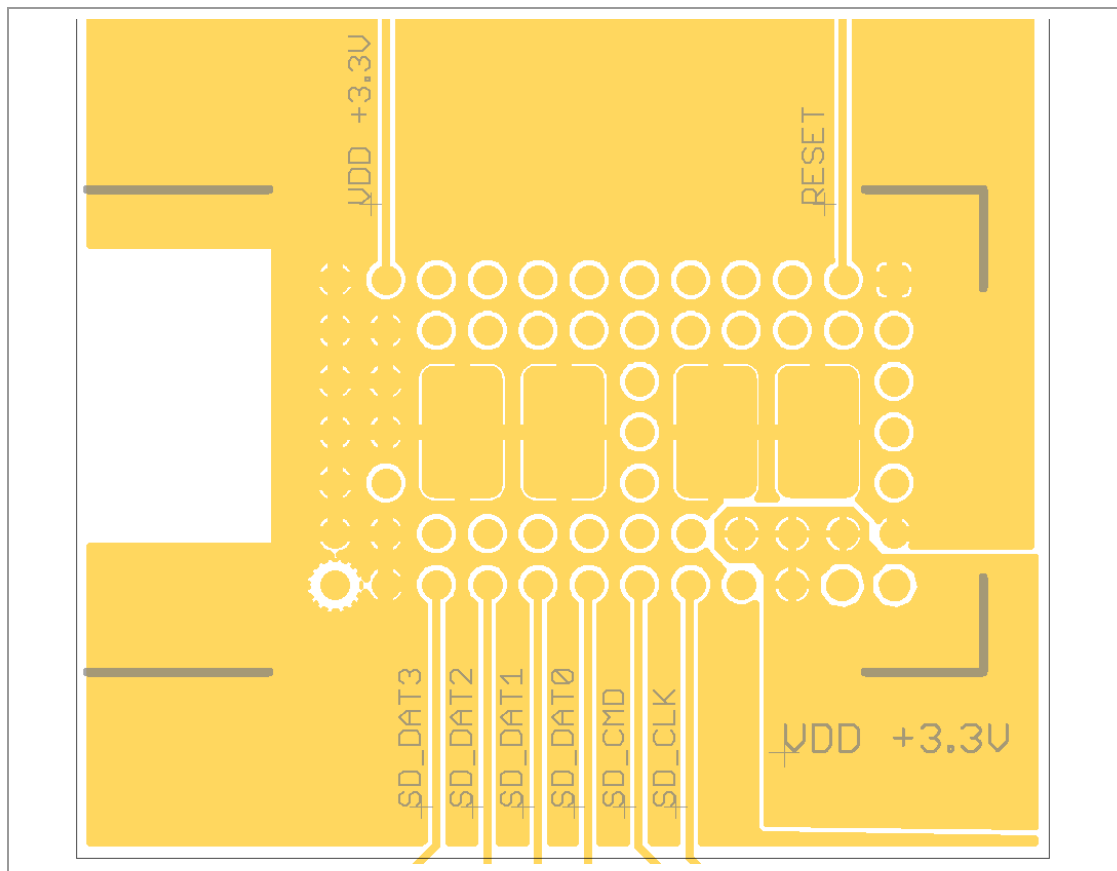
Trace width	$W = 300 \mu\text{m}$
Trace distance to ground	$S = 300 \mu\text{m}$
Substrate thickness	$H = 160 \mu\text{m}$
Effective permittivity	$\epsilon_r = 4.2$
Loss tangent	$\tan \delta = 0.006$



6 One-Layer Example for Module Variant ENWF940[x]A1EF

Functionality

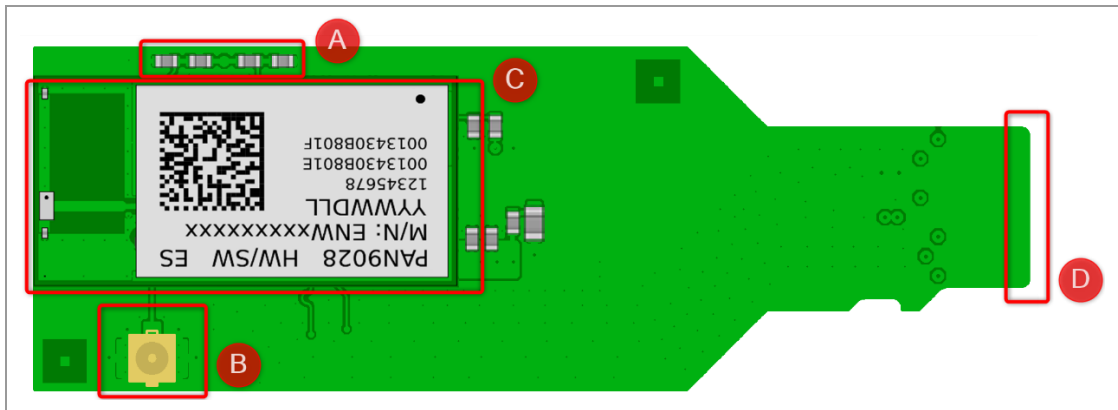
- WLAN interface: SDIO with 3.3 V
- Bluetooth interface: SDIO with 3.3 V
- On-board antenna
- No GPIOs connected
- Reset available



7 mSDIO Adapter

7.1 Functional Blocks

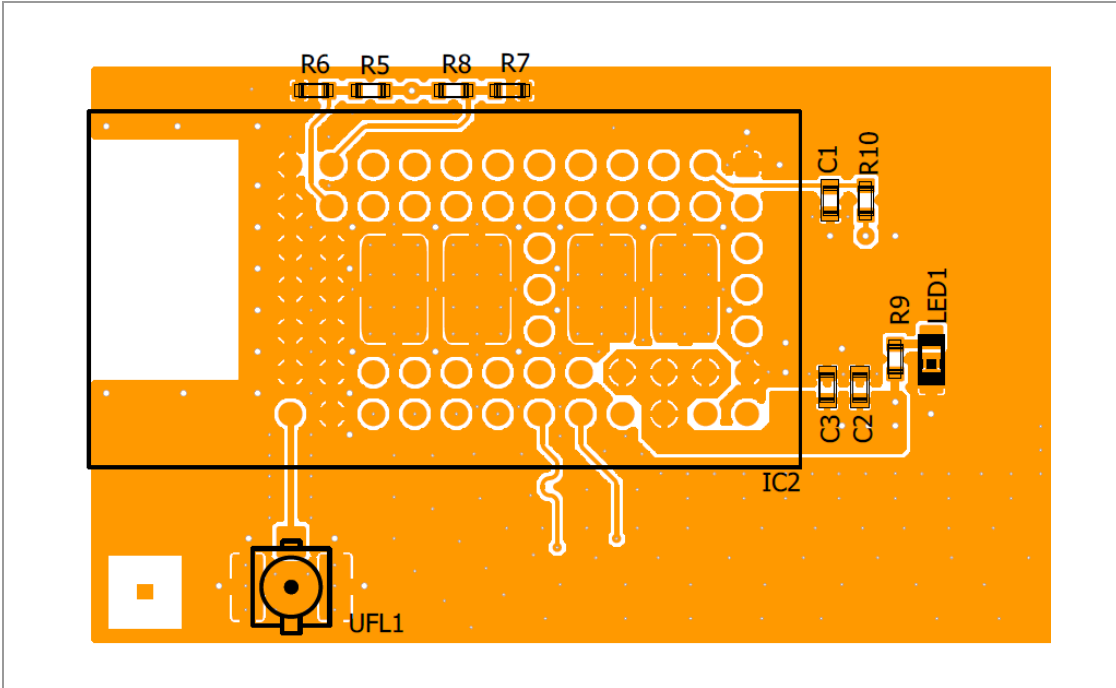
Functional Block	Description	Interface
A	On-board antenna or bottom pad selection	
B	U.FL connector	X1
C	PAN9028 module	
D	SDIO interface	



7.2 Resistor Jumper Configuration

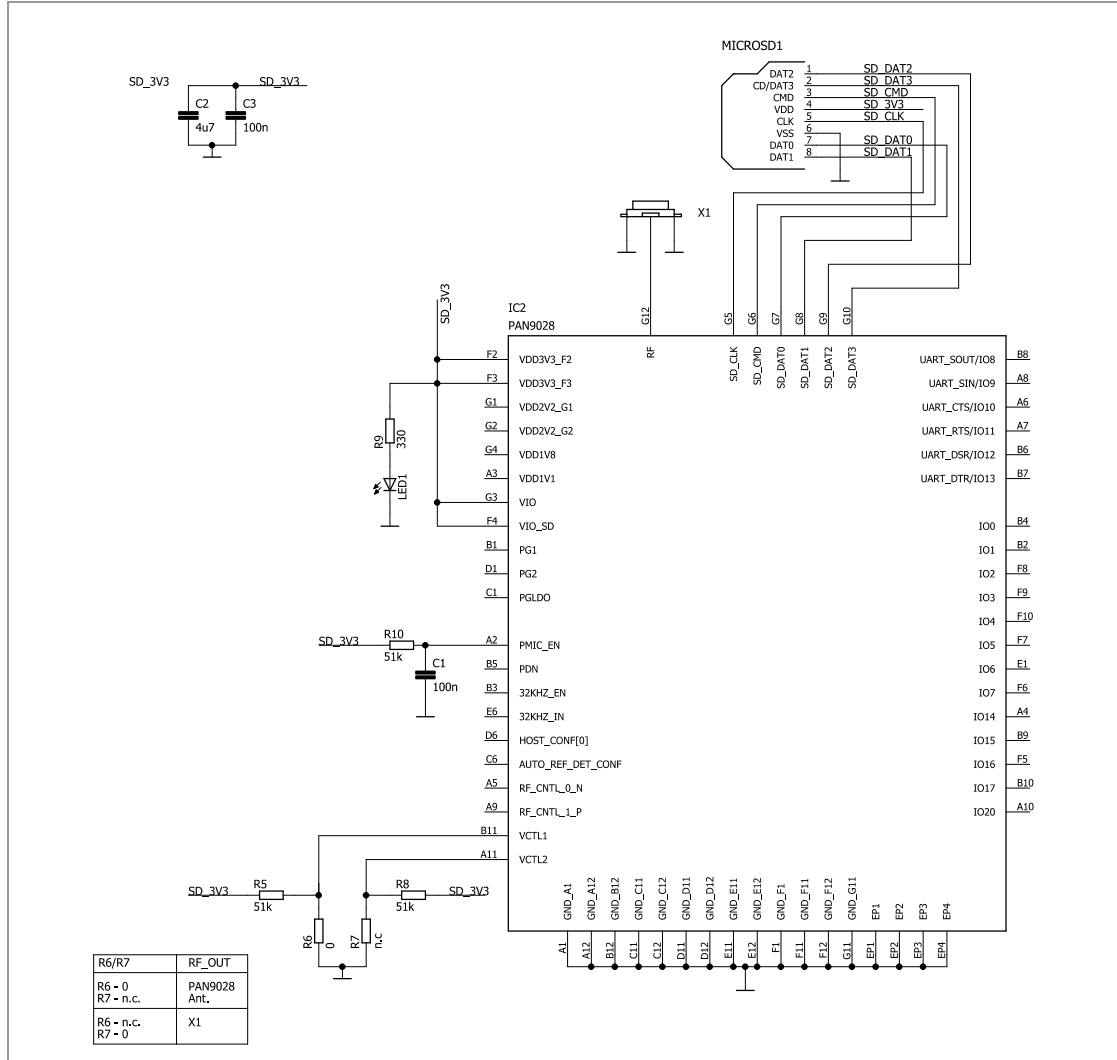
R6	R7	RF-Out
0R	n.c.	PAN9028 chip antenna
n.c.	0R	RF-UFL X1 connector

7.3 Part Placement



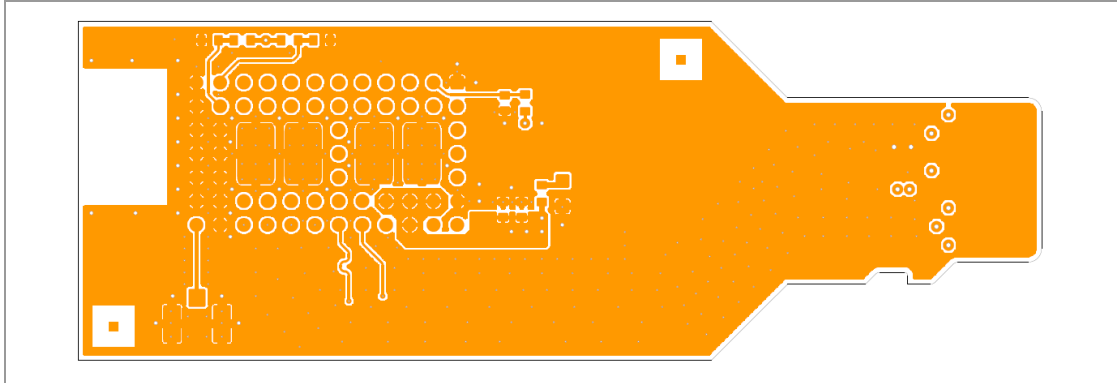
8 Reference Design

8.1 Schematic

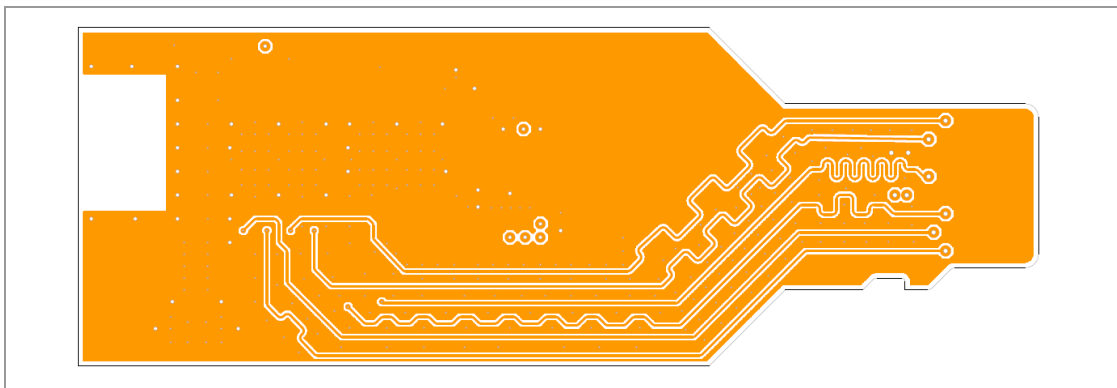


8.2 PCB Layout

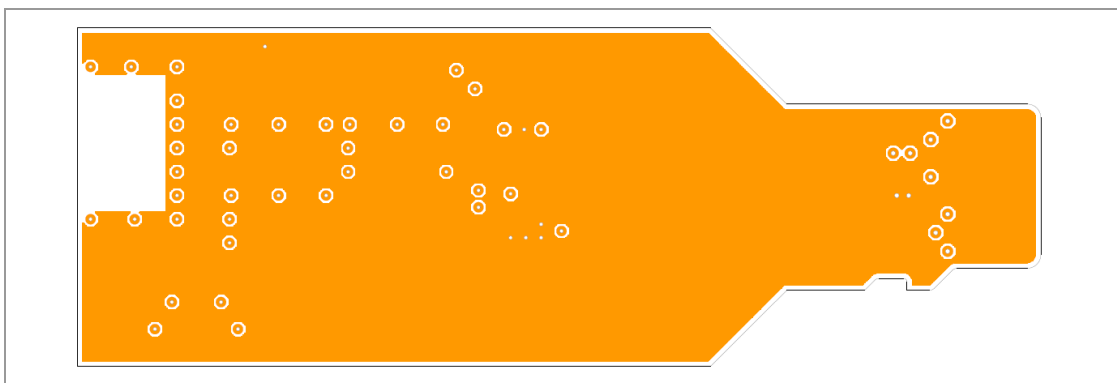
8.2.1 Top Layer



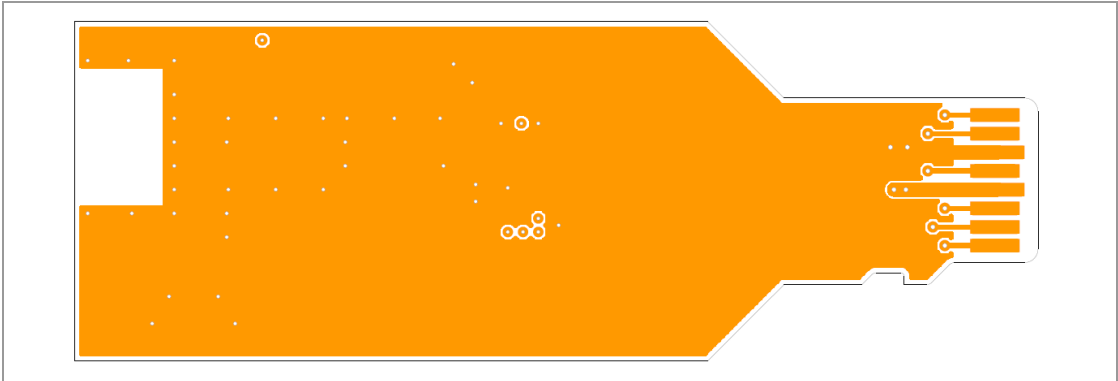
8.2.2 Second Layer



8.2.3 Third Layer



8.2.4 Bottom Layer



9 Regulatory and Certification Information

TBD

10 Restricted Use

10.1 Life Support Policy

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<https://na.industrial.panasonic.com/distributors>

Please visit the **Panasonic Wireless Technical Forum** to submit a question at

<https://forum.na.industrial.panasonic.com>

11.2 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>