PAN9320

Reference & Design Guide

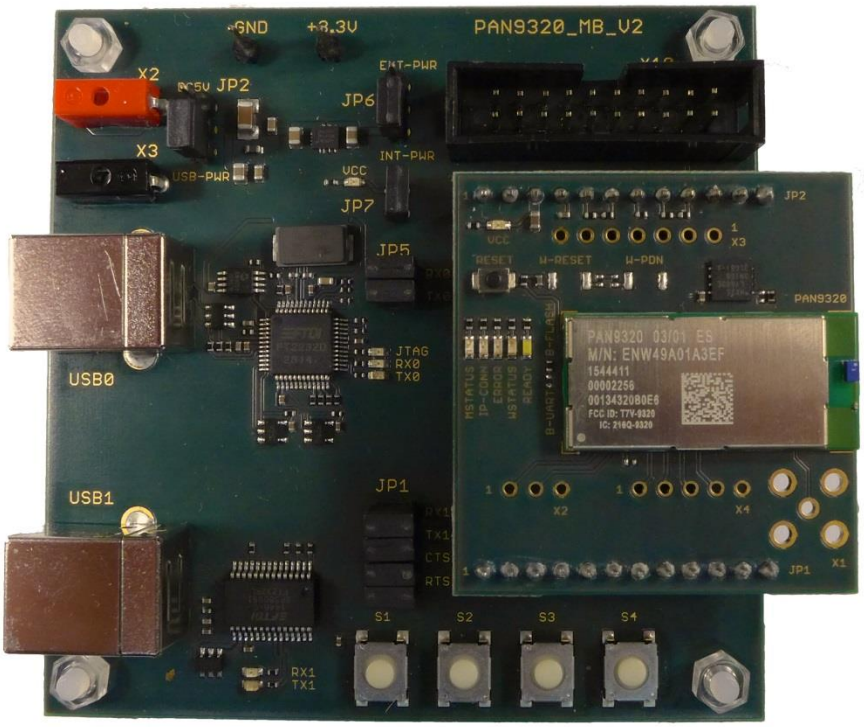


TABLE OF CONTENTS

1. SCOPE OF THIS DOCUMENT

This Reference and Design Guide covers the PAN9320/10-ETU (Easy-To-Use) and PAN9320-MB (Mother board) and its Development Kit. The goal of this document is to allow and guide users to easily and promptly integrate the PAN9320 and PAN9310 into end-products.

This guide describes the hardware and system concepts and gives useful usage and integration guidance. Software related documents are mentioned in the Quick Start Guide[3] and Communication Specification[4].

2. ORDERING INFORMATION

Ordering P/N	KIT Name	Hardware		Module on ETU	Description
		MB	ETU		
ENW49A01AYEF	PAN9320-KIT	V2	V2.1	ENW49A01A3EF	PAN9320 Development Kit with one PAN9320-MB and one PAN9320-ETU including two HS USB cable
ENW49A01AZEF	PAN9320-ETU	-	V2.1	ENW49A01A3EF	PAN9320-ETU Daughter board with PAN9320 module (incl. Chip-ANT)
ENW49A01CZEF	PAN9310-ETU	-	V2.1	ENW49A01C3EF	PAN9310-ETU Daughter board with PAN9310 module and SMA connector

3. HISTORY FOR THIS DOCUMENT

Revision	Date	Modification / Remarks
1.0	26.11.2015	Initial Release
1.1	16.12.2015	12.5.1 Schematic – Correction of C1

4. RELATED DOCUMENTS

[1] PAN9320 Datasheet
PAN9320 Download Page (Datasheet)

[2] PAN9320 Flyer
PAN9320 Download Page (Flyer)

[3] PAN9320 Quick Start Guide
PAN9320 Download Page (Quick Start Guide)

[4] PAN9320 Comm Specification
PAN9320 Download Page (Communication Specification)

[5] PAN9320 Application Note
PAN9320 Download Page (Application Note)

5. PAN9320 KEY BENEFITS

- Surface Mount Type (SMT) measured 29.0 x 13.5 x 2.66 [mm]³
- Wireless Local Area Network (WLAN) module with integrated MCU and Radio
- Operating in the 2.4GHz ISM band
- Supports the following IEEE 802.11 standards:
  - IEEE 802.11b/g payload data rates
  - IEEE 802.11n high throughput data rates
  - IEEE 802.11i security: WEP, and WPA/WPA2 (TKIP, AES-CCMP)
  - IEEE 802.11e Quality of Service (QoS)
- TX power up to +18dBm (IEEE 802.11b)
- Outstanding Rx sensitivity
  - -98dBm (IEEE 802.11b DSSS 1Mbps)
  - -75dBm (IEEE 802.11g OFDM 54Mbps)
  - -73dBm (IEEE 802.11n MCS7 HT20 65Mbps)
  - -70dBm (IEEE 802.11n MCS7 HT40 135Mbps)
- Coexistence interface for external co-located 2.4GHz radios (e.g. Bluetooth)
- Internal crystal oscillators for Radio (40MHz) and MCU (32MHz) inside
- Integrated memory for customer web contents and configuration file (1MByte)
- Memory extension with an external QSPI flash (2MByte) is optional
- Two UART interfaces (command and binary data)
- Integrated shielding to resist EMI
- Available with either integrated antenna (PAN9320) or dedicated RF pad for external antennas (PAN9310)

6. WIRELESS LOCAL AREA NETWORK OVERVIEW

A Wireless Local Area Network (WLAN) is a medium range, wireless network based on the IEEE 802.11 standard, and uses the ubiquities ISM (Industrial, Scientific and Medical) frequency range of 2,4GHz. The 802.11 standard pertains to the first two layers of the OSI model, and covers Physical Layer (PHY), the Data Link Layer (DLL) with its two sub-layers: Logical Link Control (LLC), and Media Access Control (MAC). WLAN networks utilize two operating modes to connect stations (STAs) equipped with a wireless network adapter. The first is known as the Infrastructure Mode where the wireless STAs are connected via one or more access points (APs). An AP is a device that allows STAs to connect with each other or to a wired network. The second is the Ad-hoc mode, where wireless STAs are connected without any access point.

WLAN devices typically have a high transmit power, of 15 to 20 dBm, allowing them to reach a range of up to 100 meters. Furthermore, WLAN devices are commonly used to transmit high throughput data such as Audio or Video streaming using Orthogonal Frequency Division Multiplexing (OFDM) modulation. The Carrier Sense Multiple Access with Collosion Avoidance (CSMA/CA) mechanism enables the parallel access of more than one device to the wireless medium of a IEEE 802.11 network. The following security mechanisms are deployed: 1. Adavanced Encryption Standard (AES) with Counter Mode CBC-MAC Protocol (CCMP), 2. Cipher-Based Message Authentication Code (CMAC) and 3. Wired Equivalent Privacy (WEP) with Temporal Key Integrity Protocol (TKIP). Video, voice and multimedia applications are supported by the IEEE 802.11e Quality of Service amendment.

7. DESCRIPTION OF THE PAN9320

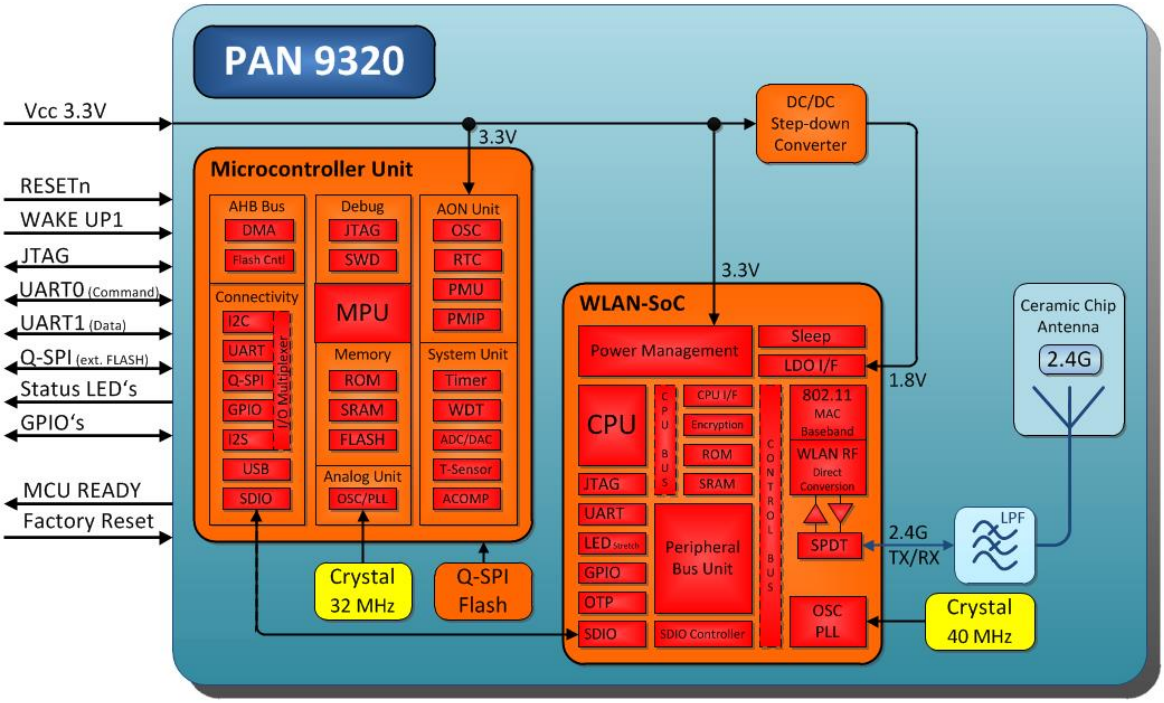
The PAN9320 module is a WLAN embedded module with a 2.4GHz ISM band wireless radio and an MCU for introduce WLAN connectivity into various electronic devices. A block diagram can be found in chapter 15.

The module is a cost-effective, low-power, fully embedded WLAN solution for the Internet of Things (IoT). It offers the customer an easy integration with a low bill-of-material. The module offers Internet functionality through HTML and JavaScript Web technologies. The PAN9320 combines advanced 802.11 wireless radio, baseband processor, medium access controller (MAC), and encryption units, controlled by a powerful CPU. Furthermore, MCU offers an in-system programmable flash memory as well as many other powerful supporting features and peripherals. The module is suitable for wireless network systems based on IEEE 802.11 b/g/n 2.4GHz where small form factor, highly integration, high throughput data rates and low RF expertise are required. It supports simultaneous Access-Point and Infrastructure Mode.

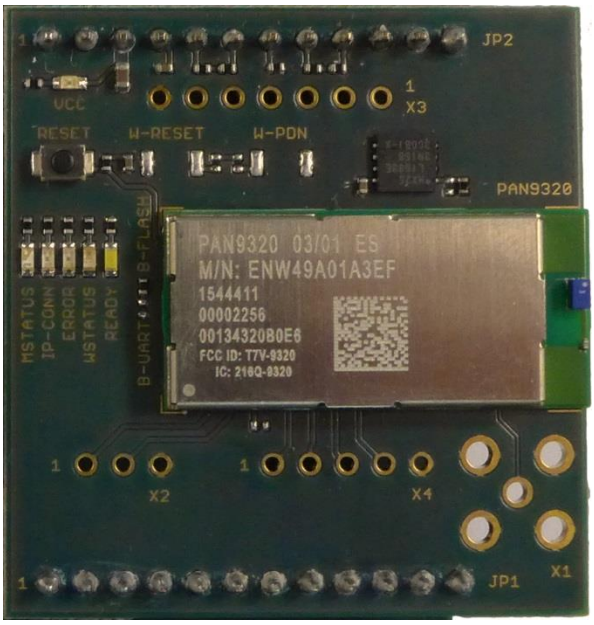
The PAN9320 integrated MCU's firmware consists of software modules with TCP/IP Network Stack, TLS1.2 Security Suite, UDP Name Services and various applications like Web Server, SMTP(s) Client, HTTP(s) Client and Cloud Communication Client on top of the 802.11 WLAN stack with WPA/WPA2 Supplicant.

The integrated flash is used for customer web contents and configuration files with a usable memory size of 1 MByte. The memory size can be extended by using an external QSPI flash memory of 2 MByte. The radio driver, MCU firmware, configuration files and web content can be updated Over-The-Air (OTA).

8. BLOCK DIAGRAM PAN9320



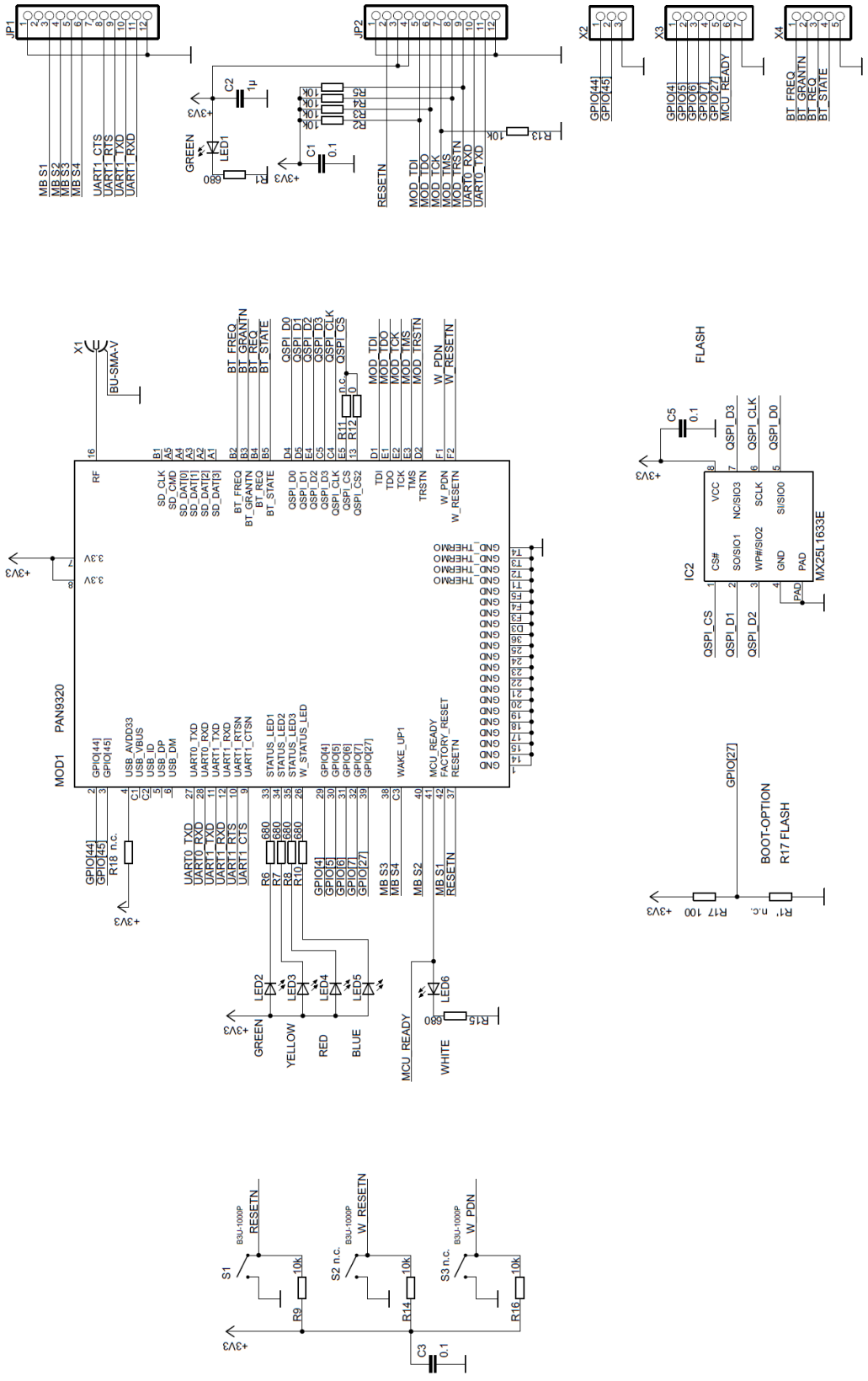
9. PAN9320-ETU (EASY-TO-USE) DAUGHTER BOARD



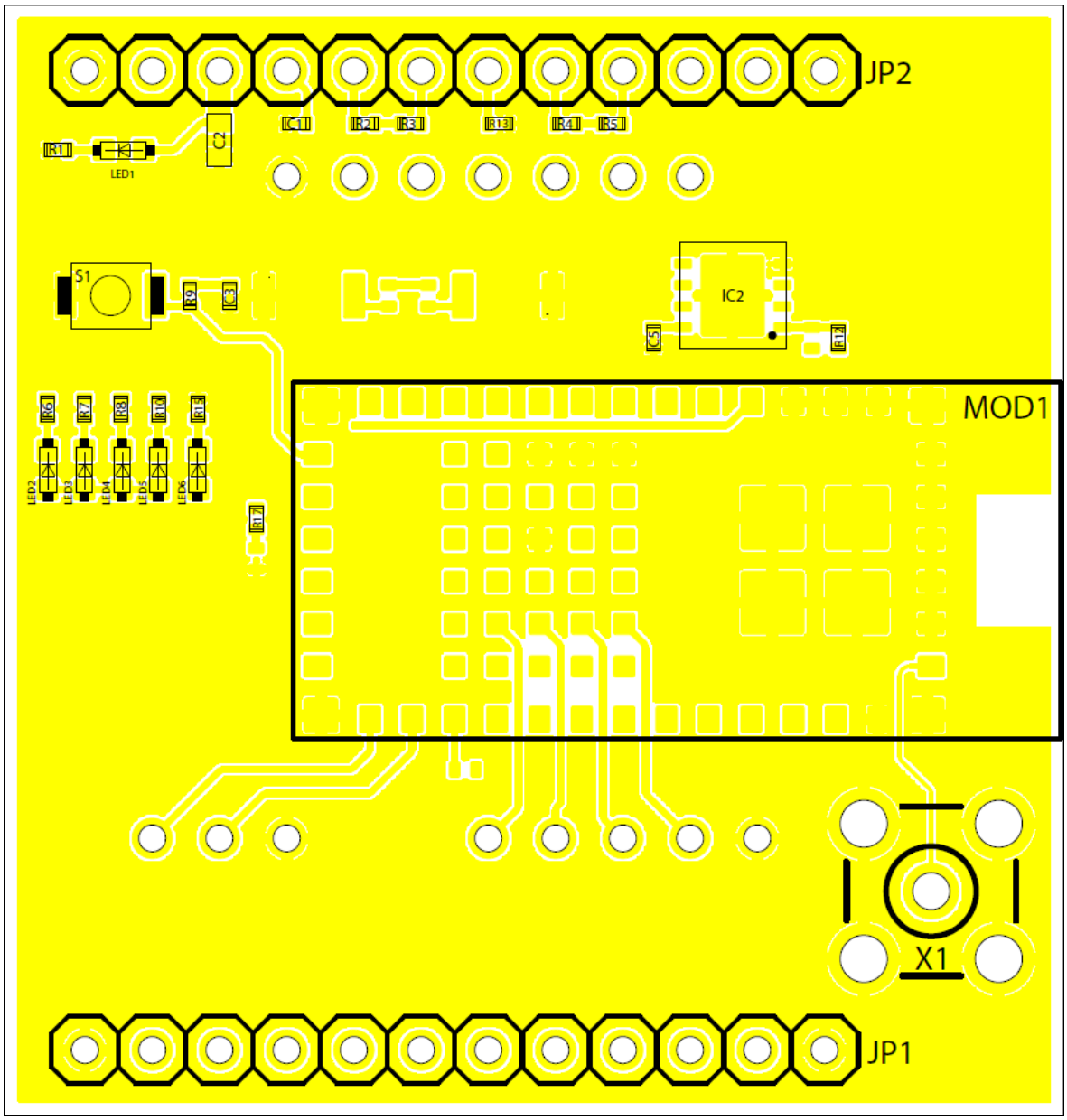
9.1. Functionality

- PAN9320-ETU Daughter board dimensions: 42.0 x 40.0 x 11.6 [mm]³
- On-board PAN9320 module with firmware and Panasonic web content example
- Separate daughter board with the PAN9310 module and SMA connector for use with an external antenna
- Two 12 pin-headers for easy integration into customer products
- Plug & Play by integrated firmware boot loader
- Automatically configured Access-Point available after power-up
- HTTP(s) connection to the PAN9320 embedded Web Server using a web-browser
- 2-wire UART0 as command interface for external HOST MCU
- 4-wire UART1 as NetCat tunnel (binary data) for TCP data communication
- Visual indications:
  - Green LED showing power status
  - Four LED's for MCU states: Ready, Heartbeat, IP-Connectivity and Error
  - Blue LED for WLAN Infrastructure connectivity (scan and connection status)
- Other peripherals:
  - Reset button for MCU
  - Seven GPIO's with Input, Output and On/Off functionality
  - GPIO pin for Factory Reset functionality
  - GPIO pin for wake-up after shut-off by UART command
  - Bluetooth Coexistence interface (4-wire)
  - QSPI interface connected to additional on-board flash memory (option)
- JTAG interface for MCU firmware programming using SEGGER programmer

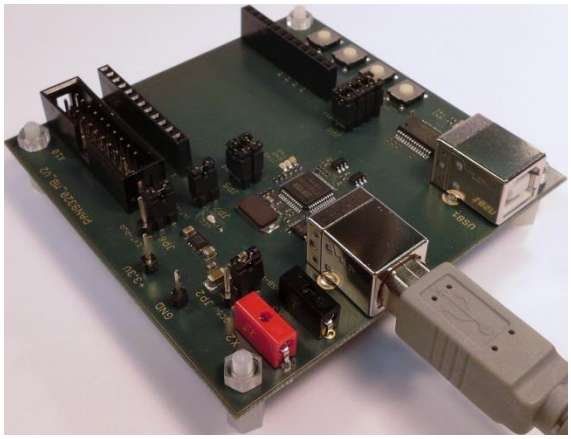
9.2. Schematic



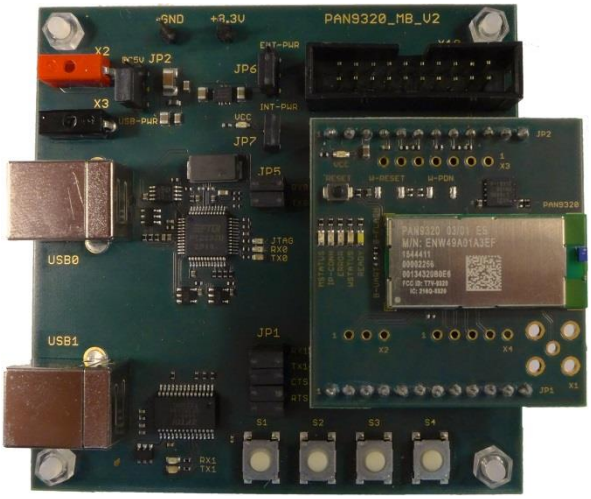
9.3. Placement Drawing



10. PAN9320-MB MOTHER BOARD



Mother board without PAN9320-ETU

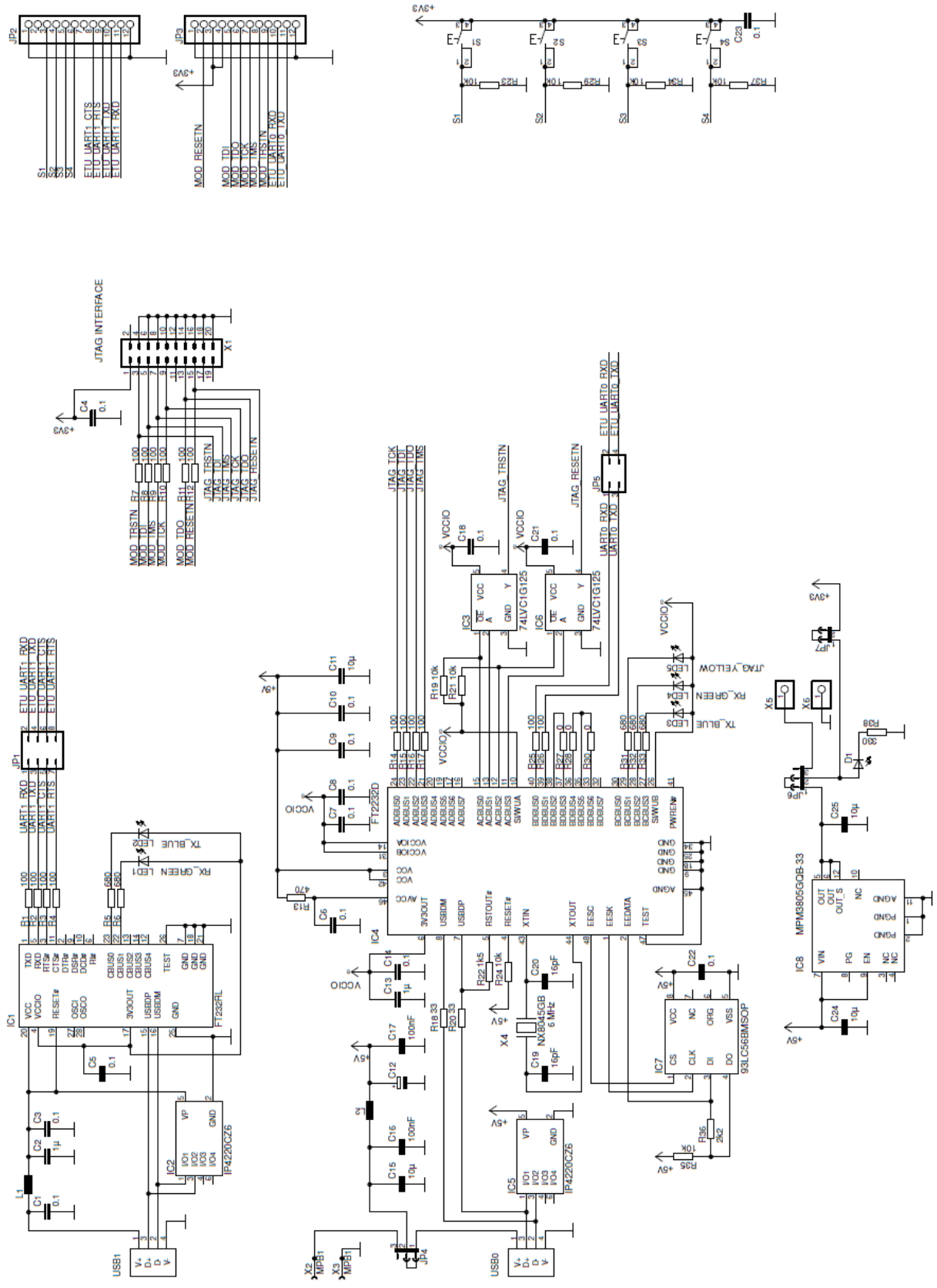


Mother board with equipped PAN9320-ETU

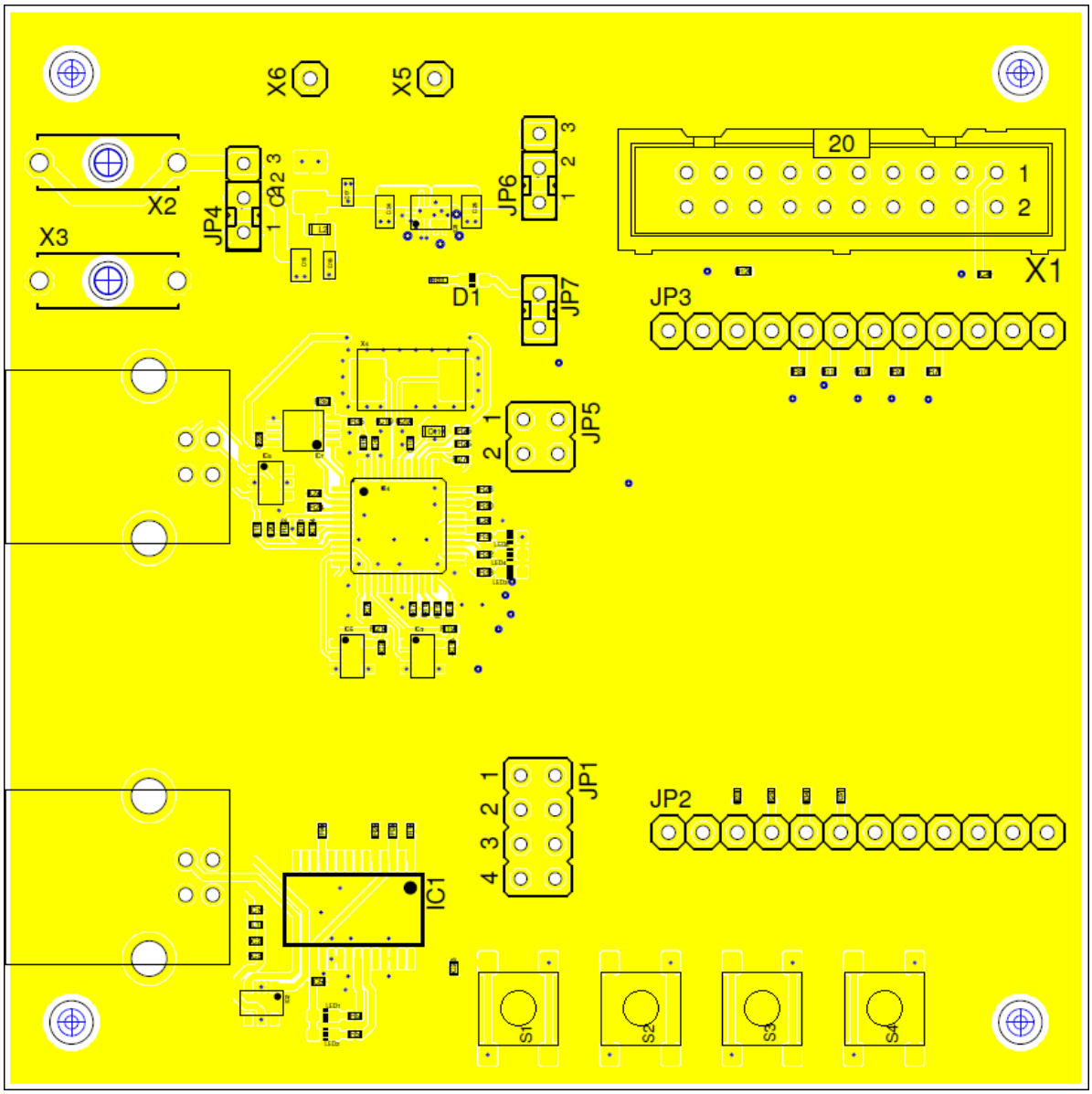
10.1. Functionality

- PAN9320-MB Mother board dimensions: 80.0 x 80.0 x 22.2 [mm]³ (height w/o ETU)
- Two female 12-pin-sockets to connect the PAN9320-ETU Daughter board
- Two mini power sockets (red & black) for external 5V DC power supply
- On-board circuitry:
  - 5V-to-3.3V DC-DC step-down converter for PAN9320 power supply
  - Dual FTDI USB-to-UART Converter using:
    - 1st COM-Port for PAN9320 UART0 command interface
    - 2nd COM-Port for JTAG programming by OpenOCD tool chain
  - Single FTDI USB-to-UART converter using COM-Port for PAN9320 UART1 NetCat tunnel interface
- Visual indications:
  - Green LED showing power status
  - Three LEDs for Dual FTDI (UART0): JTAG, RX0 and TX0
  - Two LEDs for Single FTDI (UART1): RX1 and TX1
- 20 pin JTAG connector to connect the SEGGER J-Link Programmer

10.2. Schematic



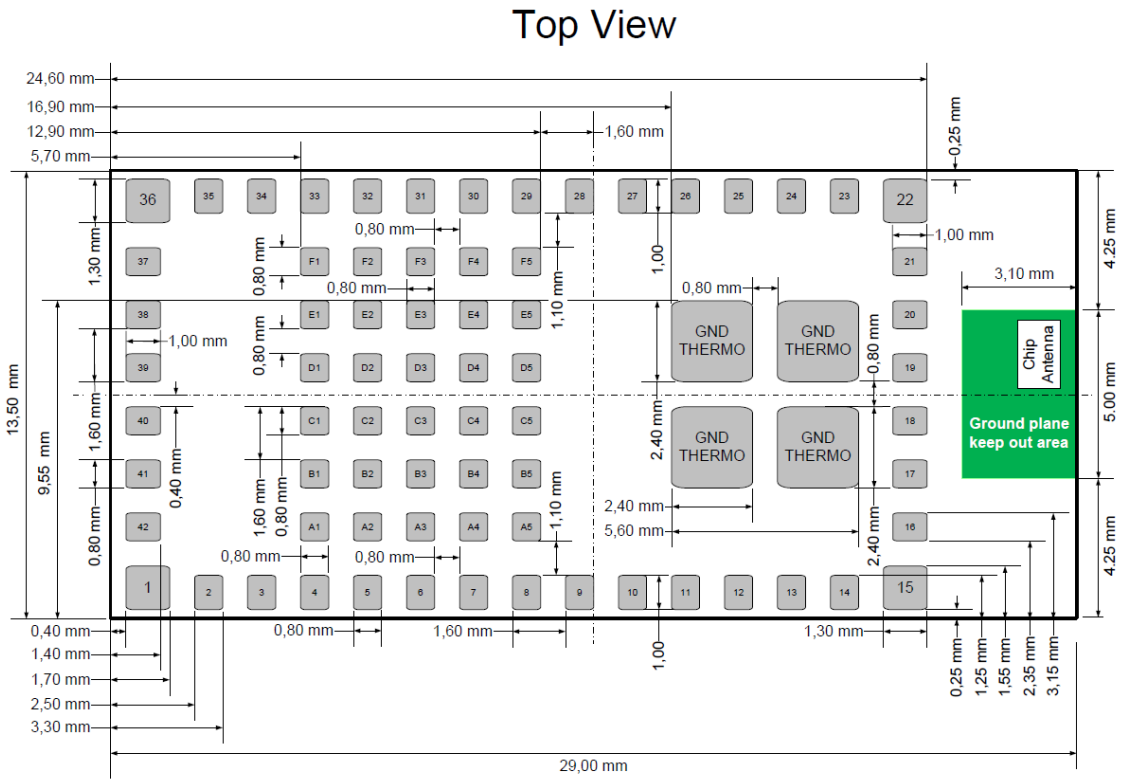
10.3. Placement Drawing



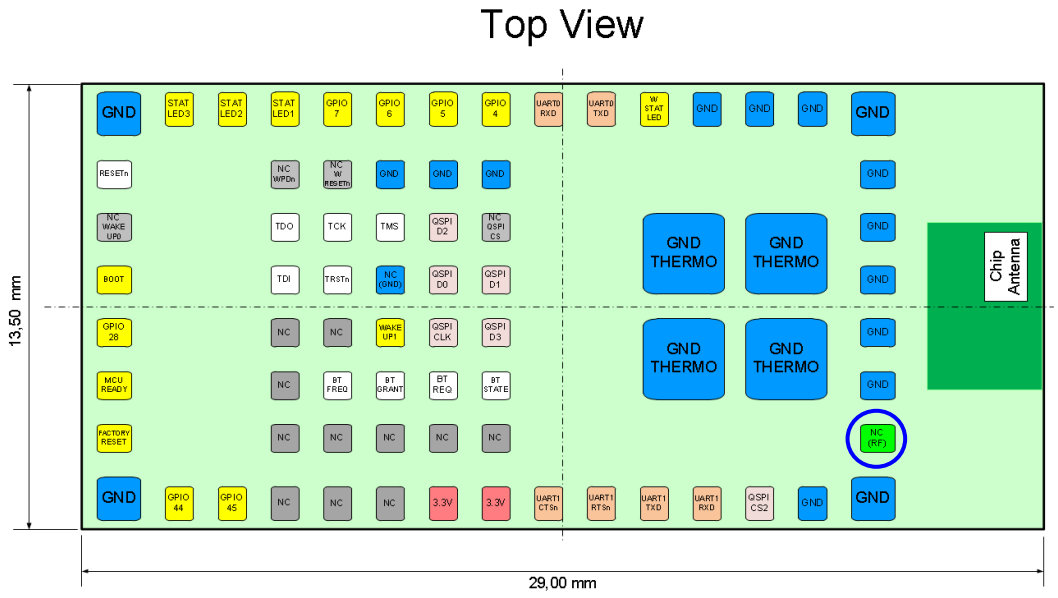
11. PAN9320 PCB LAYOUT

11.1. Footprint Dimension and Pin-Out

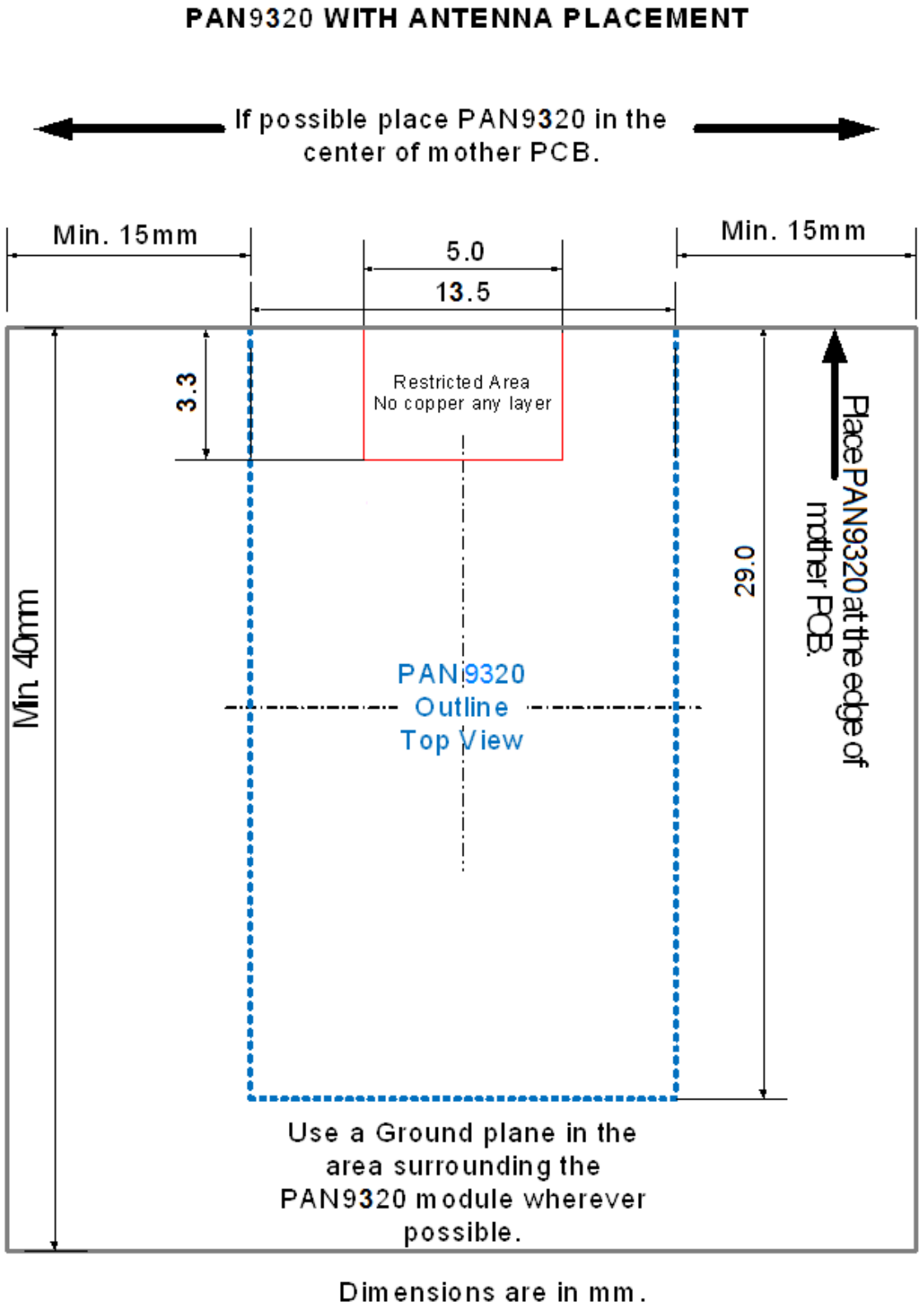
Top View, Application PCB



PAN9310 bottom pad is marked with a blue circle



11.2. Layout Recommendation

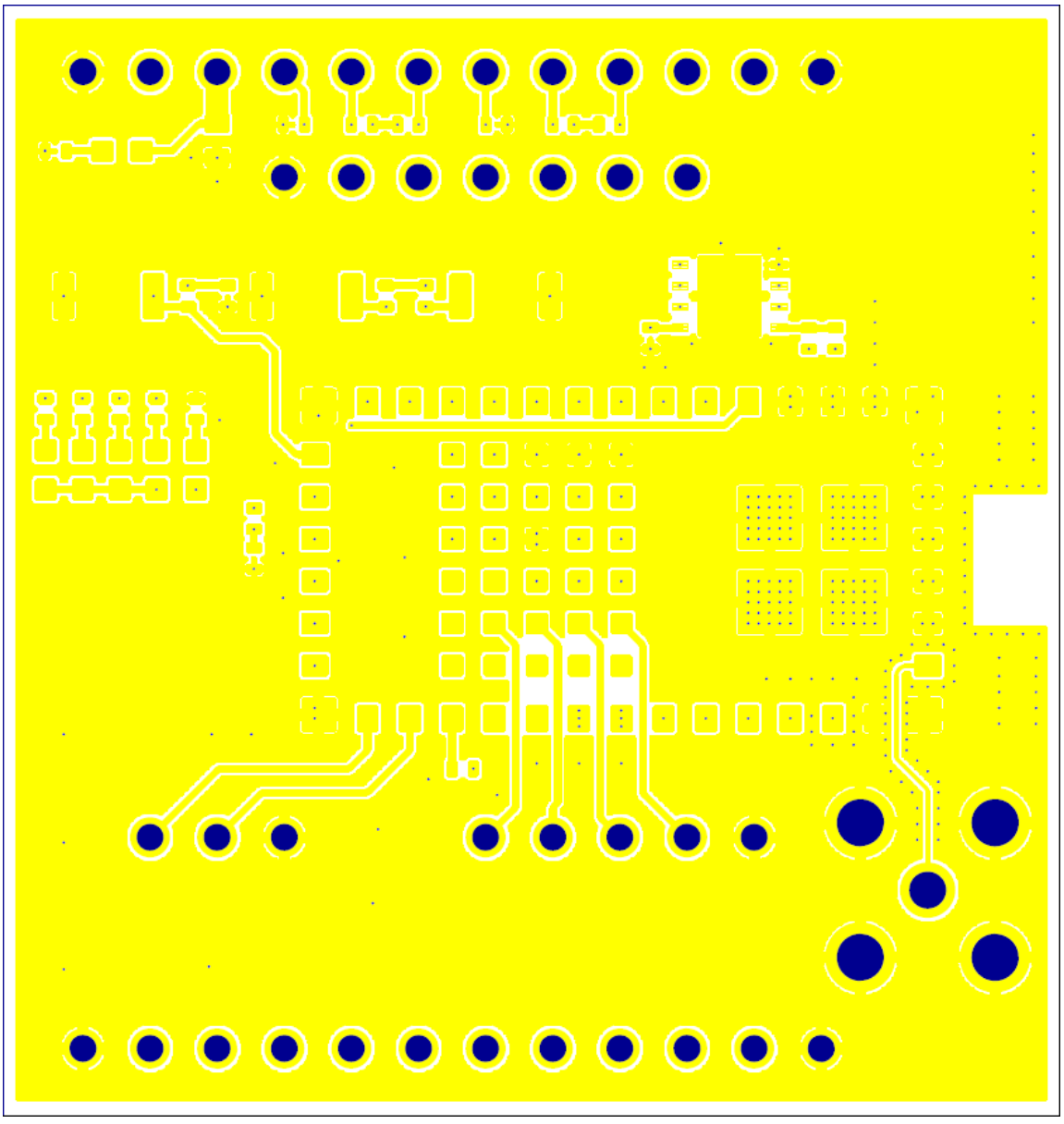


Note: The above recommendation for the Ground plane is based on a FR4 4-Layer PCB.

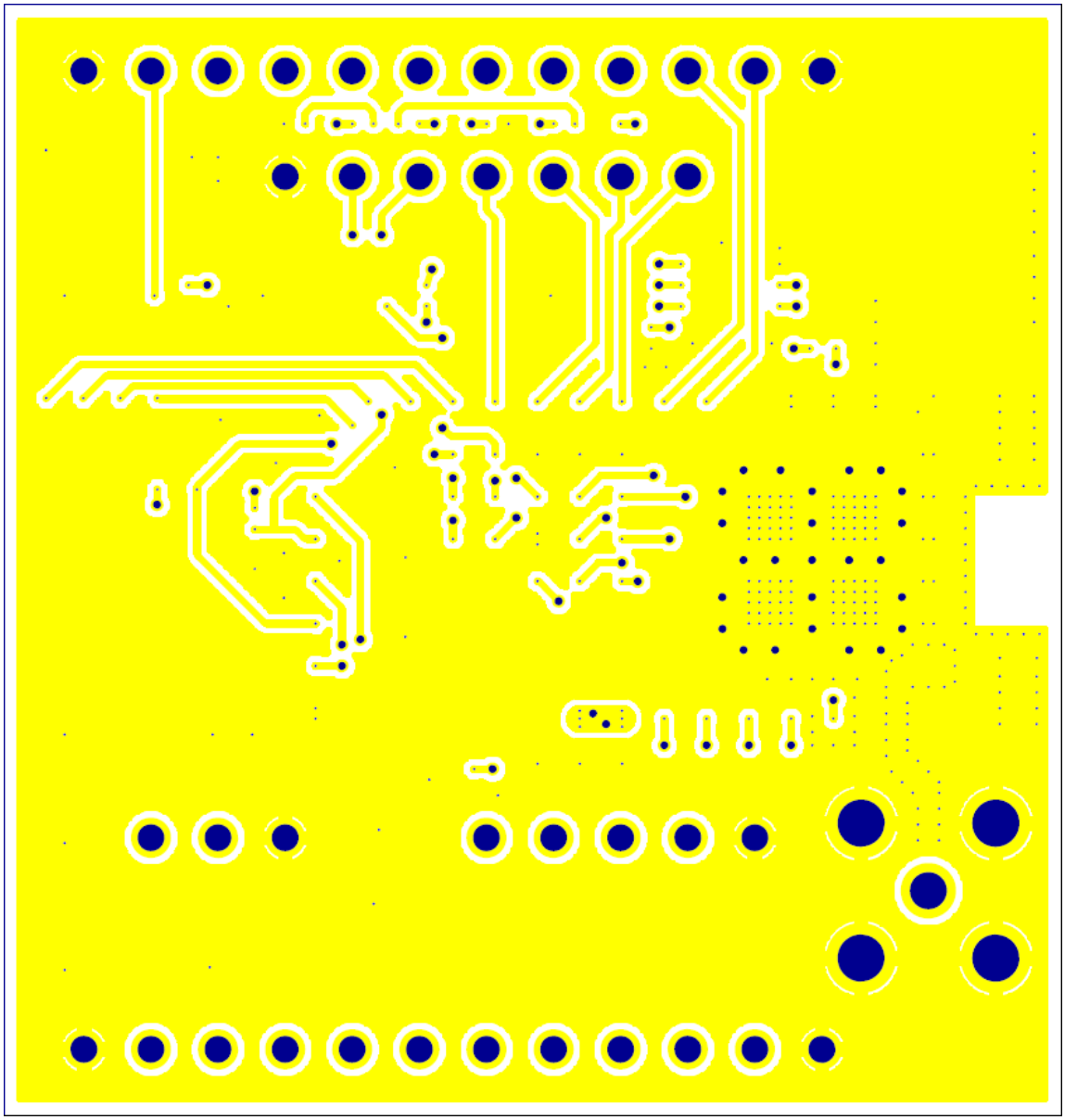
12. PAN9320-ETU DAUGHTER BOARD LAYOUT

12.1. PAN9320-ETU PCB Pattern

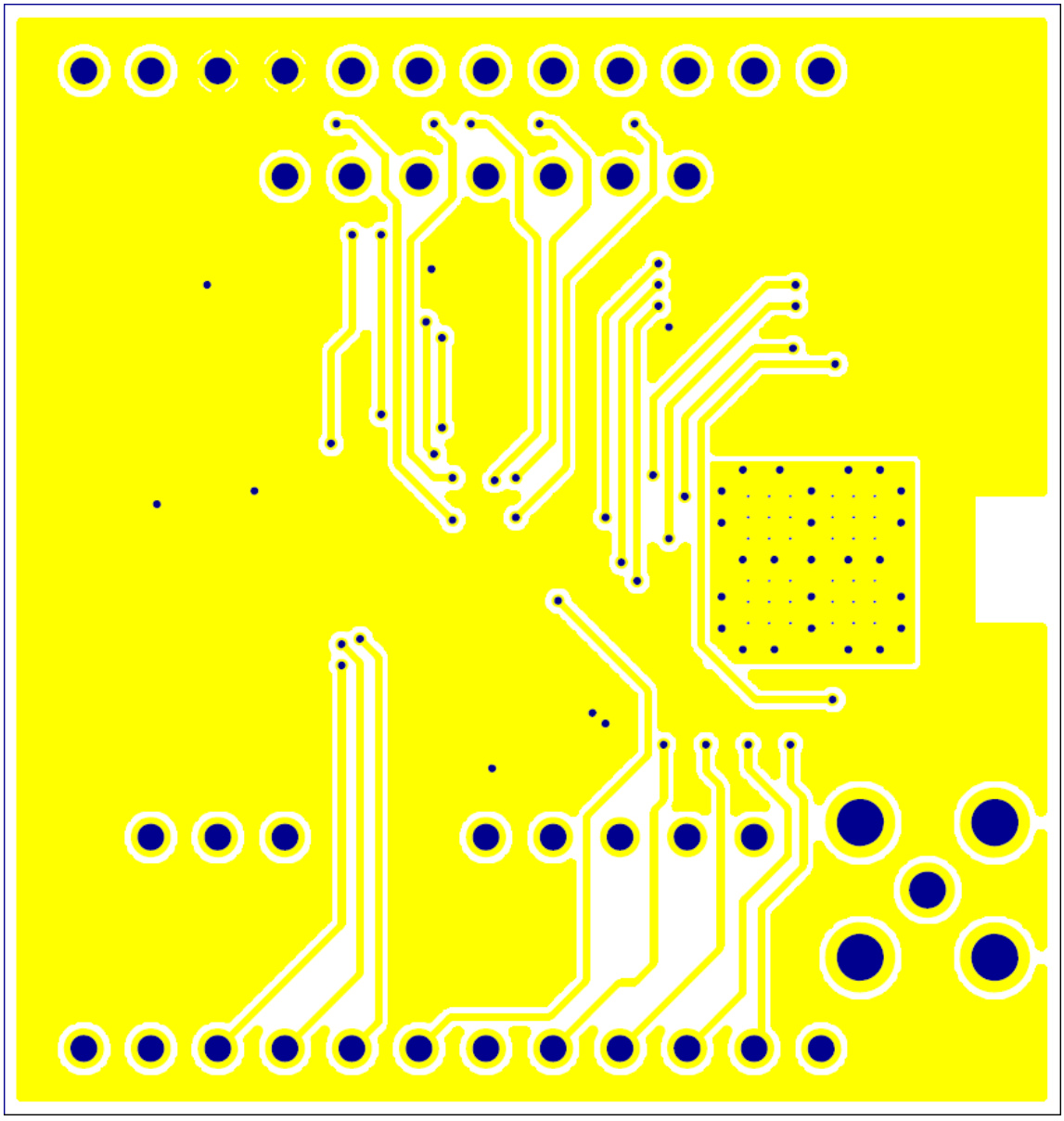
Layer 1 (Top) – Top View



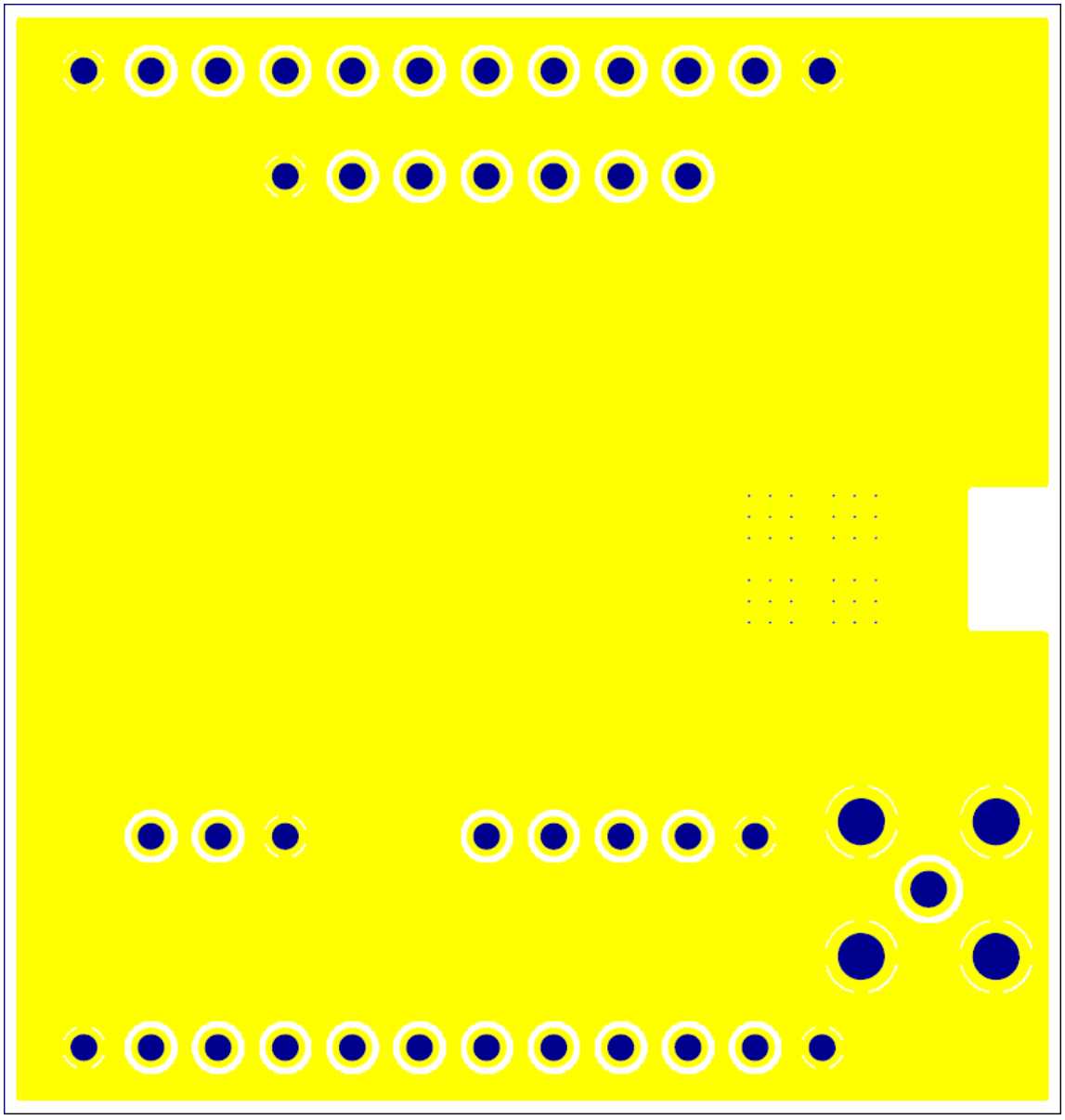
Layer 2 (Inner) – Top View



Layer 3 (Inner) – Top View



Layer 4 (Bottom) – Top View

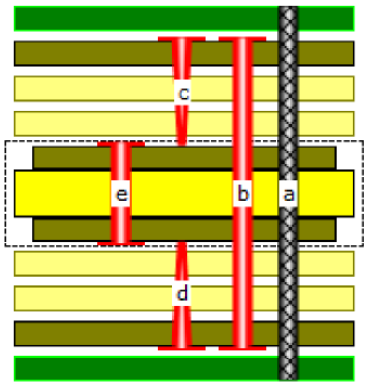


12.2. PAN9320-ETU / PAN9310-ETU PCB Stack-Up

Material FR4 (e.g. Core and PrePreg Nan-Ya NP140)

PCB thickness 1,0mm ± 10%

Layer	Thickness (Millimeter)	Stackup Picture	Family	Description	Type
ST1	0,0150		Stopplack	Stopplack	
L1	0,0390		Kupfer	12 + 27	Kupfer
	0,1072		NP140	0106	
			NP140	1080	
L2	0,0380		Kupfer	18 + 20	
	0,7100		FR4	0,710 mm	
L3	0,0380		Kupfer	18 + 20	
	0,1064		NP140	1080	
			NP140	0106	
LN	0,0390		Kupfer	12 + 27	Kupfer
STN	0,0150		Stopplack	Stopplack	
	1,1076	**Total Expected Thickness**			
	1,0000	**After Lamination**	**+0,1000**	**-0,1000**	
	1,1000	**Incl.Plating**	**+0,1100**	**-0,1100**	

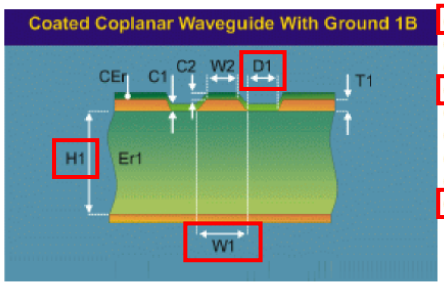


12.3. PAN9310-ETU 50 Ohm Impedance Simulation

Using modeled "Coated Coplanar Waveguide with Ground"

- Trace Target Impedance is 50 Ohm
- Trace Width is 150 µm
- Trace Distance to Ground is 140 µm
- Substrate Thickness is 107,2 µm

Impedanzinformation: 1 **Layers:** L1 L2 None None



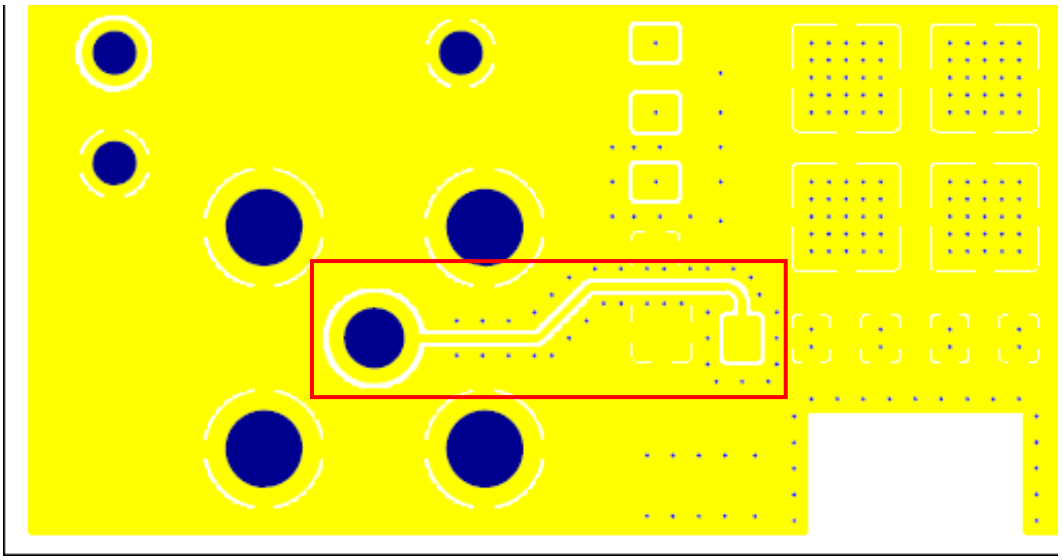
(W1) Lower Trace Width: 150
(W2) Upper Trace Width: 135
(T1) Trace Thickness: 39
(H1) Substrate 1 Height: 107,18
(Er1) Substrate 1 Dielectric: 4,2
(C1) Coating Above Substrate: 30
(C2) Coating Above Trace: 15
(CEr) Coating Dielectric: 3,6
(D1) Coplanar Ground Separation: 140

Target Impedance
50 ohms
Simulated Impedance
49,6 ohms
Predicted Impedance
49,6 ohms
Propagation Delay
5908 ps

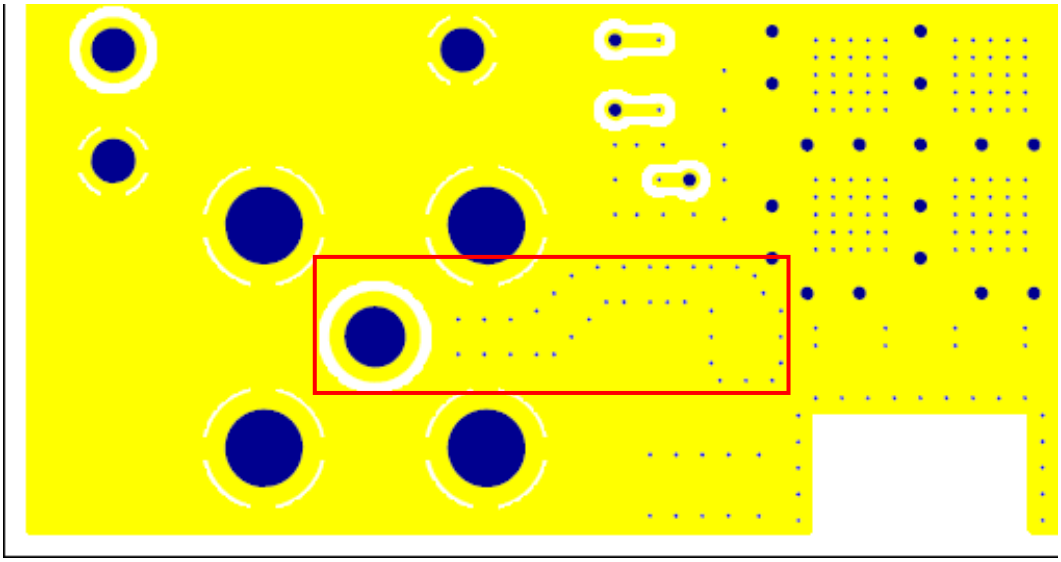
Inductance: 293 nH
Capacitance: 119,2 p
Effective Er: 3,14

12.4. PAN9310-ETU 50 Ohm Trace

- PCB extract of PAN9310-ETU with 50 Ohm pattern on Layer 1 (Top)
- The micro vias (small blue) have a laser hole with a diameter of 100µm (Cu filled)
- The red rectangular box marks the 50 Ohm track to the SMA connector



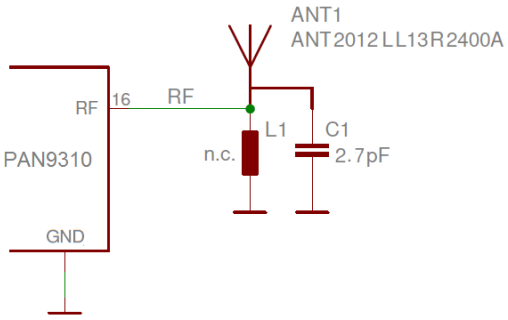
- PCB extract of PAN9310-ETU with GND on Layer 2
- The red rectangular box is marking the GND area underneath the 50 Ohm track



12.5. Chip-Antenna Reference Design

The PAN9310 module has a 50 Ohm RF pin (SMD pad). The antenna trace connected to the RF pin has to be matched to 50ohm impedance. To keep this the recommended antenna trace has to be used with the following components and design.

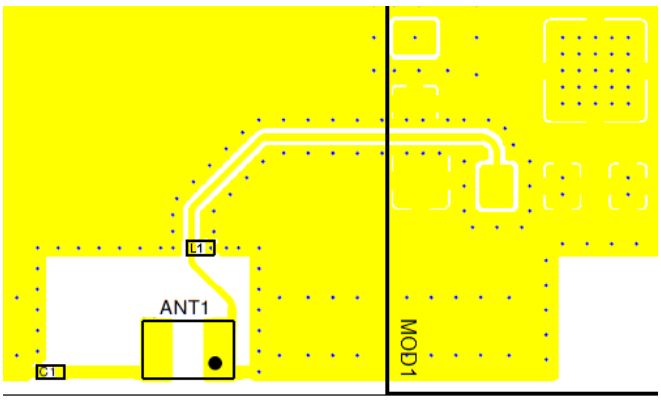
12.5.1. Schematic



- Reference Parts with listed Chip Antenna:
  - PCB: FR4, 4ML (Nan-Ya NP140)
  - ANT1: ANT2012LL13R2400A (YAGEO)
  - C1: CAP-C 2,7pF 25V= +/-0,1p 0201 COG
  - L1: n.c.

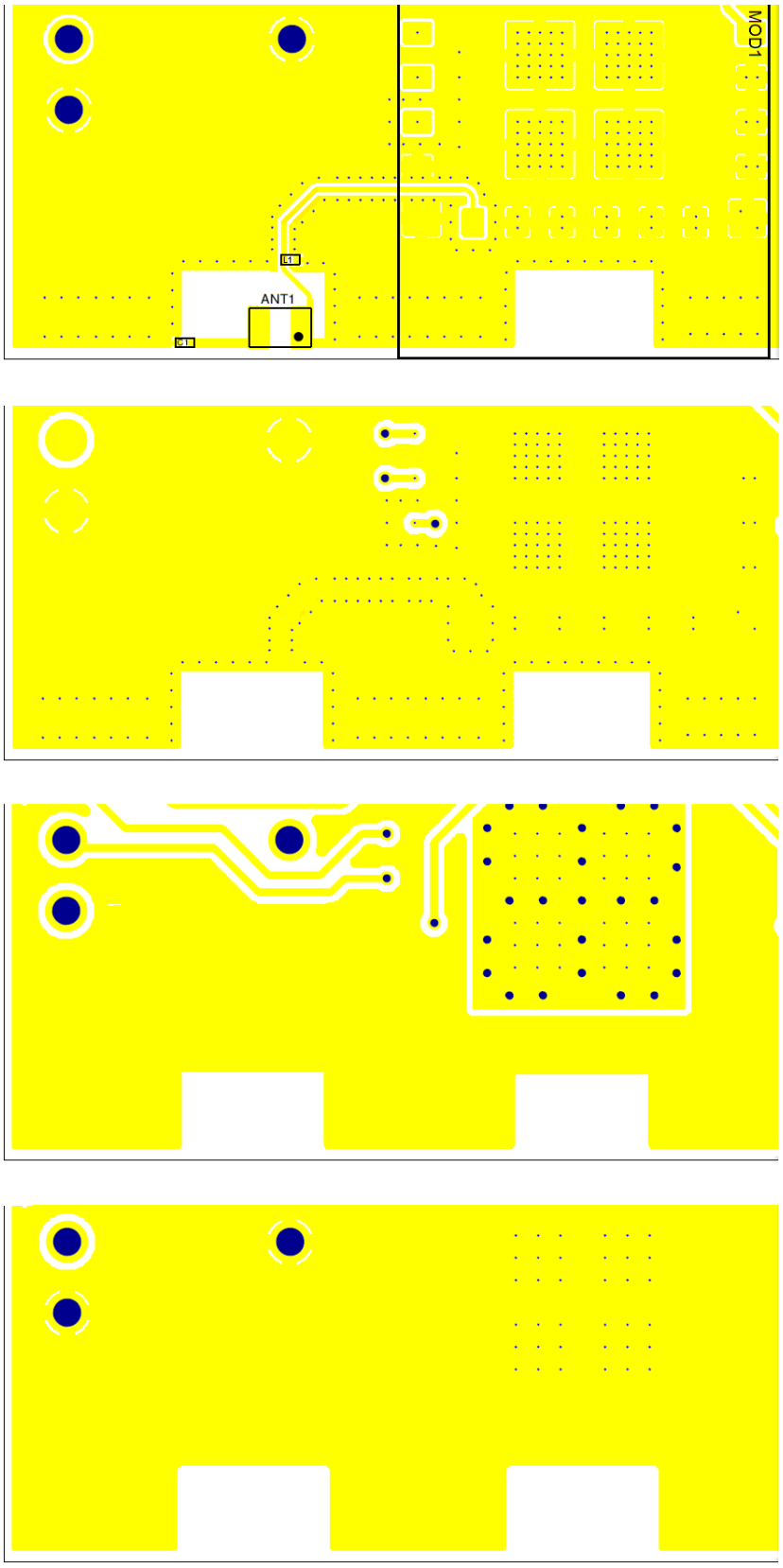
12.5.2. Antenna and Trace Layout

- Trace layout design
  - Trace Target Impedance is 50 Ohm
  - Trace Width Layer 1 is 150 µm
  - Trace Distance Layer 1 to Ground Layer 1 is 140 µm
  - Trace Distance Layer 1 to Ground Layer 2 is 107,2 µm
  - Substrate Thickness (PrePreg) between Layer 1 and Layer 2 is 107,2 µm
  - Trace length shall not exceed 2 cm
- PCB layout extract on layer 1 from RF pad of PAN9310 to chip antenna



12.5.3. PCB Layout 4-Layer

- 4ML PCB layout extract with 50 Ohm trace from PAN9310 RF-pad to chip antenna



13. PAN9320 DEVELOPMENT KIT (PAN9320-MB & PAN9320-ETU)

The PAN9320 Development Kit includes:

- 1 pc. Panasonic Carrying Case
- 1 pc. PAN9320-MB Mother board
- 1 pc. PAN9320-ETU Daughter board
- 1 pc. High-Speed USB Cable

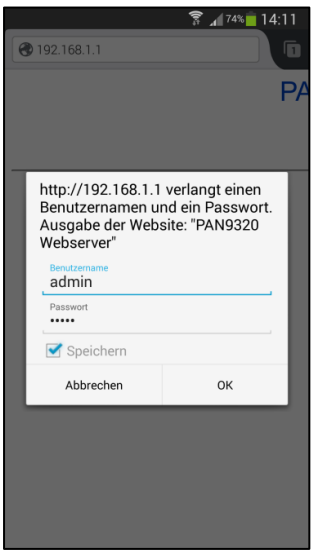
For prom■pt and easy evaluation the PAN9320-ETU comes pre-loaded with a firmware and a Panasonic Web content example. With a few simple steps the kit is ready to use:

1. Connect the PAN9320-ETU Daughter board onto the PAN9320-MB Mother board.
2. Apply power by connecting the USB0 COM-Port on the PAN9320-MB Mother board using a USB cable to a computer. After having it powered-up the PAN9320 WLAN Access-Point will be automatically configured.
3. Using a laptop, computer or any smart-device with WLAN connectivity, scan for the SSID "PAN9320_AP"
4. Connect to that SSID using the paraphrase: "PAN_9320"
5. After your device has associated with the Access-Point "PAN9320_AP" start your Web-Browser (e.g. Mozilla Firefox).
6. Type-in http://192.168.1.1 or Domain Name http://pan9320. The web-browser will connect to the embedded Web-Server on the PAN9320 module and will show the HTML content on your web-browser. When prompted for user name and password please type user "admin" and password "admin".

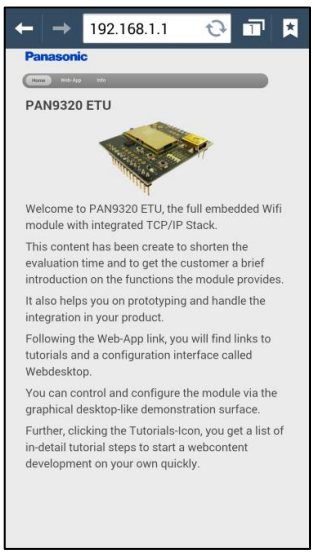
An example for the "PAN9320_AP" connection, the user authorization and HTML Web Content are depicted below.

AP connection with PSK

User Authorization



HTML Web content



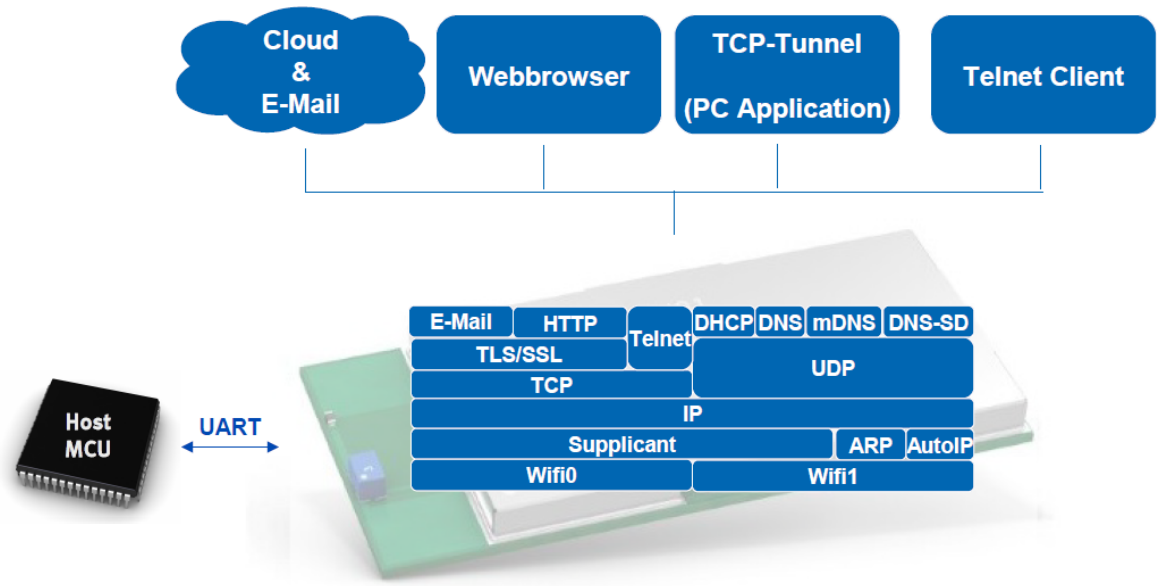
Note:

Please refer to the PAN9320 Quick Start Guide [3] for detailed information about Plug & Play the PAN9320-MB Mother board and PAN9320-ETU Daughter board.

14. PAN9320 READY TO USE COMMUNICATION SERVICE

The following key services are included in the PAN9320:

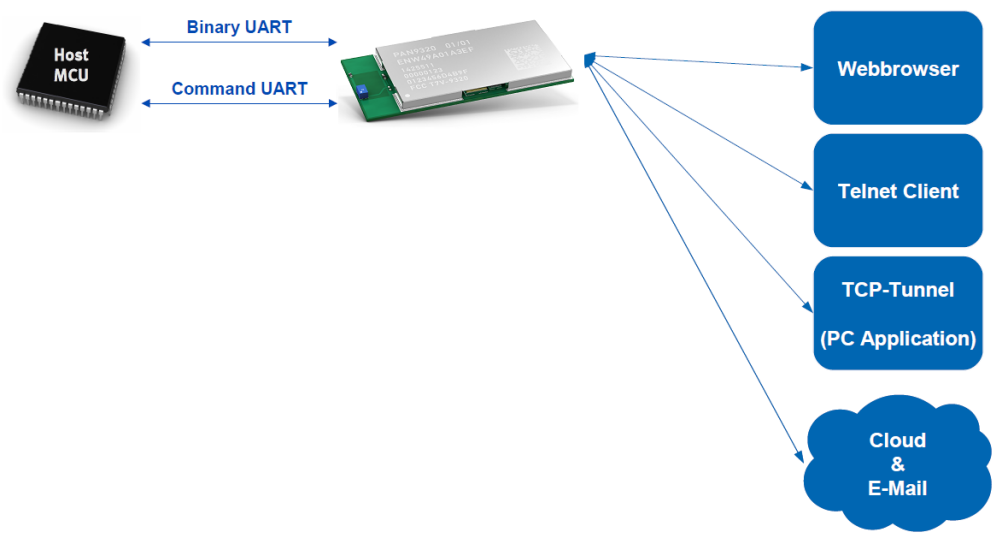
- TCP/IP Network Stack — ARP, AutoIP
- UDP Name Services — DHCP, DNS, mDNS, DNS-SD
- HTTP(s) Server — Web Server with AJAX / JSON
- HTTP(s) Client — integrated Cloud Communication Client
- SMTP(s) Client — E-Mail notifications
- TLS1.2 Security — User / Group Authentication, X.509 Certificate
- 802.11 Supplicant — WEP, WPA, WPA2, WPA2 Mixed



15. PAN9320 COMMAND INTERFACE

The PAN9320 has unique command interfaces:

- Command UART0 is used for:
  - Configuration
  - Controlling the Cloud-Client
  - Sending E-Mail
  - Request/Responses of Web-Application
  - Request/Responses of Telnet-Client
- Binary UART1 is used for:
  - Transparent UART to TCP-Tunnel
  - Firmware Updates for HOST MCU
- UART1 Dual Mode is used for:
  - Command and Binary data over one UART interface
  - Mode selection by toggle switch input including state output



- REQUEST
  - Command GET / SET
  - Module / Variable / Parameter see [4]

Command	Module	Variable	Parameter

- RESPONSE
  - Command / Module / Variable / Return Code / Parameter see [4]
  - Return Code (0 = OK)

Command	Module	Variable	Return Code	Parameter

16. GENERAL INFORMATION

Panasonic does not warranty and accepts no liability for the information contained herein. The information contained in this document is subject to change without notice. Modules containing "ES" in the series number are Engineering Samples -- i.e. PANxxxx ES. This means, the design of this product is not yet concluded. Engineering Samples may be partially or fully functional, and there may be differences to be published Data Sheet.

Engineering Samples are not qualified and are not to be used for reliability testing or series production.

Disclaimer:

Customer acknowledges that samples may deviate from the Data Sheet and may bear defects due to their status of development and the lack of qualification mentioned above.

Panasonic rejects any liability or product warranty for Engineering Samples. In particular, Panasonic disclaims liability for damages caused by

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

Panasonic disclaimes any liability for consequential and incidental damages.

In case of any questions, please contact your local sales partner or the related product manager.

17. FCC WARNING

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.
The FCC and other regulatory certifications for the PAN9320 will be published in the PAN9320 Datasheet [1].

18. LIFE SUPPORT POLICY

This Panasonic 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.