MIPOT 2.4 GHz MODEM

Product Code: **32001445**

PRODUCT SUMMARY:

The 32001445 is a **2.4 GHz transceiver** that implements a physical layer of the IEEE 802.15.4 standard, optimized for **ultra-low consumption** applications, suitable for **low power networks**.
The spread spectrum modulation assures great immunity to interferences.

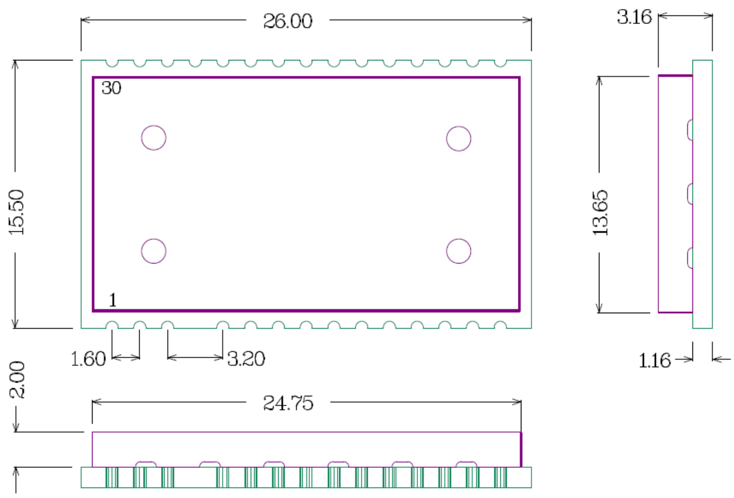
This module works as a **RF modem**, allowing the implementation of **point-to-point communication** or more complex **custom networks** (provided that the network protocol have managed from an external host).

Small LCC form factor (15.5 x 26 mm only) and ultra-low current consumption makes this module ideal for highly integrated low power (battery operated) solutions for Internet of Things (IoT) applications, security systems, alarms, sensor networks, metering, smart buildings, supply chain.

All messages can be cyphered with **AES128 encryption** algorithm ensuring confidential authentication and integrity during the exchange of data payload.

The module meets all the requirements in the **industrial temperature range -40 / 85 °C** and is compliant with **REACH**, **RoHS** and **2014/53/EU Radio Equipment (RED)** directives.

1. MECHANICAL CHARACTERISTICS



ALL DIMENSIONS ARE IN MILLIMETERS
GENERAL TOLERANCE +/-0.1MM

2. ABS. MAX. RATINGS

Transceiver Power Supply +Vcc (pin 15):	3.7 V
Max. Voltage allowed on input pins:	Vcc + 0.3 V
Storage Temperature (excl. package):	-40 ÷ 85 °C
Storage Temperature (incl. package):	-10 ÷ 65 °C
Operating Temperature:	-40 ÷ 85 °C
Radio Frequency Input, pin 2:	10 dBm

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3. PIN DESCRIPTION

Pin	Name	Pin type	Description	Notes
1	GND	Supply	Ground (0 V)	
2	RF I/O	A IN/OUT	Tx: output RF / Rx: input RF	1
3	GND	Supply	Ground (0 V)	
5	NU	NC	Not Used Pin – do not connect	
6	NDATA_INDICATE	D OUT	Data Indicate Pin	
7	NWAKE	D IN	Wake-up Pin	
8	NU	NC	Not Used Pin – do not connect	
9	NU	NC	Not Used Pin – do not connect	
10	NU	NC	Not Used Pin – do not connect	
11	UART TX	D OUT	UART TX Pin	
12	UART RX	D IN	UART RX Pin	
13	NU	NC	Not Used Pin – do not connect	
14	NU	NC	Not Used Pin – do not connect	
15	GND	Supply	Ground (0 V)	
16	GND	Supply	Ground (0 V)	
17	Vcc	Supply	Power supply	
18	SWDAT	NC	Reserved for programming – do not connect	
19	SWCLK	NC	Reserved for programming – do not connect	
20	SWV	NC	Reserved for programming – do not connect	
21	NRST	D IN	Reset. Input Pull-Up	
22	NU	NC	Not Used Pin – do not connect	
23	NU	NC	Not Used Pin – do not connect	
24	NU	NC	Not Used Pin – do not connect	
25	NU	NC	Not Used Pin – do not connect	
26	NU	NC	Not Used Pin – do not connect	
27	NU	NC	Not Used Pin – do not connect	
28	NU	NC	Not Used Pin – do not connect	
29	NU	NC	Not Used Pin – do not connect	
30	GND	Supply	Ground (0 V)	

4. ELECTRICAL CHARACTERISTICS @ 25 °C

Parameter	Min.	Typ.	Max.	Unit	Notes
Supply Voltage (Vcc):	2.6	3.3	3.7	V	
Current drain:					
• Sleep	-	2.3	-	µA	2
• Tx mode	-	96	-	mA	2
• Rx	-	13	-	mA	2
Operating frequency range:	2405	-	2480	MHz	
Tx frequency accuracy:	-	±19	-	kHz	
Sensitivity:	-	-	-93	dBm	
Output Power (on 50 Ohm load)	-	+ 14	-	dBm	3
Modulation		OQPSK			
UART Interface Data rate	9600	-	115200	bps	

Note 1:
Note 2: Current drain measured at power supply value of 3.3 V.
Note 3: All RF parameters are measured with I/O (pin 2) connected to 50-Ω impedance signal source or load.

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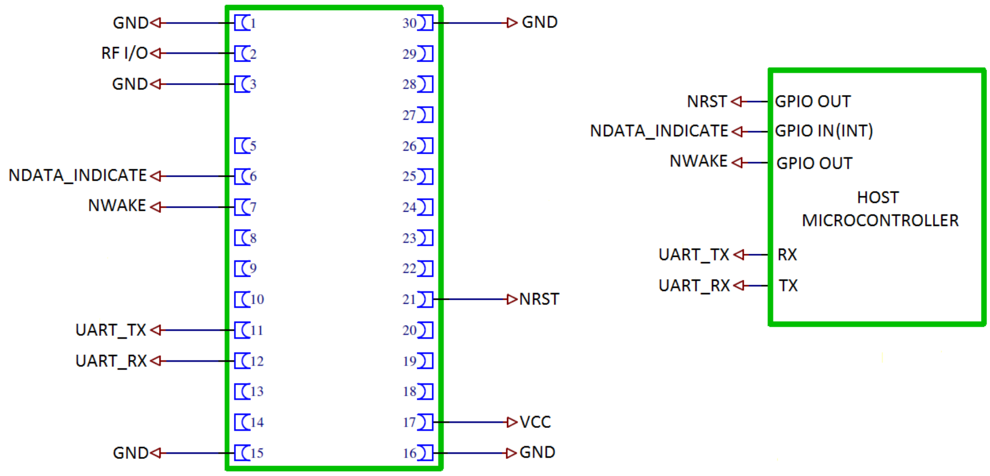
5. TYPICAL CONNECTION DIAGRAM



NOTES:
- NRST pin connection is optional but recommended.
- NDATA_INDICATE pin connection is optional but it is mandatory for low power designs where host microcontroller is in sleep state and module 32001445 activates NDATA_INDICATE pin to wake-up host microcontroller.

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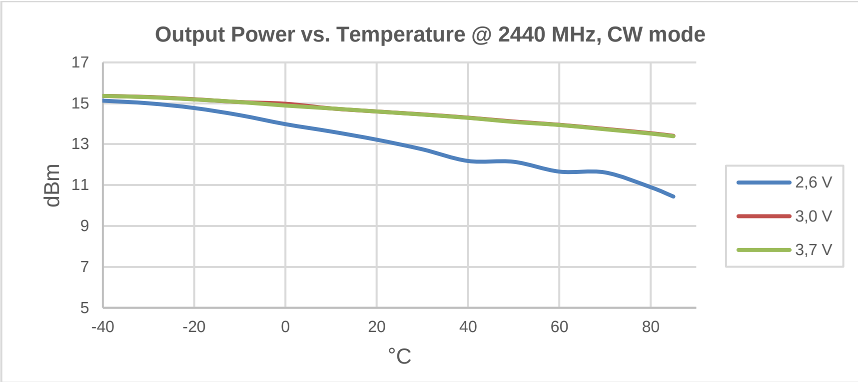
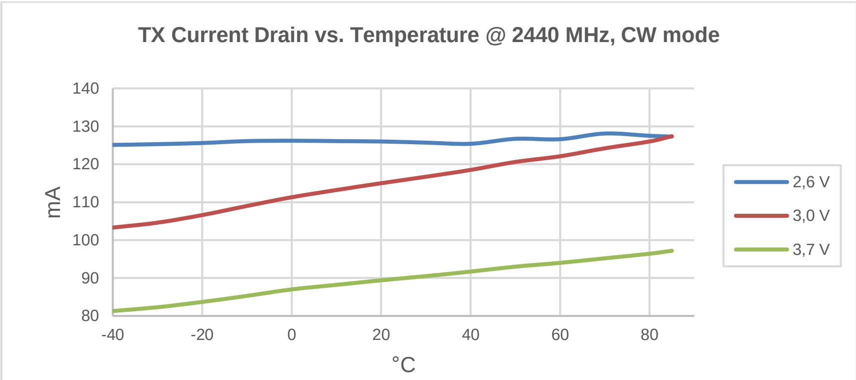
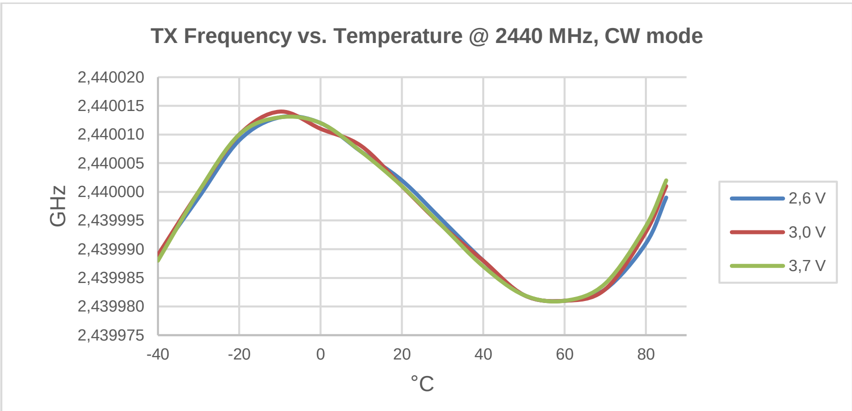
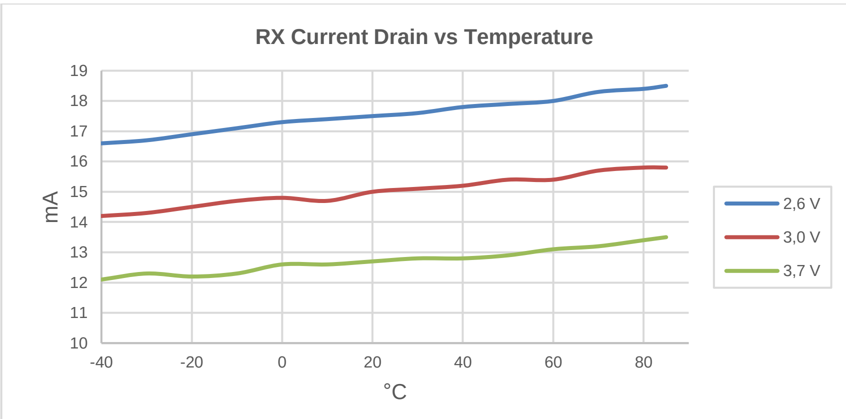
6. TYPICAL CHARACTERISTICS (*)









(*): Consider all graphs as indicative typical results in accordance with temperature variation. Values measured with continuous wave transmission, max power, load 50 Ω.

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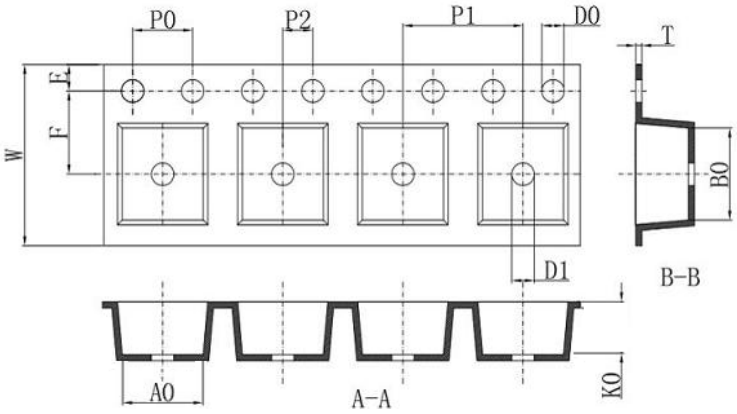
7. PROCESS INFORMATION

7.1. Delivery

The 32001445 modules are delivered in tape/reel packaging including 250 units.



Dimensions are:
W = 44 mm
P = 20 mm
T = 0.35 mm
A0 = 16 mm
B0 = 26.5 mm
K0 = 3.6 mm
D0 = 1.5 mm
D1 = 1.5 mm

7.2. STORAGE AND HANDLING

7.2.1. Moisture Sensitivity Level (MSL)

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions for devices that are sensitive to moisture-induced stress. Download the MSL standard is IPC/JEDEC J-STD-020 and from www.jedec.org.
Following table summarizes the dry pack requirements for different MSL levels in the IPC/JEDEC specification.

Dry Pack Requirement

MSL LEVEL	Dry Pack Requirement
1	Optional
2	Required
3	Required
4	Required

If a device passes MSL level 1 (according to IPC/JEDEC specification J-STD-020), it has classified as not moisture sensitive and does not require dry pack. If a device fails level 1 but passes a higher level, it is classified as moisture sensitive and must be dry packed in accordance with J-STD-033.

The 32001445 is qualified for MSL level = 3.

7.2.2. Dry Bag

Products with an MSL level of 2 or above are shipped dry packed in a Moisture Barrier Bag (MBB). Carrier materials such as trays, tubes, reels, etc., that are placed in the MBB can affect the moisture level within the dry bag. The effect of these materials is compensated by adding additional desiccant in the MBB to ensure the shelf life of the SMT packages.
IPC/JEDEC specifications require that MSD sensitive devices be packaged together with a Humidity Indicator Card (HIC) and desiccant to absorb humidity. If no moisture has been absorbed, the three fields in the HIC indicate blue color.

7.2.3. Storage and floor life

The calculated shelf life for dry packed SMT packages is a minimum of 12 months from the bag seal date, when stored in a non-condensing atmospheric environment of <40°C/90% RH.
Following table lists floor life for different MSL levels in the IPC/JDEC specification.

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Floor life	
MSL level	Floor life (out of bag) at factory ambient ≤30°C/60% RH or as stated
1	Unlimited at ≤30°C/85% RH
2	1 year
2a	4 weeks
3	168 hours
4	72 hours

The parts must be processed and soldered within the time specified for the MSL level. If this time is exceeded, or the humidity indicator card in the sealed package indicates that they have been exposed to moisture, the devices need to be pre-baked before the reflow solder process.

7.2.4. Drying

Both encapsulate and substrate materials absorb moisture. IPC/JEDEC specification J-STD-020 must be observed to prevent cracking and delamination associated with the “popcorn” effect during reflow soldering. The popcorn effect can be described as miniature explosions of evaporating moisture. Baking before processing is required in the following cases:

- Humidity indicator card: At least one circular indicator is no longer blue.
- Floor life or environmental requirements after opening the seal have been exceeded, e.g. exposure to excessive seasonal humidity.

Refer to Section 4 of IPC/JEDEC J-STD-033 for recommended baking procedures. Table 4-1 of the specification lists the required bake times and conditions for drying.

Following table provides a summary of specified recommendations:

Baking Time							
		Baking @ 125 °C		Baking @ 90 °C ≤ 5 % RH		Baking @ 40 °C ≤ 5 % RH	
Package Body	MSL Level	Exceeding Floor Life by > 72 h	Exceeding Floor Life by ≤ 72 h	Exceeding Floor Life by >72 h	Exceeding Floor Life by ≤ 72 h	Exceeding Floor Life by > 72 h	Exceeding Floor Life by ≤ 72 h
Thickness ≤ 1.4 mm	2	5 hours	3 hours	17 hours	11 hours	8 days	5 days
	2a	7 hours	5 hours	23 hours	13 hours	9 days	7 days
	3	9 hours	7 hours	33 hours	23 hours	13 days	9 days
	4	11 hours	7 hours	37 hours	23 hours	15 days	9 days
	5	12 hours	7 hours	41 hours	24 hours	17 days	10 days
	5a	16 hours	10 hours	54 hours	24 hours	22 days	10 days
Thickness >1.4 mm ≤ 2.0 mm	2	18 hours	15 hours	63 hours	2 days	25 days	20 days
	2a	21 hours	16 hours	3 days	2 days	29 days	22 days
	3	27 hours	17 hours	4 days	2 days	37 days	23 days
	4	34 hours	20 hours	5 days	3 days	47 days	28 days
	5	40 hours	25 hours	6 days	4 days	57 days	35 days
	5a	48 hours	40 hours	8 days	6 days	79 days	56 days
Thickness >2.0 mm ≤ 4.5 mm	2	48 hours	48 hours	10 days	7 days	79 days	67 days
	2a	48 hours	48 hours	10 days	7 days	79 days	67 days
	3	48 hours	48 hours	10 days	8 days	79 days	67 days
	4	48 hours	48 hours	10 days	10 days	79 days	67 days
	5	48 hours	48 hours	10 days	10 days	79 days	67 days
	5a	48 hours	48 hours	10 days	10 days	79 days	67 days

Packages of sensitive components in 32001445 have a thickness ≤1.4 mm.

- Do not attempt to bake modules at temperatures higher than 60 °C while contained in tape and rolled up in reels. If baking at higher temperature is required, remove modules from packaging and place them individually onto oven tray.
- Oxidation Risk: Baking SMT packages may cause oxidation and/or intermetallic growth of the terminations, which if excessive can result in soldering problems during board assembly. The temperature and time for baking SMT packages are therefore limited by solderability considerations. The cumulative baking time at a

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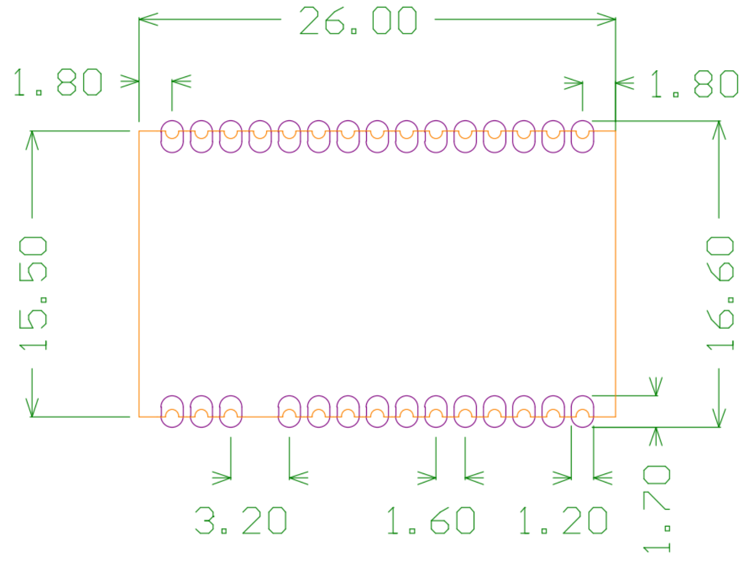
temperature greater than 90 °C and up to 125 °C shall not exceed 96 hours. If the baking temperature is not greater than 90 °C, there is no limit on baking time. Baking temperatures higher than 125 °C are not allowed.

7.3. SOLDERING INFORMATION

7.3.1. Soldering pad pattern

The finished surface on the printed circuit board pads should be made of Nickel/Gold.
The recommended soldering pad layout on the host board for the 32001445 is shown in the diagram below (purple lines):

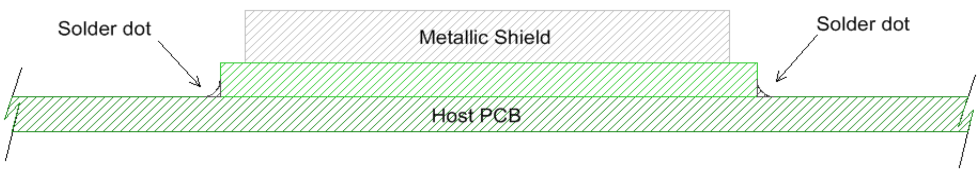


All dimensions in mm

<u>Neither via-holes nor wires are allowed on the PCB upper layer in area occupied by the module.</u>

7.3.2. Solder Paste

Module 32001445 has designed for surface mounting using half-moon solder joints (see diagram below). For proper module assembly, solder paste must be printed on the target surface of the host board. The suggested solder paste height should be within 150 µm and 180 µm.
The following diagram shows mounting characteristics for Module integration on host PCB:



7.3.3. Placement

The 32001445 module can be automatically placed on host boards by pick & place machines like any integrated circuit.

7.3.4. Soldering Profile (RoHS Process)

Note that the 32001445 module should not be allowed to be hanging upside down during the reflow operation. This means that the module will be assembled on the side of the printed circuit board that is soldered last.
Follow the recommendation for lead-free solder reflow in IPC/JEDEC J-STD-020D Standard.

Profile Feature	***Sn-Pb Assembly***	***Pb-Free Assembly***
Average Ramp-UP Rate (T_s max to T_p)	3 °C/s max	3 °C/s max
Preheat -Temperature Min (T_s min) -Temperature Max (T_s max) -Time (t_s min to t_s max)	 100 °C 179 °C 80-135 s	 130 °C 217 °C 80-135 s
Time maintained above: -Temperature (T_L) -Time (t_L)	 183 °C 30-90 s	 220 °C 30-90 s
Peak/Classification Temperature (T_p)	Max. Peak temp. 220 °C	Max. Peak temp. 250 °C
Time within 5 °C of actual Peak Temperature (t_p)	10-15 s	10-15 s
Ramp-Down Rate	4 °C/s max	4°C/s max
Time 25 °C to peak temperature	6' max	8' max

Note: All temperatures refer to topside of the package, measured on the package body surface.

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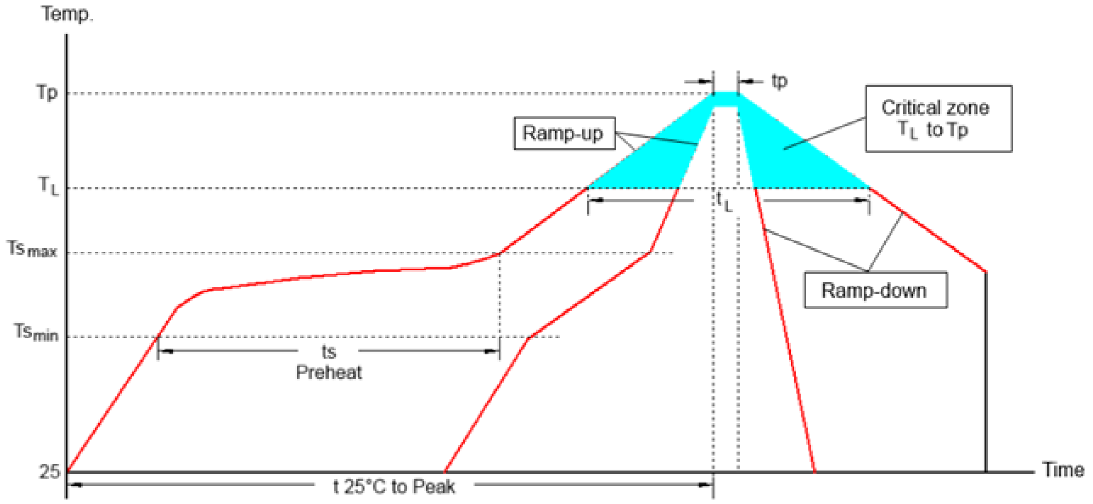

CAUTION – Please note that if the host board is submitted to a wave soldering after the reflow operation, a solder mask must be used in order to protect the 32001445 module's metal shield from being in contact with the solder wave.

The 32001445 module is a RED Directive assessed radio module manufactured and tested with the intention of being integrated into a final product.
The 32001445 module has been tested to RED Directive 2014/53/EU Essential Requirements for Health and Safety (Article 3.1a), Electromagnetic Compatibility (EMC) (Article 3.1b), and Radio (Article 3.2).

Restrictions in terms of maximum allowed RF power or duty cycle might apply: it is responsibility of the system integrator to assure conformance of the final application to these requirements.

Note: To maintain conformance to the testing applied on the 32001445, the module shall be installed in accordance with the installation instructions in this data sheet and shall not be modified.
When integrating a radio module into a completed product the integrator becomes the manufacturer of the final product and is therefore responsible for demonstrating compliance of the final product with the essential requirements of the RED Directive.

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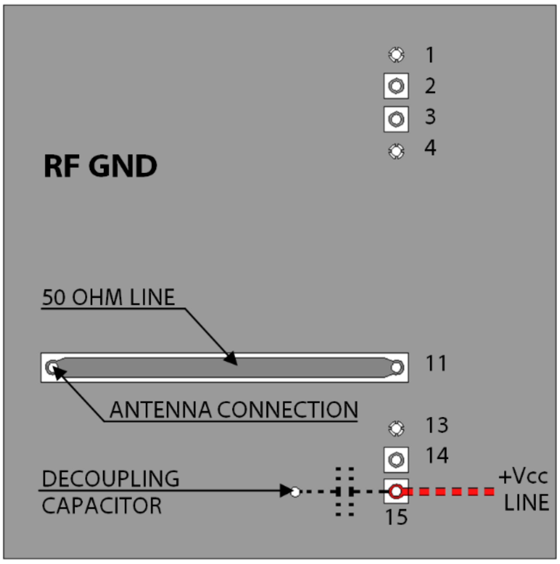
9. GUIDELINES FOR CORRECT POWER SUPPLY AND GROUND PLANE LAYOUT DESIGN IN TRANSMITTING APPLICATIONS

Developing devices that use Mipot Transmitter Modules take care when designing the layout of the ground planes and power supply paths, with particular attention to some general rules as described in the following sections.

Below is a typical layout of the solder side for a PCB suited for a transmitter:

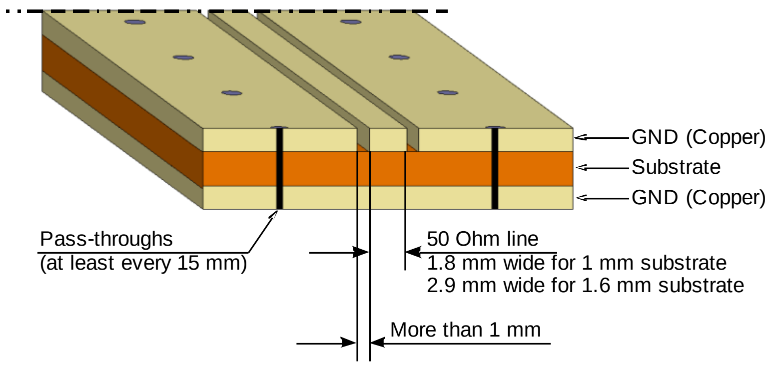
Note: Decoupling capacitors must have placed on the top side of the PCB.



This is a generic layout; modules can be different.

Ground Layer:

- Must be around the antenna output area;
- Must cover all the area around the receiver module;
- Circuit design should be a 2-side PCB, connecting both ground planes with pass-through vias at least every 15 mm each other.



Note: dimensions in the picture above is referred to a FR4 substrate PCB

Power Supply path:

- Needs a good filtered DC component;
- Should have decoupling ceramic capacitors directly connected near the power supply pin(s), taking care to connect in parallel multiple capacitance values (100 nF to 10 µF).
- Should ensure a good decoupling between Digital, RF and Power circuitry.
- Should be separate for Power, Digital and Radio blocks.

50-Ω feed line:

For a 2-layer FR4 dielectric PCB, a 50-Ω feed line is a track with a width 1.8 times the thickness of the substrate. Keep more than 1 mm of free space between the track and the ground on the same layer. Put pass-through vias to connect the top ground layer to the bottom and keep as short as possible the length of the feed line, avoiding top to bottom pass-troughs.

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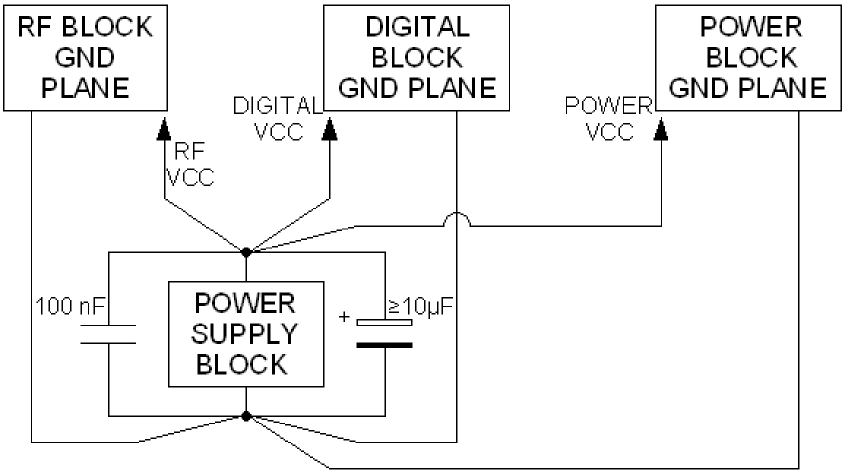
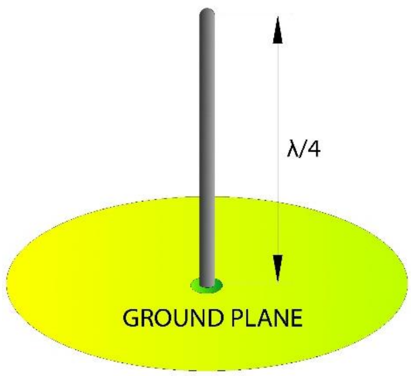
Follow these recommended Power Supply Path structure:



10. HINTS FOR ANTENNA SELECTION

A good antenna design is required to achieve the maximum performances from the Mipot modules, and obtain the required range.

The recommended antenna is the ***Vertical Quarter-Wave Monopole Antenna (vertical Whip)***, positioned on a ground plane having a radius $r \geq l$ (where l is the antenna length) that is kept free from other components and metallic objects.



The antenna length l can be determined as:

$$l = \frac{c}{4f}$$

Where:

l = antenna length [m];
f = frequency [Hz];
c = light speed, 300000000 m/s.

Typical length for a whip operating at 434 MHz is 170 mm; for a frequency of 868 MHz, the length will be 86 mm. Some length corrections will occur in depending upon the thickness, the material, the coating, etc., in order to obtain a correctly tuned device. The antenna impedance here is approximately 35 Ω, so a matching network will be mandatory to match the 50-Ω impedance of the radio module.

Other solutions are obviously possible keeping in mind that antenna design varies depending on the specific application, the materials used, the layout structure and the size of the ground plane, so a *specific design* is recommended a to getting the maximum performance.

In designing antennas, it is useful to follow some general considerations:
- Keep the area near the antenna as free as possible from other components and metallic objects.
- Keep the antenna feeder as short as possible in order to reduce losses and unwanted radiated signal.
- If possible, use a large ground plane having a radius R ≥ L, where L is the antenna length, placing the antenna at the centre.
- Ensure good electrical connections for the ground layer.
- If there is a need for long antenna connections, use a good 50-Ω coaxial cable and connectors with low insertion loss and good RF performances.

As alternative to the vertical whip, some antenna solutions can give satisfactory results if chosen correctly and dimensioned:

- **PCB antenna:**
  When space in height is an issue, a quarter-wave long PCB track is also a valid horizontal polarized antenna. Trace length will be 10 % to 20 % shorter than the theoretical value, depending on the dielectric and the thickness of the PCB. If the device has to be handheld, the antenna could be even shorter to minimize the effect of human body. Shorter version of these antennas implicates a loss of efficiency and a poor range. An impedance compensation network is mandatory to obtain the correct match with the radio.

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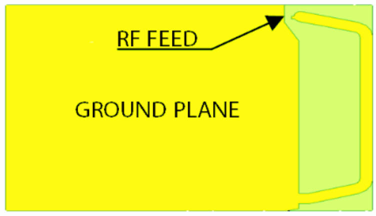
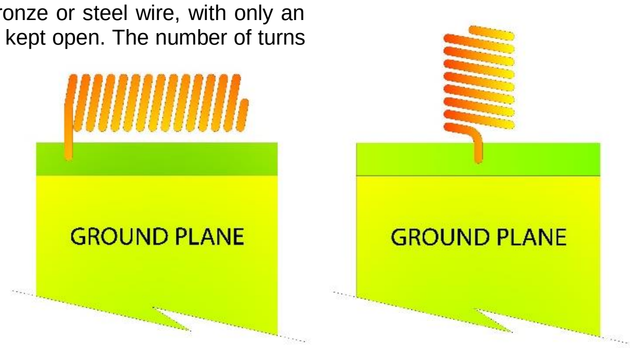
- **PCB Loop antenna:**
  This is typically a PCB track with one end connected to the RF device and the other connected to the ground. An impedance compensation network is mandatory to have the correct match with the radio.
  This is the less efficient antenna, having a reduction factor of 15-20 dB respect the quarter wave one, but it is less detuned by hand effects, so it is often used in handheld transmitters.
  Since it has very low gain and a narrow bandwidth, it would be taken care when tuning through a matching network.



- **Helical antenna:**
  This is a coil wound with copper, phosphor bronze or steel wire, with only an end connected to the RF device and the other kept open. The number of turns depends upon the wavelength, the coil diameter, the spacing of the turns and the diameter of the wire; the trick is winding a coil with a greater number of turns and then reducing them by cutting until it has tuned at the operating frequency. Spreading or compressing the coil achieves fine-tuning. If the coil is wound tightly enough, it may be shorter than one-tenth of a wavelength.
  Thanks to its high Q factor, this antenna has typically a narrow bandwidth, and the spacing of the turns has great influence on the performance. For this reason, it can be easily de-tuned by nearby objects including human body, so it might not be suitable for handheld devices.
  This antenna must have a good ground plane, and the performances are very sensitive to its position versus the ground plane. The antenna feeder must be as short as possible in order to reduce losses and unwanted signal radiate.



11. REVISION HISTORY

Revision	Date	Description
0.0	26-06-2019	Preliminary
1.0	26-11-2019	First release

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