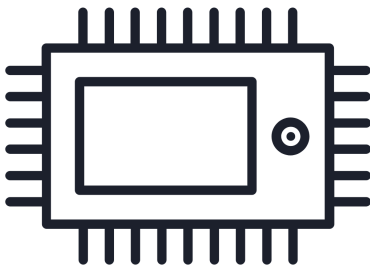


Product Description

The LumenRadio MLE-N2 (Mira Low Energy) module is a small size, cost efficient, industrial grade, multi-standard radio module, designed for high volume production of products without the need of an external antenna.

MLE-N2 is based on the Nordic Semiconductor nRF52840 and features a powerful ARM Cortex M4 microcontroller with a dual radio for Bluetooth-based protocols and 802.15.4-based protocols.

MLE-N2 is optimized for low-energy applications built on MiraOS and the MiraMesh radio stack. The MiraOS, MSS (Multi-Standard Support) feature allows concurrent operation of MiraMesh and Bluetooth v5.0, as well as 802.15.4 based protocols. This feature provides reliable mesh networking through MiraMesh with concurrent support for easy commissioning, local control and user interaction (UX/UI) over Bluetooth v5.0/NFC using a smartphone or tablet. Ultra-low energy consumption allows for battery powered products or energy harvesting operation. MLE-N2 is an SMD module and thanks to its small footprint it can easily be integrated into any product.



Features

- Based on Nordic Semiconductor nRF52840 chipset
- Up to 8 dBm configurable transmit output power
- On board PCB antenna
- NFC-A support
- -40 – +85 °C operating temperature
- ARM Cortex-M4F at 64 MHz operation
- 1 MB flash and 256 kB RAM
- AES 128-bit ECB/CCM/AAR hardware accelerator
- 12bit ADC, SPI, I2C, UART, PWM, USB 2.0, GPIO
- Pre certified for Europe (ETSI RED), US (FCC/CFR 47 Part 15 unlicensed modular transmitter approval), Canada (IC RSS)

Specifications

- Sensitivity: -95 dBm
- 103 dB link budget
- Frequency band: 2.45 GHz, ISM band (2402-2480 MHz)
- Dimensions: 19.0 mm x 15.2 mm
- Supply voltage range 1.7 - 3.6 V
- Dimensions: 19.0 x 15.2 x 2.2 mm

Contents

| | | |
|--|---|-----------|
| | PCB inverted-F antenna | 19 |
| Specifications | 3 | 19 |
| Absolute maximum ratings | 3 | |
| Recommended operating conditions | 3 | |
| Digital I/O pins | 3 | |
| RF performance | 3 | |
| Pin assignments | 5 | |
| Pin functions | 5 | |
| Common mistakes | 6 | |
| Layout considerations | 7 | |
| MLE-N2 OEM module pad dimensions | 7 | |
| Layout considerations for the main board | 7 | |
| Guidelines for mounting in enclosure | 10 | |
| PCB antenna radiation pattern | 10 | |
| Center frequency: 2402 MHz | 11 | |
| Center frequency: 2480 MHz | 15 | |
| | Power supply recommendations | 19 |
| | Mechanical specification | 20 |
| | Module packaging | 22 |
| | Carrier tape dimensions | 22 |
| | Reel marking | 22 |
| | Reflow soldering specification | 24 |
| | Product verification guideline | 25 |
| | FCC information | 25 |
| | Industry Canada statement | 26 |
| | CE | 26 |
| | Other compliances | 26 |
| | RoHS / REACH | 27 |
| | Contact and ordering information | 27 |

Specifications

- Sensitivity: -95 dBm
- Frequency band: 2.45 GHz, ISM band (2402-2480 MHz)
- Dimensions: 19.0 mm x 15.2 mm
- Supply voltage: 1.7 - 3.6 V

Absolute maximum ratings

Maximum ratings are the extreme limits to which the MLE-N2 module can be exposed for a limited amount of time without permanently damaging it. Exposure to absolute maximum ratings for prolonged periods of time may affect the reliability of the device.

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|--------|----------------------------------|------|------|-------------|------|
| VDD | Supply voltage | -0.3 | | 3.9 | V |
| TA | Operating temperature | -40 | | 85 | °C |
| VIO | IO Input voltage $VDD \leq 3.6V$ | | | $VDD + 0.3$ | V |
| VIO | IO Input voltage $VDD > 3.6V$ | | | 3.9 | V |
| VSS | Ground pad voltage | | | 0.0 | V |
| TS | Storage temperature | -40 | | +125 | °C |
| RFin | RF input power | | | +10 | dBm |
| ESD | ESD all pins, Human Body Model | | | 1 | kV |

Recommended operating conditions

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|--------|--------------------------------|------|------|------|------|
| VDD | Supply voltage | 1.7 | 3.3 | 3.6 | V |
| Vrise | Supply rise time (0 V to 3.7V) | | | 100 | ms |
| IDD | Supply peak current capability | | 150 | 250 | mA |

Please see Power supply recommendations for a more specific guideline.

Digital I/O pins

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|--------|---------------------------|-----------------|------|-----------------|------|
| VIL | Input voltage logic low | 0 | | $0.3 \cdot VDD$ | V |
| VIH | Input voltage logic high | $0.7 \cdot VDD$ | | VDD | V |
| VOL | Output voltage logic low | 0 | | 0.4 | V |
| VOH | Output voltage logic high | $VDD - 0.4$ | | VDD | V |

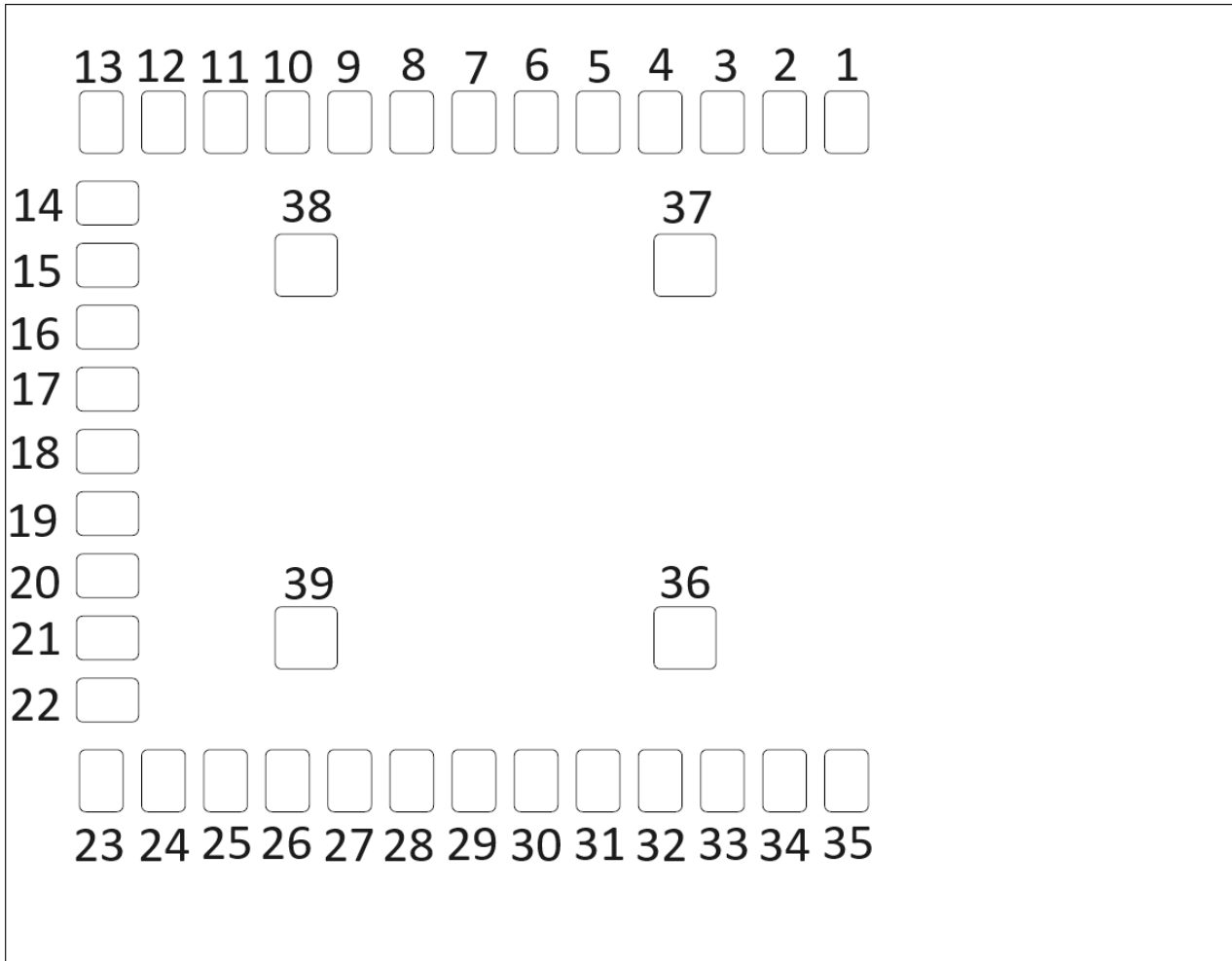
RF performance

RF performance below is valid at an ambient temperature of 25°C and a supply voltage of 3.3 V.

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---------|--------------------------------|------|------|------|------|
| f-range | Operating frequency range | 2402 | | 2480 | MHz |
| RXsens | Receiver sensitivity (0.1%BER) | | -96 | | dBm |
| TXpout | TC output power | | 8.1 | | dBm |

Pin assignments

Pin functions



Module seen from top.

| No | Name | Type | Description |
|-----|-------|---------------------------|----------------------------|
| P1 | P1.11 | Digital I/O | Low frequency signals only |
| P2 | P1.10 | Digital I/O | Low frequency signals only |
| P3 | P1.12 | Digital I/O | Low frequency signals only |
| P4 | P1.13 | Digital I/O | Low frequency signals only |
| P5 | P1.14 | Digital I/O | Low frequency signals only |
| P6 | P1.15 | Digital I/O | Low frequency signals only |
| P7 | P0.03 | Digital I/O, Analog Input | Low frequency signals only |
| P8 | P0.02 | Digital I/O, Analog Input | Low frequency signals only |
| P9 | P0.28 | Digital I/O, Analog Input | Low frequency signals only |
| P10 | P0.29 | Digital I/O, Analog Input | Low frequency signals only |
| P11 | P0.31 | Digital I/O, Analog Input | Low frequency signals only |
| P12 | P0.30 | Digital I/O, Analog Input | Low frequency signals only |

| No | Name | Type | Description |
|-----|-------------|---------------------------|--|
| P13 | DCC1 | Voltage Input | Do not connect |
| P14 | P0.27 | Digital I/O | |
| P15 | P0.04 | Digital I/O, Analog Input | |
| P16 | P0.05 | Digital I/O, Analog Input | |
| P17 | P0.06 | Digital I/O | |
| P18 | P0.07 | Digital I/O | |
| P19 | P0.08 | Digital I/O | |
| P20 | P1.09 | Digital I/O | |
| P21 | P0.12 | Digital I/O | |
| P22 | P0.11 | Digital I/O | |
| P23 | VBUS | Voltage Supply | 5V supply if USB is used, else tie to ground |
| P24 | P0.19 | Digital I/O | |
| P25 | P0.21 | Digital I/O | |
| P26 | D- | Digital I/O | USB data |
| P27 | D+ | Digital I/O | USB data |
| P28 | P0.18 | Digital I/O | nRESET |
| P29 | P0.22 | Digital I/O | |
| P30 | P0.23 | Digital I/O | |
| P31 | P1.00 | Digital I/O | |
| P32 | SWDIO | Digital I/O | Debug |
| P33 | SWDCLK | Digital I/O | Debug |
| P34 | P0.09 / NFC | Digital I/O | NFC |
| P35 | P0.10 / NFC | Digital I/O | NFC |
| P36 | VCC | Voltage Supply | Main voltage supply |
| P37 | GND | GND | |
| P38 | GND | GND | |
| P39 | GND | GND | |

Note: Low frequency I/O is a signal with a frequency up to 10 kHz.

For detailed information about pin functionality, see the Nordic Semiconductor nRF52840 product specification document.

Common mistakes

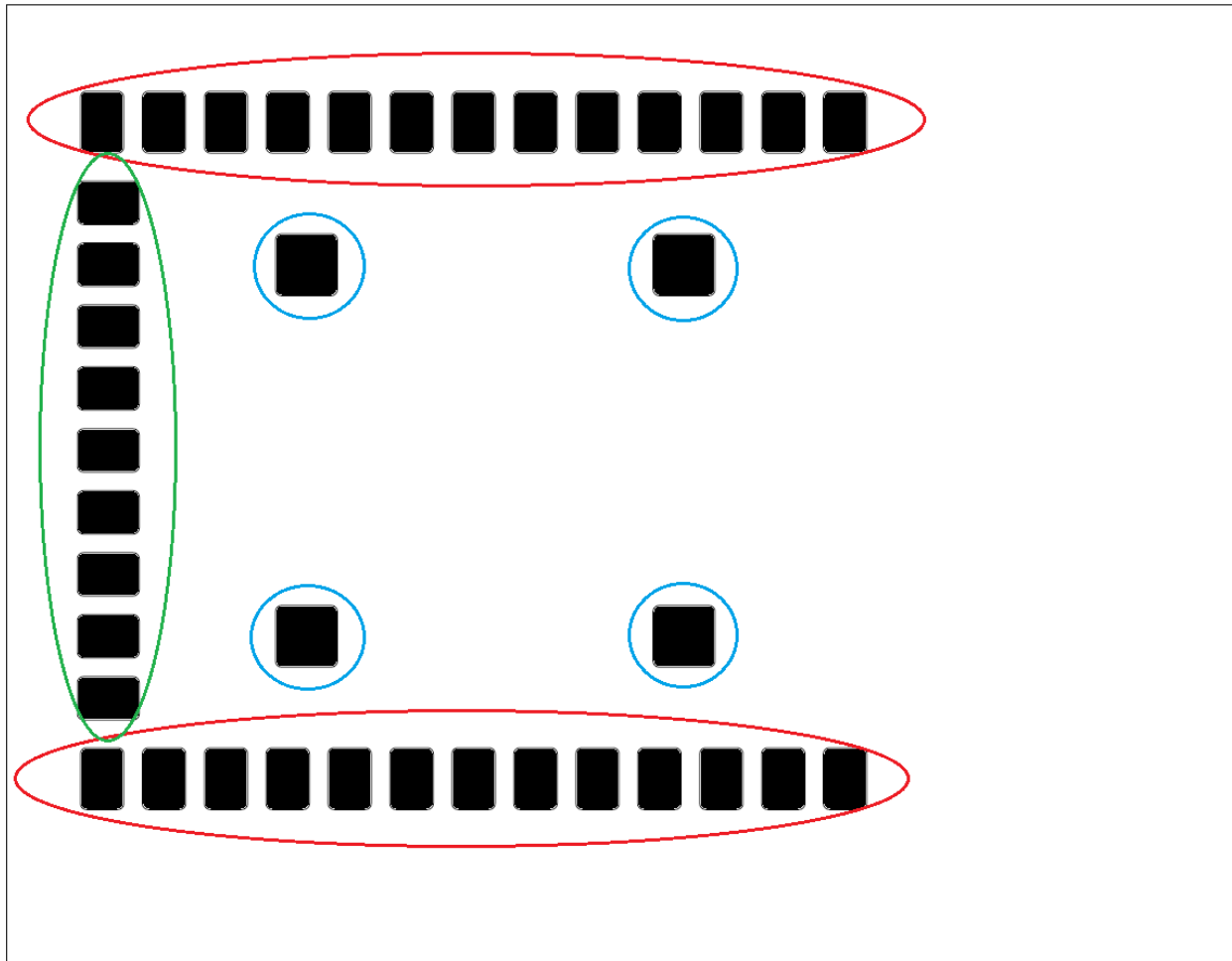
The integration of the MLE-N2 module is straightforward, but for optimal RF performance it is important to follow the power supply and layout considerations. Failure to do so may result in inferior RF performance. Some important highlights to avoid the most common mistakes are shown below:

- The carrier PCB shall be of the recommended type and have a proper ground plane
- Product enclosure and carrier PCB shall adhere to the clearance recommendations
- Product enclosure shall not block radio-signals
- Power supply pins shall have sufficient decoupling
- All ground pins shall be available on the carrier PCB
- SWDIO and SWDCLK pins shall be accessed for programming

Layout considerations

Electrical and mechanical design files are available for download at the LumenRadio online support page.

MLE-N2 OEM module pad dimensions

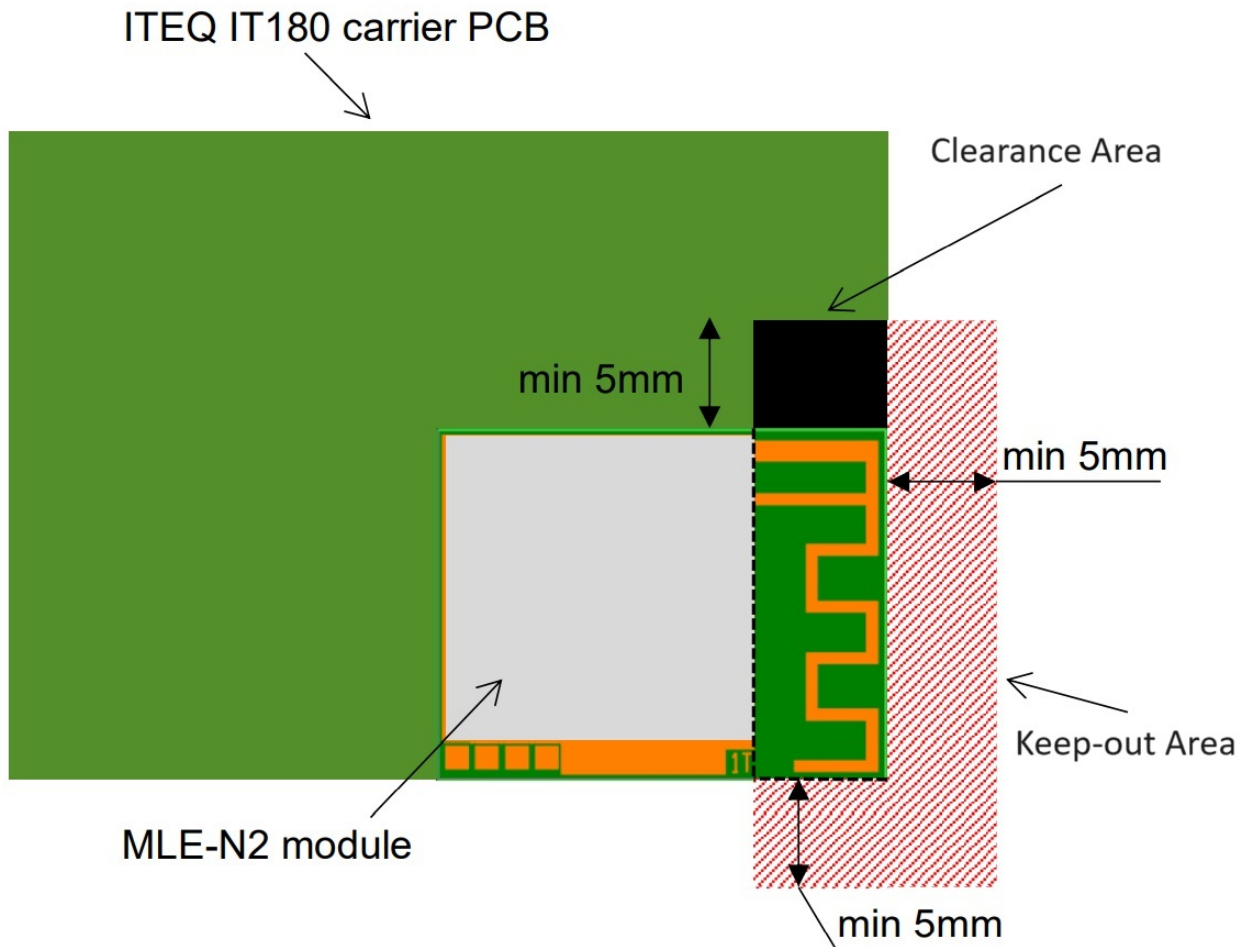


Refer to the picture above. All units in mm.

- Round rectangle top and bottom edge 1.0 x 0.7 with corner radius 0.1 (red)
- Round rectangle left edge 0.7 x 1.0 with corner radius 0.1 (green)
- Round rectangle middle 1.0 x 1.0 with corner radius 0.1 (blue)

Layout considerations for the main board

For optimum performance of the MLE-N2 antenna the carrier board PCB should be designed so that following dimensions are met:

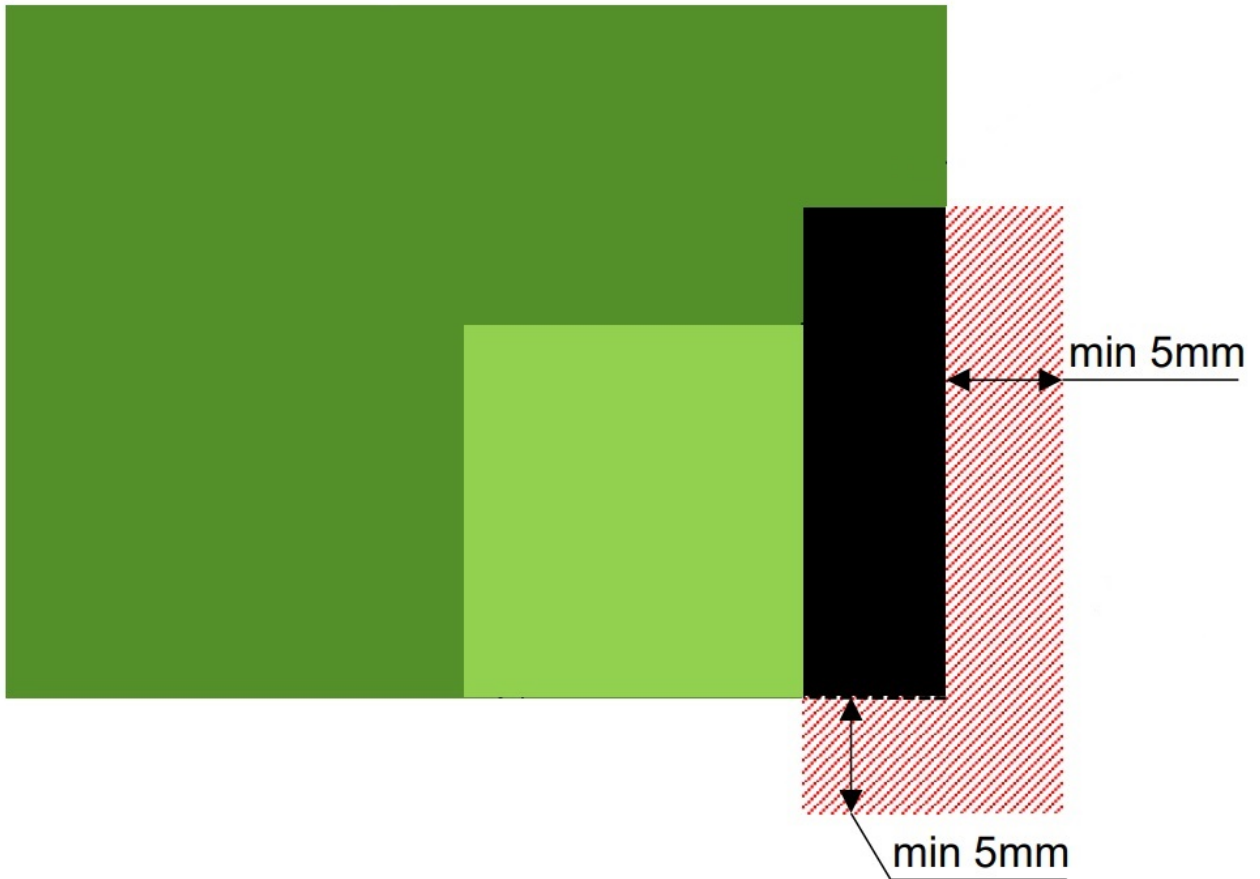


Board design example

Black Area is a carrier board clearance area. No components or traces/GND planes are allowed in this area. This area should be min 5mm wide from the board edge of MLE-N2 to the opposite board edge. Please note the orientation of the antenna and MLE-N2.

Red diagonal striped area is a keep out are “air gap” from any solid objects or carrier board PCB material.

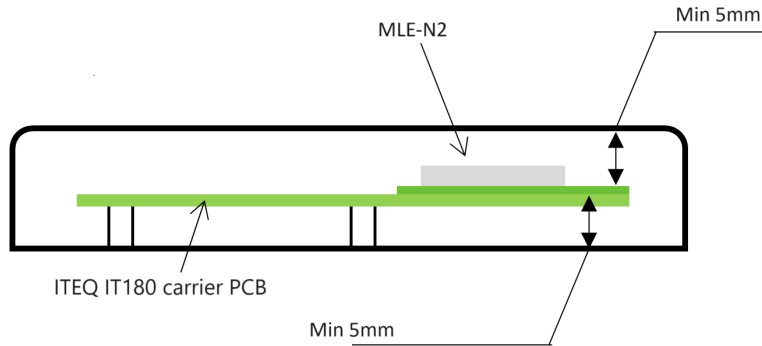
ITEQ IT180 carrier PCB



Board design without MLE

Top layer of carrier board PCB (light green area above) should be free from non-isolated GND planes, traces or vias. Black Area is a carrier board clearance area. No components or traces/GND planes are allowed in this area. This area should be min 5mm wide from the board edge of MLE-N2 to the opposite board edge. Red diagonal striped area is a keep out area "air gap" from any solid objects or carrier board PCB material.

Guidelines for mounting in enclosure



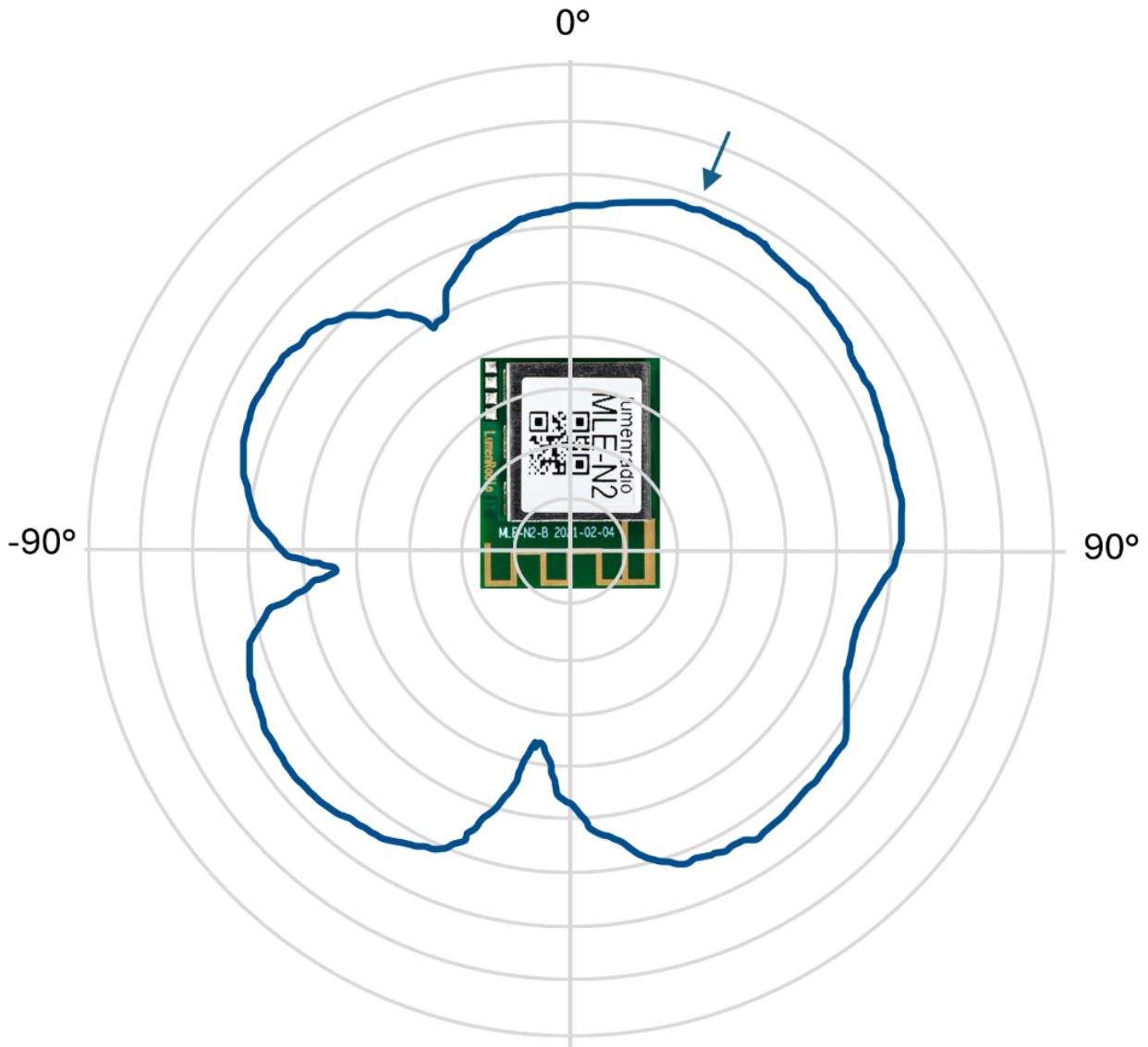
Min 5mm to solid objects under and above MLE-N2 antenna area. Note that carrier board thickness can be included in the total distance to solid objects under the antenna. I.e. for a 1.6mm carrier board standoffs needs to be min 3.4mm

PCB antenna radiation pattern

| General Specification | |
|-----------------------|-----------|
| Frequency (MHz) | 2400-2500 |
| Peak gain (dBi typ) | 0.1 |
| Impedance | 50 Ohm |

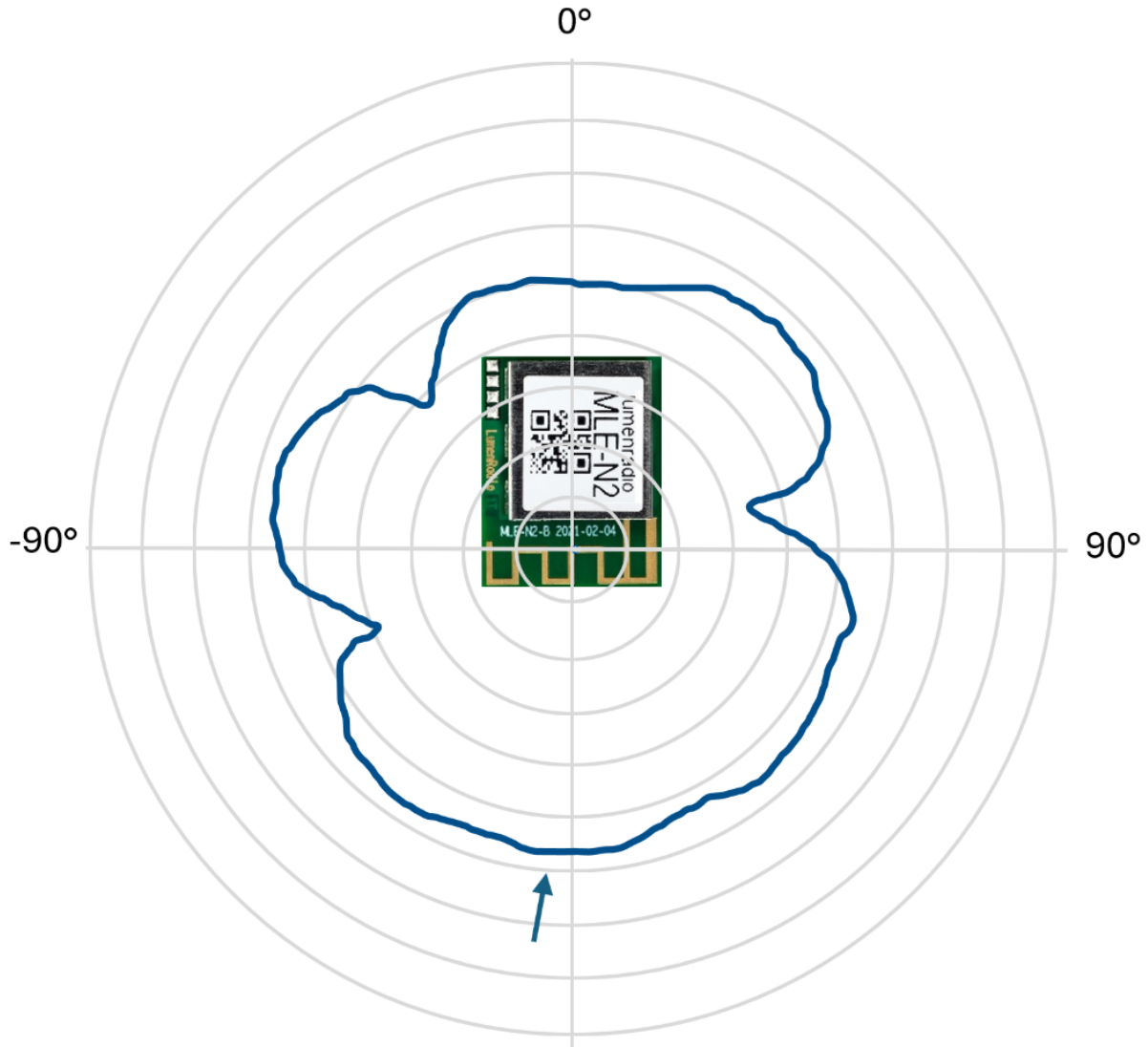
Center frequency: 2402 MHz

Antenna laying down, horizontal polarization measurement



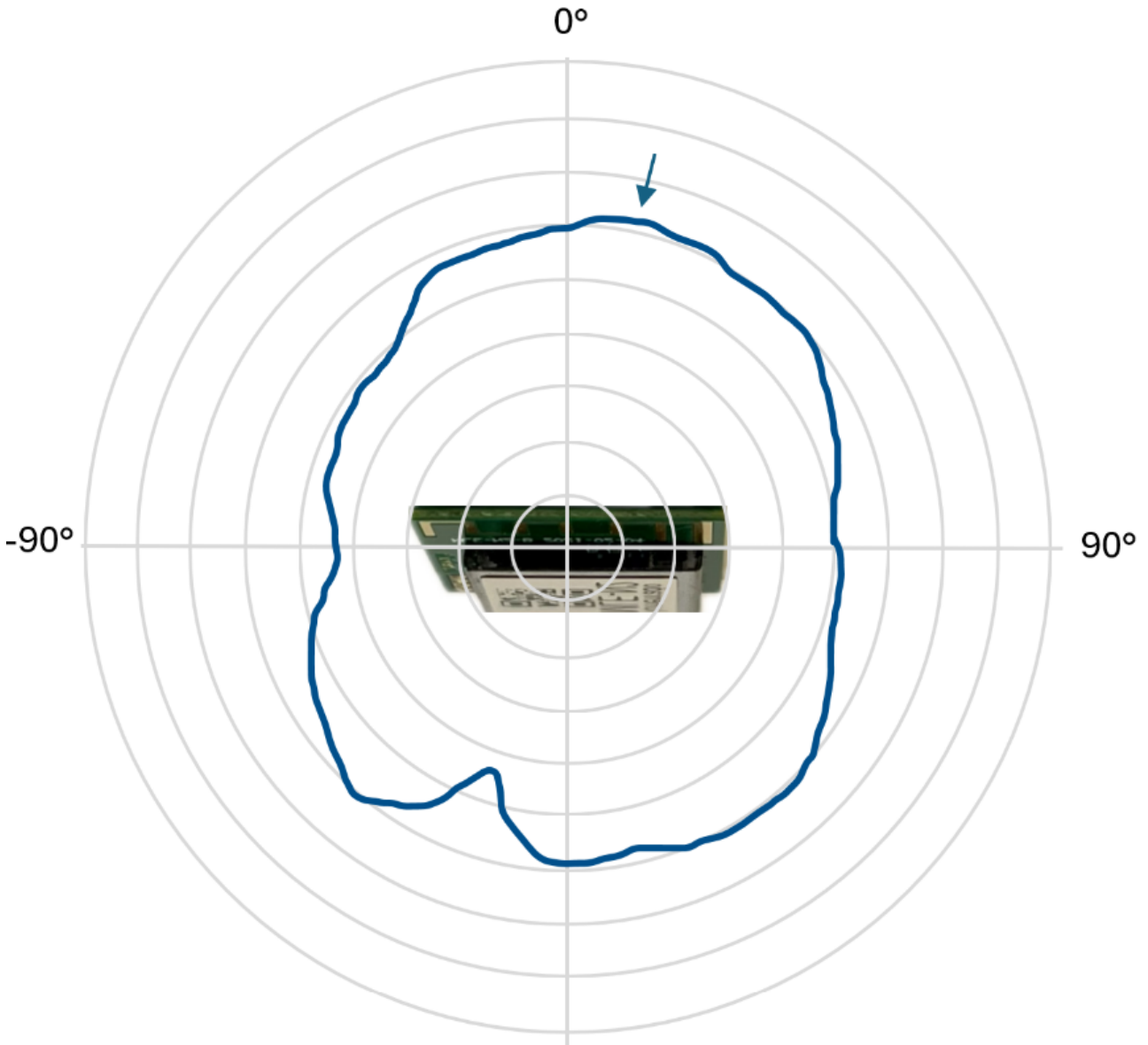
Max: -0.9 dBm

Antenna laying down, vertical polarization measurement



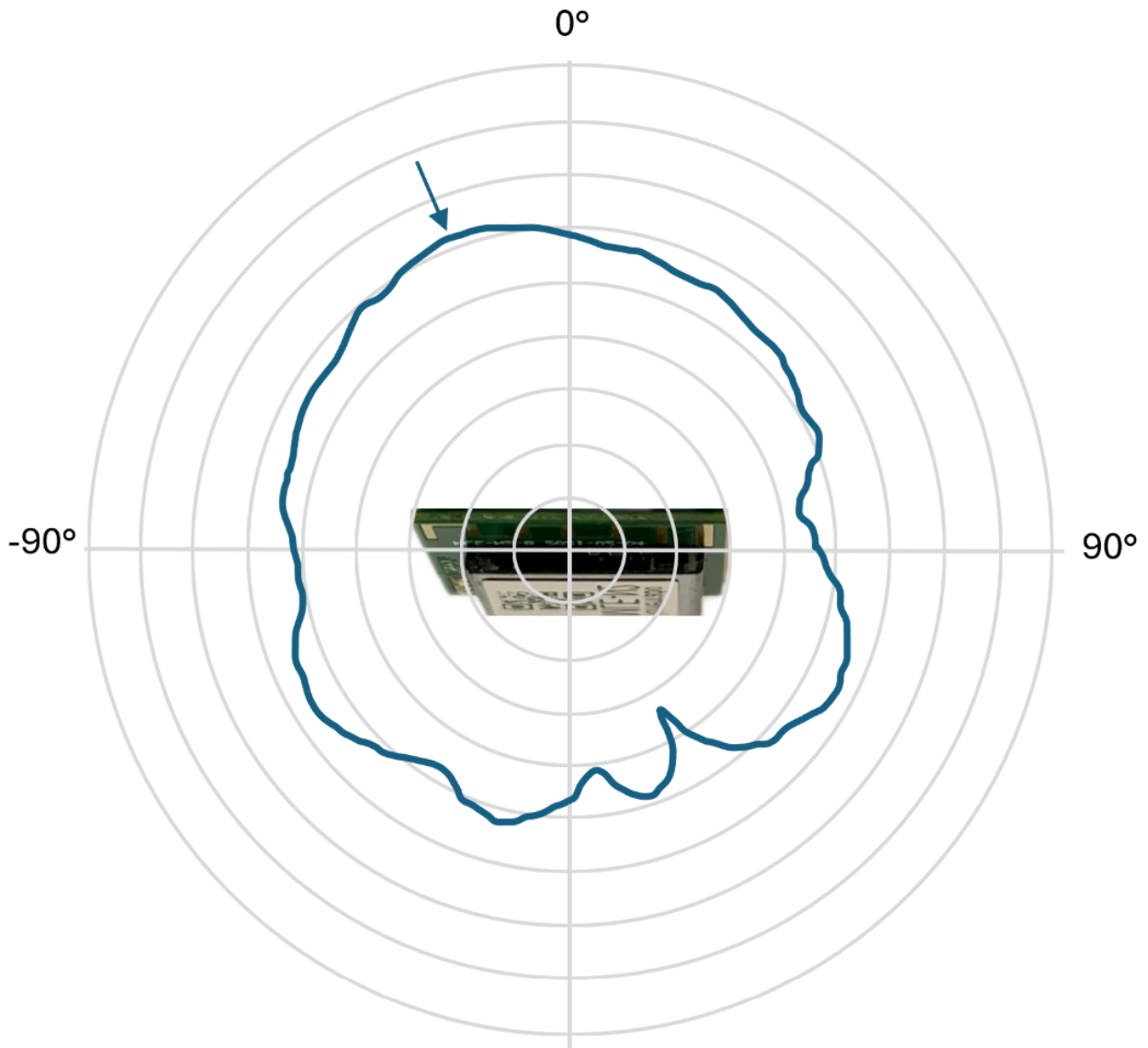
Max: -10.9 dBm

Antenna Upright, horizontal polarization measurement



Max: -6.6 dBm

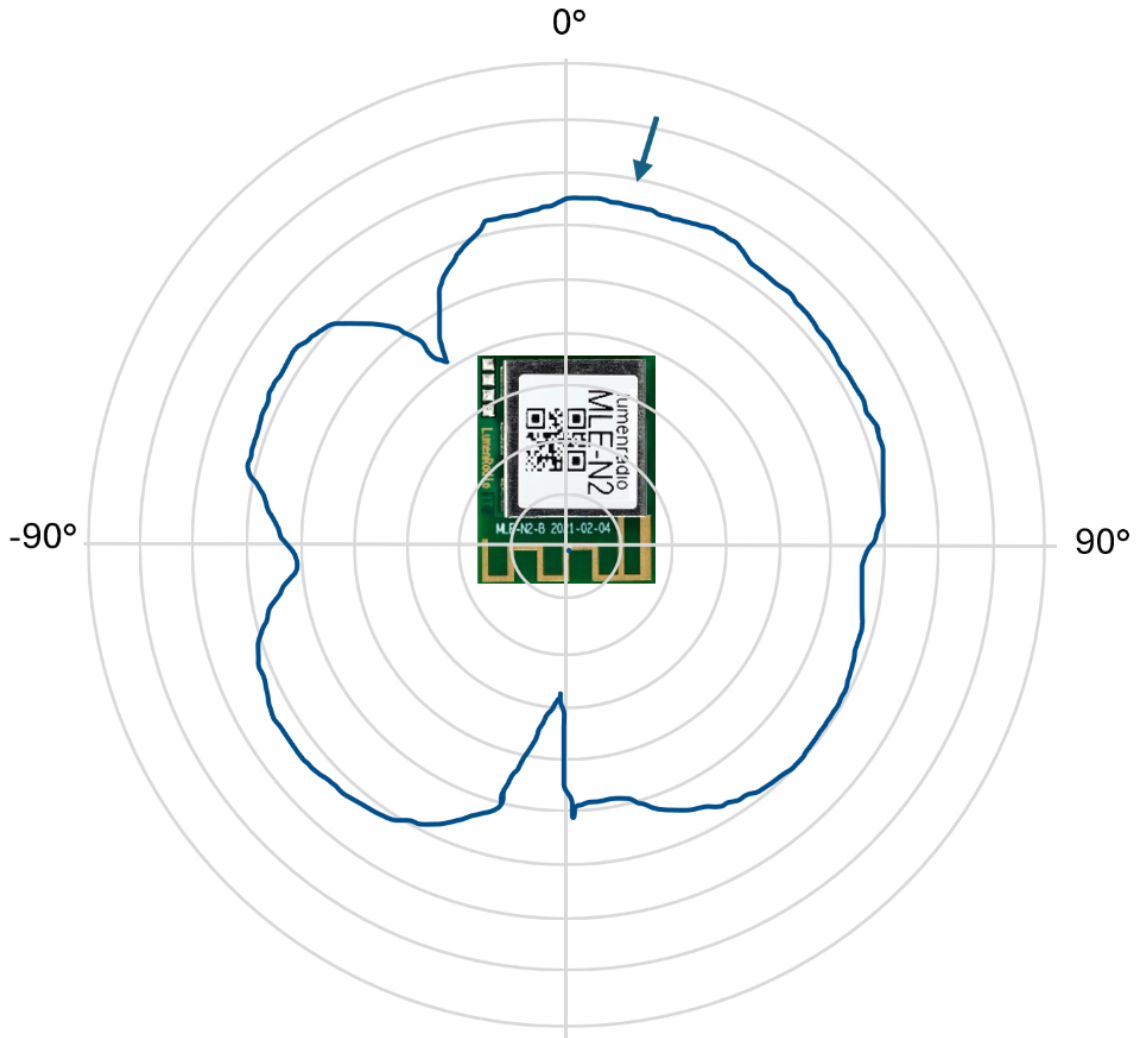
Antenna Upright, vertical polarization measurement



Max: -6.9 dBm

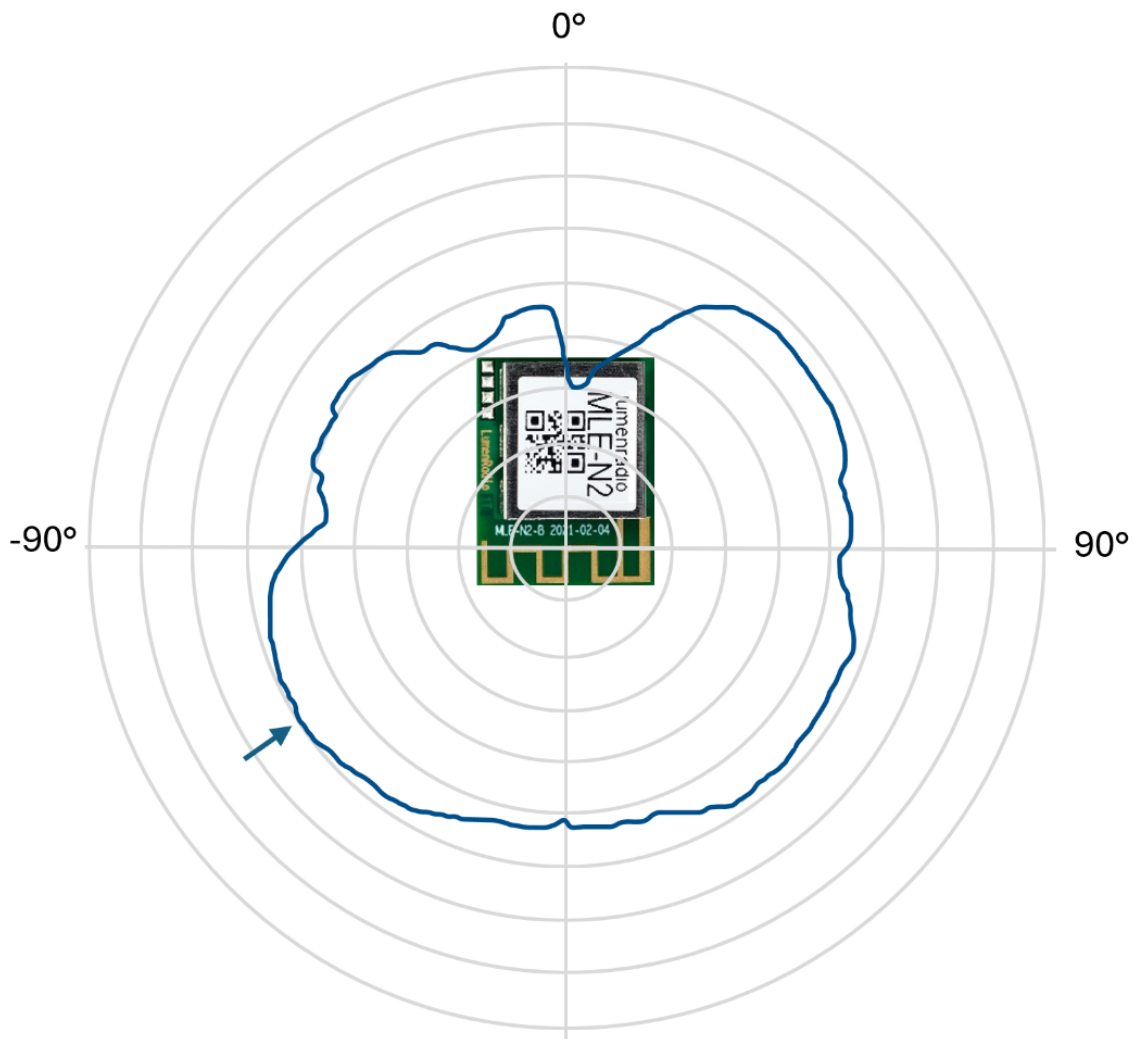
Center frequency: 2480 MHz

Antenna laying down, horizontal polarization measurement



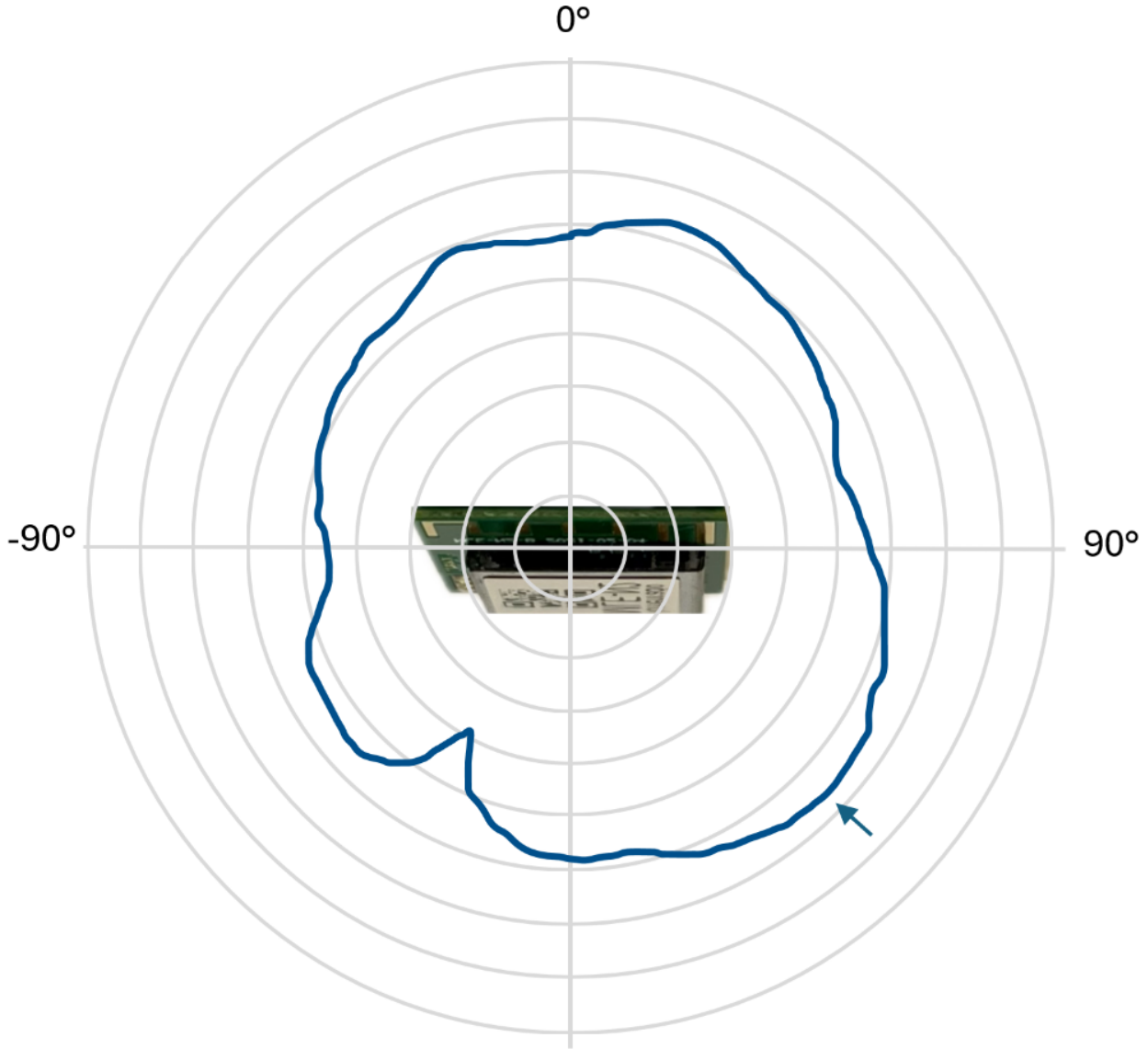
Max: 0.1 dBm

Antenna laying down, vertical polarization measurement



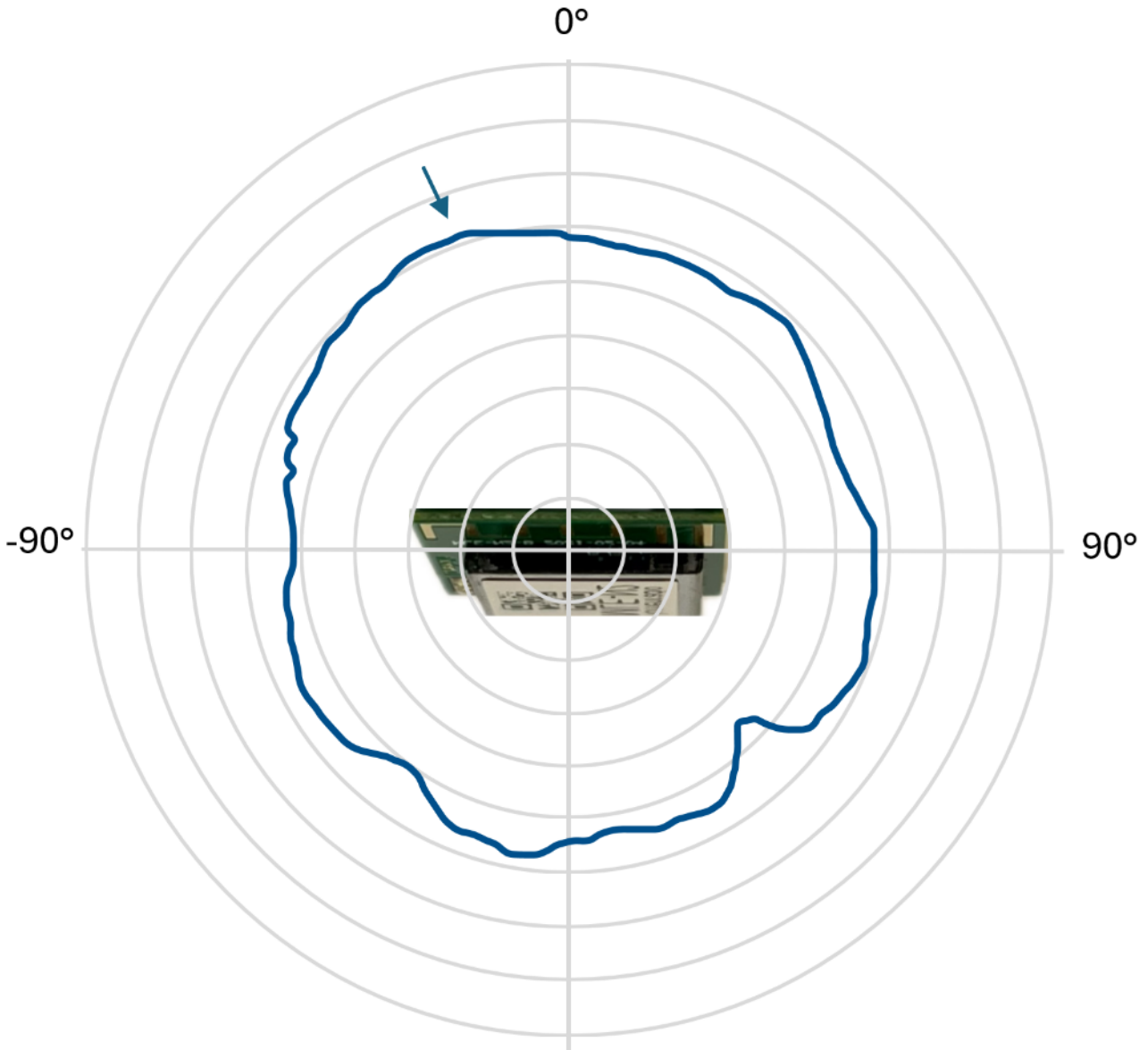
Max: -9.1 dBm

Antenna Upright, horizontal polarization measurement



Max: -4 dBm

Antenna Upright, vertical polarization measurement



Max: -6.1 dBm

PCB inverted-F antenna

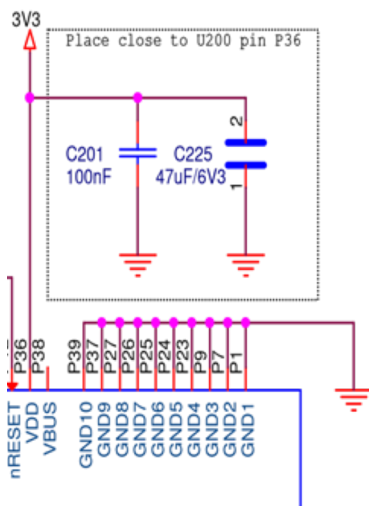
The MLE-N2 module has a built in highly effective inverted F antenna optimized for wall mount applications.



Power supply recommendations

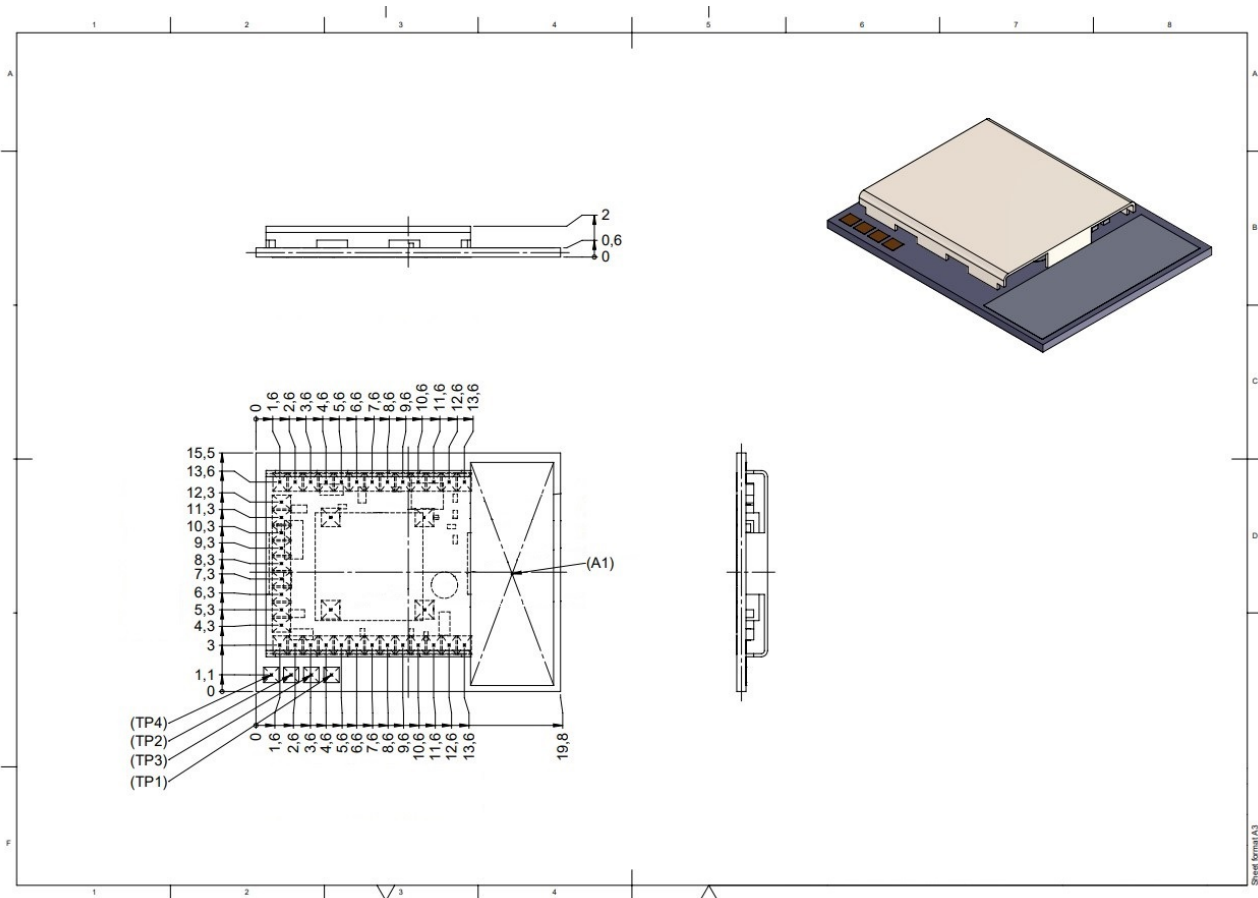
The MLE-N2 Module is designed for 3.3V operation. All pins should not have any power applied to them before the +3.3V rail is applied.

To ensure reliable operation, the supply pin should be decoupled with a 100nF ceramic capacitor close to the supply pin. It is also recommended to add a high value ceramic bulk capacitor, such as 47uF, which will reduce the current ripple of the 3.3V net.

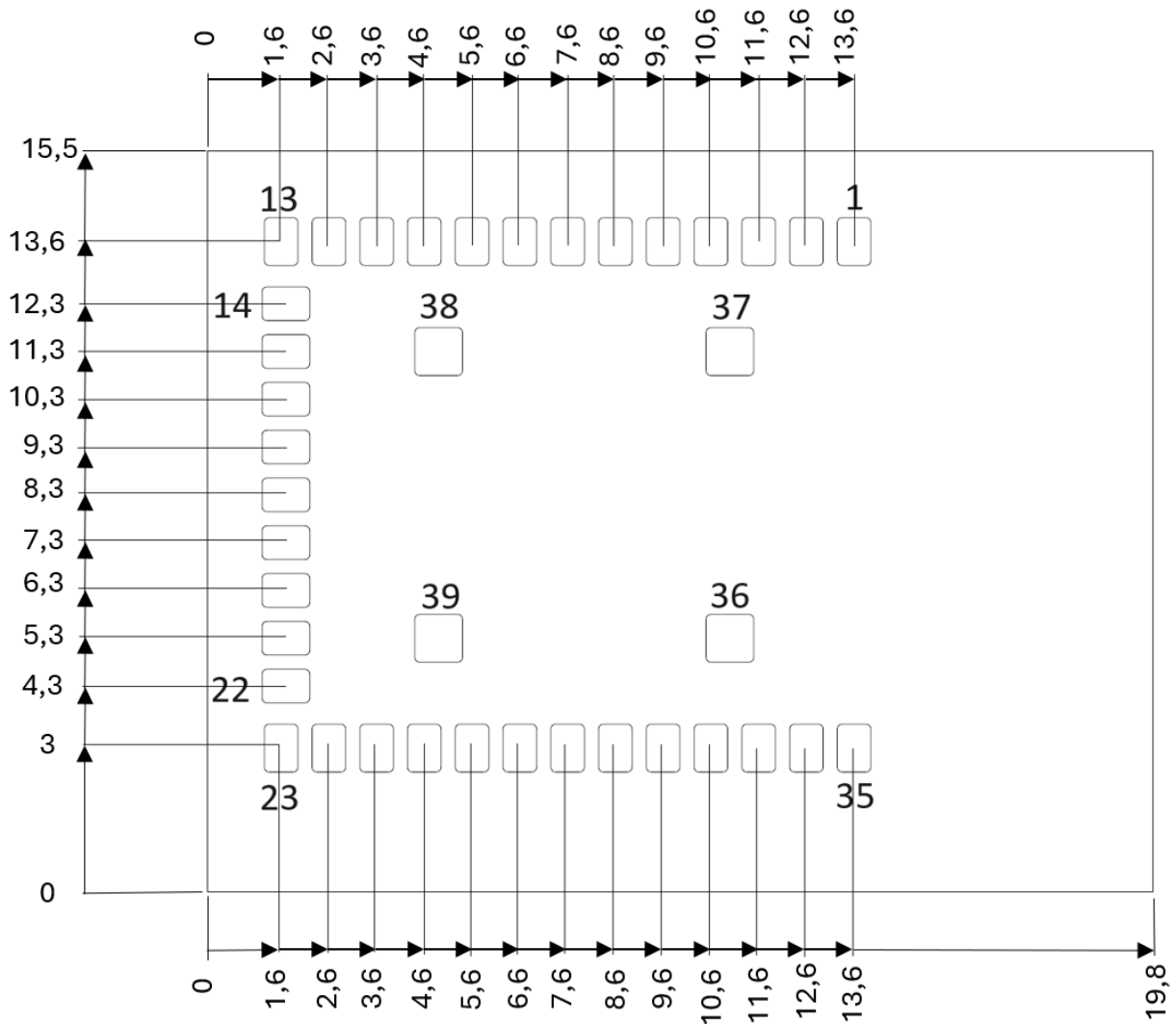


During radio transmission, current consumption will rise sharply to 150mA typical, 250mA max. A typical slew rate value is 300A/s during radio transmission.

Mechanical specification



All dimensions in mm.



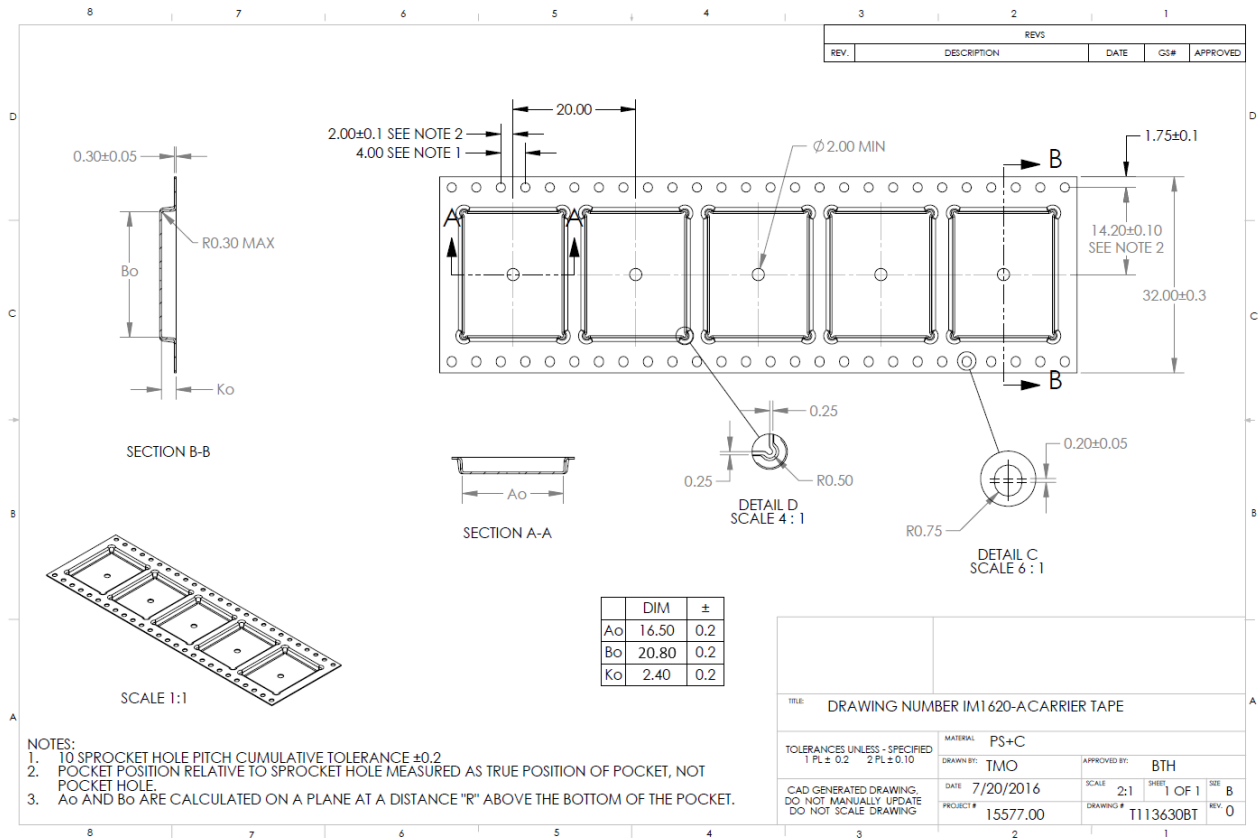
Refer to the picture above. All units in mm. All below positions are with respect to the origin point (0 , 0):

- Pin P36 position (11 , 5.3)
- Pin P37 position (11 , 11.3)
- Pin P38 position (4.9 , 11.3)
- Pin P39 position (4.9 , 5.3)

Mechanical design files in .stp and .dxf format is available for download at the LumenRadio online support page.

Module packaging

Carrier tape dimensions




Reel marking

Every reel has an identifier sticker both on the reel and the reel package.



The identifier sticker contains the following information:

| | | | |
|----------------------------------|-----------------------------------|--|--|
| PRODUCT MLE-N2 | SOFTWARE VERS. SW: XXXX |  | |
| PACKED DATE XXXX-XX-XX | XX:XX:XX | QUANTITY XXX | |

XXXXXX (serial number)

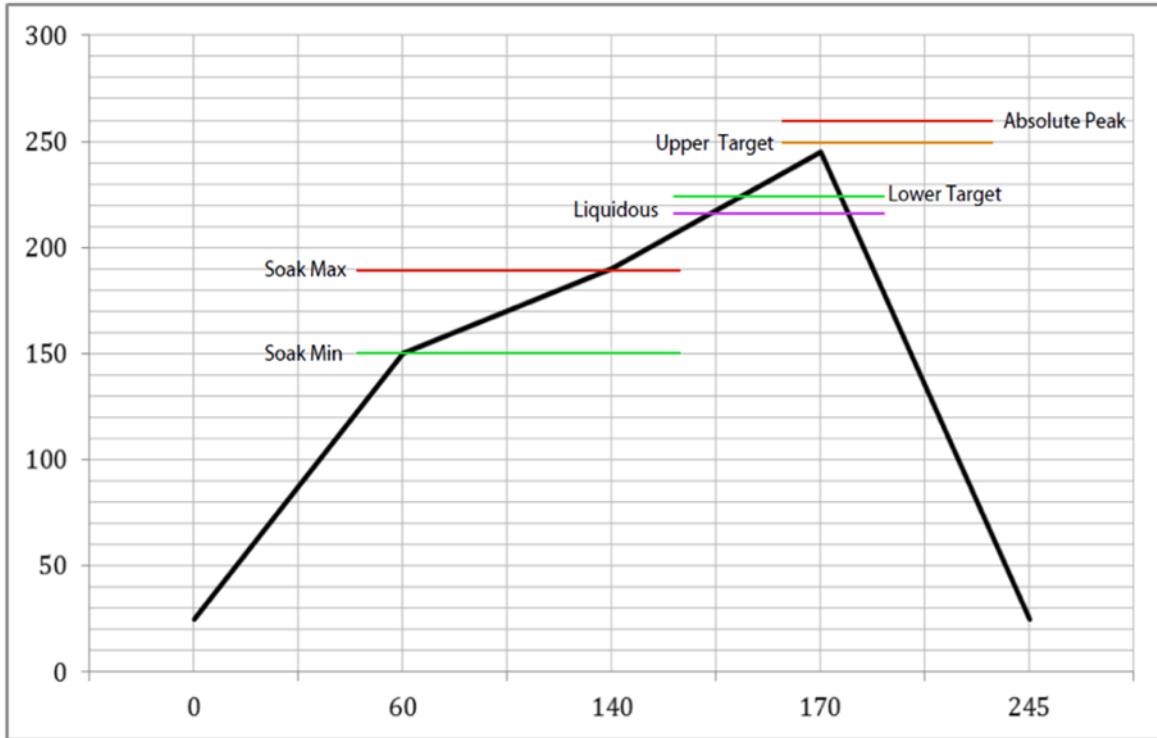


FCC ID: XRSMLN201
IC ID: 8879A-MLEN201



Reflow soldering specification

MLE-N2 is a surface mounted device (SMD) designed to be easily integrated into high-volume production lines including reflow soldering to a PCB. It is ultimately the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. The MLE-N2 module conforms to JSTD-020D1 standards for reflow temperatures.



Temperatures should not exceed the minimums or maximums presented in the table below

| Specification | Value | Unit |
|------------------------------------|---------|------|
| Temperature Inc./Dec. rate (max) | 3 | °C/s |
| Temperature Decrease rate (target) | 2-3 | °C/s |
| Soak Temp increase rate (goal) | 0.5-1.0 | °C/s |
| Flux soak period (min) | 70 | s |
| Flux soak period (max) | 120 | s |
| Flux soak temp (min) | 150 | °C |
| Flux soak temp (max) | 190 | °C |
| Time above Liquidous (min) | 50 | s |
| Time above Liquidous (max) | 70 | s |
| Time in target reflow range (goal) | 30 | s |
| Time at absolute peak (max) | 5 | s |
| Liquidous temperature (SAC305) | 218 | °C |
| Lower target reflow temperature | 225 | °C |
| Upper target reflow temperature | 250 | °C |
| Absolute peak temperature | 260 | °C |

Product verification guideline

FCC information

MLE-N2 FCC ID: XRSMLN201

Federal Communication Commission Interference Statement

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 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.

FCC Caution

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation.

FCC Declaration of Conformity

We LumenRadio AB, Johan Willins Gatan 6, 41648 Gothenburg, Sweden, declare under our sole responsibility that Mira MLE-N2 comply with Part 15 of FCC Rules.

FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This device is intended only for OEM integrators under the following conditions:

- The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- The transmitter module may not be co-located with any other transmitter or antenna

IMPORTANT NOTE

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labelling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20cm may be maintained between the antenna and users. The final end product must be labelled in a visible area with the following: "Contains FCC ID: XRSMLN201".

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter (MLE-N2) installed.

Industry Canada statement

IC: 8879A-MLEN201

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

- this device may not cause interference, and - this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: - l'appareil ne doit pas produire de brouillage, et - l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Caution Exposure

This device meets the exemption from the routine evaluation limits in section 2.5 of RSS102 and users can obtain Canadian information on RF exposure and compliance.

Le dispositif répond à l'exemption des limites d'évaluation de routine dans la section 2.5 de RSS102 et les utilisateurs peuvent obtenir des renseignements canadiens sur l'exposition aux RF et le respect.

This equipment should be installed and operated with a minimum distance of 20 centimetres between the radiator and your body.

Cet équipement doit être installé et utilisé avec une distance minimale de 20 centimètres entre le radiateur et votre corps.

The final end product must be labelled in a visible area with the following: The Industry Canada certification label of a module shall be always clearly visible when installed in the host device, otherwise the host device must be labelled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains transmitter module: 8879A-MLEN201

where 8879A-MLEN201 is the module's certification number.

CE

Mira MLE-N2 comply with the Essential Requirements of RED (Radio Equipment Directive) of the European Union (2014/53/EU). Mira MLE-N2 meet the ETSI EN 300 328 V2.2.2 conformance standards for radio performance.

Other compliances

For other local compliance regulations (CE, UL, CSA, SRRRC, C-Tick, etc.) you are responsible as the product manufacturer to ensure all required compliance testing is completed. LumenRadio are happy to advise on compliance testing – please contact LumenRadio for details.

RoHS / REACH

The MLE-N2 module complies with directive 2011/65/EU, 2015/863/EU (RoHS) of the European Parliament and the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment. The MLE-N2 module modules do not contain the SVHC (Substance of Very High Concern), as defined by Directive EC/1907/2006 Article according to REACH Annex XVII.

Contact and ordering information

LumenRadio AB
Johan Willins Gatan 6
SE-416 48 Gothenburg
Sweden
Phone: +46 31 301 03 70
www.lumenradio.com
sales@lumenradio.com

The LumenRadio support team can be reached through our support portal.

| Product | Order code |
|---------------|------------|
| MLE-N2 module | 800-8204 |