# NTL104

# DUAL ANTENNA HIGH PERFORMANCE OEM GNSS MODULE PPP, RTK+HEADING

## SPECIFICATION

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## 1. GENERAL INFORMATION

NTL104 dual antenna high precision multi-GNSS OEM module features the software and hardware platform which provides the navigation solutions and 2D orientation (Heading determination), the increased update rates and access to raw GNSS measurements in a compact form factor. The NTL104 module utilizes all supported GNSS systems concurrently, including S-band signals, to calculate the navigation solution.

The module with the integrated powerful PPP, Dual RTK Engines provides high accuracy positioning and Heading determination (Heading + Pitch) in both static and dynamic.

The future-oriented NTL104 includes an internal flash that allows firmware update by software tool designed NTLab.

The NTL104 supports the following operation modes:

- autonomous mode (standalone mode), up to 20Hz;
- PPP mode: it receives RTCM-SSR correction and calculates Position, Velocity, Time (PVT) with high accuracy, up to 20Hz;
- RTK ROVER mode: it receives RTCM correction from the Base Station and calculates PVT with high accuracy, up to 20Hz;
- RTK BASE mode: it provides RTCM3.3 output correction data for the Rover (raw GNSS measurements), up to 20 Hz.
- Heading determination: it provides 2D orientation of antenna system (Heading + Pitch) and PVT, up to 20Hz.

Autonomous mode is standard GNSS method, also known as SINGLE mode, for PVT calculation. While using this method, the navigation solution (PVT) is only obtained from the GNSS constellations, there are no error corrections made.

PPP mode is positioning mode with high level of accuracy. PPP mode requires the RTCM-SSR corrections from PPP service providers. PPP engine is designed for PPP with floating ambiguities. The typical convergence time is between 20-30 minutes. For stable and reliable operation PPP requires at least one of two message sets: 1060+1066 or 1060+1243. The principle of PPP operation is based on the difference between the L1 and L2 carrier phases, therefore it is necessary to use antennas that support the L1, L2 GNSS signals reception. The actual the convergence time required is dependent on the quality of the correction products, satellite geometry, atmospheric conditions.

RTK ROVER mode is differential positioning mode whit algorithms that incorporate ambiguity solutions and correction data from the base station. The position accuracy achievable by the module (rover) depends on the baseline length used and the accuracy of the corrections data and position from the base station.

RTK BASE mode is raw GNSS measurements generation mode. In RTK BASE mode, NTL104 generates RTCM messages: 1004+1012, MSM7, 1005, 1006, 1007, 1008, 1019, 1020, 1046, 1041, 1042, 1230, 4064.100.

Heading determination is mode that allows computing of antenna system orientation parameters (Heading and Pitch) in addition to PVT. This function is available for navigation modules with two connected antennas. Heading determination is based on differential positioning method that calculates the coordinates of the vector connecting two antennas: primary and secondary. The module can operate in SINGLE + HEADING, PPP + HEADING or RTK + HEADING modes.

*GNSS External Active Antenna Requirements:*

- Antenna voltage supply 5V;
- Maximum current 100mA;
- LNA Gain Range (minus signal loss) 20...35dB.

The external GNSS antenna(s) must have a clear line of sight to the sky during operation. Install the antenna with a clear view of the sky and clear of obstructions such as building, trees etc.

Rooftops, free from other structures with a direct view of the horizon, usually make good places to install.

This clear view allows antenna to track the maximum number of satellites during the day.

Don't install GNSS antenna near the windows of the building or indoors. When installing the GNSS antenna, choose a location where the antenna will not be covered by drifting snow or accumulated snow. It must not be covered with leaves or placed in a position where it could be blocked.

Avoid placing the GNSS antenna in close proximity to broadcast antennas, metal surfaces or powerful transmitters.

Satellite signal is blocked by the underground parking lots, bridges, tall buildings, large trees etc.

Try to choose a "lightning-protected zone".

Optimal performance will not be available in narrow streets or if the antenna is obstructed by objects.

Heading accuracy is dependent on antenna baseline length. Mount the primary and secondary antennas as far apart as possible. A minimum separation distance of 1 meter is recommended.

Poor visibility may result in a position shift or an increase in Time To First Fix (TTFF).

Incorrect antenna placement can influence on navigation solution. Good visibility of the sky is an important condition for accurate positioning and confident reception.

## 2. TOP VIEW AND INDICATION

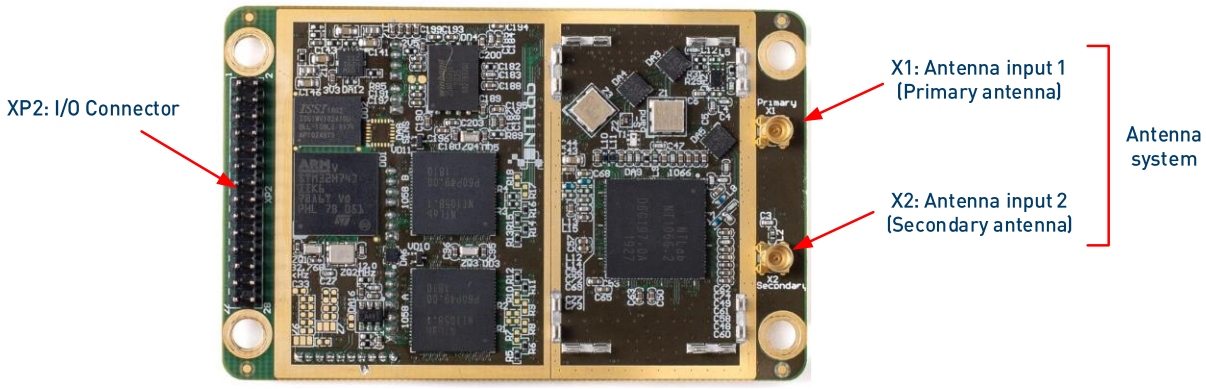


Figure 2.1 – NTL104 Top View[1]

NTL104 is implemented on the chipsets designed by NTLab company:

- 1xNT1066 is a 4-channel L1, L2, L5, S bands Radio-Frequency Front-End (RF FE) integrated circuit for GNSS signals reception and their analog processing (for amplification, filtering and down converting of the received signals to a fixed intermediate frequency);
- 1xNT1065 is a 4-channel L1, L2, L5 bands RF FE integrated circuit for GNSS signals reception and their analog processing;
- 3xNT1058 are microcontrollers which include digital Baseband Processor and 128-channels hardware correlator (3x128) for signals tracking and primary processing of digital signals.

*Connectors:*

- X1, X2 are MMCX type connectors for external active antenna(s) commutation. Central pin provides DC voltage for antenna power supply. DC voltage is wired from Pin 5 of I/O Connector XP2. It means that a host-device must provide DC voltage in accordance with active antenna requirements for NTL104.

  X1 connector is Primary antenna input. X2 connector is Secondary antenna input that is used for Heading determination only. The Secondary antenna is the source of raw GNSS measurements (raw data) for internal Dual RTK Engine. Secondary antenna data not available to the user.
- XP2 is a PLD2-28 connector. Form factor of the board and XP2 pin-out is compatible with popular GNSS receiver families (Novatel 6xx, Trimble and others). Refer to Chapter 5 for XP2 pin-out, refer to Chapter 6 for PCB dimensions.

[1] The actual product may differ in appearance

*LEDs:*

- Yellow LED VD1 is indicator of the normal operation of the MCU. It blinks during normal operation.
- Green LEDs VD2 (A), VD4 (B) and VD12 (C) are indicators of the normal performance for 3xNT1058. It blinks once per second during normal operation.
- Red LEDs VD3 (NT1066 AOK) and VD5 (NT1065 AOK) are indicators of normal hardware operation of the analog RF FE parts. It is OFF during normal operation. Otherwise, please, check active antenna circuitry. This may indicate not appropriate level of amplification in active antenna: too low or too high.
- Green LED VD6 is indicator of the module power supply. Green Solid: means the board is powered properly.
- Red LED VD7 is indicator of the Reset control (may be missing).
- Green LED VD8 is indicator of the antenna power supply. Green Solid: means the board is powered properly.
- Red LED VD9 is antenna input short-circuit indicator. It is OFF during normal operation.

## 3. BLOCK DIAGRAM

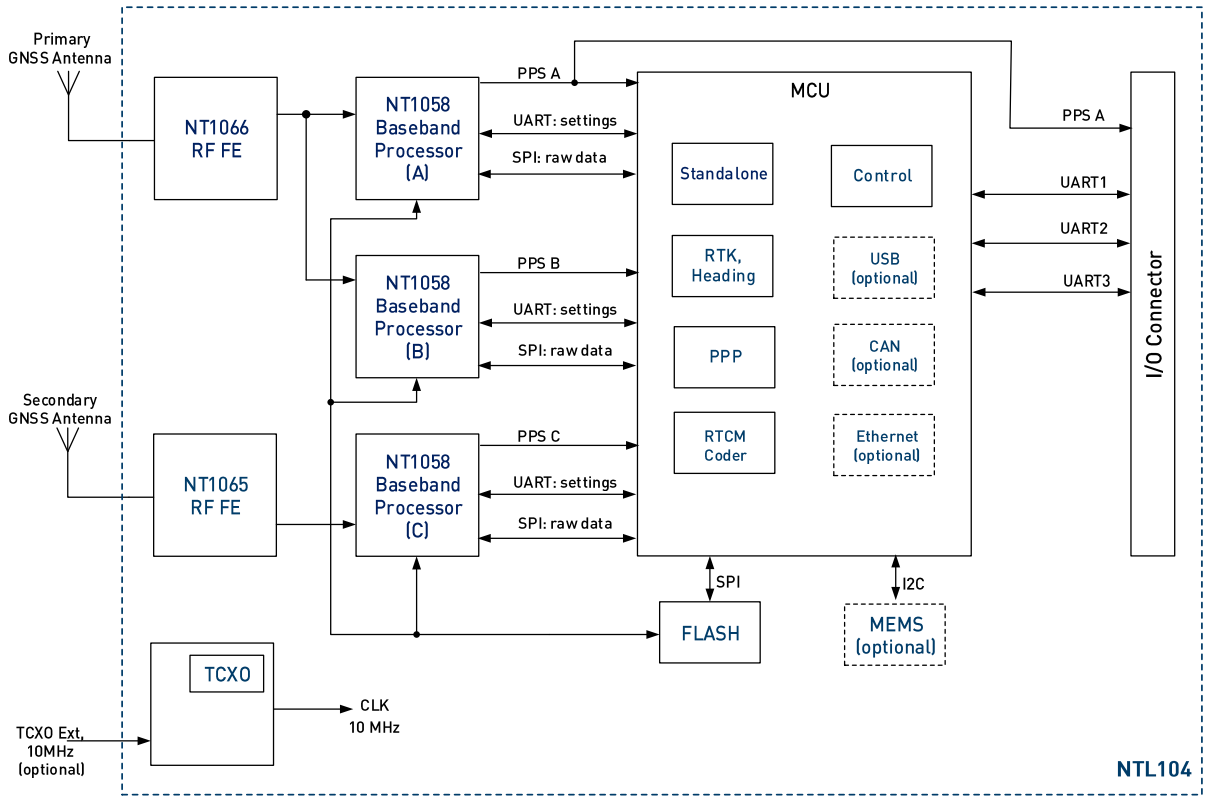


Figure 3.1 – NTL104 Block Diagram

*Notice:*

- An active antenna(s) is mandatory for the NTL104.
- The NTL104 has two power supply pins: one pin for module power supply, the other pin for antenna power supply.
- UARTs are used to transmit navigation information, to input/output RTCM correction data, to monitor module status information, to configure and control the module.
- Secondary antenna connection required for Heading determination only.
- RF FE can be clocked from the internal TCXO (by default) or the external TCXO at 10 MHz (optional).

## 4. SPECIFICATIONS

Table 4.1 – NTL104 Specification

| № | Parameter | Description | Note |
|---|---|---|---|
| 1 | Supported GNSS constellations | GPS L1 (C/A), L2 (CM), L5<br>GLONASS L1 (C/A), L2 (C/A)<br>Galileo E1, E5b, E5a<br>BeiDou B1, B2<br>NavIC L5, S-band<br>SBAS L1 | 1. Tracking user-selectable GNSS constellations<br>2. Simultaneous using of all GNSS in the navigation solution and raw measurements<br>3. EGNOS, GAGAN, WAAS, MSAS, SDCM |
| 2 | Channels | 384 | 256 channels are for Positioning and 128 channels are for Heading determination |
| 3 | Time to First Fix (TTFF): | | |
| | «Cold» Start | < 60 seconds | |
| | Signal Re-acquisition | < 2 seconds | |
| 4 | Positioning modes | Standalone | Simultaneous using of all GNSS |
| | | PPP | Using GPS L1, L2, GLONASS L1, L2 Galileo E1, E5b, E5a; RTCM SSR;<br>Ready for NavIC and BeiDou (subject of PPP corrections availability) |
| | | RTK | Simultaneous using of all GNSS; RTCM 3.3 |
| | | Heading determination | GPS L1, L2, GLONASS L1, L2 |
| 5 | Operation modes | RTK ROVER | RTCM 3.3 |
| | | RTK BASE | RTCM 3.3 |
| 6 | Operation conditions | Static mode | Static receiver, static base station |
| | | Kinematic mode | Moving receiver, static base station |
| | | Moving Base | Moving receiver, moving base station |
| 7 | Data Output Formats | NMEA 2.3, NMEA 4.11 | |
| | | NTL Binary | |
| | | RTCM 3.3 (MSM + Legacy messages) | |
| | | NovAtel OEM 6 | |
| 8 | Data update rates: | | |
| | Standalone mode | 20 Hz | 1, 2, 5, 10 Hz are available |
| | PPP mode | 20 Hz | |
| | RTK mode | 20 Hz | |
| | Heading | 20 Hz | |
| | Raw ranging measurements | 20 Hz | |
| 9 | Measurement precision (one sigma): | | |
| | C/A pseudoranges | 20 cm | Smoothed pseudoranges |
| | L1, L2 carrier phase | 0.8 mm | |

Table continuation 4.1 – NTL104 Specification

| | | | |
|---|---|---|---|
| 10 | Accuracy (RMS) | | |
| | **Horizontal:** | | |
| | Standalone mode | 1.1 m | Depends on atmospheric conditions, satellite visibility and geometry, multipath conditions, GNSS antenna. |
| | SBAS mode | 0.6 m | |
| | RTK FIX mode | 0.005 m + 0.5 ppm | |
| | PPP mode | 0.05 m | |
| | Velocity | 0.02 m/s | |
| | **Vertical:** | | |
| | Standalone mode | 1.8 m | Depends on atmospheric conditions, satellite visibility and geometry, multipath conditions, GNSS antenna |
| | SBAS mode | 0.9 m | |
| | PPP mode | 0.1 m | |
| | RTK FIX mode | 0.008 m + 1.0 ppm | |
| | Velocity | 0.03 m/s | |
| 11 | Angles Accuracy (RMS): | | |
| | Pitch | 0,15 deg | Baseline length ~2m |
| | Heading | 0,06 deg | |
| 12 | Timing Accuracy | +/- 20 ns | The PPS adjusts to the GPS/Glonass/Galileo/NavIC/BeiDou systems time with an accuracy of +/-20 ns (GPS by default).<br>It is possible to additionally shift the PPS edge along the time axis to the left/right (calibration).<br>Voltage logic level is 2.5V, pulse width is 1ms.<br>PPS is triggered by the leading edge. |
| 13 | Interfaces | 3xUART,<br>1xPPSout | |
| 14 | Maximum operating limits | | |
| | Velocity | 512 m/s | |
| | Altitude | 18000 m | |
| 15 | Operating voltage | 3...5.5V | |
| 16 | Power consumption | Up to 3.5 W | |
| 17 | Dimensions (L x W x H) | 71mm x 46mm x 12,8mm | |
| 18 | Weight | <25g | |
| 19 | Operating temperature | –40 °C ... +80 °C | |
| 20 | Storage temperature | –55 °C ... +85 °C | |

*Warning:* All specifications are at an ambient temperature of 25 °C.

## 5. COMMUNICATION PORTS AND PIN DEFINITION

Table 5.1 – I/O connector XP2 pin definitions

| Pin No | Name | I/O | Description |
|---|---|---|---|
| 1 | USB_ID | Input | MCU USB FS[2] |
| 2 | USB_VBUS | Input | MCU USB FS[2] |
| 3 | BOOT | Input | MCU boot mode selection[2] |
| 4 | TPO-MID | Output | MCU ETHERNET[2] |
| 5 | LNA_PWR | Power | Antenna power supply |
| 6 | Power | Power | NTL104 power supply voltage |
| 7 | USB_D- | I/O | MCU USB FS[2] |
| 8 | USB_D+ | I/O | MCU USB FS[2] |
| 9 | GRESET | Input | Reset control (active-GND) |
| 10 | MF01[1] | I/O | MCU GPIO |
| 11 | MF02[1] | I/O | MCU GPIO |
| 12 | D3/CAN_Rx | Input | UART Rx line[3] or CAN[2] Rx line (CMOS_3.0) |
| 13 | EVENT[1] | Input | For MCU |
| 14,17,20,22 | GND | Power | Signal and Power Ground |
| 15 | TXD1 | Output | UART Tx line[3] (CMOS_3.0) |
| 16 | RXD1 | Input | UART Rx line[3] (CMOS_3.0) |
| 18 | TXD2 | Output | UART Tx line[3] (CMOS_3.0) |
| 19 | RXD2 | Input | UART Rx line[3] (CMOS_3.0) |
| 21 | PV | Output | «Position Valid» indicator (CMOS_3.0) |
| 23 | PPS | Output | PPS time mark[4] (CMOS_2.5) |
| 24 | D3/CAN_Tx | Output | UART Tx line[3] or CAN[2] Tx line (CMOS_3.0) |
| 25 | TPO+ | Output | MCU Ethernet[2] |
| 26 | TPI+ | Input | MCU Ethernet[2] |
| 27 | TPO- | Output | MCU Ethernet[2] |
| 28 | TPI- | Input | MCU Ethernet[2] |
| Notes | 1 - Signals implemented in hardware for compatibility with Trimble and Novatel receivers, having the same form factor; not supported in actual firmware.<br>2 – It is hardware ready; basic firmware doesn't provide such options; may be developed on demand.<br>3 – *Digital inputs/outputs*:<br>$V_{IL}$ : 0.3$V_{DD}$ (max); $V_{IH}$ : 0.7$V_{DD}$ (min); $V_{IH}$ : 3.0V (max); $V_{DD}$=2.9V;<br>$V_{OL}$ : 0.3$V_{DD}$ (max); $V_{OH}$ : 0.7$V_{DD}$ (min); $V_{OH}$ : 3.0V (max); $V_{DD}$=2.9V.<br>4 – *Digital inputs/outputs*:<br>$V_{IL}$ : 0.7V (max); $V_{IH}$ : 1.75V (min); $V_{IH}$ : 2.5V (max);<br>$V_{OL}$ : 0.7V (max); $V_{OH}$ : 1.75V (min); $V_{OH}$ : 2.5V (max). | | |

Table 5.2 – Basic configuration of NTL104 UART channels

| Pin No | Name | Description |
|---|---|---|
| 15 | UART1 Tx | Available data formats:<br>• NTL Binary for nav. data transmission and control or NMEA-0183 for nav. data transmission;<br>• NovAtel, RTCM3.3 (MSM + Legacy messages) for raw ranging data transmission;<br>Baud rate: 9600...460800;<br>Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, no data. |
| 16 | UART1 Rx | Available data formats:<br>• RTCM3.3 Base station data input or RTCM-SSR messages;<br>• NTL Binary for settings control;<br>Baud rate: 9600...460800.<br>Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary. |
| | | |
| 18 | UART2 Tx | Available data formats:<br>• NTL Binary for nav. data transmission and control or NMEA-0183 for nav. data transmission;<br>• NovAtel, RTCM3.3 (MSM + Legacy messages) for raw ranging data transmission;<br>Baud rate: 9600...460800;<br>Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary. |
| 19 | UART2 Rx | Available data formats:<br>• NTL Binary for settings control;<br>Baud rate: 9600...460800.<br>Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary. |
| | | |
| 24 | UART3 Tx | Available data formats:<br>• NTL Binary for nav. data transmission and control or NMEA-0183 for nav. data transmission;<br>• NovAtel, RTCM3.3 (MSM + Legacy messages) for raw ranging data transmission;<br>Baud rate: 9600...460800;<br>Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, no data. |
| 12 | UART3 Rx | Available data formats:<br>• RTCM3.3 Base station data input or RTCM-SSR messages;<br>• NTL Binary for settings control;<br>Baud rate: 9600...460800.<br>Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary. |

## 6. BOARD LAYOUT AND DIMENSIONS

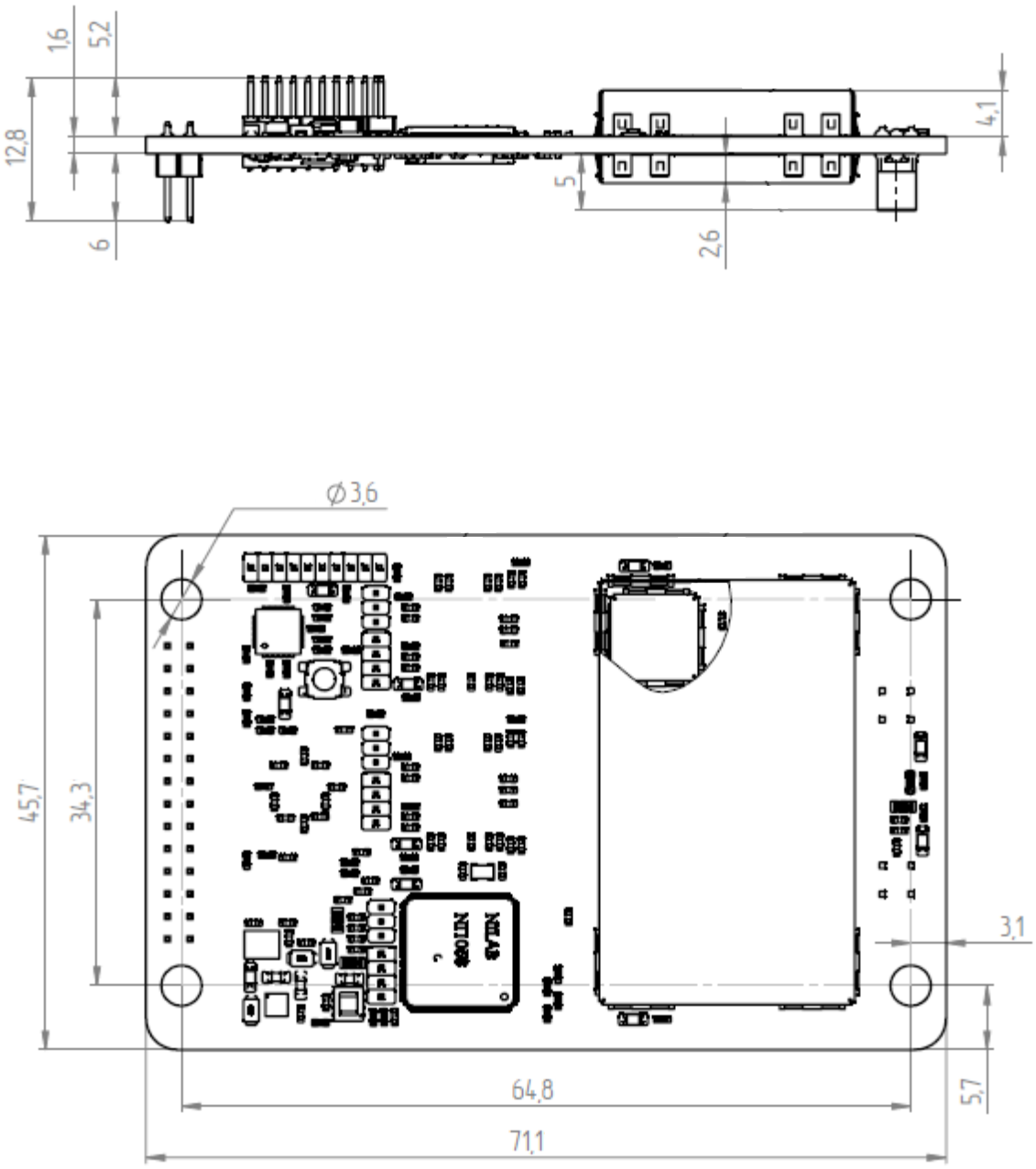


Figure 6.1 – NTL104 Board Layout and Dimensions

## CONTACTS

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