

KV104

DUAL ANTENNA HIGH PERFORMANCE

OEM GNSS MODULE

PPP, RTK+HEADING

Specification



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1. GENERAL INFORMATION

KV104 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 **KV104** 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 **KV104** includes an internal flash that allows firmware update by software tool designed Kosminis Vytis.

The **KV104** supports the following operation modes:

- autonomous mode (standalone mode), up to 20 Hz;
- PPP mode, up to 20 Hz;
- RTK ROVER mode, up to 20 Hz;
- RTK BASE mode, up to 20 Hz.
- heading determination, up to 20 Hz.

Autonomous mode is a basic method of GNSS positioning, also known as standalone, absolute or SINGLE mode for Position, Velocity, Time (PVT) calculation. While using this method, the PVT (navigation solution) is obtained without usage of any external data ("corrections").

PPP mode is a high accurate positioning mode. PPP mode requires the usage of RTCM-SSR corrections from PPP service providers. Current version of RTCM-SSR corrections supports so-called floating PPP, i.e., PPP with float ambiguities. The typical convergence time is between 20-30 minutes. PPP mode requires the use of dual-frequency measurements for estimation ionospheric delay, thus the use of dual-frequency antennas is a must for using PPP mode. The PPP convergence time depends on the quality of SSR corrections, satellite geometry, atmospheric conditions. Optimal GNSS combination for the PPP mode: GPS L1, L2, GLONASS G1, G2, Galileo E1, E5b/E5a.

RTK rover mode is a differential positioning mode that requires a set of measurements received from the reference station ("base"). Building the differences of measurements between the rover receiver and the reference station allows the rover receiver to effectively decrease the influence of the delays associated with ionosphere and troposphere as well as to get rid of the error related to satellite clocks. The position accuracy achievable by the module depends on the baseline length, quality of GNSS measurements received from the reference station, atmospheric conditions, multipath environment etc.

RTK base mode assumes generation of GNSS measurements along with information about coordinates of the reference station, antenna type and GLONASS biases. In RTK BASE mode, **KV104** can generate the following RTCM messages for rover: 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 supply voltage 5 V;
- maximum current 100 mA;
- LNA Gain Range (minus signal loss) 20 dB...35 dB

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 2 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

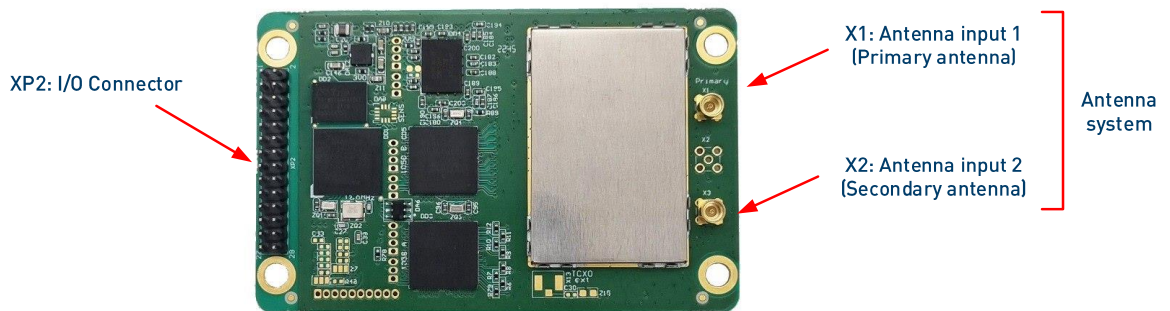


Figure 2.1– KV104 Top View¹

KV104 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 KV104.

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;
- red LED VD10 is indicator of the module power supply. It is OFF during normal operation.

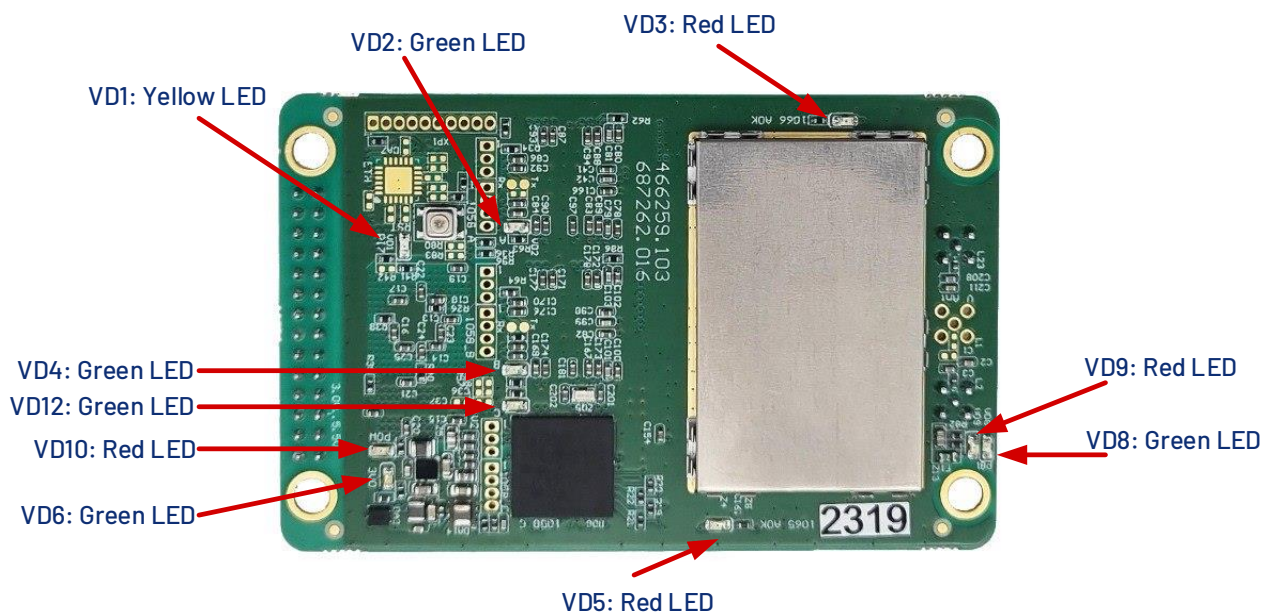


Figure 2.2- KV104 Bottom View²

² The actual product may differ in appearance

3. BLOCK DIAGRAM

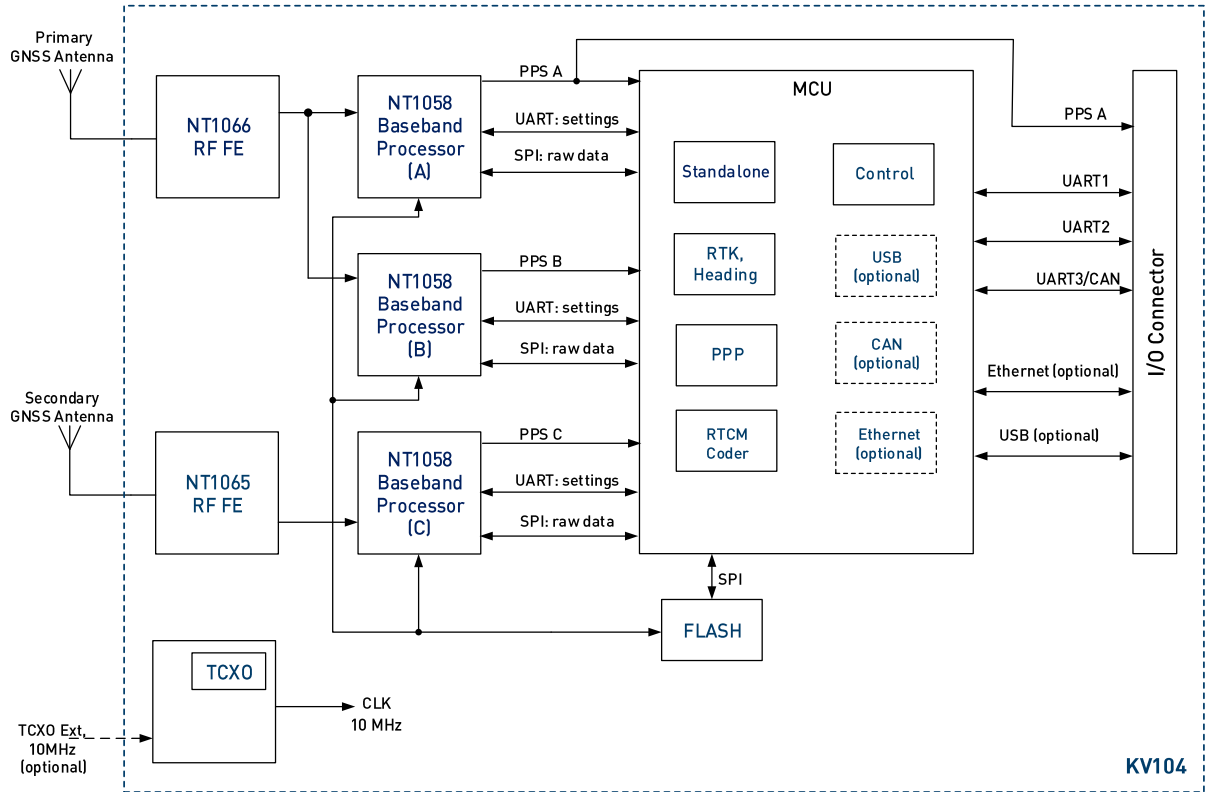


Figure 3.1- KV104 Block Diagram

Notice:

- an active antenna(s) is mandatory for the KV104;
- the KV104 has two power supply pins: one pin is for module power supply; the other pin is 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 – KV104 Specification

No	Parameter	Description	Note
1	Supported GNSS constellations	GPS L1(C/A), L2 (C)/L5 GLONASS L1(C/A), L2 (C/A) Galileo E1, E5b/E5a BeiDou B1, B2 NavIC L5, S-band SBAS L1	- tracking user-selectable GNSS constellations; - simultaneous using of all GNSS in the navigation solution and raw measurements; - EGNOS, GAGAN, WAAS, MSAS, SDCM; - simultaneous use of two frequency bands for each GNSS constellations
2	Channels	384	256 channels are for PVT 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; Ready for NavIC and BeiDou (subject of PPP corrections availability)
		RTK	simultaneous using of all GNSS; RTCM 3.4
		heading determination	GPS L1, L2, GLONASS L1, L2
5	Operation modes	RTK ROVER	RTCM 3.x
		RTK BASE	RTCM 3.x
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 SC-104 (ver.3.4)	MSM + Legacy messages
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	
GNSS 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- KV104 Specification

10	Accuracy (RMS)		
	<i>Horizontal:</i>		
	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	
	<i>Vertical:</i>		
	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 ~2 m
	heading	0,06 deg	
12	Timing Accuracy	+/- 20 ns	<ul style="list-style-type: none"> - the PPS adjusts to the GPS/Glonass/Galileo/NavIC/BeiDou systems time with an accuracy of +/-20 ns (GLONASS by default); - it is possible to additionally shift the PPS edge along the time axis to the left/right (calibration); - voltage logic level is 2.5 V, pulse width is 1 ms; - PPS is triggered by the leading edge.
13	Interfaces	3xUART, 1xPPSout	
14	Maximum operating limits:		
	velocity	515 m/s	Option: 2000 m/s, 70000 m, 36 g
	altitude	18000 m	Option is export controlled. Contact us for more information.
	acceleration	8 g	
15	Operating voltage	3.0 V...5.5 V	
16	Power consumption	Up to 3.5 W	
17	Dimensions (L × W × H)	71 mm × 46 mm × 12,8 mm	
18	Weight	< 25 g	
19	Operating temperature	-40 °C ... +71 °C	
20	Storage temperature	-55 °C ... +85 °C	
<i>Note:</i> 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	KV104 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.

2. It is hardware ready; basic firmware doesn't provide such options; may be developed on demand.

3. *Digital inputs/outputs:*

$V_{IL} : 0.3 V_{DD} (max); V_{IH} : 0.7 V_{DD} (min); V_{IH} : 3.0 V (max); V_{DD}=2.9 V;$

$V_{OL} : 0.3 V_{DD} (max); V_{OH} : 0.7 V_{DD} (min); V_{OH} : 3.0 V (max); V_{DD}=2.9 V .$

4. *Digital inputs/outputs:*

$V_{IL} : 0.7 V (max); V_{IH} : 1.75 V (min); V_{IH} : 2.5 V (max);$

$V_{OL} : 0.7 V (max); V_{OH} : 1.75 V (min); V_{OH} : 2.5 V (max).$

Table 5.2 – Basic configuration of KV104 UART channels

Pin No	Name	Description
15	UART1 Tx	<p>Available data formats:</p> <ul style="list-style-type: none"> • NTL Binary for nav. data transmission and control or NMEA-0183 for nav. data transmission; • NovAtel, RTCM3 (MSM + Legacy messages) for raw ranging data transmission; <p>Baud rate: 9600...460800; Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, no data.</p>
16	UART1 Rx	<p>Available data formats:</p> <ul style="list-style-type: none"> • RTCM3 Base station data input or RTCM-SSR messages; • NTL Binary for settings control; <p>Baud rate: 9600...460800. Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary.</p>
18	UART2 Tx	<p>Available data formats:</p> <ul style="list-style-type: none"> • NTL Binary for nav. data transmission and control or NMEA-0183 for nav. data transmission; • NovAtel, RTCM3 (MSM + Legacy messages) for raw ranging data transmission; <p>Baud rate: 9600...460800; Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary.</p>
19	UART2 Rx	<p>Available data formats:</p> <ul style="list-style-type: none"> • NTL Binary for settings control; <p>Baud rate: 9600...460800. Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary.</p>
24	UART3 Tx	<p>Available data formats:</p> <ul style="list-style-type: none"> • NTL Binary for nav. data transmission and control or NMEA-0183 for nav. data transmission; • NovAtel, RTCM3 (MSM + Legacy messages) for raw ranging data transmission; <p>Baud rate: 9600...460800; Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, no data.</p>
12	UART3 Rx	<p>Available data formats:</p> <ul style="list-style-type: none"> • RTCM3 Base station data input or RTCM-SSR messages; • NTL Binary for settings control; <p>Baud rate: 9600...460800. Default settings: 460800 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary.</p>
<p><i>Note:</i> NovAtel OEM 6: only messages for transmitting range measurements and ephemeris</p>		

6. BOARD LAYOUT AND DIMENSIONS

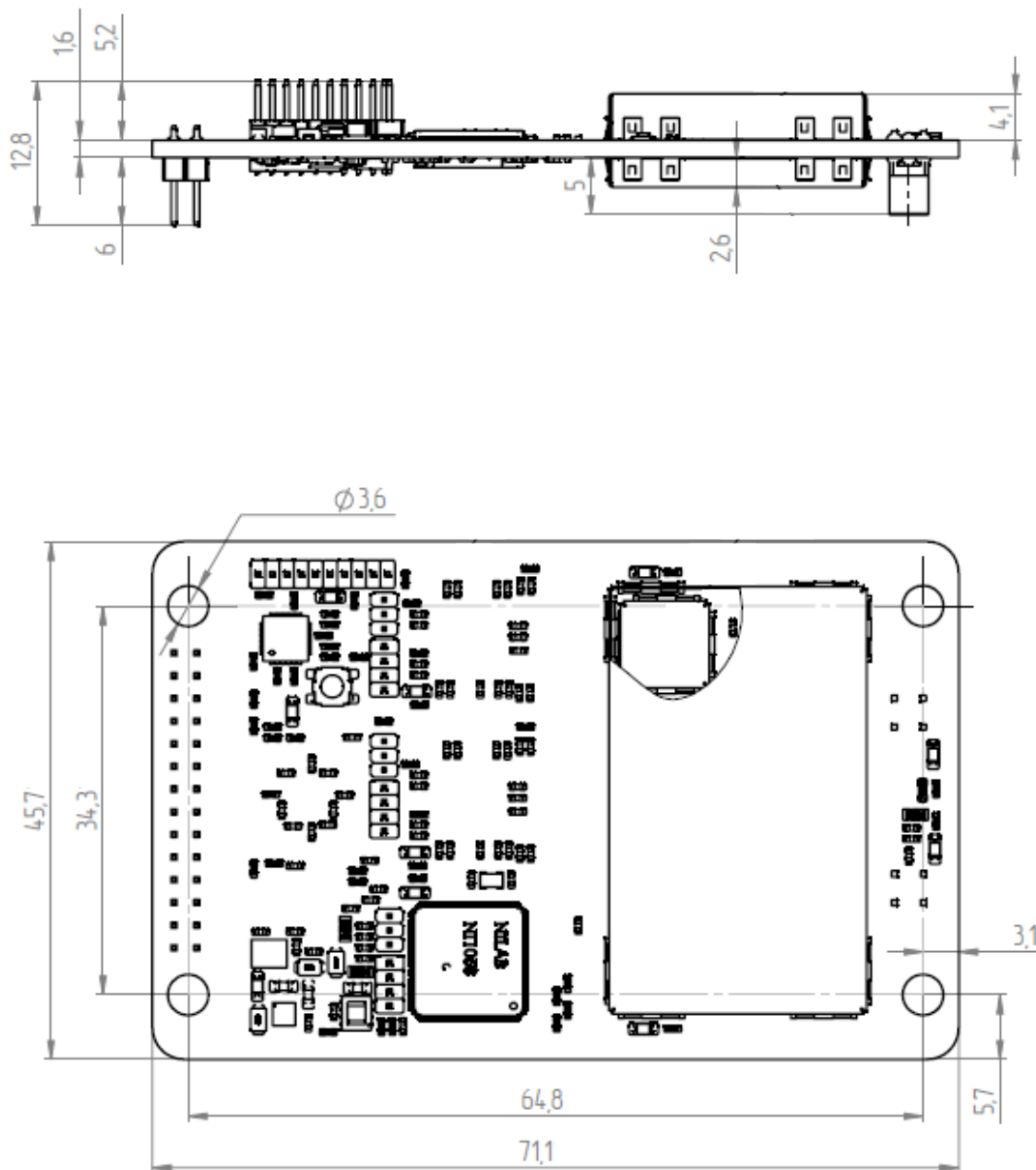


Figure 6.1- KV104 Board Layout and Dimensions

CONTACTS

Kosminis Vytis, UAB
88 Zalgirio, LT-09303 Vilnius, Lithuania
e-mail: sales@kosminis-vytis.lt

Information is subject to change without notice.
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