Multi-frequency GNSS RTK & Heading RECEIVER

NV216C-RTK-A GNSS Card

Datasheet

Version 1.0

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Revision History

Revision ID	Date	Description
1.0	February 01, 2021	First release of the document

Contents

1   General Description

1.1.   Introduction

The NV216C-RTK-A GNSS Card is an easy-to-integrate GNSS module to provide advanced and high precision navigation functions to end user applications.

The NV216C-RTK-A GNSS Card provides two independent signal processing chains each with 108 channels of combined GPS L1/L2, GLONASS L1/L2/L3, GALILEO E1/E5b, BeiDou B1/B2 and SBAS L1 code and carrier phase tracking. Position, velocity, heading & roll/pitch and time information is available at up to a maximum update rate of 50 Hz, with a 1 PPS (Pulse per Second) accuracy of 12 ns.

The NV216C-RTK-A GNSS Card uses Space Based Augmentation System (SBAS) corrections from services such as WAAS, EGNOS, MSAS, GAGAN and SDCM.

The NV216C-RTK-A GNSS Card also provides processing of code and phase differential correction in RTCM format (versions 2.2, 2.3, 3.1) to support DGNSS and RTK positioning modes.

The NV216C-RTK-A GNSS Card accepts a nominal input voltage between 3.3 and 5.0 VDC (minimum 3.0 to maximum 5.5 VDC) and uses NV216C NMEA command interfaces.
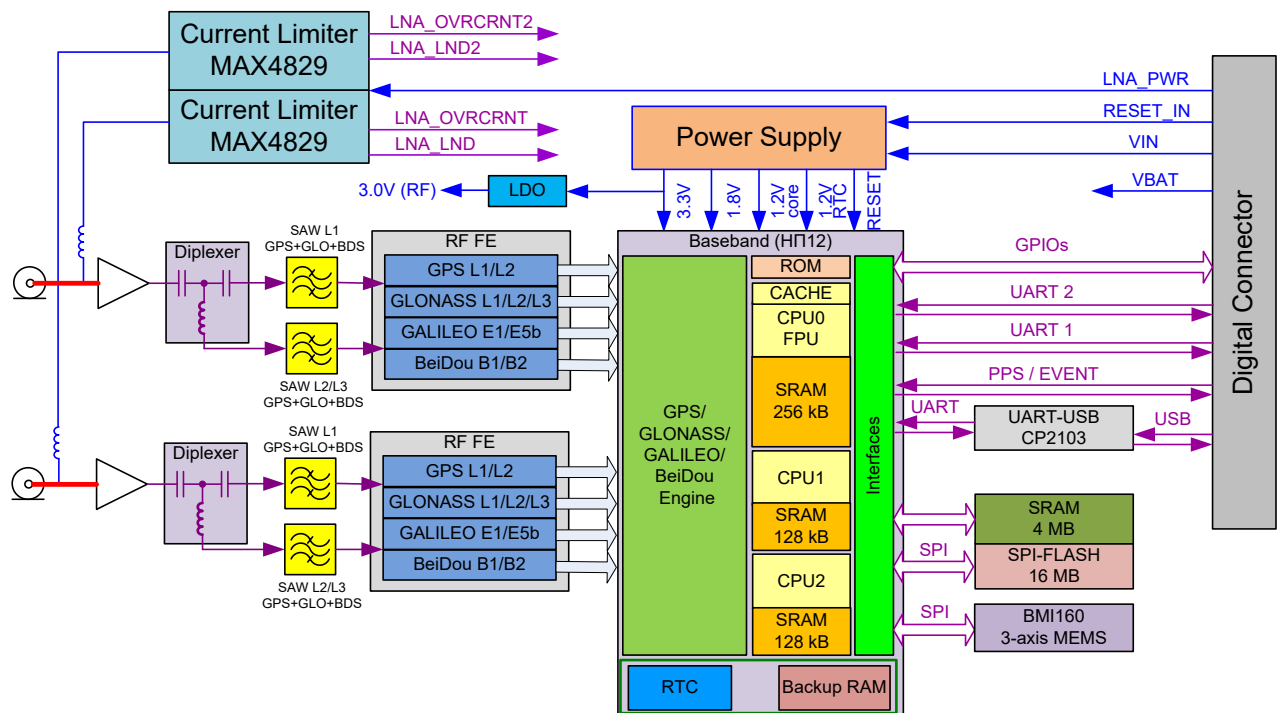

Figure 1. NV216C-RTK-A GNSS Card System Diagram

The NV08C-RTK-M GNSS Card is built on the NVS Technologies' compact NV216C high performance Global Navigation Satellite System (GNSS) receiver chipset. The NV08C's key feature is its compatibility with all existing GNSS systems such as GPS, GLONASS, GALILEO, BeiDou and Satellite Based Augmentation Systems (SBAS).

The NV216C-RTK-A GNSS Card features a highly sensitive receiver to capture and maintain the satellite signals, combined with low power consumption, even when receiving multiple GNSS and SBAS signals. Tracking satellites from multiple GNSS constellations ensures higher availability of navigation signals, when compared to single constellation alternatives, and provides increased performance, accuracy and reliability for devices used in urban and industrial environments. Each NV216C-RTK-A receiver RF-chain includes four separate RF paths (two for upper bands GNSS frequencies and two for lower bands GNSS frequencies) and a 2-stage filtration for enhanced interference immunity.

The NV216C-RTK-A GNSS Card Features:

- Integrated RTK and Heading & Pitch/Roll functionality
- Base and Rover modes
- Precise navigation, positioning and timing
- Centimeter-level positioning in RTK mode
- Data rate up to 50 Hz
- Multi-frequency GNSS signals support
- 2-stage filtration for high out-of-band interference immunity
- 216 GNSS tracking channels & Fast Search Engine
- Individual GLONASS group delay calibration assuring very high accuracy
- NMEA 0183 / IEC 61162-1 and RTCM v3.x data protocols
- Enhanced RAIM for 3D and RTK modes
- Industrial operating temperature range -40 to +85°C
- Integrated MEMS-sensors (INS)
- Very quick and simple integration
- Small size and low power consumption

Please visit www.nvs-gnss.com for more information on NVS Technologies' NV216C GNSS Receiver Module Series.

1.2. Navigation Features

Parameter	Description	
Supported GNSS signals	GPS L1 & L2 GLONASS L1 & L2 & L3 GALILEO E1 & E5b BeiDou B1 & B2 SBAS L1	
Number of channels	216 channels each capable to receive any supported signal	
Time to first fix	Cold star: Warm start: RTK initialization time (after 3D fix) Initialization reliability	< 40 s (25 s average) < 35 s (25 s average) < 10 s 99.9%
Sensitivity	Cold star: With A-GNSS: Tracking mode: RTK mode	– 143 dBm – 160 dBm – 160 dBm – 137 dBm
Accuracy [1]	Autonomous mode: Differential mode SBAS: Height: RTK mode Heading & Pitch/Roll Velocity:	< 1.5 m < 1 m < 2 m 1 cm + 1ppm 0.1 degrees @ 2m 0.05 m/s
1PPS time accuracy	12 ns accuracy (rms), 29.7 ns granularity (1/33.6 MHz)	
Update rate	Up to 20 Hz (up to 50Hz in GNSS+INS mode)	
Limitations	Velocity: Acceleration: Height:	less than 500 m/s less than 5 g less than 50,000 m

[1] RMS, 24hr static, SV @ –137 dBm

1.3. RF Functionalities

The NV216C-RTK-A GNSS Card requires one or two active antennas to be connected to the RF inputs. Active antenna supply voltage is provided by Host System though ANT_PWR pin in digital connector.

The NV216C-RTK-A GNSS Card has two RF-chains on the board. Each RF-chain includes 4 RF paths for upper and lower GNSS frequencies and features a two-stage RF-filter circuit that provides high out-of-band interference immunity. A front-end wideband RF filter ensures more than 40dB suppression of far-field interference, from sources such as GSM, WiFi, WiMAX, LTE and Bluetooth signal transmitters.

The parameters of the NV216C-CSM's RF inputs are as shown in **Table 1**.

Table 1. RF Input Parameters

Active Antenna	
1dB Compression Point	-5 dBm
Input Return Loss	-16 dB
Total Noise Figure of the analogue path at the RF input	1.2 dB

Note *–* ***Table 1*** *shows estimated values. The actual values may differ as a result of device qualification.*

The RF Diplexers output signals are further processed by two independent analogue ICs each with four separate receiver channels:

- GPS L1/GALILEO L1/BeiDou E1/SBAS L1
- GLONASS L1
- GPS L2/GALILEO E5b/BeiDou B2/GLONASS L3
- GLONASS L2

On all channels the satellite signals are first down-converted to the IF band then filtered by Polyphase Filters. The signals then pass through a Variable Gain Amplifier with Automatic Gain Control. The analogue ICs include 2-bit ADCs that convert the signals from analogue to digital to be processed by the digital baseband IC. Typically both input RF-chains are enabled to simultaneously receive all available navigation signals.

In order to facilitate fast acquisition of low level signals in poor reception areas, the NV216C-RTK-A GNSS Card contains a 33.6 MHz frequency generator (TCXO) with high temperature stability (±0.5 ppm).
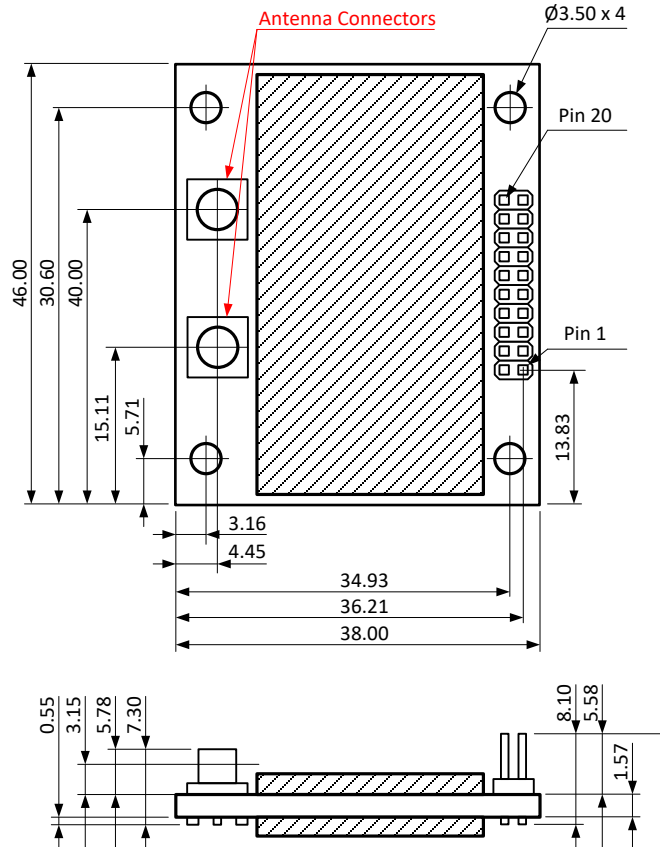
1.4. Environmental Data

Operating temperature: -40°C to +85°C
Maximum relative humidity: 98% at +40°C

2   Mechanical Specification

The NV216C-RTK-A GNSS Card size is 46x38 mm. Refer to Figure 2 for the Card's Outline Drawing.

Figure 2. NV216C-RTK-A GNSS Card Outline Drawing

Note:
1. All dimensions are in mm;
2. Dimensions are not for scale

3 GNSS Antenna Interface

The NV216C-RTK-A GNSS Card uses two MCX Jacks for active antennas connection.

Active antennas supply voltage is provided by Host System though ANT_PWR pin in digital connector.

Connection of active antenna to RF 1 input is mandatory for normal device operation. Heading & Pitch/Roll function requires connection of two active antennas to both RF 1 and RF 2 inputs.
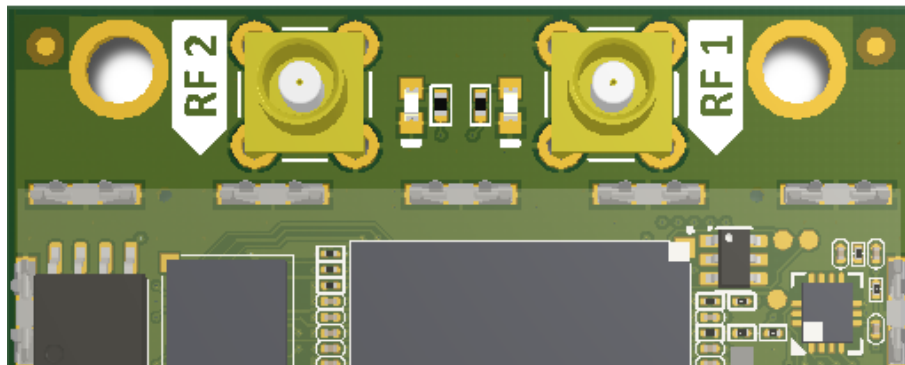
Figure 3. Active GNSS Antennas Inputs

4 Data Interfaces and Protocols

4.1 Data interface

The NV216C-RTK-A GNSS Card features 20 (2x10) pin Header 2.0 mm Pitch (male) for connection to a Host System. For communication with the Host System two UART and one USB interfaces are available on the NV216C-RTK-A GNSS Card. Drivers for USB interface are to be supplied with the NV216C-RTK-A GNSS Card.

Supported baud rate for communication with NV216C-RTK-A GNSS Card is 4800 to 921600 bps.

Figure 4. System connector

4.2 Data Protocol

The NV216C-RTK-A GNSS Card supported protocols are as follows:
- NMEA 0183 v2.3 (IEC61162-1)
- RTCM v.3.x (Standard and MSM messages)
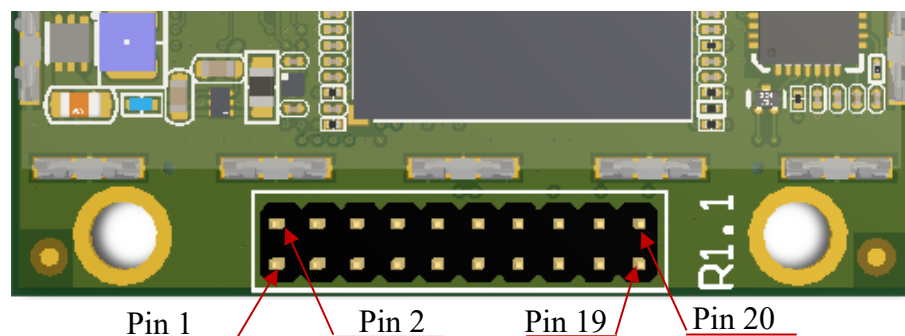- BINR (proprietary binary protocol is available if requested)

Data update/output rate: 1, 2, 5, 10, 20, 50[1] Hz

[1]50 Hz position/velocity output rate is supported with GNSS+INS mode

4.3 Default Device Configuration

By default, the NV216C-RTK-A GNSS Card interfaces are preconfigured to support the following communication protocols:

- UART 1:   NMEA, 115200 bps (messages/rates: GGA/1, RMC/1, GSV/1, GSA/1)
- UART 2:   RTCM v3.x, 115200 bps communication
- USB: NMEA, 230400 bps (messages/rates: GGA/1, RMC/1, GSV/1, GSA/1).

Refer to NV216C-RTK-A Receivers Protocol Specification for further details.

For communication with NMEA and RTCM protocol UART ports should to be configured as 1 start – 8 data - 1 stop bit.

Other NV216C-RTK-A GNSS Card default settings:
- Navigation mode: RTK Rover, All-in-View GNSS mode
- RTCM data: accounted automatically (RTK modes)
- SBAS data: automatic
- RAIM: automatic
- Navigation data update rate: 5 Hz
- NMEA messages: see the Protocol Specification document

5 Electrical Specification

5.1 Absolute Maximum Ratings

Table 2 provides the NV216C-RTK-A GNSS Card absolute maximum (stress) ratings. Operation at or beyond these maximum ratings might cause permanent damage to the device.

Table 2. Absolute Maximum Ratings

Parameter	Minimum	Maximum	Unit
Operating Temperature Range	-40	+85	°C
Relative humidity @ 40°C		98	%
Supply Voltage	-0.3	+5.5	V
External Active Antenna Supply Voltage	-0.3	+6	V
RF Input Power		20	dBm

5.2 DC Electrical Characteristics

Table 3. DC Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
Supply Voltage	3.0	3.3	5.0	V
Supply current[1]		300[1]	350	mA
Power consumption (RTK mode)[1]		600	700	mW
Power consumption (RTK and Heading & Pitch/Roll mode)[1]		1000	1200	mW
Active Antenna DC Bias (each antenna)				
Voltage	2.3	-	5.5	V
Current	10[2]	100	240[3]	mA

[1] Excluding active antenna current consumption
[2] Minimum threshold of active antenna current detector
[3] Maximum supplied active antenna current

5.3 AC Electrical Characteristics

Table 4. AC Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
Active antenna inputs				
Input P1dB		-5		dBm
Noise Figure		1.2		dB
Impedance		50		Ω
Return Loss		-15		dB

5.4   System Connector Pin Assignment

Table 5. System Connector Pin Assignment

Pin#	Name	Description	Pin#	Name	Description
1	ANT_PWR	Active antenna supply	2	VIN	Device's supply
3	USB_N	USB data "minus"	4	USB_P	USB data "plus"
5	RESET_IN	Device RESET input	6	Reserved	
7	VBAT	Backup battery supply	8	Reserved	
9	EVENT	External EVENT signal	10	GND	Ground
11	UART1 TX	UART1 transmitter output	12	UART1 RX	UART1 receiver input
13	GND	Ground	14	UART2 TX	UART2 transmitter output
15	UART2 RX	UART2 receiver input	16	GND	Ground
17	Reserved		18	GND	Ground
19	PPS	Pulse per second output	20	Reserved	

5.5   Digital Signals Specification

5.5.1   RESET_IN Signal

The RESET_IN signal can be used for NV216C-RTK-A GNSS Card reset.

The NV216C-RTK-A GNSS Card has Power Supervisor inside. Therefore Host System does not need to specially control this signal during the NV216C-RTK-A GNSS Card power up. The NV216C-RTK-A GNSS Card is in active mode when RESET_IN signal is de-asserted.

To provide forced reset of the NV216C-RTK-A GNSS Card the Host System should provide a pulse to the RESET_IN input as specified below:

- Voltage level – less than 0.7 V
- The pulse length – no less than 1 ms

After the signal is applied (RESET_IN signal level goes from low to high) the integrated power supervisor holds the NV216C-RTK-A GNSS Card in reset mode for at least 140 ms.

Table 6. RESET_IN signal level requirements

Parameter	Minimum	Typical	Maximum	Unit
High Level Input Voltage	2.1	3.3	3.6	V
Low Level Input Voltage	-0.3	0	0.7	V

5.5.2   UARTs and PPS Signals

The NV216C-RTK-A GNSS Card has 3.3V nominal voltage for UARTs and PPS I/O signals

Table 7. Input Voltage for UART1, UART2, PPS

Symbol	Parameter	IO Supply Voltage	Minimum	Typical	Maximum	Unit
V_{IH}	High Level Input Voltage	3.3V	2.0	3.3	3.6	V
V_{IL}	Low Level Input Voltage	3.3V	-0.3	0	0.8	V

5.5.3   1PPS Output

1PPS output is present at the Pin#19. By default 1PPS signal is generated permanently and independently of a valid position fix whether available or not. If a valid position fix is not available, the 1PPS signal will be generated each second as per the internal hardware's defined time scale. If a valid position fix is available, the 1PPS signal refers to a user defined time standard (UTC by default). If required the 1PPS output can be set to operate only when a valid position fix is available.

1PPS signal parameters:

- Voltage level   3.3V (CMOS)
- Output frequency   1 Hz
- True time   Refer to the pulse rising (default) or the falling edge
- Pulse duration   29.7 ns to 500 ms (1 ms by default)
- Refers to   UTC (default), GPS, GLONASS or UTC SU time standard
- 1PPS accuracy   ±12 ns (antenna cable delay to be compensated)
- 1PPS granularity   29.7 ns (33.6 MHz TCXO referenced)

The rising (or falling) edge shift is relative to the defined time-standard, and is available in the NMEA $POUTC command.

5.5.4   USB_N, USB_P Signals

USB_N, USB_P signals provides USB serial data interface for communication with Host System. USB serial data interface is compliant to the USB 2.0 full-speed device specification.

6   Functional Description

6.1   Functional overview

The NV216C-RTK-A GNSS Card provides automatic acquisition, tracking and positioning of GNSS signals in case of at least one external active antenna is connected (to RF1 input). To support Heading & Pitch/Roll functionality NV216C-RTK-A GNSS Card requires two antennas connected to RF 1 and RF 2 inputs. Navigation data is provided to the Host System by means of NMEA protocol.

6.2   GNSS Antenna Connection

The NV216C-RTK-A GNSS Card uses two MCX Jacks for active antennas connection. The active antennas supply voltage should be provided by Host System though ANT_PWR pin (pin#1 in digital connector). The active GNSS antennas inputs include an auto-detection feature with short-circuit protection. The supply current is limited to 100 mA typ. (240 mA max.) in case of short-circuit on the active antenna connector.

It is very important to select a proper antenna to achieve optimum performance.

If an active antenna is employed, excessive LNA gain and bandwidth may reduce the quality of signal reception, due to potential in-band and out-of-band interferences. As well, an active antenna with insufficient gain or bandwidth, or high cable loss may decrease the receiver's sensitivity.

Recommended active antenna parameters are as follows:
- Triple-band GPS/GLONASS/GALILEO/BeiDou Antenna
- Gain including LNA and cable losses 20 to 30 dB
- Built-in LNA noise figure <2 dB
- RF Output Impedance 50 Ω
- Return Loss <-10 dB
- Out-of-band signal Rejection: at least 35dB @ fc ± 70 MHz.

6.3   Backup Power Supply VBAT

If an independent VBAT voltage is applied, the NV216C-RTK-A GNSS Card can store (in its BRAM) navigation parameters (almanac, ephemeris, last calculated coordinates etc.).

When navigation parameters are stored, the NV216C-RTK-A GNSS Card is able to provide warm or hot starts (depending on its switch-off time and available navigation data).

If no VBAT voltage is applied to the NV216C-RTK-A GNSS Card, all data saved in the BRAM will be erased when the module is powered off.

6.4   Firmware Update

The NV216C-RTK-A GNSS Card's Firmware can be updated. The FWLoader (a software tool to download Firmware) and the latest revision of the FW are to be provided by NVS' support team.

The Host System can also download new FW to the NV216C-RTK-A GNSS Card by means of NMEA command: $PNVGPRL,R*3F\r\n.

Once NV216C-RTK-A GNSS Card receives the command it switches over to the programming mode and starts transmitting of "0x43" character (in ASCII format – character "C"). In response the Host System should download a new FW as a sequence of bytes (FW binary file) by means of the X-modem-CRC protocol. Once the binary file has been completely downloaded, the NV216C-RTK-A GNSS Card stores the new loaded FW into embedded non-volatile memory and then forces restart of the device.

NVS Technologies can support application specific requirements. Contact NVS' Support Team for customization of standard functionality.

<u>Caution</u> – The process of storing the FW to FLASH memory will only begin when transmission of the FW to the NV216C-RTK-A GNSS Card has been fully completed. (This will require a few seconds depending on the data transferring baud rate). During this process the NV216C-RTK-A GNSS Card must not be powered-off and RESET signal must not be applied. Turning off or resetting the device while downloading a FW might lead to a malfunction of the NV216C-RTK-A GNSS Card and recovery can only be done by the factory.