GPS/GLONASS/GALILEO/QZSS/SBAS RECEIVER

NV08C-CSM-BRD GNSS card

Datasheet

Version 1.1

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Revision History

Revision ID	Date	Description
0.1	February 21, 2013	Preliminary versions of the specification
1.0	August 23, 2013	Initial release
1.1	October 16, 2013	General editing

Contents

1 General Description

The NV08C-CSM-BRD Card is an easy-to-integrate card, to provide navigation functions to mobile and portable devices. The NV08C-CSM-BRD Card uses standard NMEA protocol and proprietary BINR protocol for communication with the Host System. The NV08C NMEA and BINR Protocol Specifications are available for download at http://www.nvs-gnss.com/support/documentation

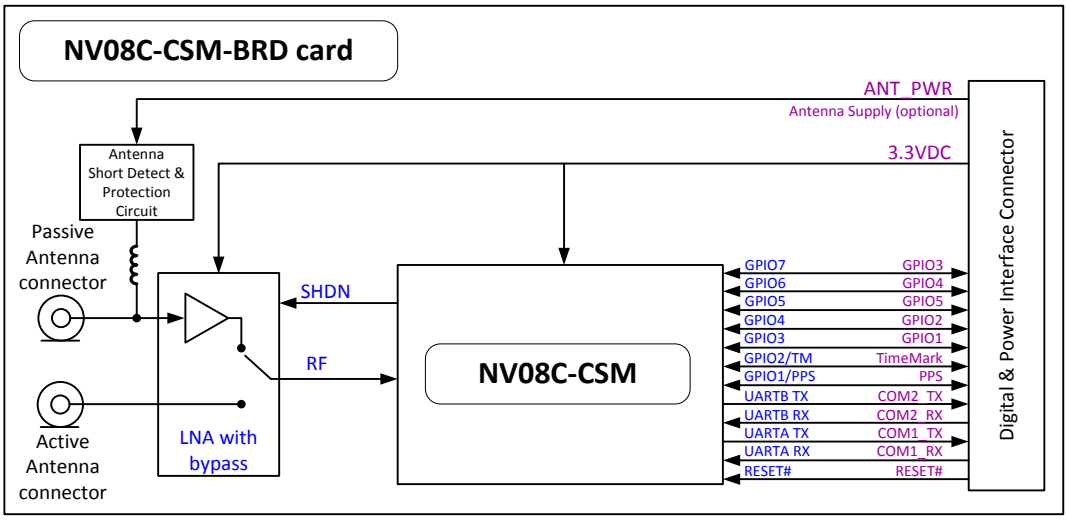

Figure 1. NV08C-CSM-BRD Card System Diagram

The NV08C-CSM-BRD Card is based on NVS Technologies' compact NV08C-CSM high performance Global Navigation Satellite System (GNSS) receiver module. The NV08C-CSM's key feature is its compatibility with existing GNSS systems such as GPS and GLONASS and Satellite Based Augmentation Systems (SBAS), as well as with newly deployed GNSS systems such as GALILEO and QZSS.

The NV08C-CSM-BRD 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 and using Assisted GNSS (A-GNSS) ensures much 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. The NV08C-CSM receiver includes two separate RF paths (GPS and GLONASS) and a 3-stage SAW filtration for enhanced interference immunity.

The NV08C-CSM-BRD Card provides flexible integration options, including active or passive antenna connection with automatic detection, antenna power supply and short circuit protection.

The NV08C-CSM-BRD Card Features:

- Very quick and simple integration
- GPS, GLONASS, GALILEO, QZSS & SBAS L1
- Precise navigation, positioning and timing
- 32 GNSS tracking channels
- 200K correlators - Ensuring fast TTFF and high signal sensitivity
- Raw Data output - Pseudorange, Carrier phase and Doppler
- Individual GLONASS group delay calibration assuring very high accuracy

- Assisted GNSS (A-GNSS) interface
- 64 KB EEPROM for firmware upgrade and data storage
- NMEA 0183 / IEC 61162-1, binary (BINR) and RTCM SC-104 data protocols
- Receiver Autonomous Integrity Monitoring (RAIM)
- Industrial operating temperature range -40 to +85°C

Please visit www.nvs-gnss.com for more information on NVS Technologies' NV08C GNSS Receiver Module Series.

2 Mechanical Specification

The NV08C-CSM-BRD Card's Outline Drawing is specified in Figure 2.

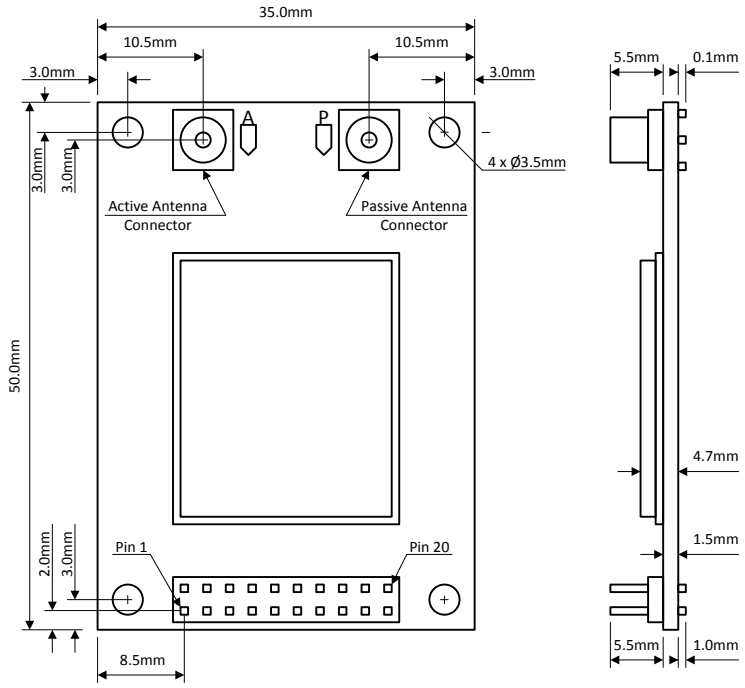

Figure 2. NV08C-CSM-BRD Card Outline Drawing

3 GNSS Antenna Interface

The NV08C-CSM-BRD Card has two RF-connectors for active or passive antenna connection respectively. Both RF-connectors are compact Jack MCX Straight 50 Ohm PCB Connector.

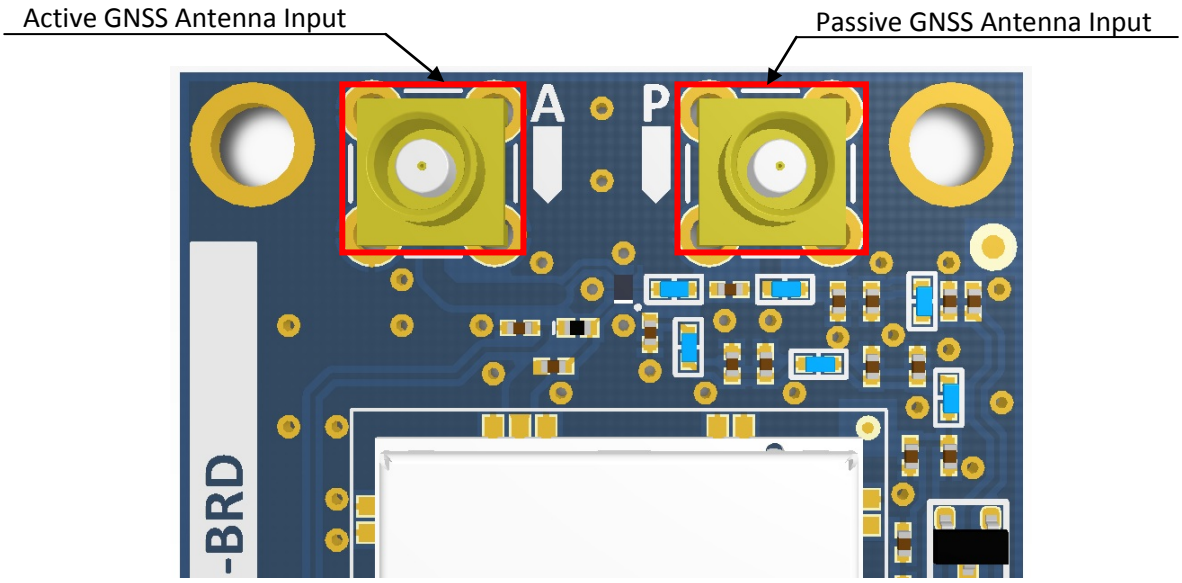

Figure 3. Location of the Active and Passive GNSS Antenna Inputs

4 Data and Program Interfaces

4.1 Data interface

The NV08C-CSM-BRD Card uses two UART primary data interfaces for communication with a Host System. Supported baud rate for communication with NV08C-CSM-BRD Card is 4800 to 230400 bps.

4.2 Data Protocol

The NV08C-Mini PCI-E's supported protocols are as follows:

- NMEA 0183 v2.3 (IEC61162-1)
- BINR (proprietary binary protocol)
- RTCM SC 104 (messages: #1, #9, #31, #34)

4.3 Default Device Configuration

By default, the NV08C-CSM-BRD's COM1 (UART A) is pre-configured to working with NMEA, 115200 bps:

messages/rates: GGA/1, RMC/1, GSV/1, GSA/1, RZD/1, GBS/10 (refer to NV08C Receivers NMEA Protocol Specification for further details)

NV08C-CSM-BRD's COM2 (UART B) is pre-configured to working with BINR, 115200 bps.

BINR is a silent protocol. It means no output messages are provided until they are requested by user. (refer to NV08C Receivers BINR Protocol Specification for further details).

For communication with NMEA protocol UART should be configured as 1 start - 8data - 1 stop. For BINR protocol UART should be configured as 1 start - 8data - **1 odd parity** - 1 stop.

***Note** – Both ports can be configured to receive differential correctional data in RTCM format. Even in this configuration, it is still possible to control the module by adding NMEA-commands to the RTCM stream, since the NV08C-CSM's SW is able to sort out data types. In order to use this option the port must first be activated by a $PORZA message to accept the RTCM data, then the NMEA message output stream can be defined by a $PORZB message. (Refer to the Protocol Specification document for $PORZA and $PORZB messages description.)*

Other NV08C-CSM-BRDdefault settings:

- Navigation mode: GPS and GLONASS
- RTCM data: accounted automatically
- SBAS data: on demand ($PONAV NMEA command)
- RAIM: automatic
- Assisted data: accounted automatically
- Navigation data update rate: 1 Hz
- NMEA messages: see the Protocol Specification document

5 Electrical Specification

5.1 Absolute Maximum Ratings

Table 1 provides the NV08C-CSM-BRD Card's absolute maximum (stress) ratings. Operation at or beyond these maximum ratings might cause permanent damage to the device.

Table 1. Absolute Maximum Ratings

Parameter	Minimum	Maximum	Unit
Storage Temperature Range	-55	+125	°C
Operating Temperature Range	-40	+85	°C
Relative humidity @ 40°C		98	%
Supply Voltage	-0.3	+3.9	V
RF Input Power		5	dBm

5.2 DC Electrical Characteristics

Table 2. DC Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
Supply Voltage	3.0	3.3	3.6	V
Supply current[1]		60[1]	90	mA
Supply current in Sleep Mode		0.2	0.3	mA
VBAT Back-up Supply Voltage	2.2	3.3	5.5	V
VBAT Back-up Supply Current[2]			0.1	mA
VBAT Back-up Supply Standby Current, I_{VBAT_STBY}		4		uA
Active Antenna DC Bias				
Voltage	2.9	3.3	3.6	V
Current	0.85[3]	-	45[4]	mA
Power Consumption				
GPS only		150		mW
GNSS		200		mW

Notes:

[1] Excluding active antenna current consumption
[2] BRAM access rate less than 1M/s
[3] Minimum threshold of active antenna current detector
[4] Maximum supplied active antenna current

5.3 AC Electrical Characteristics

Table 3. AC Electrical Characteristics

Parameter	Minimum	Typical	Maximum	Unit
RF Chains				
L1 GPS/GALILEO/SBAS Centre Frequency		1575.42		MHz
L1 GPS/GALILEO/SBAS Bandwidth		4		MHz
L1 GLONASS Centre Frequency		1601.5		MHz
L1 GLONASS Bandwidth		8		MHz
Active antenna input				
Input P1dB		+5		dBm
Noise Figure		8		dB
Impedance		50		Ω
Return Loss		-15		dB
Passive antenna input				
Input P1dB		-7		dBm
Noise Figure		1.5		dB
Impedance		50		Ω
Return Loss		-15		dB

5.4 NV08C-CSM-BRD Connector Pin Assignment

Table 4. Digital & Power Connector Pin Assignment

Pin#	Name	Description
1	ANT_PWR	Power Supply for external antenna
2	VIN	3.3 VDC Power Supply
3	GPIO1	General Purpose I/O Pin (CSM's GPIO3)

4	GPIO2	General Purpose I/O Pin (CSM's GPIO4)
5	RESET	Active low reset input
6	GPIO3	General Purpose I/O Pin (CSM's GPIO7)
7	VBAT	3.3V Back-up Power Supply
8	*NC*	*Not Connected*
9	PPS	Pulse output synchronized to UTC/GPS/GLONASS time (CSM's GPIO2)
10	GND	Digital Ground
11	COM1_TX	Transmitted Data for CSM's UART A output
12	COM1_RX	Received Data for CSM's UART A input
13	GND	Digital Ground
14	COM2_TX	Transmitted Data for CSM's UART B output
15	COM2_RX	Received Data for CSM's UART B input
16	GND	Digital Ground
17	GPIO4	General Purpose I/O Pin (CSM's GPIO6)
18	GND	Digital Ground
19	TimeMark	General Purpose I/O Pin (CSM's GPIO1, TimeMark/Event on demand)
20	GPIO5	General Purpose I/O Pin (CSM's GPIO5)

5.5 Digital Signals Specification

5.5.1 RESET# Signal

The RESET**#** signal can be used for NV08C-CSM device reset.

NV08C-CSM device has Power Supervisor inside. Therefore Host System does not need to specially control this signal during the NV08C-CSM-BRD Card power up. NV08C-CSM is in active mode when RESET# signal is de-asserted.

To provide forced reset of NV08C-CSM the Host System should provide a pulse to the RESET# 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# signal level goes from low to high) the integrated power supervisor holds the NV08C-CSM device in reset mode for at least 140 ms.

Table 5. RESET# 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 Input Voltages

Table 6. Input Voltage for GPIO7 – GPIO0

Symbol	Parameter	IO Power Supply Voltage	Minimum	Maximum	Unit
V_{IH}	High Level Input Voltage	3.3V	2.0	3.6	V

Symbol	Parameter	IO Power Supply Voltage	Minimum	Maximum	Unit
V_{IL}	Low Level Input Voltage	3.3V	-0.3	0.8	V

The NV08C-BRD's inputs and outputs are either pulled-up or pulled-down (internally) as described in Table 7. Refer to Table 8 for resistor values (BB I/O cells).

Table 7. I/O State after RESET

I/O	Pull UP/ Pull Down after RESET
GPIO5	PD
GPIO4	PU
GPIO3	PU
GPIO2	PD
GPIO1	PD
TimeMark	PU
PPS	PU
UARTA TX	PU
UARTA RX	PD
UARTB TX	PU
UARTB RX	PD

Table 8. Pull-up and Pull-down Resistors

I/O cell resistor	Supply voltage	Min	Nominal	Max
Pull-Up resistor, kOhm	VCCIO = 3.3V	28	43	86
Pull-Down resistor, kOhm	VCCIO = 3.3V	25	41	95

5.5.3 I/O DC Characteristics

Table 9. I/O DC Characteristics

Symbol	Parameter	IO Power Supply Voltage	Conditions	Minimum	Maximum	Unit
V_{OH}	High Level Output Voltage	3.3V	IOH = -100uA	VCCIO -0.2	-	V
			IOH = -4mA	VCCIO -0.4	-	
V_{OL}	Low Level Output Voltage	3.3V	IOL = 100uA	-	0.2	V
			IOL = 4mA	-	0.35	
I_L	Input Leak		-	-	±4	uA

6 Functional Description

6.1 Functional overview

The NV08C-CSM-BRD Card with a connected external antenna provides automatic acquisition, tracking and positioning of GNSS signals. Navigation data is provided to the Host System by means of NMEA (default for UART A) or BINR (default for UART B) protocols.

Either active or passive antenna connection is supported. Refer to the following section for additional information.

6.2 GNSS Antenna Connection

The NV08C-CSM-BRD Card features two separate RF coaxial connectors, to connect either an active or a passive antenna. The 3.3V supply voltage is provided to the active antenna connector. The active GNSS antenna input includes an auto-detection feature with short-circuit protection. The selection of the RF input is automatically activated when an active antenna's current is detected. When no current is drawn, the passive GNSS antenna input is selected. The NV08C-CSM-BRD Card automatically switches to the active GNSS antenna input when an external active antenna is connected (when I_{ANT} > 0.2mA). The supply current is limited to 30 mA typ. (45 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:

- GPS/GLONASS L1, bandwidth 35 MHz @ fc = 1590 MHz
- 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.

If a passive antenna is used it is essential to select an antenna with good RF output impedance matching to prevent the NV08C-NV08C-BRD's LNA from self-oscillating, and also to keep cable loss as low as possible, as it directly impacts the RF path's noise figure and decreases the receiver's sensitivity.

Recommended passive antenna parameters are as follows:

- GPS/GLONASS L1, bandwidth 35 MHz @ fc = 1590 MHz
- Average Gain: > -1 dBic
- RHCP polarization
- Axial ratio: < 3 dB
- Output impedance 50 Ohm
- Return loss < -10 dBm
- Cable Losses as low as possible.

6.3 Navigation Parameters

Table 10. Navigation Parameters

Parameter	**Description**	
Supported GNSS signals	L1 GPS/SBAS C/A L1 GLONASS CT L1 GALILEO OS Data+Pilot	
Number of channels	32 channels each capable receiving any supported signals	
Time to first fix	Cold star: Warm start: Hot start:	25 s (average) 25 s (average) 3 s (average)
Sensitivity	Cold star: With A-GNSS: Tracking mode:	– 143 dBm – 160 dBm – 160 dBm
Accuracy [1]	Autonomous mode: Differential mode SBAS: Differential mode DGNSS: Height: Velocity:	<1.5 m <1 m <1 m <2 m 0.05 m/s
PPS Accuracy	15 ns (1 Sigma), 38.5ns granularity	
Assisted GNSS	Supported	
Update rates	1 / 2 / 5 / 10 Hz	
Limitations	Velocity: Acceleration: Height:	less than 500 m/s less than 5 g less than 50,000 m

[1] RMS, 24hr static, SV @ –135 dBm

6.4 Digital IO Interfaces

The NV08C-CSM-BRD provides two UART interfaces and GPIO (GPIO1 – GPIO5) interfaces for receiver configuration (See Table 11)

Table 11. Configuration Settings

GPIO (I/O number)	Function	PIO value	Description
GPIO3	Settings saving in BRAM	GPIO3 = 1 (default)	Save all settings
		GPIO3 = 0	Do not save settings
GPIO4	Allows FW Patch download via SPI A	GPIO4 = 1 (default)	GPIO1, GPIO2, GPIO3, GPIO4 used only for configuration purpose
		GPIO4 = 0	GPIO1, GPIO2, GPIO3, GPIO4 are configured as SPI and will be used for FW Patch download from external SPI-FLASH
GPIO5 GPIO2 GPIO1	UART port configuration	GPIO5 = 0 (default) GPIO2 = 0 (default) GPIO1 = 0 (default)	UART A – 115200 NMEA (GGA/1, RMC/1, GSV/1, GSA/1, RZD/1, GBS/10*) UART B – 115200 BINR
		GPIO5 = 0 GPIO2 = 0 GPIO1 = 1	UART A – 4800 NMEA (GGA/1, RMC/1, GSV/1, GSA/1, RZD/1, GBS/10*) UART B – 19200 BINR
		GPIO5 = 0 GPIO2 = 1 GPIO1 = 0	UART A – 9600 NMEA (GGA/1, RMC/1, GSV/1, GSA/1, RZD/1, GBS/10*) UART B – 19200 BINR
		GPIO5 = 0 GPIO2 = 1 GPIO1 = 1	UART A – 19200 NMEA (GGA/1, RMC/1, GSV/1, GSA/1, RZD/1, GBS/10*) UART B – 57600 BINR
		GPIO5 = 1 GPIO2 = 0 GPIO1 = 0	UART A – 38400 NMEA (GGA/1, RMC/1, GSV/1, GSA/1, RZD/1, GBS/10*) UART B – 38400 BINR
		GPIO5 = 1 GPIO2 = 0 GPIO1 = 1	UART A – 38400 NMEA (GNS/1, RMC/1, GSA/1, GBS/10, GSV/10, DTM/30*) UART B – 4800 RTCM
		GPIO5 = 1 GPIO2 = 1 GPIO1 = 0	UART A – 4800 NMEA (GNS/1, RMC/1, GSA/1, GBS/10, GSV/10, DTM/30*) UART B – 4800 RTCM
		GPIO5 = 1 GPIO2 = 1 GPIO1 = 1	UART A – 57600 NMEA (GGA/1, RMC/1, GSV/1, GSA/1, RZD/1, GBS/10*) UART B – 57600 BINR

* - default NMEA messages and time interval

6.5 1PPS Output

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 38.5 ns to 2.5 ms (1 ms by default)
- Refers to UTC (default), GPS, GLONASS or UTC SU time standard
- 1PPS accuracy ±15 ns (antenna cable delay to be compensated)
- 1PPS granularity 38.5 ns (26 MHz TCXO referenced)

The rising (or falling) edge shift is relative to the defined time-standard, and is available in the NMEA $POUTC and BINR 72h message (generated within 20 ms after the 1PPS pulse).

6.6 Sleep Mode

When the navigation function is not required the NV08C-CSM-BRD Card can be switched to Sleep mode, to consume minimum power from the Host System. The NV08C-CSM device and input LNA are switched to IDLE mode when NV08C-CSM-BRD Card in sleep mode.

The NV08C-CSM-BRD Card is switched to Sleep mode by sending the $POPWR,1111*66<CR><LF> NMEA command.
Note: The time interval to switch the NV08C-CSM device to IDLE mode depends on the communication baud rate. The NV08C-CSM device needs to receive and decode NMEA commands. After decoding a command, a minimum of 10 ms is required to safely switch the device to IDLE mode.

The NV08C-CSM-BRD Card wakes up when the Host System sends any command via the UART.

Note: The NV08C-CSM device is sensitive to the falling edge of UART RX signals. A minimum of 10 ms after detecting a falling edge is required to switch the device from IDLE to normal operation mode, otherwise the first command cannot be properly decoded. Therefore the Host System must wait until the NV08C-CSM device has started normal operation prior to sending the next control command.

6.7 Back-up Power Supply VBAT

If an independent VBAT voltage is applied, the NV08C-BRD module can store (in its BRAM) navigation parameters (almanac, ephemeris, last calculated coordinates etc.), as well as user defined settings (ports and receiver configuration settings).

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

The user defined settings mode is defined by the GPIO3's signal level ("1" – saved, "0" – not saved). By default the GPIO3 is pulled-up ("1").

If no VBAT voltage is applied to the module, all data saved in the BRAM will be erased when the module is powered off.

6.8 Assisted GNSS

The NV08C-CSM-BRD Card supports Assisted (AGNSS). The AGNSS function uses external data to enable faster navigation when powering-up. Assisted data can be downloaded from an Assisted-server by the Host System then loaded to the NV08C-CSM-BRD Card using the BINR protocol.

6.9 Dead Reckoning Option

The NV08C-BRD features a Dead Reckoning function which provides seamless navigation even when satellite signals are partially blocked or completely unavailable (example: tree canopy, urban canyons, covered parking, tunnels, mountains etc.). The NV08C-BRD's Dead Reckoning algorithm is intended for automotive applications that provide two wheel-pulse signals from a single-axle.

***Note** – the User's system must match the signal levels to the NV08C-BRD's GPIO inputs in case of physical connection of wheel pulses. Dead Reckoning functionality is also supported with NMEA protocol in case of user can read data from CAN-base and send them to NV08C-BRD.*

Please contact NVS' Technical Support to obtain Dead Reckoning FW option support.

6.10 Firmware Update

The NV08C-CSM-BRD Card's Firmware can be updated. The PatchWriter (a software tool to download Firmware) and the latest revision of the Firmware Patch (FW) are available at www.nvs-gnss.com.

The Host System can also download new FW to the NV08C-CSM-BRD Card without using the PatchWriter. The following command is sent to the device to upload new FW:

- for NMEA protocol: $POPRL,R*2F\r\n
- for BINR protocol: 0x10 0x01 0x52 0x45 0x4C 0x4F 0x41 0x44 0x5F 0x52 0x10 0x03

When receiving the command the NV08C-CSM-BRDCard shifts into programming mode and starts the output of character 0x43 (in ASCII – character "C"). In response the Host System downloads new FW as a sequence of bytes (from FW binary file) with using the X-modem-CRC protocol. Once the binary file has been completely downloaded, the NV08C-CSM stores the new FW load into its non-volatile memory and then restarts the receiver.

NVS Technologies can support application specific requirements. Contact NVS' Technical Support Department for customization of standard functionalities.

Caution – The process of storing the Patch to FLASH memory will only begin when transmission of the Patch to the module has been fully completed. (This will require a few seconds depending on the data transferring baud rate). During this process the NV08C-CSM-BRD Card must not be powered-off and RESET signal must not be applied. Turning off or resetting the device while downloading a Patch might lead to a malfunction of the NV08C-CSM-BRD Card and recovery can only be done by the factory. The minimum baud rate for updating a FW is 57600 bps.