PCAN-GPS

Programmable Position Sensor Module with CAN Connection

User Manual

Document version 1.4.1 (2020-11-27)

Relevant Products

Product Name	Model	Part Number
PCAN-GPS		IPEH-002110

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Contents

1 Introduction

The PCAN-GPS is a programmable sensor module for position and orientation determination. It has a satellite receiver, a magnetic field sensor, an accelerometer, and a gyroscope. The sampled data can be transmitted on a CAN bus and logged on the internal memory card. The data processing is performed by a microcontroller of the NXP LPC4000 series.

The behavior of the PCAN-GPS can be programmed freely for specific applications. The firmware is created using the included development package with GNU compiler for C and C++ and is then transferred to the module via CAN. Various programming examples facilitate the implementation of own solutions.

On delivery, the PCAN-GPS is provided with a demo firmware that transmits the raw data of the sensors periodically on the CAN bus. The source code of the demo firmware as well as further programming examples are included in the scope of supply.

1.1 Properties at a Glance

- NXP LPC4000 series microcontroller (ARM Cortex-M4)
- Receiver for navigation satellites u-blox MAX-7W (GPS, Galileo, GLONASS, QZSS, and SBAS)
- Bosch BMC050 electronic three-axis magnetic field sensor and three-axis accelerometer
- Gyroscope STMicroelectronics L3GD20
- High-speed CAN channel (ISO 11898-2) with bit rates from 40 kbit/s to 1 Mbit/s
- Complies with CAN specifications 2.0 A/B

- On-chip 4 kByte EEPROM
- Internal microSD™ memory card slot, e.g. for logging position data (microSD™ memory card not in the scope of supply)
- Wake-up by CAN bus or a separate input
- 2 digital inputs (High-active)
- 1 digital output (Low-side driver)
- LEDs for status signaling
- Connection via a 10-pole spring terminal strip (Phoenix)
- Voltage supply from 8 to 30 V
- Extended operating temperature range from -40 to +85 °C (with exception of the button cell)
- New firmware can be loaded via CAN interface

1.2 Scope of Supply

- PCAN-GPS in a plastic casing
- 10-pin spring terminal strip[1]
- External antenna for satellite reception
- Windows® development package with GCC ARM Embedded, flash program, and programming examples
- Library with programming examples
- Manual in PDF format

[1] 10-pin, 3.81 mm pitch, mating connector Phoenix Contact MC 1.5/10-ST-3.81

1.3 Prerequisites for Operation

- Power supply in the range of 8 to 30 V DC
- For updating the firmware via CAN:
  - CAN interface of the PCAN series for the computer (e.g. PCAN-USB)
  - Operating system Windows 10 and 8.1 (32/64-bit)

2 Description of the Sensors

This chapter describes the characteristics of the sensors that are used in the PCAN-GPS in short form and gives instructions for use.

For additional information about the sensors, see chapter *8 Technical Specifications on page 30* and the data sheets of the respective manufacturers in *Appendix D on page 41*.

2.1 Receiver for Navigation Satellites (GNSS)

The u-blox MAX-7W receiver is designed for the following global navigation satellite systems (GNSS):

- GPS (USA)
- GLONASS (Russia)
- Galileo (Europe)
- QZSS (Japan)
- SBAS (supplementary)

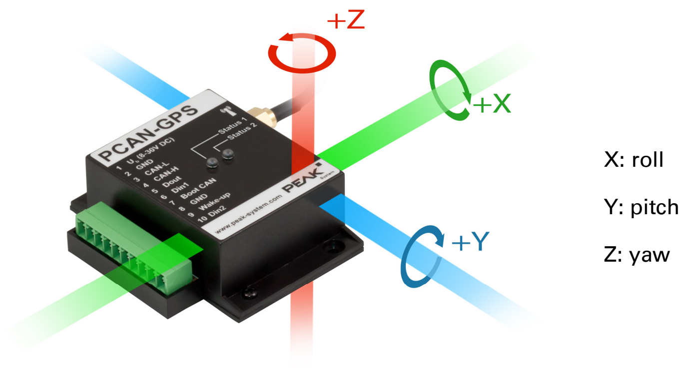
To receive a satellite signal, an **external antenna** must be connected to the SMA socket. Both passive and active antennas are suitable. An active antenna is included.

The use of **GPS and GLONASS** cannot happen simultaneously. On the one hand, the external antenna must match the respective system (the supplied one can receive both), on the other hand, the GNSS receiver must be switched.

For a faster position fix after turning on the PCAN-GPS, the internal RTC and the internal backup RAM can be supplied by the button cell. This requires a hardware modification (see section 3.2 on page 16).

2.2 Gyroscope

The STMicroelectronics L3GD20 gyroscope is a three-axis angular rate sensor. It returns the rotational speed around X, Y, and Z axis.

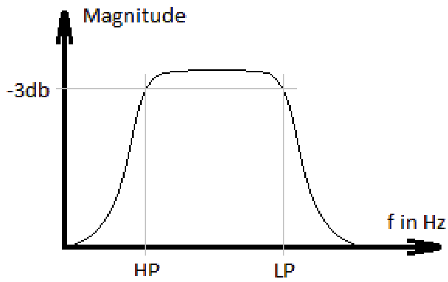


Gyroscope axes in relation to the PCAN-GPS casing

The covered **rotation angle** can be determined by integration over time.

There are two sensor-internal **filters for limitation and damping** of output values. They are implemented by configurable high-pass and low-pass.

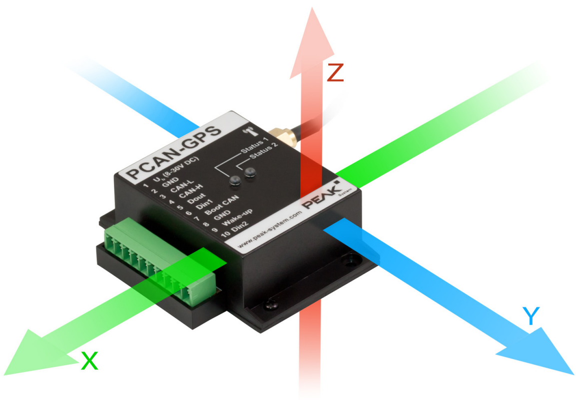
With its cut-off frequency (3 dB level), the high-pass defines the minimum angular velocity needed for transmission. With the low-pass in contrast, it is possible to affect the transmission of faster rotation angles. Typical values for output can be distinguished from intermittent fast movements. The selected filter characteristic is always to be considered together with the output data rate (ODR).



Filter curve of high-pass and low-pass

2.3 Acceleration and Magnetic Field Sensor

The acceleration and magnetic field sensor Bosch Sensortec BMC050 is used to determine the position in a magnetic field (such as the earth's magnetic field) and the acceleration along three axes.



Axes of the acceleration and magnetic field sensor
in relation to the PCAN-GPS casing

There are three **configurable control lines** to adjust the function to the respective application: Data Ready MAG, Interrupt_MAG, and Interrupt_ACC1. Interrupt_ACC2 is <u>not</u> connected to the microcontroller. All connected interrupt lines of the sensor are provided with pull-up resistors.

Since both functions of the sensor are independent of each other, also the corresponding interrupt functions are not linked. The interrupt for the acceleration sensor can be configured from seven functionalities, its timing validity can be adjusted. The functional scope of the magnetic field sensor interrupt comprises four sources.

The **offset compensation of the acceleration sensor** is done via the addition of a correction value which is copied from the EEPROM. This requires a conversion of an 8-bit value (Public Register) to a 10-bit value (Internal Register) (see table). With one of the four compensation methods, the correction value can be checked and readjusted.

Bit in Public Register	**Compensation Value for Measuring Range**			
	±2 G	**±4 G**	**±8 G**	**±16 G**
8 (msb): sign	±	±	±	±
7	500 mG	500 mG	500 mG	500 mG
6	250 mG	250 mG	250 mG	250 mG
5	125 mG	125 mG	125 mG	125 mG
4	62.5 mG	62.5 mG	62.5 mG	62.5 mG
3	31.3 mG	31.3 mG	31.3 mG	31.3 mG
2	15.6 mG	15.6 mG	15.6 mG	-
1 (lsb)	7.8 mG	7.8 mG	-	-

The correction value can be determined with four methods. A target value (± 1 G in X/Y/Z) is given in this process. The methods determine the necessary offset of the measured value until it reaches the target value. The offset appears in the Public Register and may be transferred to EEPROM.

- **Slow compensation**: Over several steps (8 or 16), the correction value is gradually adjusted (4 lsb) to reach the target value.
- **Fast compensation**: The correction value is calculated from the average of 16 measurements and the target value.
- **Manual compensation**: The user specifies a correction value.
- **Inline calibration**: The calculated correction value is stored in the EEPROM.

3 Hardware Configuration

For special applications, several settings can be done on the circuit board of the PCAN-GPS by using solder bridges:

- 3-bit coding of the hardware for polling by the firmware (see section *3.1 Coding Solder Jumpers on page 14*)
- Buffer battery for satellite reception (see section *3.2 Buffer Battery for GNSS on page 16*)

3.1 Coding Solder Jumpers

The board has three coding solder bridges to assign a permanent state to the corresponding input bits of the microcontroller. The three positions for coding solder bridges (ID 0 - 2) are each assigned to one port of the microcontroller LPC4074FBD80 (µC). A bit is set (1) if the corresponding solder field is open.

The status of the ports is relevant in the following cases:

- The loaded firmware is programmed so that it reads the status at the corresponding ports of the microcontroller. For example, the activation of certain functions of the firmware or the coding of an ID is conceivable here.
- For a firmware update via CAN, the PCAN-GPS module is identified by a 3-bit ID which is determined by solder jumpers. A bit is set (1) when the corresponding solder field is open (default setting: ID 7, all solder fields open).

Solder field	ID0	ID1	ID2
Binary digit	001	010	100
Decimal equivalent	1	2	4

See also chapter *7 Firmware Upload on page 25*.

Do the following to activate the coding solder bridges:

Danger of short circuit! Take great care when soldering to avoid short circuits.

Attention! Electrostatic discharge (ESD) can damage or destroy components on the card. Take precautions to avoid ESD.

1. Unscrew the two screws.
2. Remove the cover under consideration of the antenna connection.

3. Solder the solder bridge(s) on the board according to the desired setting.

   Figure 1 shows the positions of the solder fields on the board. The table below contains the possible settings.

4. Put the housing cover back in place according to the recess of the antenna connection.

5. Screw the two screws back into their original positions.

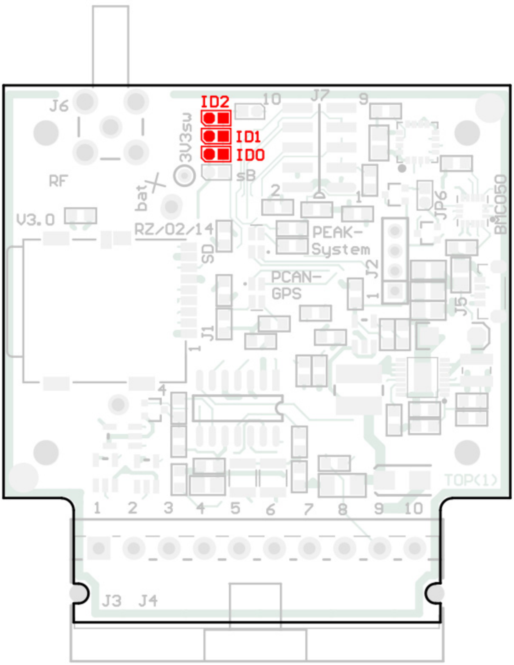


Figure 1: Solder fields for coding solder jumpers on the circuit board

Solder Field Status	Port Status
	Low
	High

3.2 Buffer Battery for GNSS

The receiver for navigation satellites (GNSS) needs about half a minute until the first position fix after switching on the PCAN-GPS module. To shorten this period, the button cell can be used as a buffer battery for a quick start of the GNSS Receiver. However, this will shorten the life of the button cell.

Do the following to connect the button cell with the GNSS receiver:

Danger of short circuit! Take great care when soldering to avoid short circuits.

Attention! Electrostatic discharge (ESD) can damage or destroy components on the card. Take precautions to avoid ESD.

1. Unscrew the two screws.
2. Remove the cover under consideration of the antenna connection.
3. Solder the solder bridge(s) on the board according to the desired setting.

   Figure 2 shows the position of the solder field **JP6** on the board. The table below contains the possible settings.
4. Put the housing cover back in place according to the recess of the antenna connection.
5. Screw the two screws back into their original positions.

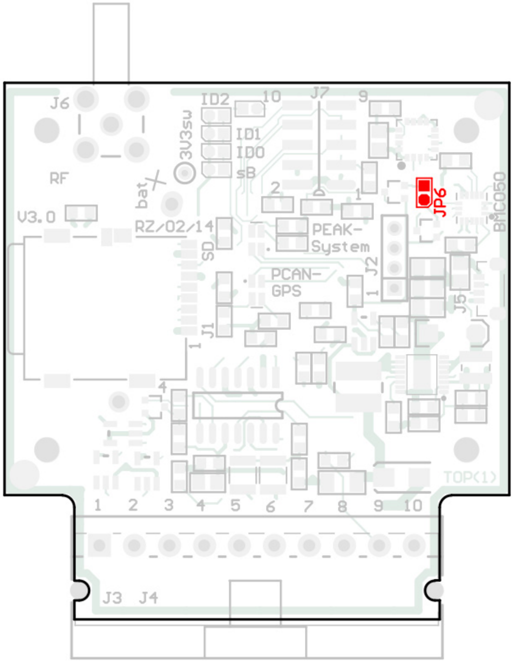
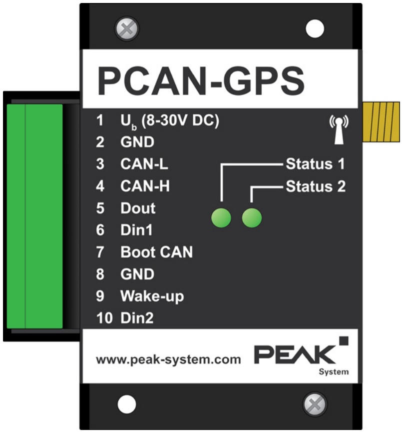


Figure 2: Solder field JP6 on the circuit board

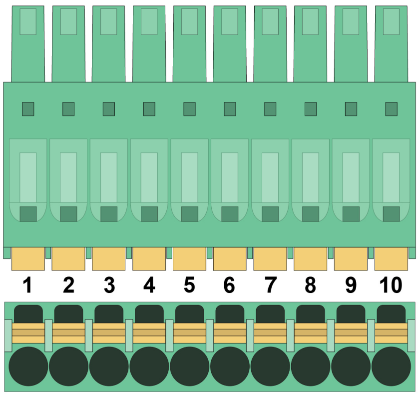
Solder Field Status	Port Status
	Default: quick start of the GNSS receiver is not activated.
	Quick start of the GNSS receiver is activated.

4 Connectors



PCAN-GPS with 10 connector pins and 2 status LEDs

4.1 Spring Terminal Strip



Spring terminal strip with 3.5 mm pitch
(Phoenix Contact FMC 1,5/10-ST-3,5 - 195234)

Terminal	Identifier	Function
1	U_b	Power supply 8 - 30 V DC, e.g. car terminal 30, reverse-polarity protection
2	GND	Ground
3	CAN_L	Differential CAN signal
4	CAN_H	
5	DOut	Digital output, Low-side switch
6	DIn1	Digital input, High-active (internal pull-down), inverting
7	Boot CAN	CAN bootloader activation, High-active
8	GND	Ground
9	Wake-up	External wake-up signal, High-active, e.g. car terminal 15
10	DIn2	Digital input, High-active (internal pull-down), inverting

4.2 SMA Antenna Connector

An external antenna must be connected to the SMA socket for the reception of satellite signals. Both passive and active antennas are suitable. For an active antenna, a supply of 3.3 V with at most 50 mA can be switched through the GNSS receiver.

The scope of supply of the PCAN-GPS provides an active antenna that is suitable for the navigation satellite systems GPS and GLONASS.

4.3 microSD™ Slot (Internal)

For the recording of, for example, status and location information, a microSD™ memory card of the types SD and SDHC can be used (not included). The maximum capacity is 32 GByte.

Freely available source code exists for the implementation of the FAT32 file system in custom firmware.

Note: The microSD™ connectivity in the PCAN-GPS module is not suitable for recording large data flows, such as the CAN traffic.

In order to **insert a memory card**, open the casing of the PCAN-GPS module by loosening the two fixing screws.

5 Operation

5.1 Starting PCAN-GPS

The PCAN-GPS is activated by applying the supply voltage to the respective ports (see chapter *4.1 Spring Terminal Strip on page 18*). The firmware in the flash memory is subsequently run.

At delivery, the PCAN-GPS is provided with a demo firmware. At a CAN bit rate of 500 kbit/s, it periodically transmits the raw values determined by the sensors. In Appendix C on page 36, there is a list of the used CAN messages.

5.2 Status LEDs

The PCAN-GPS has two status LEDs that can be green, red, or orange. The status LEDs are controlled by the running firmware.

If the PCAN-GPS module is in **CAN bootloader mode** which is used for a firmware update (see chapter *7 Firmware Upload on page 25*), the two LEDs are in the following state:

- Status 1 (left): orange, quickly blinking
- Status 2 (right): orange

5.3 Sleep Mode

The PCAN-GPS can be set into sleep mode via a specific CAN message. The voltage supply is turned off for a majority of the electronic components in the PCAN-GPS and the current consumption is reduced to 60 µA at 12 V. The sleep mode can be ended via various wake-up events. More about this in the following section 5.4.

Tip: In the supplied example application, the sleep mode is activated by a specific CAN message with the CAN ID 0x651. To do this, the lowest bit in the first data byte must be set in order to activate the sleep mode.

5.4 Wake-up

If the PCAN-GPS is in sleep mode, a wake-up signal will be required for the device to turn on again. The following subsections show the possibilities.

5.4.1 Wake-up Externally by High Level

Via pin 9 of the connector strip (see section 4.1), a high level (at least 1.3 V) can be applied over the entire voltage range in order to turn on the PCAN-GPS.

Note: As long as a voltage is present at the wake-up pin, it is not possible to turn off the PCAN-GPS.

5.4.2 Wake-up via CAN Message

When receiving any CAN message, the PCAN-GPS will turn on again.

6 Creating Own Firmware

With the help of the development package, you can program your own application-specific firmware for PEAK-System programmable hardware products.

Download of the development package:

URL: www.peak-system.com/quick/DLP-DevPack

System requirements:

- PC with Windows® 10 (32-/64-bit)
- CAN interface of the PCAN series to upload the firmware to your hardware via CAN

Content of the package:

- `Build Tools\`
  Tools for automating the build process
- `Compiler\`
  Compilers for the supported programmable products
- `Hardware\`
  Contains sub directories of the supported hardware which include several firmware examples. Use the examples for starting your own firmware development.
- `PEAK-Flash\`
  Windows tool for uploading the firmware to your hardware via CAN. Copy the directory to your PC and start the software without further installation.
- `LiesMich.txt` and `ReadMe.txt`
- `SetPath_for_VSCode.vbs`
  VBScript to modify the example directories for the Visual Studio Code IDE.

Do the following to create your own firmware:

1. Create a folder on your local PC. We recommend using a local drive.
2. Copy the complete unzipped `PEAK-DevPack` directories into your folder, incl. all subs.

   No installation is required at all.
3. Run the script `SetPath_for_VSCode.vbs`. This script will modify the example directories for the Visual Studio Code IDE (https://code.visualstudio.com/).

   After that every example directory has a folder called `.vscode` containing the needed files with your local path information.
4. Now you can start Visual Studio Code which is available for free from Microsoft.
5. Select the folder of your project and open it.

   For example: `d:\PEAK-DevPack\Hardware\PCAN-GPS\Examples\03_Timer`
6. You can edit the C code and call `make clean`, `make all`, or compile single file via the menu **Terminal > Run Task**.
7. Create your firmware with `Make All`.

The firmware is the `*.bin` in the sub directory `out` of your project folder.

6.1 Library

The development of applications for the PCAN-GPS is supported by the library `libPCAN-GPS-*.a` (`*` stands for version number), a binary file. You can access all resources of the PCAN-GPS by means of this library. Die library is documented in the header files (`*.h`) which are located in the `inc` subdirectory of each example directory.

7 Firmware Upload

The microcontroller in the PCAN-GPS is equipped with new firmware via CAN. The firmware is uploaded via a CAN bus with the Windows program PEAK-Flash.

7.1 System Requirements

- CAN interface of the PCAN series for the computer (e.g. PCAN-USB)
- CAN cabling between the CAN interface and the PCAN-GPS module with proper termination (120 Ω on each end of the CAN bus)
- Operating system Windows 10 and 8.1 (32/64-bit)
- If you want to update several PCAN-GPS modules connected to the same CAN bus, you must assign a unique ID to each module. See section *3.1 Coding Solder Jumpers on page 14*.

7.2 Preparing Hardware

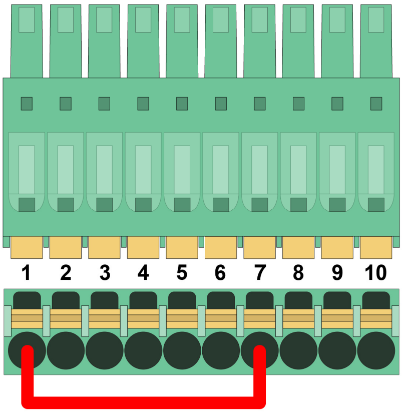
For an upload of new firmware via CAN, the CAN bootloader must be activated in the PCAN-GPS.

Do the following to prepare the hardware:

Attention! Electrostatic discharge (ESD) can damage or destroy components on the card. Take precautions to avoid ESD.

1. Disconnect the device from the power supply.

2. Establish a connection between **Boot** and the power supply $\mathbf{U}_b$.



Connection at the spring terminal strip
between terminals 1 and 7

This measure later applies the **Boot** connection with a High level.

3. Connect the CAN bus of the module with a CAN interface connected to the computer. Pay attention to the proper termination of the CAN cabling (2 x 120 Ω).

4. Reconnect the power supply again.

Due to the High level at the **Boot** connection, the PCAN-GPS starts the CAN bootloader. This can be determined by the status LEDs:

LED	Status	Color
Status 1	quickly blinking	orange
Status 2	on	orange

7.3 Firmware Transfer

A new firmware version can be transferred to the PCAN-GPS. The firmware is uploaded via a CAN bus using the Windows program PEAK-Flash.

Do the following to transfer a new firmware with PEAK-Flash

1. The software PEAK-Flash is included in the development package, which can be downloaded via the following link: `www.peak-system.com/quick/DLP-DevPack`
2. Open the zip file and extract it to your local storage medium.
3. Run the `PEAK-Flash.exe`

   The program opens.

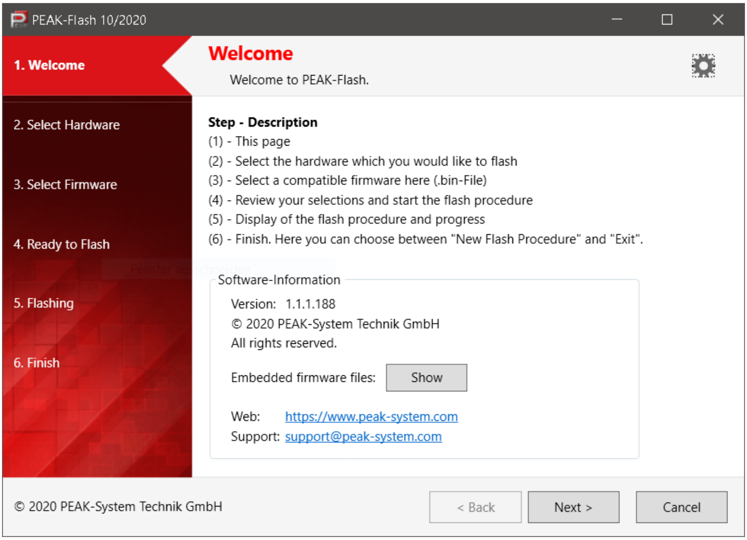


Figure 3: Main window of PEAK-Flash

4. Click the **Next** button.

5. Click on the **Modules connected to the CAN bus** radio button.
6. In the **Channels of connected CAN hardware** drop-down menu, select a CAN interface connected to the computer (e.g. PCAN-USB FD).
7. In the **Bit rate** drop-down menu, select the nominal bit rate available on the CAN bus.

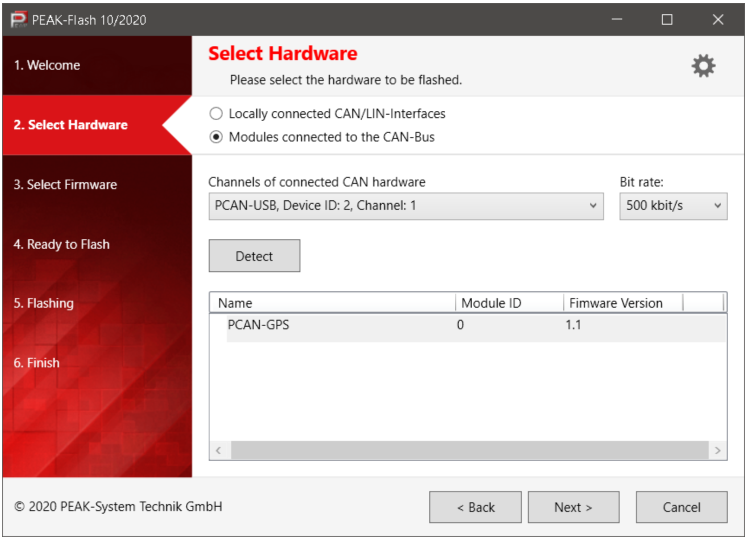


Figure 4: Hardware selection

8. Click on **Detect**.

   In the list, the **PCAN-GPS** appears together with the **Module ID** and **Firmware version**. If not, check whether a proper connection to the CAN bus with the appropriate nominal bit rate exists.
9. Click **Next**.
10. Select the **Firmware File** radio button and click **Select**.

11. Select the corresponding file (`*.bin`).

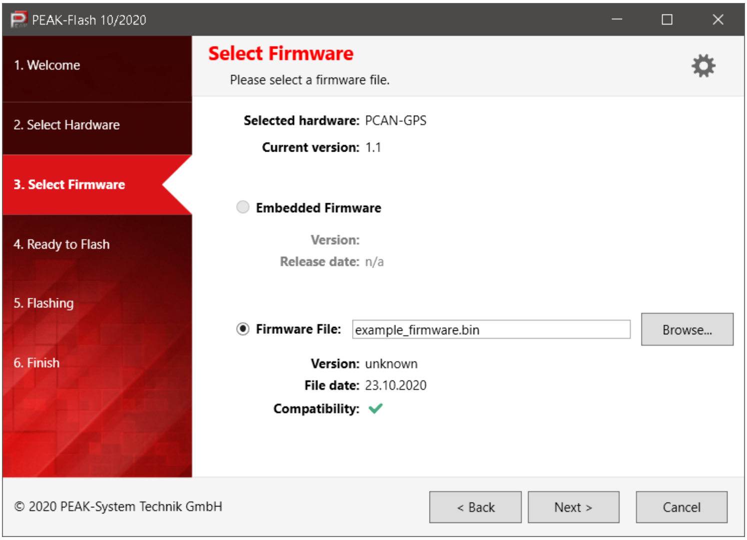


Figure 5: Selection of the firmware file (`*.bin`)

12. Click **Next**.

    The **Ready to Flash** dialog appears.

13. Click **Start** to transfer the new firmware to the PCAN-GPS.

    The **Flashing** dialog appears.

14. After the process is complete, click **Next**.
15. You can exit the program.
16. Disconnect the device from the power supply.
17. Remove the connection between **Boot** and the power supply $\mathbf{U}_b$.
18. Connect the device to the power supply.

You can now use the PCAN-GPS with the new firmware.

8 Technical Specifications

Power Supply	
Supply voltage	8 - 30 V DC
Current consumption normal operation	8 V: 100 mA 12 V: 60 mA 24 V: 30 mA 30 V: 25 mA
Current consumption sleep	60 µA
Button cell for RTC (and GNSS if required)	Type CR2032, 3 V,220 mAh, operating time without power supply of the device approx. 570 days Note: Observe the operating temperature range for used button cell.

Connectors	
Spring terminal strip	10-pole, 3.5 mm pitch (Phoenix Contact FMC 1,5/10-ST-3,5 - 195234)
Antenna	Sub-Miniature-A (SMA) Supply for activa antenna: 3.3 V, max. 50 mA
Memory card	micoSD™ slot internally for cards up to 32 GByte, types SD and SDHC

CAN	
Specification	ISO 11898-2, High-speed CAN 2.0A (Standard format) and 2.0B (Extended format)
Bit rates	40 kbit/s - 1 Mbit/s
Transceiver	NXP TJA1041T, wake-up-capable
Termination	none

Receiver for Navigation Satellites (GNSS)	
Type	u-blox MAX-7W
Receivable navigation systems[2]	GPS, GLONASS, Galileo, QZSS, SBAS
Connection to microcontroller	Serial connection (UART 2) with 9600 Baud 8N1 (default) Input for synchronization pulses (ExtInt) Output of timing pulses (default: 1/s)
Operating modes	Continuous Mode Power-save Mode
Antenna type	active or passive
Protective circuit antenna	Monitoring of the antenna current on short circuit with error message
Maximum update rate of navigation data	10 Hz
Maximum number of satellites received at the same time	56
Sensitivity	max. -161 dbm (tracking and navigation)
Time to first position fix after cold start (TTFF)	about 30 s
Accuracy of the position values	GPS: 2.5 m GPS with SBAS: 2 m GLONASS: 4 m
Supply for active antenna	3.3 V, max. 50 mA, switchable

Antenna for Satellite Reception	
Type	taoglas Ulysses AA.162
Center frequency range	1574 - 1610 MHz
Operating temperature range	-40 - +85 °C (-40 - +185 °F)
Size	40 x 38 x 10 mm
Cable length	about 3 m
Weight	59 g
Special feature	Integrated magnet for mounting

[2] The demo firmware uses GPS.

Gyroscope	
Type	STMicroelectronics L3GD20
Connection to microcontroller	SPI
Axes	roll (X), pitch (Y), yaw (Z)
Measuring ranges	±250, ±500, ±2000 dps (degrees per second)
Data format	16 bits, two's complement
Output data rate (ODR)	95 Hz, 190 Hz, 380 Hz, 760 Hz
Filter possibilities	Configurable high-pass and low-pass
Power saving modes	Sleep (2 mA), Power-down (5 µA)

Acceleration and Magnetic Field Sensor	
Type	Bosch Sensortec BMC050
Connection to microcontroller	SPI
Accelerometer	
Measuring ranges	±2/±4/±8/±16 G
Data format	10 bits, two's complement
Filter possibilities	Low-pass with 1 kHz - 8 Hz bandwidth
Operating modes	Power off, Normal, Suspend, Low-Power
Correction options	Offset compensation
Magnetic field sensor	
Sensitivity	X, Y: ±1000 µT Z: ±2500 µT
Data format	X, Y: 13 bits, two's complement Z: 15 bits, two's complement
Output data rate (ODR)	2 - 30 measurements per second
Operating modes	Power off, Suspend, Sleep, Active

Digital Inputs	
Count	2 (terminals 6 and 10)
Switch type	High-active (internal pull-down), inverting
Max. input frequency	3 kHz
Max. voltage	30 V
Switching thresholds	High: $U_{in} \geq 3$ V Low: $U_{in} \leq 2.2$ V
Internal resistance	133 kΩ

Digital Output	
Count	1 (terminal 5)
Type	Low-side driver
Max. voltage	30 V
Max. current	0.5 A
Short-circuit current	1.5 A

Microcontroller	
Type	NXP LPC4074FBD80
Clock frequency quartz	12 MHz
Clock frequency internally	max. 120 MHz (programmable by PLL)

Measures	
Size	45 x 68 x 26 mm (without SMA connector) See also dimension drawing Appendix B on page 35
Weight	Circuit board: 33 g (incl. button cell and mating connector) Casing: 17 g

Environment	
Operating temperature	-40 - +85 °C (-40 to +185 °F) (except button cell) Button cell (typical): -20 - +60 °C (-5 to +140 °F)
Temperature for storage and transport	-40 - +85 °C (-40 to +185 °F) (except button cell) Button cell (typical): -40 - +70 °C (-40 to +160 °F)
Relative humidity	15 - 90 %, not condensing
Ingress protection (IEC 60529)	IP20

Conformity	
EMV	EU Directive 2014/30/EU DIN EN 61326-1:2013-07; VDE 0843-20-1:2013-07
RoHS 2	EU Directive 2011/65/EU (RoHS 2) EU Directive 2015/863/EU (amended list of restricted substances) DIN EN IEC 63000:2019-05;VDE 0042-12:2019-05

Appendix A CE Certificate

EU Declaration of Conformity

This declaration applies to the following product:

Product name: **PGAN-GPS**

Item number(s): **IPEH-002110**

Manufacturer: PEAK-System Technik GmbH
Otto-Roehm-Strasse 69
64293 Darmstadt
Germany

CE We declare under our sole responsibility that the mentioned product is in conformity with the following directives and the affiliated harmonized standards:

EU Directive 2011/65/EU (RoHS 2) + 2015/863/EU (amended list of restricted substances)

DIN EN IEC 63000:2019-05;VDE 0042-12:2019-05
Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances (IEC 63000:2016); German version EN IEC 63000:2018

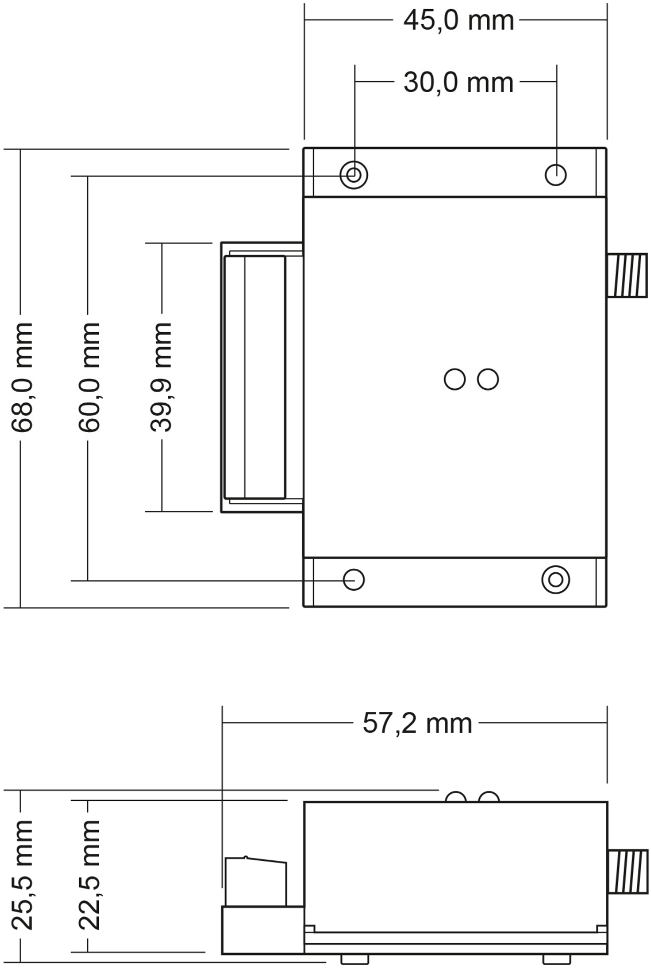
EU Directive 2014/30/EU (Electromagnetic Compatibility)

DIN EN 61326-1:2013-07;VDE 0843-20-1:2013-07
Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements (IEC 61326-1:2012); German version EN 61326-1:2013

Darmstadt, 21 October 2020

Uwe Wilhelm, Managing Director

Appendix B Dimension Drawing



The dimension drawing is not shown in actual size.

Appendix C CAN-Messages of the Demo Firmware

The two tables apply to the demo firmware which is provided with the PCAN-GPS at delivery. They list the CAN messages that, on the one hand, are transmitted periodically by the PCAN-GPS (600h to 640h) and, on the other hand, can be used to control the PCAN-GPS (650h to 657h). The CAN messages are sent in **Intel** format.

Tip: For users of the PCAN-Explorer, the development package contains an example project that is compatible with the demo firmware.

Download link to the development package:
`www.peak-system.com/quick/DLP-DevPack`

Path to the example project:
`PEAK-DevPack\Hardware\PCAN-GPS\Examples\00_Delivery_Firmware\PCAN-Explorer Example Project`

C.1 CAN Messages from the PCAN-GPS

CAN ID	Start bit	Bit count	Cycle time	Identifier	Values
600h BMC_Acceleration					
	0	16	25 ms	Acceleration_X	Conversion to mG: raw value * 3.91
	16	16		Acceleration_Y	
	32	16		Acceleration_Z	
	48	8		Temperature	Conversion to °C: raw value * 0.5 + 24
	56	2		VerticalAxis	0 = undefined 1 = X Axis 2 = Y Axis 3 = Z Axis

CAN ID	Start bit	Bit count	Cycle time	Identifier	Values
	58	3		Orientation	0 = flat 1 = flat upside down 2 = landscape left 3 = landscape right 4 = portrait 5 = portrait upside down
601h BMC_MagneticField					
	0	16	25 ms	MagneticField_X	Conversion to µT: raw value * 0.3
	16	16		MagneticField_Y	
	32	16		MagneticField_Z	
610h L3GD20_Rotation_A					
	0	32	50 ms	Rotation_X	Floating-point number[3], unit: degree per second
	32	32		Rotation_Y	
611h L3GD20_Rotation_B					
	0	32	50 ms	Rotation_Z	Floating-point number[3], unit: degree per second
620h GPS_Status					
	0	8	100 ms	GPS_AntennaStatus	0 = INIT 1 = DONTKNOW 2 = OK 3 = SHORT 4 = OPEN
	8	8		GPS_NumSatellites	
	16	8		GPS_NavigationMethod	0 = INIT 1 = NONE 2 = 2D 3 = 3D
621h GPS_CourseSpeed					
	0	32	100 ms	GPS_Course	Floating-point number[3], unit: degree

[3] Sign: 1 bit, fixed-point part: 23 bits, exponent: 8 bits (according to IEEE 754)

CAN ID	Start bit	Bit count	Cycle time	Identifier	Values
	32	32		GPS_Speed	Floating-point number[3], unit: km/h
622h	GPS_PositionLongitude				
	0	32	100 ms	GPS_Longitude_Minutes	Floating-point number[3]
	32	16		GPS_Longitude_Degree	
	48	8		GPS_IndicatorEW	0 = INIT 69 = East 87 = West
623h	GPS_PositionLatitude				
	0	32	100 ms	GPS_Latitude_Minutes	Floating-point number[3]
	32	16		GPS_Latitude_Degree	
	48	8		GPS_IndicatorNS	0 = INIT 78 = North 83 = South
624h	GPS_PositionAltitude				
	0	32	100 ms	GPS_Altitude	Floating-point number[3]
625h	GPS_Delusions_A				
	0	32	100 ms	GPS_PDOP	Floating-point number[3]
	32	32		GPS_HDOP	
626h	GPS_Delusions_B				
	0	32	100 ms	GPS_VDOP	Floating-point number[3]
627h	GPS_DateTime				
	0	8	100 ms	UTC_Year	
	8	8		UTC_Month	
	16	8		UTC_DayOfMonth	
	24	8		UTC_Hour	
	32	8		UTC_Minute	
	40	8		UTC_Second	

CAN ID	Start bit	Bit count	Cycle time	Identifier	Values
630h IO					
	0	1	100 ms	Din1_Status	
	1	1		Din2_Status	
	2	1		Dout_Status	
	3	1		SD_Present	
	4	1		GPS_PowerStatus	
	5	3		Device_ID	
640h RTC_DateTime					
	0	8	500 ms	RTC_Sec	
	8	8		RTC_Min	
	16	8		RTC_Hour	
	24	8		RTC_DayOfWeek	0 = Monday 1 = Tuesday 2 = Wednesday 3 = Thursday 4 = Friday 5 = Saturday 6 = Sunday
	32	8		RTC_DayOfMonth	
	40	8		RTC_Month	
	48	16		RTC_Year	

C.2 CAN Messages to the PCAN-GPS

CAN ID	Start bit	Bit count	Identifier	Values
650h Out_IO (1 byte)				
	0	1	Dout_Set	
	1	1	GPS_SetPower	
651h Out_PowerOff (1 byte)				
	0	1	Device_PowerOff	

CAN ID	Start bit	Bit count	Identifier	Values
652h Out_Gyro (1 byte)				
	0	2	Gyro_SetScale	0 = ±250 °/s 1 = ±500 °/s 2 = ±2000 °/s
653h Out_BMC_AccScale (1 byte)				
	0	3	Acc_SetScale	1 = ±2 G 2 = ±4 G 3 = ±8 G 4 = ±16 G
654h Out_SaveConfig (1 byte)				
	0	1	Config_SaveToEEPROM	
655h Out_RTC_SetTime (8 bytes)				
	0	8	RTC_SetSec	
	8	8	RTC_SetMin	
	16	8	RTC_SetHour	
	24	8	RTC_SetDayOfWeek	0 = Monday 1 = Tuesday 2 = Wednesday 3 = Thursday 4 = Friday 5 = Saturday 6 = Sunday
	32	8	RTC_SetDayOfMonth	
	40	8	RTC_SetMonth	
	48	16	RTC_SetYear	
656h Out_RTC_TimeFromGPS (1 byte)				
	0	1	RTC_SetTimeFromGPS	Note: The data from GPS does not contain the day of week.
657h Out_Acc_FastCalibration (4 bytes)				
	0	2	Acc_SetCalibTarget_X	0 = 0 G 1 = +1 G 2 = -1 G
	8	2	Acc_SetCalibTarget_Y	
	16	2	Acc_SetCalibTarget_Z	
	24	1	Acc_StartFastCalib	

Appendix D Data Sheets

The data sheets of components of the PCAN-GPS are enclosed to this document (PDF files). You can download the current versions of the data sheets and additional information from the manufacturer websites.

- Antenna taoglas Ulysses AA.162:
  PCAN-GPS_UserManAppendix_Antenna.pdf
  www.taoglas.com
- GNSS receiver u-blox MAX-7W:
  PCAN-GPS_UserManAppendix_GNSS.pdf
  www.u-blox.com
- Gyroscope STMicroelectronics L3GD20:
  PCAN-GPS_UserManAppendix_Gyroscope.pdf
  www.st.com
- Acceleration and magnetic field sesnor Bosch Sensortec BMC050:
  PCAN-GPS_UserManAppendix_MagneticFieldSensor.pdf
  www.bosch-sensortec.com
- Microcontroller NXP LPC4074 (User Manual):
  PCAN-GPS_UserManAppendix_Microcontroller.pdf
  www.nxp.com

Appendix E Disposal Information (Battery)

The device and the battery it contains must not be disposed of with household waste. Remove the battery from the device for proper separate disposal.

The PCAN-GPS contains the following battery:

- 1 x button cell CR2032 3.0 V