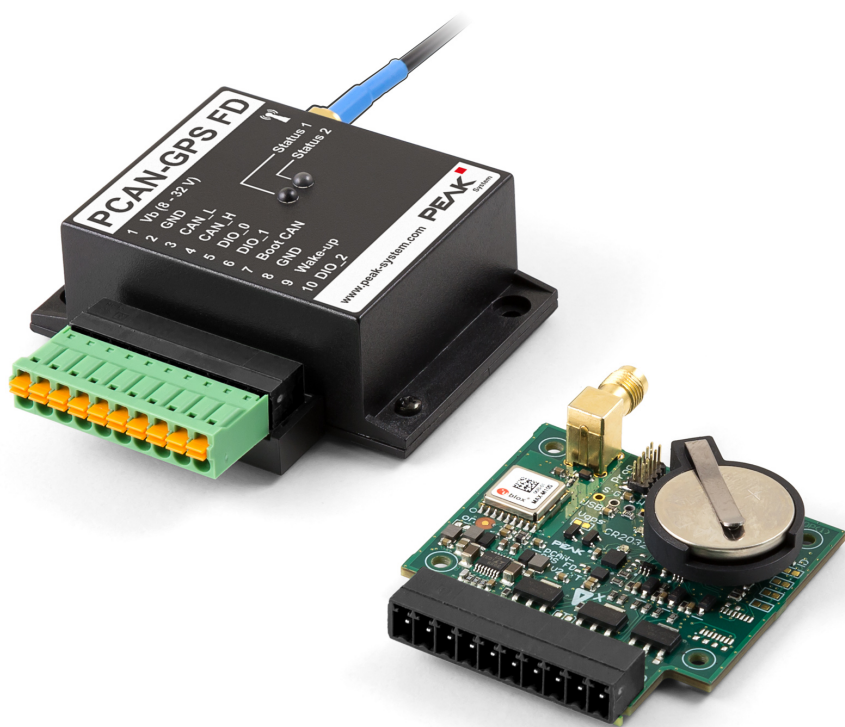


PCAN-GPS FD

User Manual



Relevant Product

Product name	Part number
PCAN-GPS FD	IPEH-003110

Imprint

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1 Introduction

The PCAN-GPS FD is a programmable sensor module for position and orientation determination with CAN FD connection. It has a satellite receiver, a magnetic field sensor, an accelerometer, and a gyroscope. Incoming sensor data is processed by the NXP microcontroller LPC54618 and then transmitted via CAN or CAN FD.

The behavior of the PCAN-GPS FD 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 FD is provided with a standard firmware that transmits the raw data of the sensors periodically on the CAN bus.

1.1 Properties at a Glance

- NXP LPC54618 microcontroller with Arm Cortex M4 core
- High-speed CAN connection (ISO 11898-2)
 - Complies with CAN specifications 2.0 A/B and FD
 - CAN FD bit rates for the data field (64 bytes max.) from 40 kbit/s up to 10 Mbit/s
 - CAN bit rates from 40 kbit/s up to 1 Mbit/s
 - NXP TJA1043 CAN transceiver
- CAN termination can be activated through solder jumpers
- Wake-up by CAN bus or by separate input
- Receiver for navigation satellites u-blox MAX-M10S
 - Supported navigation and supplementary systems: GPS, Galileo, BeiDou, GLONASS, SBAS, and QZSS
 - Simultaneous reception of 4 navigation systems
 - 3.3 V supply of active GPS antennas
- Electronic three-axis magnetic field sensor IIS2MDC from ST
- Gyroscope and three-axis accelerometer ISM330DLC from ST
- 8 MByte QSPI flash
- 3 digital I/Os, each usable as input (High-active) or output with Low-side switch
- LEDs for status signaling
- Connection via a 10-pole terminal strip (Phoenix)
- Voltage supply from 8 to 32 V
- Button cell for preserving the RTC and the GPS data to shorten the TTFF (Time To First Fix)
- Extended operating temperature range from -40 to +85 °C (-40 to +185 °F) (with exception of the button cell)
- New firmware can be loaded via CAN interface

1.2 Scope of Supply

- PCAN-GPS FD in plastic casing including
 - Mating connector: Phoenix Contact FMC 1,5/10-ST-3,5 - 1952348
 - External antenna for satellite reception

Download

- Windows development package with:
 - GCC ARM Embedded
 - Flash program
 - Programming examples
- Manual in PDF format

1.3 Prerequisites

- Power supply in the range of 8 to 32 V DC
- For uploading the firmware via CAN:
 - CAN interface of the PCAN series for the computer (e.g. PCAN-USB)
 - Operating system Windows 11 (x64/ARM64), 10 (x86/x64)

2 Description of the Sensors

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

For additional information about the sensors, see chapter 8 *Technical Data* and the data sheets of the respective manufacturers in Appendix E *Data Sheets*.

2.1 Receiver for Navigation Satellites (GNSS)

The u-blox MAX-M10S receiver module provides exceptional sensitivity and acquisition time for all L1 GNSS signals and is designed for the following global navigation satellite systems (GNSS):

- GPS (USA)
- Galileo (Europe)
- BeiDou (China)
- GLONASS (Russia)

Furthermore, the following satellite-based supplementary systems can be received:

- QZSS (Japan)
- SBAS (EGNOS, GAGAN, MSAS, and WAAS)

The receiver module supports simultaneous reception of three navigation satellite systems and the supplementary systems. A total of up to 32 satellites can be tracked simultaneously. The use of the supplementary systems requires an active GPS.

At delivery, the PCAN-GPS FD receives GPS, Galileo, BeiDou as well as QZSS and SBAS simultaneously. The navigation satellite system used can be adapted by the user during runtime. The possible combinations can be seen in Appendix E *Data Sheets*.

To receive a satellite signal, an external antenna must be connected to the SMA socket. Both passive and active antennas can be used. An active antenna is included in the scope of supply. On the sensor side, the antenna is monitored for short circuits. If a short circuit is detected, the voltage supply to the external antenna is interrupted to prevent damage to the PCAN-GPS FD.

For a faster position determination after switching on the PCAN-GPS FD, the internal RTC and the internal backup RAM can be supplied with the button cell. This requires a hardware modification (see section 4.3 *Buffer Battery for GNSS*).

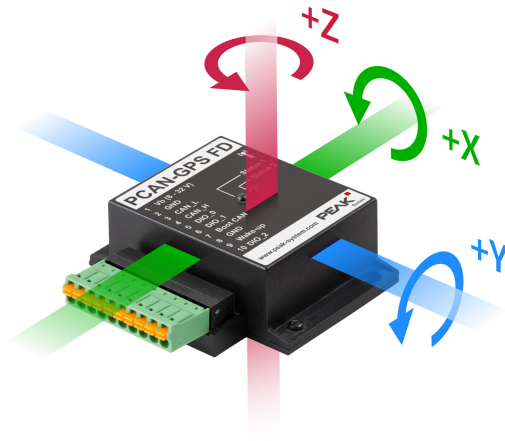
Further and detailed information can be found in Appendix E *Data Sheets*.

2.2 3D Accelerometer and 3D Gyroscope

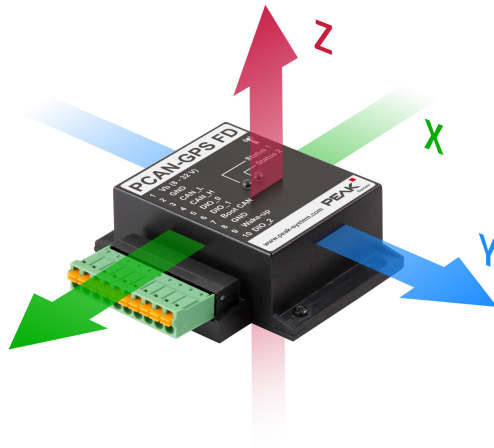
The STMicroelectronics ISM330DLC sensor module is a multi-chip module with a high-performance digital 3D accelerometer, a digital 3D gyroscope, and a temperature sensor. The sensor module measures the acceleration along the X, Y, and Z axes as well as the rotation rate around them.

In a steady state on a horizontal surface, the acceleration sensor measures 0 g on the X and Y axes. On the Z-axis it measures 1 g due to the gravitational acceleration.

The output of the values for acceleration and rotation rate can be scaled in predefined steps via the value range.



Gyroscope axes in relation to the PCAN-GPS FD casing
Z: yaw, X: roll, Y: pitch



Axes of the acceleration sensor
in relation to the PCAN-GPS FD casing

For measurement accuracy, various filters are connected in series, consisting of an analog anti-aliasing low-pass filter with a cutoff frequency dependent on the output data rate (ODR), an ADC converter, an adjustable digital low-pass filter, and a composite group of selectable, adjustable digital filters.

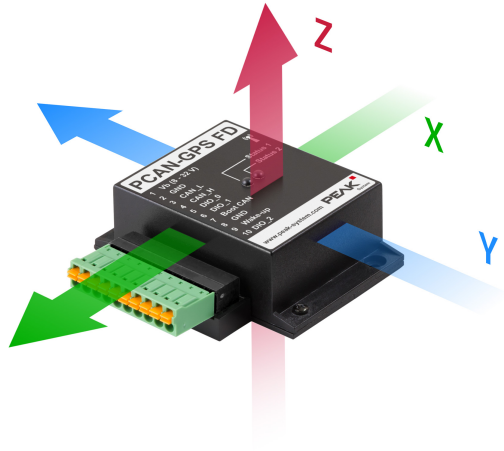
The gyroscope filter chain is a series connection of three filters, consisting of a selectable, adjustable digital high-pass filter (HPF), a selectable, adjustable digital low-pass filter (LPF1), and a digital low-pass filter (LPF2), whose cut-off frequency depends on the selected output data rate (ODR).

The sensor has two configurable interrupt outputs connected to the microcontroller (INT1 and INT2). Different interrupt signals can be applied here.

Further and detailed information can be found in Appendix E *Data Sheets*.

2.3 3D Magnetic Field Sensor

The STMicroelectronics IIS2MDC magnetic field sensor is used to determine the position in a magnetic field (e.g. earth's magnetic field). Its dynamic range is ± 50 Gauss.



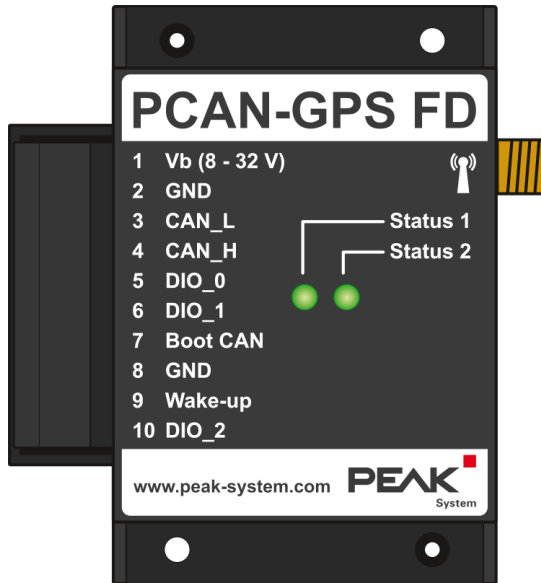
Axes of the magnetic field sensor
in relation to the PCAN-GPS FD casing

The sensor includes a selectable digital low-pass filter to reduce noise. In addition, hard-iron errors can be automatically compensated using configurable offset values. This is necessary if a magnet is placed in the immediate vicinity of the sensor, which permanently affects the sensor. Apart from this, the magnetic field sensor is factory calibrated at delivery and does not require any offset correction. The required calibration parameters are stored in the sensor itself. Each time the sensor is restarted, this data is retrieved and the sensor recalibrates itself.

The sensor has an interrupt output that is connected to the microcontroller and can generate an interrupt signal when new sensor data is available.

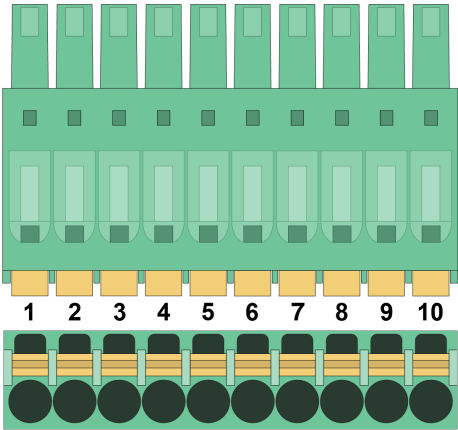
Further and detailed information can be found in Appendix E *Data Sheets*.

3 Connectors



PCAN-GPS FD with a 10-pole terminal strip (Phoenix),
a SMA antenna connector, and 2 status LEDs


3.1 Spring Terminal Strip



Spring terminal strip with 3.5 mm pitch
(Phoenix Contact FMC 1,5/10-ST-3,5 - 1952348)

Terminal	Identifier	Function
1	V _b	Power supply 8 to 32 V DC, e.g. car terminal 30, reverse-polarity protection
2	GND	Ground
3	CAN_Low	Differential CAN signal
4	CAN_High	
5	DIO_0	Can be used as input (High-active) or output with Low-side switch
6	DIO_1	Can be used as input (High-active) or output with Low-side switch
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	DIO_2	Can be used as input (High-active) or output with Low-side switch

3.2 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 provides an active antenna which can receive the navigation systems GPS, Galileo, and BeiDou with QZSS and SBAS by factory default of the PCAN-GPS FD.

4 Hardware Configuration

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

- Coding solder bridges for polling by the firmware
- Internal termination
- Buffer battery for satellite reception

4.1 Coding Solder Jumpers

The circuit board has four coding solder bridges to assign a permanent state to the corresponding input bits of the microcontroller. The four positions for coding solder bridges (ID 0 - 3) are each assigned to one port of the microcontroller LPC54618J512ET180 (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 FD module is identified by a 4-bit ID which is determined by solder jumpers. A bit is set (1) when the corresponding solder field is open (default setting: ID 15, all solder fields open).

Solder field	ID0	ID1	ID2	ID3
Binary digit	0001	0010	0100	1000
Decimal equivalent	1	2	4	8

See chapter 7 *Firmware Upload* for more information.

Activate coding solder bridges:

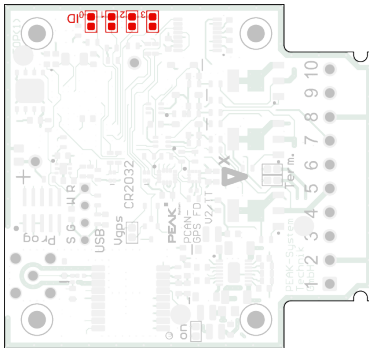


Risk of short circuit! Soldering on the PCAN-GPS FD may only be performed by qualified electrical engineering personnel.





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

1. Disconnect the PCAN-GPS FD from the power supply.
2. Remove the two screws on the housing flange.
3. Remove the cover under consideration of the antenna connection.
4. Solder the solder bridge(s) on the board according to the desired setting.



Solder fields 0 to 3 for the ID on the board

Solder field	Port status
	High
	Low

5. Put the housing cover back in place according to the recess of the antenna connection.
6. Screw the two screws back onto the housing flange.

4.2 Internal Termination

If the PCAN-GPS FD is connected to one end of a CAN bus and if there is no termination of the CAN bus yet, an internal termination with $120\ \Omega$ between the lines CAN-High and CAN-Low can be activated. Termination is possible independently for both CAN channels.



Tip: We recommend adding termination at the CAN cabling, for example with termination adapters (e.g. PCAN-Term). Thus, CAN nodes can be flexibly connected to the bus.

Activate the internal termination:



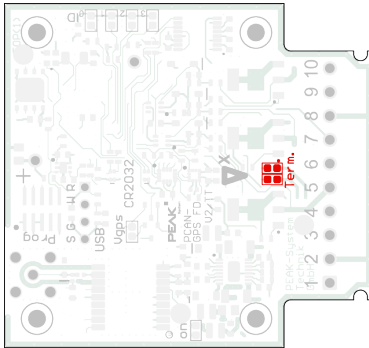
Risk of short circuit! Soldering on the PCAN-GPS FD may only be performed by qualified electrical engineering personnel.





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

1. Disconnect the PCAN-GPS FD from the power supply.
2. Remove the two screws on the housing flange.
3. Remove the cover under consideration of the antenna connection.

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



Solder fields for the termination of the
CAN channel

Solder fields	Termination
	inactive (Default)
	active

5. Put the housing cover back in place according to the recess of the antenna connection.
6. Screw the two screws back onto the housing flange.

4.3 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 FD 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.

Activate quick start via buffer battery:

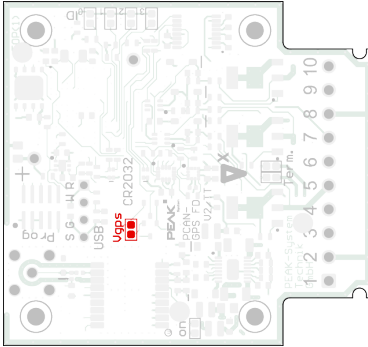


Risk of short circuit! Soldering on the PCAN-GPS FD may only be performed by qualified electrical engineering personnel.





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

1. Disconnect the PCAN-GPS FD from the power supply.
2. Remove the two screws on the housing flange.
3. Remove the cover under consideration of the antenna connection.
4. Solder the solder bridge(s) on the board according to the desired setting.



Solder field Vgps on the circuit board

Solder field	Port status
	Default: quick start of the GNSS receiver is not activated.
	Quick start of the GNSS receiver is activated.

5. Put the housing cover back in place according to the recess of the antenna connection.
6. Screw the two screws back onto the housing flange.

5 Operation

5.1 Starting the PCAN-GPS FD

The PCAN-GPS FD is activated by applying the supply voltage to the respective ports, see section 3.1 *Spring Terminal Strip*. The firmware in the flash memory is subsequently run.

At delivery, the PCAN-GPS FD is provided with a standard firmware. In addition to the supply voltage, a wake-up signal is required for its start-up, see section 5.4 *Wake-up*. The standard firmware periodically transmits the raw values measured by the sensors with a CAN bit rate of 500 kbit/s. In Appendix D *CAN Messages of the Standard Firmware* is a list of the used CAN messages.

5.2 Status LEDs

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

LEDs in CAN bootloader mode

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

LED	Status	Description
Status 1	orange, quickly blinking	CAN bootloader mode active
Status 2	orange	

LEDs when using the standard firmware

When using the standard firmware, the LED Status 1 shows the reception status of GNSS data and the LED Status 2 shows the status of the CAN communication.

LED	Status	Description
Status 1	orange	Initial state
	orange, blinking (0.5 Hz)	At least one NMEA data frame with a valid CRC has been received.
	green, blinking (0.5 Hz)	A valid time stamp was received from the navigation satellites.
	green, quickly blinking (2 Hz)	The u-blox module has a fix and can determine its position.
Status 2	green and orange, quickly blinking	CAN messages are received.

5.3 Sleep Mode

The PCAN-GPS FD can be put into a sleep mode. When programming your own firmware, you can trigger the sleep mode by a CAN message or a timeout. Thereby no high level may be present at pin 9, Wake-up.

In sleep mode, the power supply for most of the electronics in the PCAN-GPS FD is switched off and the current consumption is reduced to 175 μ A with simultaneous RTC and GPS operation. The sleep mode can be terminated via different wake-up signals. More about this can be found in the following section 5.4 *Wake-up*.

The standard firmware installed at delivery puts the PCAN-GPS FD into sleep mode after a timeout of 5 s. Timeout refers to the time passed since the last CAN message was received.

5.4 Wake-up

If the PCAN-GPS FD is in sleep mode, a wake-up signal is required for the PCAN-GPS FD to turn on again. The PCAN-GPS FD needs 16.5 ms for a wake-up. The following subsections show the possibilities.

5.4.1 Wake-up by external High Level

Via pin 9 of the connector strip (see section 3.1 *Spring Terminal Strip*), a high level (at least 8 V) can be applied over the entire voltage range in order to turn on the PCAN-GPS FD.



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

5.4.2 Wake-up via CAN

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

6 Creating Own Firmware

With the help of the PEAK-DevPack development package, you can program your own application-specific firmware for PEAK-System programmable hardware products. For each supported product, examples are included.

On delivery, the PCAN-GPS FD is provided with a standard firmware that transmits the raw data of the sensors periodically on the CAN bus. The source code of the firmware is available as example `00_Standard_Firmware`.



Note: The example of the standard firmware contains a PCAN-Explorer project for the sensor data presentation. The PCAN-Explorer is a professional Windows software for working with CAN and CAN FD buses. A license of the software is required to use the project.

System requirements:

- Computer with operating system Windows 11 (x64), 10 (x86/x64)
- CAN interface of the PCAN series to upload the firmware to your hardware via CAN

Download of the development package:

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

Content of the package:

- Build Tools Win32\
Tools for automating the build process for Windows 32-bit
- Build Tools Win64\
Tools for automating the build process for Windows 64-bit
- Compiler\
Compilers for the supported programmable products

- `Debug\`
 - OpenOCD and configuration files for hardware which supports debugging
 - `VBScript SetDebug_for_VSCode.vbs` to modify the example directories for the Visual Studio Code IDE with Cortex-debug
 - Detailed information about debugging in the enclosed documentation of the PEAK-DevPack Debug Adapter
- `Hardware\`

Sub directories with firmware examples for supported hardware. Use the examples for starting your own firmware development.
- `PEAK-Flash\`

Windows software for uploading the firmware to your hardware via CAN
- `LiesMich.txt` and `ReadMe.txt`

Short documentation how to work with the development package in German and English
- `SetPath_for_VSCode.vbs`

VBScript to modify the example directories for the Visual Studio Code IDE

Creating your own firmware:

1. Create a folder on your computer. We recommend using a local drive.
2. Unzip the development package `PEAK-DevPack.zip` completely into the folder. No installation is required.
3. Run the script `SetPath_for_VSCode.vbs`.

This script will modify the example directories for the Visual Studio Code IDE. Afterwards, each example directory has a folder called `.vscode` containing the needed files with your local path information.

4. Start Visual Studio Code. The IDE is available free of charge from Microsoft: <https://code.visualstudio.com>.
5. Select the folder of your project and open it. For example:
`d:\PEAK-DevPack\Hardware\PCAN-GPS_FD\Examples\03_Timer.`

6. You can edit the C code and use the menu *Terminal > Run Task* to call *make clean*, *make all*, or to compile a single file.
7. Create your firmware with *make all*.
The firmware is the *.bin file in the `out` sub directory of your project folder.
8. Prepare your hardware for firmware upload like described in section 7.2 *Preparing Hardware*.
9. Use the PEAK-Flash tool to upload your firmware to the device via CAN.

The tool is either started via the menu *Terminal > Run Task > Flash Device* or from the sub directory of the development package. Section 7.3 *Firmware Transfer* describes the process. A CAN interface of the PCAN series is required.

6.1 Library

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

7 Firmware Upload

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

7.1 System Requirements

- CAN interface of the PCAN series for the computer, for example PCAN-USB
- CAN cabling between the CAN interface and the module with correct termination at both ends of the CAN bus with 120 Ohm each.
- Operating system Windows 11 (x64/ARM64), 10 (x86/x64)
- If you want to update several PCAN-GPS FD modules on the same CAN bus with new firmware, you must assign an ID to each module. See section 4.1 *Coding Solder Jumpers*.

7.2 Preparing Hardware

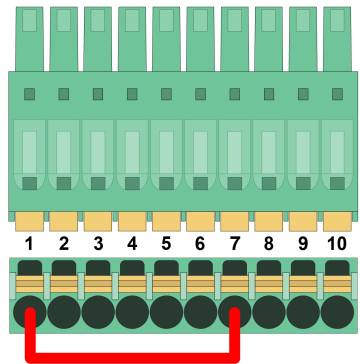
For an firmware upload via CAN, the CAN bootloader of the PCAN-GPS FD must be activated.

Activating CAN Bootloader:



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

1. Disconnect the PCAN-GPS FD from the power supply.
2. Establish a connection between **Boot** and the power supply V_b .



Connection at the spring terminal strip
between terminals 1 and 7

Because of that, a High level is later applied to the **Boot** connection.

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 Ohm).
4. Reconnect the power supply.

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

LED	Status	Description
Status 1	orange, quickly blinking	CAN bootloader mode active
Status 2	orange	

7.3 Firmware Transfer

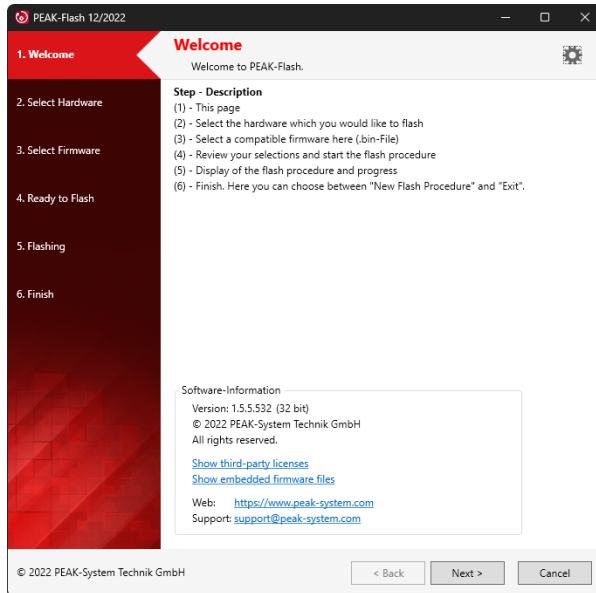
A new firmware version can be transferred to the PCAN-GPS FD. The firmware is uploaded via a CAN bus using the Windows software PEAK-Flash.

Transfer firmware with PEAK-Flash:

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

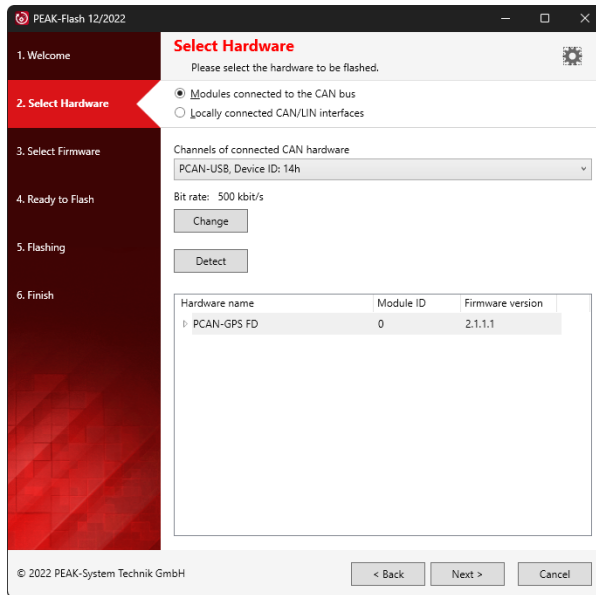
1. Open the zip file and extract it to your local storage medium.
2. Run the `PEAK-Flash.exe`.

The main window of PEAK-Flash appears.



3. Click the button *Next*.

The *Select Hardware* window appears.



4. Click on the *Modules connected to the CAN bus* radio button.

5. In the drop-down menu *Channels of connected CAN hardware*, select a CAN interface connected to the computer.

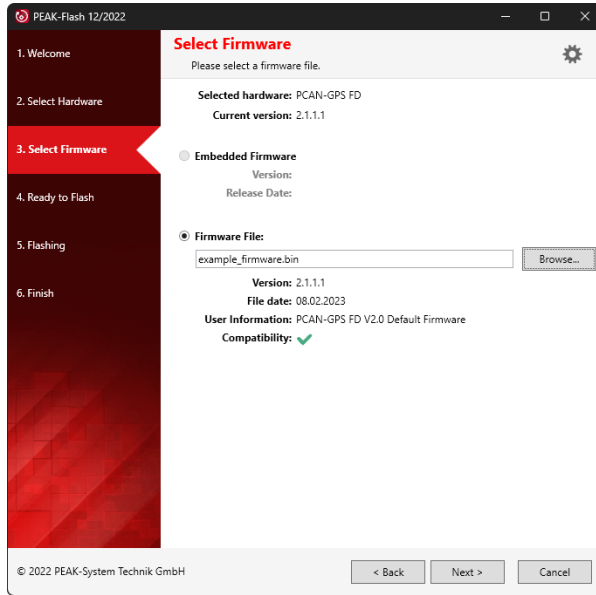
6. In the drop-down menu *Bit rate*, select the nominal bit rate 500 kbit/s.

7. Click on *Detect*.

In the list, the PCAN-GPS FD 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.

8. Click *Next*.

The *Select Firmware* window appears.



9. Select the *Firmware File* radio button and click *Browse*.

10. Select the corresponding file (*.bin).

11. Click *Next*.

The *Ready to Flash* dialog appears.

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

The *Flashing* dialog appears.

13. After the process is complete, click *Next*.

14. You can exit the program.

15. Disconnect the PCAN-GPS FD from the power supply.

16. Remove the connection between **Boot** and the power supply **V_b**.

17. Connect the PCAN-GPS FD to the power supply.

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

8 Technical Data

Power supply		
Supply voltage	8 to 32 V DC	
Current consumption	Normal operation	8 V: 50 mA 12 V: 35 mA 24 V: 20 mA 30 V: 17 mA
	Sleep mode	140 µA (RTC only) 175 µA (RTC and GPS)
Button cell for RTC (and GNSS if required)	Type CR2032, 3 V, 220 mAh Operating time without power supply of the PCAN-GPS FD: <ul style="list-style-type: none">▪ Only RTC approx. 13 years▪ Only GPS approx. 9 month▪ With RTC and GPS approx. 9 month Note: Pay attention to the operating temperature range of the inserted button cell.	
Connectors		
Spring terminal strip	10-pole, 3.5 mm pitch (Phoenix Contact FMC 1,5/10-ST-3,5 - 1952348)	
Antenna	SMA (Sub Miniature version A) Supply for active antenna: 3.3 V, max. 50 mA	

CAN (FD)

Protocols	CAN FD ISO 11898-1:2015, CAN FD non-ISO, CAN 2.0 A/B	
Physical transmission	ISO 11898-2 (High-speed CAN)	
CAN bit rates	Nominal:	40 kbit/s to 1 Mbit/s
CAN FD bit rates	Nominal:	40 kbit/s to 1 Mbit/s
	Data:	40 kbit/s to 10 Mbit/s ¹
Transceiver	NXP TJA1043, wake-up capable	
Internal termination	Activation via solder bridges; not activated on delivery	
Listen-only mode	Programmable; not activated at delivery	

¹ According to the CAN transceiver data sheet, only CAN FD bit rates up to 5 Mbit/s are guaranteed with the specified timing.

Receiver for navigation satellites (GNSS)

Type	u-blox MAX-M10S	
Receivable navigation systems	GPS, Galileo, BeiDou, GLONASS, QZSS, SBAS Note: The standard firmware uses GPS, Galileo, and BeiDou.	
Connection to microcontroller	Serial connection (UART 6) with 9600 Baud 8N1 (default) Input for synchronization pulses (ExtInt) Output of timing pulses 1PPS (0.25 Hz to 10 MHz, configurable)	
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 Note: The OPEN detection of the u-blox MAX-M10S is not enabled.	
Maximum update rate of navigation data	Up to 10 Hz (4 concurrent GNSS) Up to 18 Hz (single GNSS) Note: The manufacturer of the u-blox M10 allows up to 25 Hz (single GNSS) with an irreversible configuration. You can perform this modification on your own responsibility. However, we do not offer support for it.	
Maximum number of satellites received at the same time	32	
Sensitivity	max. -166 dbm (tracking and navigation)	

Receiver for navigation satellites (GNSS)

Time to first position fix after cold start (TTFF)	approx. 30 s
Accuracy of the position values	GPS (Concurrent): 1.5 m Galileo: 3 m BeiDou: 2 m GLONASS: 4 m
Supply for active antenna	3.3 V, max. 50 mA, switchable

Antenna for satellite reception (in scope of supply)

Type	taoglas Ulysses AA.162
Center frequency range	1574 to 1610 MHz
Receivable systems	GPS, Galileo, BeiDou, GLONASS
Operating temperature range	-40 to +85 °C (-40 to +185 °F)
Size	40 x 38 x 10 mm
Cable length	approx. 3 m
Weight	59 g
Special feature	Integrated magnet for mounting

3D gyroscope

Type	ST ISM330DLC
Connection to microcontroller	SPI
Axes	roll (X), pitch (Y), yaw (Z)
Measuring ranges	±125, ±250, ±500, ±1000, ±2000 dps (degrees per second)
Data format	16 bit, two's complement
Output data rate (ODR)	12.5 Hz, 26 Hz, 52 Hz, 104 Hz, 208 Hz, 416 Hz, 833 Hz, 1666 Hz, 3332 Hz, 6664 Hz
Filter possibilities	Configurable digital filter chain
Power saving mode	Power-down
Operating modes	Low-power, Normal, and High-performance mode

3D acceleration sensor

Type	ST ISM330DLC
Connection to microcontroller	SPI
Measuring ranges	± 2 , ± 4 , ± 8 , ± 16 G
Data format	16 bit, two's complement
Filter possibilities	Configurable digital filter chain
Operating modes	Power-down, Low-power, Normal, and High-performance mode
Correction options	Offset compensation

3D magnetic field sensor

Type	ST IIS2MDC
Connection to microcontroller	I ² C direct connection
Sensitivity	± 49.152 Gauss ($\pm 4915 \mu\text{T}$)
Data format	16 bits, two's complement
Filter possibilities	Configurable digital filter chain
Output data rate (ODR)	10 to 150 measurements per second
Operating modes	Idle, Continuous, and Single mode

Digital inputs

Count	3
Switch type	High-active (internal pull-down), inverting
Max. input frequency	3 kHz
Max. voltage	60 V
Switching thresholds	High: $U_{in} \geq 2.6 \text{ V}$ Low: $U_{in} \leq 1.3 \text{ V}$
Internal resistance	$> 33 \text{ k}\Omega$

Digital outputs

Count	3
Type	Low-side driver
Max. voltage	60 V
Max. current	0.7 A
Short-circuit current	1 A
Internal resistance	0.55 k Ω

Microcontroller

Type	NXP LPC54618J512ET180, Arm-Cortex-M4-Core
Clock frequency quartz	12 MHz
Clock frequency internally	max. 180 MHz (programmable via PLL)
Memory	512 kByte MCU Flash (Program) 2 kByte EEPROM 8 MByte QSPI Flash
Firmware upload	via CAN (PCAN interface required)

Measures

Size	68 x 57 x 25.5 mm (W x D x H) (without SMA connector)	
Weight	Circuit board:	27 g (incl. button cell and mating connector)
	Casing:	17 g

Environment

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

Conformity

RoHS 2	EU Directive 2011/65/EU (RoHS 2) + 2015/863/EU DIN EN IEC 63000:2019-05
EMC	EU Directive 2014/30/EU DIN EN 61326-1:2022-11

Appendix A CE Certificate

EU Declaration of Conformity



This declaration applies to the following product:

Product name: **PCAN-GPS FD**
Item number(s): **IPEH-003110**
Manufacturer: **PEAK-System Technik GmbH**
Otto-Röhm-Straße 69
64293 Darmstadt
Germany



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

Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances (IEC 63000:2016);
German version of EN IEC 63000:2018

EU Directive 2014/30/EU (Electromagnetic Compatibility)

DIN EN 61326-1:2022-11

Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1:
General requirements (IEC 61326-1:2020);
German version of EN IEC 61326-1:2021

Darmstadt, 26 October 2023

A handwritten signature in black ink, appearing to read "Uwe Wilhelm".

Uwe Wilhelm, Managing Director

Appendix B UKCA Certificate

UK Declaration of Conformity



This declaration applies to the following product:

Product name: **PCAN-GPS FD**
Item number(s): **IPEH-003110**

Manufacturer:

PEAK-System Technik GmbH
Otto-Röhm-Straße 69
64293 Darmstadt
Germany

UK authorized representative:

Control Technologies UK Ltd
Unit 1, Stoke Mill,
Mill Road, Sharnbrook,
Bedfordshire, MK44 1NN, UK



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

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

DIN EN IEC 63000:2019-05

Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances (IEC 63000:2016);
German version of EN IEC 63000:2018

Electromagnetic Compatibility Regulations 2016

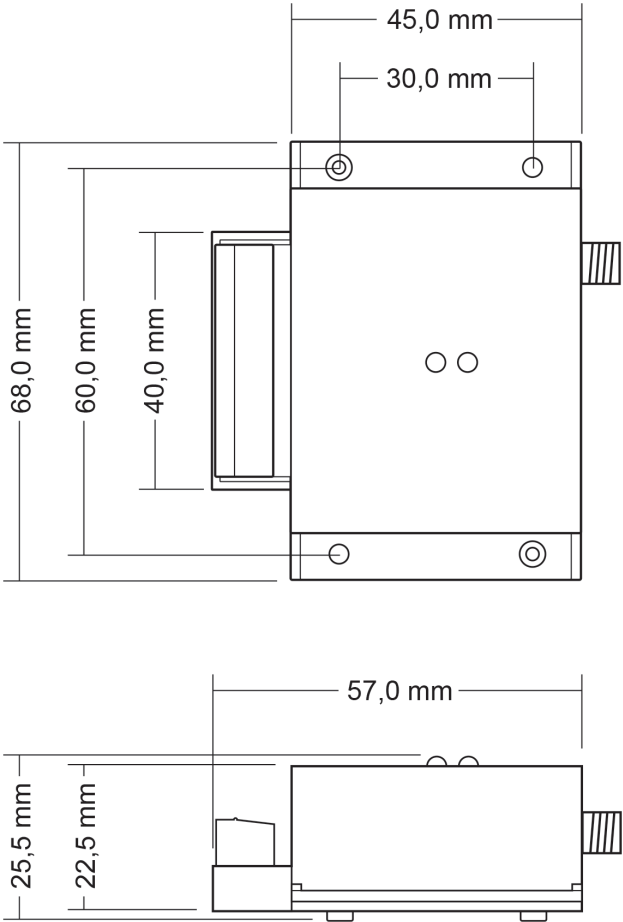
DIN EN 61326-1:2022-11

Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements (IEC 61326-1:2020);
German version of EN IEC 61326-1:2021

Darmstadt, 26 October 2023

Uwe Wilhelm, Managing Director

Appendix C Dimension Drawing



Appendix D CAN Messages of the Standard Firmware

The following two tables apply to the standard firmware which is provided with the PCAN-GPS FD at delivery. They list the CAN messages that, on the one hand, are transmitted periodically by the PCAN-GPS FD (600h to 630h) and, on the other hand, can be used to control the PCAN-GPS FD (650h to 658h). 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 standard firmware.

Download link to the development package:

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

Path to the example project:

PEAK-DevPack\Hardware\PCAN-GPS_FD\Examples\
00_Standard_Firmware\PCAN-Explorer Example Project

D.1 CAN Messages from the PCAN-GPS FD

CAN ID	Start bit	Bit count	Identifier	Values
600h	MEMS_Acceleration (Cycle time 100 ms)			
	0	16	Acceleration_X	Conversion to mG: raw value * 0.061
	16	16	Acceleration_Y	
	32	16	Acceleration_Z	
	48	8	Temperature	Conversion to °C: raw value * 0.5 + 25
	56	2	VerticalAxis	0 = undefined 1 = X axis 2 = Y axis 3 = Z axis
	58	3	Orientation	0 = flat 1 = flat upside down 2 = landscape left 3 = landscape right 4 = portrait 5 = portrait upside down
601h	MEMS_MagneticField (Cycle time 100 ms)			
	0	16	MagneticField_X	Conversion to mGauss: raw value * 1.5
	16	16	MagneticField_Y	
	32	16	MagneticField_Z	
610h	MEMS_Rotation_A (Cycle time 100 ms)			
	0	32	Rotation_X	Floating-point number ¹ , unit: degree per second
	32	32	Rotation_Y	
611h	MEMS_Rotation_B (Cycle time 100 ms)			
	0	32	Rotation_Z	Floating-point number ¹ , unit: degree per second

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

CAN ID	Start bit	Bit count	Identifier	Values
620h	GPS_Status (Cycle time 1000 ms)			
	0	8	GPS_AntennaStatus	0 = INIT 1 = DONTKNOW 2 = OK 3 = SHORT 4 = OPEN ²
	8	8	GPS_NumSatellites	
	16	8	GPS_NavigationMethod	0 = INIT 1 = NONE 2 = 2D 3 = 3D
	24	8	GPS_TalkerID	0 = GPS, SBAS 1 = GAL 2 = BeiDou 3 = QZSS 4 = Any combination of GNSS 6 = GLONASS
	32	8	GPS_SatellitesInView	
	40	1	TimeValid	
	41	1	DateValid	
	42	1	PositionValid	
	GPS_CourseSpeed (Cycle time 1000 ms)			
621h	0	32	GPS_Course	Floating-point number ¹ , unit: degree
	32	32	GPS_Speed	Floating-point number ¹ , unit: km/h

² The OPEN detection of the u-blox MAX-M10S is not enabled.

CAN ID	Start bit	Bit count	Identifier	Values
622h	GPS_PositionLongitude (Cycle time 1000 ms)			
	0	32	GPS_Longitude_Minutes	Floating-point number ¹
	32	16	GPS_Longitude_Degree	
	48	8	GPS_IndicatorEW	0 = INIT 69 = East 87 = West

CAN ID	Start bit	Bit count	Identifier	Values
623h	GPS_PositionLatitude (Cycle time 1000 ms)			
	0	32	GPS_Latitude_Minutes	Floating-point number ¹
	32	16	GPS_Latitude_Degree	
	48	8	GPS_IndicatorNS	0 = INIT 78 = North 83 = South
624h	GPS_PositionAltitude (Cycle time 1000 ms)			
	0	32	GPS_Altitude	Floating-point number ¹
625h	GPS_Delusions_A (Cycle time 1000 ms)			
	0	32	GPS_PDOP	Floating-point number ¹
	32	32	GPS_HDOP	
626h	GPS_Delusions_B (Cycle time 1000 ms)			
	0	32	GPS_VDOP	Floating-point number ¹
627h	GPS_DateTime (Cycle time 1000 ms)			
	0	8	UTC_Year	
	8	8	UTC_Month	
	16	8	UTC_DayOfMonth	
	24	8	UTC_Hour	
	32	8	UTC_Minute	
	40	8	UTC_Second	
	48	8	UTC_LeapSeconds	
	56	1	UTC_LeapSecondStatus	

CAN ID	Start bit	Bit count	Identifier	Values
630h	IO (Cycle time 125 ms)			
	0	1	Din0_Status	
	1	1	Din1_Status	
	2	1	Din2_Status	
	3	1	Dout0_Status	
	4	1	Dout1_Status	
	5	1	Dout2_Status	
	6	1		
	7	1	GPS_PowerStatus	
	8	4	Device_ID	

D.2 CAN Messages to the PCAN-GPS FD


CAN ID	Start bit	Bit count	Identifier	Values
650h	Out_IO (1 Byte)			
	0	1	DO_0_Set	
	1	1	GPS_SetPower	
	2	1	DO_1_Set	
	3	1	DO_2_Set	
652h	Out_Gyro (1 Byte)			
	0	2	Gyro_SetScale	0 = ± 250 °/s 1 = ± 125 °/s 2 = ± 500 °/s 4 = ± 1000 °/s 6 = ± 2000 °/s
653h	Out_MEMS_AccScale (1 Byte)			
	0	3	Acc_SetScale	0 = ± 2 G 2 = ± 4 G 3 = ± 8 G 1 = ± 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	
	32	8	RTC_SetDayOfMonth	
	40	8	RTC_SetMonth	
	48	16	RTC_SetYear	

CAN ID	Start bit	Bit count	Identifier	Values
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_Calibration (4 Bytes)			
	0	2	Acc_SetCalibTarget_X	0 = 0 G
	8	2	Acc_SetCalibTarget_Y	1 = +1 G
	16	2	Acc_SetCalibTarget_Z	2 = -1 G
	24	1	Acc_CalibEnabled	
658h	Out_EraseConfig (1 Byte)			
	0	1	Config_EraseFromEEPROM	

Appendix E Data Sheets

The data sheets of components of the PCAN-GPS FD 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-FD_UserManAppendix_Antenna.pdf

 www.taoglas.com

- GNSS receiver u-blox MAX-M10S:

 PCAN-GPS-FD_UserManAppendix_GNSS_DataSheet.pdf

 PCAN-GPS-FD_UserManAppendix_GNSS_InterfaceDescription.pdf

 www.u-blox.com

- 3D Accelerometer and 3D Gyroscope sensor ISM330DLC by ST:

 PCAN-GPS-FD_UserManAppendix_AccelerometerGyroscope.pdf

 www.st.com

- 3D Magnetic field sensor IIS2MDC by ST:

 PCAN-GPS-FD_UserManAppendix_MagneticFieldSensor.pdf

 www.st.com

- Microcontroller NXP LPC54618 (User Manual):

 PCAN-GPS-FD_UserManAppendix_Microcontroller.pdf

 www.nxp.com

Appendix F Disposal

The PCAN-GPS FD and the battery it contains must not be disposed of in household waste. Remove the battery and dispose of the battery and the PCAN-GPS FD properly in accordance with local regulations.

The following battery is included in the PCAN-GPS FD:

- 1 x button cell CR2032 3.0 V