CANopen (FD) for
PCAN-MicroMod FD devices

for PEAK firmware version 1.9.7.26 or higher
and EmSA CANopen firmware version 1.10.3.26 or higher

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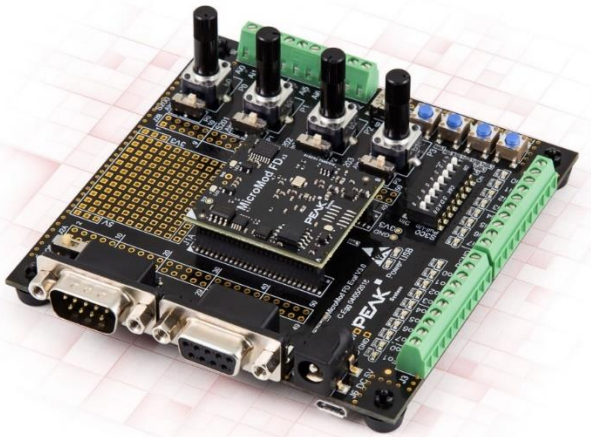
1 Introduction

The PCAN-MicroMod FD modules by PEAK-System Technik GmbH can optionally be activated to support the CANopen or CANopen FD standards. This allows their easy integration into CANopen or CANopen FD networks.

This manual summarizes the CANopen (FD) features provided and shows you how to activate the CANopen (FD) firmware.



1.1 Prerequisites

If you are missing any of the items below, you can get most of them at www.canopenstore.eu

1.1.1 Hardware

To proceed, you need at least one of the following devices:

- PCAN-MicroMod FD Evaluation Board (with inserted module)
- PCAN-MicroMod FD Analog 1
- PCAN-MicroMod FD Digital 1
- PCAN-MicroMod FD Digital 2

And any PCAN-USB FD adapter to communicate with the PCAN-MicroMod FD devices.

Use appropriate CAN cabling (including termination resistors) to connect the PCAN PC interface with the PCAN-MicroMod devices.

1.1.2 Software

Ensure that you have the latest version of PEAK's PCAN-MicroMod FD Configuration software installed. There is a separate manual from PEAK for this software and how to establish a connection between it and a PCAN-MicroMod FD.

For monitoring and analysing the CANopen (FD) communication we recommend our CANopen Magic software. Any version Lite, Standard, Professional or Ultimate will work for this purpose.

1.1.3 Activation code

The CANopen (FD) firmware license is not included with the purchase of a PCAN-MicroMod FD hardware.

To activate the CANopen (FD) firmware you either need a purchased activation code (e.g. from www.canopenstore.com or www.canopenstore.eu) or a promotional coupon code from Embedded Systems Academy GmbH.

If you have a coupon code, first retrieve your activation code from www.esacademy.org/coupon

To activate the firmware in a PCAN-MicroMod FD hardware, an Internet connection is required.

2 CANopen Basics

The PCAN-MicroMod FD devices support both classical CANopen and CANopen FD. The documents used for the implementation are:

- CiA® 301 Version 4.2.0 – CANopen application layer and communication profile
- CiA® 401 Version 3.0.0 – CANopen device profile for generic I/O modules
- CiA® 1301 Version 1.0.0 – CANopen FD application layer and communication profile
- Not yet published: CiA® 401-B/F – CANopen FD device profile for generic I/O modules

These documents are available from the CAN in Automation users group (www.can-cia.org).

This manual does not include a full description of CANopen and CANopen FD. For more details, see the publications listed above or read the book “Embedded Networking with CAN and CANopen” (ISBN 978-0692740873, www.canopenbook.com).

For CANopen system configuration, maintenance, and test we strongly suggest using CANopen utilities, monitors, and analyzers with symbolic support. These directly display symbolic names for parameters instead of plain hex numbers. PEAK-System and EmSA offer the following tools:

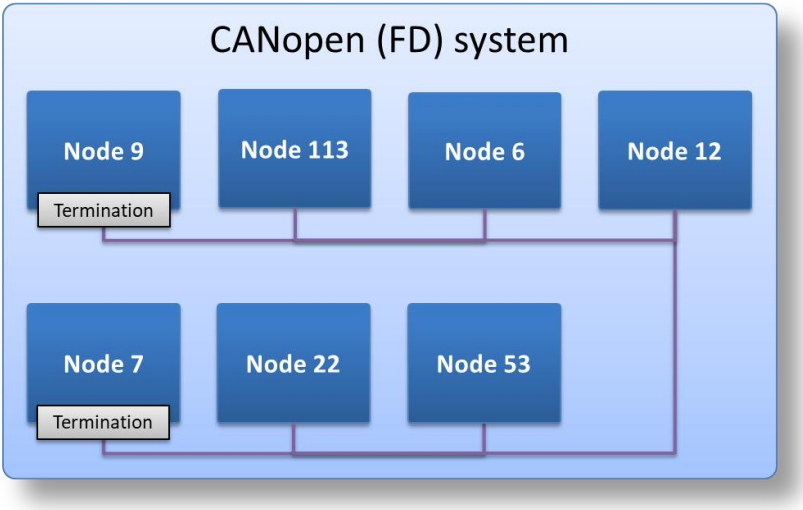
- CANopen Magic Analyzer (www.canopenmagic.com)
- CANopen Architect Editor (www.canopenarchitect.com)

In this chapter, the term CANopen refers to both concepts, classic CANopen and CANopen FD. Where applicable, CANopen FD is mentioned separately.

2.1 Wiring

The connectors and wiring of a CANopen system are not fully specified. Depending on the specific transceivers (line drivers) used by the devices, different cable layouts and terminations might be required. For details, refer to the documentation of the implemented transceivers. The PCAN-MicroMod FD devices use a Highspeed CAN FD transceiver. The signals CAN-High and CAN-Low are interconnected with all devices using a preferably shielded and twisted wire pair. In addition, GND should also be interconnect-

ed. The physical layout is that of a bus (no star or ring) with 120 Ohm termination resistors at each end.



2.2 Hardware Settings: Bit Rate and Node ID

The most essential CANopen settings are the CAN bit rate and a device's node ID.

In any CANopen system, all connected devices must use the same bit rate settings. Classic CANopen uses a single bit rate. CANopen FD is based on CAN FD and therefore uses two bit rates, the nominal and the data bit rate.

In any CANopen system, every connected device must use a unique node ID in the range of 1 to 127. The node ID of a device should be set before it is connected to a CANopen system.

Note that CANopen also offers advanced optional functionality (LSS – Layer Setting Services) to assign a node ID during operation. This requires an LSS Master, and devices supporting this functionality must provide the appropriate LSS services.

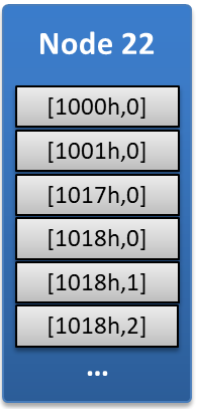
2.3 NMT: Network Management

Every CANopen device implements a CANopen Network Management state machine. Upon power-up (or reset), each device transmits a boot-up message (using CAN ID 700h + own node ID, 1 data byte set to zero). When the heartbeat producer is enabled (object

[1017h,0] in milliseconds > 0), a device produces a cyclic heartbeat message (same CAN ID as bootup) where the single data byte reflects the current device state: Pre-Operational, Operational, or Stopped.

Using the NMT Master message, an NMT Master can switch the device state of an individual or all nodes including requesting a reset.

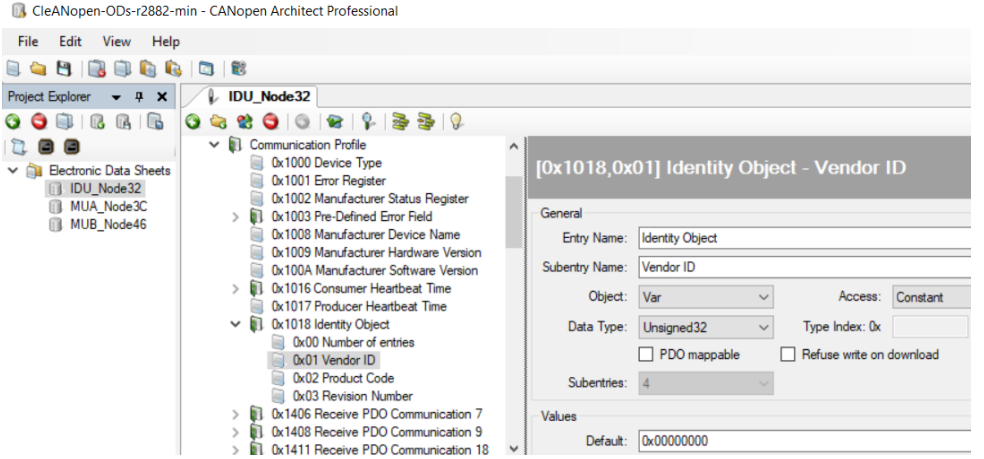
2.4 CANopen Object Dictionary



In CANopen, a device stores all its parameters (configuration parameters as well as process data) in an Object Dictionary. A 16-bit Index and an 8-bit Subindex value are used to reference a single parameter. For example, Object [1018h,1] (Index 1018h and Subindex 1) holds the 32-bit CANopen vendor ID of the device's manufacturer. Object [1008h,0] holds a string with the device's name.

2.5 EDS/XDD: Electronic Data Sheet

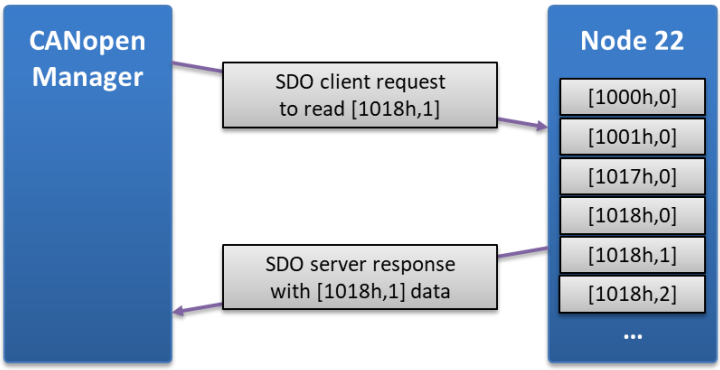
The EDS is the electronic representation of an Object Dictionary. Manufacturer of CANopen devices publish EDS files along with their products so that CANopen managers and tools can load these to provide the user direct access to the parameters provided by a device. EDS files are generated using an EDS editor like CANopen Architect.



XDD files are the newer version for EDS storage. They are based on XML and are mandatory for CANopen FD devices.

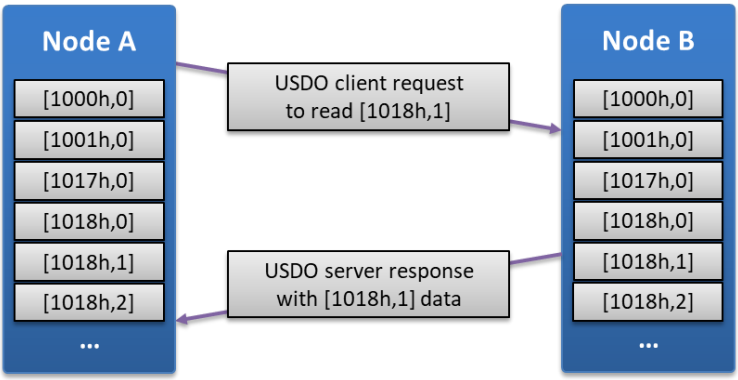
2.6 SDO: Service Data Objects (classic CANopen)

This service is available to a single manager or diagnostic tool in a classic CANopen system. It is a confirmed service with a request and a response to read or write any Object Dictionary entry in any connected node.



A request could be: “Node number 22, what is your data at [1018h,1]?”. If node 22 is present, then it sends a response containing the requested data. Data of 32 bits or less is accessed with a single message pair (request, response). If data is larger, then data gets segmented and multiple request and responses are exchanged.

2.7 USDO: Universal Service Data Objects (CANopen FD)



On CANopen FD, this service replaces the SDO. Main changes are that here every node can send USDO requests to every other node and that data sizes in a single request and response scheme can be much bigger, as CAN FD supports large data packages.

There are further advanced modes for long distance routing of messages as well as broadcasts to all nodes.

2.8 PDO: Process Data Objects

This service provides direct (unconfirmed) data exchange between multiple CANopen devices. Devices can produce TransmitPDO messages that contain multiple Object Dictionary entries and can be processed as ReceivePDO by multiple other devices.

PDOs have communication parameters (which CAN ID to use, trigger options) and mapping parameters (which Object Dictionary entries are contained in the PDO).

The figure illustrates how node 22 produces a repeated TPDO with the two Object Dictionary entries [6000h,1] and [6000h,2] in it. These can be received and processed by multiple nodes if they have matching RPDO parameters configured.

3 CANopen (FD) Firmware Activation

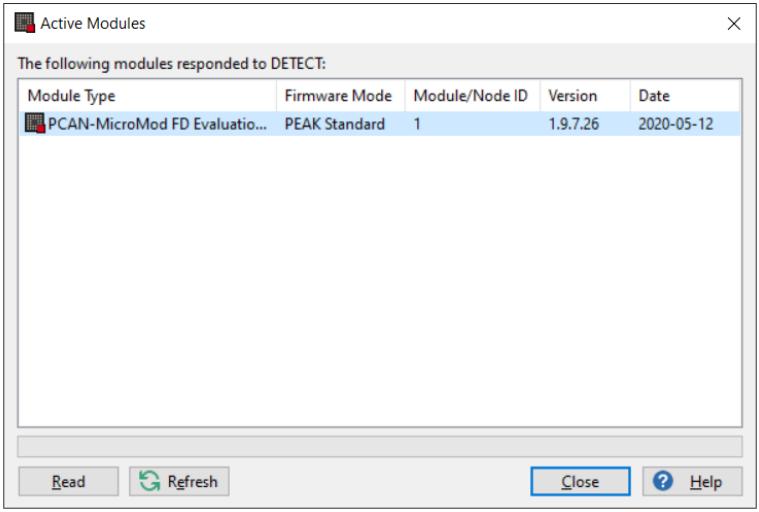
Follow these steps to activate CANopen (FD) on your PCAN-MicroMod FD hardware.

NOTE: Default CAN (nominal) bitrate is 500kbps, default CAN FD data bitrate is 2Mbps.

3.1 Connect with PCAN-MicroMod FD Configuration

Start the PCAN-MicroMod FD Configuration software and connect to your PCAN-MicroMod FD hardware. The help menu has a section “Install and Connect CAN Hardware” in case you need help to establish the connection.

From the menu, select Configuration / Read Firmware Information.



When your hardware is found, select it and click on the “Read Information” button.

3.2 Check Firmware

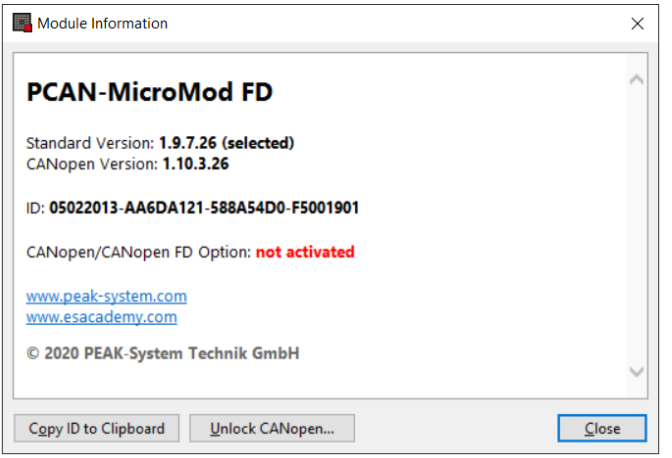
The latest firmware version is available from www.peak-system.com/produktcd/: Select the firmware directory, then the PCAN-MicroMod FD subdirectory.

If your PCAN-MicroMod FD hardware does not have the latest firmware installed, please download and install it. See the appropriate PEAK user manual for details on how to install the firmware downloaded using PCAN-Flash.

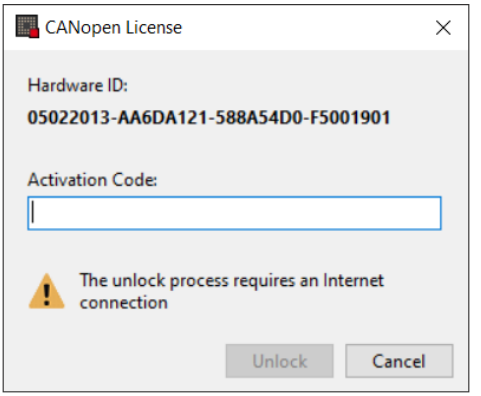
3.3 Applying an activation code

If you have updated your firmware, go back to the PCAN-MicroMod FD Configuration software. From the menu, select Configuration / Read Firmware Information. When your hardware is found, select it and click on the “Read Information” button.

The current module information is shown:

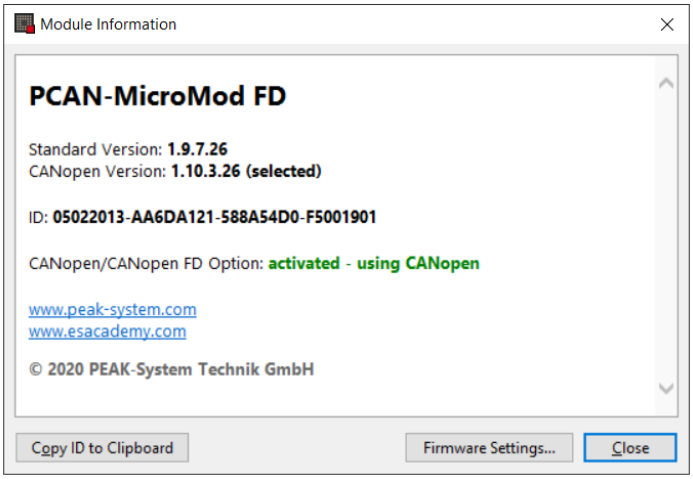


Now click on the “Unlock CANopen…” button to open the unlock window:



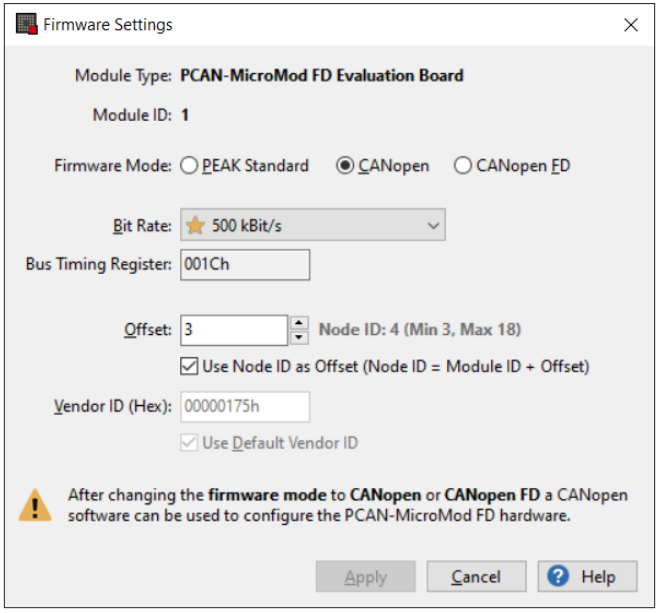
Enter your activation code and click the “Unlock” button.

The current module information changes to:



3.4 Setting Bitrate and Node ID

Klick on the button “Firmware Settings…” to open the firmware configuration window.



You can now select CANopen or CANopen FD, specify the bitrate(s) and node ID used.

The node ID can either be selected as a fixed value or as a value relative to the module ID of the PCAN-MicroMod FD (Use Node ID as Offset).

When all settings are made, click on the “Apply” button.

The selected Configuration becomes active after the next reset or power cycle.

NOTE:
Even when CANopen or CANopen (FD) are activated, the PCAN-MicroMod FD software can still be used to access the hardware. You just need to ensure that the bitrate settings of the software are set to those that were last configured for the hardware.

3.5 Returning to PEAK Standard mode

The firmware Settings described in the previous section can also be used to switch a module back to PEAK Standard mode. This process loads the manufacturer default configuration of the module, but not the default bitrate.

NOTE:
When activating the PEAK Standard mode, the bitrate configuration selected is applied. Select the 500kbps bitrate, if you want the default bitrate to be applied.

4 Operation

4.1 Device Bootup

Run LED

When the power supply is applied to connector F, the Run LED is blinking green (2 Hz)

indicating the CANopen Pre-Operational status.

Initial CANopen messages

At bootup, the device transmits two CANopen messages on the connected bus:

- 700h + node ID: Bootup Message (1 data byte)
  Indicates that the device is operational after boot-up.
- 80h + node ID: Emergency Message (8 data bytes)
  All data bytes = 00: no error condition.

Error LED

If the Error LED flashes red 1 time per second, the initial messages could not be transmitted. Possible reasons:

- No other active CAN client is on the CAN bus.
- The device's bit rate setting does not match the used bit rate on the bus.

4.2 LEDs

The CANopen Run state is indicated according to the CiA® 303-3 specification.

Run LED

LED indication (green)	State	Description
Off	Reset	If power is applied, the device is performing a reset.
1 flash per second	Stopped	The device is in Stopped state.
Blinking (2 Hz)	Pre-Operational	The device is in Pre-Operational state.
On	Operational	The device is in Operational state.

Special states besides the CiA specification:

LED indication	State	Description
Fast blinking orange	CAN flash mode	The device is ready for firmware update via CAN.
Blinking green (alternating with Error LED)	Invalid configuration	Likely the node ID or the bit rate have an invalid setting.

Error LED

The CANopen Error state is indicated according to the CiA® 303-3 specification.

LED indication (red)	State	Description
Off	No error	The device is in working condition.
1 flash per second	Warning limit reached	At least one of the error counters of the CAN controller has reached or exceeded the warning level (too many error frames).
Blinking red (alternating with Run LED)	Invalid configuration	Likely the node ID or the bit rate have an invalid setting.
On	Bus off	The CAN controller is bus-off

4.3 Error Handling

Fault conditions are announced by the CANopen Emergency (EMCY) message with the ID 80h + node ID. Each EMCY has a 16-bit error code and 5 freely definable additional (manufacturer specific) bytes. A maximum of 2 of those bytes are used, further bytes have the value 0x00.

5 Configuration files (EDS, XDD, PDF)

For each PCAN-MicroMod FD hardware we publish the Electronic Data Sheet (EDS/.eds for classic CANopen and XDD/.xdd for CANopen FD) and a PDF/.pdf containing the CANopen (FD) documentation of the device specific configuration.

The EDS can be used with other CANopen (FD) tools that allow importing these files, to support direct access to the parameters of the CANopen (FD) device.

For the latest version of published files, see

www.em-sa.com/peak