MicroControl

Systemhaus für Automatisierung

µCAN.8.dio-BOX

Manual Digital I/O-Module
Version 1.0

MicroControl GmbH & Co. KG
Lindlaustr. 2c
D-53842 Troisdorf
Fon: 02241 / 25 65 9 - 0
Fax: 02241 / 25 65 9 - 11
http://www.MicroControl.net

Inhaltsverzeichnis

µCAN.8.dio

Inhaltsverzeichnis

µCAN.8.dio

Remarks on CE-conformance of µCAN-modules

µCAN-modules which have CE-conformance label, have passed test specifications of EU-criteria 89/336/EWG "Electromagnetic Emission and Immunitiy" and standardized European norms (EN).
Papers of declaration for EU-conformance, according to Art.10 of EN, are available at:

MicroControl GmbH & Co. KG
Lindlaustr. 2 c
D-53842 Troisdorf
Germany

MicroControl reserves the right to modify this manual and/or product described herein without further notice. Nothing in this manual, nor in any of the data sheets and other supporting documentation, shall be interpreted as conveying an express or implied warranty, representation, or guarantee regarding the suitability of the products for any particular purpose. MicroControl does not assume any liability or obligation for damages, actual or otherwise of any kind arising out of the application, use of the products or manuals.

The products described in this manual are not designed, intended, or authorized for use as components in systems intended to support or sustain life, or any other application in which failure of the product could create a situation where personal injury or death may occur.

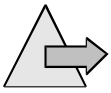
© 2002 MicroControl GmbH & Co. KG, Troisdorf
No part of this documentation may be copied, transmitted or stored in a retrieval system or reproduced in any way including, but not limited to, photography, magnetic or other recording means, without prior written permission from MicroControl GmbH & Co. KG.

1. Safety Regulations

Symbol Explanation

Attention !

This symbol marks a paragraph which explains possible danger. This danger might cause a damage to the system / plant or damage to personnel.



Note

This symbol marks a paragraph which contains useful information for the work with the device or which gives just a hint.

1.1 General Safety Regulations

Attention !

Please read the following chapter in any case, because it contains important information about the secure handling of electrical devices.

This paragraph gives important information about the conditions of use. It was written for personnel which is qualified and trained on electrical devices.

Qualified and trained personnel are persons who fulfil at least one of the following conditions:

- You know the safety regulations for automated machines and you are familiar with the machine.
- You are the operator for the machine and you have been trained on operation modes. You are familiar with the operation of devices described in this manual.
- You are responsible for setting into operation or service and you are trained on repairing automated machines. In addition you are trained in setting electrical devices into operation, to connect the earthing conductor and to label these devices.

Terms of use

The devices described in this manual can only be used for the mentioned applications. Other devices used in conjunction have to meet the safety regulations and EMI requirements.

Safety Regulations

General Safety Regulations

Attention !

To ensure a trouble free and safe operation of the device please take care of proper transport, appropriate storage, proper assembly as well as careful operation and maintenance.

Hints for Installation

Please take care to observe the actual local safety regulations.

If devices are used in a fixed machine without a mains switch for all phases or fuses, this equipment has to be installed. The fixed machine must be connected to safety earth.

If devices are supplied by mains please take care that the selected input voltage fits to the local mains.

Safety Notice

If devices are supplied by 24V DC, this voltage has to be isolated from other voltages.

The cables for power supply, signal lines and sensor lines must be installed in a way that the device function is not influenced by EMI.

Devices or machines for industrial automation must be constructed in a manner that an unintentional operation is impossible.

Attention !

By means of hardware and software safety precautions have to be taken in order to avoid undefined operation of a automated machine in case of a cable fraction.

If automated machines can cause damage of material or personnel in case of a malfunction the system designer has to take care for safety precautions. Possible safety precautions might be a limit switch or locking.

2. Operation of µCAN.8.dio-BOX

2.1 Overview

The µCAN.8.dio-BOX is the right solution for digital I/O-signals via CAN.

Fig. 1: Digital I/O-Module µCAN.8.dio-BOX

The development in automation towards decentralized „intelligent“ systems makes the communication between these components quite important.

Modern automated systems require the possibility to integrate components from different manufacturers. The solution for this problem is a common bus system.

All these requirements are fulfilled by the µCAN.8.dio-BOX module. The µCAN.8.dio-BOX runs on the standard fieldbus CAN. Typical applications for the µCAN.8.dio-BOX are industrial automation, transportation, food industry and environmental technology.

Operation of µCAN.8.dio-BOX

Overview

The µCAN.8.dio-BOX runs with the protocol

according to the device profile DS-401. Other protocol stacks are available on request.

space saving and compact

The µCAN.8.dio-BOX is designed for heavy duty applications. The aluminium cast ensures protection class IP65. The compact, space saving case gives the freedom to mount the module in many places.

inexpensive and service friendly

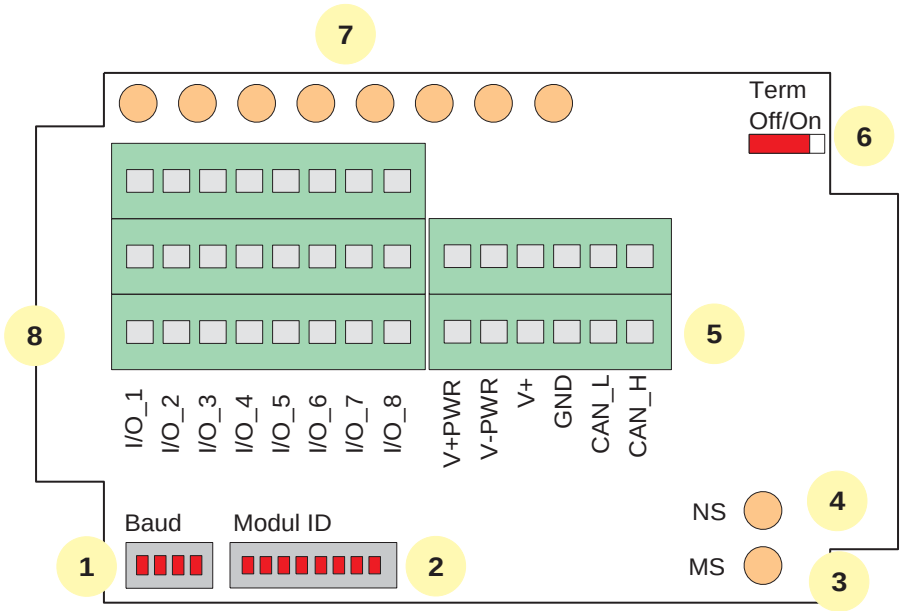
The quick and easy integration of the µCAN.8.dio-BOX in your application reduces the development effort. Costs for material and personnel are reduced. The easy installation makes maintenance and replacement quite simple.

3. Project Planning

The chapter Project Planning contains information which are important for the system engineer when using the µCAN.8.dio-BOX. These information include case dimensions and conditions of use.

3.1 Module Layout

The following figure shows the top view of the µCAN.8.dio-BOX PCB. Use the figure to identify the terminal blocks, LED's and DIP-switches.



1: Baudrate switch
2: Module address / ID
3: Bi-color LED for module status
4: Bi-color LED for network status
5: Terminal block for Power / CAN
6: Switch for CANbus termination
7: Bi-color LED for signal status
8: Terminal block for digital signals

Fig. 2: Top view of the µCAN.8.dio-BOX PCB

3.2 Operation Area

The µCAN.8.dio-BOX is a robust field module for acquisition and manipulation of digital signals via the CANbus. Every module can handle up to 8 digital I/O-signals. The port direction of each terminal (input / output) is configured via software. It is not required to setup DIP-switches or jumpers for a configuration change. The module has a power supply range of 8V - 60V DC.

The PCB is incorporated in a robust case of protection class IP65. The µCAN.8.dio-BOX is suited for mounting outside the switch cabinet. Long wires for actors or sensors are not longer necessary. Influence of EMI is reduced.

The µCAN.8.dio-BOX needs four wires for connection to the power supply and CAN bus. Special CAN bus cables are available as accessories (refer to Ordering Information).

3.3 Maximum System Layout

For an operational system at least one network manager (or supervisor system) must be connected to the bus. This network manager might be a PLC or PC equipped with a CAN card. Every µCAN.8.dio-BOX module is an active node.

A CANopen network manager can handle up to 127 network slaves (refer to Fig. 3, “Maximum System Layout”). Every module gets a unique address, which is set up via a DIP switch. The CANbus bus is connected through the µCAN modules. The last module in the network must be terminated by a termination switch (refer to “Termination” on page 23).

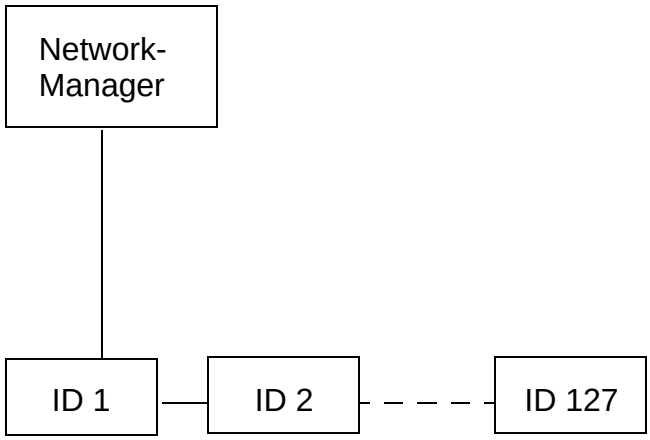


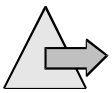
Fig. 3: Maximum System Layout

Maximum System Layout

The maximum cable length depends on the selected baudrate. The following table shows the maximum cable length recommended by the CAN in Automation (http://www.can-cia.org). These distances can be realized with the µCAN.8.dio-BOX.

Baudrate in kBit/s	Cable length in m
1000	25
800	50
500	100
250	250
125	500
100	650
50	1000
20	2500
10	5000

Table 1: Dependence of baudrate from cable length



Note

It is recommended by the CAN in Automation **not to use** the baudrate 100 kBit/s in new CANopen systems.

3.4 Case Dimensions

The case dimensions of the module are given in the drawing below. The high protection class IP65 of the module allows an assembly at places with a harsh environment. It is possible to mount the module inside a switching cabinet as well as direct on a machine. Please check the technical data section for detailled information about maximum environment conditions.

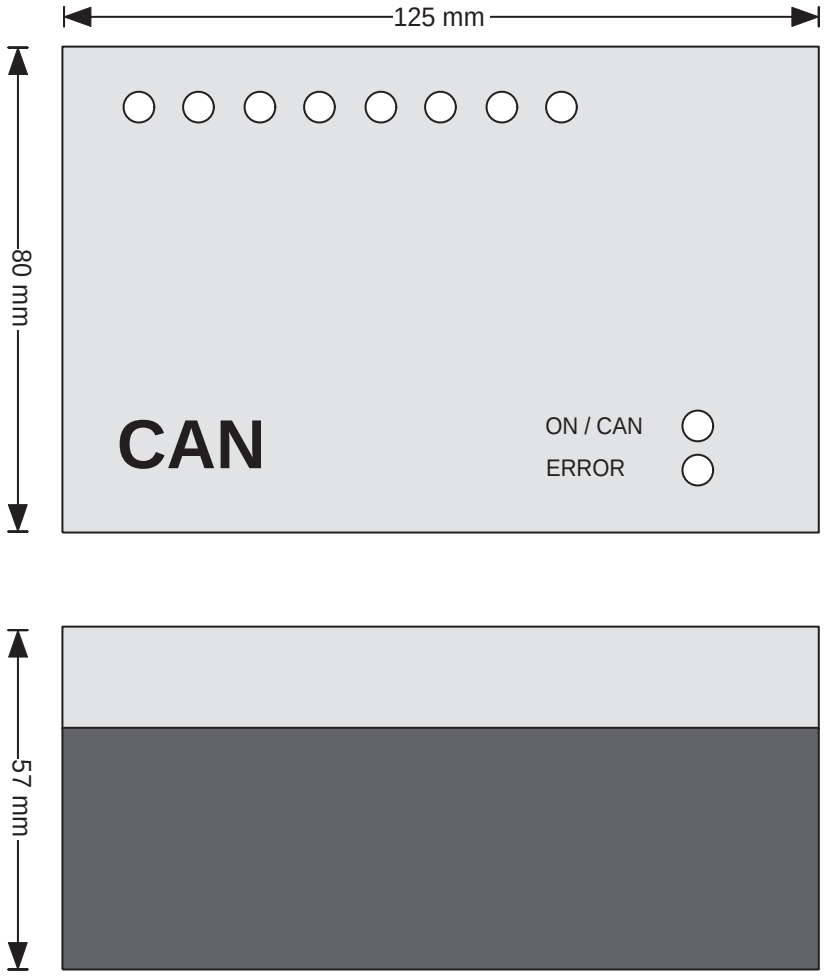


Fig. 4: Case dimensions

4. Assembly and Disassembly

4.1 Safety Regulations

Attention !

This paragraph gives important information about the conditions of use. It was written for personnel which is qualified and trained on electrical devices.

Qualified and trained personnel are persons who fulfill at least one of the following conditions:

- You know the safety regulations for automated machines and you are familiar with the machine.
- You are the operator for the machine and you have been trained on operation modes. You are familiar with the operation of devices described in this manual.
- You are responsible for setting into operation or service and you are trained on repairing automated machines. In addition you are trained in setting electrcal devices into operation, to connect the earthing conductor and to label these devices.

Terms of Use

The devices described in this manual can only be used for the mentioned applications. Other devices used in conjuction have to meet the safety regulations and EMI requirements.

Attention !

To ensure a trouble free and safe operation of the device please take care of proper transport, appropriate storage, proper assembly as well as careful operation and maintenance.

4.2 General Information

Assembly

The µCAN modules should be assembled on an at least 2 mm thick mounting plate or direct in the plant. The module is fixed with 2 screws of type M4, which are plugged into the bottom part of the case. You find an assembly template in the appendix of this manual.

Power Supply

You need a cable with two conductors for power supply. The cable is inserted from the right side into the case, where the terminals for power supply are located. However it makes sense to use a cable with four conductors in order to run the CAN bus over the same cable.

Earthed Conductor

The non-fused earthed conductor is connected at the terminal outside the case (refer to Fig. 5, “Connection of earthed conductor”). The non-fused earthed conductor may not lead inside the case because of EMI.

Attention !

The non-fused earthed conductor may not lead inside the µCAN case and may not be connected to a terminal inside the case.

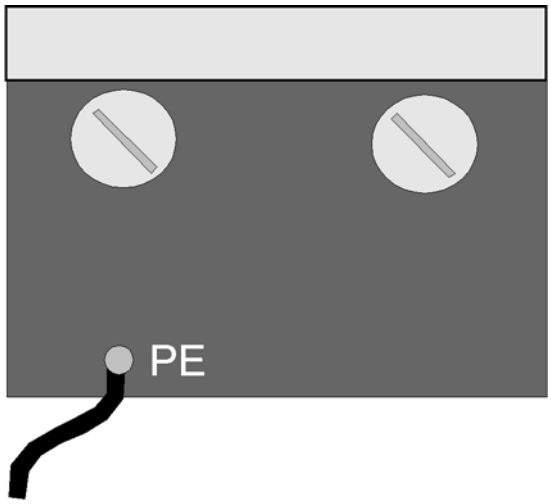


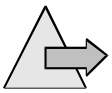
Fig. 5: Connection of earthed conductor

Attention !

Operation of the µCAN module is only permitted with closed case.

4.3 Assembly

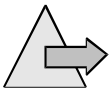
Assembly is performed with help of the template attached to this manual. With the template all necessary bore-holes for screws of type M4 can easily be drilled. If the module is directly fixed to the machine make sure to take the proper drill size for tapping.



Note

When fixing several modules at the same place please make sure to leave some area for the PG screws.

For a quick identification of the modules during operation you may use paper sticker. Please write down the ID that is set for the module.



Note

Please make sure that the first node and the last node in the CAN network is terminated with a resistor (refer to “Termination” on page 23).

4.4 Disassembly

Please make sure to disconnect the power supply from the device first!

Open the cover from the module and remove the temperature sensors first. Now you can remove the cables for CAN bus and power supply from the terminals.

Unlock the fixing screws and remove the module. For a safe transport remove the PG screws and close the cover again.

5. Installation

5.1 Potential Basics

The potential environment of a system that is realized with µCAN modules is characterized by following features:

- The CAN bus potential is isolated from the power supply.
- The electronic of the µCAN modules is isolated from the power supply.
- All µCAN modules have a separate power supply.
- All I/O signals are optically isolated from the CAN bus potential.

5.2 EMC Considerations

EMC (Electromagnetic Compatibility) is the ability of a device to work in a given electromagnetic environment without influencing this environment in a not admissible way.

All µCAN modules fit these requirements and are tested for electromagnetic compatibility in a EMC laboratory. However a EMC plan should be done for the system in order to exclude potential noise sources.

Noise signals can couple in different ways. Depending on that way (guided wave propagation or non-guided wave propagation) and the distance to the noise source the kinds of coupling are differentiated:

DC Coupling

If two electronic circuits use the same conductor we speak of a DC coupling. Noise sources are in that case: starting motors, frequency converters (switching devices in general) and different potentials of cases or of the common power supply.

Inductance Coupling

An inductance coupling is given between two current-carrying conductors. The current in a conductor will cause a magnetic field which induces a voltage in the second conductor (transformer principle). Typical noise sources are transformer, power cables and RF signal cables.

Capacitive Coupling

A capacitive coupling is given between two conductors which have a different potential (principle of a capacitor). Noise sources are in that case: parallel running conductors, static discharge and contactors.

RF Coupling

A RF coupling is given when electromagnetic fields hit a conductor. This conductor works like an antenna for the electromagnetic field and couples the noise into the system. Typical noise sources are spark plugs and electric motors. Also a radio set might be a noise source.

To reduce the impact of noise sources please take care to follow the basic EMC rules.

5.2.1 Grounding

General

All inactive metal plates must be grounded with low impedance. By this step all elements of the system will have the same potential.

Please take care that the ground potential never carries a dangerous voltage. The grounding must be connected to the safety earth.

Grounding of µCAN-Modules

The µCAN modules are grounded by the contact which is mounted under one of the PG screws (see fig. 5, “Connection of earthed conductor”). Additional contacts can be mounted under the PG screws for shielding purposes on demand. The ground potential may not be connected to a terminal inside the case.

Grounding of other modules

If µCAN modules are shipped in a plastic case they have to be grounded with a metal tape.

5.2.2 Shielding of cables

If noise is coupled to a cable shield it is grounded to safety earth via the metal cover. The cable shields have to be connected to the safety earth with low impedance.

Cable Types

For installation of the µCAN module you should only use cable with a shield that covers at least 80% of the core. Do not use cable with a shield made from metallized foil because it can be damaged very easy and has not a good shielding.

Cable Layout

In general the cable shield should be grounded on both ends. The cable shield should only be grounded on one end if an attenuation is necessary in the low frequency range. The cable shield can not be grounded on both ends for temperature sensors. The grounding on one end of the cable is necessary if

- there is no contact to the safety earth possible,
- analogue signals with only a few mV or mA are transmitted (temperature sensors).

5.2.3 CAN Cable

The CAN cable must meet the requirements of ISO11898. The cable must meet the following specifications:

Parameter	Value
Impedance	108 - 132 Ohm (nom. 120 Ohm)
Specific Resistance	70 mOhm/Meter
Specific Signal Delay	5 ns/Meter

Table 2: Specifications of CAN bus cable

The CAN bus cable is connected to the µCAN.8.dio-BOX module via terminals inside the case. For the pinning of the terminal refer to “CAN Bus” on page 20 of this manual.

Attention !

Do not confuse the signal lines of the CAN bus, otherwise communication between the modules is impossible. The shield of the CAN bus cable may never lead inside the µCAN case. Never connect the shield to one of the terminals inside the case.

5.3 Power Supply

The µCAN.8.dio-BOX modules are designed for industrial applications. By means of a DC/DC converter the CANbus of the module is isolated from the supply voltage. The supply voltage must be within the range from 8 V DC to 60 V DC. The input is protected against confusing the poles.

Please make sure not to confuse the poles when connecting the power supply. The positive supply is connected to the terminal **V+**. The positive supply for the output stage is connected to the terminal **V+PWR**.

The negative supply is connected to the terminal **GND**. The negative supply for the output stage is connected to the terminal **V-PWR**.

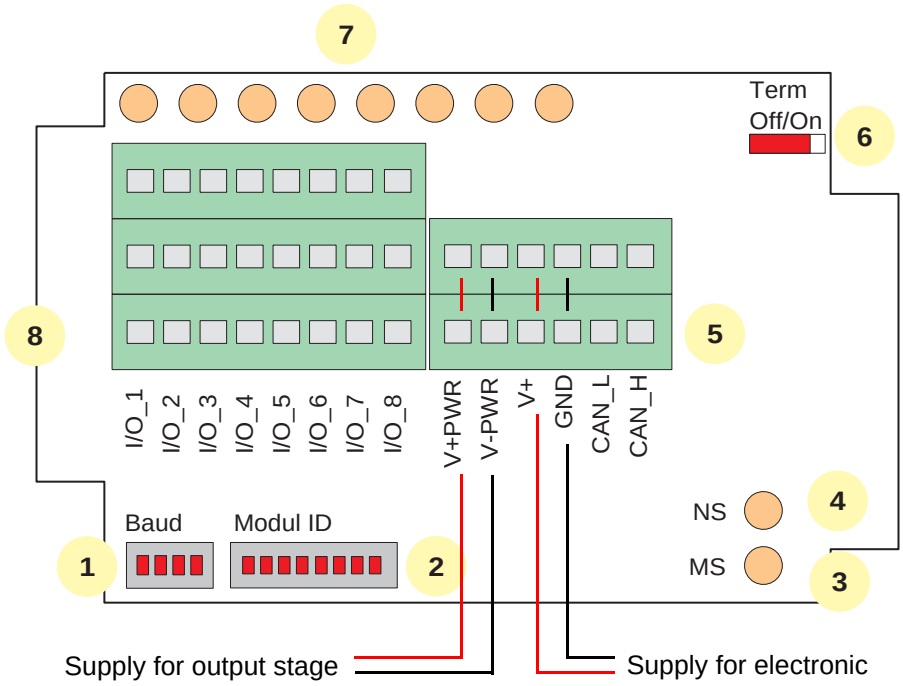


Fig. 6: Connection of power supply

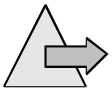
The output stage can be supplied via a separate power source or links have to be made between **V+** and **V+PWR** as well as **GND** and **V-PWR**.

Attention !

The maximum supply voltage for the **output drivers** is **50V** DC. The maximum supply voltage for the electronic is **60V** DC. Higher voltages will destroy the electronic.

Power Supply

The terminals **GND** and **V-PWR** are not linked internally. The maximum potential difference between these terminals may not exceed 50mV.



Note

You must always connect the power supply for the output stage, even if the module is only used in a digital input configuration.

Attention !

A cable shield may not lead into the housing or may not be connected to a terminal inside the housing. Cable shields have to be connected to the terminals outside the housing.

5.4 CAN Bus

The two wires of the CAN bus are connected to the appropriate terminals.

Note

To reduce the influence of EMI please take care that the CAN bus cable does not cross the wires of the signal lines.

The CAN bus line with positive potential must be connected to the terminal **CAN_H**. The CAN bus line with negative potential must be connected to the terminal **CAN_L**.

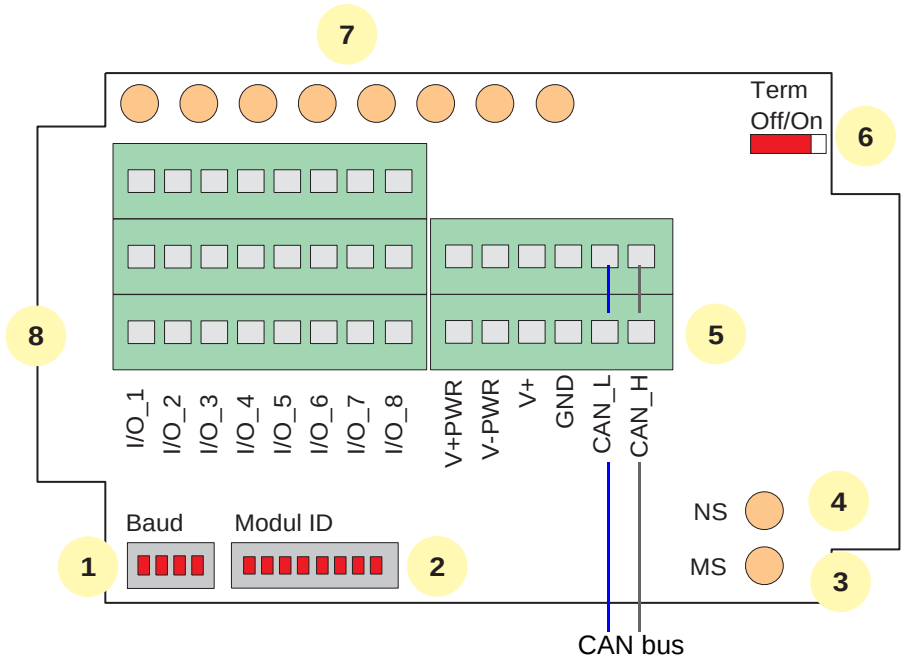


Fig. 7: Connection of CAN bus

Attention !

If you confuse the poles the communication on the bus will not be possible. The shield of the CAN bus may not lead into the housing and may not be connected to a terminal inside the housing. Cable shields have to be connected to the terminals outside the housing.

Note

If you use a Sub-D connector with 9 pins (according to CiA standard), the conductor **CAN_H** is connected to pin 7 and the conductor **CAN_L** is connected to pin 2.

5.5 Address Selection

Address selection of the µCAN.8.dio-BOX module is done via a 8-pin DIP-switch, marked "Modul-ID" which is located at the bottom of the PCB. Selection of the address may be done with a small screw driver.

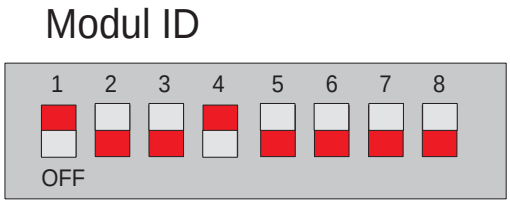


Fig. 8: Setup of module address (here address 9 is shown)

The 8-pin DIP-switch sets the binary code for the module address. The first pin of the switch (marked with ’1’) represents bit 0 of a byte. The last pin of the switch (marked with ’8’) represents bit 7 of a byte.

Attention !

Valid module addresses are within the range from 1..127, resp. 01h..7Fh. Each node within a CANopen network must have a unique module address (Node ID). Two nodes with the same Node ID are not allowed.

The selected address is read during initialization of the module, after Power-on or Reset. The module runs with the selected Node ID until a new Node ID is selected and a Reset is performed (via the CAN bus) or the power supply is switched off

Attention !

Switch 8 must always be in OFF position. Do not put all switches in the OFF position. In these configurations the module will not start to communicate on the bus.

5.6 Baudrate

Baudrate selection of the µCAN.8.dio-BOX module is done via a 4-pin DIP-switch, marked "Baud" which is located at the bottom of the PCB. Selection of the baudrate may be done with a small screw driver.

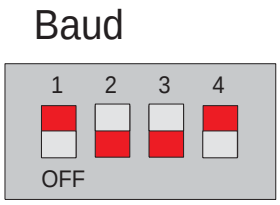


Fig. 9: Setup of baudrate (here 1 MBit/s is shown)

The 4-pin DIP-switch sets the binary code for the module baudrate. The first pin of the switch (marked with ’1’) represents bit 0 of a byte. The last pin of the switch (marked with ’4’) represents bit 3 of a byte.

The supported baudrates of the µCAN.8.dio-BOX module are given in the following table. The values are recommended by the CiA.

Baudrate (kBit / s)	1	2	3	4
1000	1	0	0	1
800	0	0	0	1
500	1	1	1	0
250	0	1	1	0
125	1	0	1	0
100	0	0	1	0
50	1	1	0	0
20	0	1	0	0
10	1	0	0	0

Table 3: Setup of baudrate

5.7 Termination

The modules at both ends in the CAN network have to be terminated with a resistor of 120 ohms. That means the modules at the end of the bus line are not reflecting back power and the communication can not be disturbed.

For termination of the µCAN.8.dio-BOX the "**Term**" switch must be turned from position "Term Off“ to position "Term On“.

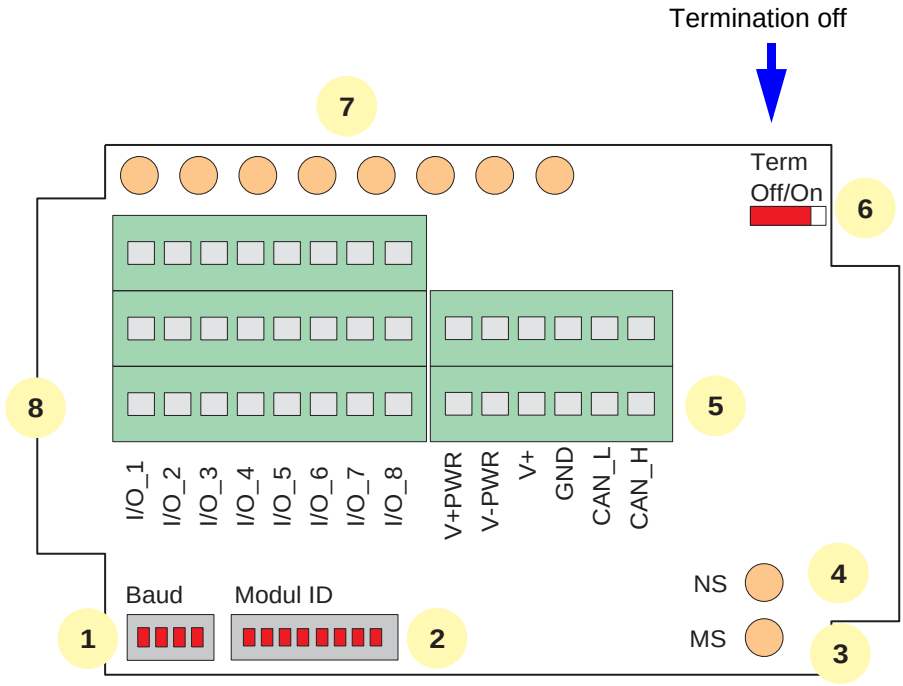


Fig. 10: Termination of CANbus

Attention !

Please make sure that only the devices at both ends of a CAN bus are terminated.

6. Digital Signals

The µCAN.8.dio-BOX has eight digital I/O terminals. The terminal are labeled with "**I/O_1**" to "**I/O_8**" from left to right on the PCB.

Please keep the basics of EMI rules in mind when planning the wiring. Only proper wiring and EMI precautions make sure that the module runs without trouble.

6.1 Function principle

Configuration of each terminal (Input or Output) is performed via CANopen. In "Digital Input" mode the Power-MOSFET is always off. The input voltage at the terminal is compared with a reference voltage, which is set to **V+PWR** / 2 (level is 50% of the output stage supply voltage).

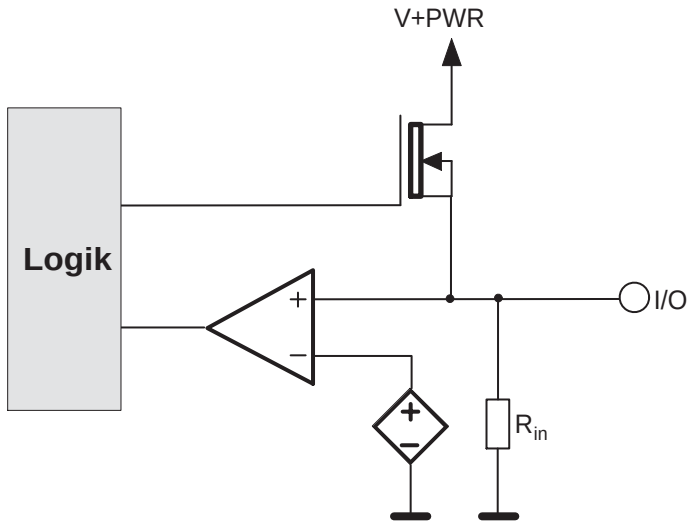


Fig. 11: Schematic digital I/O terminal

Digital Signals

Function principle

In "Digital Output" mode the Power-MOSFET is driven via the control logic. The logic block detects over current, short current and thermal overload.

Parameter	Value
V+PWR	10 .. 50 V
Impedance R_{in}	24,2 kOhm
I_{out}	1,4 A maximal
Switching Level	0,5 * V+PWR

Tabelle 4: Electrical Parameters

6.2 Pinning

The terminal block of the µCAN.8.dio-BOX is designed to connect digital sensors with 3 wires. The sensor gets the positive supply voltage (**V+PWR)** from terminal row B. The ground potential is located in terminal row C (**V-PWR**).

The binary control lines are connected to row A. The state of each line is displayed by means of bi-color LEDs.

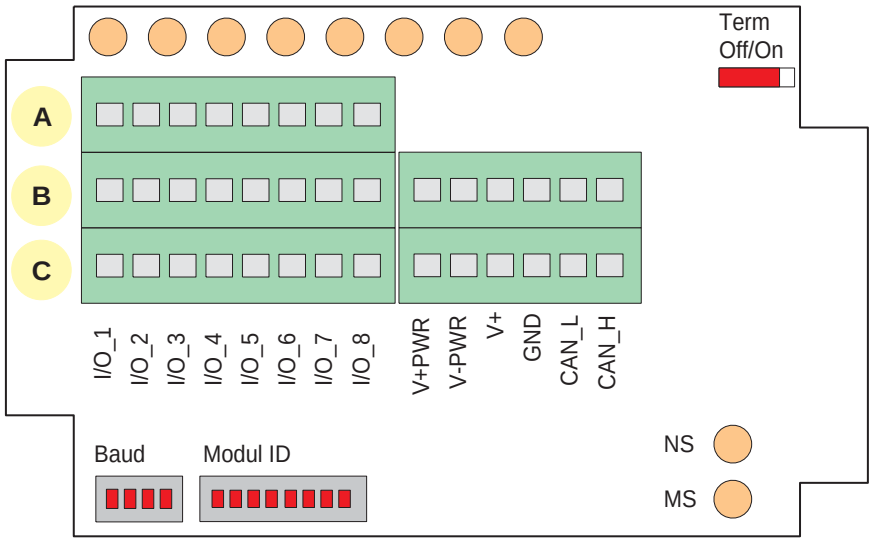


Fig. 12: Terminals for signal lines

Attention ! All signal lines may only be connected in power off state in order to prevent a damage of the electronic.

7. Diagnosis

All modules of the µCAN family have LEDs to display the operating state and to signalize an error state. The light of the LEDs can be seen through beam waveguides on top of the housing.

The µCAN.8.dio-BOX has two Duo-LEDs (green/red) labeled with "NS" (Network Status) and "MS" (Module Status) on the PCB.

Note

On the case cover the LEDs are marked as **ON/CAN** for the network status and **ERROR** for the module status.

The state of the digital I/O terminals is displayed by eight bi-color LEDs (position 7 in the figure below).

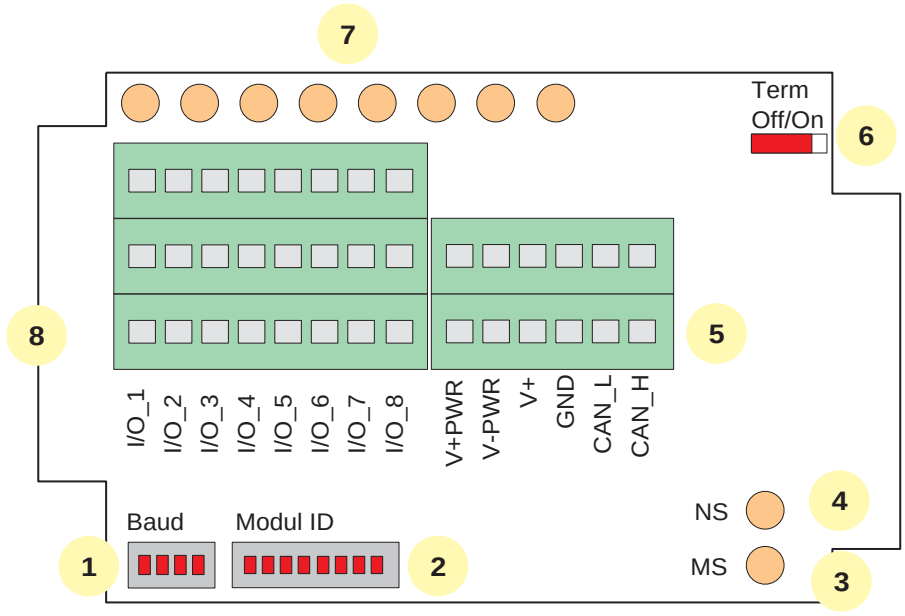


Fig. 13: Position of LEDs on the module

Note

In normal operation all LEDs should have a green or orange color. A red steady light or a red blinking of a LED indicates an error condition.

7.1 Network Status

The LED marked with Network Status" (on the case cover denoted as ON/CAN) displays the status of the communication link.

LED "ON/CAN" is	To indicate
Green, slow blinking	Device is in NMT-state "Pre-Operational"
Green, fast blinking	Device is in NMT-state "Stopped"
Green, steady on	Device is in NMT-state "Operational"
Red, fast blinking	Communication fault
Red, steady on	CAN in Bus-Off state

Table 5: LED for Network Status

7.2 Module Status

The LED marked with Module Status" (on the case cover denoted as Error) displays the status of the device hardware.

LED "ERROR" is	To indicate
Green, steady on	Normal operation
Red, steady on	Device noticed fault condition (e.g. Short-circuit of output stage)

Table 6: LED for Module Status

7.3 Signal Status

The eight LEDs above the terminal block indicate the state of the digital signal present on each input / output.

Signal LED is	To indicate
Green	Digital high-signal at terminal
Orange	Terminal configured as output, output has been switched on
Red	Terminal configured as output, short-circuit on output driver

Table 7: LED for Signal Status

8. CANopen Protocol

This chapter provides detailed information on how to connect the modules of the µCAN-series to a CANopen-Manager. A CANopen-Manager can be a PLC, a PC with a CAN interface or any other CAN-Device with NMT functionality.

For more information about CANopen manager please refer to the supplied manuals of your CANopen master device.

This documentation provides the actual implemented functions and services of the µCAN.8.dio-BOX.

8.1 Introduction

The identifiers of the µCAN.8.dio-BOX are set up according to the **Pre-defined Connection Set**, which is described in the CAN-open communication profile DS-301 in detail. The following table gives an overview of the supported services.

Object	COB-ID (dec.)	COB-ID (hex)
Network Management	0	0x000
SYNC	128	0x080
EMERGENCY	129 - 255	0x081 - 0x0FF
PDO 1 (Transmit)	385 - 511	0x181 - 0x1FF
PDO 1 (Receive)	513 - 639	0x201 - 0x27F
SDO (Transmit)	1409 - 1535	0x581 - 0x5FF
SDO (Receive)	1537 - 1663	0x601 - 0x67F
Heartbeat / Boot-Message	1793 - 1919	0x701 - 0x77F

Table 8: Identifier values according to the Pre-defined Connection Set

The direction (Transmit / Receive) has to be seen from the devices point of view.

8.2 Network Management

By means of the Network Management (**NMT**) messages the state of a CANopen node can be changed (Stopped / Pre-Operational / Operational).

Start Node

Start Node

ID	*DLC*	*B0*	*B1*
0	2	01h	Node

Node = module address, 0 = all modules

By transmitting the "Start Node" command the CAN-node will be set into Operational mode. This means that the node can handle PDO-communication.

Stop Node

Stop Node

ID	*DLC*	*B0*	*B1*
0	2	02h	Node

Node = module address, 0 = all modules

By transmitting the "Stop Node" command the CAN-node will be set into Stopped mode. This means that the node can not handle any services except NMT commands.

Pre-Operational

Enter Pre-Operational

ID	*DLC*	*B0*	*B1*
0	2	80h	Node

Node = module address, 0 = all modules

By transmitting the „Enter Pre-Operational“ command the CAN-node will be set into Pre-Operational mode. In this state the node can not handle PDO messages.

Reset Node

Reset Node

ID	*DLC*	*B0*	*B1*
0	2	81h	Node

Node = module address, 0 = all modules

By transmitting the „Reset Node“ command the CAN-node will issue a reset operation. After reset the node will send a "Boot-up Message" (refer to “Heartbeat Protocol” on page 48) and enter the Pre-operational state automatically.

8.3 SDO Communication

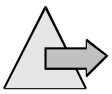
All parameters of the devices (organized in an object dictionary) are accessed via the SDO service (Service Data Object). A SDO message has the following contents:

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
	8	CMD	Index		Sub-Index	Data			

For calculation of the SDO message identifier please refer to “Introduction” on page 31.

The Command Byte (**CMD**) has the following meaning:

Master wants to read from Slave	40h
Slave answers on the read-request	42h
Master wants to write to Slave	22h
Slave answers on the write-request	60h



Note

The byte order for the fields "**Index**" and "**Data**" is least significant byte first (Intel format).

Attention !

The minimum time delay between two succeeding SDO-commands must be greater than 20ms. Faster communication might lead to an unpredictible device status.

8.3.1 SDO Abort Protocol

The SDO abort protocol is used to signalize a fault when accessing an object. This SDO abort protocol has the following format:

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
	8	80h	Index		Sub-Index	Abort Code			

The identifier as well as the index and sub-index correspond to the SDO request.

The abort code may have the following values:

Abort code	Description
0504 0001h	Client / Server command specifier not valid / unknown
0601 0000h	Unsupported access to an object
0601 0001h	Attempt to read a "write-only" object
0601 0002h	Attempt to write a "read-only" object
0602 0000h	Object does not exist in the object dictionary
0609 0011h	Sub-index does not exist

Table 9: SDO abort codes

8.4 Object Dictionary

This chapter describes the implemented objects for the digital module µCAN.8.dio-BOX. For further information please refer to the CANopen communication profile DS-301 and the device profile DS-401.

8.4.1 Communication Profile

The module µCAN.8.dio-BOX supports the following objects from the communication profile DS-301:

Index	Name
1000h	Device Profile
1001h	Error Register
1003h	Predefined Error-Register
1005h	COB-ID SYNC-Message
1008h	Manufacturer Device Name
1009h	Manufacturer Hardware Version
100Ah	Manufacturer Software Version
1010h	Store Parameters
1011h	Restore Default Parameters
1014h	COB-ID Emergency-Message
1017h	Heartbeat Producer Time
1018h	Identity Object
1400h	1st Receive PDO Parameter
1600h	1st Receive PDO Mapping
1800h	1st Transmit PDO Parameters
1A00h	1st Transmit PDO Mapping

Table 10: Supported objects of the communication profile

Device Profile

Index 1000h

The object at index 1000h describes the type of device and its functionality.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned32	ro	Device Profile	0003 0191h

The object is read-only. Only sub-index 0 is supported. An access to other sub-indices will lead to an error message.

Example: read parameter, module ID = 2, index = 1000h

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
602h	8	40h	00h	10h	00h	00h	00h	00h	00h

As response the µCAN.8.dio-BOX will send:

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
582h	8	42	00	01h	00	91h	01h	03h	00

Byte 5 + Byte 6 = 0191h = 401d (Device Profile Number)
Byte 7 + Byte 8 = 0003h = 3 (Additional Information)

Error Register

Index 1001h

The object at index 1001h is an error register for the device.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Error Register	00h

The object is read-only. Only sub-index 0 is supported. An access to other sub-indices will lead to an error message.

Example: read parameter, module ID = 2, Index = 1001h

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
602h	8	40h	01h	10h	00	00	00	00	00

As response the module will return its error register value. The following error types are supported:

Generic Error

Bit 0 is set to ’1’. The generic error is set due to hardware faults.

Communication Error

Bit 4 is set to ’1’. The communication error is set due to faults on the CAN bus.

The object is read-only. Only sub-index 0 is supported. An access to other sub-indices will lead to an error message.

Pre-defined Error Field

Index 1003

The object at index 1003h holds the errors that have occured on the device. The object stores a maximum of 10 error conditions.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	rw	Number of errors	00h
1 .. 10	Unsigned32	ro	Standard error field	0000 0000h

The object supports the sub-indices 0 to 10. An access to other sub-indices will lead to an error message. Writing to sub-index 0 will clear the error history.

Example: read parameter, module ID = 2, Index = 1003h

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
602h	8	40h	03h	10h	05h	00h	00h	00h	00h

As response the module will return the error value at position 5 in the history.

Manufacturer Device Name

Index 1008

The object at index 1008h contains the manufacturer device name.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Visible String	ro	Device name	µCAN.8.dio

The object is read-only. Only sub-index 0 is supported. An access to other sub-indices will lead to an error message.

Manufacturer Hardware Version

Index 1009h

The object at index 1009h contains the manufacturer hardware version.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Visible String	ro	Hardware version	HW-1.1

The object is read-only. Only sub-index 0 is supported. An access to other sub-indices will lead to an error message.

Manufaturer Software Version

Index 100Ah

The object at index 100Ah contains the manufacturer software version.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Visible String	ro	Software version	SW-1.0

The object is read-only. Only sub-index 0 is supported. An access to other sub-indices will lead to an error message.

Store Parameters

Index 1010h

The object at index 1010h supports the saving of parameters in a non volatile memory.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Number of objects	3
1	Unsigned32	rw	Save all parameters	1
2	Unsigned32	rw	Save communication	1
3	Unsigned32	rw	Save application	1

In order to avoid storage of parameters by mistake, storage is only executed when a specific signature is written to the appropriate sub-index. The signature is "save".

Example: save all parameters, module ID = 2, index = 1010h

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
602h	8	22h	10h	10h	01h	73h	61h	76h	65h

As response the µCAN.8.dio-BOX will send:

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
582h	8	60h	10h	10h	01h	00h	00h	00h	00h

Index 1011h

Restore Default Parameters

The object at index 1011h supports the restore operation of default parameters.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Number of objects	3
1	Unsigned32	rw	Restore all param.	1
2	Unsigned32	rw	Restore commun.	1
3	Unsigned32	rw	Restore application	1

In order to avoid the restoring of default parameters by mistake, restoring is only executed when a specific signature is written to the appropriate sub-index. The signature is "load".

Example: restore all parameters, module ID = 2, Index = 1011h

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
602h	8	22h	11h	10h	01h	6Ch	6Fh	61h	64h

As response the µCAN.8.dio-BOX will send:

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
582h	8	60h	11h	10h	01h	00h	00h	00h	00h

Identity Object

Index 1018h

The object at index 1018h contains general information about the device.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	4
1	Unsigned32	ro	Vendor ID	0000 000Eh
2	Unsigned32	ro	Product Code	0013 9F70h
3	Unsigned32	ro	Revision Number	0001 0000h
4	Unsigned32	ro	Serial Number	-

The object is read-only. Only sub-indices 0 to 4 are supported. An access to other sub-indices will lead to an error message.

Vendor ID

The Vendor ID contains a unique value allocated to each manufacturer. The numbers are managed by the CAN in Automation (http://www.can-cia.org).

Product Code

The Product Code identifies a specific device version.

Revision Number

The Revision Number consists of a major revision number (upper word) and a minor revision number (lower word). The major revision number identifies a specific CANopen behaviour. The minor revision number identifies different versions with the same CANopen behaviour.

Serial Number

The Serial Number identifies a specific device.

8.4.2 Device Profile

In this section you will find all device profile (DS-401) specific indices for the µCAN.8.dio-BOX.

Index	Name
6000h	Read Input 8-Bit
6002h	Polarity Input 8-Bit
6005h	Global Interrupt Enable Digital
6006h	Interrupt Mask Any Change 8-bit
6007h	Interrupt Mask Low-to-High 8-bit
6008h	Interrupt Mask High-to-Low 8-bit
6200h	Write Output 8-Bit
6202h	Change Polarity Output 8-Bit
6206h	Error Mode Output 8-Bit
6207h	Error Value Output 8-Bit

Table 11: Supported objects of device profile DS-401

Digital Input Value

Index 6000h

By a read operation of index 6000h the state of the digital inputs can be retrieved.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	01h
1	Unsigned8	ro	Read Input 8-Bit	-

The object is read-only. Only sub-indices 0 and 1 are supported. An access to other sub-indices will lead to an error message.

Example: read digital inputs, module address = 1

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
601h	8	40h	00h	60h	01h	00h	00h	00h	00h

As response the µCAN.8.dio-BOX will send:

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
581h	8	42h	00h	60h	01h	01h	00h	00h	00h

In this example the digital input 1 has a high level, all other inputs have a low level.

8

Input Polarity

Index 6002h

With the object at index 6002h the polarity of the digital inputs can be changed..

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	01h
1	Unsigned8	rw	Polarity Input 8-Bit	00h

Only sub-indices 0 and 1 are supported. An access to other sub-indices will lead to an error message.

Global Interrupt

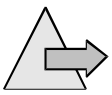
Index 6005h

The object at index 6005h enables and disables globally the interrupt behaviour without changing the interrupt masks.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	01h
1	Unsigned8	rw	Global Interrupt	FFh

Only sub-indices 0 and 1 are supported. An access to other sub-indices will lead to an error message.

The default value of FFh enables transmission of a PDO for each digital input. Each bit corresponds to a digital input. Setting a value of ’0’ will disable the transmissions of a PDO.



Note

The object is used in combination with the objects at index 6006h, 6007h and 6008h.

Interrupt Mask

Index 6006h

The object at index 6006h determines, which input port lines shall activate an interrupt by positive or/and negative edge detection.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	01h
1	Unsigned8	rw	Interrupt Any Change	FFh

Only sub-indices 0 and 1 are supported. An access to other sub-indices will lead to an error message.

Each bit corresponds to a digital input. A value of ’0’ means the interrupt is disabled.

Digital Outputs

Index 6200h

The object at index 6200h accesses the digital outputs of the module.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	01h
1	Unsigned8	rw	Write Output	00h

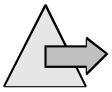
Only sub-indices 0 and 1 are supported. An access to other sub-indices will lead to an error message.

Example: Set output 8 to high level

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
601h	8	22h	20h	62h	01h	80h	00h	00h	00h

As response the µCAN.8.dio-BOX will send:

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
581h	8	60h	20h	62h	00h	00h	00h	00h	00h



Note

A digital output can only be set, if the specified output terminal is configured properly (port direction = output). This is done via the object 5FF5h (refer to “Port Direction” on page 47).

Output Polarity

Index 6202h

With the object at index 6002h the polarity of the digital inputs can be changed.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	01h
1	Unsigned8	rw	Polarity Output 8-Bit	00h

Only sub-indices 0 and 1 are supported. An access to other sub-indices will lead to an error message.

8.4.3 Manufacturer Specific Objects

In this section you will find all manucaturer specific indices for the µCAN.8.dio-BOX

Index	Name
5FF5	Port Direction

Table 12: Manufacturer specific objects

Port Direction

Index 5FF5h

The object at index 5FF5h is used to modify the port direction of each terminal.

Sub-Index	Data Type	Acc	Name	Default Value
0	Unsigned8	rw	Port direction	00h

Only sub-index 0 is supported. An access to other sub-indices will lead to an error message. Writing a '1' will define the terminal as output.

Example: Configure terminals 1 - 4 as outputs

ID	DLC	B0	B1	B2	B3	B4	B5	B6	B7
601h	8	22h	F5h	5Fh	00h	0Fh	00h	00h	00h

As result the µCAN.8.dio-BOX will send the following message:

ID	DLC	B0	B1	B2	B3	B4	B5	B6	B7
581h	8	60h	F5h	5Fh	00h	00h	00h	00h	00h

Note

By default all terminals are configured as digital inputs. The outputs can only be set, if they have been configured properly with the object 5FF5h.

8.5 Heartbeat Protocol

The Heartbeat Protocol is used in order to survey other CANopen nodes in the network and retrieve their network state.

Heart Beat ID

The Identifier for the Heartbeat Protocol is set to 700h + module address. The Identifier can not be changed. The message repetition time (called "Heartbeat Producer Time") is configured with object 1017h.

The Heartbeat Protocol transmits one byte of data, which represents the network state.

Network State	Code (dec.)	Code (hex)
Bootup	0	00h
Stopped	4	04h
Operational	5	05h
Pre-Operational	127	7Fh

Table 13: Status Information for Heartbeat

After Power-on / Reset the module will send the "Bootup message" to signal that it finished the initialization sequence.

Example: Power-on of module with address 2

ID	*DLC*	*B0*
702h	1	00h

Producer Heartbeat Time

Index 1017h

The object at index 1017h defines the cycle time of the heartbeat. The producer heartbeat time is 0 if it is not used. The time is a multiple of 1ms.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned16	rw	Producer Time	0000h

Only sub-index 0 is supported. An access to other sub-indices will lead to an error message.

Example: Producer Time 1000 ms, module address 1

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
601h	8	22h	17h	10h	E8h	03h	00h	00h	00h

The answer you will receive from the module is:

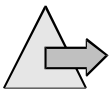
ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
581h	8	60h	17h	10h	00h	00h	00h	00h	00h

Note

The Heartbeat Producer Time is not saved inside the non-volatile memory autonomously. It is necessary to store this parameter via object 1010h (refer to “Store Parameters” on page 40).

8.6 PDO Communication

The real-time data transfer is performed by means of "Process Data Objects" (PDO). The transfer of PDOs is performed with no protocol overhead.



Note

PDO communication is only possible in the network state "Operational".

8.6.1 Transmission Modes

Event Driven

Message transmission is triggered by the occurrence of an object specific event. For synchronous PDOs this is the expiration of the specified transmission period, synchronised by the reception of the SYNC object. For acyclically transmitted synchronous PDOs and asynchronous PDOs the triggering of a message transmission is a device-specific event specified in the device profile.

Timer Driven

Message transmission is either triggered by the occurrence of a device-specific event or if a specified time has elapsed without occurrence of an event.

8.6.2 Receive-PDO

Index 1400h

The object at index 1400h defines communication parameters for the Receive-PDO.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	2
1	Unsigned32	rw	COB-ID for PDO	200h + Node
2	Unsigned8	rw	Transmission Type	FFh

Only sub-indices 0 to 2 are supported. An access to other sub-indices will lead to an error message.

COB-ID for PDO

Sub-Index 1 defined the identifier for the Receive PDO. The 32-bit value has the following structure.

Bit 31	Bit 30	Bit 29	Bit 28 - 0
PDO valid, 0 = valid 1 = not valid	RTR allowed, 0 = yes 1 = no RTR	Frame type, 0 = 11 Bit 1 = 29 Bit	Identifier,

Table 14: Definition of COB-ID for PDO

In order to enable the PDO the most significant bit (Bit 31) must be set to 0. In order to disable the PDO the most significant bit must be set to 1. In the default setting the PDO is active (Bit 31 = 0).

Transmission Type

The transmission type defines the transmission character of the PDO.

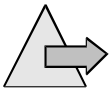
Transmission Type	Description
00h	acyclic synchronous,
01h - F0h (1 - 240 dez)	cyclic synchronous,

Table 15: Einstellung des Transmission Type

The Receive-PDO processes a message with 1 byte process data. The contents is copied into object 6200h (refer to “Digital Outputs” on page 46) and modifies the digital outputs.

Example: Set outputs 1 - 4, module address = 1

ID	*DLC*	*B0*
201h	1	0Fh



Note

A communication with PDOs is only possible in Operational Mode. A digital output can only be set, if the specified output terminal is configured properly (port direction = output). This is done via the object 5FF5h (refer to “Port Direction” on page 47).

8.6.3 Transmit PDO

Index 1800h

The object at index 1800h defines communication parameters for the Transmit-PDO.

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned8	ro	Largest Sub-Index	5
1	Unsigned32	rw	COB-ID for PDO	180h + Node
2	Unsigned8	rw	Transmission Type	FFh
5	Unsigned16	rw	Event Timer	0000h

Only sub-indices 0 to 2 and 5 are supported. An access to other sub-indices will lead to an error message.

COB-ID for PDO

Sub-Index 1 defined the identifier for the Transmit-PDO. The 32-bit value has the following structure.

Bit 31	Bit 30	Bit 29	Bit 28 - 0
PDO valid, 0 = valid 1 = not valid	RTR allowed, 0 = yes 1 = no RTR	Frame type, 0 = 11 Bit 1 = 29 Bit	Identifier,

Table 16: Definition of COB-ID for PDO

In order to enable the PDO the most significant bit (Bit 31) must be set to 0. In order to disable the PDO the most significant bit must be set to 1. In the default setting the PDO is active (Bit 31 = 0).

Transmission Type

The transmission type defines the transmission character of the PDO.

Transmission Type	Description
00h	acyclic synchronous,
01h - F0h (1 - 240 dez)	cyclic synchronous,
FFh (255 dez)	event driven, PDO is sent when Event Timer elapses

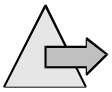
Table 17: Setup of Transmission Type

PDO Communication

The Transmit-PDO has 1 byte of process data. The contents is copied from object 6000h (refer to “Digital Input Value” on page 44) into the PDO.

Example: Input 1 was changed from 0 to 1, module address = 1

ID	*DLC*	*B0*
181h	1	01h



Note

The PDO is also transmitted on change of a digital output. Transmission of the PDO is only possible in Operational Mode. By means of objects 6005h to 6008h the interrupt behaviour of the PDO can be changed.

8.6.4 Synchronisation Message

Index 1005h

The object at index 1005h defines the identifier for the SYNC-message. On reception of a message with this identifier the transmission of PDOs is triggered (refer to “Transmit PDO” on page 53)..

Sub-Index	Data Type	Acc.	Name	Default Value
0	Unsigned32	rw	COB-ID SYNC	80h

Only sub-index 0 is supported. An access to other sub-indices will lead to an error message.

Example: Set SYNC-ID to 10, module address 1

ID	DLC	B0	B1	B2	B3	B4	B5	B6	B7
601h	8	22h	05h	10h	0Ah	00h	00h	00h	00h

As answer you will get the following message:

ID	DLC	B0	B1	B2	B3	B4	B5	B6	B7
581h	8	60h	05h	10h	00h	00h	00h	00h	00h

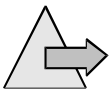
The default identifier is 80h in order to ensure a high priority of the SYNC-message.

Note

The SYNC-identifier is not saved inside the non-volatile memory autonomously. It is necessary to store this parameter via object 1010h (refer to “Store Parameters” on page 40)

8.7 Emergency Message

Emergency objects are triggered by the occurrence of a device internal error situation and are transmitted from an emergency producer on the device.



Note

An emergency is different from a SDO Error Message. The last one only holds the access error to the object dictionary, whereas an emergency display a severe hardware/software failure.

The emergency identifier has the default value 128d + module-address. The emergency message has the following structure:

ID	*DLC*	*B0*	*B1*	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*
	8	Error Code		00h	Manufacturer Specific Error Field				

The following emergency error codes are supported:

Error Code (hex)	Description
0000	Error Reset or No Error
1000	Generic Error
2300	Current, Device Output
5000	Device-Hardware
6000	Device-Software

Table 18: Emergency Error Codes

9. Technical Data

Power Supply	
Supply Voltage, U_{PWR}	8 .. 60 V DC, reverse current protected
Power Consumption	1,5 W (60 mA @ 24 V DC) without load
Isolation	Fieldbus/Supply: 500 Veff
Physical Interface	Terminal Block (2,5 mm^2)

CAN-Bus	
Baudrates	10 kBit/s .. 1 MBit/s
Status on the bus	active node
Protocol	CANopen, DS-401
Physical Interface	Terminal Block (2,5 mm^2)

EMC	
Electromagnetic immunity	according to EN 50082-2
Electrostatic discharge	8 kV air discharge, 4 kV contact discharge, according to EN 61000-4-2
Electromagnetic fields	10 V/m, according to ENV 50204
Burst	5 kHz, 2 kV according to EN 6100-4-4
Conducted RF-Disturbance	10 V, according to EN 61000-4-6
Electromagnetic emission	according to EN 50081-2

Mechanic	
Case	Aluminium
Dimensions	125 * 80 * 57 mm (L * B * H)
Weight	540 g
Protection class	IP65

Digital Inputs	
Impedance	24,2 kOhm
Valid Low-Level	$U_{in} < 0,4 * U_{PWR}$
Valid High-Level	$U_{in} > 0,6 * U_{PWR}$

Digital Outputs	
Type	Highside Power-MOSFET
Maximum voltage	50 V
Maximum current	1,4 A
Short circuit detection	5 A, each output short circuit protected
Module maximum current	6 A

Index

I