USER GUIDE

AL CAN I/O-Modul

Doc. 1.0

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AL CAN I/O-MODUL - USER GUIDE

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Kontron Electronics GmbH

Max-Planck-Str. 6
72636 Frickenhausen
Germany
www.kontron-electronics.de

Kontron Europe GmbH

Gutenbergstr. 2
85737 Ismaning
Germany
www.kontron.com

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Revision History

Revision	Brief Description of Changes	Date of Issue	Author / Editor
Rev. 0.1	Initial Version	2021-04-20	Tur
Rev. 0.2	Pre-Release	2021-06-14	We
Rev. 1.0	Initial Release	2023-08-29	Tur
Rev. 1.1	Corrected the description of digital inputs connector. The counters are on DI1 and DI3, not DI5 and DI12.	2023-10-09	Tur

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Symbols

The following symbols may be used in this user guide:

⚠DANGER

DANGER indicates a hazardous situation which, if not avoided,
will result in death or serious injury.

⚠WARNING

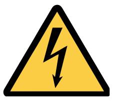
WARNING indicates a hazardous situation which, if not avoided,
could result in death or serious injury.

NOTICE

NOTICE indicates a property damage message.

⚠CAUTION

CAUTION indicates a hazardous situation which, if not avoided,
may result in minor or moderate injury.



Electric Shock!
This symbol and title warn of hazards due to electrical shocks (> 60 V) when touching products or parts of products. Failure to observe the precautions indicated and/or prescribed by the law may endanger your life/health and/or result in damage to your material.

ESD Sensitive Device!
This symbol and title inform that the electronic boards and their components are sensitive to static electricity. Care must always therefore be taken during all handling operations and inspections of this product in order to ensure product integrity.

HOT Surface!
Do NOT touch! Allow to cool before servicing.

Laser!
This symbol informs of the risk of exposure to laser beam and light emitting devices (LEDs) from an electrical device. Eye protection per manufacturer notice shall review before servicing.

This symbol indicates general information about the product and the user guide.

This symbol also indicates detail information about the specific product configuration.

This symbol precedes helpful hints and tips for daily use.

For Your Safety

Your new Kontron Electronics product was developed and tested carefully to provide all features necessary to ensure its compliance with electrical safety requirements. It was also designed for a long fault-free life. However, the life expectancy of your product can be drastically reduced by improper treatment during unpacking and installation. Therefore, in the interest of your own safety and of the correct operation of your new Kontron Electronics product, you are requested to conform with the following guidelines.

High Voltage Safety Instructions

As a precaution and in case of danger, the power connector must be easily accessible. The power connector is the product's main disconnect device.

⚠CAUTION

Warning

All operations on this product must be carried out by sufficiently skilled personnel only.

⚠CAUTION

Electric Shock!

Before installing a non-hot-swappable Kontron Electronics product into a system always ensure that your mains power is switched off. This also applies to the installation of piggybacks. Serious electrical shock hazards can exist during all installation, repair, and maintenance operations on this product. Therefore, always unplug the power cable and any other cables which provide external voltages before performing any work on this product.

Earth ground connection to vehicle's chassis or a central grounding point shall remain connected. The earth ground cable shall be the last cable to be disconnected or the first cable to be connected when performing installation or removal procedures on this product.

General Safety Instructions for IT Equipment

⚠WARNING

Please read this chapter carefully and take careful note of the instructions, that have been compiled for your safety and to ensure to apply in accordance with intended regulations. If the following general safety instructions are not observed, it could lead to injuries to the operator and/or damage of the product; in cases of non-observance of the instructions Kontron Electronics is exempt from accident liability, this also applies during the warranty period.

The product has been built and tested according to the basic safety requirements for low voltage (LVD) applications and has left the manufacturer in safety-related, flawless condition. To maintain this condition and to ensure safe operation, the operator must not only observe the correct operating conditions for the product but also the following general safety instructions:

- The product must be used as specified in the product documentation, in which the instructions for safety for the product and for the operator are described. These contain guidelines for setting up, installation and assembly, maintenance, transport and storage.
- The on-site electrical installation must meet the requirements of the country's specific local regulations.
- If a power cable comes with the product, only this cable should be used. Do not use an extension cable to connect the product.
- To guarantee that enough air circulation is available to cool the product, ensure that if the product has ventilation openings the openings are not covered or blocked. If an air filter is provided, this should be cleaned regularly. Additionally, make sure the system is well ventilated by observing if heat-dissipating elements are covered/obstructed by objects as this can cause a build-up of heat and stop heat from being dispersed into the ambient environment.
- Do not place the system close to heat sources or damp places.

- Only products or parts which fulfill the requirements of SELV circuits (Safety Extra Low Voltage) as stipulated by IEC 60950-1 may be connected to the available interfaces.
- Before opening the product, make sure that the product is disconnected from the mains. Complete disconnection is only possible if the power cable is disconnected and removed. Ensure that there is free and easy access to enable disconnection.
- If the product is opened for the insertion or removal of expansion devices (depending on the configuration of the system), this may only be carried out by qualified persons.
- If extensions are made to the product, the following must be observed:
  - All effective legal regulations and all technical data for the expansion devices are adhered to.
  - The power consumption of any expansion devices does not exceed the specified limitations.
  - The current consumption of the system does not exceed the value stated on the product label.
- Only original accessories that have been approved by Kontron Electronics can be used.
- Please note: safe operation is no longer possible when any of the following applies:
  - Damage is visible.
  - The device no longer functions.

  In these cases, the device must be switched off and it must be ensured that the device can no longer be operated.

Additional Safety Instructions for DC Power Supply Circuits

- To guarantee safe operation of products with DC power supply voltages larger than 60 volts DC or a power consumption larger than 240 VA, please observe that:
  - The product is set up, installed and operated in a room or enclosure marked with "RESTRICTED ACCESS", if there are no safety messages on product as safety signs and labels on the product itself.
  - No cables or parts without insulation in electrical circuits with dangerous voltage or power should be touched directly or indirectly.
  - A reliable protective earthing connection is provided.
  - A suitable, easily accessible disconnecting product is used in the application (e.g. overcurrent protective product), if the product itself is not disconnectable.
  - A disconnect product, if provided in or as part of the equipment, shall disconnect both poles simultaneously.
  - Interconnecting power circuits of different products causes no electrical hazards.
- A sufficient dimensioning of the power cable wires must be selected – according to the maximum electrical specifications on the product label – as stipulated by EN60950-1 or VDE0100 or EN60204 or UL508 regulations.
- The product does not generally fulfill the requirements for "centralized DC power systems "(UL 60950-1, Annex NAB; D2) and therefore may not be connected to such products!

Special Handling and Unpacking Instruction

NOTICE

ESD Sensitive Device!

Electronic boards and their components are sensitive to static electricity. Therefore, care must be taken during all handling operations and inspections of this product, in order to ensure product integrity at all times.

Do not handle this product out of its protective enclosure while it is not used for operational purposes unless it is otherwise protected.

Whenever possible, unpack or pack this product only at EOS/ESD safe workstations. Where a safe workstation is not guaranteed, it is important for the user to be electrically discharged before touching the product with his/her hands or tools. This is most easily done by touching a metal part of your system housing.

It is particularly important to observe standard anti-static precautions when changing piggybacks, ROM devices, jumper settings etc. If the product contains batteries for RTC or memory backup, ensure that the product is not placed on conductive surfaces, including anti-static plastics or sponges. They can cause short circuits and damage the batteries or conductive circuits on the product.

Lithium Battery Precautions

If your product is equipped with a lithium battery, take the following precautions when replacing the battery.

⚠CAUTION

Danger of explosion if the battery is replaced incorrectly.

- Replace only with same or equivalent battery type recommended by the manufacturer.
- Dispose of used batteries according to the manufacturer's instructions.

General Instructions on Usage

In order to maintain Kontron Electronics's product warranty, this product must not be altered or modified in any way. Changes or modifications to the product, that are not explicitly approved by Kontron Electronics and described in this user guide or received from Kontron Electronics Support as a special handling instruction, will void your warranty.

This product should only be installed in or connected to systems that fulfill all necessary technical and specific environmental requirements. This also applies to the operational temperature range of the specific board version that must not be exceeded. If batteries are present, their temperature restrictions must be considered.

In performing all necessary installation and application operations, only follow the instructions supplied by the present user guide.

Keep all the original packaging material for future storage or warranty shipments. If it is necessary to store or ship the product then re-pack it in the same manner as it was delivered.

Special care is necessary when handling or unpacking the product. See Special Handling and Unpacking Instruction.

Quality and Environmental Management

Kontron Electronics aims to deliver reliable high-end products designed and built for quality, and aims to complying with environmental laws, regulations, and other environmentally oriented requirements. For more information regarding Kontron Electronics's quality and environmental responsibilities, visit http://www.kontron.com/about-kontron/corporate-responsibility/quality-management.

Disposal and Recycling

Kontron Electronics's products are manufactured to satisfy environmental protection requirements where possible. Many of the components used are capable of being recycled. Final disposal of this product after its service life must be accomplished in accordance with applicable country, state, or local laws or regulations.

WEEE Compliance

The Waste Electrical and Electronic Equipment (WEEE) Directive aims to:

- Reduce waste arising from electrical and electronic equipment (EEE).
- Make producers of EEE responsible for the environmental impact of their products, especially when the product become waste.
- Encourage separate collection and subsequent treatment, reuse, recovery, recycling and sound environmental disposal of EEE.
- Improve the environmental performance of all those involved during the lifecycle of EEE.

Environmental protection is a high priority with Kontron Electronics.
Kontron Electronics follows the WEEE directive.
You are encouraged to return our products for proper disposal.

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1/ Introduction

This user guide describes the Automation Line AL CAN I/O-MODUL. New users are recommended to study the installation instructions within this user guide before switching on the power.

Kontron Electronics's AL CAN I/O-MODUL is developed specifically for control cabinet applications with flexible DIN rail mounting positions for use when space is limited. The fanless design ensures a significantly prolonged lifespan and high system availability.

1.1. Product Overview

Before working with the AL CAN I/O-MODUL, Kontron Electronics recommends that users take a few minutes to learn about the various parts of the AL CAN I/O-MODUL.

The AL CAN I/O-MODUL is a flexible industrial grade CAN IO fanless device, designed for use in demanding applications requiring a flexible rapid rail attachment solution. It's internal STM32 MCU allows for fast CAN communication while providing long-term availability and supports a varied number of onboard digital and analog inputs and outputs.

All variants are available in a robust steel chassis, designed for operation in a DIN rail environment using a vertical orientation.

General features are:

- CAN-Bus connection up to 1MBaud
- 12 digital inputs, 2 can be used as counters*
- 12 digital outputs, 4 configurable as PWM outputs*
- 4 analog inputs for 0V ... +10V or 0mA ... 20mA, resolutions 12 bits, single ended
- 4 analog outputs for 0V ... +10V, resolution 12 bits
- 2 temperature inputs for PT100 sensors with 2 to 4 wires, -40°C to +125°C (Resolution 0.5°C)
- Fanless passive cooling

*For further details, see technical information in chapter 2.1 on page 18.

The AL CAN I/O-MODUL is intended for 24/7 continuous operation and longtime industrial applications. All components are selected to ensure a long lifetime.

Figure 1: AL CAN I/O-MODUL

The AL CAN I/O-MODUL is designed for operation in a DIN rail environment using a vertical orientation as desktop version.

1.2. Ordering Information

Check that your delivery is complete, and contains the items listed below. If you discover damaged or missing items, contact your dealer.

Table 1: Scope of Delivery

Art.-No.	Delivered Item	Description
50099 036	AL CAN I/O-MODUL	Complete device in housing without connectors. The connectors must be ordered separately. See 0 Accessories.
	Other variants on request	

1.3. Accessories

Table 2: Accessories

Art.-No.	Delivered Item	Description
30099 002	AC Connector Set AL CAN I/O-MODUL	Connector set contains: 1x 3 pin power connector, 1x DI: 14pin; 1x DO: 12pin; 1x AI/AO: 8pin; 1x Temp: 4pin; 1x CAN/Shield: 4pin

2/ Specification

2.1. Technical Specification

The AL CAN I/O-MODUL has the following technical specification.

Table 3: CAN Interface

Transfer speed	Baud rate 1 Mbit/s
Galvanic separation	No
CANopen support	No
SAE J1939 support	No
Connection	The connection of the CAN interface is present twice on the board and internally bridged, this way it is possible to daisy chain the CAN-Bus connection to the next module. The last module on the CAN-Bus must have an external 120 Ohms termination resistor plugged in between H-02 and L02 (CAN-High and CAN-Low).

Table 4: Digital Inputs (DI)

Number of digital inputs	12 (2 can be used as counters*)
Voltage input range	0V ... 24 VDC (+15%)
Tilting voltage log. 0 ⇔log. 1	10 V ... 13 V
Input current	max. 6 mA
Ri	ca. 4500 Ohms
(*) Counter input frequency	max. 100 kHz
(*) Counter Process image	Count direction is upwards, 32-bit value, auto stops at the end/by reaching the max value of 4'294'967'295 (= $FFFFFFFF_h$)

Table 5: Digital Outputs (DO)

Number of digital outputs	12 (4 can be configured as PWM outputs*)
Output voltage – log. 1	24 V (power supply switched via High Side switch)
Output voltage – log. 0	high-impedance, connection open
Allowed consumers	ohm, inductive
Single output load	up to ca. 0.8A (overload protection per channel at ca. 0.8A)
Total output load	max. 5A (all outputs in total)
(*) PWM	max. 24kHz, default resolution 1000 steps (0.1%) Pre-scaler and resolution are configurable offering flexibility in setting the base frequency and resolution.

Note: The Digital Outputs (DO) require a separate supply of power to work. This means 24 volts have to be supplied to the power connector pin *24VDC_Out*. For further details see chapter 3.2.4 Power Connector (X300).

Table 6: Analog Inputs (AI)

Number of analog inputs	4 (single ended), after power up/reset configured as voltage inputs
Measurement range voltage / current	0V ... +10 V / 0 ... 20mA
Input resistance	ca. 10 kΩ (Voltage) / 50Ω (Current)
Resolution	12 Bit
Measurement accuracy	<± 0.3%
Maximum voltage input	max. 20V (no overload protection)
Maximum current input	max. 40mA (no overload protection)

Table 7: Analog Outputs (AO)

Number of analog outputs	4
Signal voltage	0V ... 10V
Allowed load	> 5 kΩ (Output is short circuit protected)
Accuracy	< ± 0.1%
Resolution	12 Bit

Table 8: Temperature Inputs (PT100)

Number of PT100 inputs	2
Connection	2 to 4 wire
Resolution	0.5°C (-40°C - +125°C)
Temperature deviation	<± 0.25°C

2.2. Mechanical Specification

Table 9: Mechanical Specification

Dimensions	AL
Width	111 mm (4.37")
Depth	76 mm (3"), Housing + Clamp: 83mm (3.27")
Height	25 mm (1"), Housing + Screw: 28 mm (1.1")
Weight (chassis only)	Approx. ~0,3 kg (~0,66 lbs.)
Construction	Stainless Steel housing
Mounting	DIN Rail according to EN 60715
Color	Stainless Steel
Protection class	IP20

For more detailed mechanical information, refer to the outline dimensions drawings within this chapter. Each dimension drawing shows the main external mechanical features such as the position and size of mounting holes for the DIN rail mounting clamp.

2.3. Power Specification

The AL CAN I/O-MODUL is powered by a 3-pin Input power connector on the side panel and has no internal power supply. The standard input voltage of 24V DC is converted internally to supply all other required voltages.

Table 10: Power Specification

Nominal Input Voltage	24V DC
Input Voltage Range	24V DC ± 15%
Input Power Mating Connector	3-pin Phoenix Contact 180° FMC 1,5/ 3-ST-3,5 BK CN1 (Phoenix 1709334)

2.3.1. Power Consumption

The power consumption of the AL CAN I/O-MODUL depends on the implemented mainboard capacity and external interfaces in use, for more information see Table 11: Power Consumption.

Table 11: Power Consumption

Power Consumption	
Voltage	24V DC ± 15% (Max. range)
Current	60 mA to 5.5 A / < 125W (depending on I/O configuration)

2.3.2. Protective Earth

There is no protective earth stud bolt on the front panel connected to the chassis GND inside the system. Protected Earth is directly attached to the housing and electronic ground.

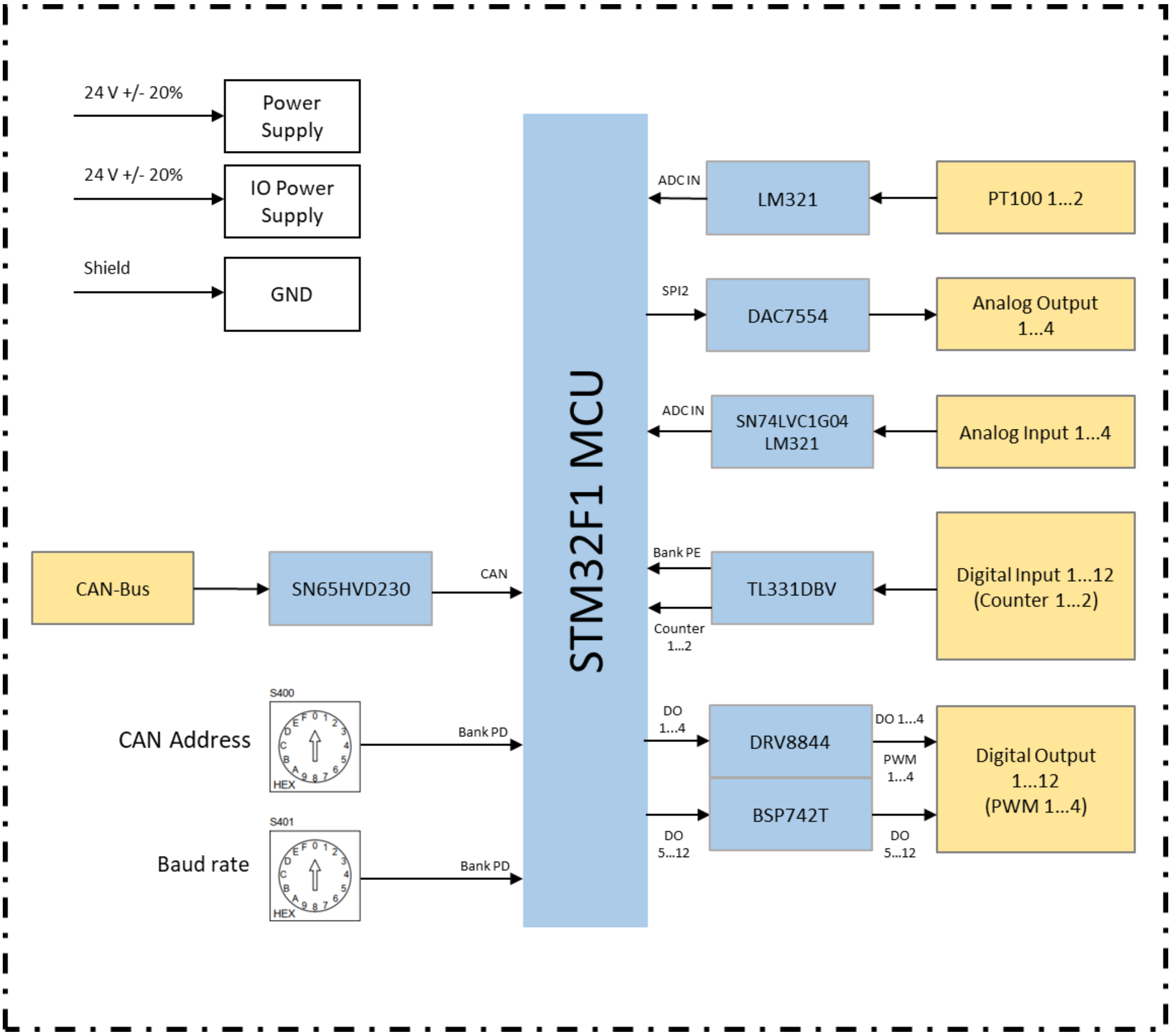
2.3.3. Environmental Specification

Table 12: Environmental Specification

Temperature (Operating)	0°C…55°C ambient
Relative Humidity (Operating)	95%, non-condensing

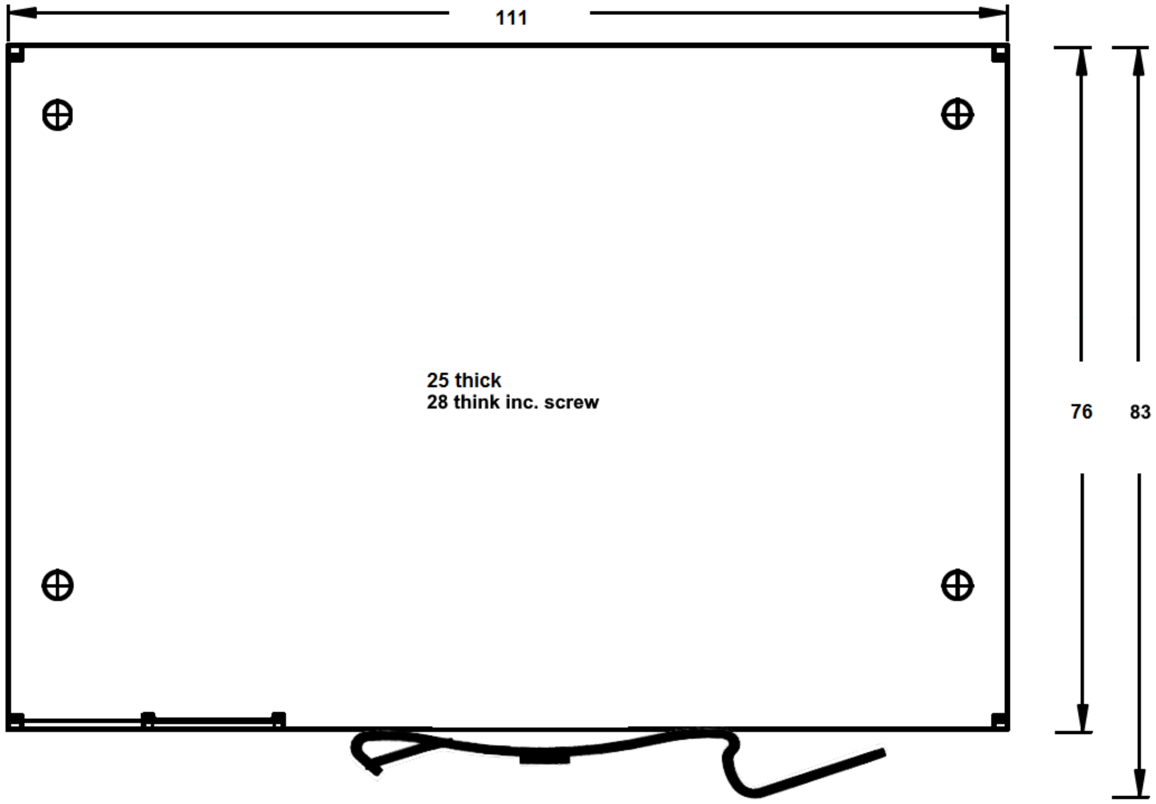
2.4. Block Diagram

Figure 2: Block Diagram



The following outline dimensions drawings shows the main external mechanical features for the AL CAN I/O-MODUL.

Figure 3: Dimensions (Measurements in mm)



3/ Connector Description

The side and front panel includes all the I/O connectors.

Figure 4: Side and Front Panel View

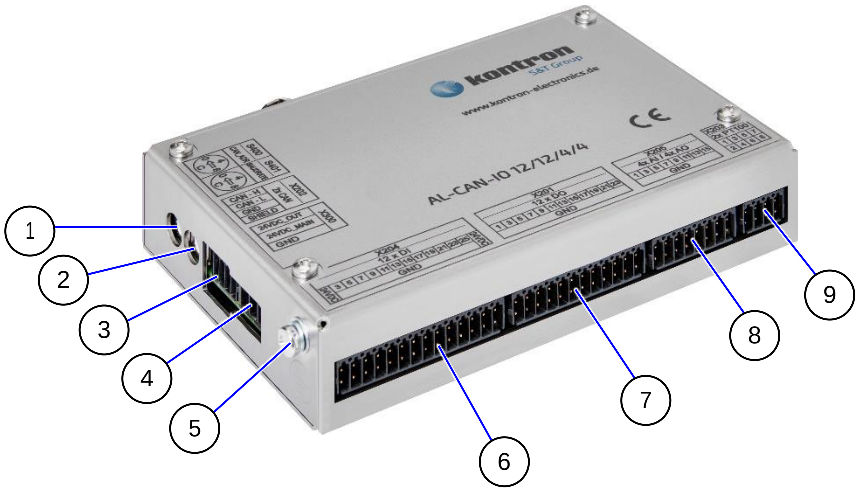


Table 13: Front Panel Connectors

Item	Label	Function	Chapter
1	S400	CAN address switch	3.1.1, 3.2.1
2	S401	Baud rate switch	3.1.2, 3.2.2
3	X202	CAN-Bus, GND and Shield connector (6-pin Phoenix Contact)	3.1.3, 3.2.3
4	X300	DC power connector (3-pin Phoenix Contact)	3.1.4, 3.2.4
5	FE	Functional earth	3.1.5
6	X204	Digital input connector (28-pin Phoenix Contact)	3.1.6, 3.2.5
7	X201	Digital output connector (24-pin Phoenix Contact)	3.1.7, 3.2.6
8	X205	Analog input / Analog output connector (16-pin Phoenix Contact)	3.1.8, 3.2.7
9	X203	Temperature input / PT100 (8-pin Phoenix Contact)	3.1.9, 3.2.8

3.1. Connectors and Switches

3.1.1. CAN Address Switch (S400)

There is one rotary switch which allows to set the CAN-Bus address of the device, see Figure 4 (pos.1).
The rotary switch offers 16 positions which allows for 16 different CAN-Bus addresses on its own, but in combination with the baud rate switch (S401), the baud rate switch acts as an address switcher (adding an offset of 32 to the base address) thus allows for up to 32 CAN-Bus addresses to be chosen from. Please see the following tables.

For a more detailed view of the switch and it's coding, refer to chapter 3.1.2 on page 25.

Position CAN address switch (S400)	Address offset	Resulting CAN-Bus address
0	0	0
1	0	1
2	0	2
3	0	3
4	0	4
5	0	5
6	0	6
7	0	7
8	0	8
9	0	9
A	0	10
B	0	11
C	0	12
D	0	13
E	0	14
F	0	15

Table 14: CAN Bus addresses if S401 is between 0 and 7

Position CAN address switch (S400)	Address offset	Resulting CAN-Bus address
0	32	32
1	32	33
2	32	34
3	32	35
4	32	36
5	32	37
6	32	38
7	32	39
8	32	40
9	32	41
A	32	42
B	32	43
C	32	44
D	32	45
E	32	46
F	32	47

Table 15: CAN Bus addresses if S401 is between 8 and A

3.1.2. Baud Rate Switch (S401)

There is one rotary switch which allows to set the baud rate of the device, see Figure 4 (pos.2).
There are 8 possible baud rates available, ranging from 1 Mbit to 10 kBit, switch positions 0 to 7.
This switch also acts as an address offset switch to the CAN address switch (S400), allowing the device to have one of up to 32 CAN-Bus addresses, but repeating the possible baud rate settings in the switch positions 8 to F. Please see *Table 14* and *Table 15* above and *Table 16* below.

For a more detailed view of the switch and it's coding, refer to chapter 3.2.2 on page 27.

Position Baud rate switch (S401)	Baud rate	Address offset for S400
0	1Mbit	0
1	500kBit	0
2	250kbit	0
3	125kbit	0
4	100kbit	0
5	50kbit	0
6	20kbit	0
7	10kbit	0
8	1Mbit	32
9	500kBit	32
A	250kbit	32
B	125kbit	32
C	100kbit	32
D	50kbit	32
E	20kbit	32
F	10kbit	32

Table 16: Baud rates

3.1.3. CAN-Bus Connector (X202)

There is a one CAN-Bus connector where each pin is bridged to another pin on the same plug to allow daisy chaining of the CAN IO modules, see Figure 4 (pos.3).

For the pin assignment of the CAN-Bus connector, refer to chapter 3.2.3 on page 28.

3.1.4. Power Connector (X300)

There is one 3-pin power connector on the side panel supporting an input DC voltage range of 24V DC ±15%, see Figure 4 (pos.4). This connector must also be supplied with the DC output voltage for the digital outputs of the module.
The mating connector required to connect the power connector to a DC main power source is not supplied with the AL CAN I/O-MODUL. For information on how to connect the mating connector to the side panel input power connector, refer to chapter 6.2.1 Wiring the DC Mating Power Connector.

For the pin assignment of the input power connector, refer to chapter 3.2.4 on page 28.

Note: The Digital Outputs (DO) require a separate supply of power to work. This means 24 volts have to be supplied to the power connector pin *24VDC_Out*.

3.1.5. Protective Earth (FE)

The GND pin of the power connector is connected to functional earth of the electronics and to the metal housing of the AL CAN I/O-MODUL, see Figure 4 (pos.5).

3.1.6. Digital Input Connector (X204)

There are 12 24 volts digital inputs available on the front panel of the AL CAN I/O-MODUL, see Figure 4 (pos.6).

The connector however has a total of 28 pins, with 4 pins supplying constant 24V DC for small external devices, such as sensors, switches, relays and small actuators and 12 pins offer a connection to GND for easier cable management.

For the pin assignment of the digital input connector, refer to chapter 3.2.5 on page 28.

3.1.7. Digital Output Connector (X201)

There are 12 digital outputs available on the front panel of the AL CAN I/O-MODUL, see Figure 4 (pos.7).
The voltage level is 24V DC nominally. The digital outputs are designed as 24V DC outputs with high side drivers.

The connector however has a total of 24 pins where the remaining 12 pins offer a connection to GND for easier cable management.
For the pin assignment of the digital input connector, refer to chapter 3.2.6 on page 29.

Note: The Digital Outputs (DO) require a separate supply of power to work. This means 24 volts have to be supplied to the power connector pin *24VDC_Out*. For further details see chapter 3.2.4 Power Connector (X300).

3.1.8. Analog Input / Output Connector (X205)

There are 4 analog inputs and 4 outputs available on the front panel of the AL CAN I/O-MODUL, see Figure 4 (pos.8).
The 4 analog inputs can be configured to measure voltage or current. The possible value ranges are 0V to 10V or 0mA to 20mA.
The power up / reset default setting is *voltage* measurement.
The 4 analog outputs are none configurable voltage outputs capable of voltages between 0V to 10V.

The connector however has a total of 16 pins where the remaining 8 pins offer a connection to GND for easier cable management.
For the pin assignment of the analog input / output connector, refer to chapter 3.2.7 on page 29.

3.1.9. Temperature Input Connector – PT100 (X203)

There are 2 PT100 temperature inputs available on the front panel of the AL CAN I/O-MODUL, see Figure 4 (pos.9).
Each sensor can be connected using a 2 wire, 3 wire or 4 wire configuration.

For the pin assignment of the temperature input connector, refer to chapter 3.2.8 on page 29.

3.2. Front Panel Connector Pin Assignments

3.2.1. CAN Address Switch (S400)

Rotary Switch	Position	Address no offset	Address with offset 32(*)
	0	0	32
	1	1	33
	2	2	34
	3	3	35
	4	4	36
	5	5	37
	6	6	38
	7	7	39
	8	8	40
	9	9	41
	A	10	42
	B	11	43
	C	12	44
	D	13	45
	E	14	46
	F	15	47

Table 17: CAN Address Switch (S400)

(*) The address offset is activated when the switch S401 is between positions 8 and F, refer to chapters 3.1 and 3.1.2 for additional information.

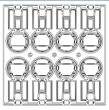
3.2.2. Baud Rate Switch (S401)

Rotary Switch	Position	Baud rate	Address offset for S400(*)
	0	1Mbit	0
	1	500kBit	0
	2	250kbit	0
	3	125kbit	0
	4	100kbit	0
	5	50kbit	0
	6	20kbit	0
	7	10kbit	0
	8	1Mbit	32
	9	500kBit	32
	A	250kbit	32
	B	125kbit	32
	C	100kbit	32
	D	50kbit	32
	E	20kbit	32
	F	10kbit	32

Table 18: Baud Rate Switch (S401)

(*) This address offset is added to the address selection of S400, the device's CAN-Bus address. Also refer to chapters 3.1 and 3.1.2 for additional information. The baud rate selection has been doubled to make use of all available positions on the rotary switch and to have 16 additional CAN-Bus addresses by adding an offset to the selected base address.

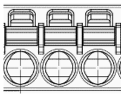
3.2.3. CAN-Bus Connector (X202)

CAN-Bus	Pin	Signal Name
 1 3 5 7 2 4 6 8	1	CAN H-01
	2	CAN H-02
	3	CAN L-01
	4	CAN L-02
	5	GND - 01
	6	GND - 02
	7	Shield
	8	Shield

Note: Pin 1 and Pin 2 are internally bridged as are Pin 3 and Pin 4, Pin 5 and Pin 6 and 7 and 8. This allows for daisy chaining of CAN-Bus modules.

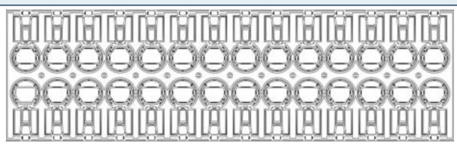
Phoenix Contact Connector 180° DFMC 0,5/4-ST-2,54 (Phoenix 1844594)

3.2.4. Power Connector (X300)

3-Pin Power Mating Connector	Pin	Signal Name
 1 (+), 2 (+), 3 (-),	1	24VDC_Out
	2	24VDC_Main
	3	GND

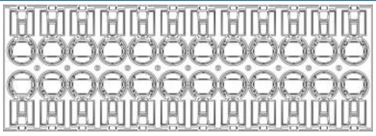
Phoenix Contact Connector 180° FMC 1,5/ 3-ST-3,5 BK CN1 (Phoenix 1709334)

3.2.5. Digital Input Connector (X204)

Digital Inputs	Pin	Signal Name	Pin	Signal Name
 1 3 5 7 9 11 13 15 17 19 21 23 25 27 2 4 6 8 10 12 14 16 18 20 22 24 26 28	1	24VDC	2	24VDC
	3	DI-01 (Counter 1)	4	GND
	5	DI-02	6	GND
	7	DI-03 (Counter 2)	8	GND
	9	DI-04	10	GND
	11	DI-05	12	GND
	13	DI-06	14	GND
	15	DI-07	16	GND
	17	DI-08	18	GND
	19	DI-09	20	GND
	21	DI-10	22	GND
	23	DI-11	24	GND
	25	DI-12	26	GND
	27	24VDC	28	24VDC

Phoenix Contact Connector 180° DFMC 0,5/ 14-ST-2,54 (Phoenix 1844691)

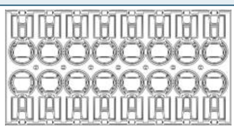
3.2.6. Digital Output Connector (X201)

Digital Outputs	Pin	Signal Name	Pin	Signal Name
 1 3 5 7 9 11 13 15 17 19 21 23 2 4 6 8 10 12 14 16 18 20 22 24	1	DO-01 (PWM-1)	2	GND
	3	DO-02 (PWM-2)	4	GND
	5	DO-03 (PWM-3)	6	GND
	7	DO-04 (PWM-4)	8	GND
	9	DO-05	10	GND
	11	DO-06	12	GND
	13	DO-07	14	GND
	15	DO-08	16	GND
	17	DO-09	18	GND
	19	DO-10	20	GND
	21	DO-11	22	GND
	23	DO-12	24	GND

Phoenix Contact Connector 180° DFMC 0,5/ 12-ST-2,54 (Phoenix 1844675)

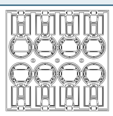
Note: The Digital Outputs (DO) require a separate supply of power to work. This means 24 volts have to be supplied to the power connector pin *24VDC_Out*. For further details see chapter 3.2.4 Power Connector (X300).

3.2.7. Analog Input / Output Connector (X205)

Analog Inputs / Outputs	Pin	Signal Name	Pin	Signal Name
 1 3 5 7 9 11 13 15 2 4 6 8 10 12 14 16	1	AI-01	2	GND
	3	AI-02	4	GND
	5	AI-03	6	GND
	7	AI-04	8	GND
	9	AO-01	10	GND
	11	AO-02	12	GND
	13	AO-03	14	GND
	15	AO-04	16	GND

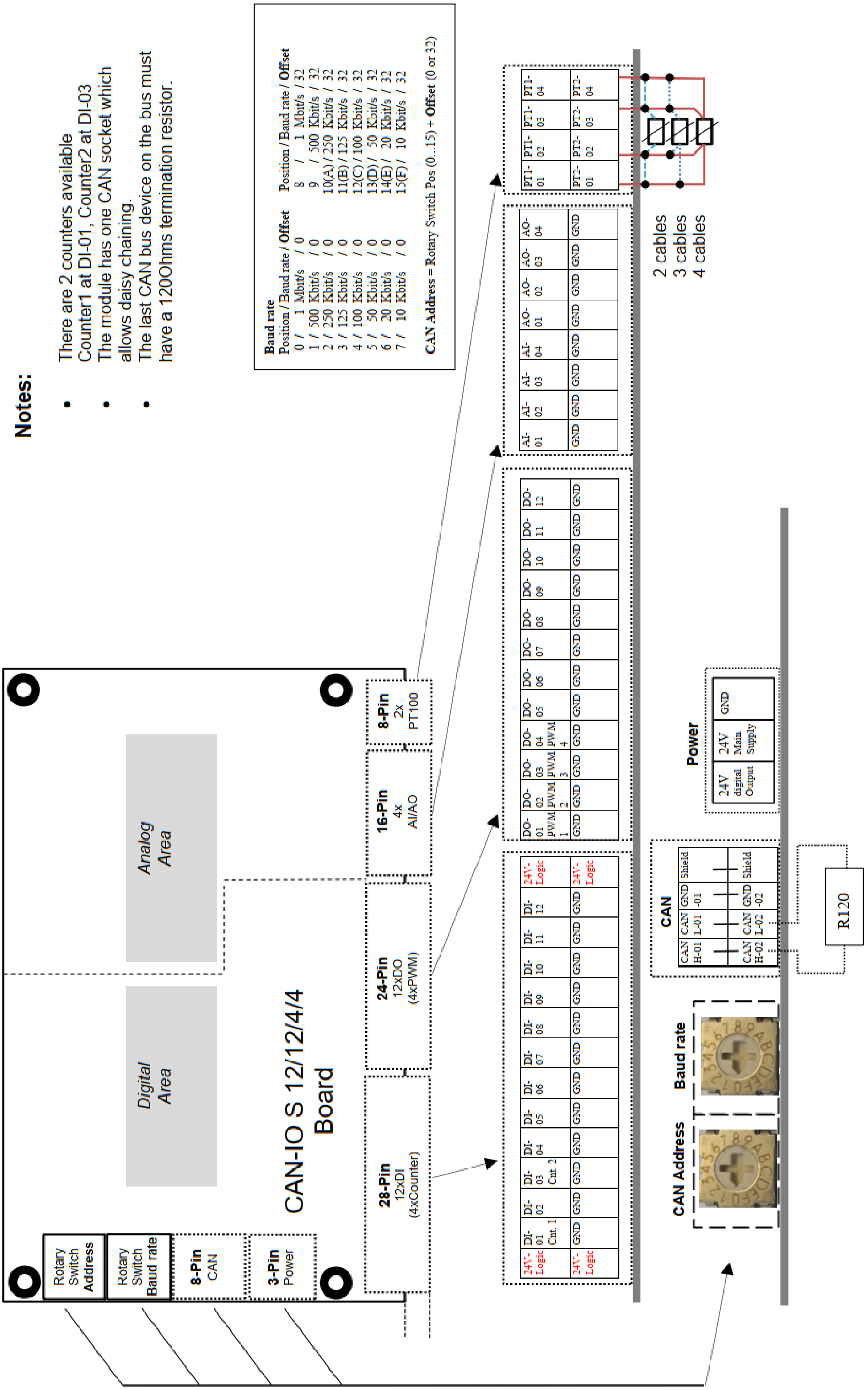
Phoenix Contact Connector 180° DFMC 0,5/ 8-ST-2,54 (Phoenix 1844633)

3.2.8. Temperature Input Connector – PT100 (X203)

PT100 Input	Pin	Signal Name
 1 3 5 7 2 4 6 8	1	PT1-01
	2	PT2-01
	3	PT1-02
	4	PT2-02
	5	PT1-03
	6	PT2-03
	7	PT1-04
	8	PT2-04

Phoenix Contact Connector 180° DFMC 0,5/4-ST-2,54 (Phoenix 1844594)

3.3. Device Overview



4/ Accessing Components

This chapter contains important information that users must read before accessing components. Follow these procedures properly when accessing or installing component to extend the system.

The AL CAN I/O-MODUL is factory configured to meet customer requirements. Kontron Electronics does not recommend opening the system as this may cause damage to internal components.

WARNING

The installation/removal of system components may only be performed by a qualified person. Observe the “General Safety Instructions for IT-Equipment” and the “installation instructions” contained within this user guide.

ESD Sensitive

Follow the safety instructions for components that are sensitive to electrostatic discharge (ESD). Failure to observe this warning notice may result in damage to the product or/and internal components.

4.1. Accessing Internal Components

4.1.1. Opening the Chassis

The AL CAN I/O-MODUL is factory configured to meet customer requirements. Kontron Electronics does not recommend opening the system as this may cause damage to internal components.

5/ Thermal Considerations

⚠WARNING

Hot Surface - heatsink

Danger of burns. Heatsink can get very hot. To avoid burns and personal Injury:

- Do not touch the heatsink when the product is in operation
- Allow the product to cool before handling
- Wear protective gloves
- Always turn the product off when not in use

5.1. Heatsink Plate

The AL CAN I/O-MODUL is a fanless and passively cooled system. When mounting the AL CAN I/O-MODUL in a DIN rail enclosure or housing take care not to obstruct the airflow over the chassis, as this stops sufficient heat dispersing into the ambient environment and causes a build-up of heat.

6/ Installation Instructions

6.1. DIN Rail Mounting

The AL CAN I/O-MODUL is a rail mount box device designed for use in a DIN rail enclosure or housing by attaching a DIN rail mounting clamp. The DIN rail mounting clamp can be attached on the rear side of the chassis.

To attach the DIN Rail mounting clamp, follow the steps below:

1. Make sure that the DIN Rail Mounting clamp is in the upright position.
2. Clip the top of the DIN rail clamp into the DIN rail and push the bottom of the DIN rail firmly until it clamps on to the bottom of the DIN rail.

6.2. Power Connector

The AL CAN I/O-MODUL is connected by the input power connector on the side panel to a DC power source via a DC power supply wiring consisting of the power mating connector and the assembled wires. For information on how to wire the connector, see Chapter 6.2.1: Wiring the DC Mating Power Connector.

6.2.1. Wiring the DC Mating Power Connector

To wire the power mating connector, following the step below.

1. Cut three (1.5 mm^2) AWG24 isolated wires to the required length and strip each end 5 mm – 7 mm.
2. Twist the striped wire-ends and provide them with ferrules.
3. Hold the power connector up right or use a holding device to do so. Hold it firmly in place while pressing down the button for the push-in spring connection to open the spring of the Phoenix power mating connector so that you can insert the end of the prepared wires.
4. Insert the wires into the corresponding clamp of the Phoenix power mating connector. Make sure that you have the right polarity of the connection. For the pin assignment of the input power connector, refer to chapter 3.1.4 Power Connector (X300).
5. Release the pressure of the push-in spring connection button to secure the wires into the Phoenix power mating connector's inner spring.

i

The wires used for power connections must be clearly marked (+/-) to ensure proper connection to the side panel input power connector and to the main power source. In addition, the cables must have some form of support to minimize the strain on the unit's connectors.

i

The Digital Outputs (DO) require a separate supply of power to work. This means 24 volts have to be supplied to the power connector pin *24VDC_Out*. For further details see chapter 3.2.4 Power Connector (X300).

7/ Starting Up

Before using the system, become familiar with the system components and follow the startup instructions below.

7.1. Connecting to Power Supply

The AL CAN I/O-MODUL connects to a DC main power supply via a Phoenix Contact input power connector on the side panel and corresponding power cable.

When starting the AL CAN I/O-MODUL, the functional earth connection must always be made first and disconnected last. Kontron Electronics recommends that the last connections attached to the system should be the power cable. Following a proper cabling procedure will prevent a false power-on condition, which could result in an operational failure.

CAUTION

The AL CAN I/O-MODUL must be connected to a DC mains power supply complying with the SELV (Safety Extra Low Voltage) requirements of EN 60950-1 standard. It must be observed that wiring and short-circuit/overcurrent protection is performed according to the applicable standards, regulations and respect to the electrical specification of the AL CAN I/O-MODUL. The disconnecting device (fuse/circuit breaker) rating must be in accordance with the AL CAN I/O-MODUL's wire cross-section.

To power the AL CAN I/O-MODUL, follow the steps below:

1. Ensure that the DC power source is switched off via a disconnecting device (circuit breaker), in order to ensure that no power is flowing from the external DC power source during the connection procedure.
2. Connect the power connector with wiring (refer to Chapter 6.2: Power Connector and Chapter 6.2.1: Wiring the DC Mating Power Connector) to the Input power connector located on the side panel, see Figure 4: Side and Front Panel (pos. 4). Pay attention to the polarity of the connections. For more information on the input power connector's polarity, see Chapter 3.2.4: Power Connector.
3. Connect the DC power cable's other end to the DC main power supply.
4. Switch on the disconnecting device (circuit breaker) in order to apply voltage to the AL CAN I/O-MODUL.

NOTICE

The power can be disconnected at any time without regard to the AL CAN I/O-MODUL internal processor. The main functions are realized through a microcontroller MCU with a nonerasable program.

DANGER

Cutting the AL CAN I/O-MODUL off from the power supply will turn off the unit and all its outputs, it is no longer possible to control any attached actuators. It must be ensured that turning off the power supply of the AL CAN I/O-MODUL that all attached peripherals are in a safe state or can handle any sudden power loss on their own.

Example programs:

Example programs with Linux SocketCAN communication written in C, Python, CODESYS and QT can be found on our Git server at:
https://git.kontron-electronics.de/sw/ked/can-io/al-can-io-12-12-4-4

8/ CAN Command Reference

This chapter is intended as a reference and documentation of all available CAN commands which are understood by the AL CAN I/O-MODUL. The device does not support CANopen, however users will find some basic similarities of the CAN commands in this chapter and how CANopen commands are defined. Prior knowledge in CAN-Bus communication is recommended.

The different CAN commands are documented with their function and if needed, which data as payload needs to be sent to the AL CAN I/O-MODUL to perform the desired action. At the end of this chapter is a whole section with examples showing how to communicate with the device on a basic level using the program *cansend* from the *can-utils* packages as it is found under Debian Linux for example. This program can be used for a first commissioning of the AL CAN I/O-MODUL without the need for a self-written program. This allows for a straightforward test to see if the CAN-Bus wiring is correct and if the module is responding.

8.1. Legend and definitions

- **Blue Fields** = Master (CPU) is sending
- **Orange Fields** = Slave (CAN IO module) is sending an answer

- PT100 = Resistance value and Temperature will be transmitted (e.g.: at 0.00°C = 100.00 ohms)
- Counter can only count upwards to 2^32.
- U/I direction = Switch between current (0-20mA) and voltage measurement (0-10V) for the analog inputs
- Baud rate = (0 = 1Mbit, 1 = 500kbit, 2 = 250kbit, 3 = 125kbit, 4 = 100kbit, 5 = 50kbit, 6 = 20kbit, 7 = 10kbit), will become active only after a power cycle!

The descriptions and commands used in this documentation are taken in part from the CANopen specification, but the implemented protocol does not support CANopen or SAE J1939.

Controller	Master of the CAN communication, e.g. a PLC with CAN interface
Module	Slave of the CAN communication, the here mentioned AL CAN I/O-MODUL device for example
Node-ID	A selectable ID (CAN-ID) or device address which identifies the module on the bus
COB-ID	Communication Object Identifier (general description)
NMT	Network Management Objects, used to control different modes of the module
PDO	Process Data Object, requested or transmitted I/O data
SDO	Service Data Object, change the configuration of Inputs and Outputs, e.g. change the analog inputs from voltage measurement to current measurement or set and enable the PWM functionality and so on
SDO Download	The controller (client/master) sends data (request) to the module (slave/server). The answers the request with a response. If the download was successful otherwise it sends an SDO Abort
SDO Upload	Module (slave/server) replies to the controllers (client/master) request and send the desired data (response) to the controller (client/master). If the requested data is not available an SDO Abort is sent
D1...D8	8 data bytes in a CAN telegram (message)
Data	Data in a CAN telegram (message), data types which consists of multiple bytes always start with the lowest part fist
Function	Describes the function of a telegram
Slave	Designates the AL CAN I/O-MODUL device

Master	Designates the parent controller, usually a PLC
Heartbeat	These are cyclically sent telegrams when can be received by all connected CAN-Bus devices. The receiver (consumer) can detect the failure of a sender (producer) through a time supervision and can initiate countermeasures, e.g. go into a save state.
Producer	This is the sender of a Heartbeat telegram
Consumer	This is the receiver of a Heartbeat telegram

Table 19: Default CAN-IDs

Default CAN-ID	Service
000_h	Network Management (NMT)
080_h	Synchronizing Object
080_h+Node-ID	Emergency
180_h+Node-ID	TX Process Data Objects (PDO)
200_h+Node-ID	RX Process Data Objects (PDO)
280_h+Node-ID	TX Process Data Objects (PDO)
300_h+Node-ID	RX Process Data Objects (PDO)
380_h+Node-ID	TX Process Data Objects (PDO)
400_h+Node-ID	RX Process Data Objects (PDO)
480_h+Node-ID	TX Process Data Objects (PDO)
500_h+Node-ID	RX Process Data Objects (PDO)
580_h+Node-ID	TX Service Data Objects (SDO)
600_h+Node-ID	RX Service Data Objects (SDO)
700_h+Node-ID	BOOT-UP Protocol
700_h+Node-ID	Nodeguarding and Heartbeat

Address and Baud rate switches

To allow for a wider address range, the free positions on the baud rate switch are used to introduce an offset to the address switch. The baud rate settings are repeated in the positions 8_h … F_h but the address receives an offset of 32.

Position Address switch (S400)	Address	Position Baud rate switch (S401)	Baud rate	Address offset	Resulting Address (example)
0	0+Offset	0	1Mbit	0	0
1	1+Offset	1	500kBit	0	1
2	2+Offset	2	250kbit	0	2
3	3+Offset	3	125kbit	0	3
4	4+Offset	4	100kbit	0	4
5	5+Offset	5	50kbit	0	5
6	6+Offset	6	20kbit	0	6
7	7+Offset	7	10kbit	0	7
8	8+Offset	0	1Mbit	0	8
9	9+Offset	1	500kBit	0	9
A	10+Offset	2	250kbit	0	10
B	11+Offset	3	125kbit	0	11
C	12+Offset	4	100kbit	0	12
D	13+Offset	5	50kbit	0	13
E	14+Offset	0	1Mbit	0	14
F	15+Offset	1	500kBit	0	15
0	0+Offset	8	1Mbit	32	32
1	1+Offset	9	500kBit	32	33
2	2+Offset	A	250kbit	32	34
3	3+Offset	B	125kbit	32	35
4	4+Offset	C	100kbit	32	36
5	5+Offset	D	50kbit	32	37
6	6+Offset	E	20kbit	32	38
7	7+Offset	F	10kbit	32	39
8	8+Offset	8	1Mbit	32	40
9	9+Offset	9	500kBit	32	41
A	10+Offset	A	250kbit	32	42
B	11+Offset	B	125kbit	32	43
C	12+Offset	C	100kbit	32	44
D	13+Offset	D	50kbit	32	45
E	14+Offset	E	20kbit	32	46
F	15+Offset	F	10kbit	32	47

Table 20: CAN Address and Baud Rate Switches

8.2. CAN Commands

8.2.1. NMT Commands

NMT commands can be used to change the operating state of the module or instruct it to perform a reset.

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8	Function
Network Management Objects (NMT) can be sent in any state									
000h	01h	Node-ID							Operational
000h	02h	Node-ID							Stop
000h	80h	Node-ID							Pre-Operational
000h	81h	Node-ID							Reset
700h+Node-ID	1	2	3	4	5	6	7	8	After Reset / Bootup

Table 21: NMT Commands

8.2.2. Description of the NMT Commands

8.2.2.1. States, Start-Up and Operation of the AL CAN I/O-MODUL module

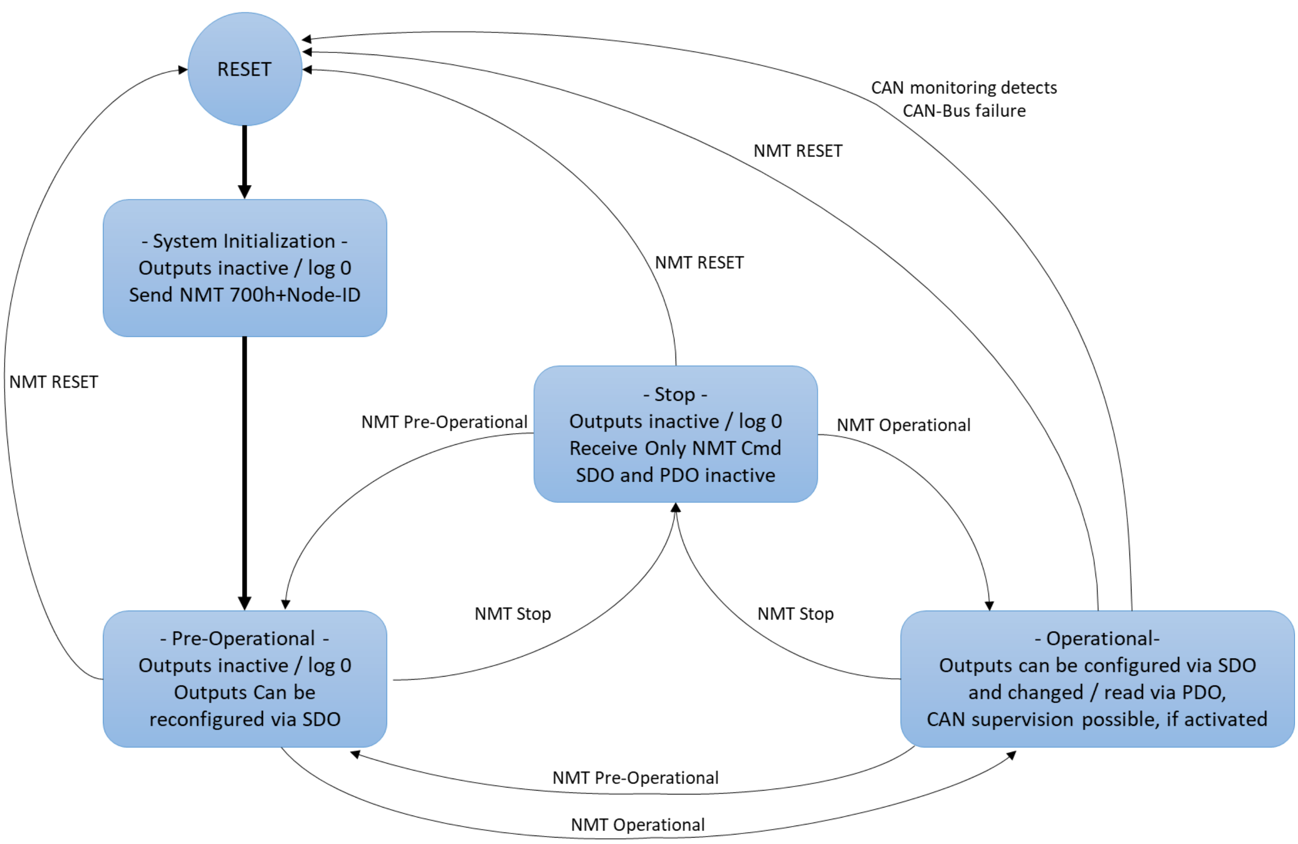


Figure 5: States Diagram

8.2.2.2. RESET

After a RESET, no matter if it occurred due to a power on or an NMT-Reset command, the module does a *System Initialization* and then goes into the state *Pre-Operational*. All outputs of the module are switched to an inactive state and the configuration of the I/Os is reset to their default settings. These settings are:

- Input 1…12 → Set to Digital Input
- Output 1…12 → Set to Digital Output, 0V / high resistance
- Analog Input 1…4 → Set to 0V…10V voltage input
- Analog Output 1…4 → Set to 0V…10V voltage output 0V

8.2.2.3. Pre-Operational

When entering this state, all outputs of the module are reset to their default configuration (see 8.2.2.2 RESET). All configuration settings and values must be re-transmitted to the module to restore the desired functionality. In this state it is possible to configure the Inputs and Outputs via SDO, meaning their functions can be changed, if the corresponding input or output has an alternate function. A Heartbeat signal will be sent if it is active.

8.2.2.4. Operational

The module can receive SDO telegrams, which allows the user to change the configuration of the inputs and outputs during operation, but it also sends and receives PDOs. The PDOs allow the user to request the current state of the inputs and set the outputs of the module. A Heartbeat signal will be sent if it is active.

8.2.2.5. Stop

All outputs are turned to an inactive state and will be reset to their default configuration, see also chapter 8.2.2.2 RESET. All configuration settings and values must be re-transmitted to the module to restore the desired functionality, with exception of the Heartbeat signal. In this state the module only accepts NMT commands, meaning this state can only be left using an NMT command or doing a power cycle, after which the module will enter the *Pre-Operational* state, see chapter 8.2.1 and the diagram at the beginning of chapter 8.2.2. A Heartbeat signal will be sent if it is active.

8.2.3. Object Dictionary

Index	Sub	RW	Data 5,6,7,8 (as they are sent)	Function
0x1016	0x00	R	0x01, 0x00, 0x00, 0x00	Number of Consumer Heartbeat
0x1016	0x01	R/W	0x00**IDtttt** (default 0x00000000 = no supervision) ID = Node-ID of the Producer of the Heartbeat tttt = [ms] Monitoring time	Consumer Heartbeat Time Which Node-ID (Producer) should the module monitor using which monitoring time.
0x1017	0x00	R/W	0xtttt (Default value 0x0000), 0x00, 0x00 tttt = Module sends out a Heartbeat in intervals of [ms]	Producer Heartbeat Time [ms] > 0 → Module sends Heartbeat = 0 → Module sends no Heartbeat
0x2000	0x00	R	HW-Type, Bugfix, Minor, Major	Hardware type (functional model), Hardware revision (version)
0x2001	0x00	R	0, Bugfix, Minor, Major	0x00, Software revision (version)
0x2002	0x00	R	Index Baud rate, 0x00,0x00,0x00	Index Baud rate: 0 = 1 MBit/s 1 = 500 kbit/s 2 = 250 kbit/s 3 = 125 kbit/s 4 = 100 kbit/s 5 = 50 kbit/s 6 = 20 kbit/s 7 = 10 kbit/s
0x2003	0x00	R/W	Send interval (LSB), Send interval (MSB), Choice, 0x00	Cyclic sending of the chosen PDOs in [ms]
0x2004	0x00	R/W	Counter State1, Counter State2, 0x00, 0x00	State of the counters: 1 = Start, 2 = Stop 4 = Reset + Stop
0x2005	0x00	R/W	4-Bit switch for the Analog In to/from voltage (U) / current (I), 0x00, 0x00, 0x00	Analog Input, U/I direction U = 1, I = 0, default U
0x2006	0x00	R/W	4-Bit switch for the Digital Out / PWM Out, PWM Prescaler (LSB), PWM Prescaler (MSB), 0x00	Switch 4 Channels to Bit = 0 digital Output Bit = 1 PWM Output PWM base frequency = 72 MHz / (Prescaler x Cycle)
0x2007	0x00	R/W	Mode 0 / 1, PWM Cycle (LSB), PWM Cycle (MSB), 0x00	Set Telegram Mode PDO 400 PWM Cycle = Number of steps between 0%...100% If cycle = 0 → Default value = 1000

Table 22: Object Dictionary

8.2.4. SDO Download (Write Access)

The master (control device) writes data into the object dictionary of the slave (module).

COB-ID	D1 Control	D2 Index Low	D3 Index High	D4 Subindex	D5 Data	D6 Data	D7 Data	D8 Data	Function
Service Data Objects (SDO) are only accessible in Pre-Operational and in Operational states (send & receive)									
600h+ Node-ID	23h	16h	10h	01h	HB-Time LSB	HB-Time MSB	Node-ID Producer HB	00h	Consumer Heartbeat [ms], Time used by the module to monitor the supplied ID
600h+ Node-ID	23h	17h	10h	00h	HB-Time LSB	HB-Time MSB	00h	00h	Producer Heartbeat [ms], Intervall used by the module to send its own Heartbeat: > 0 Modul sends HB = 0 Modul sends no HB
600h+ Node-ID	23h	03h	20h	00h	PDO send rate (LSB)	PDO send rate (MSB)	Choice of PDO to send, one bit per PDO	00h	PDO send rate [ms] > 0 Send PDOs cyclically = 0 Don't send cyclically Choice of PDOs: Bit0 = COB-ID 180h Bit1 = COB-ID 280h Bit2 = COB-ID 380h Bit3 = COB-ID 480h PDOs: Bit = 1 → send Bit = 0 → don't send.
600h+ Node-ID	23h	04h	20h	00h	Counter1	Counter2	00h	00h	Set Counter 1-2: 1 = Start, 2 = Stop, 4 = Reset + Stop
600h+ Node-ID	23h	05h	20h	00h	AI 1…4 (4-bits)	00h	00h	00h	Analog Input U / I direction Bit0 = Analog Input 1 Bit1 = Analog Input 2 Bit2 = Analog Input 3 Bit3 = Analog Input 4 Values: 1 = U (voltage), 0 = I (current), default U (voltage)
600h+ Node-ID	23h	06h	20h	00h	PWM 1…4 (4-bits)	Prescaler Low (3…	Prescaler High 0xFFFF$_h$)	00h	Switch 4 Channels to Bit = 0 digital Output Bit = 1 PWM Output Set Prescaler 3…FFFF$_h$
600h+ Node-ID	23h	07h	20h	00h	Mode 0/1 PDO 400	PWM Cycle Low (10…	PWM Cycle High 0xFFFF$_h$)	00h	Set Telegram Mode PDO 400 Set PWM Cycle
600h+ Node-ID	23h	08h	20h	00h	W	00h	00h	00h	Test fuse F200 W>0 simulates a break

									W=0 State of fuse is valid
580h+ Node-ID	60h	03h 04h 05h 06h 07h 08h	20h	00h	00h	00h	00h	00h	SDO received, positive response

Table 23: SDO Download (Write Access)

As a rule, for all data types, if a data type consists of more than one byte, the lowest byte always comes first within a CAN telegram. This rule applies to all telegrams of the protocol.

It is required to always send 4 data bytes, no matter if the actual number of needed bytes is less. Because of this the control byte always has the value 23h.

Using SDOs it is possible to read and write data objects in the module, the module is always the data server.

Every action originates or is initiated from/by the control device (Master) and every telegram will be acknowledged or replied to by the AL CAN I/O-MODUL.

8.2.4.1. Download Request

Telegram structure for writing (view from the controller)

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8
600h+Node-ID	Control (23h)	Index Low	Index High	Subindex	Data	Data	Data	Data

Control Byte (D1)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	0	Not used	Not used	1	1

Use *Index* and *Subindex* to address the actual data object in the module. The telegram must always contain 4 bytes of payload (data, D5 ... D8); however, the actual number of significant bytes can be smaller. The module expects 4 bytes of data. The *Control* byte (D1) must always be set to 23_h.

8.2.4.2. Download Response

Each request will be answered with a response.

a. Positive Response

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8
580h+ Node-ID	Control (60h)	Index Low	Index High	Subindex	Data 00h	Data 00h	Data 00h	Data 00h

Control Byte (D1):

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	1	0	0	0	0	0

b. Negative Response

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8
580h+ Node-ID	Control (80h)	Index Low	Index High	Subindex	Data 02h 00h 10h	Data 00h 00h 00h	Data 01h 02h 07h	Data 06h 06h 06h

Control Byte (D1):

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	0	0	0	0	0

Data Error code (D8…D5):

0x06010002 Write action performed on read only Service Data Object

0x06020000 Service data not supported by module

0x06070010 Size of the data type does not match the number of needed data bytes

8.2.5. SDO Upload (Read Access)

The master (control device) reads data from the Object Dictionary of the slave (module).

COB-ID	D1 Control	D2 Index Low	D3 Index High	D4 Subindex	D5 Data	D6 Data	D7 Data	D8 Data	Function
Service Data Objects (SDO) are only accessible in Pre-Operational and in Operational states (send & receive)									
600h+ Node-ID	40h	16h	10h	00h / 01h	00h	00h	00h	00h	SDO read, Subindex 00h and 01h
580h+ Node-ID	43h	16h	10h	00h	01h	00h	00h	00h	How many other bus members can be monitored
580h+ Node-ID	43h	16h	10h	01h	Timeout LSB	Timeout MSB	Node-ID of the Producer	00h	Monitored member (Master) address and time [ms]
600h+ Node-ID	40h	17h	10h	00h	00h	00h	00h	00h	SDO read
580h+ Node-ID	43h	17h	10h	00h	01h	00h	00h	00h	How many members can be monitored / how many IDs and times can be configured = 1

Continued next page…

The master (control device) reads data from the Object Dictionary of the slave (module).

COB-ID	D1 Control	D2 Index Low	D3 Index High	D4 Subindex	D5 Data	D6 Data	D7 Data	D8 Data	Function
Service Data Objects (SDO) are only accessible in Pre-Operational and in Operational states (send & receive)									
600h+ Node-ID	40h	00h…08h	20h	00h	00h	00h	00h	00h	SDO read, Index 0h to 7h
580h+ Node-ID	43h	00h	20h	00h	HW type	HW version bugfix	HW version minor	HW version major	Hardware type = 1 (functional model), Hardware revision (version)
580h+ Node-ID	43h	01h	20h	00h	00h	SW version bugfix	SW version minor	SW version major	00h, Software revision (version)
580h+ Node-ID	43h	02h	20h	00h	Baud rate	00h	00h	00h	Baud rate 0 =1Mbit…7 =10kbit
580h+ Node-ID	43h	03h	20h	00h	PDO send rate (LSB)	PDO send rate (MSB)	Choice of PDO to send, one bit per PDO	00h	PDO send rate [ms] > 0 Send PDOs cyclically = 0 Don't send cyclically Choice of PDOs: Bit0 = COB-ID 180h Bit1 = COB-ID 280h Bit2 = COB-ID 380h Bit3 = COB-ID 480h PDOs: Bit = 1 → send Bit = 0 → don't send
580h+ Node-ID	43h	03h	20h	00h	Send interval (LSB)	Send interval (MSB)	00h	00h	Send interval [ms] for automatic sending of PDOs (only inputs)
580h+ Node-ID	43h	04h	20h	00h	Counter1	Counter2	00h	00h	Counter 1 – 2 1 = running 2 = stopped 4 = stopped and zero
580h+ Node-ID	43h	05h	20h	00h	AI 1…4 (4-bits)	00h	00h	00h	Analog Input U / I direction Bit0 = Analog Input 1 Bit1 = Analog Input 2 Bit2 = Analog Input 3 Bit3 = Analog Input 4 Values: 1 = U (voltage), 0 = I (current), default U (voltage)
580h+ Node-ID	43h	06h	20h	00h	PWM 1…4 (4-bits)	Prescaler Low (3…	Prescaler High 0xFFFFh)	00h	Output Function Bit = 0 digital Output Bit = 1 PWM Output, Prescaler of PWM
580h+ Node-ID	43h	07h	20h	00h	Mode 0/1 PDO 400	PWM Cycle Low (10…	PWM Cycle High 0xFFFF)	00h	Selected telegram mode for PDO 400, PWM Cycle

580h+ Node-ID	43h	08h	20h	00	W	00h	00h	00h	Test fuse F200 W>0 simulates a break W=0 State of fuse is valid

Table 24: SDO Upload (Read Access)

As a rule, for all data types, if a data type consists of more than one byte, the lowest byte always comes first within a CAN telegram. This rule applies to all telegrams of the protocol.

The module will always send 4 data bytes, no matter if the actual number of needed bytes is less. Because of this the control byte always has the value 43h.

Using SDOs it is possible to read and write data objects in the module, the is always the data server.

Every action originates or is initiated from/by the control device (Master) and every telegram will be acknowledged or replied to by the AL CAN I/O-MODUL.

8.2.5.1. Upload Request

Telegram structure for reading (view from the controller):

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8
600h+ Node-ID	Control (40h)	Index Low	Index High	Subindex	Data 00h	Data 00h	Data 00h	Data 00h

Control Byte (D1)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	0	0	0	0	0

Use *Index* and *Subindex* to address the actual data object in the module. The telegram must always contain 4 bytes of payload (data, D5 ... D8); however, the actual number of significant bytes can be smaller. The module will send (respond) 4 bytes of data with the *Control* byte (D1) always set to 43_h.

8.2.5.2. Upload Response

Each request will be answered with a response.

a. Positive Response

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8
580h+ Node-ID	Control (43h)	Index Low	Index High	Subindex	Data	Data	Data	Data

Control Byte (D1):

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	0	0	0	1	1

b. Negative Response

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8
580h+ Node-ID	Control (80h)	Index Low	Index High	Subindex	Data 00h	Data 00h	Data 02h	Data 06h

Control Byte (D1):

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	0	0	0	0	0

Data Error code (D8…D5):
0x06020000 Service data not supported by module

8.3. PDOs

Using PDOs the controller (Master) can read and write process data from the module. There are two ways to get/read process data from the module. The controller can request the wanted process data from the module (polling) or have it sent cyclically.

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8	Function
Process Data Objects (PDO) are only possible in Operational Mode (send & receive)									
180h+ Node-ID									Get Digital In 1-12
180h+ Node-ID	DI 1…8	DI 9…12	00h	00h	00h	00h	00h	00h	Send Digital In 1-12; High=1, Low=0
200h+ Node-ID	DO 1…8	DO 9…12							Set Digital Out 1-12; High=1, Low=0
280h+ Node-ID									Get Analog In 1-4
280h+ Node-ID	AI1 Low	AI1 High	AI2 Low	AI2 High	AI3 Low	AI3 High	AI4 Low	AI4 High	Send Analog In 1-4; 16Bit/Input
300h+ Node-ID	AO1 Low	AO1 High	AO2 Low	AO2 High	AO3 Low	AO3 High	AO4 Low	AO4 High	Set Analog Out 1-4; 16Bit/Output
380h+ Node-ID									Get Temp PT100-1/2
380h+ Node-ID	PT100-1 R Low	PT100-1 R High	PT100-2 R Low	PT100-2 R High	PT100-1 T Low	PT100-1 T High	PT100-2 T Low	PT100-2 T High	Send Resistance & Temp PT100-1/2; 16Bit/PT100
400h+ Node-ID (Mode 0)	PWM1 Low	PWM1 High	PWM2 Low	PWM2 High	PWM3 Low	PWM3 High	PWM4 Low	PWM4 High	Set PWM Duty Cycle 0…1000 = 0,0% …100,0%
400h+ Node-ID (Mode 1)	PWM 1…4 (4-Bit)	PWM High	PWM Low						Set PWM Duty Cycle equal for PWM1 to 4 0…1000 = 0,0% …100,0%
480h+ Node-ID									Get Counter 1-2
480h+ Node-ID	Counter1 Low0	Counter1 High0	Counter1 Low1	Counter1 High1	Counter2 Low0	Counter2 High0	Counter2 Low1	Counter2 High1	Send Counter 1-2 32Bit/Counter

Table 25: Overview available PDOs

As a rule, if a data type consists of more than one byte, the lowest byte always comes first within a CAN telegram. This rule applies to all telegrams of the protocol. For a more detailed description of the individual PDOs, see the following chapters.

8.3.1. Digital Inputs (DI 1…12)

This command can be used to request the module to send its current state of the digital inputs.

180h+ Node-ID									Get Digital In 1-12

The module will reply with this telegram:

180h+ Node-ID	DI Bit 1…8	DI Bit 9…12							Send Digital In 1-12; High=1, Low=0

<u>Note:</u> DI 1 is the lowest/first bit in the first data byte of the reply telegram, DI 9 is the first/lowest bit in the second data byte of the reply telegram and DI 12 is the 4th bit in the second data byte of the reply telegram.

Bit = 0 → Input <= Voltage value

Bit = 1 → Input >= Voltage value

Also see technical information on page 18, Table 4: Digital Inputs (DI) about the voltage levels.

8.3.2. Digital Outputs (DO 1…12)

This command can be used to tell the module to set its digital outputs according to the 2 bytes in the payload of the telegram.

200h+ Node-ID	DO Bit 1…8	DO Bit 9…12							Set Digital Out 1-12; High=1, Low=0

For each digital output DO 1...12 there is one corresponding bit in one of the two bytes. DO 1 is the lowest bit and DO 12 is the highest bit of the 12 bits used for the digital outputs. The remaining bits are unused and will be ignored by the module.

<u>Note:</u> DO 1 is the lowest/first bit in the first data byte of the telegram, DO 9 is the first/lowest bit in the second data byte of the telegram and DO 12 is the 4th bit in the second data byte of the telegram.

Bit = 0 → Output low (0V)

Bit = 1 → Output active, equals supply voltage

Also see technical information on page 18, Table 5: Digital Outputs (DO) about the voltage levels.

8.3.3. Analog Inputs (AI 1…4)

This command can be used to request the module to send its current values of the analog inputs.

280h+ Node-ID									Get Analog In 1-4

The module will reply with this telegram:

280h+ Node-ID	AI1 Low- Byte	AI1 High- Byte	AI2 Low- Byte	AI2 High- Byte	AI3 Low- Byte	AI3 High- Byte	AI4 Low- Byte	AI4 High- Byte	Send Analog In 1-4 16Bit/Input

Each value of an analog input consists of 2 bytes, meaning it is a 16-bit value. The voltage or current is measured directly at the input and is converted into a fixed floating-point format with 2 decimal places.

Examples for voltage measurement:

- Input is 10 volts → value 1000 will be transmitted
- Input is 3.5 volts → value 350 will be transmitted
- Input is 0.75 volts → value 75 will be transmitted

Examples for current measurement:

- Input is 17.5mA → value 1750 will be transmitted
- Input is 0.75 → value 75 will be transmitted

Using the corresponding SDO, the analog inputs can be switched from voltage measurement to current measurement and back. This is possible for each analog input individually, however after each power on or Reset command, all analog inputs default to voltage measurement. The change from voltage to current measurement changes the internal impedance, see the technical specifications on page 18,

Note: The Digital Outputs (DO) require a separate supply of power to work. This means 24 volts have to be supplied to the power connector pin *24VDC_Out*. For further details see chapter 3.2.4 Power Connector (X300).

Table 6: Analog Inputs (AI) for further information.

The telegram defines the analog values as 2 bytes where the first byte (low byte) comes first and then the second byte (high byte). Keep this in mind if you are working on a system that swaps high and low bytes (byte ordering / endianness).
All values are measured using an AD converter with a 12bit resolution. The second decimal place is not as precise because of the resolution and can fluctuate.

8.3.3.1. Switch from Voltage to Current Measurement – SDO 600h Index 2305h

Using this command in *Pre-Operational* or *Operational* mode allows the user to change the measurement setting of the analog inputs from voltage to current measurement and back.

600h+ Node-ID	23	05	20	00	AI 1…4 (4-bit)				Set U/I direction U = 1, I = 0, default U

The setting of each analog input is determined by one of four bits in the above telegram.
The values of the bits are:

Bit 2^0 → 1 = Voltage input, 0 = Current input (Analog Input 1)
Bit 2^1 → 1 = Voltage input, 0 = Current input (Analog Input 2)
Bit 2^2 → 1 = Voltage input, 0 = Current input (Analog Input 3)
Bit 2^3 → 1 = Voltage input, 0 = Current input (Analog Input 4)

8.3.4. Analog Outputs (AO 1…4)

The analog outputs allow the user to output a positive voltage value between 0V and 10V.

300h+ Node-ID	AO1 Low-Byte	AO1 High-Byte	AO2 Low-Byte	AO2 High-Byte	AO3 Low-Byte	AO3 High-Byte	AO4 Low-Byte	AO4 High-Byte	Set Analog Out 1-4 16Bit/Output

Each analog value consists of 2 bytes (16Bits) of a fixed floating-point format with two decimals places. The telegram includes all 4 analog outputs, which means each time one analog output needs to be changed, the values for all four analog outputs must be transmitted. Also refer to the technical information on page 19, Table 7: Analog Outputs (AO).

Examples:

- transmitting value 1000 → the output will be set to 10.00 volts
- transmitting value 350 → the output will be set to 3.50 volts
- transmitting value 75 → the output will be set to 0.75 volts

The telegram defines the analog values as 2 bytes where the first byte (low byte) comes first and then the second byte (high byte). The voltage output values are realized through a DAC with a 12Bit resolution. Because of this, changes to the second decimal place of the of the voltage value will not always result in a change of the real voltage value calculated by the DAC.

8.3.5. Temperature Inputs (PT100 1…2)

This CAN command instructs the module to send its analog temperature values.

380h+ Node-ID									Get Temp PT100-1/2

The module will respond with the following telegram:

380h+ Node-ID	PT100-1 R Low-Byte	PT100-1 R High-Byte	PT100-2 R Low-Byte	PT100-2 R High-Byte	PT100-1 T Low-Byte	PT100-1 T High-Byte	PT100-2 T Low-Byte	PT100-2 T High-Byte	Send Resistance & Temp PT100-1/2; 16Bit/PT100

Each value of a temperature input consists of 2 bytes, meaning it is a 16-bit value. The resistance and the corresponding temperature are measured directly at the input and are converted into a fixed floating-point format with 2 decimal places.

Examples:

- measured 100.00 ohms → transmitted value is 10000 (ohms) and 0 (temperature) or 0.0 °C
- measured 84.271 ohms → transmitted value is 8424 (ohms) and -4000 (temperature) or -40.00 °C
- measured 146.068 ohms → transmitted value is 14606 (ohms) and 12000 (temperature) or 120.00 °C

All temperatures outside of the defined temperature range, see technical information on page 19 Table 8: Temperature Inputs (PT100), will be transmitted as -20000 or +20000. The value -20000 also signals a short circuit of the sensor cables whereas the value +20000 means no sensor cable is connected or a cable is broken.

The telegram defines each of the PT100 values as 2 bytes where the first byte (low byte) comes first and then the second byte (high byte).

All values are measured using an AD converter with a 12bit resolution. The second decimal place is not as precise because of the resolution and can fluctuate.

8.3.6. PWM Outputs (1…4)

8.3.6.1. Duty Cycle

400h+ Node-ID (Mode 0)	PWM1 Low-Byte	PWM1 High-Byte	PWM2 Low-Byte	PWM2 High-Byte	PWM3 Low-Byte	PWM3 High-Byte	PWM4 Low-Byte	PWM4 High-Byte	Set PWM Duty Cycle 0…1000 = 0.0% …100.0%
400h+ Node-ID (Mode 1)	PWM 1…4 (4 Bits)	PWM High-Byte	PWM Low-Byte						Set PWM Duty Cycle is the same for PWM1 to 4 0…1000 = 0,0% …100,0%

There are two options to change the duty cycle of the PWM outputs. Both options can be sent to the module using the same CAN command, *COB-ID 400h*. In which way the module interprets the telegram is defined by the mode, which is either *0* or *1* and can be set using the *SDO 600h 07h* command.

Mode 0 allows to set or change all four PWM outputs with one telegram or command. All PWM outputs can have different duty cycle settings.

Mode 1 allows to set the same duty cycle setting for individual PWM outputs depending on the selection in the telegram. Using the first 4 bits in the first byte of the telegram, any combination of one up to four selected PWM outputs is possible.
The selection options are:

Bit 2^0 → PWM1
Bit 2^1 → PWM2
Bit 2^2 → PWM3
Bit 2^3 → PWM4

All PWM values have a value range of 0.0% to 100.0% and must be transmitted as a number format of 0 … 1000, meaning the values have a fixed one places decimal.
Note: This format will be kept even if the PWM cycle of 1000 is changed, all values will be recalculated and converted internally, for example:

Cylce: 500 (instead of 1000)
PWM value: 600 (= 60.0%)
→ internal PWM value = (500 / 1000) * 600 = 300

The PWM cycle can be changes using the CAN command *SDO 600h 07h*, also see further down. By default, and after a RESET the PWM cycle value will be set to 1000.
If the PWM function is not active, the PWM telegrams and commands will still be accepted by the module, however the output will remain a *normal* digital output and does not switch to PWM mode.

8.3.6.2. PWM Activation and Settings

600h+ Node-ID	23	06	20	00	PWM 1…4 (4 bits)	Prescaler Low (3…	Prescaler High 0xFFFF)		Switch 4 Channels to Bit = 0 digital Output Bit = 1 PWM Output Set Prescaler
600h+ Node-ID	23	07	20	00	Mode 0/1 PDO 400	PWM Cycle Low (10…	PWM Cycle High 0xFFFF)		Set Telegram Mode PDO 400 Set PWM Cycle

With these two SDOs the general behavior of the PWM outputs can be set. Each of these SDOs also resets the duty cycle of the PWM outputs to 0, switching the outputs to *logic 0*. After any change the duty cycle must be set again. This mechanism should prevent an unwanted behavior or output while changing the Prescaler or the PWM resolution.

8.3.6.3. Changing DO / PWM Outputs and Prescaler (SDO 600h Index 2306h)

Using this SDO four of the digital outputs can be switched from a digital output mode to a PWM mode, see chapter 3.2.6 which digital outputs can be changed. For each of the four outputs there is one bit which determines the function of the output, every combination of these four bits is allowed, everything from zero up to four PWM outputs.
The options are:

Bit 2^0=0/1 → 0=digital Output01, 1=PWM1
Bit 2^1=0/1 → 0=digital Output02, 1=PWM2
Bit 2^2=0/1 → 0=digital Output03, 1=PWM3
Bit 2^3=0/1 → 0=digital Output04, 1=PWM4

The Prescaler setting included in the SDO defines together with the PWM Cycle the base frequency of the PWM output. The PWM cycle is by default a value of 1000 and can be changed if needed.

Background: Using a PWM Cycle of 1000 offers 1000 PWM steps between 0% and 100%. This means the Pulse width can be changed in steps of 0.1%.

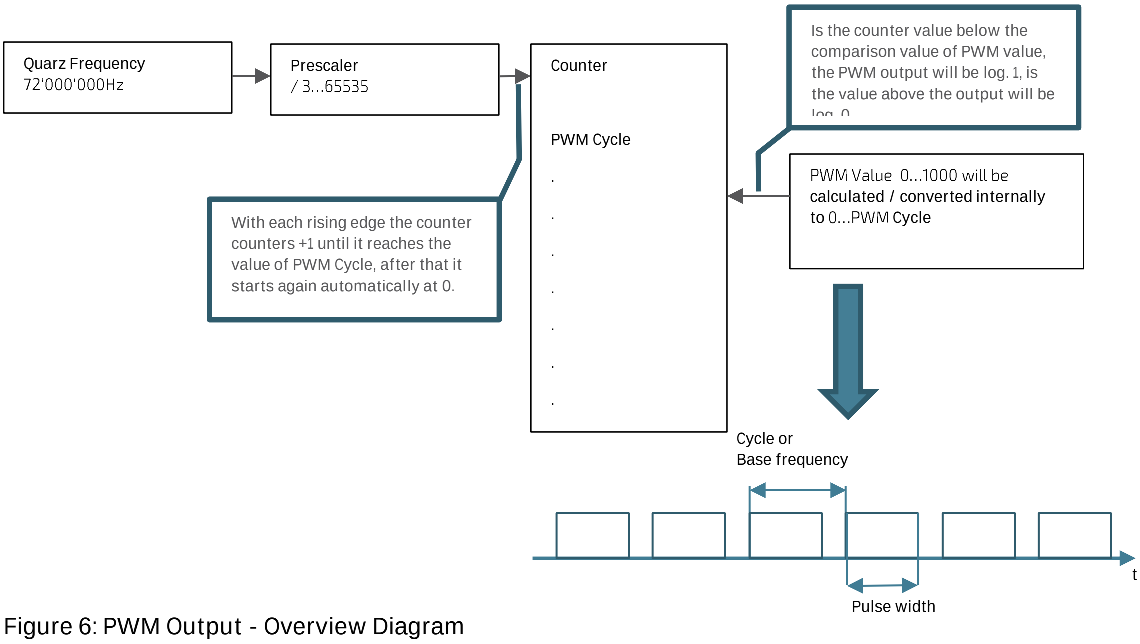


Figure 6: PWM Output - Overview Diagram

8.3.6.4. Formula to Calculate the PWM Base Frequency

The base frequency for the PWM outputs can be calculated with the following formula:

Base frequency = 72'000'000Hz / (Prescaler x PWM Cycle)

For the default PWM Cycle of 1000 steps, the following example frequencies can be calculated:

Base frequency = 72000000 / (3 * 1000) = 24000Hz
Base frequency = 72000000 / (4 * 1000) = 18000Hz
Base frequency = 72000000 / (5 * 1000) = 14400Hz
...

Base frequency = 72000000 / (100 * 1000) = 720Hz

... and so on

8.3.6.5. PWM Format and Resolution (SDO 600h Index 2307h)

600h+ Node-ID	23	07	20	00	Mode 0/1 PDO 400	PWM Cycle Low (10…	PWM Cycle High 0xFFFF)		Set Telegram Mode PDO 400 Set PWM Cycle

Using this SDO the module be instructed on how to interpret the *PDO 400h*.
There are two modes to choose from:

Mode 0:
All four PWM values (PWM duty cycle) for all four PWM outputs can be transmitted using one single *PDO 400h*. All four values can be different and do not have to be the same. The values will be internally calculated and the active PWM outputs (*SDO 600h Index 2307h*) will output a PWM signal with their duty cycle.

Mode 1:
In this mode the PDO 400h allows to select individual PWM outputs and only set a PWM value for the selected PWM outputs while all not selected PWM outputs keep their settings and remain unchanged. To set every PWM output individually, four PDO 400h telegrams are needed to set a new PWM value for each activate PWM output. PWM outputs can be activated using the SDO 600h Index 2307h. An activate PWM output will output a PWM signal with their duty cycle.

PWM Cycle:
If this value is set to 0, the module will use the default value of 1000, also see the examples above. If a different value is transmitted to the module, the base frequency will change. Usually this should not be needed, simply sending a value of zero is enough to work with the PWM outputs.
If a more precise division of the PWM base frequency is needed, this value can be changed, but can result in a degradation of the resolution. The PWM values (duty cycles) will still be transmitted in the format 0 to 1000 and calculated internally based on the new resolution.
The module does not check the plausibility of the maximum base frequency, this means it should not be higher then 24kHz. The following formula and examples illustrate this.

Base frequency = 72‘000‘000Hz / (Prescaler x PWM Cycle)

For an example PWM Cycle of 100 steps, the following example frequencies can be calculated:

Base frequency = 72000000 / (30 * 100) = 24000Hz
Base frequency = 72000000 / (31 * 100) = 23225.80645Hz
Base frequency = 72000000 / (32 * 100) = 22500Hz
...

Base frequency = 72000000 / (100 * 100) = 7200Hz

... and so on

Choosing a good Prescaler value and a matching PWM Cycle, it is possible to near a desired PWM base frequency. However, the maximum base frequency of 24kHz should not be exceeded and special attention has to be paid to the resolution of the PWM duty cycle, this should always be checked by the user and is not done by the module.

It is recommended to keep the PWM Cycle value of 1000. The configured Prescaler and PWM Cycle will be applied to all active PWM outputs.

8.3.7. Counter Inputs (1…2)

480h+ Node-ID									Get Counter 1-2

This command instructs the module to send both its 32-bit counter values and responds with the following telegram:

480h+ Node-ID	Counter1 Low0	Counter1 High0	Counter1 Low1	Counter1 High1	Counter2 Low0	Counter2 High0	Counter2 Low1	Counter2 High1	Send Counter 1-2 32-bit/Counter

Each counter value consists of four bytes beginning with the least significant byte.
Both counter inputs are physically normal digital inputs and are internally connected to the counter inputs of the microcontroller. This means there is no special configuration via SDO necessary. This also means that counter inputs can be directly started, stopped, read and reset. The counters count all positive/rising edges detected at the corresponding digital input.

If the counter value reaches 2^32 (0xFFFFFFFF) the counter will be automatically stopped. It does not continue and will not automatically reset to zero.

500h+ Node-ID	Counter1	Counter2							Set Counter 1-2 1 = Start, 2 = Stop 4 = Reset + Stop

This command controls the counters. The module will only accept the control codes 1, 2 and 4. All other values will be ignored, which also allows to control each counter individually by setting the command value for the other counter to an invalid value, like 0 for example.

8.4. Heartbeat (SDO 600h Index 1016h and 1017h)

The module has a heartbeat functions, which means the module can be a Producer of a heartbeat telegram. This telegram is sent in fixed intervals and allows the controller (Master) to detect if the module (Slave) has stopped working or if the connection is lost.

However, there is another option in which the module can be a Consumer and therefor can monitor the heartbeat signal of another module (usually the Master) on the bus. This allows for a time-based supervision of the other module and if a failure is detected, the module can go into a safe state including its outputs (“Stop”).

An activated heartbeat is sent in the states “Pre-Operational”, “Operational” and “Stop”. After a “RESET” the heartbeat must be configured and activated again. The monitoring options can be set via SDO, all SDOs will be acknowledged:

Write:

COB-ID	D1 Control	D2 Index Low	D3 Index High	D4 Subindex	D5 Data	D6 Data	D7 Data	D8 Data	Function
Service Data Objects (SDO) are only accessible in Pre-Operational and in Operational states (send & receive)									
600h+ Node-ID	23h	16h	10h	01h	HB-Time LSB	HB-Time MSB	Node-ID Producer HB	00h	Consumer Heartbeat [ms], Time used by the module to monitor the supplied ID
600h+ Node-ID	23h	17h	10h	00h	HB-Time LSB	HB-Time MSB	00h	00h	Producer Heartbeat [ms], Interval used by the module to send its own Heartbeat > 0 Modul sends HB = 0 Modul sends no HB

Table 26: Heartbeat - SDO write

Read:

COB-ID	D1 Control	D2 Index Low	D3 Index High	D4 Subindex	D5 Data	D6 Data	D7 Data	D8 Data	Function
Service Data Objects (SDO) are only accessible in Pre-Operational and in Operational states (send & receive)									
600h+ Node-ID	40h	16h	10h	00h / 01h	00h	00h	00h	00h	SDO read, Subindex 00h and 01h
580h+ Node-ID	43h	16h	10h	00h	01h	00h	00h	00h	How many other bus members can be monitored
580h+ Node-ID	43h	16h	10h	01h	Timeout LSB	Timeout MSB	Node-ID of the Producer	00h	Monitored member (Master) address and time [ms]
600h+ Node-ID	40h	17h	10h	00h	00h	00h	00h	00h	SDO read
580h+ Node-ID	43h	17h	10h	00h	HB-Time LSB	HB-Time MSB	00h	00h	Producer Heartbeat [ms], Interval used by the module to send its own Heartbeat > 0 Modul sends HB = 0 Modul sends no HB

Table 27: Heartbeat - SDO read

8.4.1. Consumer – Heartbeat (Monitoring)

If the heartbeat monitoring is active, the following applies:
Is the configured time window passed, the module will perform a RESET, which means all outputs and inputs are in their default state, see also chapter 8.2.2.2 on page 39. After that the module goes into the "Pre-Operational" state. In this state the module can send a heartbeat as a Producer, but it no longer acts as a Consumer and monitors the heartbeat of another module on the bus. The module has to be configured again via SDOs to activate wanted or needed functions. Using an NMT command the module can be switched into the "Operational" state. All output values can then be set again using PDOs.

If the SDO Index 1016h - Subindex 01h with value 0 is sent to the module, the monitoring can be deactivated directly. The monitoring can be activated with a value > 0 in the states "Pre-Operational" and "Operational". The state "Stop" does not allow the reception of SDO telegrams, only NMT commands are possible.

8.4.2. Producer – Heartbeat (Sending)

If the Index 1017h is set to a value greater than 0 [ms] using an SDO command, the module will start to send out its Heartbeat telegram in intervals of the given *ms* value. The sending of the Heartbeat signal is done in every state after the initialization state. This option will remain active even after a RESET or a power cycle of the module.

If the Heartbeat time is greater than zero, the module will send the following telegram:

COB-ID	D1 Data	D2 Data	D3 Data	D4 Data	D5 Data	D6 Data	D7 Data	D8 Data	Function
700h+ Node-ID	State	00h	00h	00h	01h	00h	00h	00h	Heartbeat Information Sate of the module: 00h Bootup auto 04h Stopped 05h Operational 7Fh Pre-Operational

Table 28: Heartbeat Producer Telegram

The *Bootup* message (telegram) will be sent automatically after each *Reset* or *Power Up*. This message is sent only once.

8.5. PDO Cyclic Transmission

Using an SDO command from the manufacture specific parameter section, see chapter 8.2.4 on page 41, instructs the module to send the states of all of its inputs in regular intervals to the controller (Master), which eliminates the need for polling the information each time the current states of the inputs are needed. The data is sent via a PDO every given [ms] set by the user.

COB-ID	D1 Control	D2 Index Low	D3 Index High	D4 Subindex	D5 Data	D6 Data	D7 Data	D8 Data	Function
Service Data Objects (SDO) are only accessible in Pre-Operational and in Operational states (send & receive)									
600h+ Node-ID	23h	03h	20h	00h	PDO send rate (LSB)	PDO send rate (MSB)	Choice of PDO to send, one bit per PDO	00h	PDO send rate [ms] > 0 Send PDOs cyclically = 0 Don't send cyclically Choice of PDOs: Bit0 = COB-ID 180h Bit1 = COB-ID 280h Bit2 = COB-ID 380h Bit3 = COB-ID 480h

									PDOs: Bit = 1 → send Bit = 0 → don't send.

Table 29: Cyclic Transmission activation - SDO 600h

The send rate set via SDO determines in which timely manner or interval the module sends its input states via PDOs to the controller (Master). The PDOs are only sent out in the state "Operational", in every other state the automatic transmission of the data is halted. If the module was reset through a power cycle or a RESET command, the automatic transmission of the input states data must be configured again. The send rate is based on a time value in [ms]. If the value is zero, the cyclic sending of the PDO is switched off.

Each PDO has one bit assigned to it, which means if the bit equals one, the PDO associated with that bit is sent out in regular intervals, if the bit is zero, the PDO is not sent. If all bits are zero, no PDO is sent out automatically, no matter if a time value is set or not.

The module can send the following PDOs automatically:

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8	Function
Process Data Objects (PDO) are only possible in Operational Mode (send & receive)									
180h+ Node-ID	DI 1…8	DI 9…12	00h	00h	00h	00h	00h	00h	Send Digital In 1-12; High=1, Low=0
280h+ Node-ID	AI1 Low	AI1 High	AI2 Low	AI2 High	AI3 Low	AI3 High	AI4 Low	AI4 High	Send Analog In 1-4; 16Bit/Input
380h+ Node-ID	PT100-1 R Low	PT100-1 R High	PT100-2 R Low	PT100-2 R High	PT100-1 T Low	PT100-1 T High	PT100-2 T Low	PT100-2 T High	Send Resistance & Temp PT100-1/2; 16Bit/PT100
480h+ Node-ID	Counter1 Low0	Counter1 High0	Counter1 Low1	Counter1 High1	Counter 2 Low0	Counter 2 High0	Counter 2 Low1	Counter 2 High1	Send Counter 1-2 32Bit/Counter

Table 30: PDOs sent cyclically

8.6. Emergency Message (EMCY)

The module can send out so called Emergency Messages or Emergency Telegrams to the controller (Master) to inform it about internal errors that have occurred. These Emergency Message are only sent out in the states "Pre-Operational" and "Operational", but not in the state "Stop".

These messages need no acknowledgement and are sent out by the module automatically once when an error occurs and once if the error is no longer present. The telegram is defined as follows:

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8	Function
Emergency Objects (EMCY) are sent out in any state, except in Stop									
80h+ Node-ID	EEC Low	EEC High	ER	VSER NR	VSER Low 0	VSER 1	VSER 2	VSER High 3	Transmission of error states

8.6.1. ECC (Emergency Error Code)

The following ECCs are used by the module:

- 0x0000 No Error
- 0xFF00 Other Error

8.6.2. Error Register (ER)

Bit	Description
0	General Error
1	Current
2	Voltage
3	Temperature
4	Communication
5	Reserved (always 0)
6	Reserved (always 0)
7	Other Error (VSER = Vendor specific error)

Table 31: Emergency Message - Error Register (ER) Bits

Bit 0 is set for every error, the bits 1...7 are used for a more detailed differentiation of the errors and can be set in addition to bit 0.

The module uses the following ER codes:

- 0x00 No Error
- 0x81 Other Error (VSER)

8.6.3. Vendor Specific Error (VSER)

With this error the module will always send an explicit error to every ECC/ER combination. In the first byte of these vendor specific data is always the error number (NR) of the ECC/ER combination, the remaining bytes can contain further specific data, see next topic.

8.6.3.1. Used Emergency Messages

COB-ID	D1	D2	D3	D4	D5	D6	D7	D8	Function
Emergency Objects (EMCY) are sent out in any state, except in Stop									
80h+ Node-ID	EEC Low	EEC High	ER	VSER NR	VSER Low 0	VSER 1	VSER 2	VSER High 3	Transmission of error states

EEC	ER	VSER	Description
0000h	00h	00h 00h 00h 00h 00h	Voltage supply for DI available
FF00h	81h	01h 00h 00h 00h 00h	Voltage supply for DI missing (Connection error)

The terminal block of the twelve digital inputs also has a hook up to the 24 volts supply voltage. This supply voltage is connected to a fuse (F200). This supply voltage is also monitored by the module and if it is lost, cut or disconnected, the module will send out a message with an alert about this event.

The fuse is a so-called poly switch fuse, this means if an overload (e.g. a short circuit) occurs, the fuse will have a high resistance. If the connection or supply problem has been solved, the fuse will have a low resistance and the 24 volts will be available again.

The occurrence of an error will be reported immediately, however the disappearance of an error will not be reported right away, it is delayed by one second to avoid a permanent sending of EMCY messages if an error comes and goes all the time. The time threshold is fixed and cannot be changed, the optional Inhibit Time Object (0x1015) is not needed for this.

An error or failure of the fuse F200 can be simulated using an SDO.
Object dictionary:

0x2008	0x00	R/W	W, 0x00, 0x00, 0x00	Test fuse F200 W>0 simulates a break W=0 State of fuse is valid

8.7. Examples

In this chapter some examples will be shown on how to use the CAN command reference to talk to the module. The examples are based on the KBox A-330-RPI (also known as Pi-Tron) which uses internally the Raspberry Pi Compute Module and has one CAN-Bus connection. The usage of the CAN-Bus might be different on other systems and has to be adapted. However, these examples can help to evaluate the functions of the module, its communication, and the behavior.

The programs used in the examples are *cansend* and *candump* from the *can-utils* package available from the Debian Linux repositories on the Internet. To demonstrate the command usage, two terminal windows are used, one to send a command or data to the module and one window which shows the response of the module.

The module used here has the *Node-ID 4* and uses a baud rate of 125 kBits. The *cansend* program uses a notation where the lowest byte is on the left and the highest on the right, just as the CAN telegrams in the command reference do.

8.7.1. Sending NMT Command RESET

Once both devices are connected to each other and are power up, the module can be reset using the NMT command RESET, see chapter 8.2.1, and the module will respond with its boot up telegram.
The COB ID is *000h* with payload byte 0 = *81h* und byte 1 = *Node-ID* (in this example *04h*)
The module will respond with *700h + Node-ID* and 8 bytes of data which will be *01h*, *02h*, *03h*, *04h*, *05h*, *06h*, *07h* and *08h*.

The *cansend* command looks like this:

→ cansend can0 000#8104

The program is instructed to use the CAN-Bus port "*can0*" for communication. The COB-ID is placed in front of the pound sign and after the pound sign comes the data bytes in hexadecimal format. In this example the value *81h* and *04h* are considered as two bytes which are being sent to the module. If executed on the Raspberry Pi it looks like this:

Sending Side | Receiving Side

Figure 7: Sending NMT Command RESET

Once the NMT command is sent, which also appears on the receiving side, the response of the module is exactly what was expected. The module is now in the "Pre-Operational" state, also see chapter 8.2.2 about the different states of the module and how to transition from one to the other.

The module is now ready to be configured further.

8.7.2. Sending NMT Command Operational

After a power up or a reset, the module goes through its *Initialization* state and then enters the *Pre-Operational* state. In this state different settings can be changed, but for this example the module is switched to Operational state, so that reading and writing of the digital inputs and outputs is possible.

The COB ID is *000h* with payload byte 0 = *1h* und byte 1 = *Node-ID* (in this example *04h*)
The module will transition from *Pre-Operational* state to *Operational* state, there is no response or confirmation of this command.

The *cansend* command looks like this:

→ cansend can0 000#0104

Sending Side

```
pi@pitron:~ $ cansend can0 000#0104
pi@pitron:~ $
```

Receiving Side

```
pi@pitron:~ $ candump can0
  can0  000   [2]  01 04
```

Figure 8: Sending NMT Command Operational

The images show that the NMT command went was sent, as it is also received again through the *candump* program. However, there is no response from the module. This can only be checked by polling or reading data from the module through PDOs. It can help to activate the Heartbeat to receive regular messages from the module to see if it is alive.

8.7.3. Turning on Digital Outputs using COB-ID 200_h (PDO)

The digital outputs can be set using the COB-ID 200_h and setting one or all of the 12 bits in the first two bytes to 1. The setting of the digital outputs is done with COB ID 200_h + *Node-ID* with payload byte 0 = *DO 1 - 8* and byte 1 = *DO 9 - 12*
The module will not send an acknowledgement or response to this PDO. The digital outputs are spread over 12 bits in the first two bytes of the telegram. There eight bits in byte 0 and four bits in byte 1.

Setting DO1 (first bit in byte 0) to on, the *cansend* command looks like this:

→ cansend can0 204#0100

Sending Side

```
pi@pitron:~ $ cansend can0 204#0100
pi@pitron:~ $
```

Receiving Side

```
pi@pitron:~ $ candump can0
  can0  204   [2]  01 00
```

Figure 9: Turning on Digital Outputs

The PDO is sent to the module, as it is also received again through the *candump* program. However, there is no response from the module.

To also switch another DO on, like DO12 which is the last digital output, the fourth bit in byte 1 has to be set to one.

The *cansend* command looks like this:

→ cansend can0 204#0108

Sending Side

```
pi@pitron:~ $ cansend can0 204#0108
pi@pitron:~ $
```

Receiving Side

```
pi@pitron:~ $ candump can0
  can0  204   [2]  01 08
```

Figure 10: Turning on multiple Digital Outputs

Each output which is on and has to stay on, the corresponding bit in byte 0 and byte 1 has to be set to one and must remain one, otherwise the output will turn off. Outputs cannot be set individually.

8.7.4. Reading Digital Inputs using COB-ID 180_h (PDO)

Digital Inputs can be read from the module using the COB-ID *180_h* and sending no payload. The response from the module will be a CAN telegram also carrying the COB-ID *180_h* with two bytes as payload which contain the states of the twelve digital inputs of the module. In the first byte are the inputs DI1 to DI8 and in the second byte are the inputs DI9 to DI12.
Reading digital inputs, COB-ID *180_h + Node-ID*, payload none, the response is COB-ID *180_h+Node-ID* with two bytes as payload.

Reading all digital inputs, the *cansend* command looks like this:

- → cansend can0 184#
- → Response: COB-ID *184_h* plus two bytes, DI1 = 1 (bit 0 in byte 0) and DI12 = 1 (bit 4 in byte 1)

Sending Side / Receiving Side

Figure 11: Reading Digital Inputs

The PDO is sent to the module and a response has been received as well, as seen on the receiving side in the above image. This means the digital output which were set in the previous step have now been read back through the digital inputs. Why is that? The answer is that there are cables connected between the digital outputs and the digital inputs of the same module. This is an easy way to test the outputs and inputs and to see if the communication between the controller and module is working, without having to do much cabling or programming.

8.7.5. Turning on Analog Outputs using COB-ID 300_h (PDO)

The analog outputs of the module can be set using the COB-ID 300_h and sending eight bytes which contain the four 16-bit values for the four analog outputs. All four analog outputs have to be set at the same time.
The setting of the analog outputs is done with COB ID 300_h + *Node-ID* with payload byte 0 and byte 1 = AO1, byte 2 and byte 3 = AO2, byte 4 and byte 5 = AO3 and byte 6 and byte 7 = AO4.
The module will not send an acknowledgement or response to this PDO. Also see chapter 8.3.4 for the definition of the telegram.

In this example AO1 is set to 3.5 volts, which has to be converted to an integer value and then to a hex value and then split up into two bytes so it can be sent using the *cansend* program. The hex value conversion and splitting might not be needed on other systems or programs, but for this example it is a good practice. The remaining bytes in this PDO are left 0, meaning the other analog outputs will remain at 0 volts.

Conversion: 3.5 * 100 = 350_d = $15E_h$ → Splitting $15E_h$ into two bytes: *byte 0 = $5E_h$, byte 1 = 1_h*

Setting AO1 to 3.5 volts, the *cansend* command looks like this:

- → cansend can0 304#5E01000000000000

Sending Side / Receiving Side

Figure 12: Turning on Analog Outputs

The receiving side shows that the telegram was sent, but there is no response as expected but also no error. The analog output should now have a value of 3.5 volts.

8.7.6. Reading Analog Inputs using COB-ID 280_h (PDO)

Analog Inputs can be read from the module using the COB-ID *280_h* and sending no payload. The response from the module will be a CAN telegram also carrying the COB-ID *280_h* with eight bytes as payload which contain the values of the four analog inputs of the module. Remember that in this example the analog inputs of the module are in voltage mode.
Reading analog inputs is done with COB-ID *280_h + Node-ID*, payload none, the response is COB-ID *280_h+Node-ID* with eight bytes as payload. Also see chapter 8.3.3 for the definition of the telegram.

Reading all analog inputs, the *cansend* command looks like this:

- → cansend can0 284#
- → Response: COB-ID *284_h* plus eight bytes, AI1 = 15E (byte 0 and byte 1), AI2 = 0 (byte 2 and byte 3), AI3 = 0 (byte 4 and byte 5) and AI4 = 0 (byte 6 and byte 7)

Sending Side | Receiving Side

Figure 13: Reading Analog Inputs

The PDO was sent to the module and it responded with a PDO containing the values of all analog inputs. Since in this example the analog outputs are connected to the analog inputs, setting the Analog Output 1 to $15E_h$ or 3.5 volts, the value can be read back from Analog Input 1. After combining the two bytes for Analog Input 1 from $5E_h$ and 01_h to $15E_h$, the value can be converted back to decimal format and we get 350. If 350 is divided by one hundred, the result is 3.5 volts.

Combine: $5E_h$ + 1_h → $15E_h$ Convert: $15E_h$ → 350_d Calculate: 350_d / 100 = 3.50 volts

8.7.7. Activating the Heartbeat Telegram (Producer)

Writing a time to the modules index 1017_h using the SDO COB-ID 600_h and the control number 23_h, the module will start to transmit its Heartbeat telegram in intervals given by the user. In this example the module is instructed to send a Heartbeat telegram every second until it is stopped. First one second muss be converted to milliseconds and then into a hex format and split up into two bytes, so it can be sent to the module using the *cansend* program. In this example byte 0 is the low byte and byte 1 is the high byte. Also see chapter 8.4 for a definition of the telegram.

Convert time: 1s = 1000ms → Convert to hex: $1000_d = 38E_h$ → Splitting $38E_h$ into two bytes: byte 0 = $8E_h$, byte 1 = 3_h

Activating the Heartbeat, the *cansend* command looks like this:

→ cansend can0 604#23171000E8030000

Sending Side | Receiving Side

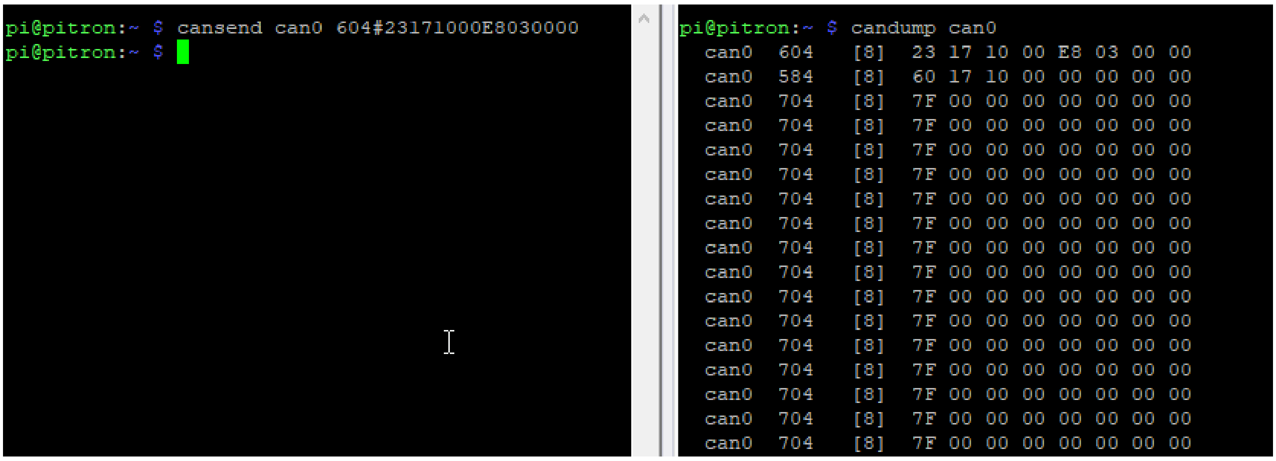


Figure 14: Activating the Heartbeat Telegram

After the SDO has been sent to the module, the SDO command is acknowledged with COB-ID 580_h + Node-ID and control number 60_h as well as the index the Heartbeat time was written to, Also see chapter 8.2.4.2 for possible SDO responses. After the response telegram from the module the Heartbeat telegrams start coming in, as seen on the receiving side above. The telegrams arrive every second from now on, until the module is turned off, there is a fault or connection problem.

9/ Standards, Certifications and Directives

The AL CAN I/O-MODUL is currently in test and aims to comply with the requirements of the following standards.

If the user modifies the product, prerequisites for specific approvals such as CE conformity declaration (safety requirements) may no longer apply.

Table 32: Standards, Certifications and Directives Compliance

CE-Mark Compliant with EU Directives	Electromagnetic Compatibility	Directive 2014/30/EU
	Low Voltage	Directive 2014/35/EU
	RoHS II	Directive 2011/65/EU
EMC 2014/30/EU Immunity/ Emission	EN 61000-6-2 EN 61000-6-3	Electromagnetic compatibility (EMC), part 6-2: Generic standards- Immunity for industrial environment Electromagnetic compatibility (EMC), part 6-3: Generic standards- Emission for industrial environment
WEEE 2002/96/ EC	Waste Electrical and Electronic Equipment Directive (WEEE Directive)	Compliant with the Waste Electrical and Electronic Equipment (WEEE) directive to reduce waste of electrical and electronic equipment, encourage recycling and environmental disposal and increase the environmental awareness of producers.

10/ Shipment and Unpacking

10.1. Packaging

All parts are delivered together in a product specific cardboard package designed to provide adequate protection and absorb shock. Kontron Electronics recommends keeping the packaging to store or transport the product.

10.2. Unpacking

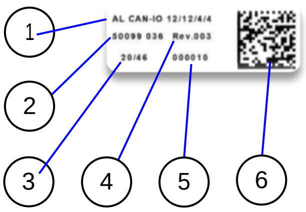
Proceed as follows to unpack the unit:

1. Remove packaging.
2. Do not discard the original packaging. Keep packaging for future relocation or storage.
3. Check the delivery for completeness by comparing it with the original order.
4. Keep the associated paperwork. It contains important information for handling the unit.
5. Check the contents for visible shipping damage.
6. If you notice any shipping damage or inconsistencies between the contents and the original order, contact Kontron Electronics for help and information.

10.3. Type Label and Product Identification

The type label is position on contains the following information.

Figure 15: AL CAN I/O-MODUL Type Label (Example)



1. Product name (AL CAN I/O-MODUL)
2. Article number
3. Production date
4. Revision number
5. Serial number
6. Barcode with article-, rev., date and serial number

11/ Technical Support

11.1. First Steps

Connect the AL CAN I/O-MODUL to a power source and the CAN-Bus to a PLC or PC with a CAN-Interface. In order to be able to talk to the unit, a program is needed which creates the necessary commands and data packets which must be sent via CAN-Bus to the AL CAN I/O-MODUL in order to perform various kinds of actions and to read and write the analog and digital inputs and outputs of the device. See chapter 8.7 on page 62 for some examples.

Example programs with Linux SocketCAN communication written in C, Python, CODESYS and QT can be found on our Git server at:

- Git: https://git.kontron-electronics.de/sw/ked/can-io/al-can-io-12-12-4-4

11.2. Extended Support

For detailed technical support please contact:

- E-mail: support@kontron-electronics.de

Make sure you have the following product identification information in your e-mail:

- Product name,
- Product model number
- Serial number (SN) of the unit

Please explain the nature of your problem in your e-mail.

The serial number can be found on the type label on the device.

11.3. Disclaimer & License Information

The software examples and programs shown and mentioned in this documentation for the AL CAN I/O-MODUL are provided "as is" and without any warranty. You use the programs and examples at your own risk. The examples provided are purely for educational purposes and do not constitute a complete program in any way.

For further information you can contact us:

Kontron Electronics GmbH

Max-Planck-Str. 6
72636 Frickenhausen
Germany

Web: www.kontron-electronics.de
E-Mail: support@kontron-electronics.de

12/ Storage, Transportation and Maintenance

12.1. Storage

If the product is not in use for an extended period time, disconnect the power plug from the AC outlet. If it is necessary to store the product then re-pack the product as originally delivered to avoid damage. The storage facility must meet the products environmental requirements as stated within this user guide. Kontron Electronics recommends keeping the original packaging material for future storage or warranty shipments.

12.2. Transportation

To ship the product, use the original packaging, designed to withstand impact and adequately protect the product. When packing or unpacking products always take shock and ESD protection into consideration and use an EOS/ESD safe working area.

12.3. Maintenance

Maintenance or repair on the open product may only be carried out by qualified personnel authorized by Kontron Electronics.

Cleaning

- For light soiling, clean the product with a dry cloth.
- Carefully remove dust from the surface of the chassis and cooling fins using a clean, soft brush.
- Stubborn dirt should be removed using a mild detergent and a soft cloth.

NOTICE

Do not use steel wool, metallic threads or solvents like abrasives, alcohol, acetone or benzene for cleaning the AL CAN I/O-MODUL.

13/ Warranty

Kontron Electronics defines product warranty in accordance with regional warranty definitions. Claims are at Kontron Electronics's discretion and limited to the defect being of a material nature. To find out more about the warranty conditions and the defined warranty period for your region, following the steps below:

1. Visit Kontron Electronics's Term and Conditions webpage.

   http://www.kontron-electronics.de/downloads/agbaebs

2. Click on the relevant document.

> The AL CAN I/O-MODUL is factory configured to meet customer requirements. Kontron Electronics does not recommend opening the system as this may cause damage to internal components.

13.1. Limitation/Exemption from Warranty Obligation

In general, Kontron Electronics shall not be required to honor the warranty, even during the warranty period, and shall be exempted from the statutory accident liability obligations in the event of damage caused to the product due to failure to observe the following:

- General safety instructions for IT equipment within this user guide.
- Warning labels on the product and warning symbols within this user guide.
- Information and hints within this user guide.

Additionally, alterations or modifications to the product that are not explicitly approved by Kontron Electronics, described in this user guide, or received from Kontron Electronics Support as a special handling instruction will void your warranty.

Within the warranty period, the product should only be opened by Kontron Electronics. Removing the protection label and opening the product within the warranty period exempts the product from the statutory warranty obligation.

Due to their limited service life, parts which by their nature are subject to a particularly high degree of wear (wearing parts) are excluded from the warranty beyond that provided by law.

14/ Disposal

Final disposal of this product after the product's service life must be accomplished in accordance with the applicable country, state, or local laws or regulations.

Kontron Electronics manufactures products to satisfy environmental protection requirements where possible. Many of the components used are capable of being recycled.

Kontron Electronics follows the Waste Electrical and Electronic Equipment (WEEE) Directive that aims to reduce waste arising from Electrical and Electronic waste and encourages customers to return Kontron Electronics products for proper disposal. For more information regarding WEEE compliance, see the Disposal and Recycling section at the start of this user guide.

Appendix A: List of Acronyms

Table 33: List of Acronyms (Example)

AC	Alternating Current
CPI	Advanced Configuration Control Interface
CPU	Central Processing Unit
DC	Direct Current
DIO	Digital Input/Output
DP	Display Port
ECC	Error Checking and Correction
EHCI	Enhanced Host Controller Interface
ESD	Electrostatic Discharge
GbE	Gigi bit Ethernet
GPU	Graphics Processing Unit
HD/HDD	Hard Disk /Drive
HDMI	High Definition Multimedia Interface
HPM	PICMG Hardware Platform Management specification family
H/W	Hardware
IOL	IPMI-Over-LAN
IOT	Internet of Things
KVM	Keyboard Video Mouse
LAN	Local Area Network
LVD	Low Voltage Device
M.2	Next smaller generation of mSATA
MEI	Management Engine Interface
mPCIe	Mini PCI-Express

mSATA	Mini SATA
OS	Operating System
PCIe	PCI-Express
RAM	Read Access Memory
RoHS	Restriction of the use of certain hazardous substances
RTC	Real Time Clock
SATA	Serial-ATA
SEL	System Event Log
SELV	Safety Extra Low Voltage
SIO	Super Input/output
SMBus	System Management Bus
SMWI	System Monitor Web Interface
SOL	Serial Over LAN
SSD	Solid State Drive
TPM	Trusted Platform Module
UEFI	Unified Extensible Firmware Interface
USB	Universal Serial Bus
VGA	Video Graphics Array
VLP	Very Low Profile
WEEE	Waste Electrical and Electronic Equipment
WLAN	Wireless LAN
XHCI	eXtensible Host Controller Interface

kontron

About Kontron Electronics

Kontron Electronics is your complete supplier of electronics and automation solutions. We offer

- own control products for the automation of machines and devices,
- development and production for individual, complex electronic modules
- production services for your existing electronic assemblies
- assembly services for complete systems

With our existing control, visualisation and automation systems, we can put together turnkey complete solutions for your machines and equipment in the shortest possible time.
For your individual requirements we have a large group of engineers and technicians available, who develop your tailor-made solution with a lot of experience and imagination.
Kontron Electronics is a full-service provider for the development and production of complex electronic modules, components and systems for industrial and medical applications.

Kontron Electronics GmbH

Max-Planck-Str. 6
72636 Frickenhausen
Germany

Tel.: + 49 7022 4057-0
Fax: + 49 7022 4057-22
info@kontron-electronics.de