INTEGRATION MANUAL

Integrated motor drive
IMD 100

DEIF A/S · Frisenborgvej 33 · DK-7800 Skive
Tel.: +45 9614 9614 · Fax: 9614 9615
Info@deif.com · www.deif.com/wind-power

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1. Introduction

This document describes the IMD 100 in details to enable the integration of the IMD in a pitch system. It is intended for customers R&D personnel, who will integrate the IMD in the pitch system. All aspects of the integration are included in this manual:

- Mechanical integration:
  - Mechanical specifications and requirements
  - Description of mechanical installation options
  - Space requirements
- Electrical requirements:
  - Description of electrical connections
  - Requirements for all electrical interfaces
- Configuration
  - Configuration of the IMD for a specific system using the IMD Manager
  - Creation of a configuration file for use in production
- Operation – control and monitoring
  - Communication
  - Operational states
  - Input and output states
  - Monitoring parameters
  - Warnings
  - Errors
  - Interpretation of numeric representation – units' conversion
- Starting the IMD in the laboratory for the first time

Read instructions

Read the *IMD 100 function description*(document no. 4189360013) in order to understand the functions of the IMD. Description of the functions is not repeated in this manual.

References are made in this manual to *IMD 100 Installation instructions, IMD Manager Installation instructions, IMD Manager user manual* and *IMD 100 Datasheet.* Have these at hand while reading this manual.

1.1 Conventions

The following conventions are used in this document:

Used in document	Description
`Monotype` font	Used when describing a path or text input in a machine human interface
␣ ↵	Used to illustrate a space and Enter characters
	A yellow symbol that illustrates hazard type (this symbol is an example for general hazard). There are different types such as electrical, chemical and so on.
Danger!	A signal word used to indicate an imminently hazardous situation, which if not avoided, will result in death or serious injury. (ISO 3864)
Warning!	A signal word used to indicate an imminently hazardous situation, which if not avoided, could result in death or serious injury. (ISO 3864)
Caution!	A signal word used to indicate a potentially hazardous situation, which if not avoided, could result in minor or moderate injury. (ISO 3864)
	A blue symbol that illustrates a need for mandatory action. In this example read instructions. Other types of blue symbols exist and always indicate mandatory action.
	A symbol used to draw attention to extra information or an action that is not mandatory
Current	When “current” is used it always means electrical current. When a reference to time is made “present” or “ongoing” are used.
IMD	When the IMD is mentioned, it means the IMD 100 series
Binary description	In binary descriptions the first bit is bit zero

2. Safety precautions

Attention

The permitted environmental conditions must be observed.

EN 60204, and relevant local regulations must be observed.

Power supply of protection class I and of protection degree IP20. Do not use outside or in wet or damp rooms.

The equipment must be installed, operated and used for its intended function as described by the manufacturer. If this requirement is ignored, safety protection provided by the equipment may be impaired.

In the event of a fault we recommend that you return the unit to the manufacturer.

Company policy and local regulations regarding PPE must always be followed, regardless whether the PPE is shown in this manual or not.

2.1 Mechanical work

Use eye, hand and hearing protection

Use protection for eyes, hand and hearing, if the mounting holes for bolts and heat sink need to be made.

Caution!

Risk of hand injury.

The IMD is heavy. Be careful with your hands when mounting the IMD in the cabinet.

2.2 Electrical work

Disconnect power

Ensure that all power is disconnected when working with the IMD, except for during testing, commissioning and service.

Danger!

Risk of burns and electrical shock from short circuit, electrical arc and uninsulated wires.

Live work is not permitted, except for during test, verification, commissioning, and service.

Observe local regulation when working with electrical components.

Danger!

Risk of burns and electrical shock from short circuit, electrical arc and uninsulated wires.

Commissioning and maintenance work on this device may only be carried out by a qualified electrician.

When the IMD has been powered, there is a risk of stored energy even when the power is disconnected. Wait 5 minutes after the power is disconnected and verify zero energy according to company procedures on the outputs before performing any work.

Caution!

Risk of electrical shock from touch current if the protective earth is removed when the IMD is energized.

Do not remove the protective earth is removed when the IMD is energized.

2.3 Thermal precautions

Info

During operation, the IMD can reach high surface temperatures. The temperature levels depend on the ambient temperature inside and outside the cabinet.

Warning!

Risk of severe burns.

The heat sink of the IMD can reach high temperature.

Do not touch until the surface (see pos. 1 in Figure 1 on page 13) is cooled down.

Caution!

Risk of burns.

The sides of the IMD can reach medium high temperature.

Do not touch until the surface (see pos. 2 in Figure 1 on page 13) is cooled down.

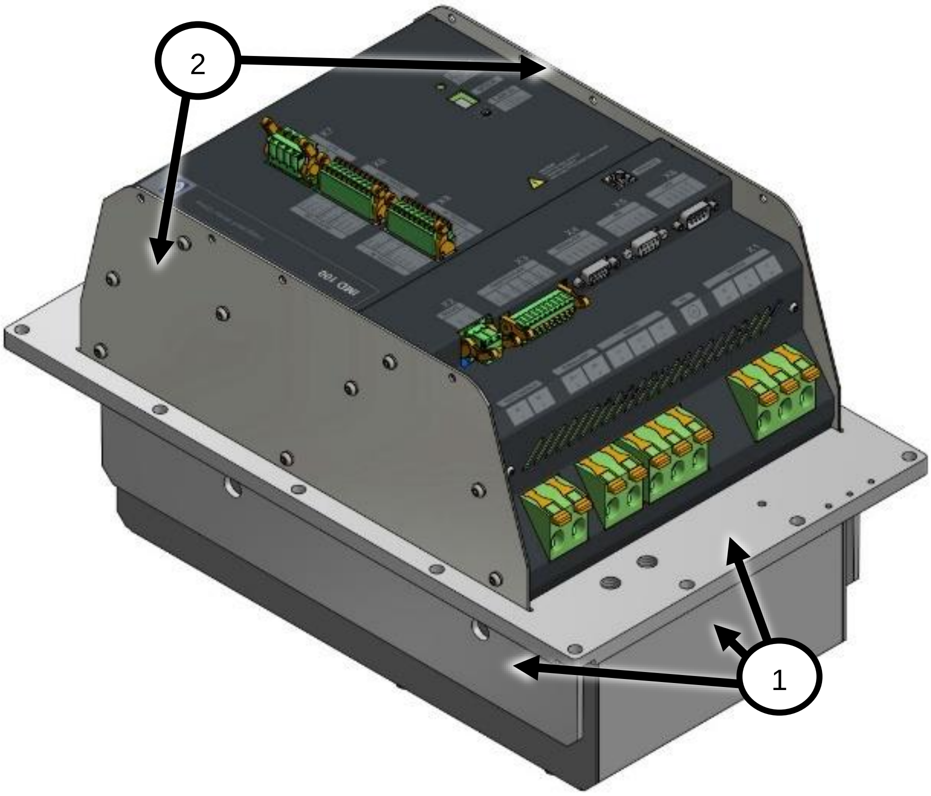


Figure 1 Hot surface areas

3. Avoiding damage to the IMD

Certain situations may result in product damage and should therefore be avoided by observing the precautions described in this section. These situations are not likely to occur under normal use of the IMD, but might occur in the lab or during service.

The situation list may not be comprehensive. Other, unknown situations that are not described in this section could occur.

3.1 Connecting the safe energy

Possible damage: Damage to internal power components.

How to avoid:

If the safe energy was disconnected from the SE terminals, the mains supply must be turned on before the safe energy is turned on.

3.2 Switching mains ON and OFF

Possible damage: DC-link Pre-charge circuit damaged due to repeated MAINS ON and OFF operations

How to avoid:

If the MAINS connections are switched ON and OFF more than once, wait 60 seconds before switching ON after switch OFF.

3.3 Overloading the ballast resistor

Possible damage: Ballast circuit ((switch or resistor) damaged due to overload.

How to avoid:

- The ballast resistor value is adequate for the DC-link Vmax.
- Never use single pulse longer than 1 s during safe energy test.
- Wait 10 minutes (at 25ºC) if the IMD is restarted and the ballast resistor has been loaded (hot)

3.4 Connecting the mains with overvoltage

Possible damage: Total damage to the IMD.

How to avoid:

The mains supply must never exceed the range specified in the Data sheet.

4. Mechanical integration

This section describes the mechanical aspects of the IMD. See IMD 100 Datasheet for physical dimensions.

4.1 Integrating the IMD in a cabinet

4.1.1 Environmental requirements

The IMD must be mounted in a closed cabinet where the requirements for ingress protection of components do not exceed IP 20.

The IMD heatsink is mounted through a hole in the cabinet and requirements for ingress protection outside the cabinet do not exceed IP 55 (IP 54 for IMD 122 B).

When designing the pitch system, pay attention to IMD location in the hub, to avoid debris entering the heatsink (1). Take the hub rotation into account, so that loose objects are not funnelled into the heatsink.

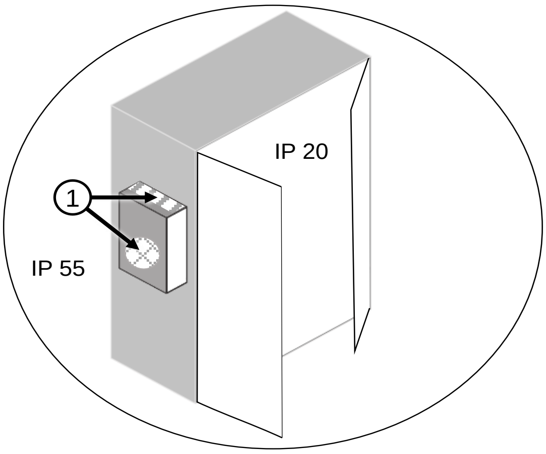


Figure 2 Environmental requirements and considerations

For other environmental requirements, see *IMD 100 Datasheet*.

4.1.2 Temperature considerations

This section describes the considerations concerning temperature and ventilation when designing the cabinet in which the IMD is placed, and the location of the cabinet.

4.1.2.1 Personal safety considerations

The heat sink (both in and out) can get hot depending on the ambient temperature and the activity of pitching the blade. If there is a risk of people touching the back of the IMD (the heat sink outside the cabinet) it is recommended to implement measures to protect personnel such as physical guards, information, or any other means.

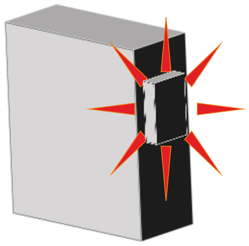


Figure 3 Risk of heat hazard

4.1.2.2 Cabinet cooling considerations

The ambient temperature range defined in the *IMD 100 Datasheet* must be maintained at all times. This also applies inside the cabinet, where the IMD itself also contributes with heat radiation, mainly because part of the heat sink is located inside the cabinet. The IMD shuts down the output drive at 90 ºC, thereby the heat sink temperature will never exceed 90 ºC.

IMD 122:

Figure 4 on page 16 shows the heat radiation of the IMD inside the cabinet as a function of the heat sink temperature. At this temperature, the heat contribution from the IMD inside the cabinet is approximately 69 W.

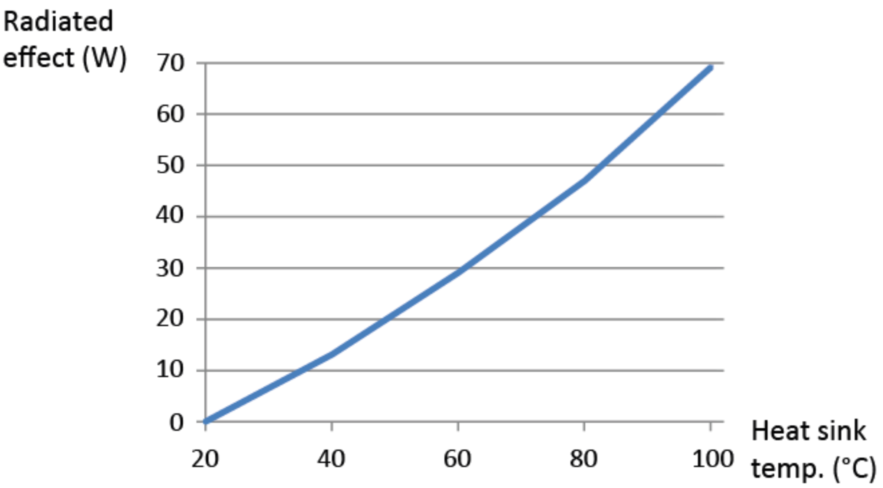


Figure 4 Radiated heat from the IMD inside the cabinet

IMD 135:

Figure 5 on page 17 shows the heat radiation of IMD 135 inside the cabinet as a function of the heat sink temperature. At this temperature, the heat contribution from the IMD inside the cabinet is approximately 81 W.

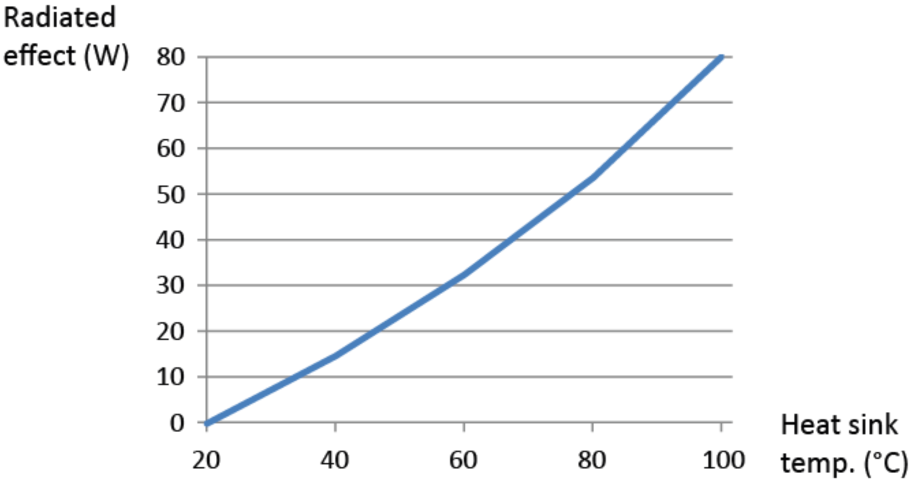


Figure 5 Radiated heat from the IMD inside the cabinet

4.1.2.3 Free space around the IMD

Outside the cabinet, keep free space around the IMD at least as shown in Figure 6 on page 17 (IMD 122 C), Figure 7 on page 18 (IMD 122 B) and Figure 8 on page 18 (IMD 135). There must be adequate ventilation in this space.

Inside the cabinet, keep at least 20 mm free space from the sides of the IMD and 80 mm free space from top and bottom of the IMD. There must be adequate ventilation in this space.

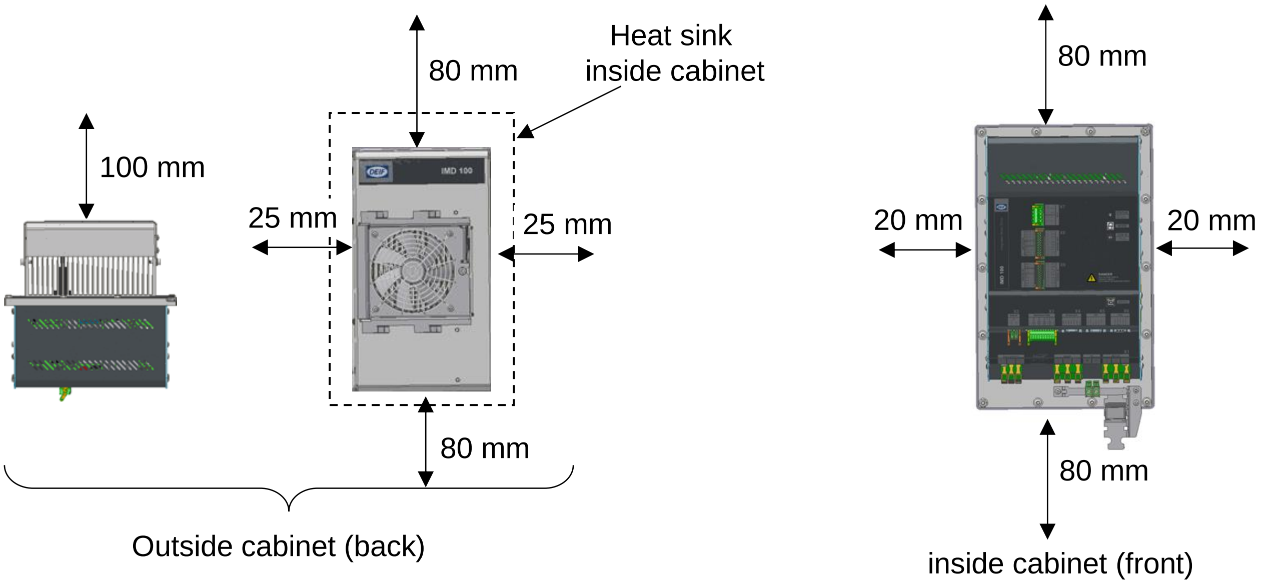


Figure 6 IMD 122 C free space requirements

Note for IMD 122 C: The 100 mm indicated is recommended to enable easy replacement of the fan. The minimum requirement due to temperature is 50 mm.

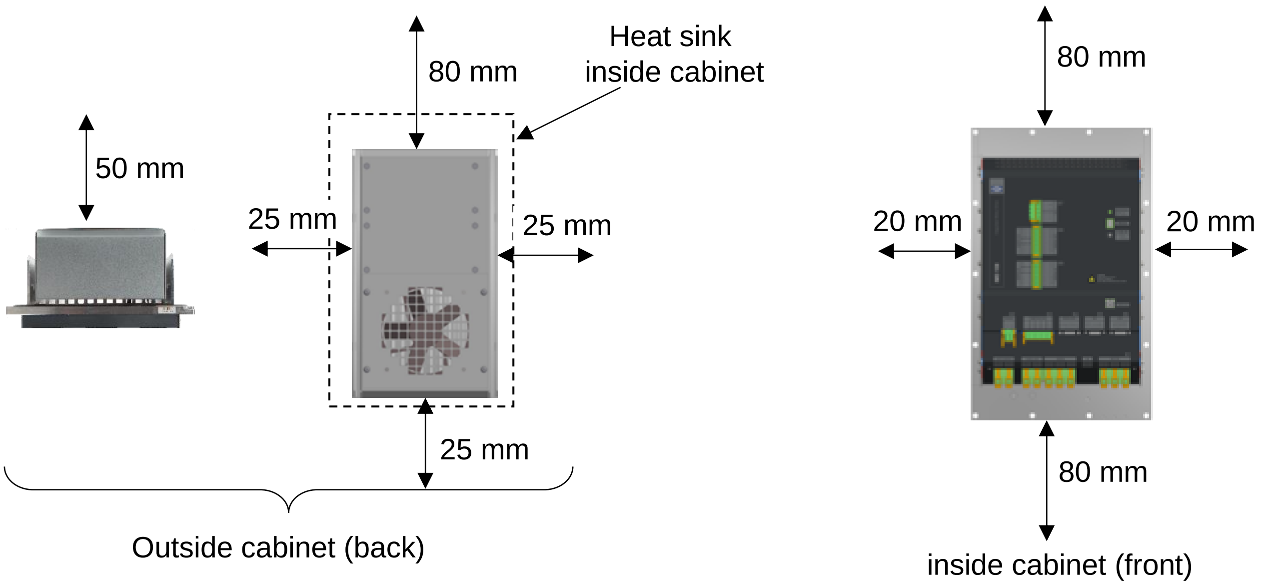


Figure 7 IMD 122 B free space requirements

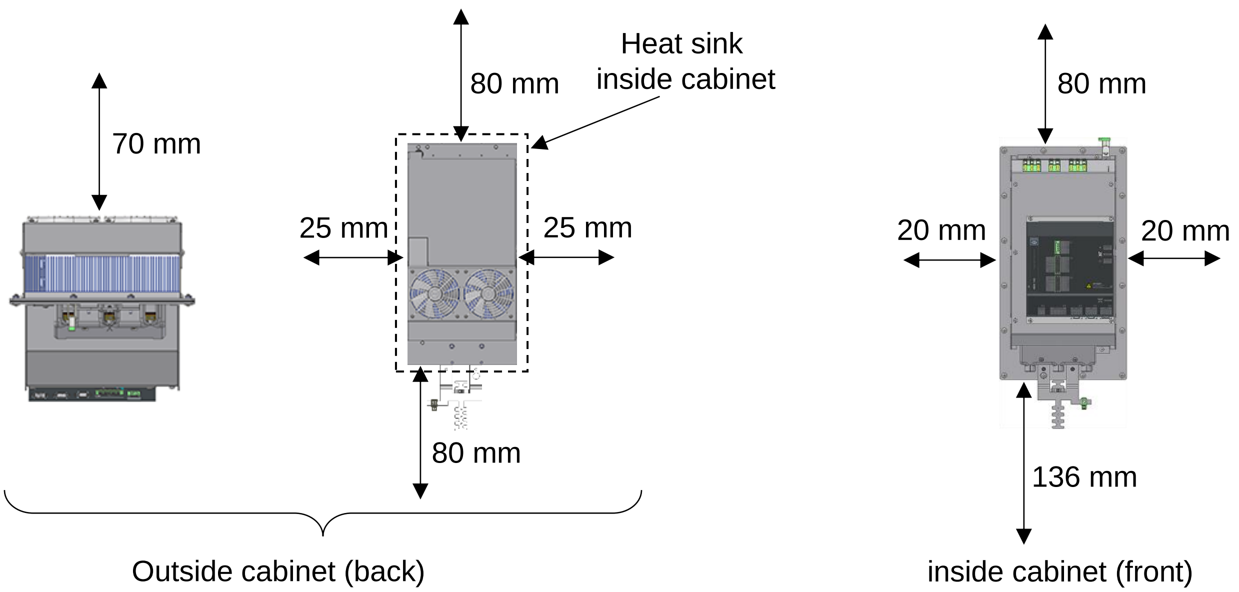


Figure 8 IMD 135 C free space requirements

Note for IMD 135: Consider the outside space (25 mm) around the IMD with regards to fan replacement.

4.1.3 Mounting of the IMD in the cabinet

A rectangle hole and 14/16 x ⌀7 mm holes for M6 bolts must be made in the cabinet where the IMD is to be mounted.

The holes for the bolts and heat sink are to be made according to the following drawing:

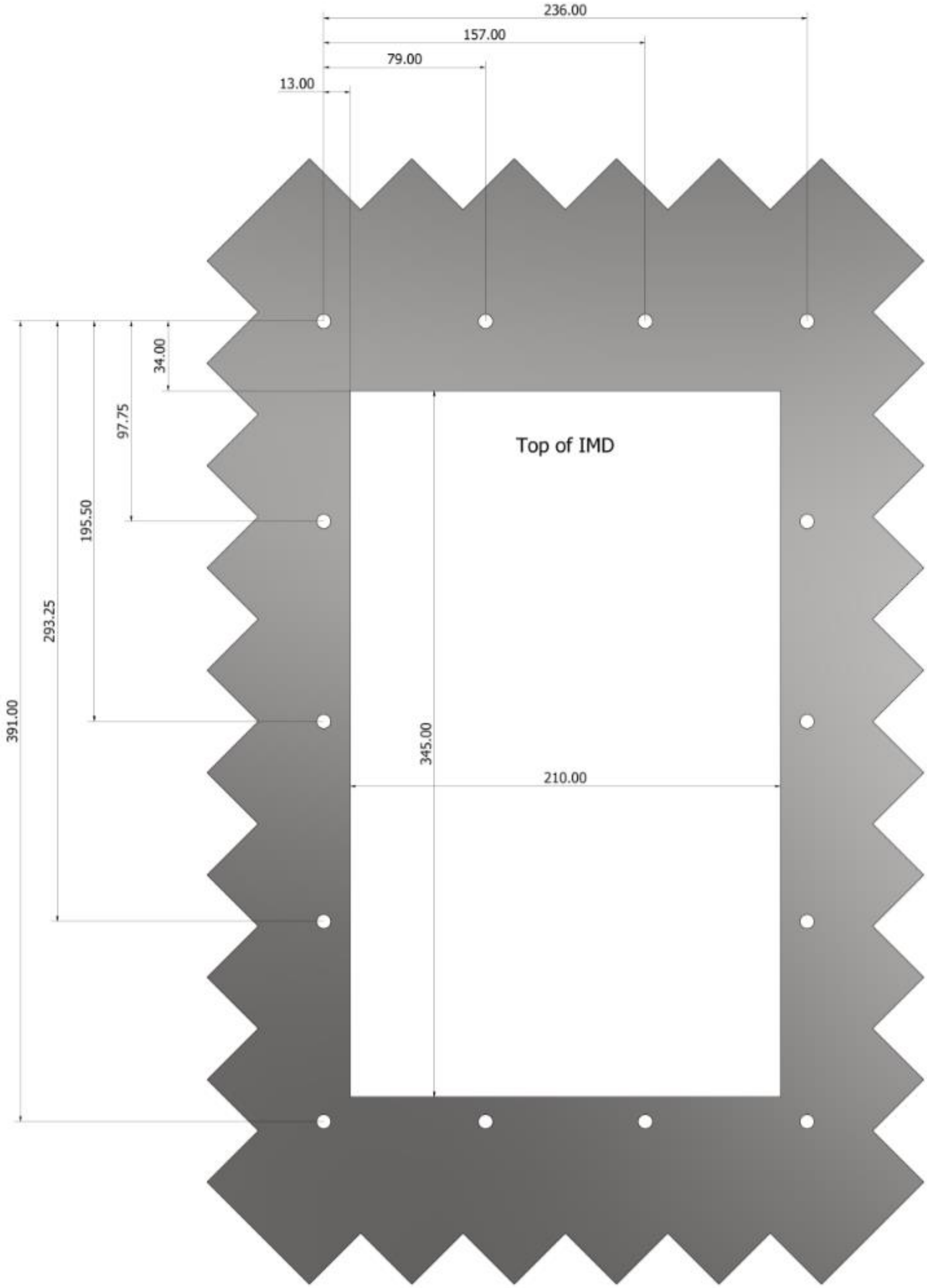


Figure 9 Cabinet cut-out drawing for IMD 122

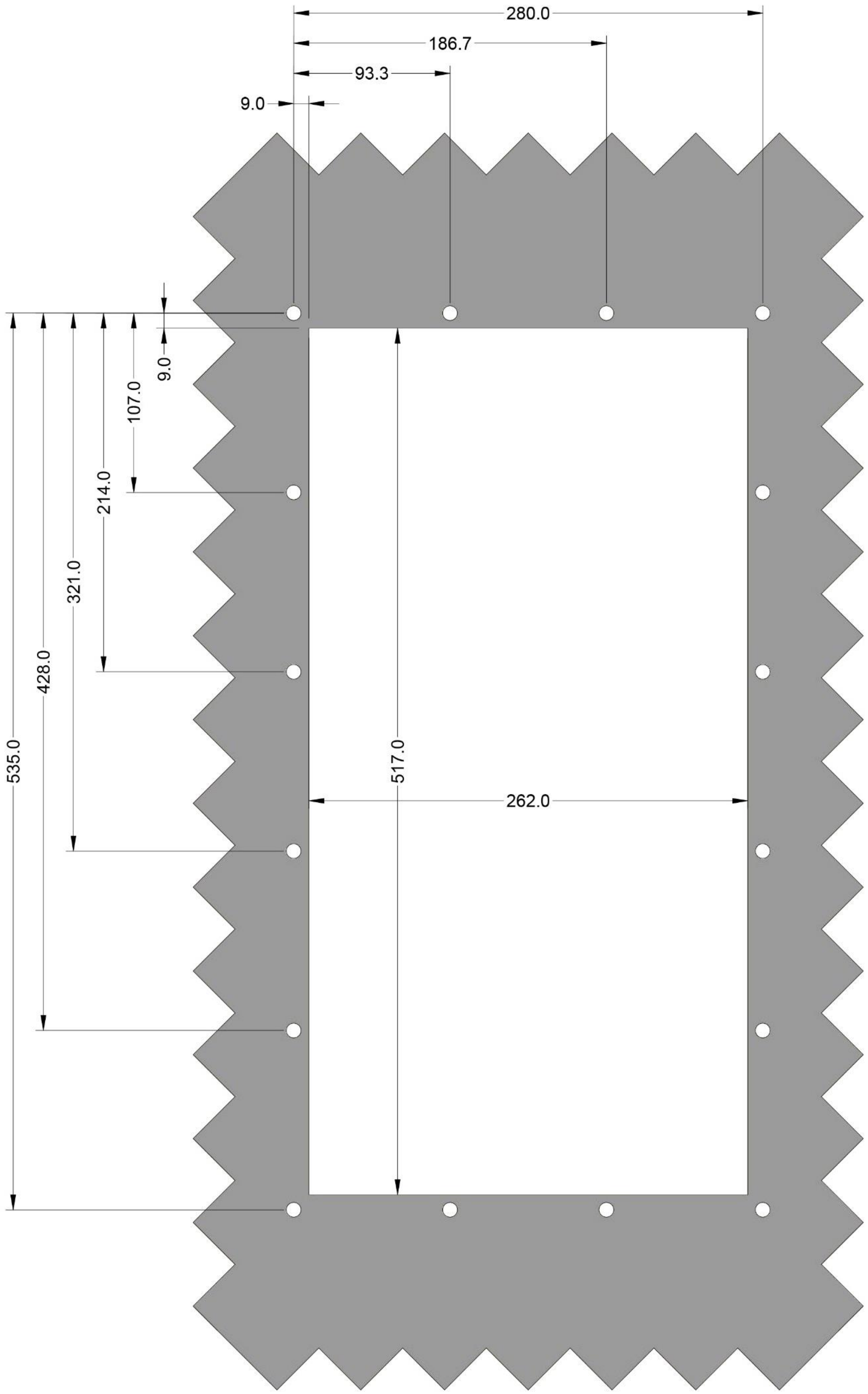


Figure 10 Cabinet cut-out drawing for IMD 135

Ensure there are no sharp edges that can harm the workers who will mount the IMD.

A gasket seal at the back of the IMD ensures tight assembly (IP 54) as shown in the following figure (pos. 1). Fan housing might differ from the shown figure.

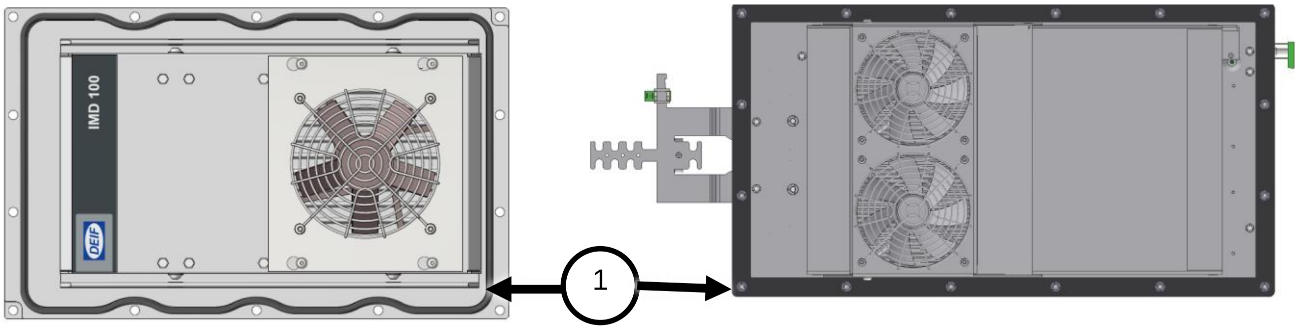


Figure 11 Gasket seal at the back of the IMD

In order to ensure that the gasket is properly compressed, the optional mounting frame can be used. All needed material is delivered in the package, and it is possible for one person to mount the IMD in a cabinet. See *the IMD 100 Installation instructions* for the installation procedure using the mounting frame.

If the mounting frame is not used, it is recommended to use 14 pcs. M6 mm bolts and M6 nuts to fix the IMD in place. Use serrated washers to ensure that bolts do not open unintentionally due to vibrations and extensive temperature changes. Ensure that the necessary torque is applied to the bolts and nuts to ensure a tight assembly, and that the cabinet wall is adequately rigid to ensure proper mounting.

Info

Be aware that the *IMD 100 Installation instructions* does not describe in details the mounting procedure if the mounting frame is not used**.**

5. Electrical HW connections and requirements

This section describes in details the electrical requirements for all terminations of the IMD.

The following figures illustrates the variants of the IMD with their HW functions:

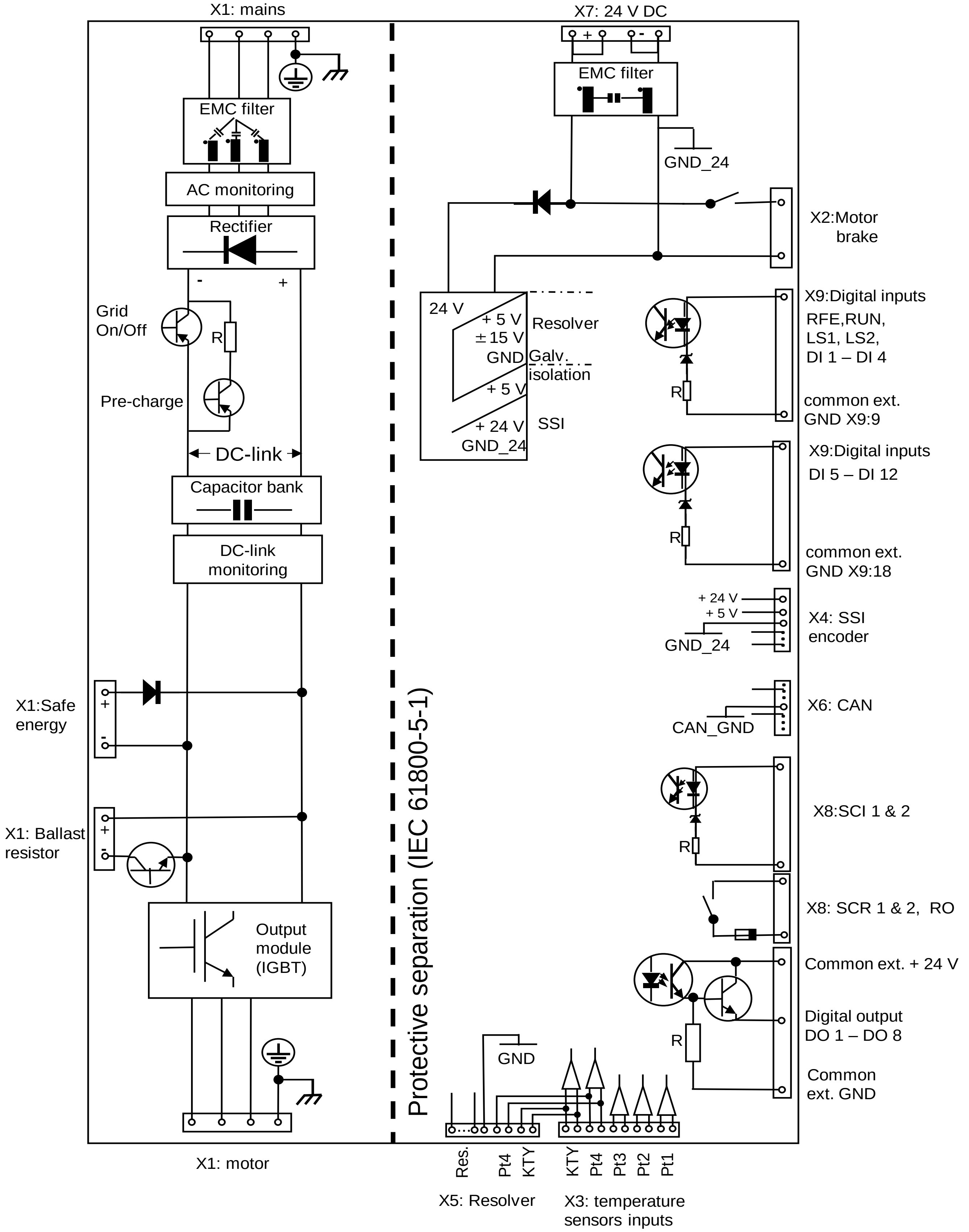


Figure 12 IMD 122 B

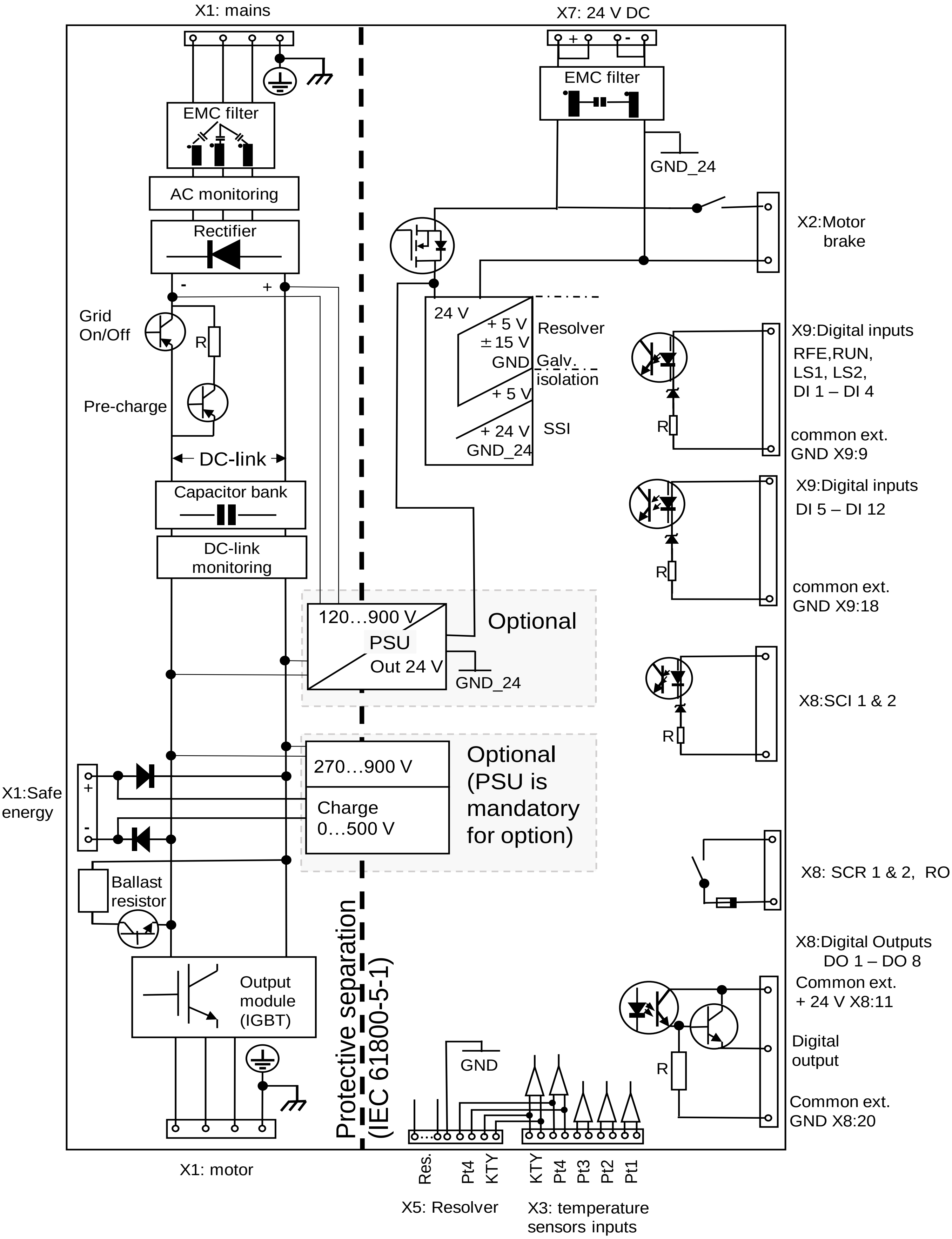
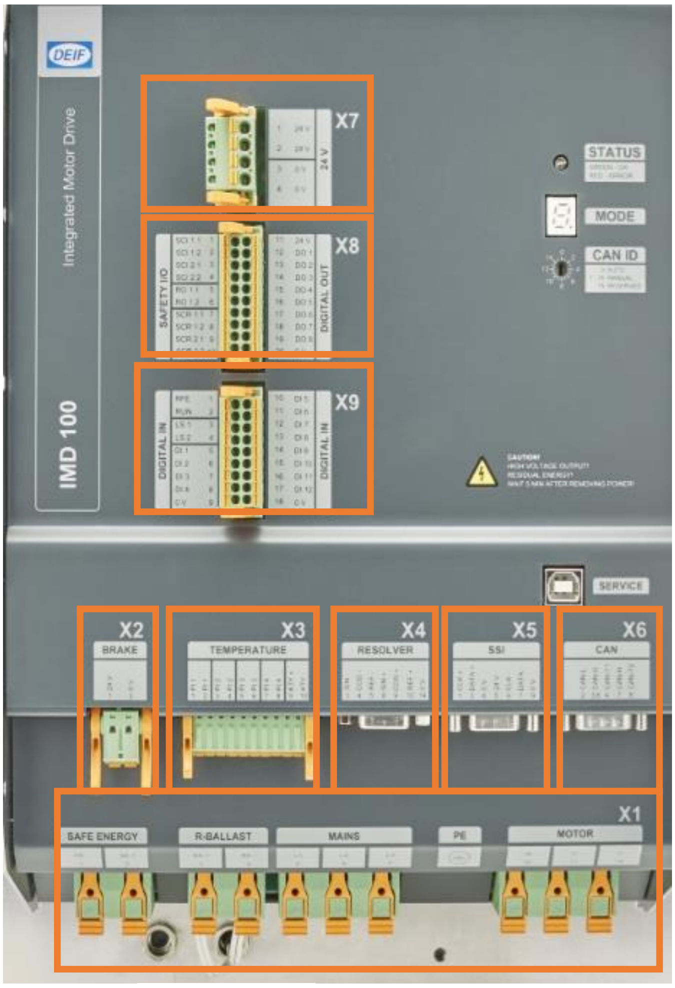


Figure 13 IMD 122 C / 135 C

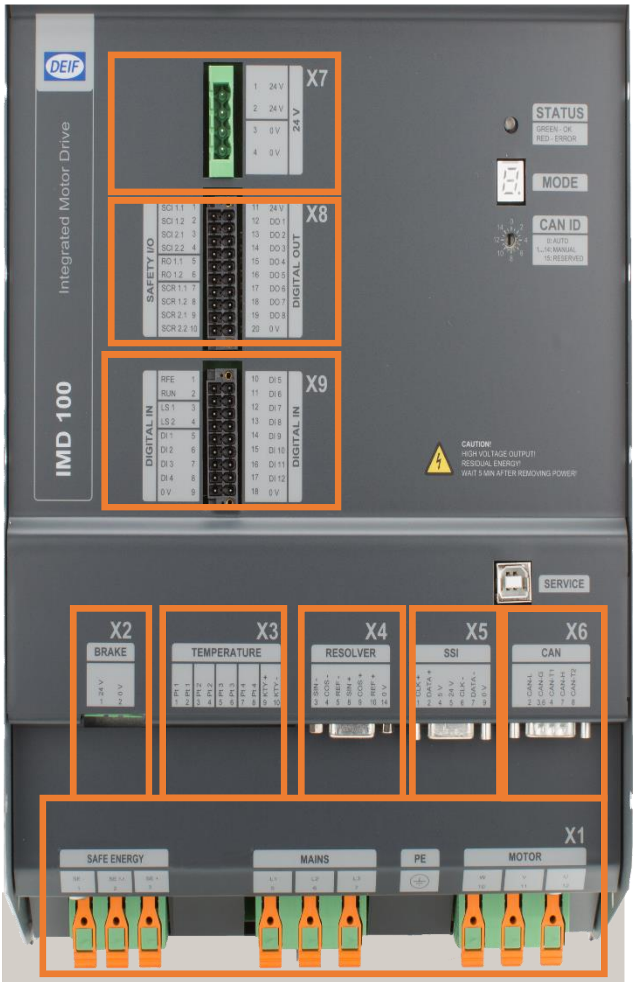
All connectors in the IMD (with the exception of the earth terminal) are push-in spring connectors, which can withstand the constant vibration in a wind turbine while keeping a good electrical connection as well as providing for fast installation process. Except for the power connections (X1) all connectors are male-female (removable) connectors that makes it possible to make wiring sets for production, thus enabling fast assembly.

For detailed description of how to use the different connectors and the specific safety precautions needed to be taken, see the *IMD 100 Installation instructions*.

Following is an overview of the connections that need to be made.



IMD 122 B



IMD 122 C

Figure 14 IMD 122 connections overview

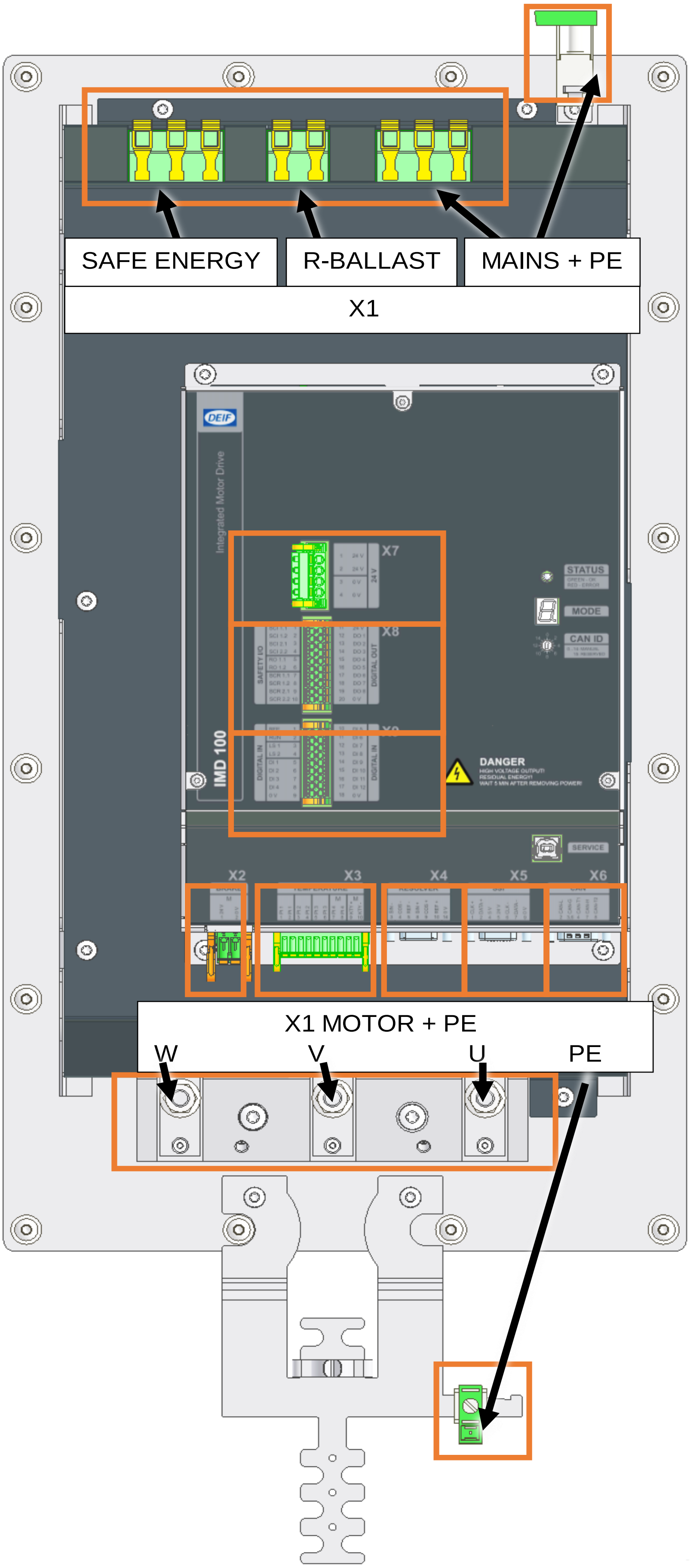

SAFE ENERGY
R-BALLAST
MAINS + PE
X1
X7
X8
X2
X3
X4
X5
X6
STATUS
MODE
CAN ID
DANGER
SERVICE
IMD 100
Integrated Motor Drive
X1 MOTOR + PE
W
V
U
PE

Figure 15 IMD 135 C connections overview

The types of connectors used in the IMD are listed in the following table:

Table 1 IMD connector types

Connector type on IMD	IMD connector designation	Direct / removable connector
Phoenix PLH 16	X1	Directly to connector
M8 threaded rod with nuts (IMD 135 only)	X1 (MOTOR)	Directly to connector
Phoenix SPT 2.5 (IMD 122 C with external ballast resistor option)	X1 (R-BALLAST)	Directly to connector
M5 threaded rod with nuts (IMD 122 A, B, C early production)	X1 (PE terminal)	Direct (PE/Earth)
Phoenix AKG 16 GN (IMD 122 C / IMD 135 C)	X1 (PE terminals)	Direct (PE/Earth)
Phoenix FK-MCP 2,5	X2, X7	Connected through removable connector
Phoenix FK-MCP 1,5	X3, X8, X9	Connected through removable connector
15 pole Sub-D female	X4	Connected through removable connector
9 pole Sub-D female	X5	Connected through removable connector
9 pole Sub-D male	X6	Connected through removable connector

Due to the use of spring-loaded connectors, the use of ferrules (termination sleeves) is optional. However, ferrules must be used if more than one wire is connected to the same connector. Follow the ferrule manufacturer instruction on how to use a ferrule. The following table lists the technical specifications for the used Phoenix connectors:

Table 2 Phoenix connector's technical data

	PLH 16	SPT 2.5	FK-MCP 1.5	FK-MCP 2.5
Conductor cross section flexible, without ferrule	0.75 – 25 mm^2	0.2 – 2.5 mm^2	0.14 – 1.5 mm^2	0.2 – 2.5 mm^2
Conductor cross section flexible, with ferrule without plastic sleeve	0.75 – 16 mm^2	0.25 – 2.5 mm^2	0.25 – 1.5 mm^2	0.25 – 2.5 mm^2
Conductor cross section flexible, with ferrule with plastic sleeve	0.75 – 10 mm^2	0.25 – 1.5 mm^2	0.25 – 0.5 mm^2	0.25 – 2.5 mm^2
Stripping length (without ferrule)	18 mm	10 mm	9 mm	10 mm
Ferrule length	18 mm	10mm	10 mm	10 mm
Rated voltage	1000 V	400 V	160 V	320 V
Rated current	76 A	24 A	8 A	12 A

5.1 Shielding and EMC

If the IMD is used in a wind turbine or any other environment where EMC (ElectroMagnetic Compatibility) protection is required, shielding from cabinet to cabinet (or cabinet to unit) is required. In such cases the cable shielding is connected directly to PE and cabinet earthing, and may not be used for anything else (such as CAN GND). The EMC protection shielding is though also effective as shielding against interference to the signal wires. In essence, any cable from outside the cabinet is shielded, and the shield needs to connected to PE. It is important that these cable shields are connected to both cabinet (through EMC glands) and the IMD (through the connector housing or any other means).

Requirements for cables: any cables going through the cabinet walls must be shielded and the shields must be connected to PE.

The following illustration illustrates the principle of the protection:

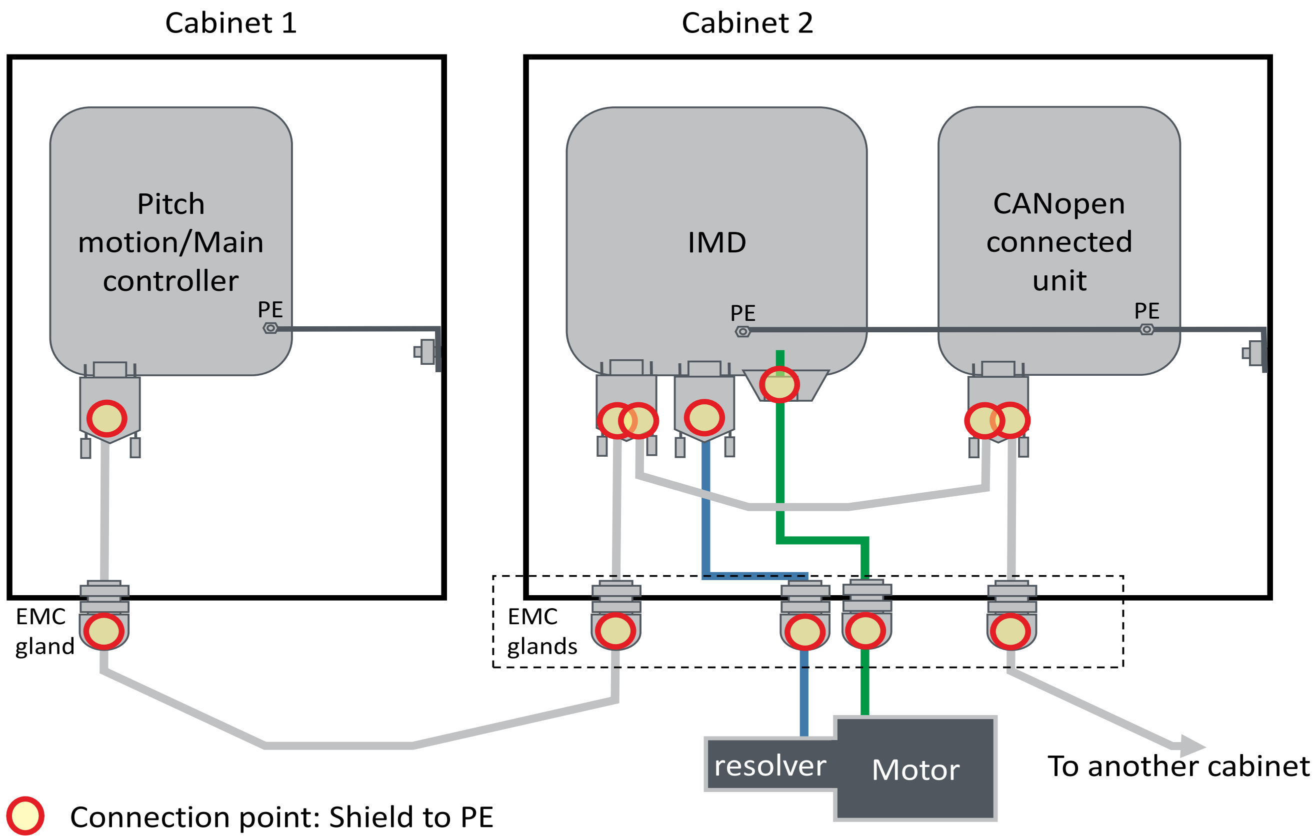


Figure 16 Cable shielding example

The following figure illustrates how the two types of connections are realized in a connector. Since there are different types of connectors and cables, this illustration is an example only.

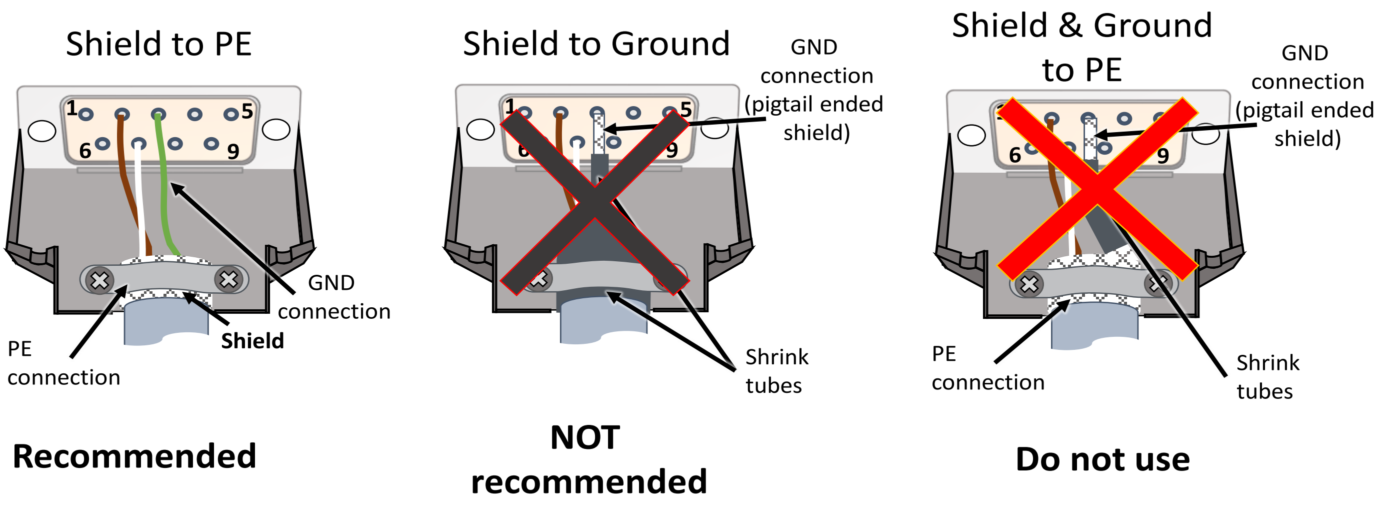


Figure 17 Realization of shielding in connectors

Attention
The use of shield to ground (with a pigtail) is not recommended.
Do not use shield to ground (with a pigtail) and to PE

5.2 Power connections (X1)

Danger!
Risk of burns and electrical shock from short circuit, electrical arc and uninsulated wires.
Live work is not permitted, except for during commissioning and service.
Observe local regulation when working with electrical components.

Disconnect power
Ensure that all power is disconnected when connecting cables to the IMD. If the IMD was powered, wait at least 5 minutes after the power is disconnected, due to residual voltage in the IMD.

Phoenix PLH16 connector is used for connections in X1 (direct connector).

Phoenix SPT 2.5 connector is used for R-BALLAST connections in IMD 122 C equipped with External ballast resistor option.

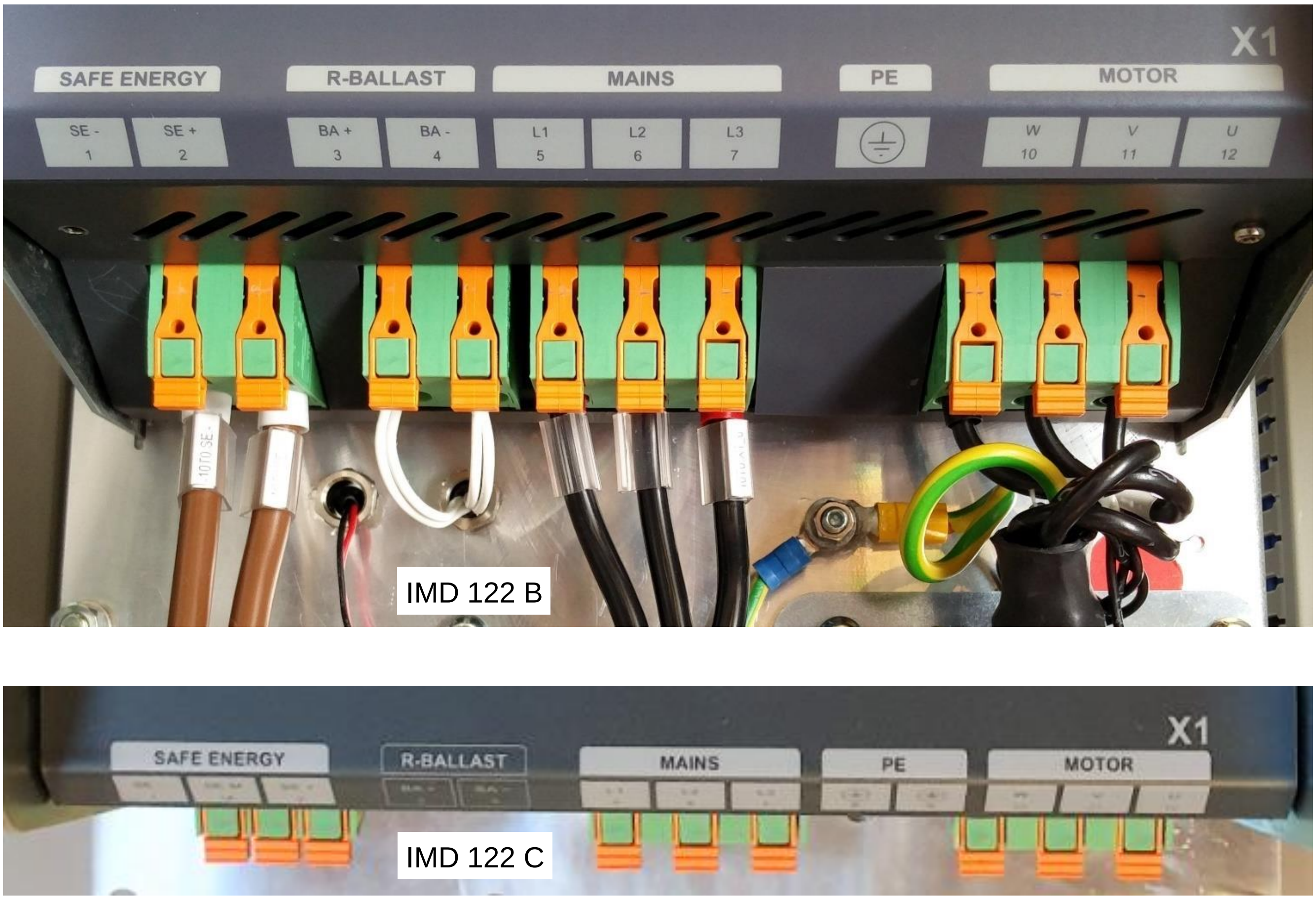


Figure 18 X1 connections IMD 122

Figure 19 X1 connections IMD 135 C

5.2.1 Motor connections requirements

The motor connections are the output from the IMD to the motor.

The requirements for the motor used with the IMD are listed in the following table:

Table 3 Motor requirements

Motor type	• Synchronous 3 phases AC motor • Asynchronous 3 phases AC motor • DC motor
Insulation	• Adequate for the voltage of the Mains input • Adequate for non-sinusoidal waveform of the IMD output
Resolver	Frequency: 10 kHz Voltage: 7 V AC pp No. of poles: 2 to 8
Built-in temperature sensor	Pt100, KTY 84 or PTC*, double insulated
Built-in brake	Voltage: 24 ± 10% V DC Current: Maximum 5 A
Maximum cable length	10 m

* If PTC sensor is used the following IMD functions are not available:

- High motor temperature warning
- Actual motor temperature reading (only motor temperature too high error)

Info
Long temperature sensor’s wires will impact the accuracy of the temperature measurements.

Motor cable requirements:

The motor cable must be shielded. If any other cables (for example for the brake or the temperature sensor) are inside the same cable they must be shielded separately.

The following figure illustrates an example of a cable containing the motor, brake, and temperature sensor connections.

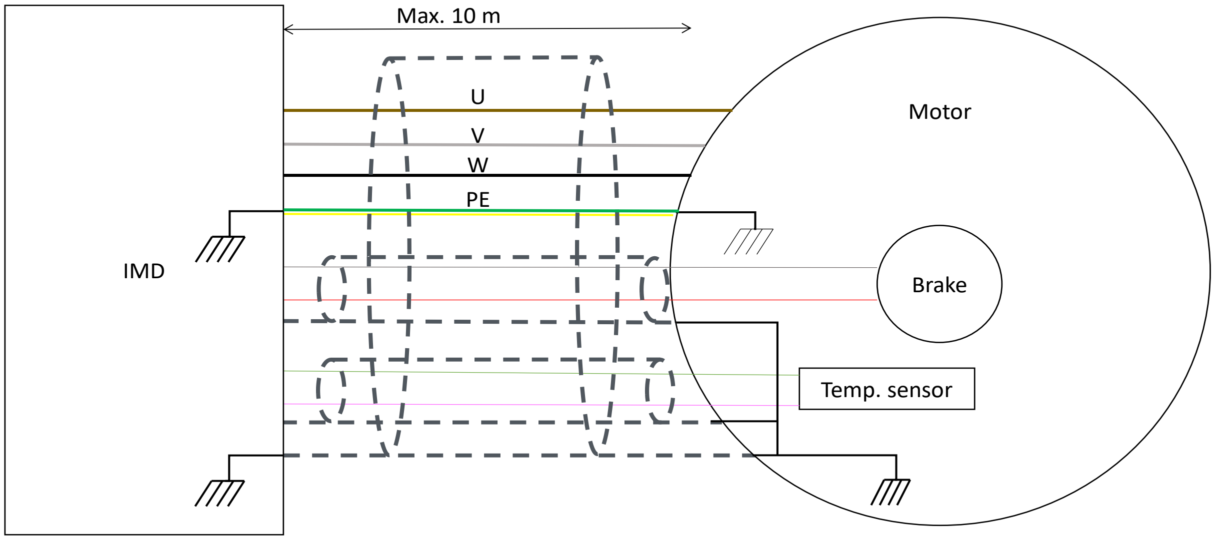


Figure 20 Requirements for motor cable shielding (example)

Wire and cable constraints:

Brake:

The brake wires are typically part of the motor cable. They are connected to X2, see constraints on wire cross section in Table 2 on page 26 (FK-MCP 2.5).

Motor phase:

Phase wires IMD 122 B/C: See Table 2 on page 26 (PLH 16) for suitable wire cross section.

Phase wires IMD 135 C: Use 8 mm cable lugs (not delivered) appropriate for the cross section of the wire used. The lug's width must not exceed 18 mm.

Protective earth:

The protective earth wire is connected to X1, PE terminal.

IMD 122 C, IMD 135 C: Phoenix AKG 16 GN flat screws terminal.

IMD 122 B and early production of IMD 122 C: M5 threaded rod with nuts and washers. Suitable cable lugs for the used wires (not delivered) are needed for the connection.

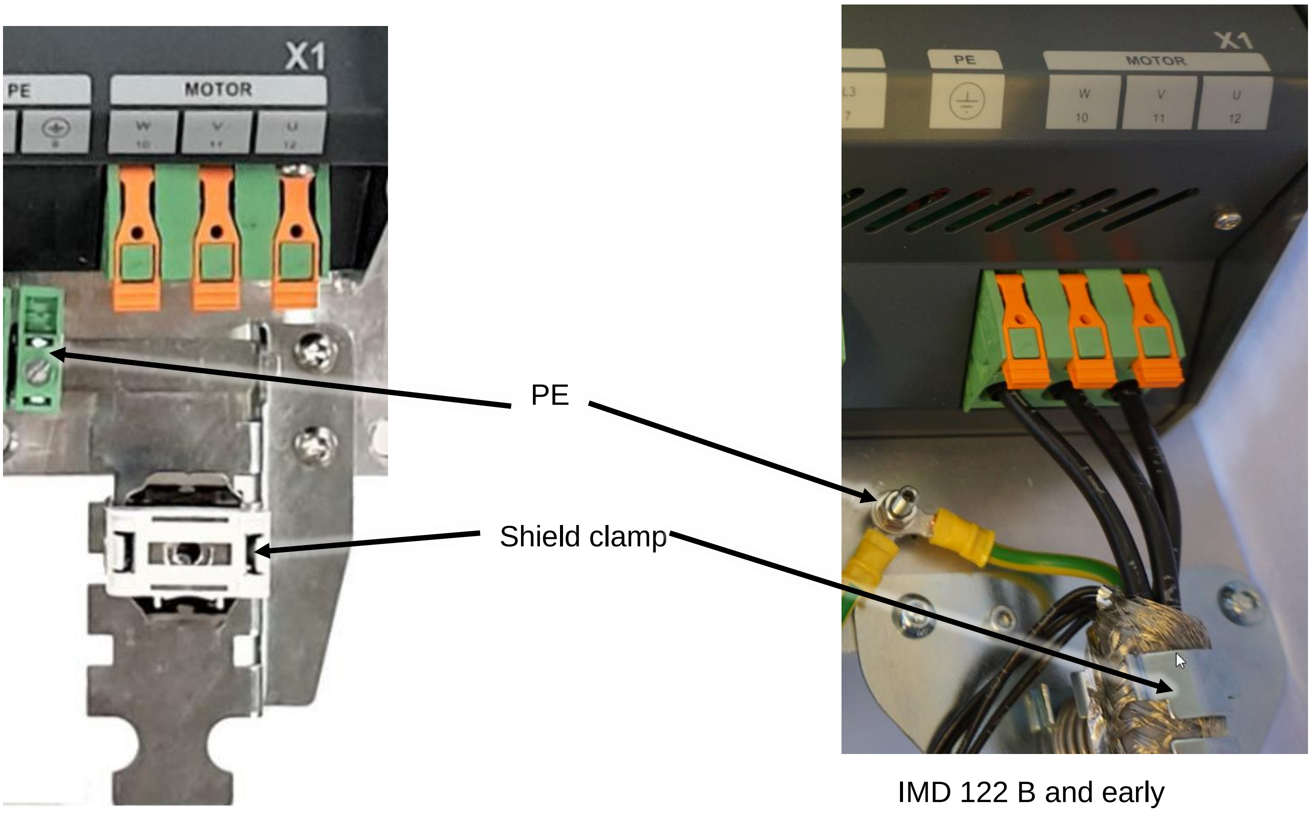
Shield:

The shield clamps have the following specifications for the shield diameter:

IMD 122 B/C: 6 to 20 mm

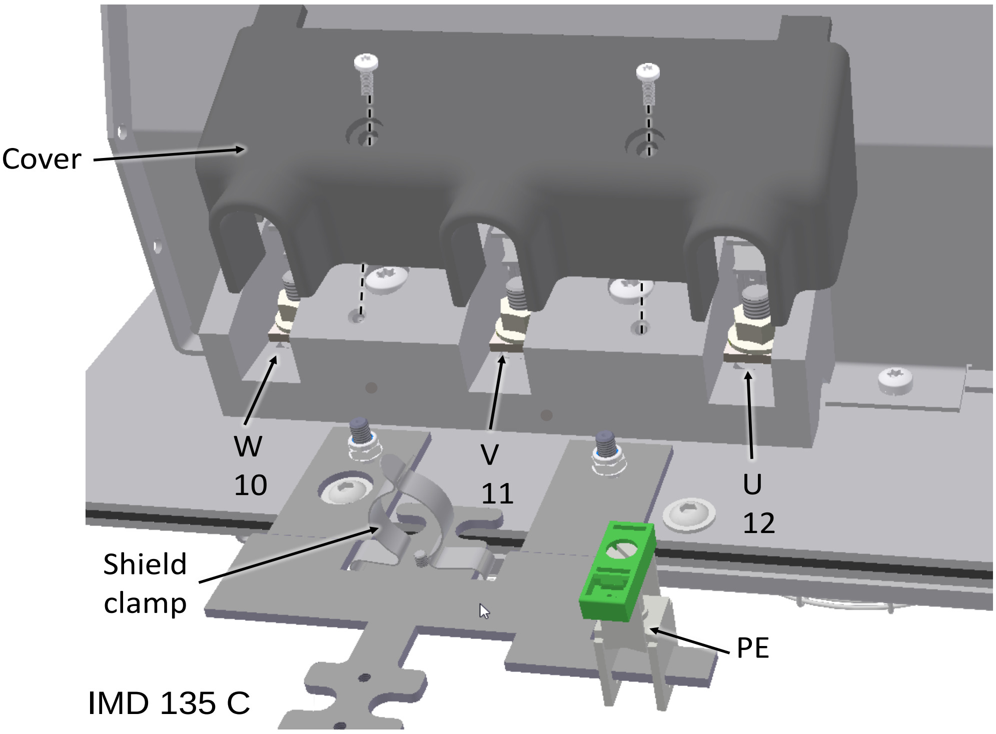
IMD 135 C: 23 to 29 mm

The wires from the motor cable are connected as follows:



IMD 122 C

IMD 122 B and early production of IMD 122 C



IMD 135 C

Terminal no.	Terminal text	Description
PE, ⏚	⏚	Protective earth for motor output. The minimum size of the protective earth conductor must comply with local safety regulations for high protective earthing conductor current.
X1, Motor, 10	W	W motor output
X1, Motor 11	V	V motor output
X1, Motor, 12	U	U motor output

See *IMD 100 Installation instructions* for instructions about preparing the motor cable for connections, and how to use the connectors.

5.2.2 Mains supply connections requirements

The mains connection is used to connect the IMD to the grid. The connection must have protective earthing. The IMD supports all earthing system types defined in BS 7671 (TN-S, TN-C-S, TT, TN-C, and IT).

Attention

The IMD must not be operated without connection to protective earthing. The mains supply must never exceed the range specified in the Data sheet. Risk of destruction of the IMD.

See *IMD 100 Datasheet* for mains input specifications.

Requirements for external components connected to the Mains input:

EMC filters	Not needed *. Built-in EMC filter and input DC-link filter capacitors eliminates the need for external filters. Leakage current is less than 60mA.
Main circuit breaker	Optional.
Fuses	Mandatory. Use maximum 32 A fuse type F, FF, or semiconductor automatic type D.

* In environment with very high electromagnetic interference or total harmonic disturbance it might be necessary to use an external EMC filter and/or line choke.

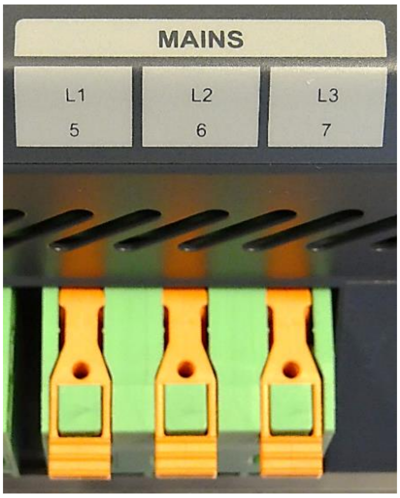
See Table 2 on page 26 (PLH 16) for suitable wire cross section.

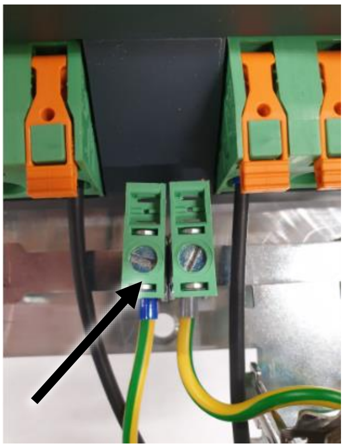
The protective earth wire is connected to X1, PE terminal.

IMD 122 C and IMD 135 C: Phoenix AKG 16 GN flat blade screws terminal.

IMD 122 B and early production of IMD 122 C: M5 threaded rod with nuts and washers. Suitable cable lugs for the used wires (not delivered) are needed for the connection.

The mains wires are connected as follows:





IMD 122 C

IMD 122 B and early production of IMD 122 C

IMD 135 C

Terminal no.	Terminal text	Description
PE, ⏚	⏚	Protective earth from mains supply. The minimum size of the protective earth conductor must comply with local safety regulations for high protective earthing conductor current.
X1, Mains, 5	L1	L1 Mains power input
X1, Mains, 6	L2	L2 Mains power input
X1, Mains, 7	L3	L3 Mains power input

The IMD is not sensitive to the order of the phases.

See *IMD 100 Installation instructions* for instructions about how to use the connectors.

5.2.3 Safe energy connection requirements

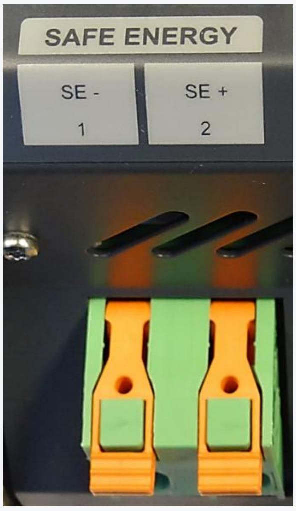
Safe energy source can be either batteries or ultra-caps. See *IMD 100 Datasheet* for Safe energy specifications.

Requirements for external components connected to the SE input:

Fuses	Mandatory. Use maximum 50 A fuse type F, FF, or semiconductor automatic.
Voltage	120 -500 V DC

The safe energy wires are connected as follows:

IMD 122 B	IMD 122 C	IMD 135 C



Terminal no.	Terminal text	Description
X1, SAFE ENERGY, 1	SE-	Safe energy negative terminal.
X1, SAFE ENERGY, 1A	SE M	Safe energy midpoint terminal (IMD 122 C, 135 C only).
X1, SAFE ENERGY, 2	SE+	Safe energy positive terminal.

See Table 2 on page 26 (PLH 16) for suitable wire cross section.

See *IMD 100 Installation instructions* for instructions about how to use the connectors.

5.2.4 Ballast resistor requirements

IMD 122 B: The ballast resistor is built in the IMD fan house, and is already connected to the R-BALLAST terminals upon delivery. The ballast resistor is a 20 Ω 300 W resistor (in total). The resistor is dimensioned for the motors which the IMD is designed to control.

It is however possible to use other resistors instead of the built-in resistor by disconnecting the resistor's wires from the R-BALLAST connectors and connecting the new resistors wires instead.

IMD 122 C: The IMD 122 C does not have built in ballast resistor as standard. It is possible to order the IMD with the "Internal ballast" option, in which case, the ballast resistor terminals are not available.

IMD 135: The IMD 122 C does not have built in ballast resistor as standard. A ballast resistor cannot be ordered with the IMD.

Attention

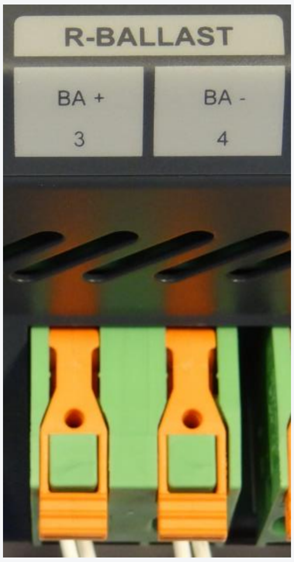
Dimensioning and implementing another ballast resistor must only be done by experts. The minimum ballast resistor value must ensure that the current to the resistor does not exceed the specification in the IMD 100 Datasheet. The current also depends on the configured DC-link maximum value (see section 8.4.1 on page 81 for details).

Absolute minimum resistor values:

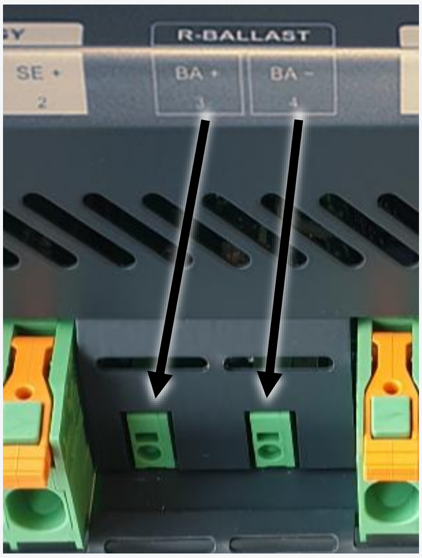
- IMD 122 B/C: 12 Ω
- IMD 135 C: 10 Ω

The ballast resistor wires are connected as follows:

IMD 122 B



IMD 122 C



IMD 135 C

Terminal no.	Terminal text	Description
X1, R-BALLAST, 3	BA +	Positive terminal for the ballast resistor
X1, R-BALLAST, 4	BA -	Negative terminal for the ballast resistor

See Table 2 on page 26 (PLH 16, SPT 2.5) for suitable wire cross section.

5.3 Peripheral and temperature connections (X2, X3, X4, X5)

Connecting the peripheral motor connections depends on the actual motor used. The temperature sensor(s) connections may come with their own separate cables, as part of the resolver cable, or inside the motor cable.

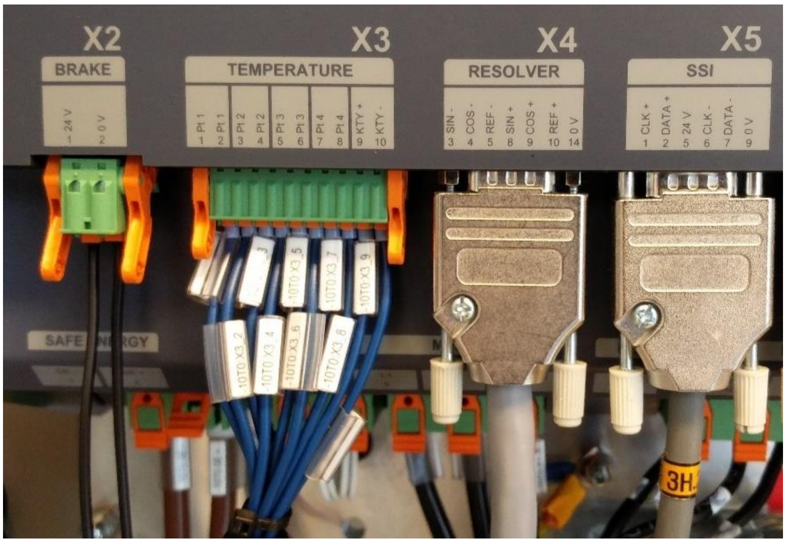
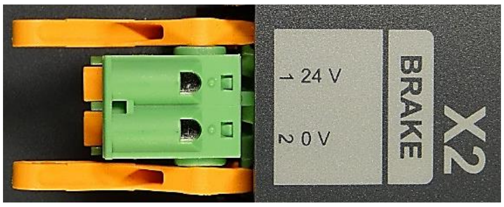


Figure 21 X2, X3, X4, and X5 connections

5.3.1 Connecting the motor brake (X2)

The brake is an integral part of the motor. See requirements for the brake Table 3 on page 30. The brake wires are typically part of the motor cable. They are connected to X2, see constraints on wire cross section in Table 2 on page 26 (FK-MCP 2.5).

The brake wires are connected as follows:



Terminal no.	Terminal text	Description
X2, BRAKE, 1	24 V	Positive terminal for the brake
X2, BRAKE, 2	0 V	Negative terminal for the brake

5.3.1.1 Motor brake requirements

Brake voltage	24 V DC
Maximum brake current	5 A DC

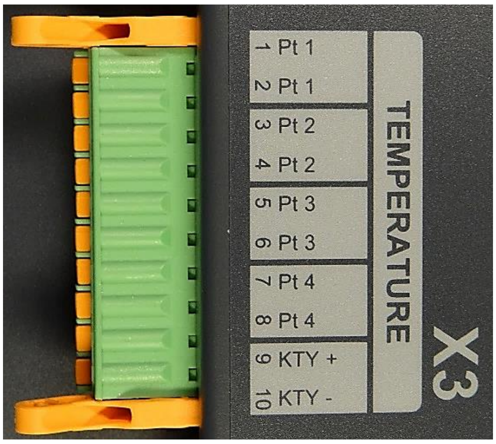
Maximum allowed current to the brake is 5 A DC.

5.3.2 Connecting the temperature sensors (X3, optional)

If the motor temperature sensor wires are not in the resolver cable, the sensor is connected to X3. (Never connect the same sensor to both X3 and X4 connectors.) If Pt100 is used as motor sensor, it must be connected to Pt 4, and Pt 4 is then configured as motor temperature sensor (KTY 84 is the default motor temperature sensor (see section 8.4.2 on page 88). When Pt 4 is not configured as Motor temperature sensor, it can be used in the same way as the other three Pt 100 sensor inputs.

Info
PTC sensor can be used instead of KTY sensor.

If X3 is used, the motor temperature sensors wires are connected as follows:



Terminal no.	Terminal text	Description
X3, 1	Pt 1	First terminal for Pt 1 (Pt100) temperature sensor. NOTE If a built-in charger is used with temperature compensation, Pt 1 terminals must be used for the sensor.
X3, 2	Pt 1	Second terminal for Pt 1 (Pt100) temperature sensor. NOTE If a built-in charger is used with temperature compensation, Pt 1 terminals must be used for the sensor.
X3, 3	Pt 2	First terminal for Pt 2 (Pt100) temperature sensor
X3, 4	Pt 2	Second terminal for Pt 2 (Pt100) temperature sensor
X3, 5	Pt 3	First terminal for Pt 3 (Pt100) temperature sensor
X3, 6	Pt 3	Second terminal for Pt 3 (Pt100) temperature sensor
X3, 7	Pt 4	First terminal for the Pt100 motor temperature sensor
X3, 8	Pt 4	Second terminal for the Pt100 motor temperature sensor
X3, 9	KTY +	Positive terminal for the KTY 84 or PTC sensor
X3, 10	KTY -	negative terminal for the KTY 84 or PTC sensor

See wire cross section constraints in Table 2 on page 26 (FK-MCP 1.5).

Info

The accuracy of the temperature measurements might be impacted if the temperature sensor's wires are long. See accuracy specification in the *IMD 100 Datasheet*.

5.3.3 Connecting the resolver (X4)

The resolver is a measuring system for a motor revolution. It is robust and insensitive to high temperature. The architecture of a resolver corresponds to a rotating transformer. The IMD is compatible with most industrial resolvers.

The rotor is powered by the reference. The stator provides the modulated frequency of the rotary-sine and cosine signals. The amplitudes of these signals are digitized and evaluated in the servo amplifier.

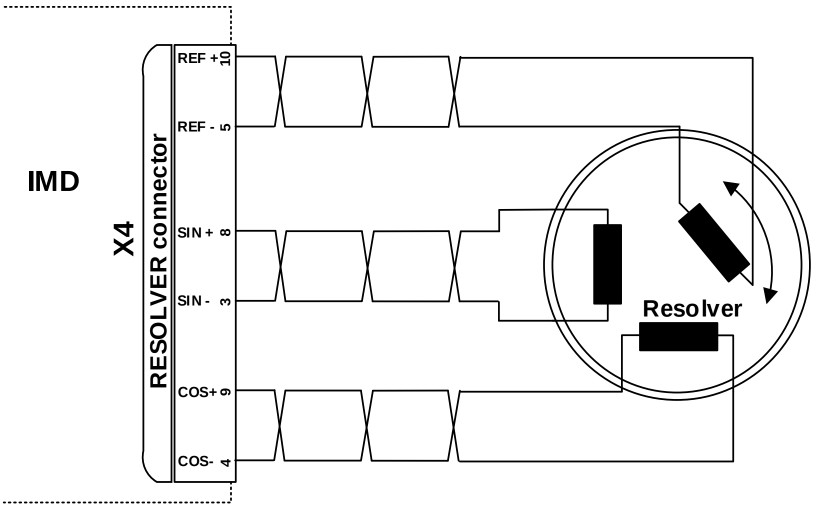
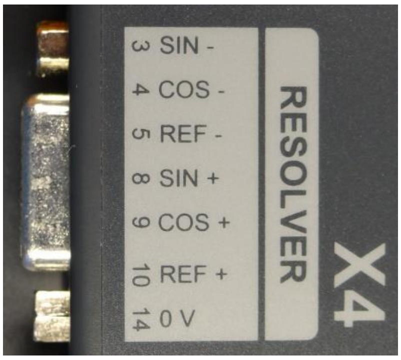


Figure 22 Resolver architecture and connections

The digitized signals are used for position and speed control.

Pt4 and KTY motor temperature sensors can be connected to the IMD through either X3 or X4. Never connect the same sensor to both connectors

The resolver wires are connected to a male 15 pole D-sub connector as follows:



Terminal no.	Terminal text	Description
1, 2, 13, 15		Not connected
3	(s3) SIN-	Sine signal Low
4	(s4) COS-	Cosine signal Low
5	(r2) REF-	Exciter ref voltage Low

Terminal no.	Terminal text	Description
6	PT 4 - 1	PT 100 temp. sensor 4 - 1 (Motor)
7	KTY +	KTY temp. sensor + (Motor)
8	(s1) SIN+	Sine signal High
9	(s2) COS+	Cosine signal High
10	(r1) REF+	Exciter ref voltage High
11	PT 4 - 2	PT 100 temp. sensor 4 - 2 (Motor)
12	KTY -	KTY temp. sensor - (Motor)
14	0 V	Reference potential

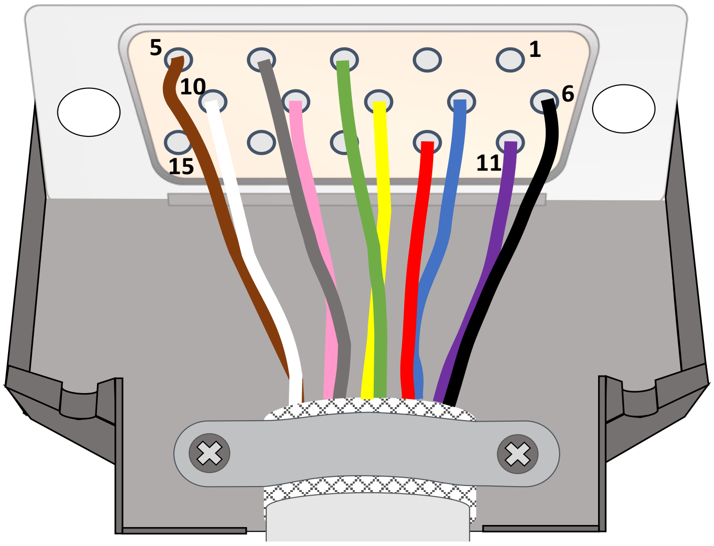


Figure 23 Resolver D-sub connection

Info
Colour coding may differ depending on the cable used.
The depicted connections are shown with both KTY 84 and Pt100 sensors connected.

Shields must be connected to the housing of both connectors (D-sub and the connector to the resolver) as depicted in the following figure:

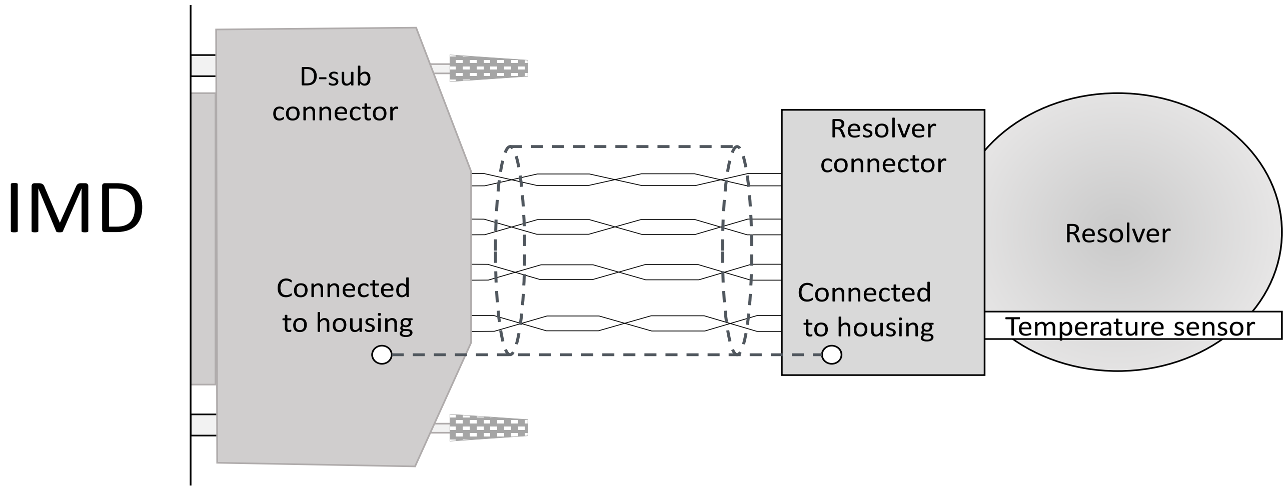


Figure 24 Shield connection

5.3.3.1 Cable requirement

Use only shielded resolver cables with twisted pairs.

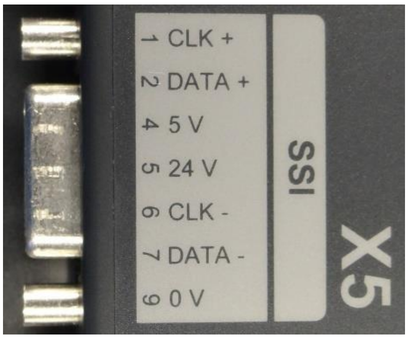
5.3.3.2 Connector housing requirements

Use metal or metalized 9 pole male D-sub housing. All shields must be connected to the connector housing.

5.3.4 Connecting the SSI (X5), optional

The Synchronous Serial Interface (SSI) sensor is an optional component. It is typically used by the application SW to determine the position of the blade. It is never used by the IMD for actual control, though the SSI value can be read by an extern pitch motion controller, main controller, or the IMD Manager.

The SSI wires are connected to a female 9 pole D-sub connector as follows:



Terminal no.	Terminal text	Description
1	CLK +	Output clock positive signal
2	DATA +	Input data channel positive signal
3, 8		Not connected
4	5 V	+5 V DC
5	24 V	+24 V DC
6	CLK -	Output clock (negative)

Terminal no.	Terminal text	Description
7	DATA -	Input data channel (negative)
9	0 V	Reference potential

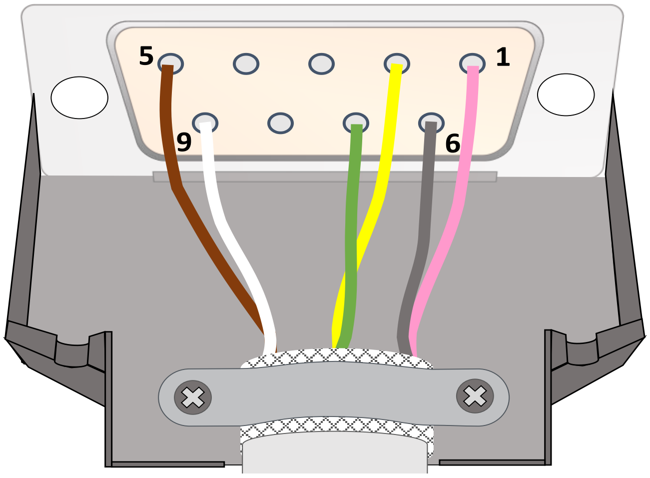


Figure 25 SSI encoder D-sub connection

Info
Colour coding may differ depending on the cable used.
The depicted connection is for a 24 V DC SSI encoder.
Read the encoder's manual to determine if the direction input needs to be terminated.

Shields must be connected to the housing of both connectors (D-sub and the connector to the encoder) as depicted in the following figure:

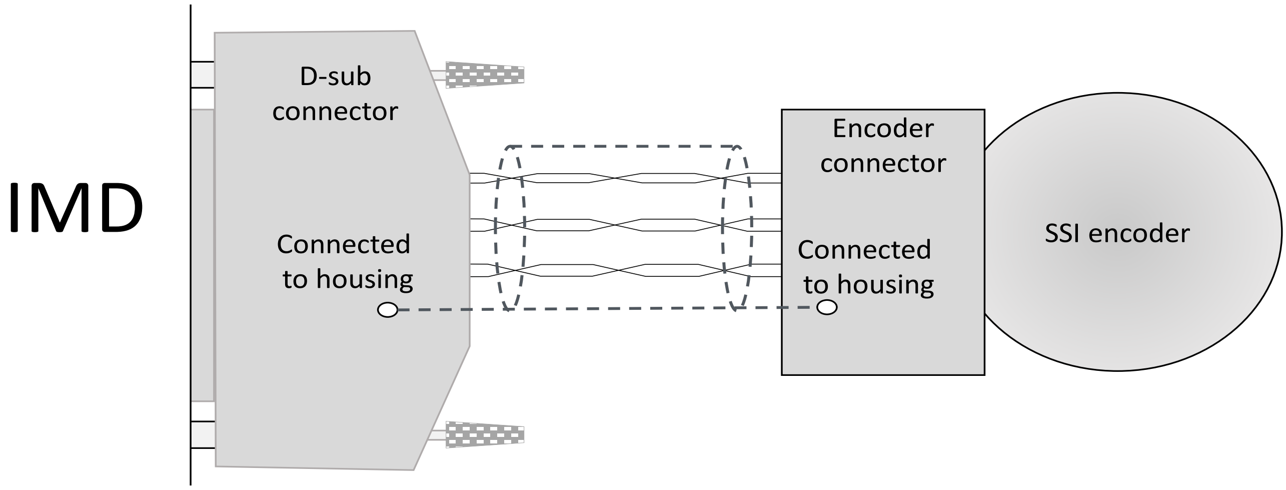


Figure 26 **Shield requirement to SSI cable with temperature sensor**

Info

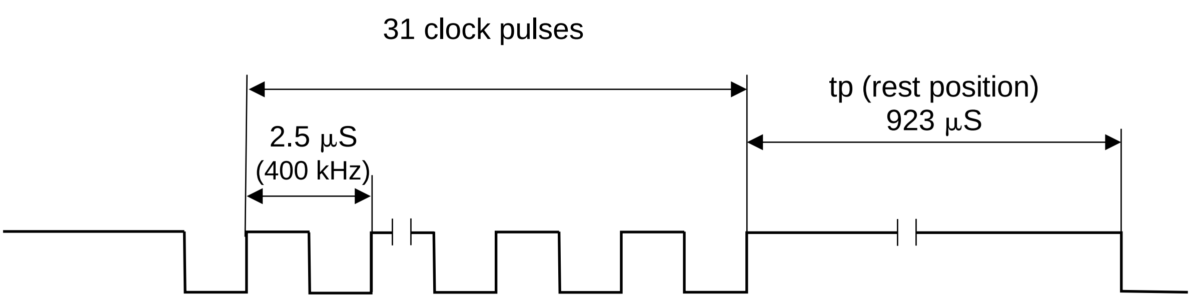
Some SSI encoders have no connector and the cable is already connected to the encoder from the factory.

5.3.4.1 SSI encoder requirements

Only absolute encoder with some specific data formats is supported. The SSI encoder must comply with the following requirements:

	Unit	Specifications	Note
SSI Encoder type	N/A	Absolute encoder, single-turn, or multi-turn	Incremental encoder is not supported
SSI encoder supply voltage	V DC	5 or 24	
SSI encoder current	A DC	24 V DC: Max. 0.2 5 V DC: Max 0.5	Internal thermal fuse in IMD
SSI encoder interface differential input / output	V DC	Complies with RS485	(IMD input impedance is 150 Ω)
SSI encoder resolution	Bits	Single-turn: 12+1 Multi-turn: 12+12(+1)	Single turn: 12 bit resolution per revolution + special bit Multi-turn: 12 bit resolution per one revolution + 12 bits for number of turns + special bit (special bit is optional)
SSI encoder output format	N/A	Single-turn: Binary Multi-turn: Gray code	
SSI encoder clock frequency	kHz	The top of the clock frequency range must be higher than 500 Hz	(the IMD clock frequency is approximately 400 kHz)

The clock pulses sent from the IMD are according to the following:



Info

After sending the LSB (multi-turn) or special bit (single-turn), the encoder sends a zero. This zero is used to determine whether the SSI input is OK (status in Reg. 0x9B, bit 31). If a wrong type encoder is configured, the SSI input indication will be mainly off, but at some positions it might be on.

5.3.4.2 Cable requirements

Use only shielded encoder cables with twisted pairs.

5.3.4.3 Connector housing requirements

Use metal or metalized 9 pole male D-sub housing. All shields must be connected to the connector housing.

5.4 Communication

5.4.1 Connecting the CAN bus (X6)

A CAN network must be terminated with 120 Ω at both ends. If there are no input/output connectors in each unit, the CAN bus can also be implemented as an open ring. Figure 28 on page 45 illustrates a typical implementation of three IMDs in a hub. Note that CAN low is always connected to CAN low and CAN high is always connected to CAN high. Termination resistors are only used in IMD 3 by connecting pin 2 to pin 4, and pin 7 to pin 8 (it is assumed that the pitch motion controller or main controller is terminated as well).

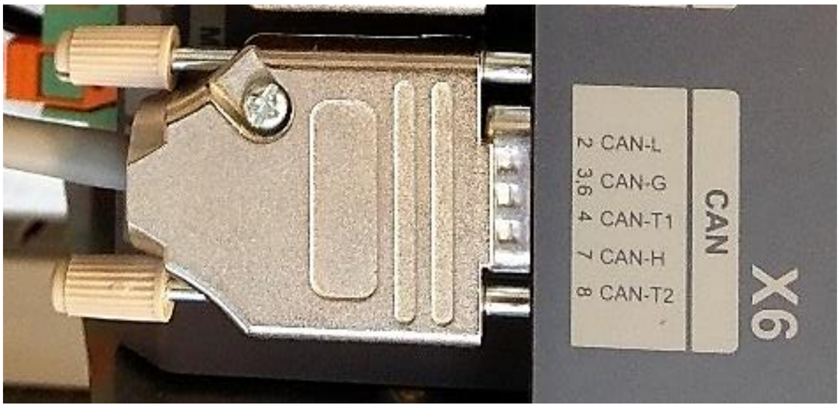


Figure 27 X6 connection

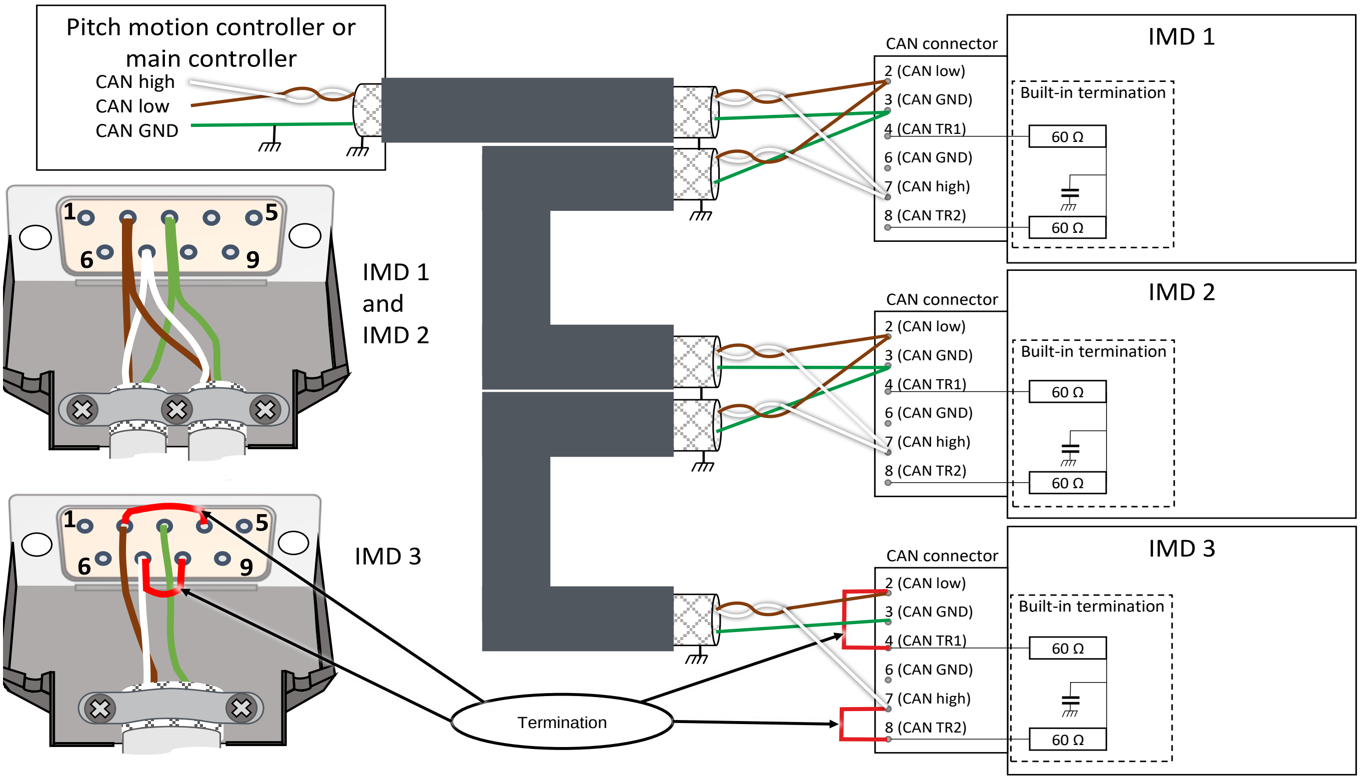


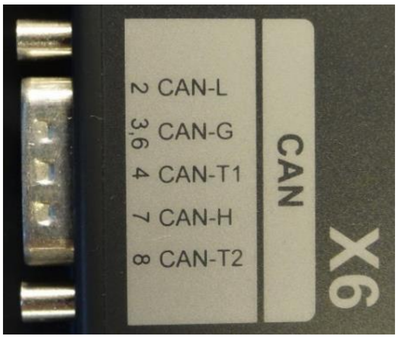
Figure 28 CAN connections

Attention

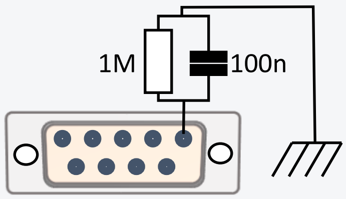
Shields must be connected to the D-sub connector housing (see section 5.4.1.1 on page 46 and section 5.4.1.2 on page 46) unless they carry the CAN GND. See also general shielding and lightning protection in section 5.1 on page 27.

The CAN GND must be connected in one, and one place only to PE.

The CAN wires are connected to a male 9 pole D-sub connector as follows:



Terminal no.	Terminal text	Description
1,9		Not connected
2	CAN-L	CAN low
3, 6	CAN-G	CAN GND
4	CAN-T1	CAN termination resistor T1

Terminal no.	Terminal text	Description
5	-	Optional shielding terminal containing the following circuit inside the IMD: 
7	CAN-H	CAN high
8	CAN-T2	CAN termination resistor T2

5.4.1.1 Cable requirement

It is required that shielded cables with twisted pairs are used for the CAN connections. Cables designed for CAN bus communication according to ISO 11898 are recommended. Two pairs or one cord and a twisted pair must be used. CAN H and CAN L must always be a twisted pair. See also section 5.1 on page 27.

Info

In some cases, it is possible to use the CAN connections without common ground, and thus use a shielded 2 wire cable for units in different cabinets. However, without common GND the communication might get unstable, and it is not possible to predict beforehand whether it will happen or not. DEIF recommends to use cables that have either an extra twisted pair or an extra inner shield in order to be able to connect the common GND between the units.

5.4.1.2 Connector housing requirements

Use metal or metalized 9 pole female D-sub housing. All shields must be connected to the connector housing.

5.5 Connecting 24V, digital and safety I/O (X7, X8, X9)

X7, X8, and X9 are implemented as a male-female connector with the male part on the IMD and the wires are connected to the female part. All female parts are delivered with the IMD.

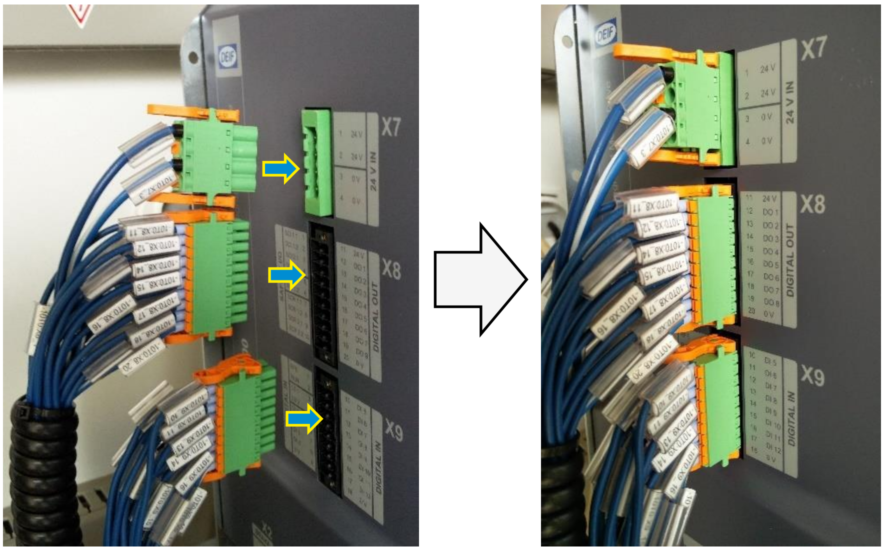


Figure 29 Male-female connectors

See detailed description of how to connect wires to the female connector and how to connect/disconnect the female to the male connectors in the *IMD 100 Installation instructions*.

See detailed description of the functions of the connections in the IMD function description.

5.5.1 Connecting digital inputs (X9)

All inputs in X9 have the following HW specifications:

Voltage range	0 – 36 V DC
Digital low	0 – 5 V DC
Digital high	9 – 36 V DC
Impedance	Approximately 2.4 kΩ
Input current (high)	Approximately 7.3 mA @ 24 V DC

Info
To calculate the approximated input current at a specific voltage: I = (U – 6)/2460

Typical implementation of circuit for digital input:

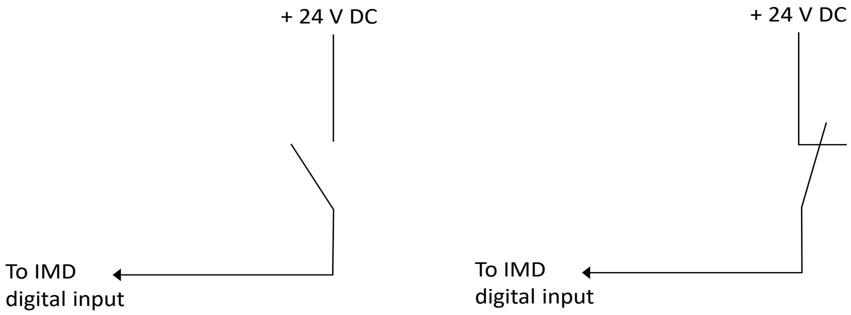
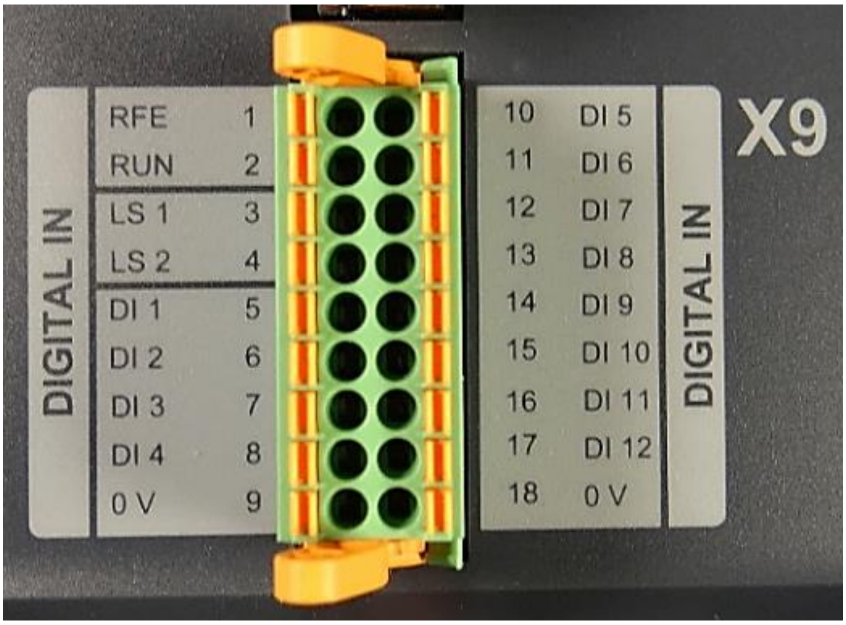


Figure 30 Typical digital input interfaces

The digital input wires are connected to the female connector as follows:

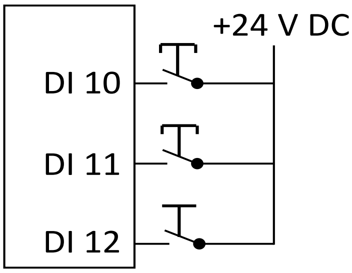


Terminal no.	Terminal text	Description
1	RFE	Rotational Field Enable, intended to be used as safe torque off for emergency stop buttons. Disables the power module and engages the brake. Use a normally closed switch connected to +24 V DC.
2	RUN	Device enable. If in motion, the motor actively decelerates and brake sequence started. If not in motion the device is disabled and the motor brake is engaged.
3	LS 1	Limit switch 1 (active high or low is configurable)
4	LS 2	Limit switch 2 (active high or low is configurable)
5	DI 1	Digital input 1
6	DI 2	Digital input 2
7	DI 3	Digital input 3
8	DI 4	Digital input 4
9	0 V	Ground
10	DI 5	Digital input 5
11	DI 6	Digital input 6
12	DI 7	Digital input 7
13	DI 8	Digital input 8
14	DI 9	Digital input 9, (reserved for manual operation 360 “360 enabled” if manual operation 360 is enabled in the configuration)
15	DI 10	Digital input 10, (reserved for manual operation “-“ [CCW] if manual operation is enabled in the configuration)

Terminal no.	Terminal text	Description
16	DI 11	Digital input 11, (reserved for manual operation “+“ [CW] if manual operation is enabled configuration)
17	DI 12	Digital input 12, (reserved for manual operation “Manual enable“ if manual operation is enabled configuration)
18	0 V	Ground

Attention
The digital inputs are galvanically isolated from the IMD circuit by optocouplers. Ground from the external circuit must be connected to terminal 18.

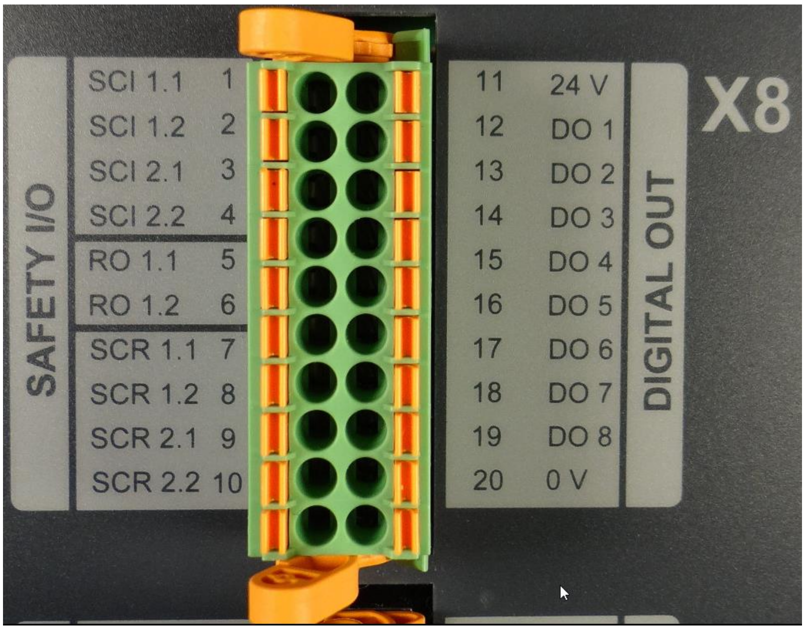
Recommended connections for manual operation:



5.5.2 Connecting safety I/O and digital outputs (X8)

X8 connector contains safety-chain inputs and outputs, additional relay output (RO), and eight digital outputs.

The wires are connected to the female connector as follows:



Terminal no.	Terminal text	Description
1	SCI 1.1	Safety-chain input channel 1 (+)

Terminal no.	Terminal text	Description
2	SCI 1.2	Safety-chain input channel 1 (-)
3	SCI 2.1	Safety-chain input channel 2 (+)
4	SCI 2.2	Safety-chain input channel 2 (-)
5	RO 1.1	Additional relay output contact 1
6	RO 1.2	Additional relay output contact 2
7	SCR 1.1	Safety-chain relay channel 1 contact 1
8	SCR 1.2	Safety-chain relay channel 1 contact 2
9	SCR 2.1	Safety-chain relay channel 2 contact 1
10	SCR 2.2	Safety-chain relay channel 2 contact 2
11	+24 V	+ 24 V DC supply for all outputs
12	DO 1	Digital output 1
13	DO 2	Digital output 2
14	DO 3	Digital output 3
15	DO 4	Digital output 4
16	DO 5	Digital output 5
17	DO 6	Digital output 6
18	DO 7	Digital output 7
19	DO 8	Digital output 8, it is recommended to use this output for the Fan + (red wire). See also section 8.4.8 on page 100.
20	0 V	Ground for all outputs, also used for Fan - (black wire)

Attention
The digital outputs are galvanically isolated from the IMD circuit by optocouplers. Ground and +24 VDC from the external circuit must be connected to terminal 11 and 20.

5.5.2.1 Safety I/O

In order to be able to implement a safety-chain according to ISO 13849, two safety-chain relays (SCR) and two safety-chain inputs (SCI) are implemented in the IMD. See *IMD 100 function description* manual for detailed description of how the safety I/O is implemented and functions.

Safety-chain inputs (SCI) have the same HW specifications as all other digital inputs specified in section 5.5.1 on page 47.

Safety-chain output (SCR) are relay outputs, protected with a PTC multi-fuse (0.5 A). If the current exceeds the fuse value, the fuse will heat up and disconnect the output. When the fuse is cooled down, it will automatically reconnect the output.

The safety-chain outputs relay contacts have the following HW specifications:

Maximum voltage	30 V DC
Maximum current	0.25 A DC

Attention

The safety-chain inputs must be connected no matter if safety chain is used or not. See Figure 31 on page 51 for detailed information of how to connect the safety-chain inputs when the safety chain is not used.

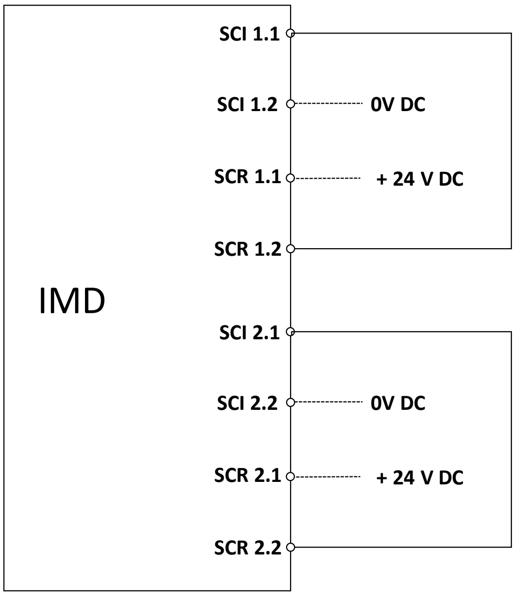


Figure 31 Safety-chain input connections when safety-chain is not used

5.5.2.2 Additional relay output

The relay output RO has the same characteristics as the safety-chain relays. It is protected with a PTC multi-fuse (0.5 A). If the current exceeds the fuse value, the fuse will heat up and disconnect the output. When the fuse is cooled down, it will automatically reconnect the output. This relay output is a distributed output that can be used for any purpose.

The output RO relay contacts have the following HW specifications:

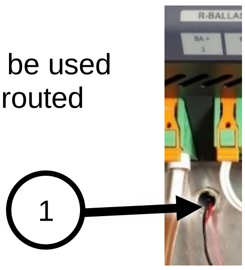
Maximum voltage	30 V DC
Maximum current	0.25 A DC

5.5.2.3 Digital outputs

There are eight digital outputs that can be used for any purpose. The outputs are supplied from X8 supply (terminals 11 and 20).

Info

IMD version B only: One of the outputs between DO5 to DO8 must be used for the fan (DO 8 is recommended to be used). The fan wires (1) are routed through the heat sink to the left of the R-ballast.



The digital outputs have the following HW specifications:

Voltage supply range at X8/11	12 to 36 V DC
Maximum output current	250 mA DC
Output high	> supply voltage at X8/11 – 1V DC
Output low	< 3 VDC

5.5.3 Connecting 24V (X7)

Depending on the options of the IMD, X7 can be input or output:

- IMD has “24 VDC out” option: X7 acts as output or input for backup (use of X7 is optional)
- IMD has no “24 VDC out” option: X7 acts as input (use of X7 is mandatory)

The 24 V is used as a supply for the IMD internal control and the following outputs (connected internally):

- Brake
- Resolver
- Temperature sensors
- SSI

X7 has double poles for both plus and minus, to enable chaining the supply. If chaining is not needed any of the inputs can be used.

The following figure illustrates some application examples:

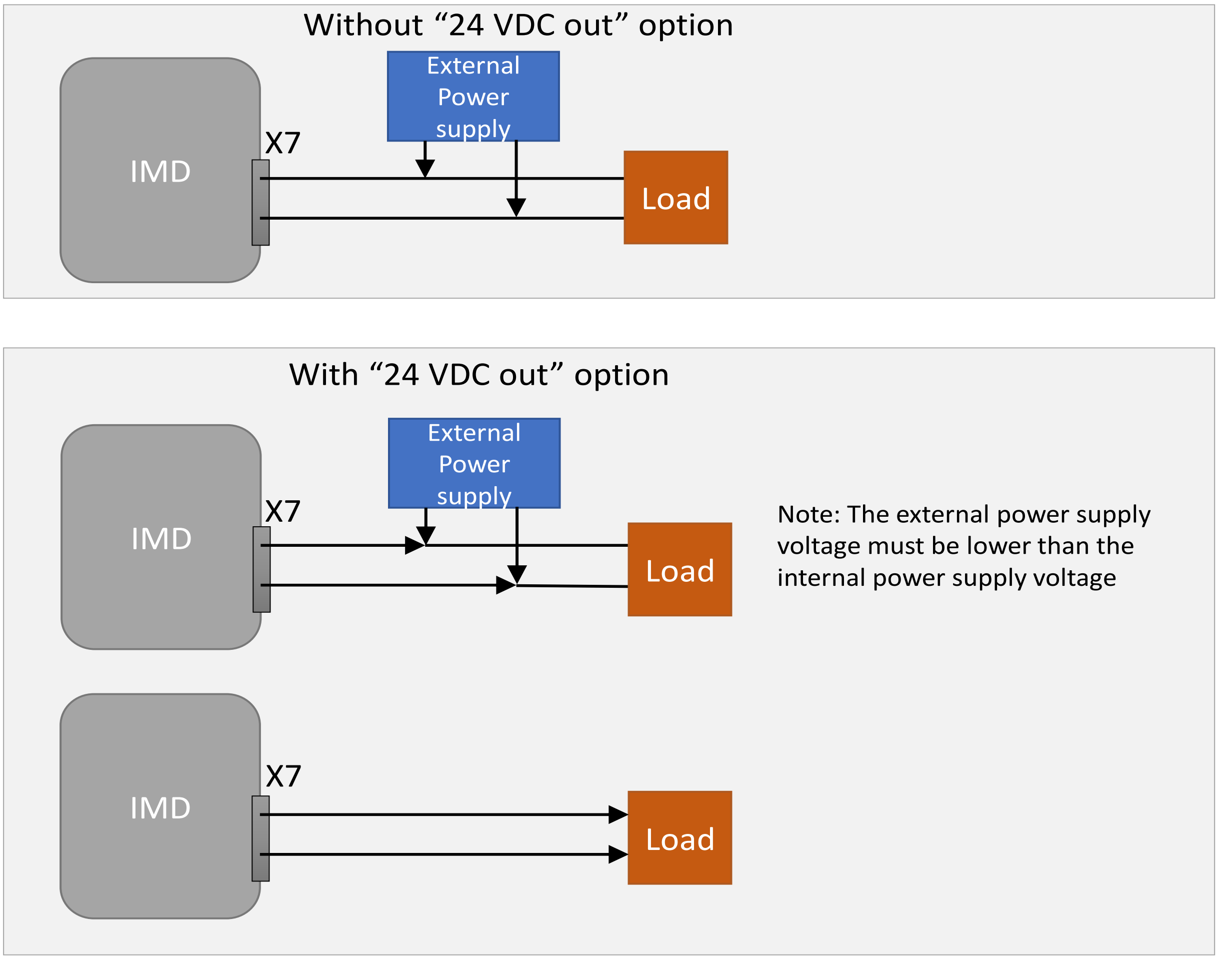


Figure 32 Typical applications

NOTE When an external power supply is connected to X7, consider power that may be drawn from the motor brake output. Se section 6.4 on page 63.

With “24 VDC out” option:

Table 4 External power supply specifications

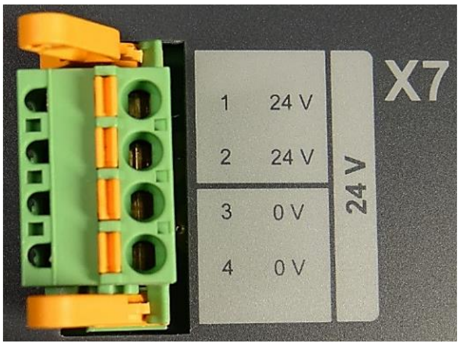
Input voltage	24 ± 10% V DC No voltage dip (at brake current + 0.25 A DC inrush current) below 20 V DC is allowed.
Input current (IMD only)	Maximum current through X7: 7 A DC. Minimum current calculated (sum) from the following consumptions: • IMD internal + fan: 1 A DC • SSI consumption • Brake consumption

Without "24 VDC out" option:

Table 5 Internal power supply output and external power supply input specifications

Output voltage	24 ± 2% V DC
Maximum output current available at X7	6 A – brake current – SSI encoder current, (the actual currents used by the motor brake and SSI encoder must be subtracted from 6 A).
External power supply voltage	21 to 23.5 V DC. No voltage dip below 20 V DC is allowed.
External power supply current (IMD input)	Maximum current through X7: 7 A DC Minimum current calculated (sum) from the following consumptions: • IMD internal + fan: 1 A DC • SSI consumption • Brake consumption

The wires are connected to the female connector as follows:



Terminal no.	Terminal text	Description
1, 2	24 V	+ 24 V DC input or output depending on IMD variant and option
3, 4	0 V	0 V DC input or output depending on IMD variant and option

6. Functions description

This section describes in more details functions that are not described or described in a high-level manner in the IMD 100 function description. The SCI (Safety-chain input) and RFE (Rotation Field Enabled) inputs are safety related, and are fully described in the IMD 100 function description.

6.1 IMD states

The following flowchart shows the operational states of the IMD, and indicates the conditions for changing from one state to another. Some states are not mentioned since they are path states only, and will not be seen by the user, or omitted for simplicity.

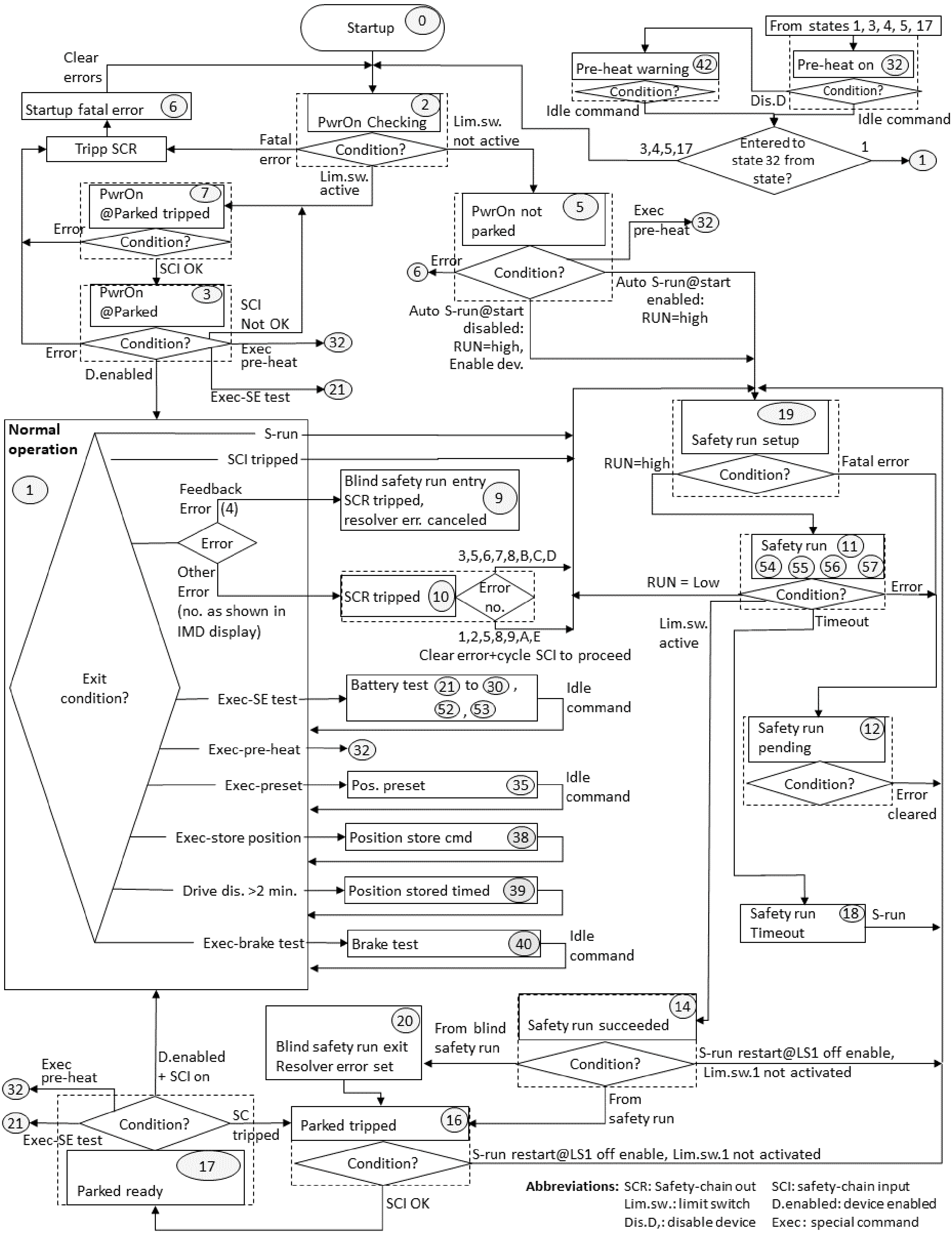


Figure 33 IMD states

The following table describes the states of the IMD (some states are omitted since they will not be seen by the user). In the conditions to proceed column, the conditions for leaving the state are given. Conditions to proceed that are user or application actions (either through the IMD Manager, through the CAN interface or manual operation) are formatted as `monotype`.

Table 6 IMD operational states description

No	Name	Description	Conditions to proceed
1	Normal operation	This state is the state when the IMD is ready to operate and there are no active errors. The condition for entering this state are that the device is enabled (see section 9.4 on page 133 for details). Once in this state, it will remain in this state even if the device is disabled by “Enable dev.” button/CAN command, or low on the RUN input.	• Active error • Safety-chain input tripped • Safety run execution • `Manual operation*` • `Execution of special commands`
2	PwrOn checking	Power on checking. This state is the first state during start-up and a return step if start-up error was cleared. In this step the IMD makes a self-test, check for errors and check whether a limit switch is activated, in order to determine whether the present position is known.	• Error is active • Limit switch is active • Limit switch is not active
3	PwrOn @Parked	Power on at parked. This state is entered if a limit switch is activated at start-up.	• Error is active • Safety chain input is OK, and the `device is enabled (RUN is high and Enable dev. is set)` • `Execution of special command pre-heat` • `Execution of special command SE-test` • `Manual operation*`
5	PwrOn not parked	Power on not parked. This state is entered if no limit switch is activated at start-up, and thus the position is unknown. In this state the IMD will check the state of the Auto safety run enabled bit in reg. 0x01.	• Error is active • Auto safety run enabled = 0: `RUN = high and Enable dev. is set` • Auto safety run enabled = 1: `RUN = high`. “Enable dev.” is set automatically by the IMD • `Execution of special command pre-heat` • `Manual operation*`

No	Name	Description	Conditions to proceed
6	Start-up error	An error is found during the start-up sequence. SCR outputs 1 and 2 are tripped, and the IMD remains in this state until the errors are cleared by the user or the application SW. After the errors are cleared, the SCI inputs must be cycled to initiate restart.	• Errors cleared and SCI 1 and 2 are cycled
7	PwrOn@Parked tripped	The blade is fully feathered (limit switch activated, but the state of the safety chain is either unknown (when entering the state) or tripped.	• SCI inputs indicate that the safety chain is not tripped (SCI OK) • Error is active
9	Blind safety run initiate	The IMD can only enter this state from normal operation (1) and if the resolver is not OK. It is used to create another entry point to the safety run so that blind safety run parameter values will be used. It also temporarily cancels the feedback error (the error will be set again when exiting the safety run at state 20). This is needed in order to override the error check in states 19 and 11.	• None. The IMD automatically proceeds to safety run setup (state 19)
10	SCR tripped	An error occurred in normal operation state. The IMD automatically trips the SCR outputs 1 and 2. A special case is for errors 5 and 8. If these errors were triggered by DC-link Vmax or DC-link Vlow, the IMD automatically proceeds to safety run (19). If these errors were triggered by HW DC-link or DC-link Vmin, the IMD will stay in state 10 until the error is cleared and SCI is cycled.	• If the error that caused state 10 is error number 3, 6, 7. B, C or D, the IMD automatically proceeds to safety run (19). • If the error number is different than 3, 6, 7. B, C or D, clear errors and cycle SCI inputs See also description to the left.
11	Safety run step 0	The IMD executes a safety run: the motor runs with the configured speed until a limit switch is activated, a configured timeout is reached, or the position for step 1 is reached (and speed profile is enabled). If an error occurs during the safety run a different error state path is taken. See also state 54 to 57.	• Active error – will proceed to Safety run pending (12) • Limit switch active • Timeout • Position for step 1 reached (state 54) • Run input is low
12	Safety run pending	An error occurs during the safety run.	• Clear errors

No	Name	Description	Conditions to proceed
14	Safety run succeeded	The performed safety run ended with activation of a limit switch. IMD determines whether to proceed to state 16 or 20 (safety run or blind safety run was performed).	• If S-run restart@LS1 off is enabled, and limit switch 1 not activated (not after blind safety run) • From safety run • From blind safety run
16	Parked tripped	End of a safety run after the limit switch is activated. It can also enter this state if in Parked ready and the safety chain inputs are not OK.	• Safety-chain inputs reset • If S-run restart@LS1 off is enabled, and limit switch 1 not activated • `Safety-run is initiated`
17	Parked ready	Device enable will be disabled automatically when the IMD enters this state. The IMD waits for Enable dev. in order to go to normal operation.	• Active error or safety-chain inputs missing • `Enable dev.` • `Safety-run is initiated` • `Execution of special command SE-test` • `Manual operation*`
18	Safety run timeout	The safety run did not reach a limit switch before the configured timeout elapsed.	• `Initiate a new safety run with S-run or restart the IMD` • `Manual operation*`
19	Safety run setup	The IMD checks whether it can perform a safety run, and if yes, whether it should be a safety run or blind safety run. If there are no active errors the Device enable will be set automatically.	• Active error – will proceed to Safety run pending (12) • RUN input is high
20	Blind safety run exit	The feedback error that was cancelled in state 9, is set back.	• None
21-30, 52, 53	Safe energy test	Safe energy test is ongoing.	• `Execution of special command Idle`
32	Pre-heat	Preheating of the motor is ongoing	• `Execution of special command Idle` • `Device disabled`
35	Pos. preset	Changing the resolver value of the actual position is ongoing.	• `Execution of special command Idle`

No	Name	Description	Conditions to proceed
38	Store position	Storing the actual position in the non-volatile memory is ongoing.	• None. The IMD automatically returns to normal operation.
39	Store position timed	The IMD stores actual position in the EEPROM, if the device is disabled and the resolver value is not the same as the last stored actual position, Automatically every 2 minutes.	• None. The IMD automatically returns to normal operation.
40	Brake test	Brake test is ongoing	• `Execution of special command Idle`
42	Pre-heat warning	The Device enable was disabled in Pre-heat. When in this state, the pre-heat is turned off.	• `Execution of special command Idle`
54	Safety run step 1	The IMD executes a safety run: the motor runs with the configured speed until a limit switch is activated, a configured timeout is reached, or the position for step 2 is reached. If an error occurs during the safety run a different error state path is taken.	• Active error – will proceed to Safety run pending (12) • Limit switch active • Timeout • Position for step 2 reached (state 55) • Run input is low
55	Safety run step 2	The IMD executes a safety run: the motor runs with the configured speed until a limit switch is activated, a configured timeout is reached, or the position for step 3 is reached. If an error occurs during the safety run a different error state path is taken.	• Active error – will proceed to Safety run pending (12) • Limit switch active • Timeout • Position for step 3 reached (state 56) • Run input is low
56	Safety run step 3	The IMD executes a safety run: the motor runs with the configured speed until a limit switch is activated, a configured timeout is reached, or the position for step 4 is reached. If an error occurs during the safety run a different error state path is taken.	• Active error – will proceed to Safety run pending (12) • Limit switch active • Timeout • Position for step 4 reached (state 57) • Run input is low
57	Safety run step 4	The IMD executes a safety run: the motor runs with the configured speed until a limit switch is activated, or a configured timeout is reached. If an error occurs during the safety run a different error state path is taken.	• Active error – will proceed to Safety run pending (12) • Limit switch active • Timeout • Run input is low

No	Name	Description	Conditions to proceed
58	Pre-safety run setup	The IMD determines whether to reconnect mains for the safety run	• Continues automatically to state 19.
59	Manual operation	The motor is controlled by digital input 10 (“-“ direction) and digital input 11 (“+” direction).	• `Digital input 12 goes low.`
* Manual operation is a combination of digital input 12 being high and either digital input 10 or 11 being activated.			

6.2 Internal flags

The IMD uses some internal flags that are visible as status flags. The same flag may also be mapped to a register in order to be able to read directly, without need to mask the result (the register value is either zero or one).

See also general definition of the parameter in the Parameter list, and bit mapping in Reg. 0xD8 (section 13.2.11 on page 209) and Reg. 0x40 (section 13.2.4 on page 202).

Table 7 Internal flags

Flag	Register	Description
SCR 1 and 2	0xD8 bit 10	Indicates the state of the Safety-chain relays. 0 = relays tripped, 1 = relays are ON. This parameter also indicates whether the IMD can be enabled or not. When the relays are tripped, the IMD cannot be enabled without clearing the errors and cycling the safety-chain inputs.
Dev.Enabled	0x40 bit 0	Dev.Enabled is turned on when both “Enable dev.” and RUN are active.
GO	0xD8 bit 11	Go is turned on when the IGBT is enabled. In normal circumstances, it will be turned on together with Dev.Enabled is turned on (when both “Enable dev.” and RUN are active). However, if for some reason the IGBT is not enabled, it will remain off.
Mains disconnected	0xD8 bit 14	State of the connection between 400VAC to the DC-link. 1: DC-link is disconnected 0: DC-link is connected Note: this flag is used in the IMD Manager to show the power source of the DC-link.
Brake output	0xD8 bit 15	The brake output is active.
Brake delay	0x40 bit15	The brake is in the process of either being activated or deactivated (brake delay is on).
Logic-5	0xDF	The state of Logic-5 logical function (mapped to DO 5)
Logic-6	0xDE	The state of Logic-6 logical function (mapped to DO 6)
Logic-7	0xE1	The state of Logic-7 logical function (mapped to DO 7)
Logic-8	0xE0	The state of Logic-8 logical function (mapped to DO 8)
SCR 1 and 2	0xE2	The same as 0xD8 bit 10 (SCR 1 and 2)

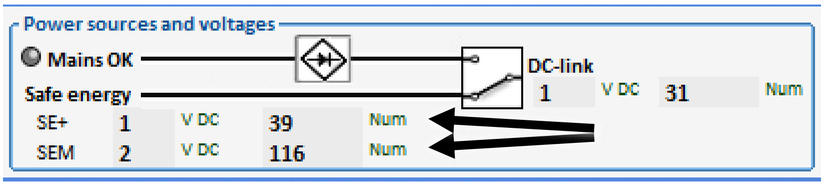
Flag	Register	Description
GO	0xE3	The same as 0xD8 bit 11 (GO)
LS 1	0xE4	The state of limit switch 1 digital input
LS 2	0xE5	The state of limit switch 2 digital input
Logic-1	0xE6	The state of DI 1 (digital input)
Logic-2	0xE7	The state of DI 2 (digital input)
RUN	0xE8	The state of RUN digital input
I fault	0xE9	If 1: Internal error in the power section (an error will be generated as well)
I ballast	0xEA	Internal state of the Ballast circuit. 0: Ballast resistor is OFF, 1: Ballast resistor is ON

6.3 Safe energy monitoring

The IMD monitors continuously the SE voltage. Using CAN/CANopen or the IMD Manager, it is possible to read the actual SE voltage. IMD 122 C has an extra input for measurement of the mid-point voltage. A wrong mid-point voltage, SE voltage or both, is an indication that a battery or ultra-capacitor module are defective). No warning or configuration are associated with this function, and the IMD does not take any action or evaluation. Evaluating the value and taking actions is done by external controller.

If the SE voltage is below SE Vlow parameter value, a “POWERVOLTAGE sources < min” warning is generated, it is not possible to disconnect mains either from the IMD Manager or CAN/CANopen.

NOTE If no SE source is connected, the measured values of SE+ and SEM are random (0 to DC-link voltage) due to the protection circuit or the charger. However, the charger will detect it and report an error.



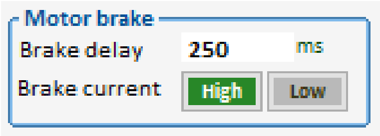
6.4 Brake control

The brake system is an integrated part of the pitch system. The brake is a negative brake, which means, that it is spring activated and brakes the blade motor whenever there is no power applied to the brake. The brakes are powered directly from the IMD (24 V DC). The brake is automatically activated/deactivated when either the drive enable (RUN) digital input is changes, or an Enable command OFF/ON is sent to the IMD.

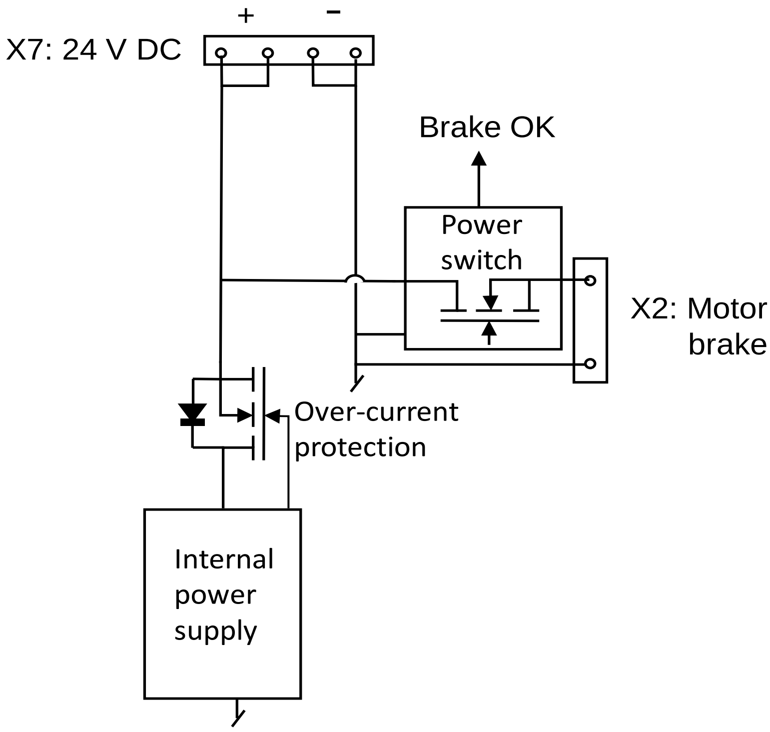
The motor brake is supplied from the internal power supply or from X7. The motor brake current through the power switch can be configured to high or low, which optimises open circuit detection of the used brake.

Table 8 Brake current settings

Brake current	Setting
Less than 2 A	Low
More than 2 A	High



The following figure shows a simplified circuit diagram (IMD with internal power supply) of the relevant internal connections to X2:



The power switch has overcurrent, short-circuit protection, as well as open circuit detection.

The over-current and short-circuit protection are based on the switch temperature, approximately 8 A. The short-circuit initial current is higher.

NOTE The current limit from the internal power supply is approximately 6 A. If there is a 24 V backup connected to X7, a short-circuit (initial) or excessive current will be drawn from the external power supply.

The brake OK signal indicates No open circuit and temperature not too high. It is shown in the IMD Manager and available in CAN.

6.4.1 Brake engagement (Brake output OFF)

Before starting the brake engagement sequence, the motor output of the IMD is ON, which means that the Run input is high, and the Enable dev. is active. The brake output is ON (brake disengaged).

Once the Run input is set to Low or the Enable dev. is deactivated, the IMD will stop the blade motor motion with the pre-configured (ramp limit) deceleration ratio. When the speed reaches zero and after 50 ms fixed delay, the brake output is turned OFF. While the speed is zero at this point, the modulation to the motor is still ON to ensure that the blade motor holds its position. After the preconfigured brake output OFF delay has passed, the modulation to the motor stops.

The brake delay purpose is to ensure that the brake efficiency is 100% before stopping the modulation (position control). The following figure illustrates the described sequence.

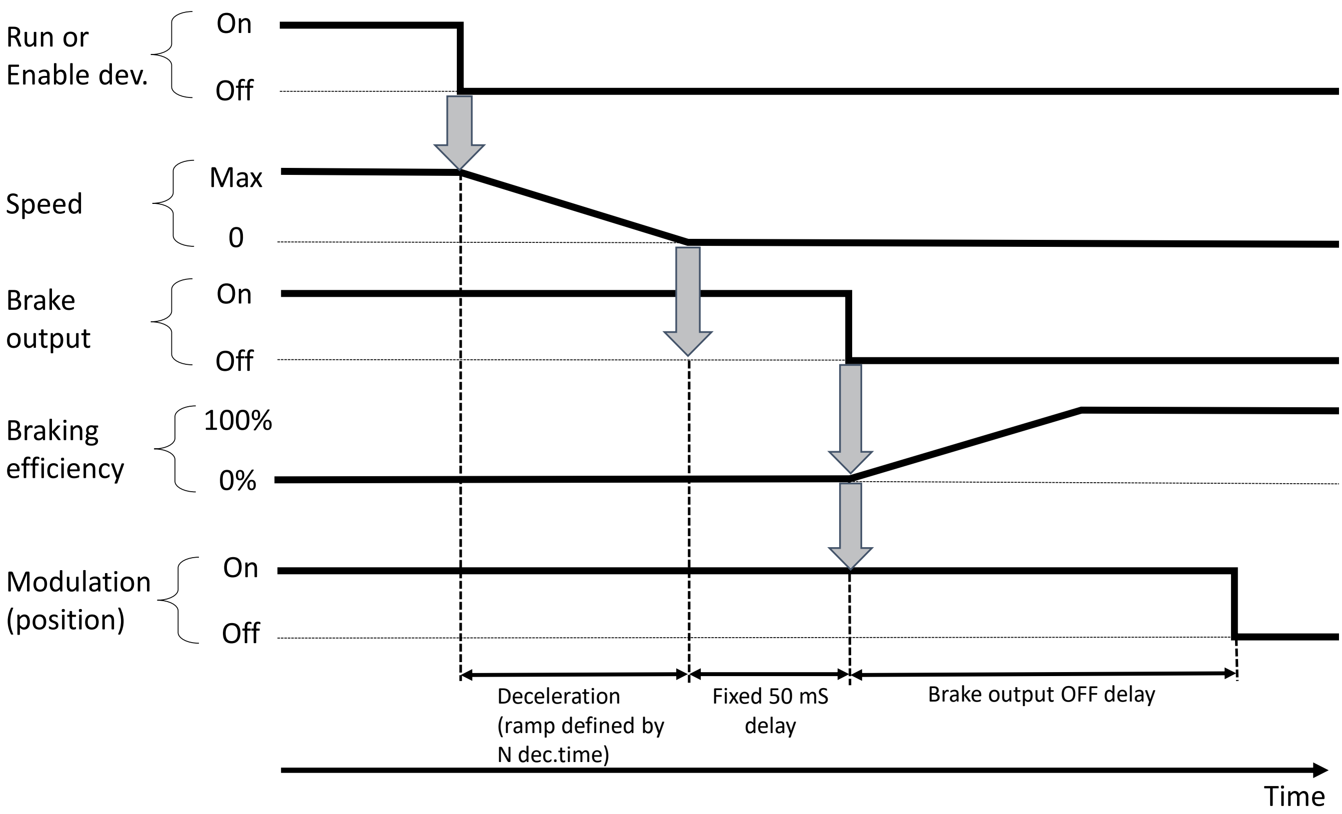


Figure 34 Brake engagement sequence

Info

Figure 34 on page 64 illustrates a case where the blade motor is stopped and brake activated while in motion. If the blade motor is not in motion the speed is already zero and the Ramp-limit deceleration time is therefore equal with zero.

6.4.2 Brake disengagement (Brake output ON)

Before starting the brake engagement sequence, the motor output of the IMD is OFF, which means that either the Run input is low, or the Enable dev. is inactive, or both. The brake output is OFF (brake engaged).

When RUN input is set to high and the Enable dev. is active, the IMD starts the modulation to fix the blade motor position. After a fixed 15 ms delay, the brake output is turned ON. When the brake output ON delay has passed, the IMD will ramp up the speed in order to pitch the blade to the desired position. The following figure illustrates the described sequence (the order of the of the signals/function is different compared with Figure 34 on page 64 for simplicity reasons).

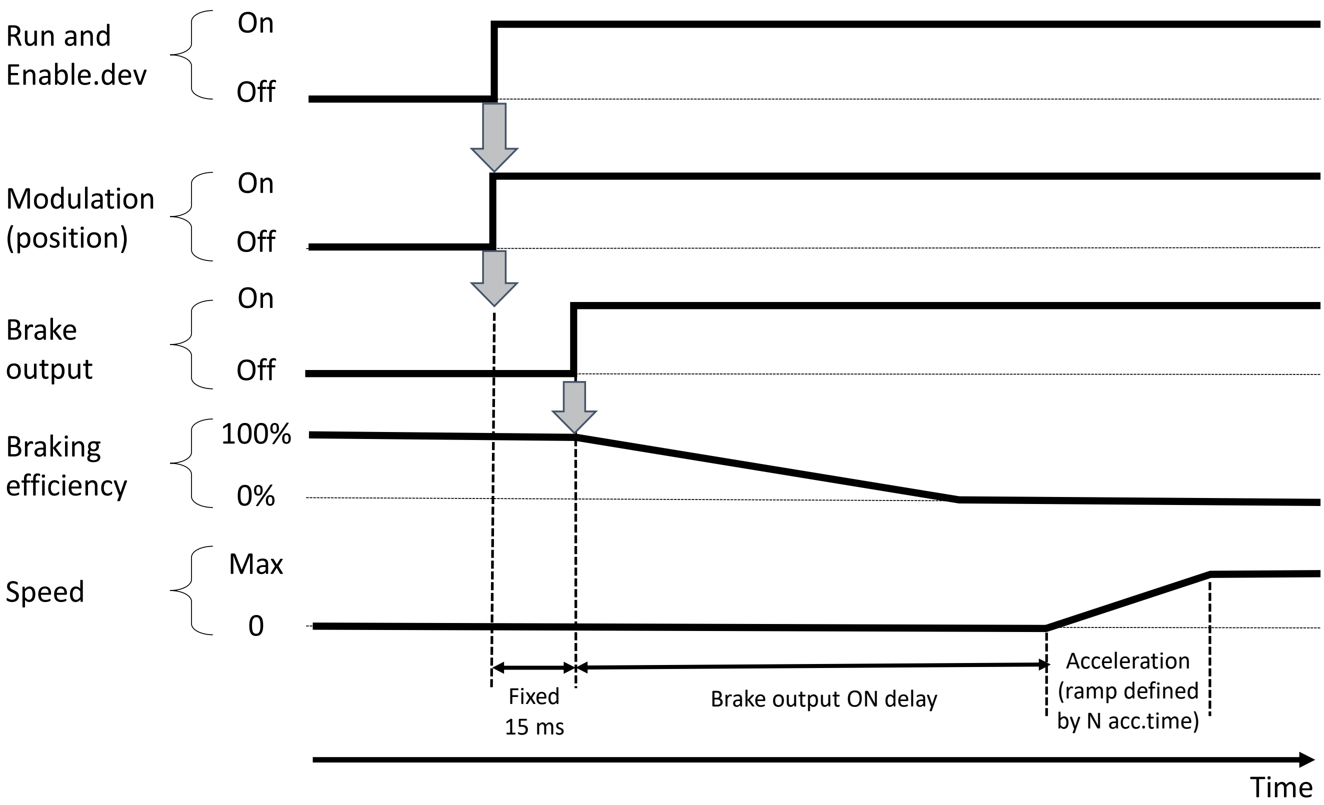


Figure 35 Brake disengagement sequence

7. Communication

There are two ways to communicate with the IMD:

- CAN/CANopen
- Serial interface over USB (Service)

The CAN/CANopen communication is used for communication with the Pitch Motion Controller (PMC) or the main controller if the pitch motion controller is implemented in the main controller application. The serial interface is used for communicating with a PC running the IMD Manager.

Info
When using the IMD Manager while the IMD is also connected to CAN/CANopen interface, the CAN/CANopen PDO (Process Data Object) will overwrite data sent from the IMD Manager through the service port on PDO updates.

7.1 CAN/CANopen interface

The proprietary CAN interface requires that each unit in the same network has its own addresses, one for receiving and one for sending. These two addresses are pre-configured from the factory.

The IMD has also a HW switch on the front for offset (node ID) of the addresses so it is not necessary to SW configure the IDs for each IMD. The switch can be set during installation of the IMD.

7.1.1 CANopen network structure and management

The implementation of the CAN network structure can vary. The following figure illustrates the basic CAN network implementation.

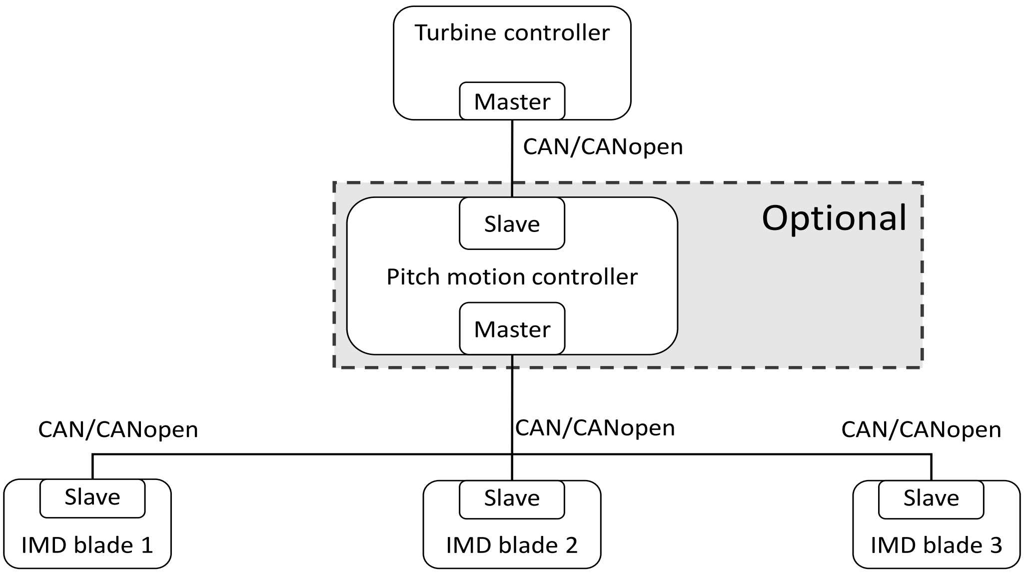


Figure 36 basic CAN network implementation

In order to control a CANopen slave via the NMT service, a set of commands are defined:

Command value	Description
0x01	Go to operational
0x02	Go to stopped
0x80	Go to pre-operational
0x81	Go to reset application
0x82	Go to reset communication

The following example will make a slave with Node ID 1, to enter pre-operational state:

CAN ID	Data
0	0x80 0x01

Info
The states referred to here, are CANopen states and not general IMD states.
PDO's will only be active when the slave is in state operational. SDO is active in both pre-operational and operational.

7.1.2 CAN proprietary Interface

The actual addresses of the IMDs, are the configured base addresses + the switch value (1 to 14). For example, if the configured base value is 0x200 and the CAN switch is set to 3, the address will be 0x203 (515 decimal).

The following table describes the CAN interface default values:

Table 9 CAN proprietary Interface

Device address	Short symbol	Default value	Parameter register number in the IMD
Receiving address	Rx ID	0x200 + Switch ID	0x68
Sending address	Tx ID	0x180 + Switch ID	0x69
Bit rate*	Baudrate (kbps)	500	0x73

* The bit rate is initialized only at power-up. It is not possible to change the speed on the fly.

The CAN interface implementation in the IMD is a proprietary protocol, which is a simpler variant of the CANopen. However, if nodes other than IMDs and DEIF PMC or DEIF main controller are to be implemented in the same network, it is recommended to use CANopen, which is a universal protocol.

It is possible to configure the IMD to auto-report through CAN a specific parameter value at the configured auto report interval (1 to 254 ms). Maximum eight registers can be configured to auto report. Use 0x3D to configure CAN auto report.

7.1.2.1 Communication with charger over proprietary CAN

Always use 0x8011 command to read or write charger parameters.

Find the parameter sub object ID in section 13.3.1 on page 228.

Read from the charger:

Composing the telegram:

Step		Example (reading scaled current)
1	Command	0x8011
2	Combine with parameter index	+ 0x0200 (charger current has sub object ID 2, 00 is filer)
3	Result	0x8211
4	Build the telegram as follows: 3D XX YY ZZ ZZ - telegram MSB YY ------- telegram LSB XX ----------- fill byte 3D ------------------ Read command	0x3D 00 11 82

Write to the charger:

Composing the telegram:

Step		Example (Setting nominal voltage to 450 V)
1	Command	0x8011
2	Combine with parameter index	+ 0x1100 (Nominal voltage has sub object ID 17 = 0x11, 00 is filer)
3	Result	0x**91**11
4	Calculate voltage data (unit is 0.1 V)	450*10= 4500 = **1194**
4	Build the telegram as follows: WW XX YY ZZ ZZ - data MSB YY ------- data LSB XX ----------- telegram MSB WW ------------------ telegram LSB	0x**11 91 94 11**

7.1.3 CANopen interface

See section 13.3 on page 211 for a description and a list of parameters (CANopen objects).

Info

CANopen uses little-endian format. That means that the least significant byte is sent first and the most significant byte is sent last. For example, object ID 2098 is sent as 98 20. The same also applies to data. However, it is not the whole data field that is little-endian, but each object in the data field. Example of TPDO1 which has the following format:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
POS-Actual (Obj. 0x206D)				POS-Actual_2 (Obj. 0x206F)			

Data	Interpretation
7B 3C 3F 4F FF 1F 00 00	Resolver position: 4F 3F 3C 7B SSI encoder position: 00 00 1F FF

7.1.3.1 CANopen node ID

In CANopen the same address (Node ID) is used for both send and receive. The Node ID of each IMD is a given by a value from the CAN ID switch on the IMD, and a software base Node ID, set in the IMD Manager. The switch has valid values from 0 to 14.
In the following examples, the base Node ID is given as a hexadecimal value.

Examples:	
Result	Conditions
Actual node ID = 1 (decimal)	CAN ID switch position = 1 Base node ID = 0x0
Actual node ID = 17 (decimal)	CAN ID switch position = 1 Base node ID = 0x10

Exceptions:	
Result	Conditions
Change of CAN ID switch or base node ID while the IMD is on: the existing Node ID will still be used. If the CANopen slave is reset, Node ID 127 will be used (the content of reg. 0x68 is ignored in this case). *At next restart*:* the value of reg. 0x68 will be changed to 1, and node ID 1 will be used.	CAN ID switch position = 0 Base node ID = 0x0
Change of CAN ID switch while the IMD is on: The existing Node ID will still be used. If the CANopen slave is reset, Node ID 4 will be used. *At next restart:* the content of reg. 0x68 will be automatically changed back from 1 to 0 and Node ID = base node ID + CAN ID switch will be used.	The content of reg. 0x68 was automatically changed from 0 to 1 at restart due to 0 value of register and CAN ID switch. The CAN ID switch is changed while the IMD is still on, to for example 3.
Change of CAN ID switch or base node ID while the IMD is on: the existing Node ID will still be used. If the CANopen slave is reset, Node ID 127 will be used (the content of reg. 0x68 is ignored in this case). *At next restart*:* Content of reg. 0x68 will be automatically changed, so that ID switch value + Base node ID =127.	CAN ID switch value + Base node ID >127

* It is assumed that the configuration was saved to startup before restarting the IMD.

7.1.3.2 Using Read Process Data Objects (RPDOs)

RPDOs are used to initiate/change processes in the IMD. Four types of RPDOs are predefined and the transmission type is set to 254 (other RPDOs can be defined if needed using a CANopen manager):

Table 10 RPDO1 – position control

Used for: Changing position				COB ID: 0x200+Node ID			
Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Device mode value (Obj. 0x2051)		Position destination value (Obj. 0x206E)				N-limit value (Obj. 0x2034)	

Example of enabling N-clip, setting position destination, and 90% speed limit in IMD with Node ID 1:

COB	Data	Interpretation
201	40 00 58 56 25 3C 32 73	Device mode (Reg. 0x51): 00 40 0000 0000 0100 0000 ↑ Bit 15 ↑ bit 0 Position destination value (Reg. 0x6E): 3C 25 56 58 N-limit value (Reg. 0x34): 73 32

Table 11 RPDO2 – speed control

Used for: Changing speed				COB ID: 0x300+Node ID	
Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**
Device mode value (Obj. 0x2051)		N-set value (Obj. 0x2031)		Logic Out block value (Obj. 0x2098)	

Example of enabling N-clip, setting speed value, and setting RO on in IMD with Node ID 1:

COB	Data	Interpretation
301	40 00 20 4E 00 01	Device mode (Reg. 0x51): 00 40 0000 0000 0100 0000 ↑ Bit 15 ↑ bit 0 N-set value (Reg. 0x31): 4E 20 Logic Out block value (Reg. 0x98): 01 00 0000 0001 0000 0000 ↑ Bit 15 ↑ bit 0

Table 12 RPDO3 – special commands

Used for: Executing a special command		COB ID: 0x400+Node ID
Byte 1	**Byte 2**	
Special commands value (Obj. 0x2003)		

Example of starting pre-heating in IMD with Node ID 2:		
COB	**Data**	**Interpretation**
402	02 00	Special commands (Reg. 0x03): 00 02

Table 13 RPDO4 – safety run

Used for: Initiating a safety run		COB ID: 0x500+Node ID
Byte 1	**Byte 2**	Any value written in byte 1 and 2 will cause the IMD to start a safety run (go to state 19, safety run setup)
Fun_safety run value (Obj. 0x2078)		

Example of initiating safety run in IMD with Node ID 3:		
COB	**Data**	**Interpretation**
503	01 00	Fun_safety run (Reg. 0x78): 00 01

Info

The IMD will always execute the last sent RPDO. If a position command is sent (RPDO1) and a following speed command (RPDO2) are sent, the IMD will not stop at the position of the first PDO, but will continue with the speed and direction specified in RPDO2 that was the last sent RPDO until another RPDO is sent making it stop.

7.1.3.3 *Using Transmit Process Data Objects (TPDOs)*

TPDOs are used to give feedback from the IMD to the application SW. They are sent automatically by the IMD at the configured intervals (standard interval is 1 s, which can be changed using a CANopen manager). Eight TPDOs can be configured in the IMD. Four of these are preconfigured and follow CANopen standard COB IDs:

Table 14 TPDO1 mapping

Reports: Resolver Position value, SSI encoder position value				COB ID: 180+node id			
Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
POS-Actual (Obj. 0x206D)				POS-Actual_2 (Obj. 0x206F)			

Example:		
COB	**Data**	**Interpretation**
181	7B 3C 3F 4F FF 1F 00 00	Resolver position (Reg. 0x6D): 4F 3F 3C 7B SSI encoder position (Reg. 0x6F): 00 00 1F FF

Table 15 TPDO2 mapping

Reports: Speed, current, output power, DC-link voltage				COB ID: 280+node id			
Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
N act (filt) (Obj. 0x20A8)		I act (filt) (Obj. 0x205F)		PowerOut (Obj. 0x20F6)		DC-link (Obj. 0x20EB)	

Example:		
COB	**Data**	**Interpretation**
281	4F 71 58 00 F7 02 95 3E	Speed: 71 4F → 2656 RPM Current: 00 58 → 8.2 A Power out: 02 F7 → 759 (relative value of the output power) DC-link voltage: 3E 95 → 536 V DC

Table 16 TPDO3 mapping

Reports: General IMD status, Digital output status				COB ID: 380+node id			
Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Drive status (Obj. 0x2040)				Logic in block (Obj. 0x209B)			

Example:		
COB	**Data**	**Interpretation (see also relevant bit mapping sections)**
381	90 47 00 40 07 00 03 31	Drive status (Reg. 0x40): 40 00 47 90 0100 0000 0000 0000 0100 0111 1001 0000 Bit 31 bit 0 Logic out block (Reg. 0x9B): 31 03 00 07 0011 0001 0000 0011 0000 0000 0000 0111 Bit 31 bit 0

Table 17 TPDO4 mapping

Reports: Device mode, errors and warnings, logical inputs and outputs						COB ID: 480+node id	
Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Device mode (Obj. 0x2051)		Errors/Warnings (Obj. 0x208F)				Logic in/out Block (Obj. 0x20D8)	

Example:		
COB	**Data**	**Interpretation (see also relevant bit mapping sections)**
481	04 00 00 00 20 00 31 76	Device mode (Reg. 0x51): 00 04 0000 0000 0000 0100 Bit 15 bit 0 Errors/warnings (Reg. 0x8F): 00 20 00 00 0000 0000 0010 0000 0000 0000 0000 0000 Bit 31 bit 0 Logic in/out block (Reg. 0xD8): 76 31 0111 0110 0011 0001 Bit 15 bit 0

7.1.3.4 Using Service Data Objects (SDOs)

SDO service can be used to read data from or write data to an object in the IMD, provided the object has a CAN ID (20xx). Read or write operations might be limited depending on the access type of the specific object. The SDO server receives requests at the standard COB ID 0x600 + Node ID, and will respond at COB ID 0x580 + Node ID.

Read Example:		
COB	**Data**	**Interpretation (see also relevant bit mapping sections)**
601	40 98 20 00 00 00 00 00	Application: Read object 2098 from node with node ID 1
581	4B 98 20 00 01 01 00 00	Reply from node: 0x0101 0000 0001 0000 0001 ↑ ↑ Bit 15 bit 0

Consult the CANopen standard specification CiA-301, for detailed information on how the SDO service works, and the format of the reply SDOs.

See section 13.3 on page 211 for object IDs and data definitions.

7.1.3.5 Firmware update via CANopen implementation guidelines

To initiate and perform FW upgrade through CANopen, a special SW must be developed and implemented by the customer in the Pitch Motion Controller, or the Turbine Main Controller. This section gives guidelines for the implementation of this SW.

It is expected that whoever develops this SW has knowledge of how to use and program CANopen communication. This knowledge is outside the scope of this manual.

The following tables lists the sequence of actions needs to be done to perform the FW update:

Step	CAN Object type	Operation	To/from object	Write/ expected-read data	Description
1	SDO	Write	To 0x1F51 sub 1 (Program control)	0	Stop application and invoke the bootloader. if application refuses SDO_ABORT otherwise reset forced reaction SDO timeout due to no SDO response
2	SDO	Read	From 0x1000 sub 0 (Device Type)	0x424F4F54	Check that the bootloader is active: 0x424F4F54: Bootloader is running 0x0: Application is running
3	SDO	Write	To 0x1F51 sub 1 (Program control)	3	Erase the flash memory allocated to the application. Takes approximately 10 s.
4	SDO	Read	From 0x1F57 sub 1 (Flash Status)	2	Read the flash status to verify that the application is deleted: 0 = Application OK 1 = busy 2 = No application in flash
5	SDO	Write domain	To 0x1F50 sub 1 (Download Program Data)	Transfer `CoU_IMD.crc`	Transfer the application file in 7 bytes blocks to the IMD.
6	SDO	Read	From 0x1056 sub 1 (Application Id)	Any value except for 0 (zero)	Check that the downloaded crc is correct. If there is any error the value will be 0.
7	NMT	reset COMM			If the value in step 6 is 0 (error), reset the communication and repeat steps 5 and 6.
8	NMT	Reset NODE			If the value in step 6 is not 0 (success), restart the IMD to start the application.
9	SDO	Read	From 0x1000 sub 0 (Device Type)	0	Check that the application is active: 0x0: Application is running 0x424F4F54: Bootloader is running

7.2 Serial data interface

The serial data interface is implemented as a virtual com port over USB. It is mainly used for a communication with a PC running the IMD Manager for configuration or monitoring/troubleshooting purposes. The interface allows for 16 bit or 32 bit data packages. The following figures shows the format for both options.

Serial/USB 16 bit data package format									
Sending from the PC to the drive								Drive response to the PC	
Char1	Char2	Char3	Char4	Char5	Char6	Char7		Byte1	Byte2
Reg. ID	Reg. ID	Data	Data	Data	Data	Sync		Data	Data
Bits 07..04	Bits 03..00	Bits 15..12	Bits 11..08	Bits 07..04	Bits 03..00	"X"		Bits 07..04	Bits 07..04
ascii	ascii	ascii	ascii	ascii	ascii	ascii		binary	binary

Serial/USB 32 bit data package format															
Sending from the PC to the drive												Drive response to the PC			
Char1	Char2	Char3	Char4	Char5	Char6	Char7	Char8	Char9	Char10	Char11		Byte1	Byte2	Byte3	Byte4
Reg. ID	Reg. ID	Data	Data	Data	Data	Data	Data	Data	Data	Sync		Data	Data	Data	Data
Bits 07..04	Bits 03..00	Bits 31..28	Bits 27..24	Bits 23..20	Bits 19..16	Bits 15..12	Bits 12..08	Bits 07..04	Bits 03..00	"X"		Bits 07..04	Bits 07..04	Bits 07..04	Bits 07..04
ascii	ascii	ascii	ascii	ascii	ascii	ascii	ascii	ascii	ascii	ascii		binary	binary	binary	binary

The following example shows a 16 bit format read operation from register ID 0x30, which contains the actual speed value:

Example of reading actual speed, 16 bit format (Return value of up to ± 32767 equals to 2 bytes)									
Sending from the PC to the drive								Drive response to the PC	
Char1	Char2	Char3	Char4	Char5	Char6	Char7		Byte1	Byte2
Reg. ID	Reg. ID	Data	Data	Data	Data	Sync		Data	Data
Bits 07..04	Bits 03..00	Bits 15..12	Bits 11..08	Bits 07..04	Bits 03..00	"X"		Bits 07..04	Bits 07..04
3	**D**	**0**	**0**	**3**	**0**	**X**		**Lo byte**	**Hi byte**
Read register (0x3D)		Actual speed value register (0x30)				ascii		Value of register 0x30	

When using the IMD Manager the serial connection is plug and play.

Follow the instructions in the IMD Manager Installation instructions to install the IMD Manager.

8. IMD configuration

This section describes how to configure the IMD in a specific setup (such as motor, resolver brake and so on). When the configuration is finished and verified, it can be saved as a configuration file created for use in installation process during production. See the IMD Manager user manual for detailed information about how to use the IMD Manager.

Info
If a parameter is not applicable due to another parameter setting, it will be hidden.

8.1 Prerequisites

The following is needed for the configuration:

8.1.1 Hardware

IMD connected with all the HW that is going to be used in the turbine. Some of the HW can be simulated if necessary:

- Motor (with or without resolver)
- Brake (if the IMD is to control the brake)
- Connections of digital inputs and outputs
- Protected (fused) 400 V AC. The connection must have a breaker.
- If the IMD variant used doesn't contain 24 V DC power supply, a separate 24 V DC power supply is needed as well.
- Protected (fused) batteries or ultra-caps for safe energy. The connection must have a breaker.
- Safety-chain connections, or if safety-chain is not used, SCI inputs must be connected either as shown in Figure 31 on page 51 or through RO relay in order to be able to reset the IMD safety-chain. If RO is used, it is possible to open and close it using the IMD Manager.
- A computer for the IMD manager connected to the "Service" connector of the IMD.
- Datasheet and specifications for motor, resolver (if used) and brake.

Info
It is possible to configure the IMD without the accessories (motor, resolver, SSI encoder and so on) and mains. In this case 24 V DC power supply must be connected to X7. Errors will be present for the missing components, but the parameter configuration can be done. Some of the described procedures (for example resolver offset calibration) cannot be performed. The SE charger (option) cannot be configured without mains.

8.1.2 Software

A computer with the IMD Manager and USB driver running. See IMD Manager Installation instructions for PC requirements and SW installation instructions.

8.2 Safety

See safety precautions in section 2 on page 11.

8.3 Turning the power on

1. Follow the procedure described in section 9.15 on page 148
2. Configure the IMD Manager communication (See IMD Manager user manual)

Attention
Monitor the actual current during the configuration. Before the drive is configured with all parameters for the actual motor, high currents may be generated.

8.4 Configuring general parameters

The general parameters are configured in the “Configuration 1/3” tab.

8.4.1 Configuring the general servo fields

The “Servo” fields are general configurations of the IMD. The red dashed rectangle in the following figure shows the parameters that are to be configured.

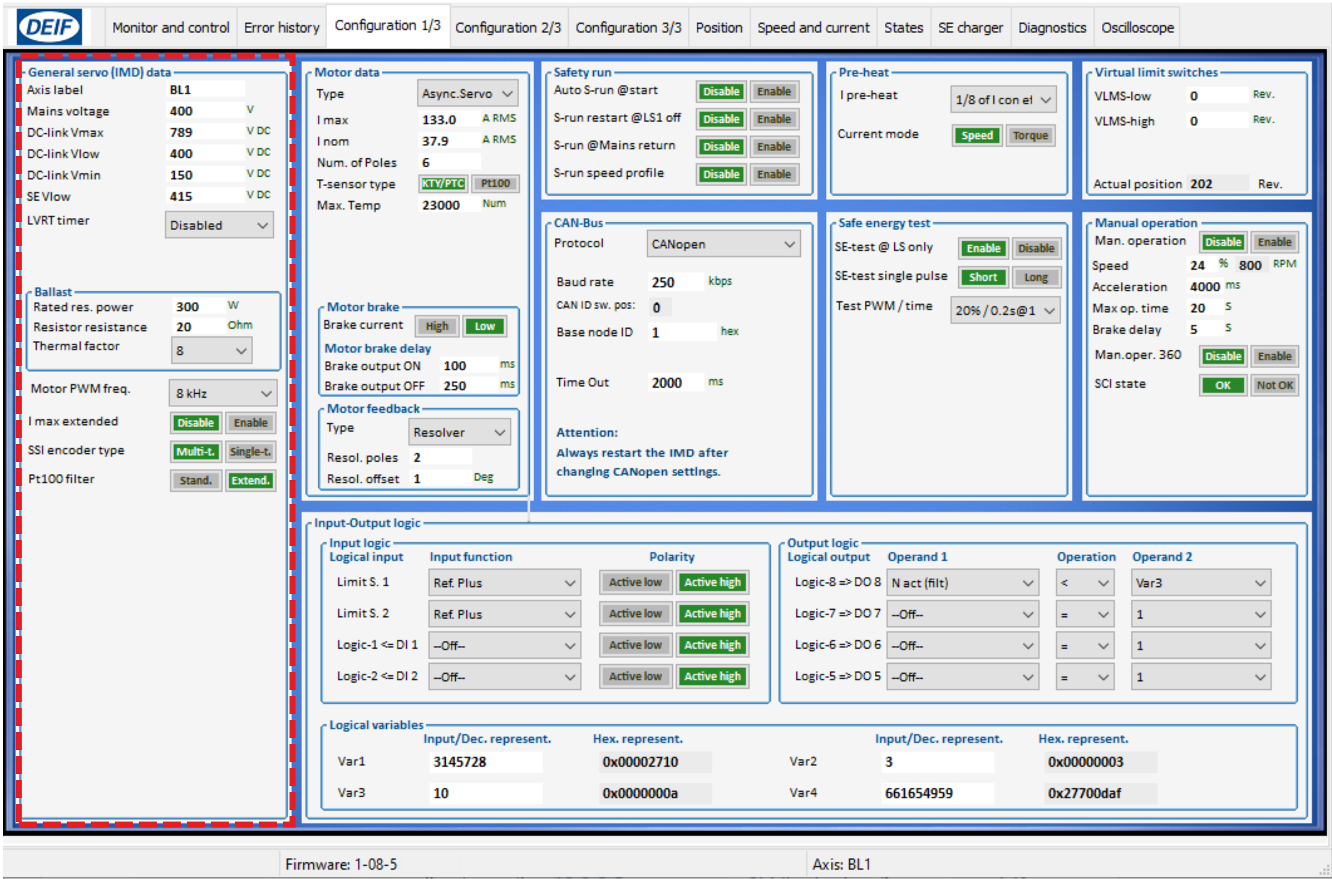
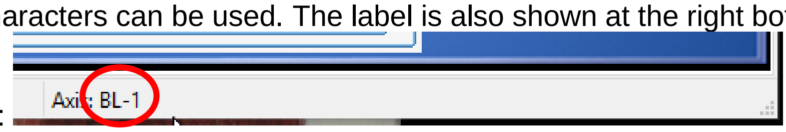


Figure 37 Servo data in IMD Manager configuration 1/3

Fill in the following fields:

- **Axis label:** The label is an optional parameter that can be used to differentiate between different IMDs. Up to 4 characters can be used. The label is also shown at the right bottom of the IMD Manager as well: 

- **Mains:** Mains voltage. Enter the nominal voltage used.

There are several thresholds (settings, errors and warnings) which are related to the voltages on the DC-link and SE voltage. These are depicted in the following figure, and described after the figure:

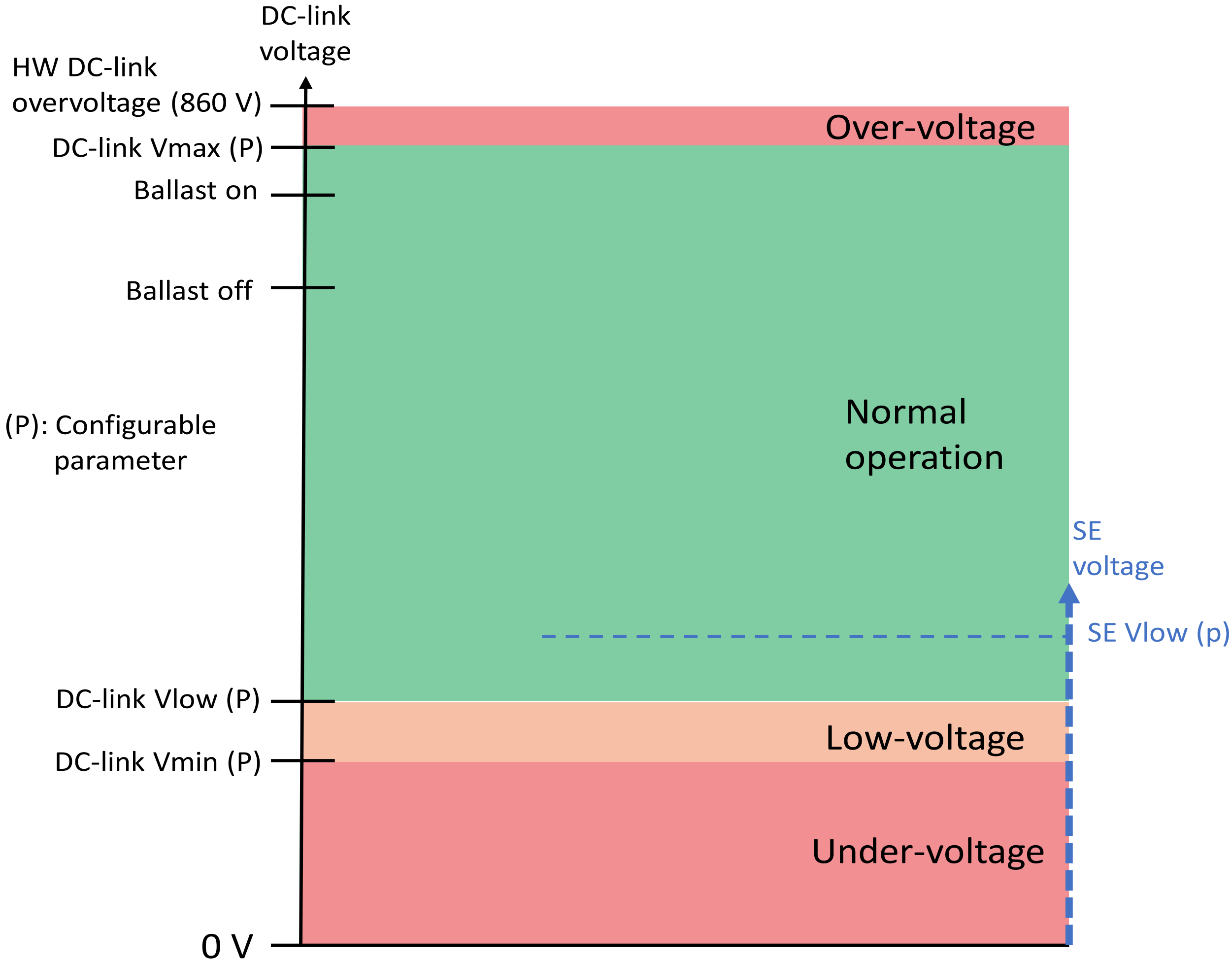


Figure 38 DC-link voltages thresholds

- **DC-link Vmax:** The level at which the IMD will generate an error end perform a safety run. This parameter also determines the ballast on and off thresholds, which are connected and disconnected automatically when needed according to the following:
  - Ballast on: DC-link voltage > DC-link Vmax – (1/32 * DC-link Vmax)
  - Ballast off: DC-link voltage < V ballast on – (2/32 * V ballast on)

  The ballast resistor state can be monitored by reading reg. 0xEA (0: resistor OFF, 1: resistor ON). It can be difficult to monitor the ballast resistor since the ON time of the resistor can be as short as 250 µs.

Example ballast ON: $789 - \frac{1}{32} * 789 = 765$ Ballast ON when DC-link voltage is above 765 V DC	DC-link V max: 789 V DC
Example ballast OFF: $765 - \frac{2}{32} * 765 = 717$ Ballast Off when DC-link voltage is below 717 V DC	DC-link V max: 789 V DC

The nominal voltage of the DC-link must be considered when configuring the DC-Vmax.
Determine the nominal voltage by: *nominal voltage = Mains input voltage * √2*.
Typical values of DC-link maximum voltages are:

Mains voltage (tolerance)	DC-link voltage (nominal – highest)	Recommended DC-link Vmax
3 x 230 (±10 %)	325 – 358 V DC	Use default value (789 V)
3 x 400 (±10 %)	565 – 622 V DC	Use default value (789 V)
3 x 415 (±10 %)	587 – 646 V DC	Use default value (789 V)
3 x 480 (±8 %)*	679 – 735 V DC	Use value 840 V

* +8 % of 480 V AC is the maximum allowed input voltage for the IMD

When configuring this parameter, the ballast resistor OFF value must have enough margin above the expected highest DC-link voltage, to ensure that the connection to the ballast resistor will be disconnected after it was connected. On the other hand, the higher the DC-link Vmax is, the higher will ballast ON and OFF be, and the higher the current / power in the ballast resistor.

When mains input values above 3x415 are used, using the default DC-link V max (789 V) will result in a ballast OFF threshold which is too close the highest case of the DC-link voltage. It is recommended to use higher values for the DC-link Vmax (see table above).

- **DC-link Vlow:** The level at which the IMD will generate UNDERVOLTAGE error, trips safety chain and performs a safety run. If Mains is disconnected from the DC-link, the IMD will attempt to reconnect the Mains.
- **DC-link Vmin:** The level at which the IMD will disable the drive and engage the brake. The minimum voltage value must be above 120 V DC. This parameter is used to protect the IMD output module (the current will be very high at low voltage), and the energy source from depletion. In firmware older than 1.04.0, this parameter had also the function of SE Vlow.
- **SE Vlow:** The minimum allowed voltage of the safe energy. A warning is generated if the safe energy voltage is below this voltage. If the SE voltage is bellow SE Vlow, it is not possible to disconnect AC mains from the DC-link (see section 9.3 on page 131). However, disconnecting the AC mains is always possible if SE Vlow is set to zero. This parameter is available in firmware 1.04.0 or higher.
- **LVRT timer:** Defines the behaviour of the IMD in low voltage situation (Low Voltage Ride through). If the Mains is not OK it is possible to configure the IMD for automatic safety run. The following values can be configured:
    - **Disabled:** No safety run is performed after a mains failure
    - **5 s:** Safety run is performed 5 seconds after a mains failure
    - **10 s:** Safety run is performed 10 seconds after a mains failure
    - **15 s:** Safety run is performed 15 seconds after a mains failure
- **Ballast group:**
    - **Rated res. power:** The ballast resistor effect in W (default 300, equal to the standard built-in resistor in IMD 122 B and early production of 122 C). This value is used for the ballast overload error calculation.
    - **Resistor resistance:** The ballast resistor impedance in Ω. (default 20, equal to the standard built-in resistor.) Observe the requirements for the resistor in section 5.2.4 on page 35.
    - **Thermal factor:** The thermal factor selection is set to define for the IMD, how fast the ballast resistor is able to cool down again after it has been hot. It is used for optimization of the Ballast energy overload error on one hand, and protection of the resistor on the other hand. In normal

situation when the standard pre-mounted ballast resistor is used, it is recommended to select "2" (smallest factor, longest cooling time). If an external resistor with better cooling conditions is used, use a higher factor since the IMD would then be able to brake / decelerate more before generating a Ballast energy overload error.

- **Motor PWM freq.:** Switching frequency of the motor output. Higher frequency will cause higher switching loss, and therefore higher heat dissipation in the IMD. Note that motors are specified for minimum switching frequency in order to reach their maximum specified torque. It is recommended to use lowest allowable switching frequency (for the motor) to reduce switching losses.

  Configuring the PWM frequency to 12 kHz automatically derates the maximum peak current (I max pk, reg. 0xC4) to 85 %, or 98 % if I max extended is enabled.

Info

Changing the PWM to 12 kHz will take effect on I max pk immediately, but will not be shown in the I max pk field in "Configuration 2/3" before the parameters are reloaded or a new value is entered for I max pk.

- **I max extended:** this parameter affects I max pk (reg. 0xC4) and T-peak (0xF0) in the "Current parameters" group in the "Configuration 2/3" tab.

I max extended	I max pk (reg. 0xC4)	T-peak (0xF0)
Disable	Maximum value is 100 %. See also Motor PWM frequency parameter.	Maximum 6 s
Enable	Maximum value is 115 % See also Motor PWM frequency parameter	If I max pk is set to above 100, the maximum value is 3 s. If the value of T-peak was above 3 s when I max pk is set to above 100, T-peak is automatically reduced to 3 (s).

- **SSI encoder type:** The IMD has an interface towards an absolute SSI encoder that can be used to determine the absolute position of the blade. Both single-turn and multi-turn can be used. Data transmission: Only single transmission is supported. Multiple transmission (repeat of the sent data) is not supported.

  Multi-turn: Only 12+12 (12 bits resolution [4096] per revolution + 12 bits number of revolutions [4096]) format is supported. Special bit can be sent from the encoder, but it will be discarded by the IMD. Gray code data format is automatically configured when configuring the SSI type to multi-turn.

  Single-turn: Only 12+1 (12 bits resolution [4096] per revolution + 1 special bit) format is supported. Binary data format is automatically configured when configuring the SSI type to single-turn.

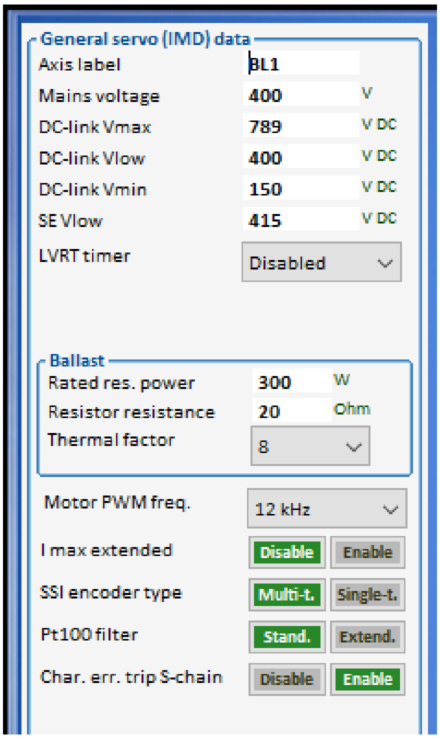
- **Pt100 filter:** The Pt100 inputs are multiplexed by the measuring circuit. The multiplexing cycle time can be prolonged from 40 ms to 80 ms by changing the filter from "Stand." to "Extend.". Extended option is intended in high EMI environment.

- **Char.err.trip S-chain:** The behaviour of the IMD when the built-in charger reports an error. Disabled: The charger error is shown as a warning. Enabled: The charger error is shown as a warning. 10 seconds after the warning is generated the warning is escalated to an error, the safety chain is tripped and a safety run is performed. If a "Clear errors" command is sent before 10 s are passed, the timer is reset. If the reason for the error is still present, the timer starts again.

8.4.1.1 Example of Servo configuration

The following example show configuration when five ultra-cap modules of 90 V DC are used as safe energy, and 3 x 400 V AC is used as the mains input.

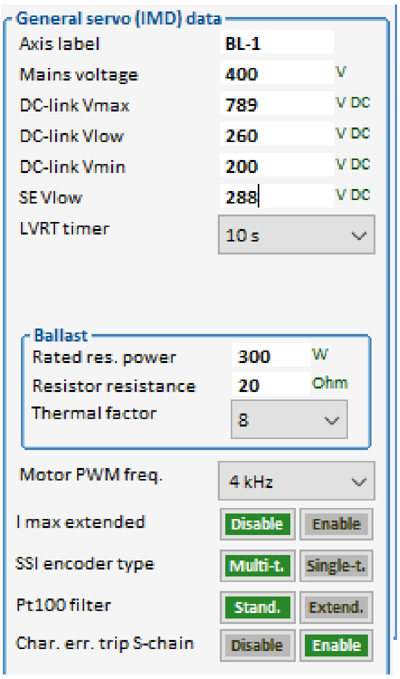
Parameter	Value	Description
Axis label	BL-1	Identifying name for the IMD. Here BL(ade)-1 is used.
Mains voltage	400	Standard 3 x 400 V AC is used
DC-link Vmax	789	Default DC-link Vmax is used since the mains voltage is not above 440 V AC.
DC-link Vlow	300	If the DC-link voltage is down to 300 V DC, it means that the ultra-caps are also at 300 V DC which is far under their nominal 450 V DC. Therefore, a safety run should be started, and the mains connected if it is disconnected.
DC-link Vmin	150	The ultra-cap modules can tolerate depletion to a comparatively low point. Under this voltage, output current will be too high, and for IMDs with internal power supply, a risk that the power supply will shut down.
SE Vlow	400	This threshold is used to give a warning that something in the safe energy system is not as it is supposed to be (under normal circumstances).
LVRT timer	Disabled	No automatic safety run is performed after a mains failure
Ballast-P	300	The standard built-in ballast resistor is used.
Ballast-R	20	The standard built-in ballast resistor is used.
Motor PWM frequency	4 kHz	4 kHz is selected in order to minimize switching losses
I max extended	Disable	There is no need for the extra current
SSI encoder type	Multi-t.	Multi-turn encoder is used
Pt100 filter	Stand.	No extra cycle time is needed
Char. err. trip S-chain	Enable	Charger error will be escalated to IMD error after Charger timeout, causing safety-chain trip and safety run.



The following example show configuration when 24 x 12 V DC batteries are used as safe energy, and 3 x 400 V AC is used as the mains input.

Parameter	Value	Description
Axis label	BL-1	Identifying name for the IMD. Here BL(ade)-1 is used.
Mains voltage	400	Standard 3 x 400 V AC is used
DC-link Vmax	789	Default DC-link Vmax is used since the mains voltage is not above 440 V AC.
DC-link Vlow	260	If the DC-link voltage is down to 260 V DC, it means that the batteries are also at 260 V DC which is far under their nominal 288 V DC. Therefore, a safety run should be started, and the mains connected if it is disconnected.
DC-link Vmin	200	Batteries cannot tolerate depletion to a low voltage. Under this voltage output current will be high, and for IMDs with internal power supply, a risk that the power supply will shut down.
SE Vlow	288	This threshold is used to give a warning that something in the safe energy system is not as it is supposed to be (under normal circumstances).
LVRT timer	10 s	Safety run is performed automatically 10 seconds after the Mains is not OK, unless there is controller intervention or mains return.
Ballast-P	300	The standard built-in ballast resistor is used.
Ballast-R	20	The standard built-in ballast resistor is used.
Motor PWM frequency	4 kHz	4 kHz is selected in order to minimize switching losses
I max extended	Disable	There is no need for the extra current
SSI encoder type	Multi-t.	Multi-turn encoder is used
Pt100 filter	Stand.	No extra cycle time is needed

Parameter	Value	Description
Char. err. trip S-chain	Enable	Charger error will be escalated to IMD error after Charger timeout, causing safety-chain trip and safety run.



8.4.2 Configuring motor data

Configure the motor data according to the data in the motor datasheet/specifications in the "Configuration 1/3" tab. The red dashed rectangle shows the parameters that are to be configured.

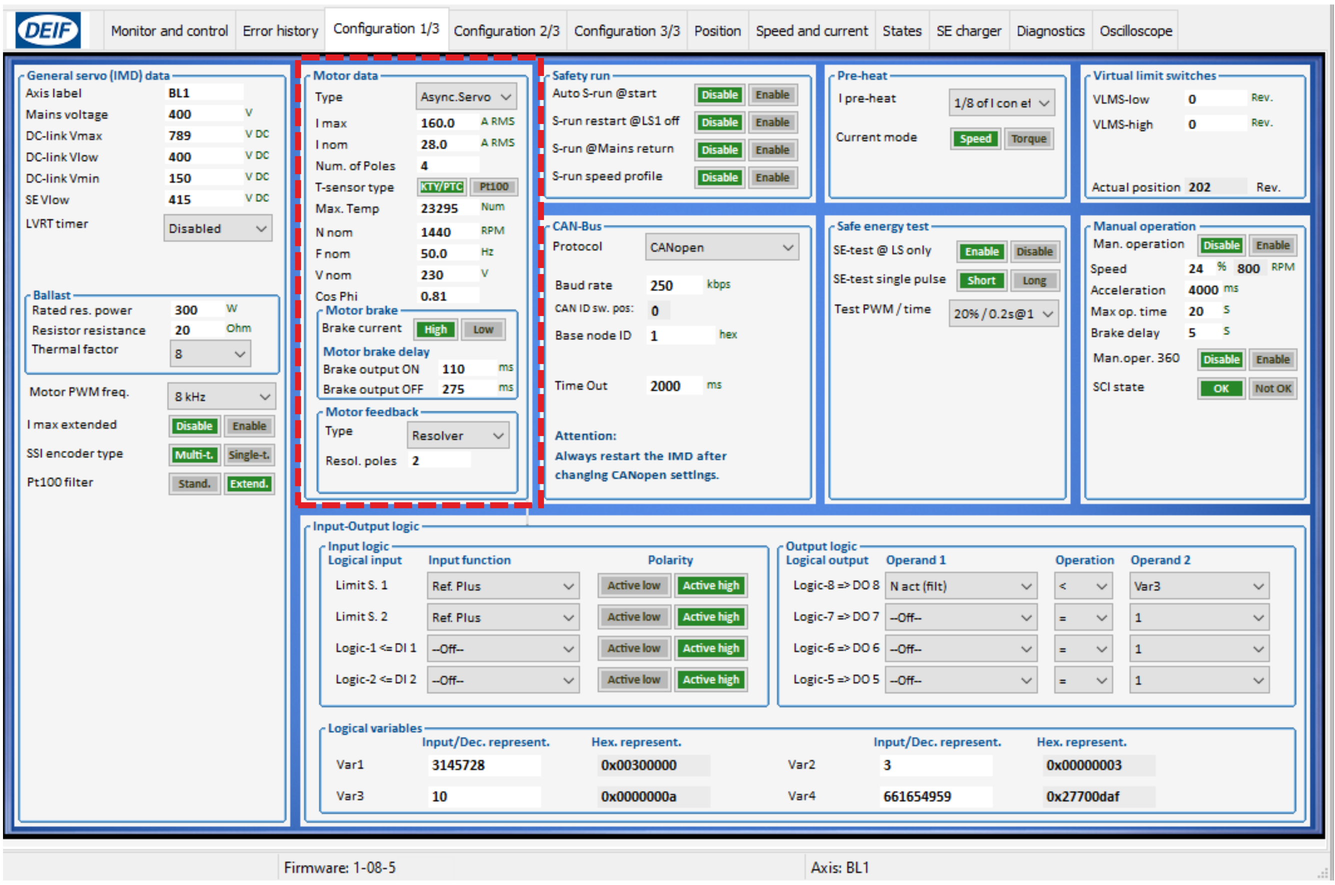


Figure 39 Motor data in IMD Manager configuration 1/3

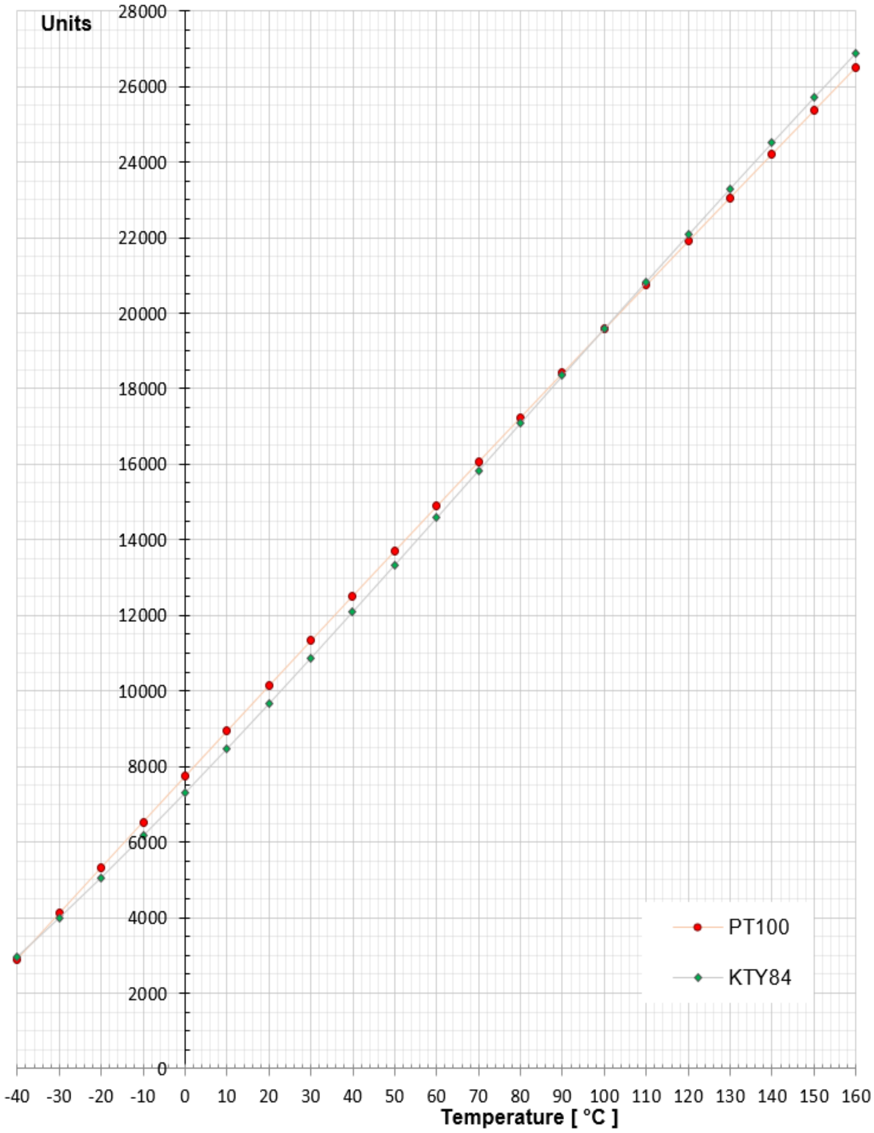
NOTE The shown figure above shows the parameters when Asynchronous servo motor is selected as the motor type. Not all parameters are available is other motor types are selected.

Parameters:

- **Type**: Select one of the following options in the dropdown list
  - Sync. Servo: Permanent magnet synchronous motor with feedback (resolver)
  - Async.V/F: AC induction motor, voltage frequency controlled, with no feedback
  - Async. Servo: Servo asynchronous motor with feedback (resolver)
- **I max:** Maximum motor current – the value is given as RMS
- **I nom:** Nominal continues motor current – the value is given in RMS
- **Num. of poles:** Number of poles in the motor (often called 2p)
- **T-sensor type:** Select whether the built-in temperature sensor is KTY 84/PTC or Pt100.

- **Max. Temp**: Maximum allowed motor temperature based on either KTY84/PTC or Pt100 sensor which is selected in 0x01. The temperature is given in number units, which can be derived from the following table (for a more precise formula see section 10.3.2 on page 172 (KTY 84) or section 10.3.3 on page 176 (Pt100)) :

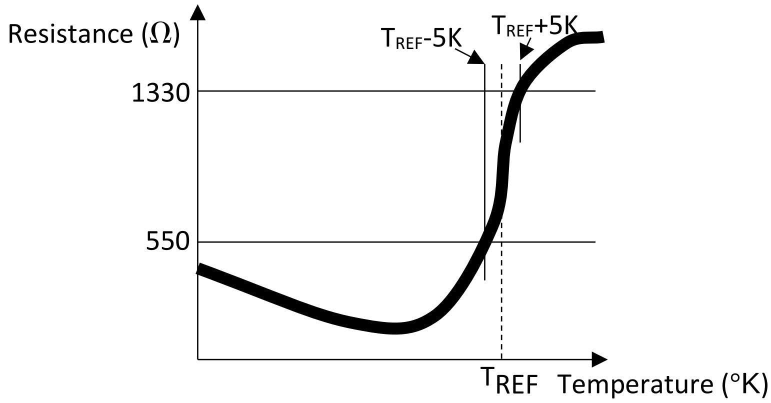
Temp. (ºC)	Units KTY 84	Units Pt100
-40	2968	2897
-30	3993	4112
-20	5060	5324
-10	6164	6531
0	7301	7735
10	8467	8935
20	9657	10132
30	10868	11325
40	12094	12514
50	13332	13700
60	14579	14883
70	15832	16061
80	17086	17237
90	18340	18409
100	19590	19577
110	20834	20741
120	22070	21903
130	23295	23060
140	24508	24214
150	25707	25365
160	26891	26512



See description of function in IMD 100 function description.

Special considerations when PTC is used:

PTC is a nonlinear sensor. While a MOTORTEMP warning will still be active at 87.5% of max motor temp, it will most likely come at the same time as the MOTORTEMP error. The PTC typical resistance characteristics are depicted in the following figure:



It is the PTC Tref (also called Tn) that is the decisive factor for the triggering of the MOTORTEMP error. Typically, PTC according to DIN 44081/82 or IEC60034-11:2004 is used, which means that there are three PTCs in series, one in each winding. When configuring the maximum temperature for the motor, it is imperative that the threshold is not below the resistance in minimum temperature, which might result in a MOTORTEMP error if the weather is extremely cold and the motor was not running for a while. It is recommended to configure the maximum temperature to the following (assuming the T_{REF}-5K ≈ 550Ω):

1 PTC: Configure the Max. Temp to 9300 (corresponding to 550Ω)

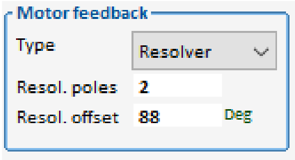
3 PTCs: Configure the Max. Temp to 30950 (corresponding to 1650Ω)

- **Brake current:** Select High or Low depending on the brake current. The detection (Brake OK flag) and protection of the brake output circuit is adjusted to higher current.
- **Motor brake delay:**
  - **Brake output ON**: The time needed from when the brake output is ON (activated) until the brake is disengaged (released). See section 6.4.2 on page 65 for details. Manufacturers often gives the time from 100% brake power to 1 or 10% brake power. In such case or if in doubt it is recommended to add some delay to ensure that that the brake is fully disengaged before starting with motor movement.
  - **Brake output OFF**: The time needed from when the brake output is OFF (deactivated) until the brake is fully engaged with 100% efficiency. Do not use a value higher than 1000 ms. The IMD will stop modulation after approximately 1 s if the value is 1000 or higher and only the brake will be used to stop the motor. See section 6.4.1 on page 64 for details. . Manufacturers often gives the time from 0% brake power to 90% brake power. In such case or if in doubt it is recommended to add some delay to ensure that that the brake is fully engaged before stopping the modulation.

  NOTE The brake release and brake engage times are different depending on the brake. In some brakes the release time is shorter than the brake time, while in others it is the opposite.

- **N nom:** Nominal motor speed in revolutions per minute (RPM) – not used if Sync. Servo is selected as motor type.
- **F nom:** Nominal motor frequency – not used if Sync. Servo is selected as motor type.
- **V nom:** Nominal motor voltage – not used if Sync. Servo is selected as motor type.
- **Cos Phi:** The cosine value of the motor – not used if Sync. Servo is selected as motor type.
- **Feedback:** Select the feedback method in the dropdown list. Only “Resolver” is supported as feedback method. If no resolver is used (motor type is Async.V/f), select “SLS” (sensor-less).

- **Resol. poles:** The number of poles in the resolver – not used if “SLS” is selected as feedback.
- **Resol. Offset:** Offset of the resolver. Only applicable for synchronous motor with resolver (Motor type “Sync. Servo”). Cannot be configured at this point. The configuration is done later (see section 8.6.1 on page 113).



8.4.2.1 *Motor configuration example*

Following are examples of motor data configuration. Getting the correct values requires a combination of the motor name plate (identification plate) and the data sheet. Deciphering the name plate often requires data from the data sheet, after which it is possible to go back to the data sheet and retrieve the correct values. Some values may need extra calculation with the available data.

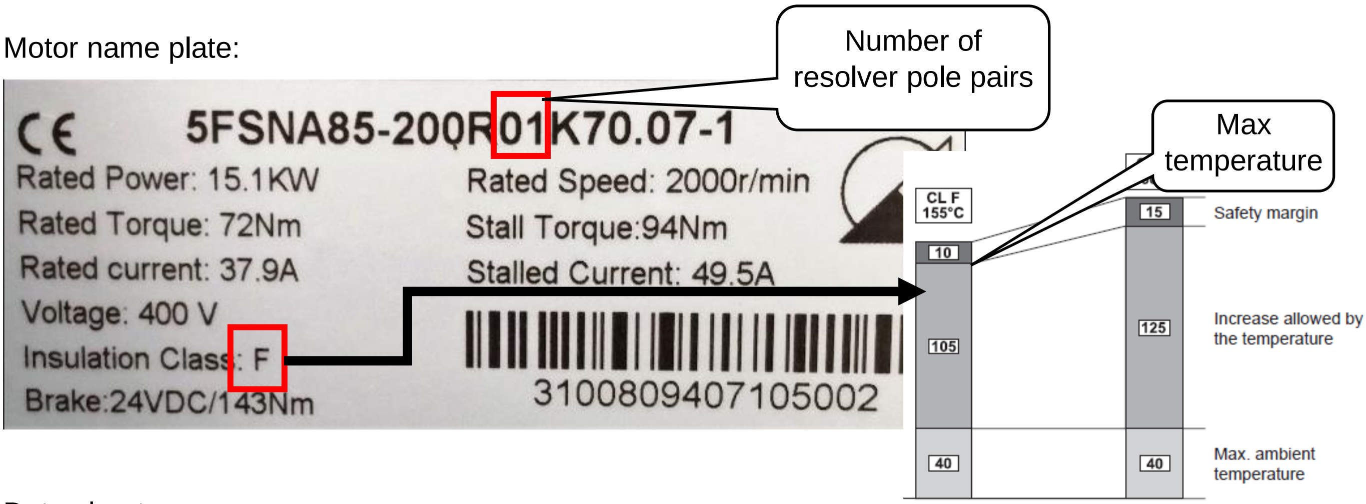
Synchronous servo motor example:

The following data is needed:

I nom, I max, Number of poles (motor), temperature sensor type, maximum temperature, Brake delay, number of poles (resolver).

The following figure shows the needed data collected in different parts of the data sheet and the name plate.

Motor name plate:



Data sheet:

Technical data		
Number of Poles		6
Rated Power	kW	15.1
Rated Voltage	VAC	400
Voltage Constant	mV*min	150
Rated Speed	1/min	2000
Stall Torque	Nm	94
Rated Torque	Nm	72
Torque Constant	Nm/A	2.4
Stall Current	A	49.5
Rated Current	Arms	37.9
Peak Current	Apk	188

Braking torque (Nm)	≥143
Brake closing time (ms)	60
Brake release time (ms)	450
Brake excitation current DC (A)	1.8
Brake excitation voltage DC (V)	24 (+5% , -10%)

Signal Connection

S2	S4	PT100+	PT100-	R2	KTY84+	KTY84-	R1	S1	S3
1	2	3	4	7	8	9	10	11	12

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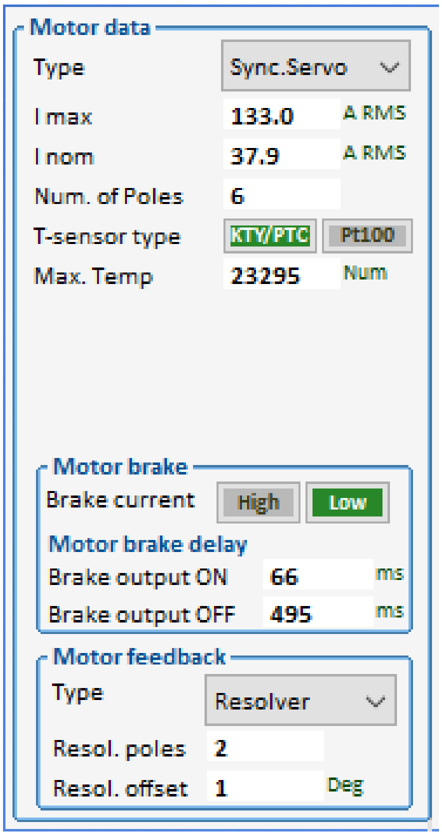
Table 18 Motor data for configuration:

Motor data	Value	Comments
I max	133	188 Apk equals 133 Arms
I nom	37.9	Rated current
Num. of Poles	6	Number of motor poles
Temperature sensor type	KTY/PTC	KTY 84 is shown in the signal connector, and used in the actual system.
Maximum temperature	23295	Insulation class F: 40º + 105º = 145. Extra 15º margin is added: 130º=23295 according to section 10.3.2.2 on page 174. (Data for KTY 84 conversion is used.)
Brake current	Low	The brake current is 1.8 A, which is considered low
Brake output ON delay	495	Break release time. The release range is not specified, and therefore 10% is added to 450.
Brake output OFF delay	66	Break closing time. The closing range is not specified, and therefore 10% is added to 60.
Number of resolver poles	2	1 pair = 2 poles

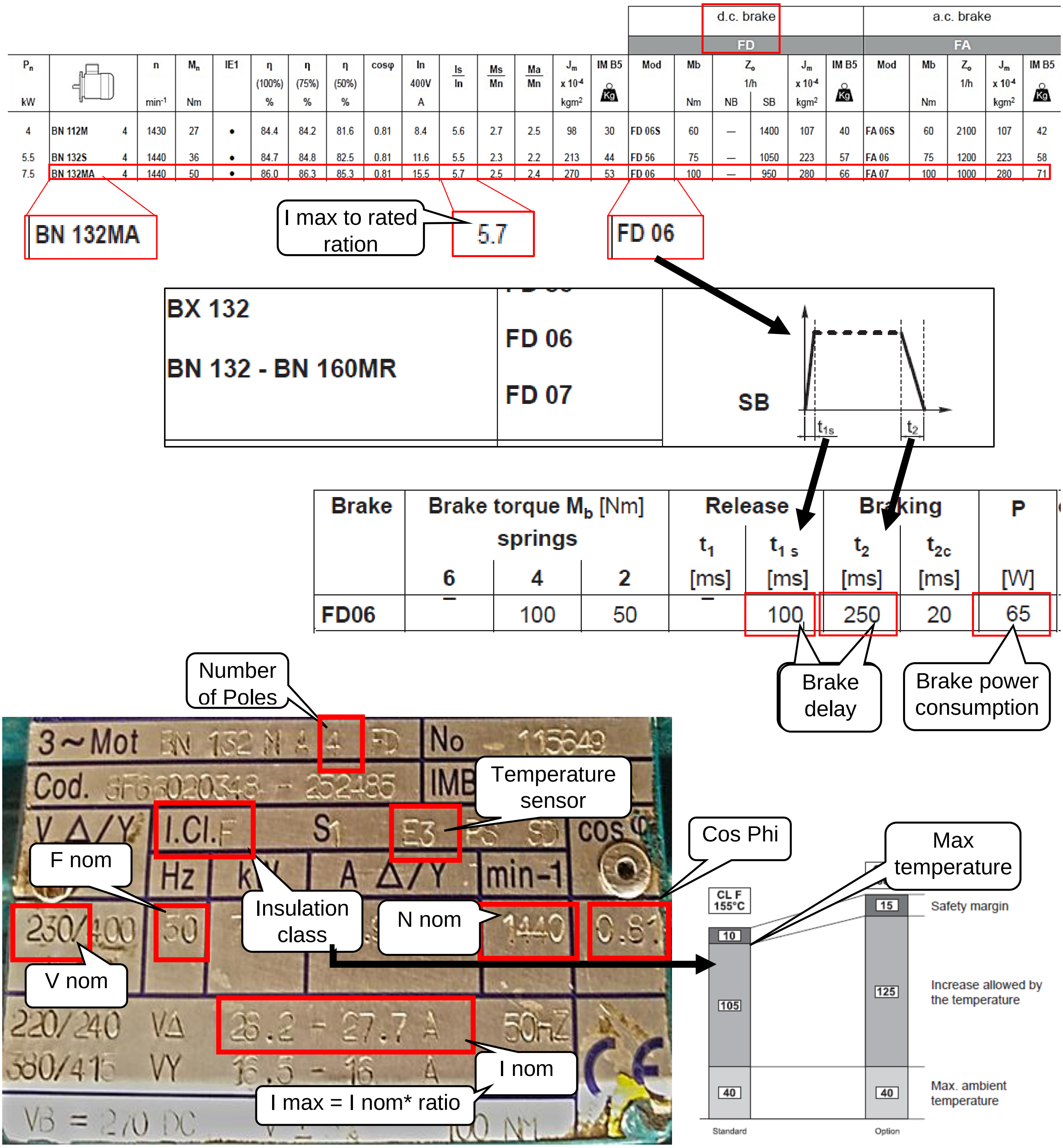


Asynchronous servo motor example:

The following data is needed:

N nom, F nom, V nom, Cos Phi, I nom, I max, Number of poles (motor), temperature sensor type, maximum temperature, Brake delay, number of poles (resolver).

The following figure shows the needed data collected in different parts of the data sheet and the name plate.

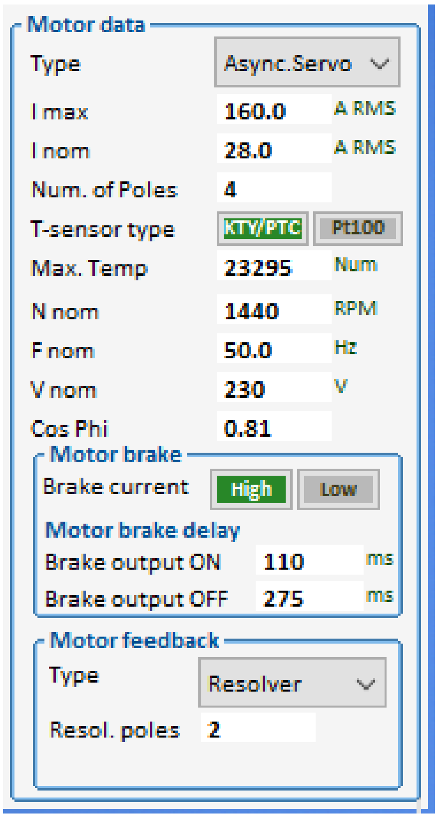


The resolver in this example is an external resolver:

According to Baumer's data sheet "P1" in the type number indicates the number of pole pairs:
1 pole pair = 2 poles.

Table 19 Motor data for configuration:

Motor data	Value	Comments
I max	160	I max = 28*5.7 ≈ 160
I nom	28	Interpolation between 27.7 and 28.2
Num. of poles	4	Number of motor poles
Temperature sensor type	KTY/PTC	E3 option is a PTC thermistor, which is very similar to KTY 84. IMD's KTY input is used for this type of sensor.
Maximum temperature	23295	Insulation class F: 40º + 105º = 145. Extra 15º margin is added: 130º=23295 according to section 10.3.2.2 on page 174. (Data for KTY 84 conversion is used.)
N nom	1440	Nominal speed
F nom	50	Nominal frequency
V nom	230	The motor is going to be connected as Δ with 230 V AC voltage
Cos Phi	0.81	
Brake current	High	The brake current is calculated from the brake consumption power: 65 W / 24 V = 2.7 A.
Brake output ON delay	110	Break release time. The release range is not specified, and therefore 10% delay is added.
Brake output OFF delay	275	Break braking time. The braking range is not specified, and therefore 10% delay is added.
Resol. poles	2	Number of resolver poles



8.4.3 Configuring the safety run fields

The “Servo” fields are general configurations of the IMD. The red dashed rectangle in the following figure shows the parameters that are to be configured.

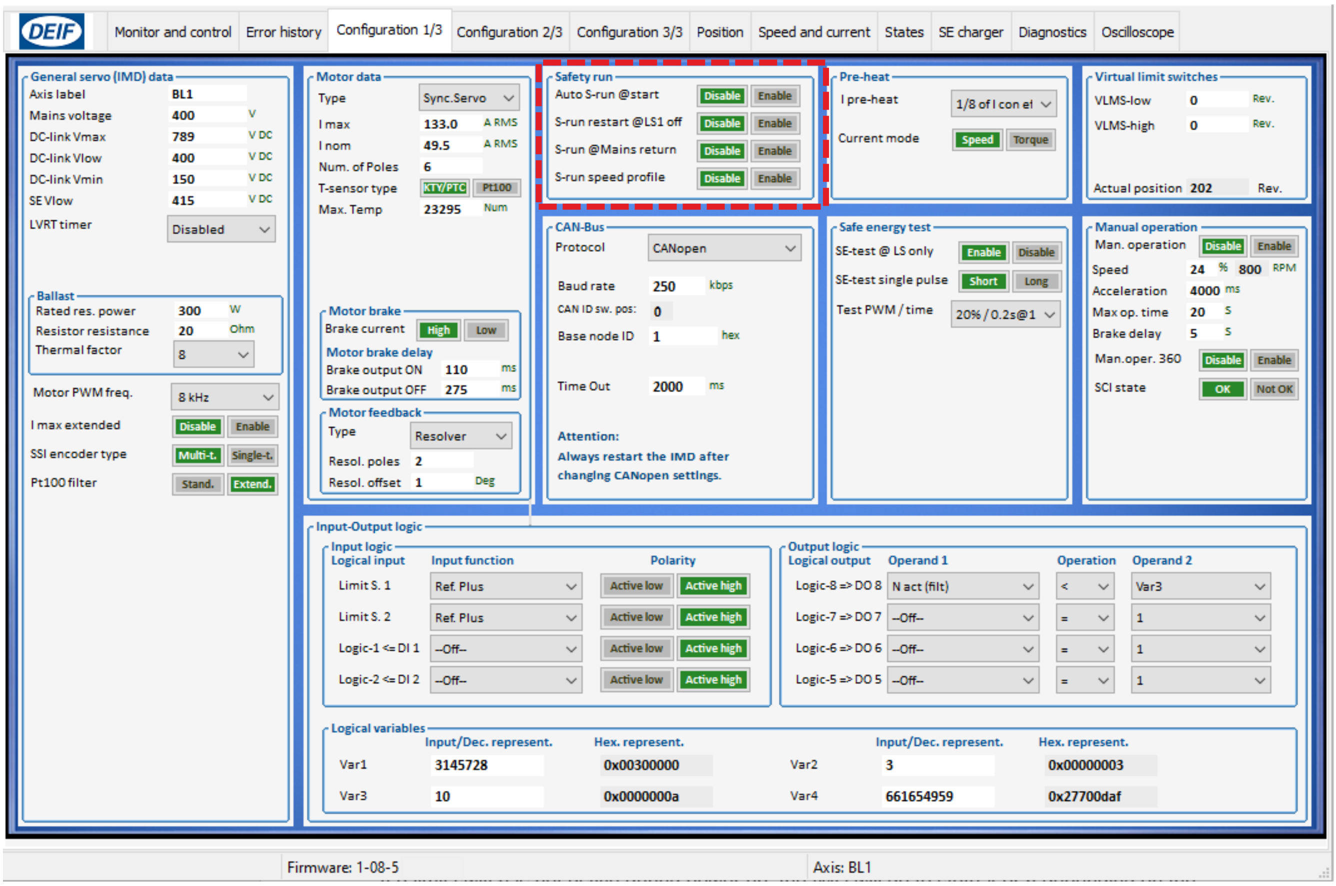


Figure 40 Safety run data in IMD Manager configuration 1/3

Fill in the following fields:

- **Auto S-run @ start:** Auto safety-run @ start is a function that enables automatic safety-run at IMD power up, if no limit switch is active before or during the power up.

  If a limit switch is not active during power up, the IMD will go to state 4 or 5 depending on the temperature. If the temperature is not too cold, it will end in state 5 (PwrOn not parked).
  If Auto S-run @ start is *enabled*, it is not necessary to enable the drive with a command (or the Enable dev. button). It will be done automatically and the IMD will proceed from state 5 (PwrOn not parked) to state 19 (safety run setup) automatically as soon as RUN input is high.

  If Auto S-run @ start is *disabled*, it is necessary to send the command or click on the Enable dev. button as well as set the RUN input is high, before the IMD will proceed from state 5 (PwrOn not parked) to state 19 (safety run setup).

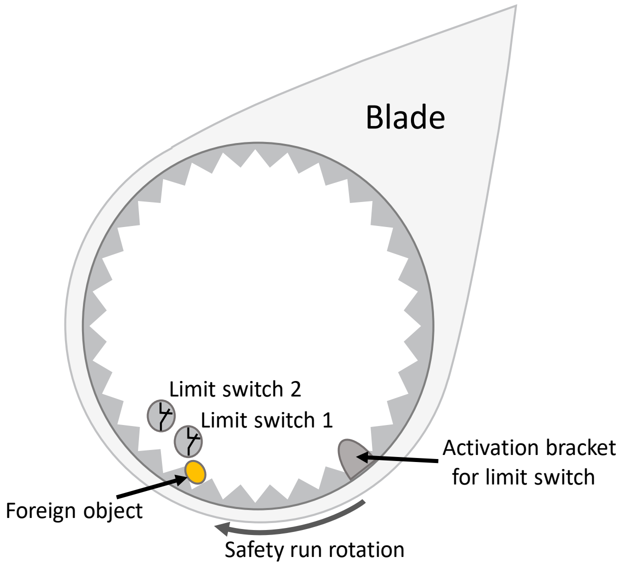
  See section 6.1 on page 55 for states chart and description.

- **S-run restart @ LS1 off:** Auto safety-run restart is a function that enables restart of a safety-run if limit switch 1 deactivates after a successful safety run in “Safety-run succeeded” or “Parked tripped” state (states 14 and 16, see section 6.1 on page 55).

  Enabled: If limit switch 1 is activated in a safety run and then deactivated while still in state 14 or 16 (Safety-run succeeded, Parked tripped), the IMD will restart the safety run. A delay of one second is added before the state changes from state 16 (Parked tripped) to state 17 (Parked ready), even if the safety chain is OK.

Disabled: The safety run will not restart, even if limit switch 1 is deactivated while in state 14 or 16 (Safety-run succeeded, Parked tripped) after being activated during a safety run.

The function ensures that the safety run has actually moved the blade to stop position and in case a foreign object (can be a debris from the hub or blade such as loos bolts and so on) has activated the limit switch during the safety run, thus ending the safety run before the blade has actually reached stop position. The following figure illustrates such a scenario.



Without the auto safety-run restart function, the safety run will stop when the foreign object activates limit switch 1, even if the foreign object falls off and the limit switch is deactivated again.

If the auto safety-run restart function is enabled, the IMD will initiate a new safety run that will try to move the blade until a limit switch is activated. Note that the auto safety-run restart function can only be initiated from "Safety-run succeeded" or "Parked tripped". If the safety-chain inputs are OK and the IMD entered "Parked ready" state, the auto safety-run restart function will not be initiated.

Attention

It is recommended only to enable this function if two limit switches are implemented in the pitch system. If there is only one limit switch and it breaks during the activation, the function will cause the blade to continue pitching until the safety run timeout has past, thus bringing the blade to an unwanted position.

Caution!

When this function is enabled, extra attention is required from installation and service personnel. If the IMD is in state "Parked tripped" and the limit switch breaks or for other reason deactivated, the blade might start pitching if no other precautions are taken.

- **S-run @ mains return:** Safety run after AC mains missing during safety run, and return later on. This function only applies to systems where there is no safe energy, and the 24 V DC supply to the IMD is not interrupted (will have no effect in variants with internal 24 V DC power supply).
  Disable: Safety run is not resumed
  Enable: Safety run is automatically resumed when the AC mains returns while the IMD is in state 12 (Safety-run pending). The IMD goes to state 12 if the AC mains is missing during a safety run.

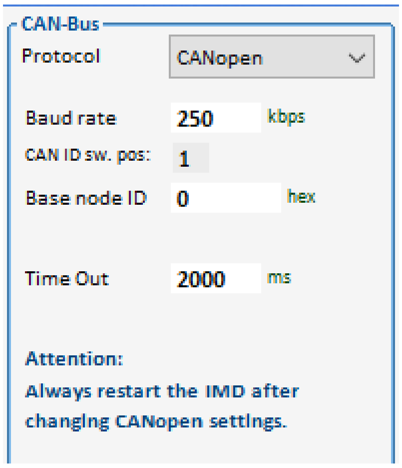
- **S-run speed profile:** S-run speed profile is a stepwise safety run, where four extra steps are defined with position and speed for each step.

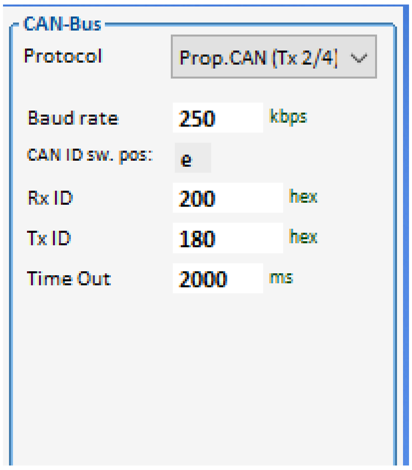
  Enabled: the configured speed profiled will be used whenever safety run is executed
  Disabled: Only step zero (N S-run (step 0) will be executed.

  The position of the resolver must be calibrated when using a speed profile. Calibration is done placing the blade in position zero and using the Preset pos. function to set the number of resolver revolutions to zero (see section 9.2 on page 130)

8.4.4 Configuring the CAN bus

Configure the CAN interface (se also section 7.1 on page 66 for additional information).





Parameters:

- **Protocol:** Select the protocol to be used in the dropdown list
- **Baud rate:** It is recommended to use 250 kbps to avoid communication errors and processor load
- **CANopen, Base node ID:** Configure the node ID offset in Hexadecimal. The resulting address is Base node ID+CAN ID switch position/value.
- **Prop.CAN, Rx ID:** Configure the receive address ID offset in Hexadecimal. The resulting address is Rx ID+CAN ID switch position/value.
- **Prop.CAN, Tx ID:** Configure the transmit address ID offset in Hexadecimal. The resulting address is Tx ID+CAN ID switch position/value
- **Time Out:** Recommended timeout is between 2 to 3 seconds, should be a higher than the controller time out setting. Setting the timeout time to zero, disables the timeout function and no error will be generated if the CAN/CANopen communication stops (at some point after initialization)..

The “CAN ID sw.” is for information only. It shows the state of the CAD ID switch on the IMD.

CANopen: If the Base node ID or CAN ID switch are changed, the IMD must be restarted. Se section 7.1.3.1 on page 70 for details about the IMD behaviour when the Base node ID or ID switch are changed.

8.4.5 Configuring the safe energy test

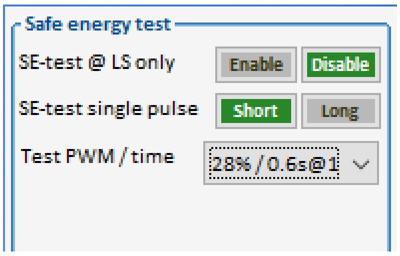
The purpose of the IMD safe energy test is to enable an external application to evaluate the state of the safe energy source, in order to ensure that the safe energy source is able to provide the needed energy at any time. Performing the test at regular intervals will enable timely replacement of the source if the batteries or ultra-caps are bad.

The safe energy test is done by doing the following:

1. Disconnecting the mains
2. Measuring the safe energy voltage
3. Slightly depleting the safe energy source with the ballast resistor and measuring the voltage again
4. Disconnecting the ballast resistor, waiting a specific time interval, and measuring the voltage once more
5. The state of the safe energy source can be estimated by evaluating the results (done by an external application)

The whole process of the safe energy test is done by an external application SW, using the special functions in the IMD. Performing the test manually from the IMD Manager will not be adequate, since the timing cannot be precise enough.
The depletion of the safe energy source can be done in two ways:

- Defining a duty cycle (PWM) and then starting (special command 5) and stopping (special command 6) the depletion with the special commands
- Defining a single pulse (100% duty cycle) interval and using special command 15 to execute it.



There are three configuration parameters for the safe energy test:

1. **“SE-test @ LS only”:** Whether it is possible to execute a battery test only when a limit switch is activated (select “Enable”), or also when a limit switch is not activated (select “Disable”).
2. **“SE-test single pulse”:** Selecting whether a pulse duration will be short or long. The selection will give different values in the next parameter (drop down list). This is only applicable for pulse width and will not change PWM values.
3. **“Test PWM/time”:** Pulse width modulation, or pulse time (interval) when using a pulse width. Depending on the selection of short or long pulse, different values will be shown. If PWM is used, the setting of long or short pulse is ignored.

Table 20 PWM time definitions ”Short” single puls

Test PWM/time	Single pulse (s)	Time ON (ms)	Time OFF (ms)	Total period (ms)
20%/0.2s@100%	0.2	0.25	1	1.25
25%/0.3s@100%	0.3	0.25	0.75	1
33%/0.4s@100%	0.4	0.25	0.5	0.75
50%/0.5s@100%	0.5	0.25	0.25	0.5
28%/0.6s@100%	0.6	0.5	1.25	1.75
33%/0.7s@100%	0.7	0.5	1	1.5
40%/0.8s@100%	0.8	0.5	0.75	1.25
50%/0.9s@100%	0.9	0.5	0.5	1

Table 21 PWM time definitions ”Long” single puls

Test PWM/time	Single pulse (s)	Time ON (ms)	Time OFF (ms)	Total period (ms)
20%/1s@100%	1	0.25	1	1.25
25%/2s@100%	2	0.25	0.75	1
33%/3s@100%	3	0.25	0.5	0.75
50%/4s@100%	4	0.25	0.25	0.5
28%/5s@100%	5	0.5	1.25	1.75
33%/6s@100%	6	0.5	1	1.5
40%/8s@100%	8	0.5	0.75	1.25
50%/10s@100%	10	0.5	0.5	1

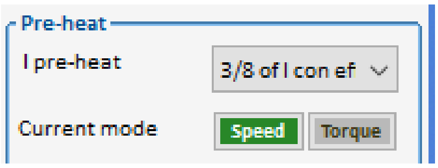
Example:	
Executing special command 5 will start a PWM of 28% duty cycle (28% on, 72%off) until special command 6 is executed. Executing special command 15, will connect the ballast resistor for a period of 0.6 seconds, and then disconnect it.	SE-test single pulse: Short Test PWM/time: 28% / 0.6s@100%
Selecting Long single pulse will change the value in the selectable list to: *28% / 5s@100%.* Executing special command 5 will start a PWM of 28% duty cycle (28% on, 72%off) until special command 6 is executed. Executing special command 15, will connect the ballast resistor for a period of 5 seconds, and then disconnect it	SE-test single pulse: Long Test PWM/time: not changed manually

Attention
Single pulse longer than 1s might damage the built-in ballast resistor, depending on the safe energy voltage.

8.4.6 Configuring pre-heating

There are two configuration parameters for the pre-heating

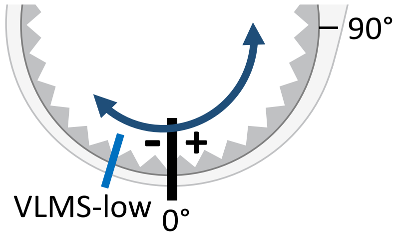
- I pre-heat: the current that will used for pre-heating: 1/8 to 8/8 of I con eff (defined in reg. 0xC5). Select the desired current from the dropdown list.
- Current mode: Select whether the speed or torque parameters are used during pre-heating. It is recommended to select Speed.



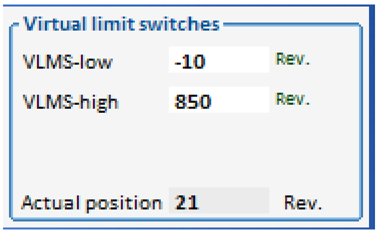
8.4.7 Configuring virtual limit switches

The VLMS' function is based on the resolver's number of revolutions. Zero calibration must be performed to use the VLMS. "Limit +" and "Limit –" flags are used for the VLMS function.

- VLMS-low: defines the number of full revolutions value for the low virtual switch. The position for the VLMS-low is positive if before zero, and negative if past zero:



- VLMS-high: defines the number of full revolutions value for the high virtual switch. The position for the VLMS-high is always positive.



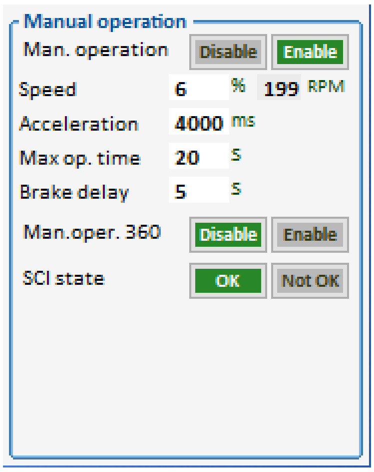
The actual position shows the actual position of the motor in full revolutions for information purpose.

8.4.8 Configuring manual operation

Manual operation has the following configuration parameters that must be configured before it can be used:

- Manual operation Enable/disable: click on "Enable" to enable entering into manual operation mode. When "Enable" is clicked, digital inputs 10, 11 and 12 are reserved for manual operation.
- Speed: the speed that will be used during manual operation. The speed is entered in percentage of Nmax-100. The resulting speed in RPM is shown.
- Acceleration: Ramp time that will be used for the acceleration from zero to manual operation speed. It is given is ms from zero to Nmax-100. The actual time in ms used to accelerate from zero to the manual speed can be calculated as: acceleration time * speed percent / 100.
- Max op. time: the maximum operation time of the motor in seconds. After this time the motor will stop even if an input is still high. It is still possible to cycle the input and the motor will start again with new operation time.
- Brake delay: A delay from motor stop until the brake is engaged in seconds. It is intended to prevent the brake from being engaged / disengaged multiple times during a short period of time if the manual operation is used in pulses.
- Man. oper. 360: Enables or disables the possibility to ignore VLMS while in manual operation mode. When "Enable" is clicked, digital input 9 is reserved for manual operation 360.
- SCI state: Defines the state of SCI (safety chain inputs) that manual operation is possible:
  - OK: safety chain inputs must be OK to enter manual operation mode

- Not OK: safety chain inputs must be not OK (safety chain tripped) to enter manual operation mode



8.4.9 Configuring input-output logic

Attention
Configuration of external fan control (if mounted in the IMD) and limit switch are mandatory.

The logical mapping to inputs and outputs is done in the “Input-output logic” group.

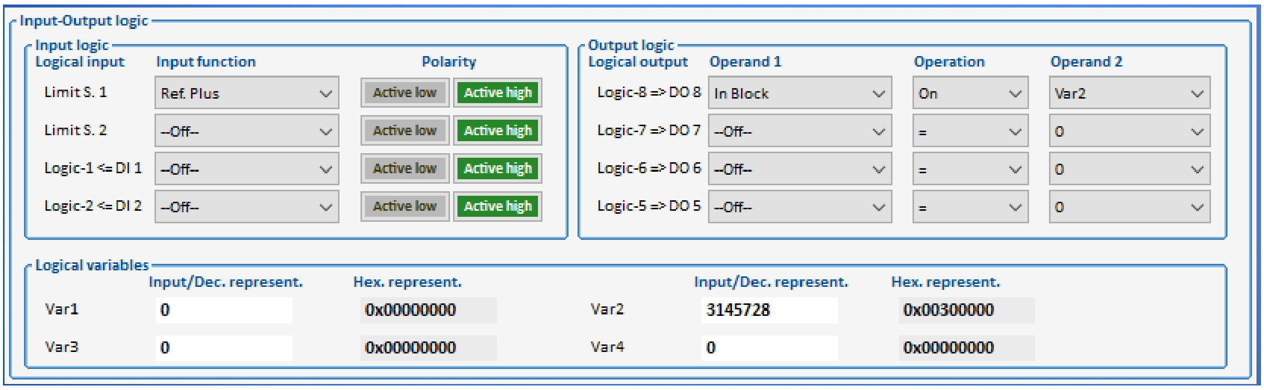
The mandatory definitions are:

- Limit S.: At least one limit switch must be defined as “Ref. Plus”. If no “Ref Plus” is defined the safety run will always end with timeout. Ensure that the correct polarity for the switch is defined.
- Logic 8 => DO8 (IMD 122 B only):
  It is recommended to configure the IMD so the fan cools automatically when needed according to the following table:
  Table 22 Fan start and stop

Reason for start	Start (approximately)	Stop (approximately)
Output module temperature	Above 60 ºC	Below 55 ºC
Load on ballast resistor	Above 25 %	Below 12.5 %

Configuring the output as a logical output will automatically configure the fan function for the recommended start and stop. Control of external fan connection (it is recommended to connect the fan to DO 8). Operand 1 = In Block, Operation = On, Operand 2 = VarX, VarX = 0x300000 (VarX is one of the four logical variables: Var1, Var2, Var3, or Var4)

Operand 2 does not have to be Var2, but the same variable that is defined as Operand 2 must also be defined as 0x300000. 0x300000 is a mask that enables Logic in block (Reg. 0x9B) bits 20 (status of Ballast load ≥ 25%) and 21 (Temp IGBT ≥ 60º C). if any of these flags equals one, the fan will be turned on.



Any other application specific definitions can be made. See IMD Manager user manual for details about how to configure the input and output logic.

8.5 Configuring the control parameters data

Control parameters are configured in “Configuration 2/3” tab.

- Speed
- Current
- Magnetic field weakening
- Position

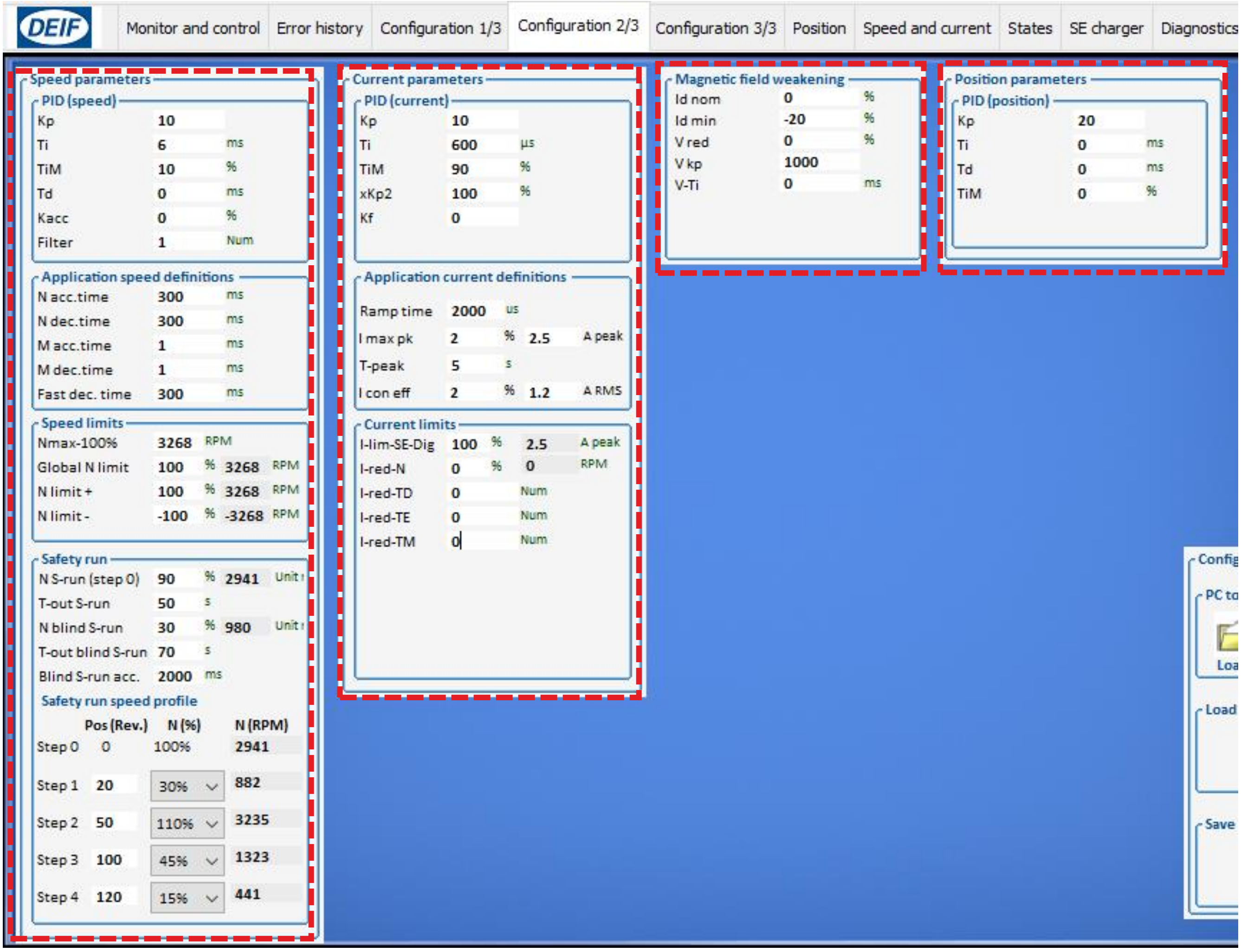


Figure 41 Parameter data

These parameters define the PID control characteristics as well as the limits that will be applied. The following sub sections describe how to fill these parameters.

For a detailed description of the function of parameters such as T-peak, I-con eff, and so on, see IMD 100 function description.

8.5.1 General PID parameters

The IMD is a PID (Proportional Integral Derivative) controller and while explaining PID controllers is outside the scope of this manual (information which is widely available), this section describes the general PID parameters that are configured in the following sections.

There are four parameters which can be configured in the Current, Speed and Position parameters (the parameters in the current are slightly different). These are: Kp, Ti, Tim, Td.

These parameters determine the following (illustrated in Figure 42 on page 104):

- How fast the motor will reach its set point
- Overshoot when set point is reached
- Settling time of over/undershoot
- Final error

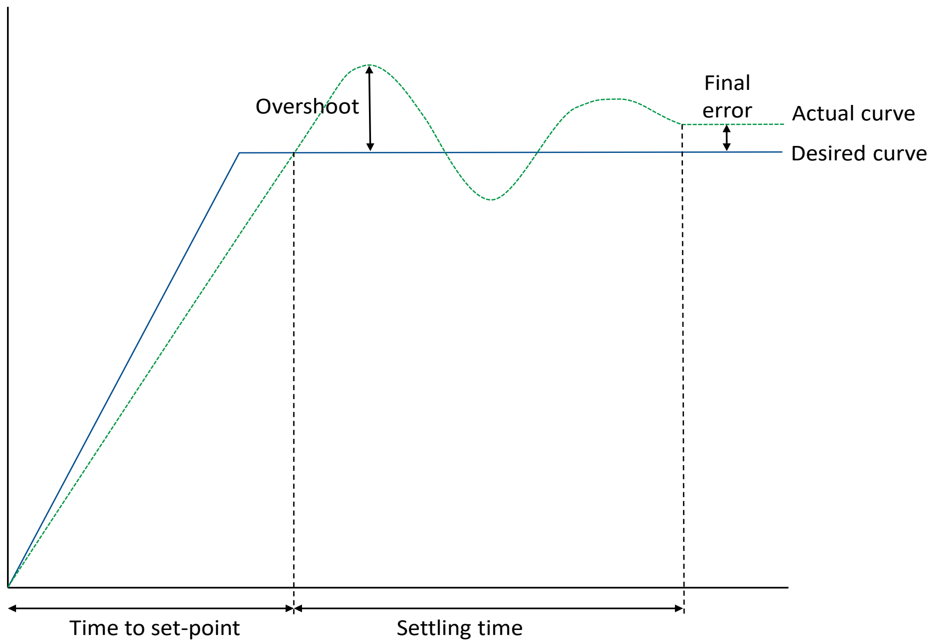


Figure 42 PID parameters

The following table show how increasing the value of configured parameters affect the actual curve:

Parameter	Time to set point	Overshoot	Settling time	Final error
Kp ↑	shorter	Larger	Little effect	Smaller
Ti ↑	shorter	Larger	Longer	Eliminated
Td ↑	Little effect	Smaller	Shorter	Little effect

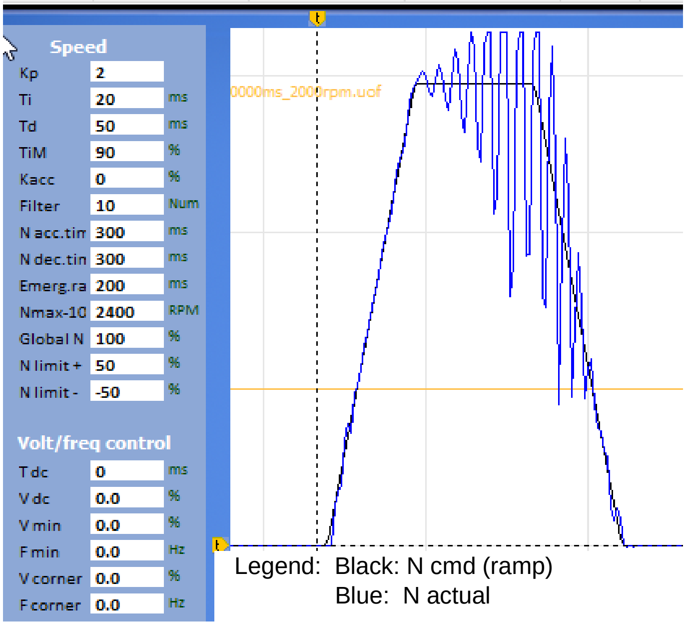
The Tim parameter, limits the maximum possible effect of Ti. It can be compared to setting a maximum speed limit. As long as the speed is under the limit, it can be changed very rapidly. Once it gets above the limit it will be limited, and not be allowed to increase any more. It can be useful for example to limit the effect of the integral part (Ti) when the blade is subjected to turbulence for a short while, which increases the torque and then disappears. Limiting the Ti with the Tim parameter will ensure that the motor doesn't suddenly get too much power.

Several control loops are part of the total blade control, and not all of them are controlled by the IMD. This must be taken into account when the PID parameters of the IMD are configured.

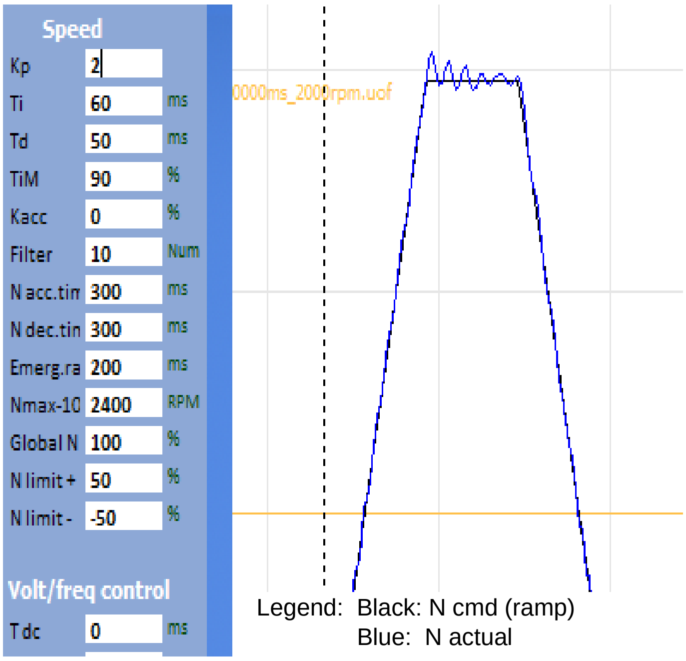
It is recommended to use the scope of the IMD Manager when optimizing the PID parameters.

The following examples show the influence of changing PID parameters, as captured by the scope in the IMD Manager. They are not meant as tutorial, merely to show how optimization can be performed.

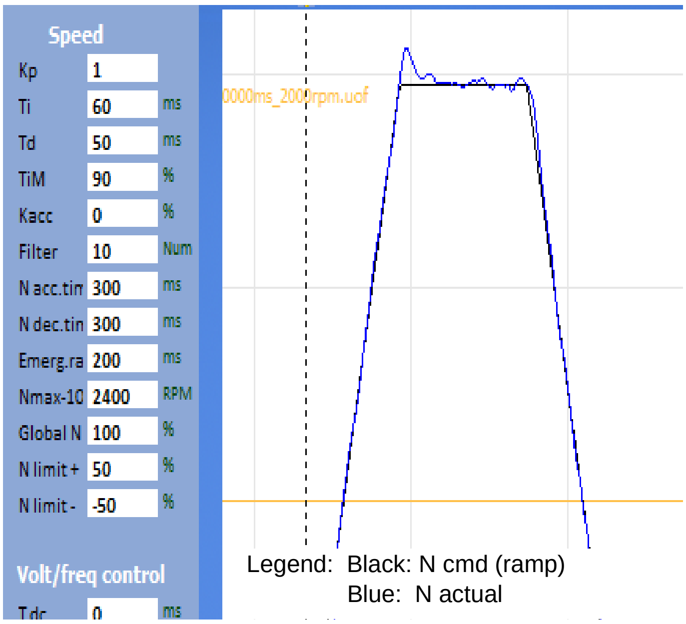
In this parameter settings, settling time is very long. On the other hand, the overshoot is very small. The Ti parameter is relatively low (20), which causes the motor to oscillate.



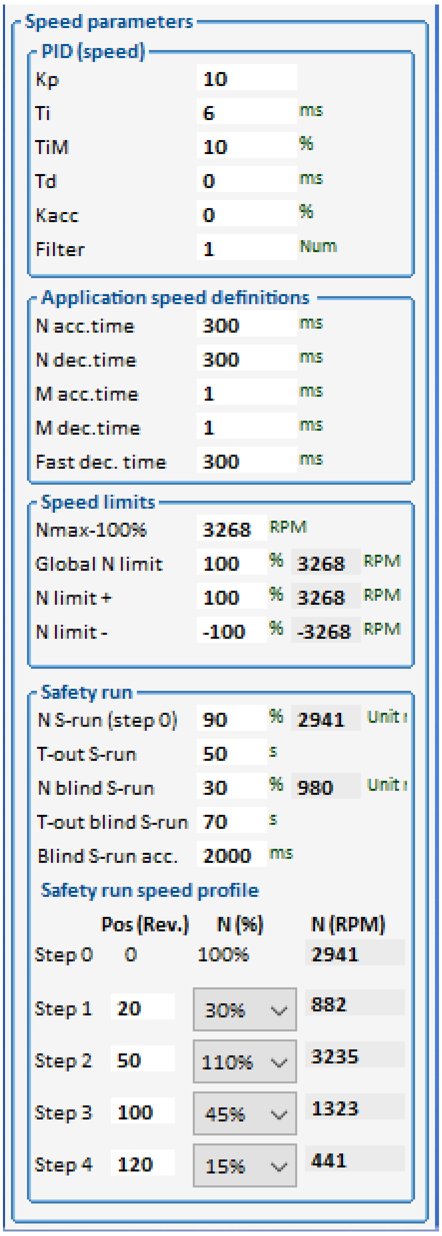
The Ti parameter is set higher (60). Settling time is shorter. On the other hand, the overshoot is slightly higher.



The Kp parameter is set lower (1). Settling time is shorter. On the other hand, the overshoot is slightly higher.



8.5.2 Configuring speed parameters

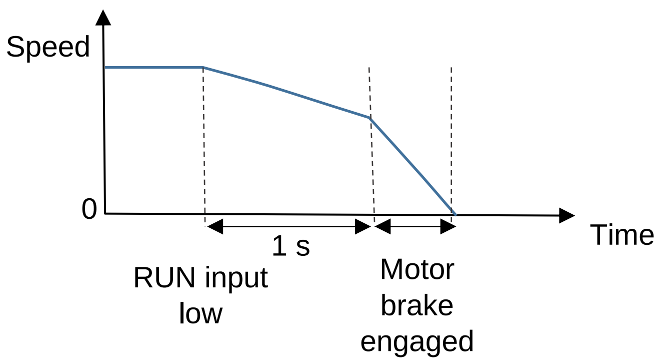


Fill in the following fields:

- **PID (proportional–integral–derivative) control parameters**: Only experienced and qualified person should adjust these parameters (see also section 8.5.1 on page 103).
  - **Kp:** Proportional amplification in the speed controller.
  - **Ti:** Integration time for the speed controller.
  - **Td:** Differential time constant for the rate time in the speed controller.
  - **TiM:** Maximum value of the speed integral memory.
  - **Kacc:** Dynamic acceleration value directly to the current controller. There is a risk of current oscillations if this parameter is adjusted too high.
  - **Filter:** Low-pass filtering of the feedback input to the speed control. Used to decrease the variation of the speed in order to keep it stable.
- **Application speed definitions**
  The purpose of acceleration and deceleration ramps is to lower the load on the motor and turbine during start and stop of pitch operation.

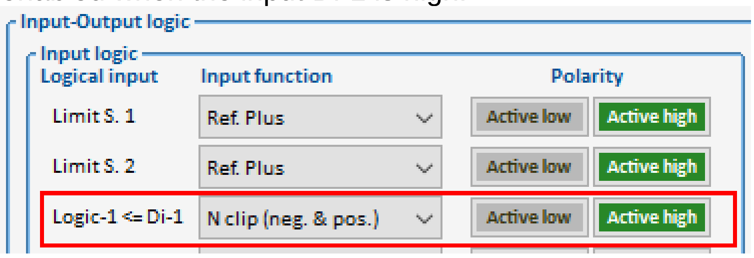
- **N acc. time**: Time in ms that will be used to accelerate from zero RPM to Nmax-100% RPM. This time defines an acceleration ramp (slope) that will be applied whenever an acceleration is performed.
- **N dec. time:** Time in ms that will be used to decelerate from Nmax-100% RPM to zero RPM. This time defines a deceleration ramp (slope) that will be applied whenever deceleration is performed.
  NOTE When a limit switch is activated during a safety run, or a safety run time is exceeded, the shortest of *N dec. time* and *Fast dec. time* will be used.
- **M acc. time:** Time in ms that will be used to accelerate from zero torque to max torque. This time defines an acceleration ramp (slope) that will be applied whenever an acceleration is performed.
- **M dec. time:** Time in ms that will be used to decelerate from max torque to zero torque. This time defines a deceleration ramp (slope) that will be applied whenever deceleration is performed.
- **Fast dec. time:** Ramp time (slope) for emergency situation. This time is used (overrides the N dec. time) if any of the following situations occur:
  - There is an error that forces a controlled motor stop. Note that some errors do not allow a controlled stop, and the brake will stop the motor.
  - The drive is disabled while the motor is in motion.
  - A limit switch is activated during a safety run, or a safety run timeout exceeded, and *Fast dec. time* < *N dec. time*
  - RUN input goes low. If the deceleration defined is longer than 1 s, the output is disabled and the brake is engaged:

RUN input goes low, (Fast dec. time > 1s defined):

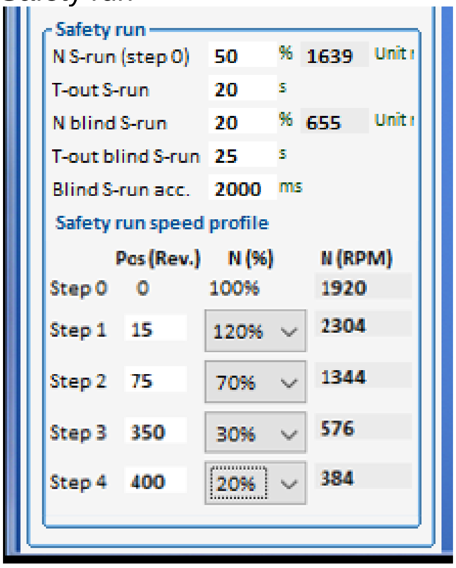


- **Speed limits:**
  The speed limits can be defined globally, for a specific direction or both. It is always the lowest value that will be used.
  - **Nmax-100%:** Maximum speed in RPM. This is the speed that will be a base for any relative speed calculation.
  - **Global N Lim:** Global speed limit, for both directions. Defined as percent of Nmax-100%. This speed limit is always enabled and will not allow the speed to exceed this limit.
  - **N Lim+, N Lim-:** Maximum speed limit, for positive (+) and negative (-) directions. Defined as percent of Nmax-100%. Commonly used in conjunction with position control. This speed limit is not active unless N-clip is enabled. Enabling N-clip can be achieved in one of the following ways:
    1. Set bit 6 in reg. 0x51 to 1 (set to zero to disable)
    2. Configure a logical input to N clip. In the following example the N Lim+ and N Lim– will be

enabled when the input Di-1 is high:



- Safety run

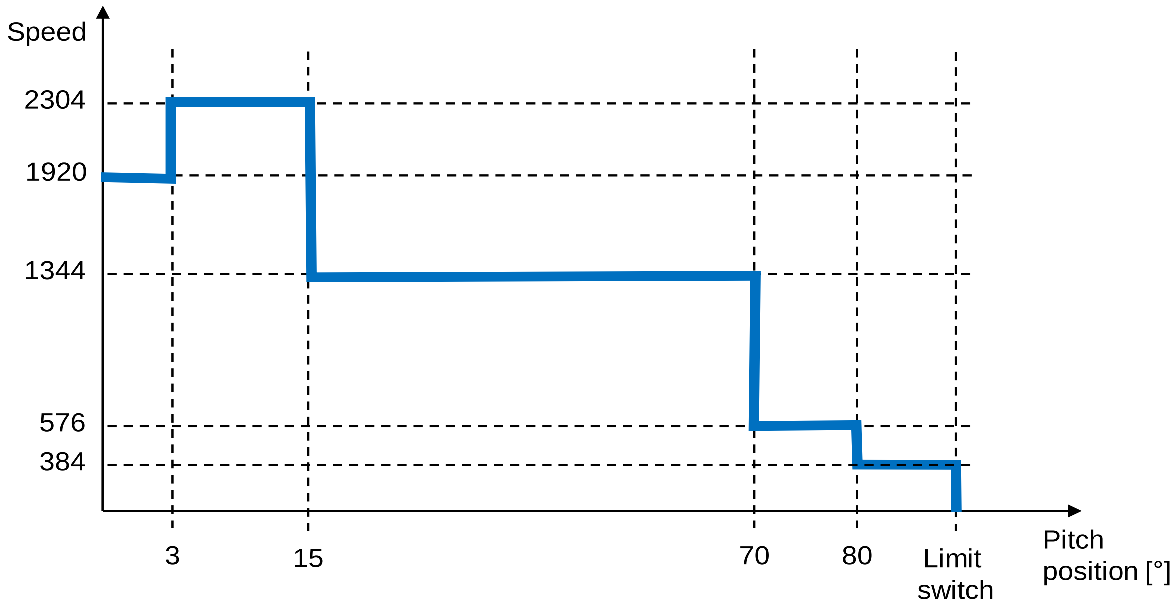


  - **N safety-run:** maximum speed during safety run. Defined as percent of Nmax-100%. A negative value in this parameter means that the motor will run the other way.
  - **T-out safety-run:** time out for safety run (the time after which the IMD will go from state 11 to state 18 (see section 6.1 on page 55) if a ref. Plus (limit switch) is not activated.
  - **N blind safety-run:** maximum speed during blind safety run (safety run without resolver feedback). Defined as percent of Nmax-100%. A negative value in this parameter means that the motor will run the other way.
  - **T-out blind safety-run:** time out for blind safety run (the time after which the IMD will go from state 11 to state 18 (see section 6.1 on page 55) if a ref. Plus (limit switch) is not activated.
  - **Blind S-run acc.:** Acceleration ramp for blind safety run. The slope of the ramp is defined as the time it will take to accelerate from zero RPM to Nmax-100% RPM.

    Safety run speed profile: (must be enabled in “Configuration 1/3”, “General servo” group). When using the speed profile, the resolver revolutions number must be calibrated to 0 at blade position zero using the Pos. preset (see section 9.2 on page 130). Step 0 always start at 0 revolutions, with the configured “N S-run (step 0)” speed, and cannot be changed. Steps one to four must be configured, by entering the position where the step starts as absolute number of revolutions, and the speed that will be used from this position in percent of “N S-run (step 0)”. The direction is defined in “N S-run (step 0)”. Percentage is always positive. The absolute number means that the IMD will change step when the motor has turned the number of revolutions defined, independent of the direction.

    The number of revolutions per degree must be known in order to be able to configure the safety run speed profile. See IMD 100 function description for description on how to calculate the number of revolutions per degree.

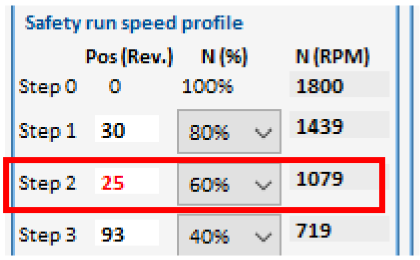
    Following is an example of a desired safety run curve and the configuration needed to achieve it:



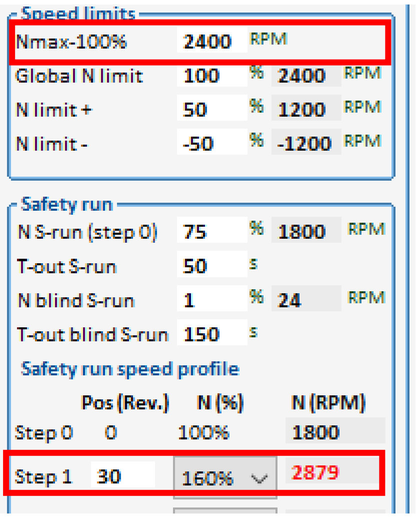
Assuming the total ratio of motor axis to blade rotation is 1800 (the ratio of revolutions per degree is five), and the N S-run (step0) is 1920, the four steps are configured as follows:

Step	No. of revolutions	Speed (%)	Speed (RPM)
0	0	**100**	1920
1	**15** (3x5)	**120**	2304
2	**75** (15x5)	**70**	1344
3	**350** (70x5)	**30**	576
4	**400** (80x5)	**20**	384

When configuring the position, the number of revolutions must be any step must be higher than the previous step. If this is not the case, the number of revolutions will be shown in red.



The speed is set by selecting a percentage value from the dropdown list, which allows values from 5% to 160%. If the resulting value exceeds Nmax-100%, the speed in RPM will be shown in red. If not corrected, the IMD will use Nmax-100% speed instead for this step



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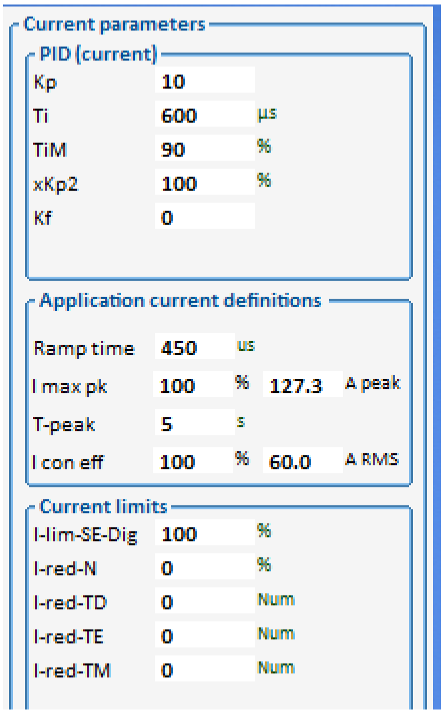
8.5.3 Configuring current parameters



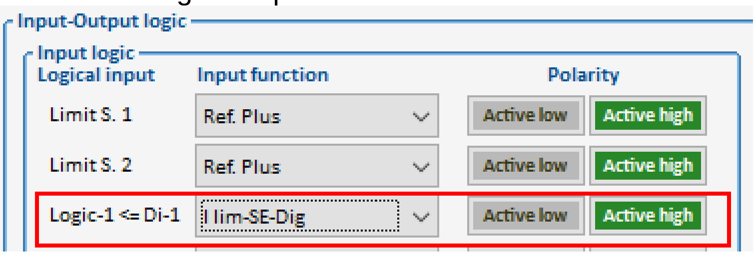
Fill in the following fields:

- **PID (proportional–integral–derivative) control parameters**: Only experienced and qualified person should adjust this parameter (see also section 8.5.1 on page 103).
  - **Kp:** Proportional amplification in the current controller.
  - **Ti:** Integration time for the current controller.
  - **TiM:** Maximum value of the current integral memory.
  - **xKp2:** Proportional amplification on overshoot current controller.
  - **Kf:** Feedforward amplification current controller.
- **Application current definitions**
  - **Ramp time:** The time in us that the motor will accelerate from zero to I con eff.

- **I max pk (%):** The maximum peak current value. See function description in IMD 100 function description.
  The value of this parameter is given as percentage of:
  Device design current (reg. 0xC6) $* 1.5 * \sqrt{2}$
  The resulting current can be seen in **I max pk (A peak)** field. Note that this value is peak value and not RMS. The maximum is 100% unless I max extended is selected in the Servo fields (see section 8.4.2.1 on page 91), which allows up to 115%.
- **T-peak:** The maximum time that the current is allowed to be at I max pk. See function description in IMD 100 function description. The maximum is 6 seconds unless I max extended is selected in the Servo fields (see section 8.4.2.1 on page 91), in which case the maximum is 3 seconds.
- **I con eff (%):** The maximum continuous current during drift (normal operation). See function description in IMD 100 function description, where this parameter is described as I-nom. The value of this parameter is given as percentage of Device design current (reg. 0xC6). The resulting current can be seen in **I con eff (A RMS)** field. Note that this value is RMS.

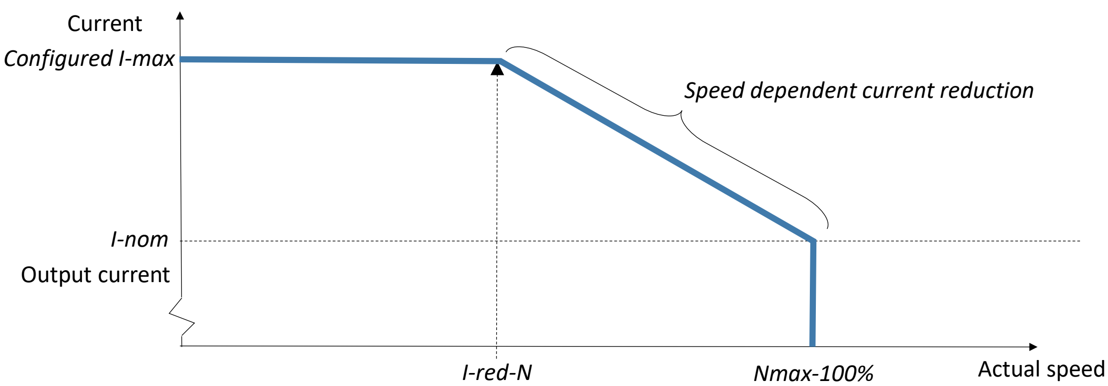
- **Current limits**
  - **I-lim-SE-dig:** A current limit that is used to lower the current in various situations. The main purpose of this current limit is to lower the energy used when safe energy is used. The current limit will be applied if any of the following conditions is true:
    - When there is no mains input
    - A CAN/CANopen command is sent, activating the current limit
    - An input for logical input that is configured to enable the current limit becomes active.

    In the following example the current limit will be activated when input Di-1 is high:

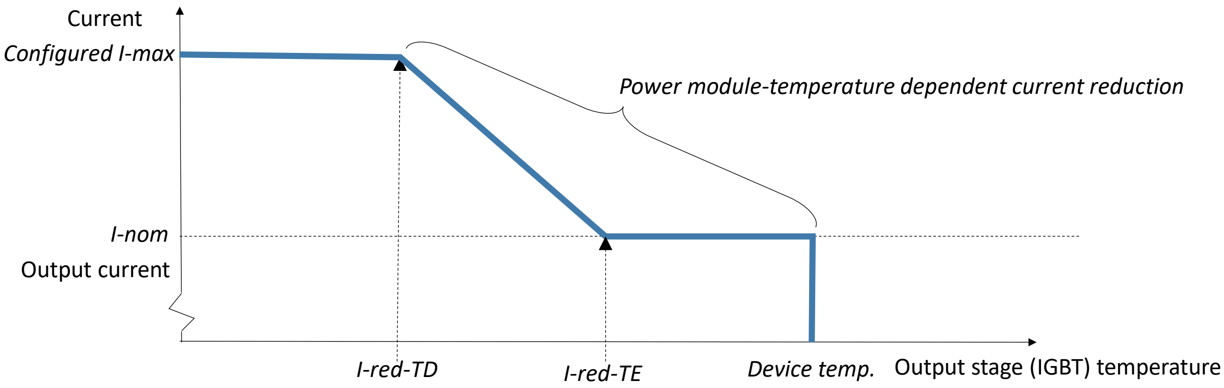


    In this field the value of the current limit in % of I max pk is defined.

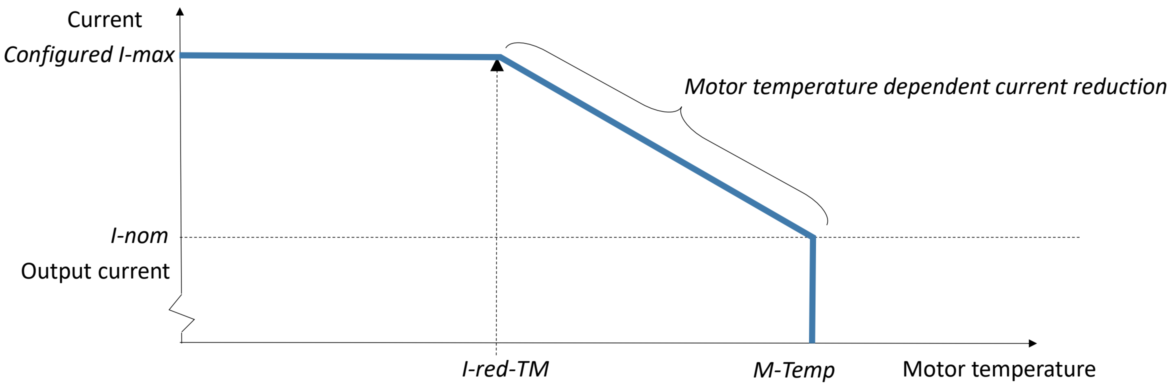
    Use 100% if this function is not to be used. This is an optional parameter.
  - **I-red-N:** Current limit that becomes effective due to speed, in percent of Nmax-100% (defined in reg. 0xC8). This parameter specifies the speed at which the current limitation start. The limit is on I max pk, linear from I-red-N speed, until Nmax-100% speed where the limit reaches I nom. This current limit is dynamic and is always related to present speed.
    Zero disables the function. This is an optional parameter.



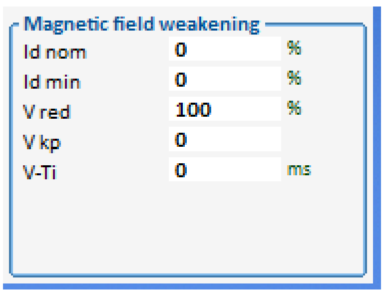
  - **I-red-TD:** Current limit that becomes effective due to power module (IGBT) temperature. Start temperature in units. The limit is on I max pk, linear from temperature until TE temperature, where the limit reaches I nom at **I-red-TE**. This function is disabled if either I-red-TE is zero or if it is larger than I-red-TD. This is an optional parameter.



- **I-red-TE:** Current limit that becomes effective due to power module (IGBT) temperature. The temperature in units in which the current limit becomes equal to I nom. See I-red-TD. Setting I-red-TE is zero disables the function. This is an optional parameter.
- **I-red-TM:** Ramp reduction from I red-TM to M-temp – Number is motor temperature. The reduction state changes as soon as the motor temperature is above the configured value. Can only be used when the temperature sensor in the motor is linear.



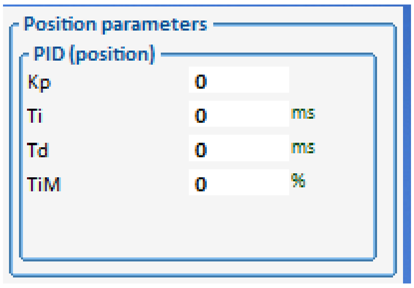
8.5.4 Configuring magnetic field weakening parameters



Fill in the following fields:

- **Id nom:** Magnetizing current in percent of the nominal current of the motor (from “Motor data” group). By optimizing this parameter (can only be done after additional motor parameters are configured – see section 8.6.2 on page 118) it is possible to achieve higher speed with the same load, resulting in higher speed in maximum modulation while in operation
- **.Id min:** min. Id-current 50-80%
- **V red:** Output voltage for the field weakening (80%)
- **V kp:** Control amplification for the field weakening (500-2000)
- **V-Ti:** Rated time field control (0-2000). Too high value will cause oscillation

8.5.5 Configuring position parameters



Fill in the following fields:

- **PID control parameters** (see also section 8.5.1 on page 103):
  - **Kp:** Proportional amplification in the position controller. When this parameter is set to zero, position mode is disabled and it is not possible to set the motor to go to a specific position. Always use speed limits when position mode is enabled (see section 8.5.2 on page 106).
  - **Ti:** Integration time for the position controller. Only experienced and qualified person should adjust this parameter.
  - **Td:** Differential time constant for the rate time in the position controller. Only experienced and qualified person should adjust this parameter.
  - **TiM:** Maximum value of the position integral memory. Only experienced and qualified person should adjust this parameter.

8.6 Configuring async. motor parameters and resolver offset

8.6.1 Configuring resolver offset

Info

This section is only applicable for Permanent magnet synchronous motor with resolver (EC Servo).

The resolver offset needs to be determined once for each motor type. It is not a parameter that needs to be determined for each motor. It is determined during the integration process, and the offset value is then part of the configuration file.

Attention

If the motor manufacturer cannot guaranty that all motors of the same type are calibrated in the same way, each motor must be offset calibrated.

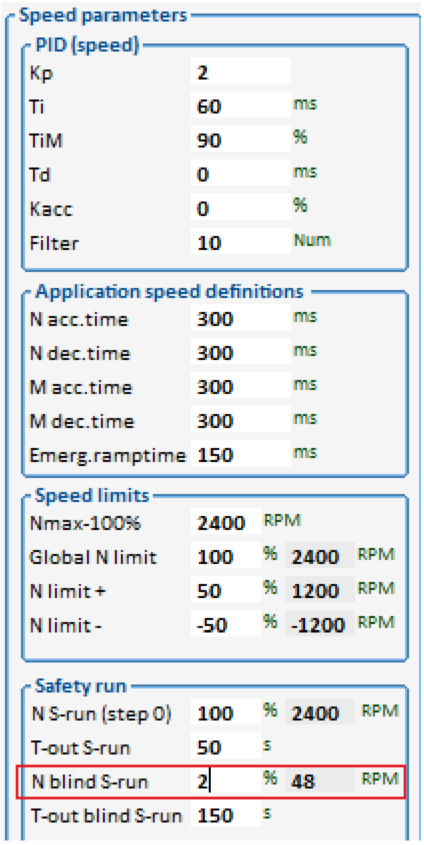
8.6.1.1 Prerequisites

In order to perform the resolver, offset determination, the following is needed:

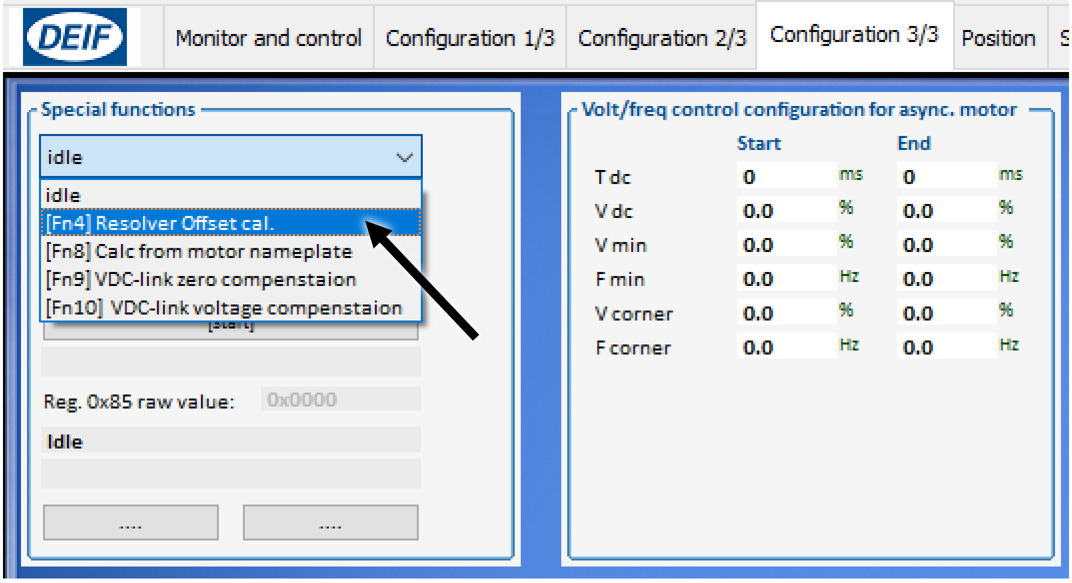
- The IMD Manager must be running on a PC and connected to the IMD through the “Service” connector.
- The IMD must be configured for the motor used
- Power connections (mains and motor) must be connected
- The resolver must be connected to the IMD
- The motor must be able to rotate free without load
- Safety-chain, RUN and RFE inputs must be valid. See section 5.5.2.1 on page 50 for safety-chain input information. RUN and RFE must be able to toggle.

8.6.1.2 Offset determination

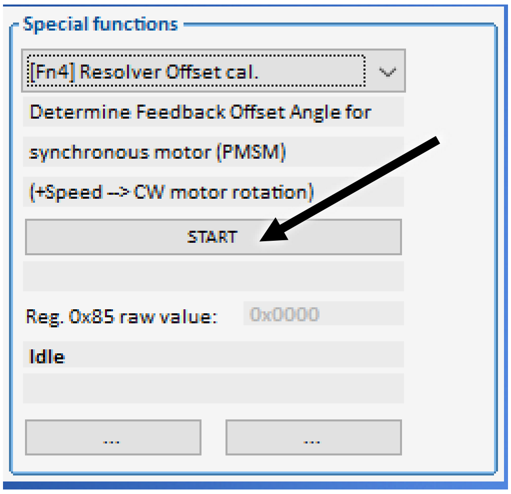
1. Set “RUN” input OFF
2. In the IMD Manager “Configuration 2/3” tab, set “N blind safety-run” in the “Safety run” group to approximately 60 RPM. The value is entered as percent of Nmax-100%.



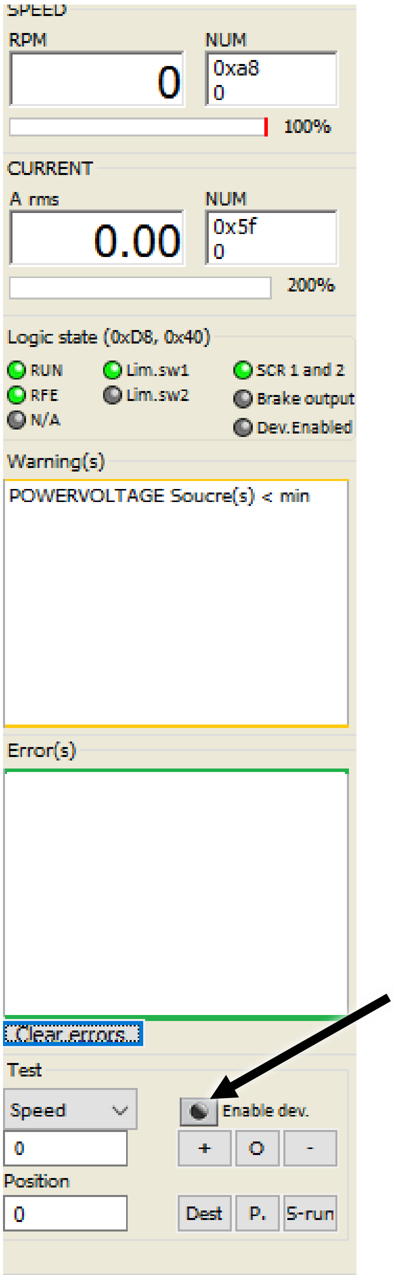
3. Click on the “Configuration 3/3” tab and select “[Fn4] Resolver Offset cal.” in the “Special Functions” dialog box.



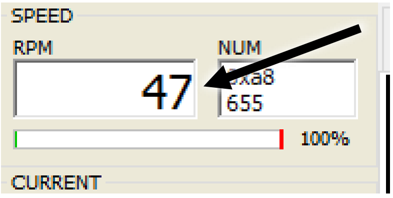
4. Set “RUN” input ON.
5. In the “Configuration 3/3” tab press “Start”



6. Click on "Enable dev." button to enable the IMD (the icon will turn green when the IMD is enabled)



7. The motor will shake a little, and then slowly rotate one revolution. Observe the "RPM" field and verify that the number shown is positive (no "-" in front of the number).



If the number is negative, do the following:

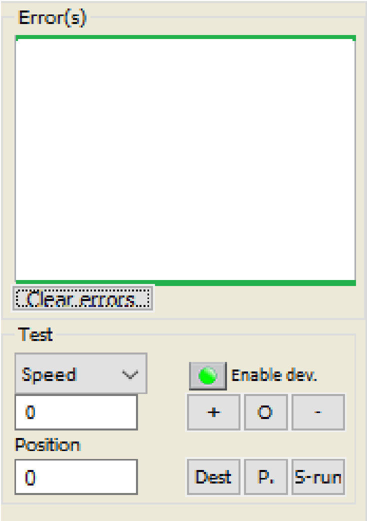
a. If you have not saved the configuration to the EEPROM yet, do it now so you don't lose the configuration made until now (in case the 24 V DC is internal).

b. Set "RUN" input OFF

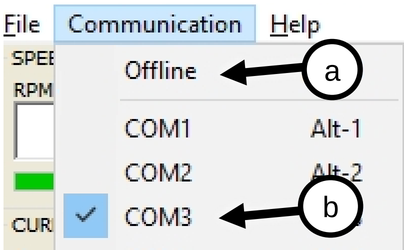
c. Disconnect the mains power, wait for discharge of the capacitors

d. Swap two phases in the motor cable

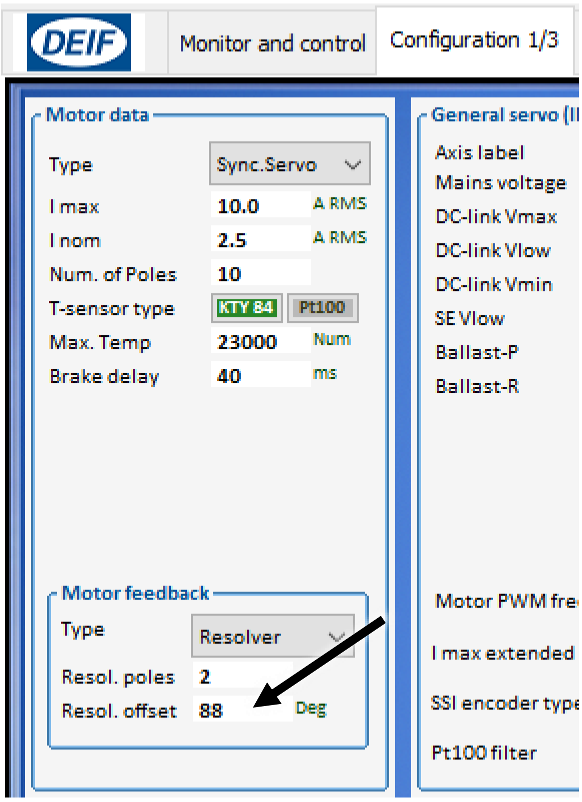
   e. Reconnect mains power and repeat steps 2 (on page 114) to 7 (on page 116 ,this step)
8. Click on “Enable dev.” again to disable the IMD



9. Update the parameters in the IMD Manager
   f. Note the used com port (COM3 is shown) and click “Offline” in the “Communication” menu



   g.
   h. Click on the same COM port used before. The IMD Manager will refresh all values, including the resolver offset:



10. Save the configuration to the EEPROM (see IMD Manager user manual).

8.6.2 Configuring additional motor parameters

Attention

If the motor type is **Sync. Servo**, all configurable parameters in “Additional motor parameters” must be set to zero.

The additional motor parameters are the electrical properties of the motor. There are two ways this can be done:

- Enter the data from the data sheet manually (if available). If this is done, “L sigma-q” value must be filled before “L sigma-d” value.
- Use the automatic calculation procedure (calculates the parameter values using data from the name plate).

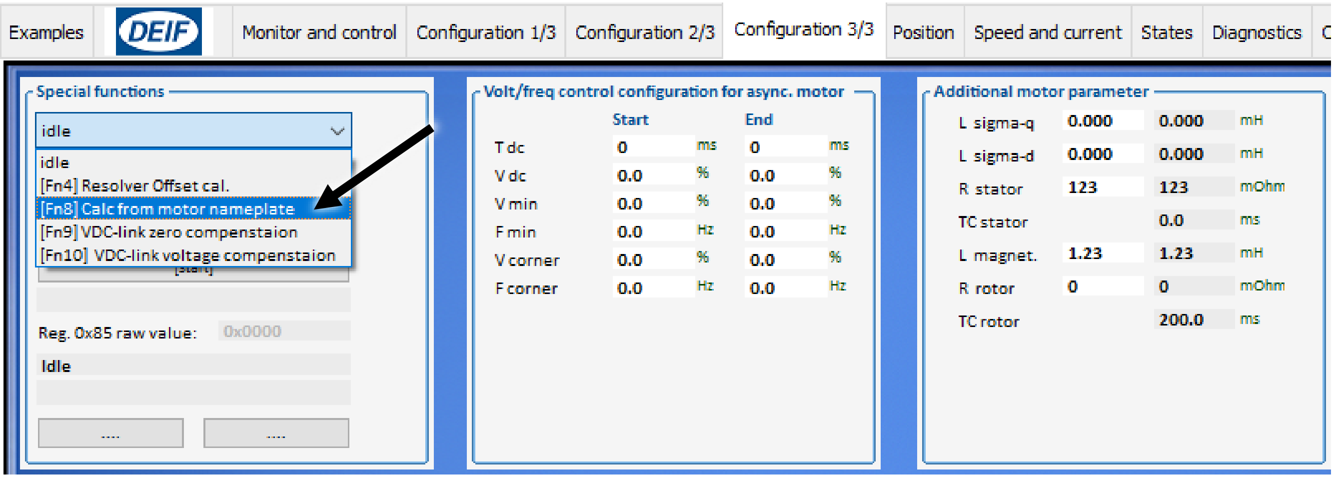
The following procedure describes how to use the automatic calibration procedure.

8.6.2.1 Prerequisites

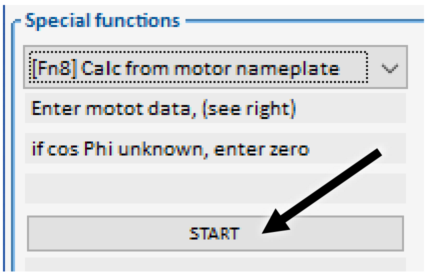
Before configuring the additional parameters all the fields in the “Motor data” group in “Configuration 1/3” tab must be filled.

8.6.2.2 Calculation procedure

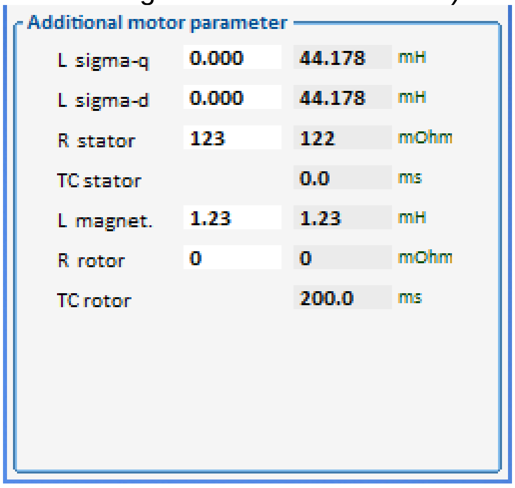
1. Select “[Fn8] Calc from motor nameplate” in the “Special function” group in the “Configuration 3/3” tab.



2. Click on “START” button



3. The IMD Manager will now calculate the values and save them in the appropriate registers. The same values are inserted in the Read-only fields (the editable fields are only updated when the IMD Manager connects to the IMD).



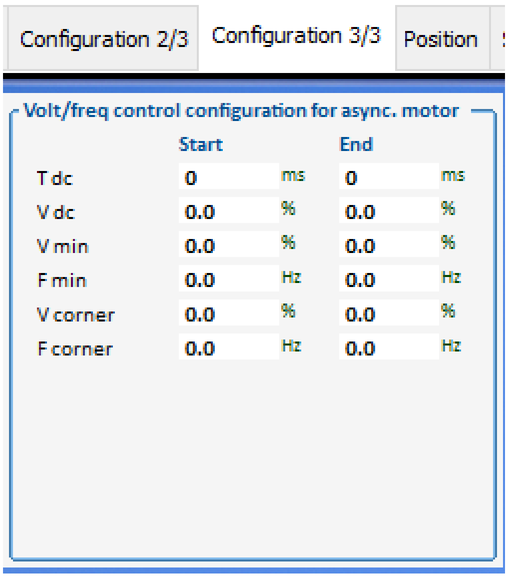
Info

It is possible to optimize these parameters, which is the reason that editable fields are placed in the same group. Changing the “L magnet” or “R rotor” will change the TC rotor (time constant for rotor). By optimizing TC rotor, it is possible to achieve higher speed with the same load, resulting in less current consumption while in operation.

8.6.3 Configuring volt/freq control for async. motor

This section is only applicable for asynchronous motors

Some additional voltage and frequency parameters need to be configured when controlling asynchronous motor. These parameters define the voltage/frequency curve generated by the IMD. These are configured in the “Configuration 3/3” tab:



Parameter description:

- **Start**

   - **T dc:** DC pre-magnetization time
   - **V dc:** DC pre-magnetization start voltage
   - **V min:** Minimum voltage at movement start
   - **F min:** Minimum frequency at movement start
   - **V corner:** Voltage at rated speed in percentage of the mains input
   - **F corner:** Frequency at rated voltage. Use motor nominal frequency.
- **End (reserved for future use)**
   - **T dc:** -
   - **V dc:** -
   - **V min:** -
   - **F min:** -
   - **V corner:** -
   - **F corner:** -

8.7 Configuring SE charger parameters (option)

The SE charger is a hardware option that can be ordered with the IMD. It is not possible to add it later. The charger is an advanced multistage programmable charger, capable of optimised charging for different types of supported energy sources. Refer to the IMD 100 function description for more information about the charger.

8.7.1 Charger configuration management

Configuration can only be done when the charger is in Setup mode, which is done with a “Setup mode” button in the “SE charger” tab. Charging stops when the charger is in Setup mode, and starts again automatically at the Bulk stage when the Setup mode is disabled.

Like other parameters of the IMD, the charger parameters configuration is done in the values stored in the RAM. As soon as the Setup mode is disabled, it uses the parameter values from the RAM. Like other IMD parameters, any values changed in the RAM, must be saved to EEPROM in order to be used after restart, reset, or load of new parameters. This is done in the “SE charger” tab, see IMD Manager user manual for instructions.

It is also possible to configure the charger by executing a configuration script. The configuration script can set the charger in setup mode configure all parameters, save all parameters to EEPROM and take the charger out of setup mode.

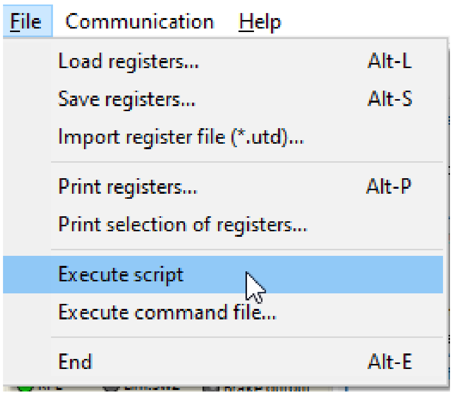
8.7.2 Configuring the charger with a script

8.7.2.1 Prerequisites

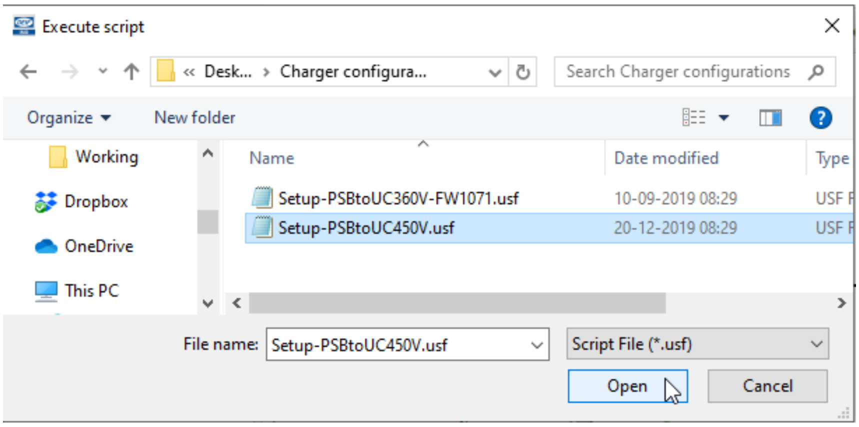
- A configuration script is available
- Connect 3x400 V AC to the IMD mains terminals and turn on the power.
- Connect the PC to the IMD with a USB cable and connect to the drive

8.7.2.2 *Configuring the charger*

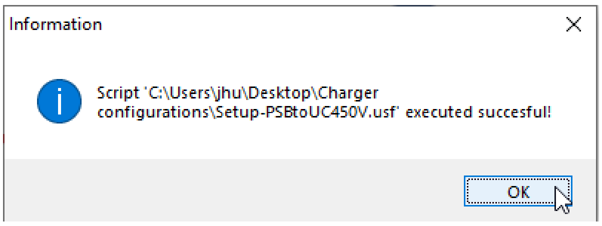
1. Click on File→Exec script:



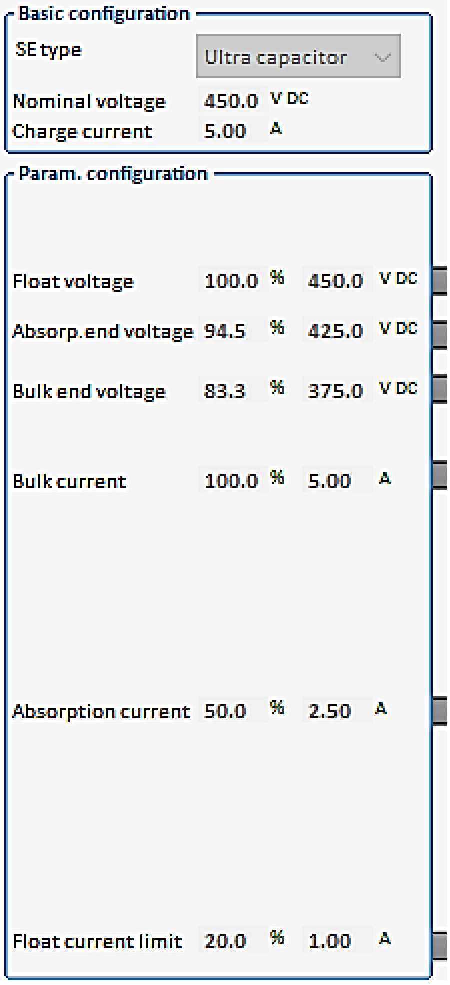
2. Navigate to the folder where the configuration scripts are stored. Select the appropriate configuration and click "Open":



3. The IMD manager executes the script (indicated with a ) When completed, click "OK" in the dialog box:



4. Click on the "SE charger" tab and verify that the charger is configured as expected:



8.7.3 Configuring the charger manually

The charger has 2 parameter types:

- **Basic parameters**: Must always be configured.
- **Parameter configuration**: Can either be configured manually or used with the factory defaults (select with the "Set factory default" button). There is a set of factory defaults parameters for each SE type.

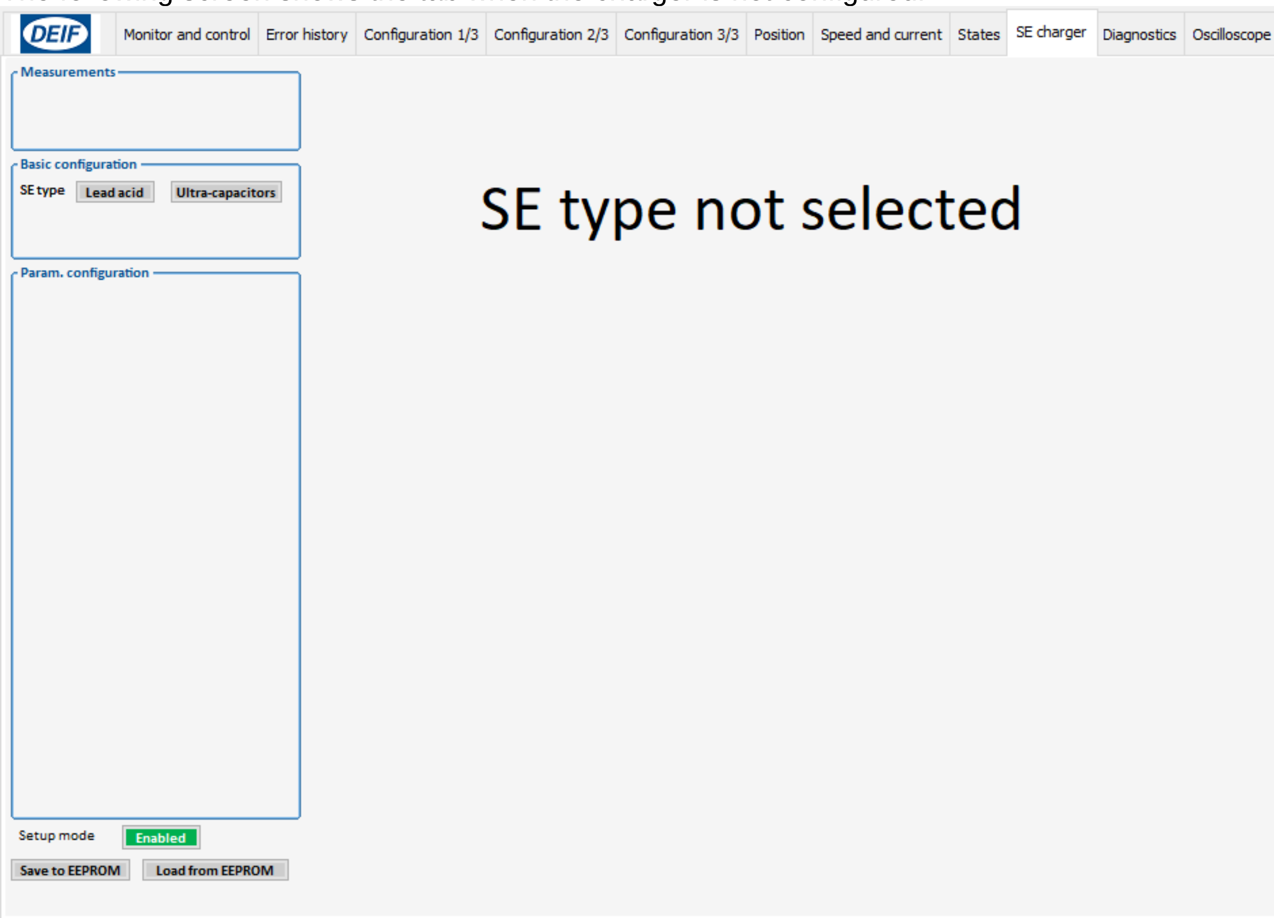
NOTE To achieve maximum performance and life time of the energy source, consult the energy source supplier, and have the applicable charging characteristics at hand.

8.7.3.1 Configuring type and basic configuration

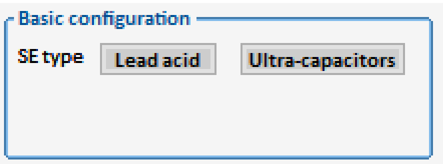
1. Click on the "SE charger" tab. If the Setup mode is disabled (

) click on the "Disabled" button to enable the Setup mode.

The following screen shows the tab when the charger is not configured:

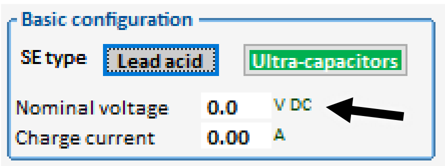


2. In the “Basic configuration” group, click on the SE type used:



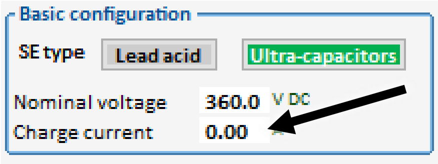
When the SE type is selected, the area on the right-side changes to the charging curve applicable for the selected SE type, and the relevant parameters are shown on the left-side.

3. Enter the nominal voltage of the used SE source (the sum of all elements’ nominal voltage):



NOTE Resolution in any voltage setting is 100 mV. This applies to all voltage charge values.

4. Enter the charge current parameter value. This value is the 100% current value. All other current parameters' values are defined as percentage of this value.

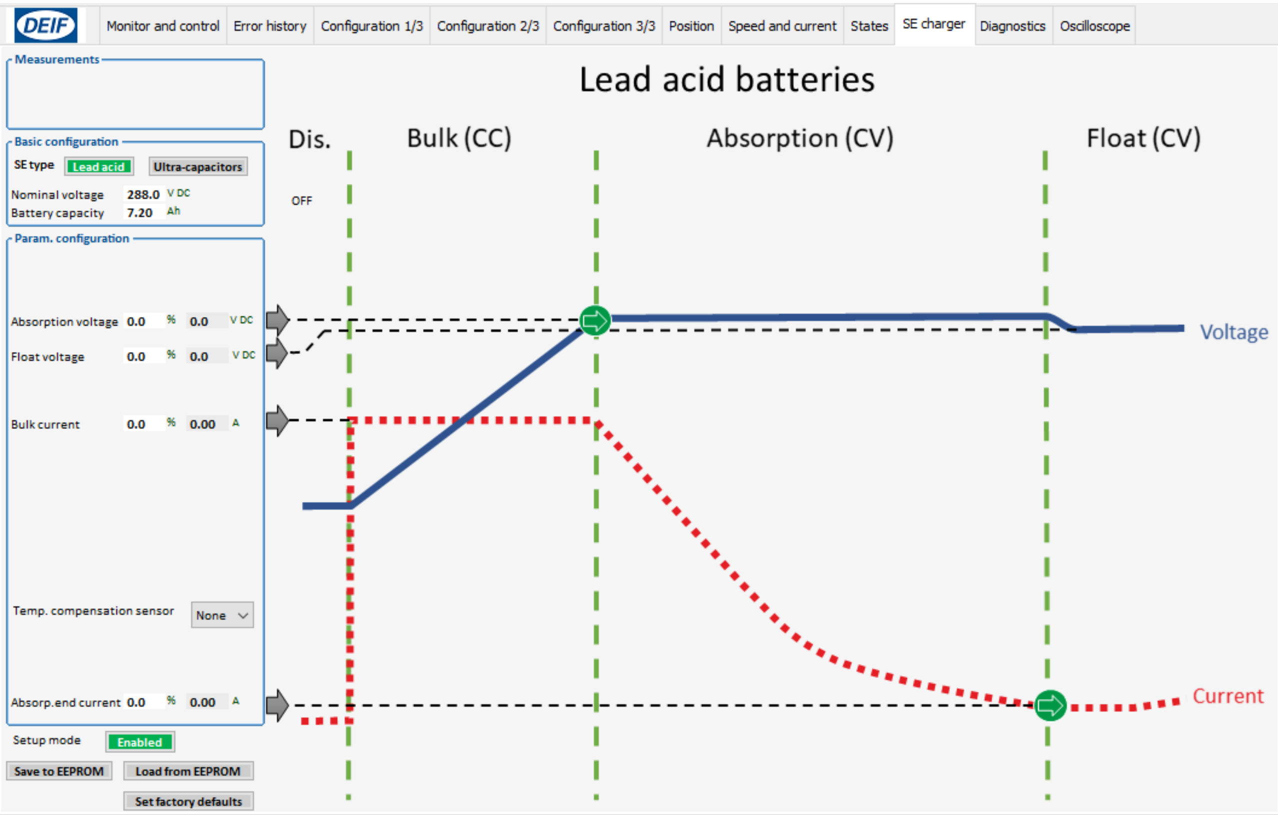


NOTE Resolution in any current setting is 10 mA. This applies to all current charge values. If this or any resulting current is above 5 A, the charger will use 5 A.

5. According to the selected SE type, go to the applicable step:
    a. Lead acid: Section 8.7.3.2 on page 124
    b. Lithium Ion: Section 8.7.3.4 on page 127
    c. Ultra-capacitor: Section 8.7.3.3 on page 126

NOTE When entering a value in percent, the resulting voltage in Volt or current in Ampere, will be shown after hitting "Enter" or moving the cursor to another field. There is no restraint on the percentage values (may be above 100%).

8.7.3.2 Configuration of Lead acid SE type parameters:



Lead acid charging process:

- Bulk stage: Charging starts in Bulk stage with constant current (*Bulk current*). The Bulk stage continues until the voltage reaches *Absorption voltage*, and the charger goes to absorption stage.
- Absorption stage: Charging is done with constant voltage (*Absorption voltage*) until the current drops to *Absorp.end current*, and the charger goes to float stage.
- Float stage: This is the final stage. Charging is done with constant voltage (*Float voltage*).

1. Enter the "Absorption voltage" in percentage (with one decimal) of the "Nominal voltage":

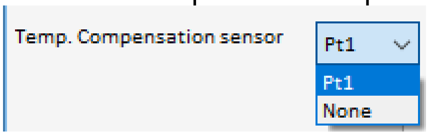
When the value of this parameter is reached, the charger goes from Bulk to Absorption stage, and keep charging with this value as constant voltage.

2. Enter the "Float voltage" in percentage (with one decimal) of the "Nominal voltage":
This voltage is used as constant voltage in the Float stage.

3. Enter the "Bulk current" in percentage (with one decimal) of the "Charge current":

This current is used as constant current in the Bulk stage.

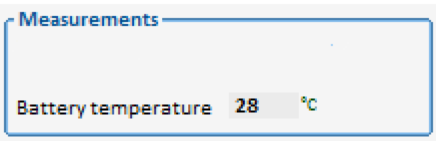
4. Select the temperature compensation sensor:

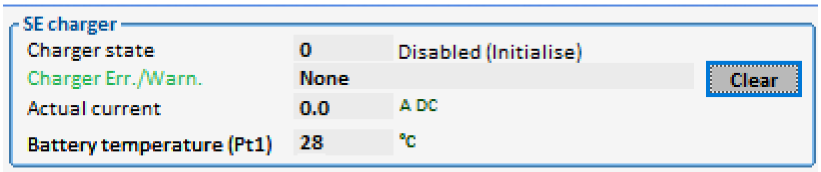


None: No temperature compensation.
Pt1: The charger compensates the voltage according to the battery temperature (+3 mV/cell/ºC when the temperature is below 25 ºC, and -3 mV/cell/ºC when the temperature is above 25 ºC). The number of cells is calculated from the nominal voltage. The compensated voltage is not indicated in the configured parameters on the left side.

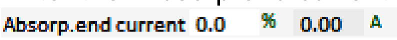
When a temperature sensor is selected, the charger will generate a warning if the battery temperature is below -30 ºC or above 60 ºC.

If a temperature sensor is selected, the temperature value is shown in both "Measurements" group in the "SE charger" tab, and in the "SE charger" group in the "Monitor and control" tab.



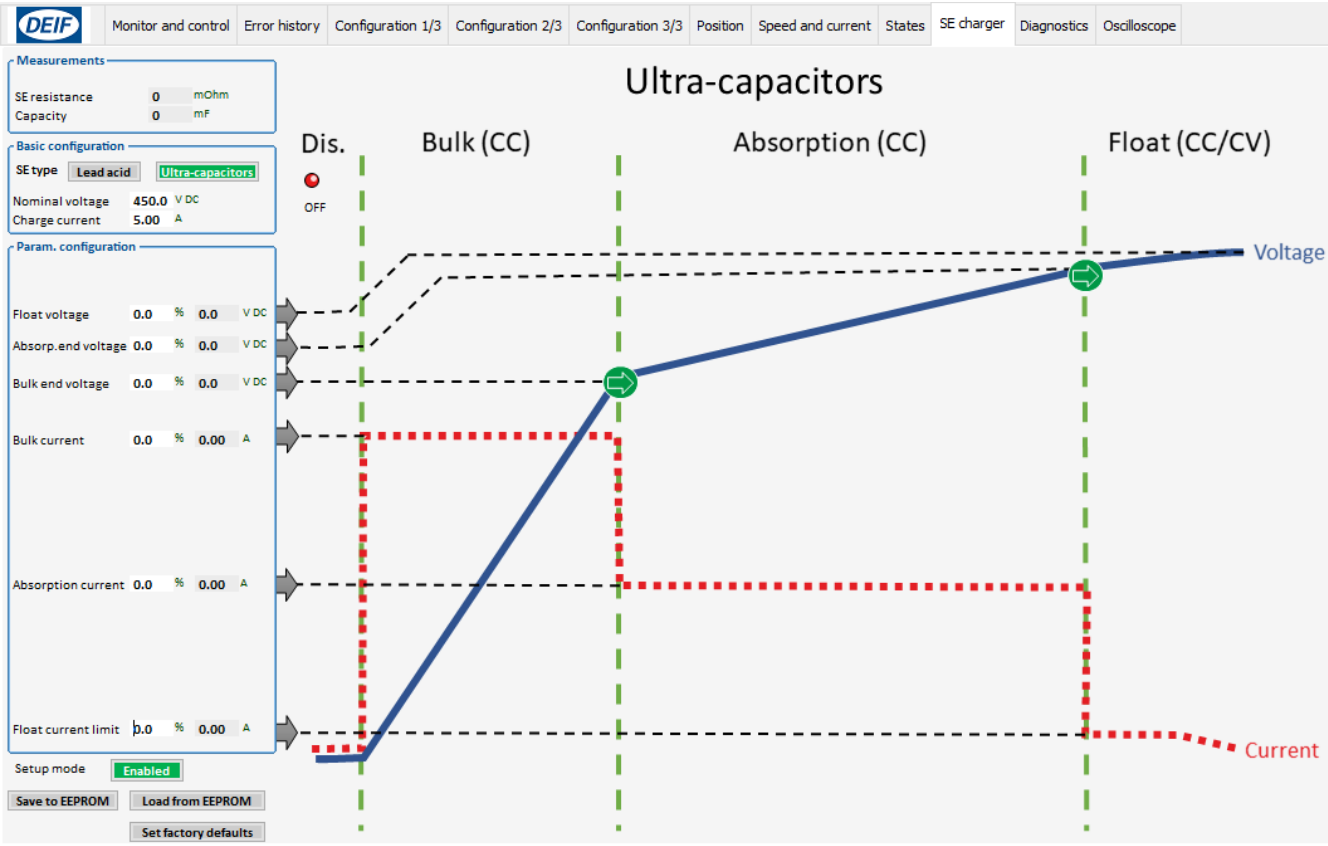


5. Enter the "Absorp.end current" in percentage (with one decimal) of the "Charge current":



When the value of this parameter is reached, the charger goes from Absorption to Float stage.

8.7.3.3 Configuration of Ultra-capacitor SE type parameters:



Ultra-capacitors charging process:

- Bulk stage: Charging starts in Bulk stage with constant current (*Bulk current*). The Bulk stage continues until the voltage reaches *End voltage*, and the charger goes to absorption stage.
- Absorption stage: Charging is done with constant current (*Absorption current*) until the voltage reaches *Absorp.end voltage*, and the charger goes to float stage.
- Float stage: This is the final stage. Charging is done with current limit (*Float current* limit) and voltage limit (*Float voltage*). The stage starts with *Float current limit* until the voltage reaches *Float voltage.* Charging is then continued with *Float voltage*.

1. Enter the "Float voltage" in percentage (with one decimal) of the "Nominal voltage":
   Float voltage 0.0 % 0.0 V DC
   This voltage is used as a voltage limit in the Float stage.
2. Enter the "Absorp. end voltage" in percentage (with one decimal) of the "Nominal voltage":
   Absorp.end voltage 0.0 % 0.0 V DC
   When the value of this parameter is reached, the charger goes from Absorption stage to Float stage.
3. Enter the "End voltage" in percentage (with one decimal) of the "Nominal voltage":
   End voltage 0.0 % 0.0 V DC
   When the value of this parameter is reached, the charger goes from Bulk to Absorption stage.
4. Enter the "Bulk current" in percentage (with one decimal) of the "Charge current":
   Bulk current 0.0 % 0.00 A
   This current is used as constant current in the Bulk stage.
5. Enter the "Absorption current" in percentage (with one decimal) of the "Charge current":
   Absorption current 0.0 % 0.00 A
   This current is used as constant current in the Absorption stage.

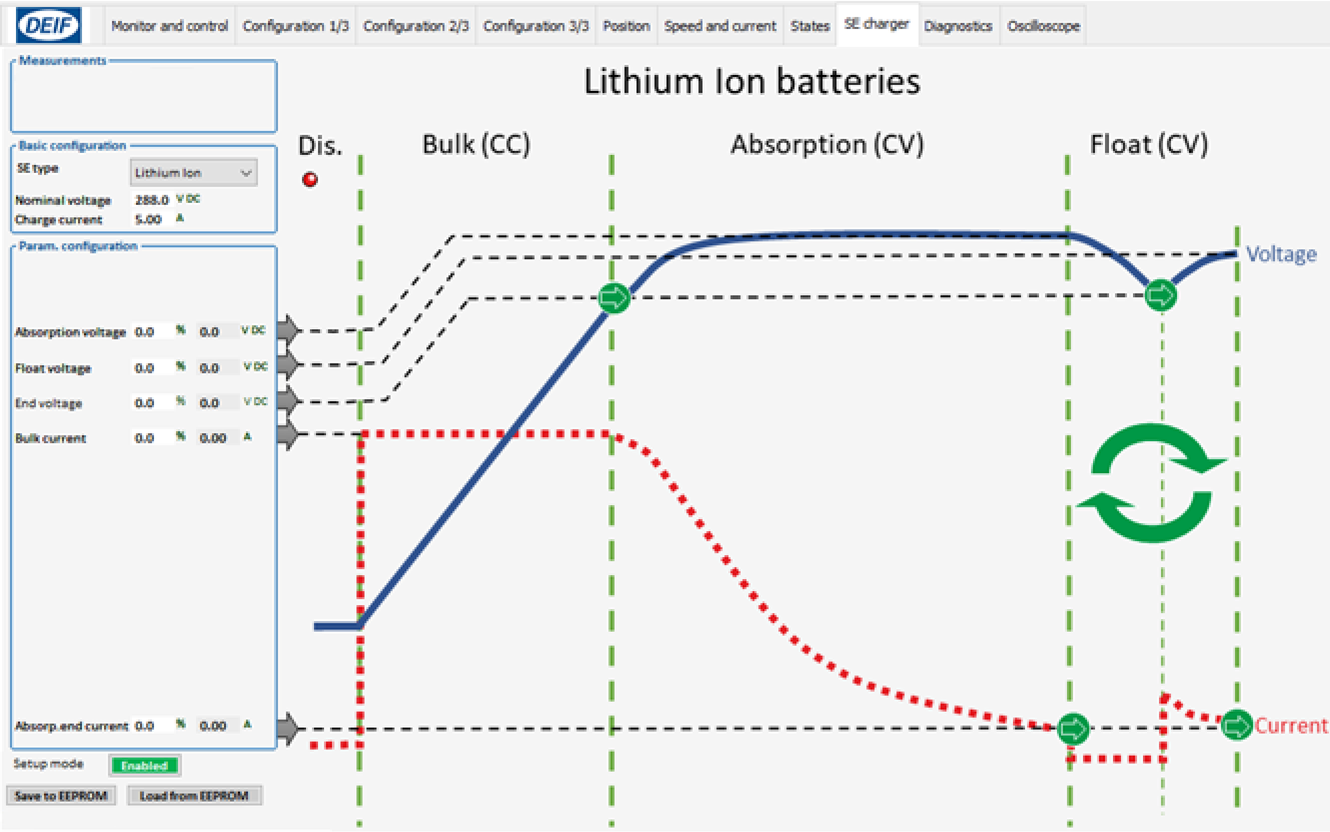
6. Enter the "Float current limit" in percentage (with one decimal) of the "Charge current":

   Float current limit 0.0 % 0.00 A

   This current is used as current limit in the float stage.

   NOTE Both voltage and current are limits in the Float stage. In the beginning of the stage the current limit is active until the voltage limit is reached, after which, the voltage limit will be active.

8.7.3.4 Configuration of Lithium Ion SE type parameters:



Lithium Ion charging process:

- Bulk stage: Charging starts in Bulk stage with constant current (*Bulk current*). The Bulk stage continues until the voltage reaches *End voltage*, and the charger goes to absorption stage.
- Absorption stage: Charging is done with constant voltage (*Absorption voltage*) until the current drops to *Absorp.end current*, and the charger goes to float stage.
- Float stage: This is the final stage. Charging is stopped until SE voltage drops to *End* voltage, that causes restart of charging with constant voltage (*Float voltage*). When the charge current drops to *Absorp.end current* the charging is stopped again. This cycle continues as long as the charger is in the float stage.

1. Enter the "Absorption voltage" in percentage (with one decimal) of the "Nominal voltage":

   Absorption voltage 0.0 % 0.0 V DC

   This value is used as constant voltage value during the Absorption stage.

2. Enter the "Float voltage" in percentage (with one decimal) of the "Nominal voltage":

   Float voltage 0.0 % 0.0 V DC

   This voltage is used as constant voltage in the Float stage. It is possible to use the same value as the "Absorption voltage".

3. Enter the “End voltage” in percentage (with one decimal) of the “Nominal voltage”:
   

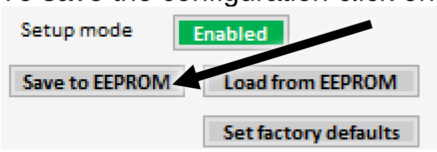
   When the value of this parameter is reached, the charger goes from Bulk to Absorption stage, as well as for transition from rest (no charge) to charge in the float stage.
4. Enter the “Bulk current” in percentage (with one decimal) of the “Charge current”:
   

   This current is used as constant current in the Bulk stage.
5. Enter the “Absorp. end current” in percentage (with one decimal) of the “Charge current”:
   

   When the value of this parameter is reached, the charger goes from Absorption to Float stage, as well as from charge to rest (no charge) in the float stage.

8.7.3.5 *Completing the configuration*

Perform one of the two:

- To start the charger with the configured parameters without saving to EEPROM:
  Click on “Setup mode” button (). The running configuration can be saved later.
- To save the configuration click on “Save to EEPROM” button:
  

9. Operational procedures

This section describes operational procedures which can be executed either by using the IMD Manager or the CAN/CANopen interface.

9.1 Brake test

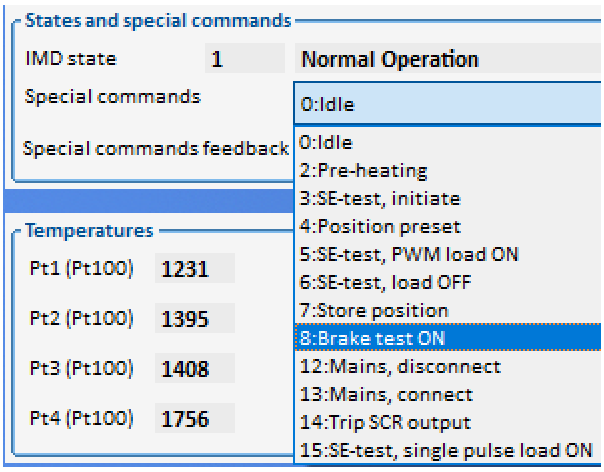
It is possible to manually test the brake output in order to verify that the brake is released and the motor can turn. Activating the brake test is done by using function 08 in the special commands.

9.1.1 Prerequisites

The IMD must be in Normal operation state, and the Device must be disabled (reg. 0x51 bit 2 = 1).

9.1.2 Activation

IMD Manager: Select “8:Brake test” in the “States and special commands” in the “Monitor and control” tab.



CAN/CANopen: send “8” to the special commands register (reg. 0x03)

The IMD changes state to 40 – “Brake test”, turns the brake output (X2) on, and changes the “Brake output” LED indication in the IMD Manager to on.

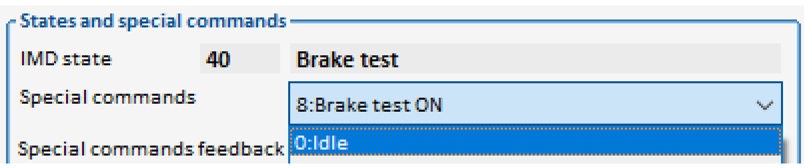
9.1.3 Operation

The IMD will remain in this state until “0” (Idle) is sent to special commands register (reg. 0x03).

It is not possible to use the “Enable dev.” button or enable the device through CAN while the IMD is in brake test.

9.1.4 Deactivation

IMD Manager: Select “0:Idle” in the “States and special commands” in the “Monitor and control” tab.



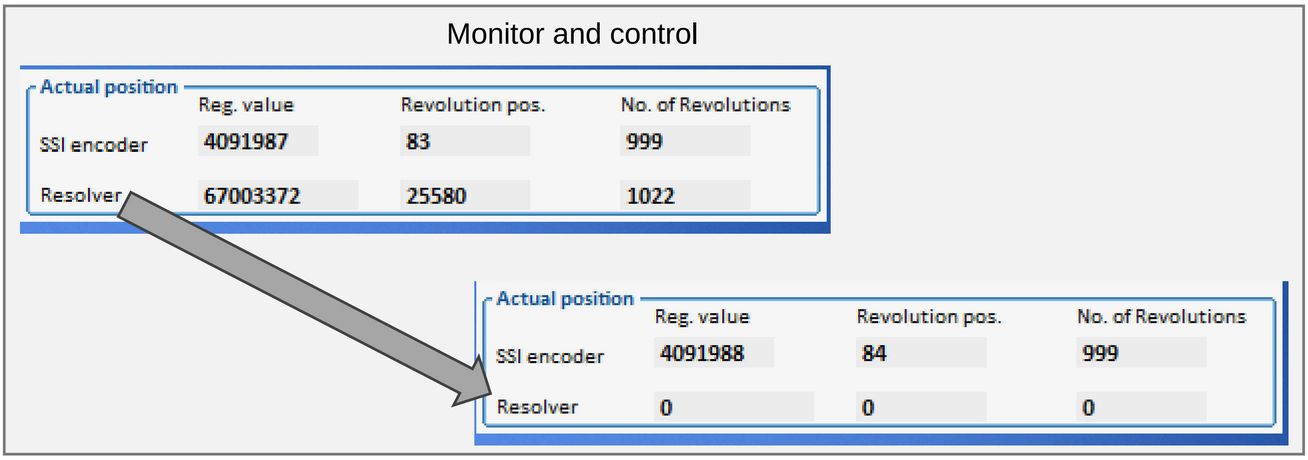
CAN/CANopen: send “0” to the special commands register (reg. 0x03).

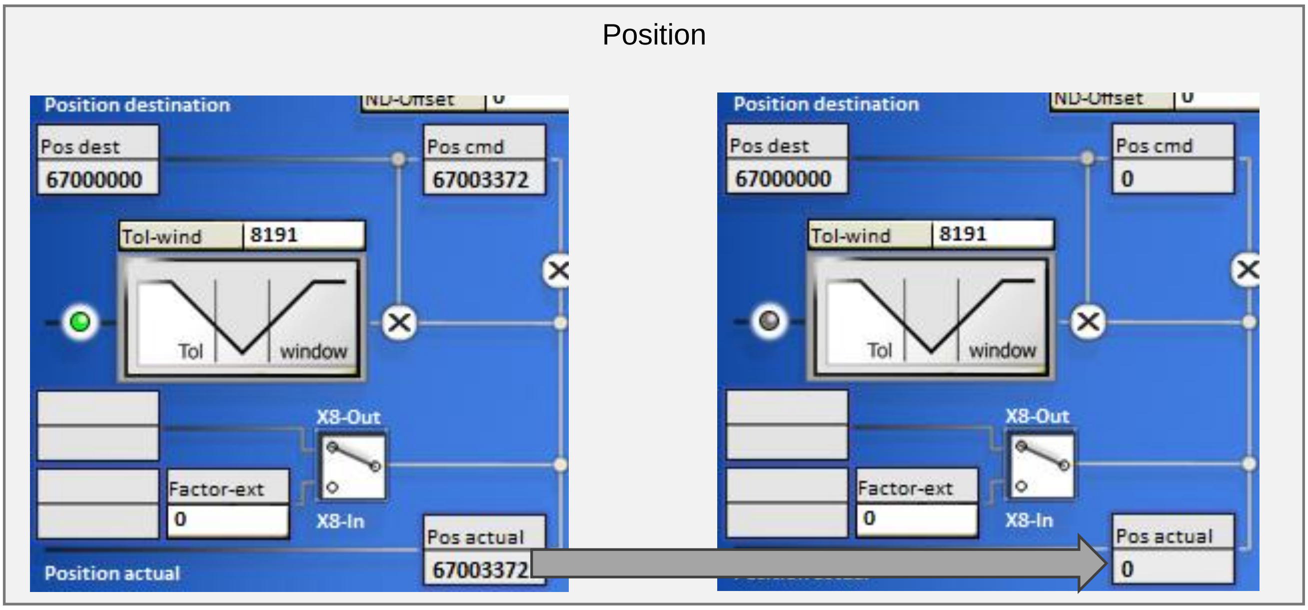
The IMD goes back to “Normal operation” state, turns the brake output (X2) off, and changes the “Brake output” LED indication in the IMD Manager to off.

9.2 Changing actual position value (Pos. preset)

It is possible to change the value of the actual position value. The position is a 32 bits value where the low 16 bits indicates the position of the motor within one revolution. The high 16 bits indicates the number of revolutions. This function is normally used to reset the revolution counter to zero, when using speed profile for safety run, or calibrating zero revolutions for use with the Virtual limit switches (VLMS).

The following figure shows how the actual position is changed when the position is changed to zero (in both “Position” and “Monitor and control” tabs):



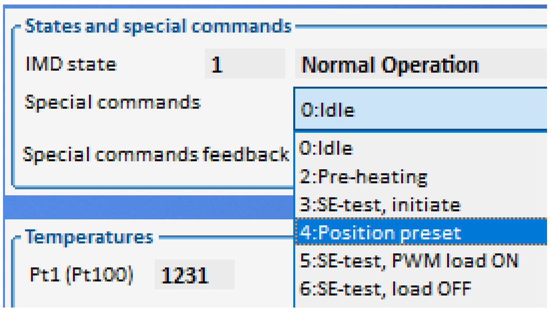


9.2.1 Prerequisites

The IMD must be in Normal operation state, and the Device must be disabled (Reg. 0x51 bit 2 = 1).

9.2.2 Activation

IMD Manager: Select “4: Pos. preset” in the “States and special commands” in the “Monitor and control” tab.



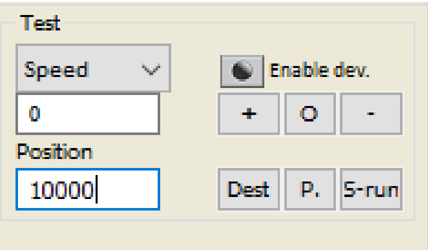
CAN/CANopen: send “4” to the special commands register (Reg. 0x03)

The IMD changes to state 35 – “Pos. preset”.

9.2.3 Operation

It is now possible to change the actual position value.

IMD Manager: Enter the desired value in the “Position” field. The value must be a 32 bits value which can be entered in decimals (max 4294967295) or Hexadecimals (max 0xFFFFFFFF).

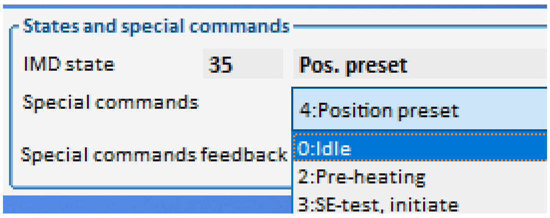


1. Click on the “P.” button
2. The new value is now used as actual position.

CAN/CANopen: write the desired value to 0x7A

9.2.4 Deactivation

IMD Manager: Select “0:Idle” in the “States and special commands” in the “Monitor and control” tab.



CAN/CANopen: send “0” to the special commands register (Reg. 0x03). The IMD goes back to “Normal operation” state.

9.3 Disconnecting AC mains from DC-link (Mains, disconnect)

It is possible to disconnect the AC mains supply from the DC-link internally in the IMD (it has no effect on safe energy).

Info

This function is not supported in IMD 100 A version

Attention

After executing “Mains, disconnect” command, safe energy is the only power source until “Mains, connect” command is executed.

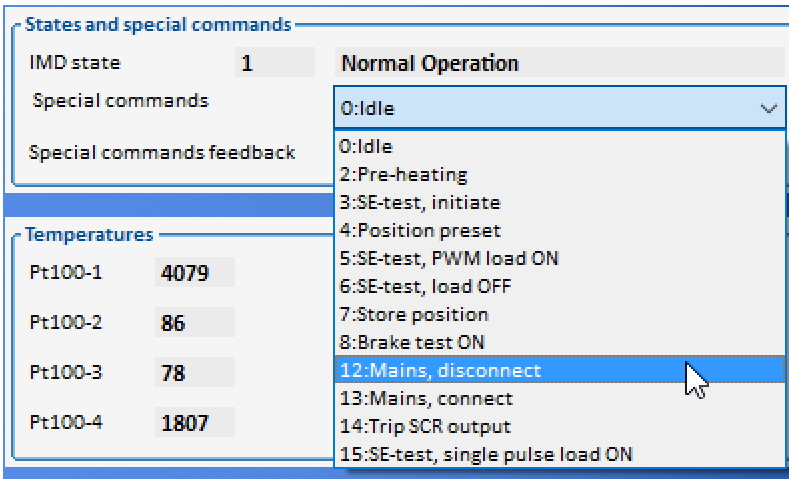
“Mains, disconnect” also cancels the LVRT timer if it is active.

9.3.1 Prerequisites

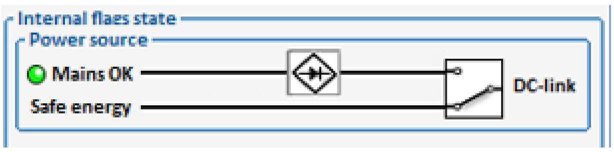
- SE Vlow warning is not active

9.3.2 Activation

IMD Manager: Select “12:Mains, disconnect” in the “States and special commands” in the “Monitor and control” tab.



The indication in the “Power source” group in the “Monitor” tab will change to show that the Mains is the energy source of the DC-link (will also change if the command is executed through CAN/CANopen):



CAN/CANopen: send “`12`” to the special commands register (reg. 0x03)

The IMD remains in state 1 – “Normal operation” and disconnects the AC mains from the DC-link. The flag “Mains, disconnect” changes from 0 to 1.

9.3.3 Operation

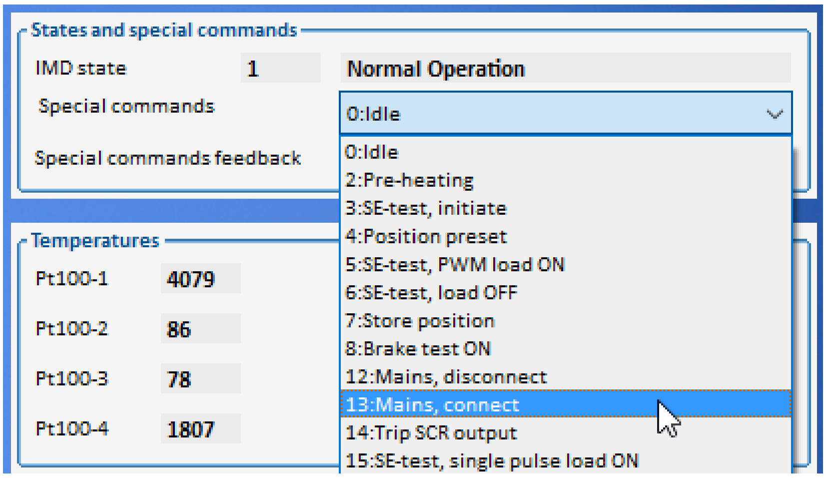
After the “Mains, disconnect” command is executed, the Mains stays disconnected, and the IMD is using the safe energy. The IMD will not reconnect the mains automatically unless a safety run is performed, and the DC-link voltage is below DC-link Vlow.

Sending “0” to the special commands register (reg. 0x03) will not reconnect the AC mains supply to the DC-link.

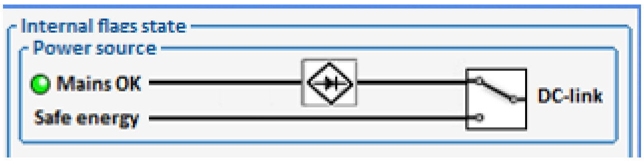
9.3.4 Deactivation

NOTE The Mains must be in OK state to be able to reconnect the Mains.

IMD Manager: select “13:Mains, connect” in the “States and special commands” in the “Monitor and control” tab.



The indication in the “Power source” group in the “Monitor” tab will change to show that the Mains is the energy source of the DC-link (will also change if the command is executed through CAN/CANopen):



CAN/CANopen: send “13” to the special commands register (reg. 0x03). The IMD reconnects the AC mains to the DC-link. The flag “Mains, disconnect” changes from 1 to 0.

9.4 Enabling the power module

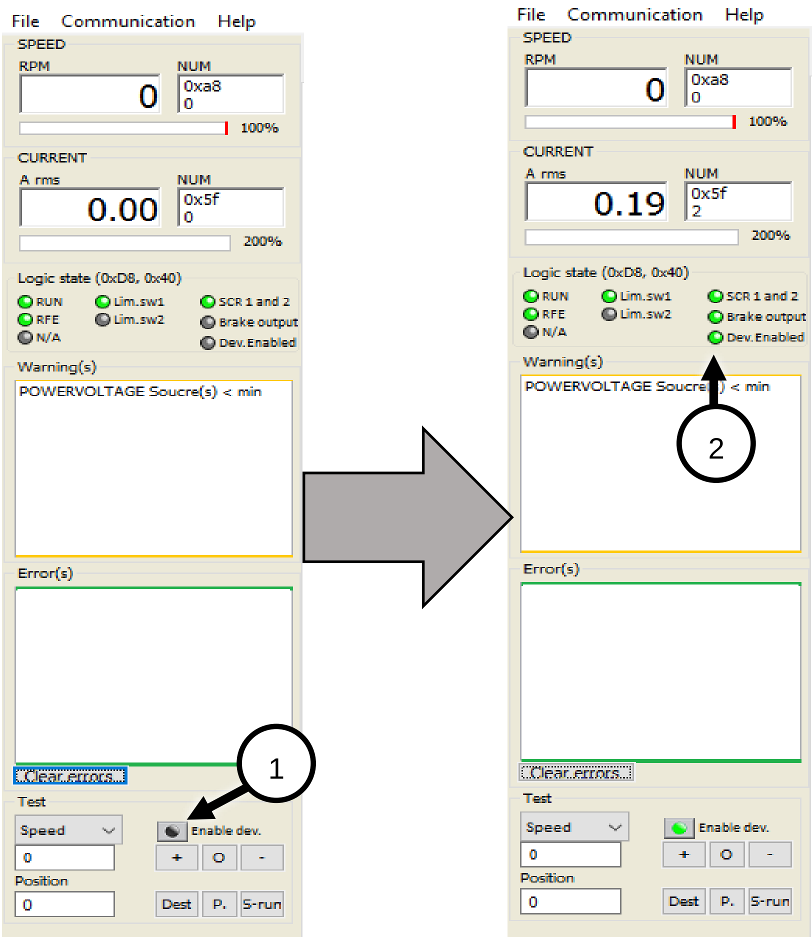
The power module (IGBT) requires several signals to be enabled.

- HW inputs:
  - RFE (X9-1) digital input must be high
  - RUN (X9-2) digital input must be high
- SW control:
  - “Enable off” bit (bit 2) in register 0x51 must be set to zero in one of the following ways:
    - Writing zero in the register

- Clicking on the “Enable dev.” button in the IMD Manager (pos.1),
- Sending CANopen command “not enable off” (the register value is inverted).

The state of this bit can be monitored by the “Enable dev.” LED in the IMD Manager or by reading register 0x51. Note that this bit is inverted:
Enable off = 0: device is enabled
Enabled off = 1: device is disabled

The state of the power module can be monitored by the “Dev.Enabled” LED in the IMD Manager (pos.2):



If the IMD is waiting for a safety-chain reset, (for example after the input in one of the SCI inputs was cycled) the following actions must be performed in this order to get the IMD back to normal operation:

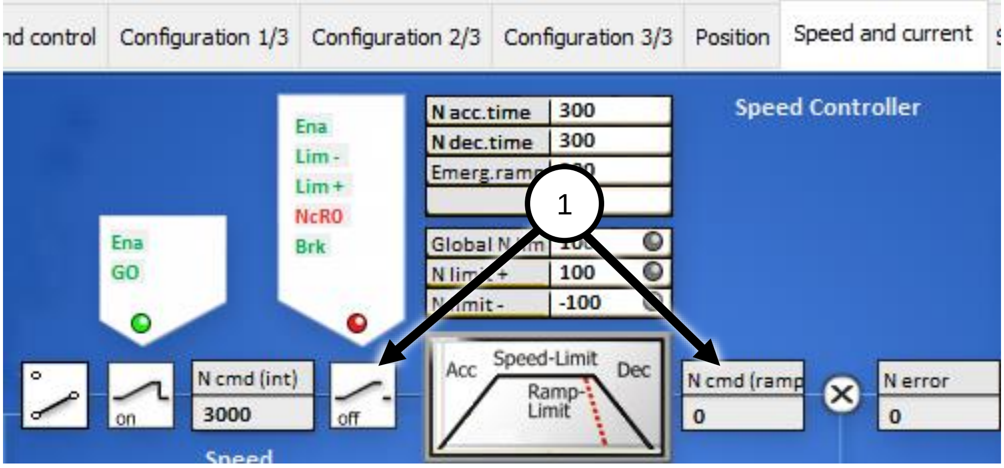
1. Any errors must be cleared (error removed and cleared)
2. Cycle safety-chain inputs
6. Reset “Enable off” bit

Timing: After the RUN input has gone high, a 5 ms delay must pass before command values can be sent to the drive.

The “Enable off” bit can also be reset automatically at start-up if no limit switch is activated. See auto safety-run at start-up in section 8.4.3 on page 95.

9.5 Forcing speed zero

It is possible to force the speed controller (it will have the same effect on torque) by using a logical input or a CAN command that sets the NcR0 bit. When the NcR0 bit is set, the switch to the speed ramp is set to Off, and the N cmd (ramp) is set to zero. This function has no effect on the N cmd (int) and it is still possible to change the value of N cmd (int). As long as this function is enabled (NcR0) the motor is held in position by the IMD.



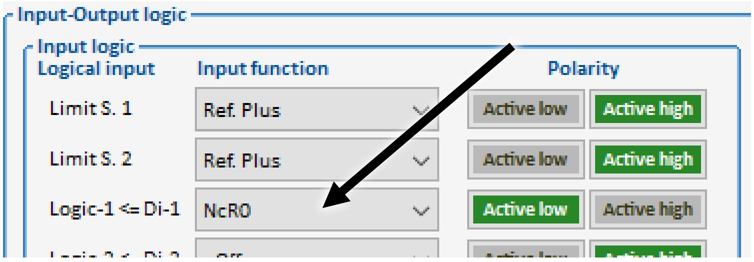
9.5.1 Prerequisites

The IMD must be in state 1 (Normal operation).

9.5.2 Activation

HW input:

1. Connect the wire to either Di-1 or Di-2 terminals.
2. In the IMD Manager "Configuration 1/3", set the logical input for the connected terminal to NcR0:



7. Select the polarity (active low or active high) depending on the source.

IMD Manager: Do the same as for HW input. Set the NcR0 on by changing the polarity.

CAN/CANopen: Set bit 1 in the Device mode register (Reg. 0x51, bit 1 = 1)

9.5.3 Operation

See description in the beginning of section 9.5 on page 134.

9.5.4 Deactivation

HW input: the NcR0 will be deactivated when the polarity is changed to the not active polarity.

IMD Manager: Change the polarity, or set the Input function of the logic input to –Off–.

CAN/CANopen: Reset bit 1 in the Device mode register (Reg. 0x51, bit 1 = 0)

Info

Logical input must be in inactive or Off, AND bit 1 in register 0x51 must be zero in order to disable NcR0.

9.6 Manual operation

It is possible to control the motor manually using digital inputs 10, 11, and 12 for service purposes. These inputs are intended to be connected to three switches in the pitch cabinet, and can be used with practically no regards to the logical state of the IMD. If VLMS are used, it is not possible to pitch past them in this mode. See section 9.7 on page 138 for pitching past the VLMS.

During manual operation the position is stored by the IMD every time the motor and brake output are deactivated.

If a “Bus timeout” error is active when the manual operation is activated, the error is reset.

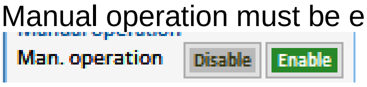
There are two main manual operation modes depending on the configuration of Reg. 0x01 bit 23 (SCI state):

- Reg. 0x01 bit 23 (SCI state) set to OK: manual operation depends entirely on the digital inputs 10, 11, and 12. When going out of the mode, the IMD always goes to normal operation state (1).
- Reg. 0x01 bit 23 (SCI state) set to Not OK: manual operation dependent on both digital inputs 10, 11, and 12 and special commands. When going out of the mode, the IMD always performs a safety run.

9.6.1 Reg. 0x01 bit 23 (SCI state) set to OK

9.6.1.1 Prerequisites

- Manual operation must be enabled in the configuration (0x01, bit 30 =1).



- SCI state for manual operation must be set to OK (0x01, bit 23 =0).

- Three switches must be connected to Digital inputs 10, 11 and 12 and 24 V DC (see section 5.5.1 on page 47).
- The IMD must be in one of the states that allow entry to manual operation (have manual operation as condition to proceed, see Table 6 on page 57). The safety chain must be in OK state.

9.6.1.2 Activation

The IMD is brought into manual operation mode by activating DI 12 (high) following by either DI 11 or DI 10 (rising edge).

9.6.1.3 Operation

While in manual operation mode only activating DI 10 or DI 11 will move the motor (D10: “-“ direction, D11: “+” direction). The configuration parameters for manual operation will be used.

If either RUN or RFE inputs are low, or the SCI, input changes state, the output to the motor will be disabled.

If Virtual limit switches (VLMS) are used, the motor stops (normal stop) when the number of revolutions defined in the VLMS is reached. It is than only possible to move the motor the other way (In the direction of where it came from).

No automatic actions (such as safety run) will be performed while in manual operation mode.

9.6.1.4 Deactivation

Deactivate DI 12 (low), the IMD performs a safety run.

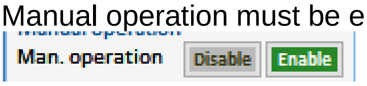
9.6.2 Reg. 0x01 bit 23 (SCI state) set to Not OK (safety chain tripped)

If CAN/CANopen connection is not active (not connected or communication error) the manual operation will behave as described in section 9.6.1 on page 136 (activation, operation and deactivation), except for the following:

- SCI state must be Not OK
- On exit from manual mode the IMD performs a safety run
- Activating DI 12 if the SCI state is OK stops any motor movement
- Operation mode 360 is automatically enabled (0x01 bit 22=1) if DI 9 is activated
- DI10 and DI 11 are always enabled

9.6.2.1 Prerequisites

- Manual operation must be enabled in the configuration (0x01, bit 30 =1).



- SCI state for manual operation must be set to Not OK (0x01, bit 23 =1).

- Three switches must be connected to Digital inputs 10, 11 and 12 and 24 V DC (see section 5.5.1 on page 47).
- The IMD must be in one of the states that allow entry to manual operation (have manual operation as condition to proceed, see Table 6 on page 57). The safety chain must be in OK state.

9.6.2.2 Activation

The IMD is brought into manual operation mode by activating DI 12 (high). Any motor movement is stopped.

9.6.2.3 Operation

While in manual operation mode only activating DI 10 or DI 11 will move the motor (D10: "-" direction, D11: "+" direction). It is possible to disable/enable the function of DI 10 and DI 11 by sending (CAN/CANopen) a value to the special commands register (0x03):

Value (dec.)	Description
26	DI 10 and DI 11 are disabled, activating them does not move the motor
27	DI 10 and DI 11 are enabled, activating them moves the motor as described above

The configuration parameters for manual operation will be used.

If either RUN or RFE inputs are low, or the SCI, input changes state, the output to the motor will be disabled.

If Virtual limit switches (VLMS) are used, the motor stops (normal stop) when the number of revolutions defined in the VLMS is reached. It is than only possible to move the motor the other way (In the direction of where it came from).

No automatic actions (such as safety run) will be performed while in manual operation mode.

9.6.2.4 Deactivation

Deactivate DI 12 (low).

If the SCI state is configured to OK, the IMD always goes to normal operation state.

If the SCI state is configured to Not OK, the IMD performs a safety run.

9.7 Manual operation 360

Manual operation 360 is the same as manual operation except that VLMSs are ignored, and the motor keeps moving past the VLMS.

9.7.1 Prerequisites

- The IMD is in manual operation mode
- Reg. 0x01 bit 22 (Manual operation 360) must be enabled (1). This can be done either by configuration using the IMD Manager, or by sending (CAN/CANopen) a value to the special commands register (0x03):

Value (dec.)	Description
23	Manual operation 360 is enabled (0x01 bit 22=1)
24	Manual operation 360 is disabled (0x01 bit 22=0)

9.7.2 Activation

The IMD is brought into manual operation 360 mode by activating DI 9 (high).

9.7.3 Operation

The VLMS are ignored.

9.7.4 Deactivation

Deactivate (low) DI 9 to go back to “Manual mode”.

Deactivate (low) DI 12. To go back to normal operation state or perform a safety run (depending on the SCI state configuration). If DI 12 is deactivated the state of DI 9 does not matter.

9.8 Manually activating the fan

It is possible to activate the fan manually by using function 17 in the special commands.

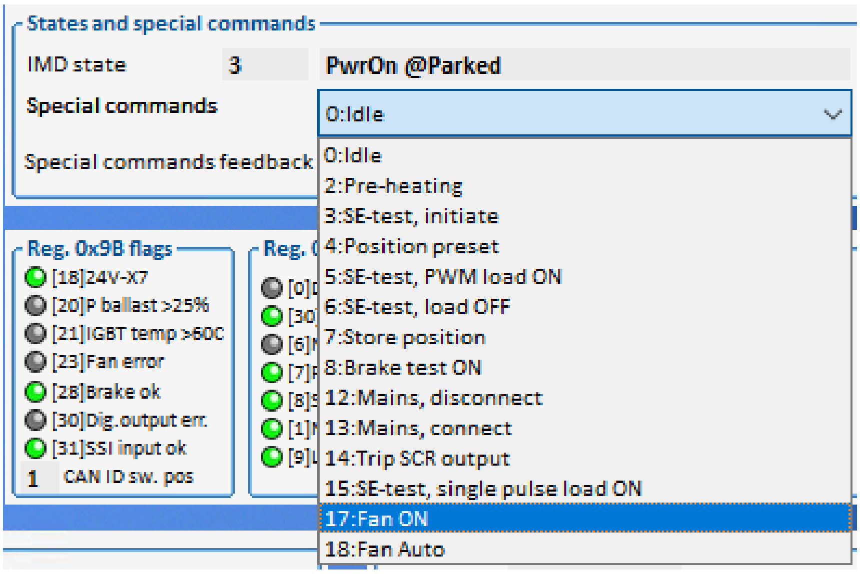
Info
This function is not supported on IMD 122 A and IMD 122 B.

9.8.1 Prerequisites

None.

9.8.2 Activation

IMD Manager: Select “17:Fan ON” in the “States and special commands” in the “Monitor and control” tab.



CAN/CANopen: send “17” to the special commands register (reg. 0x03)

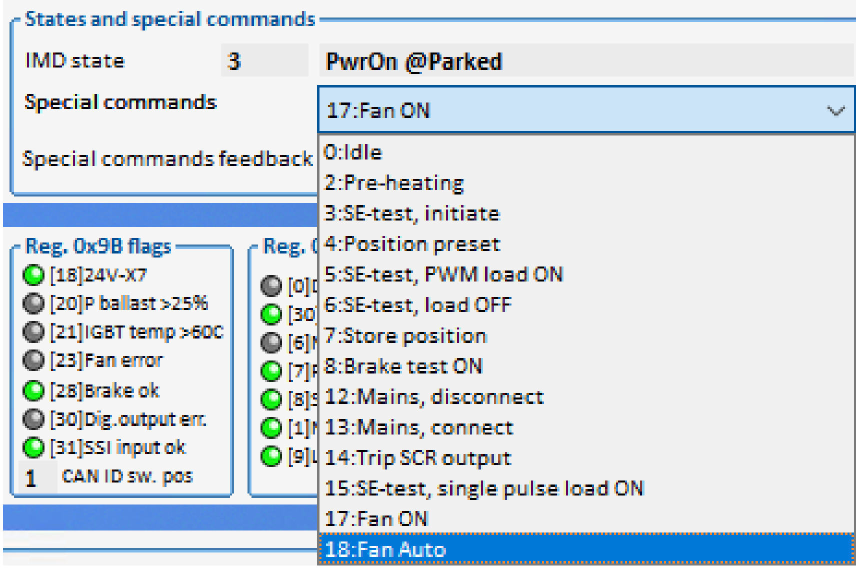
The IMD will turn on the fan.

9.8.3 Operation

The fan remains ON until special command 18 is sent to the IMD.

9.8.4 Deactivation

IMD Manager: Select “18:Fan Auto” in the “States and special commands” in the “Monitor and control” tab.



CAN/CANopen: send “`18`” to the special commands register (reg. 0x03).

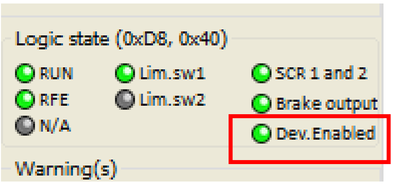
The fan will be back to in automatic control.

9.9 Manually initiating a Safety run

A safety run can be initiated manually either through CAN/CANopen command, or from the IMD Manager.

9.9.1 Prerequisites

If in Normal operation state, the drive must be enabled.



Note: Manual safety run can also be initiated while in states 3 (PwrOn @Parked), 4 (PwrOn not parked), or 5 (PwrOn not parked cold) where it only requires that the RUN input is high.

9.9.2 Activation

IMD Manager: Click on the “S-run” button in the quick access area.

CAN/CANopen: send “`1`” to the “start safety run” register (Reg. 0x78)

The IMD will change to state 19 (Safety run setup) and start a safety run.

9.9.3 Operation

N/A

9.9.4 Deactivation

Once initiated, a safety run cannot be deactivated. It stops only by activation of a limit switch, or timeout.

9.10 Normal operation

Normal operation is the state where the IMD controls the motor under normal conditions.

9.10.1 Prerequisites

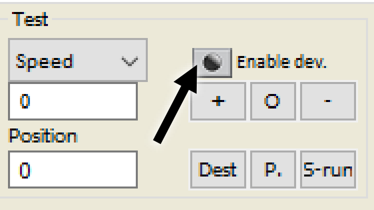
The IMD must be in either Start up at park (3) or Parked ready (17) states.

RFE and RUN inputs (X9, terminals 1 and 2) must be high.

Safety chain inputs must be OK.

9.10.2 Activation

IMD Manager: Click on the “Enable dev.” button:



CAN/CANopen: changes the “Enable dev.” (reg. 0x51 bit 2) to “0” (on).

9.10.3 Operation

While in normal operation mode, is possible to disable and enable the drive by SW (reg. 0x51 bit 2), or HW (RUN input, X9-terminal 2). Both SW and HW must be enabled in order to enable the drive.

When the drive is disabled, the output to the motor goes to zero, and the brake output is deactivated (+24 off). The “Dev. Enabled” and “GO” flags are set to zero.

9.10.4 Deactivation

Only errors and special commands will take the IMD out of the normal operation mode.

9.11 Pre-heating the motor

Activating the pre-heat function is done by using function 02 in the special functions.

9.11.1 Prerequisites

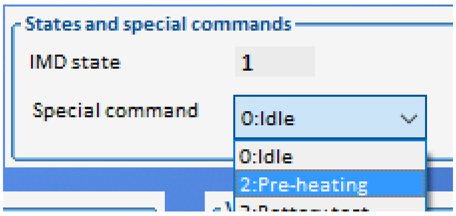
The Device must be disabled (reg. 0x51 bit 2 = 1).

The IMD must be in one of the following states:

- Normal operation (1)
- PwrOn@Parked
- PwrOn not Parked
- Parked ready

9.11.2 Activation

IMD Manager: Select “2:Pre-heating” in the “States and special commands” in the “Monitor and control” tab.



CAN/CANopen: send “2” to the special commands register (reg. 0x03)

The IMD changes state to 32 – “Pre-heating on” and changes the “Dev. Enable” LED indication in the IMD Manager to on.

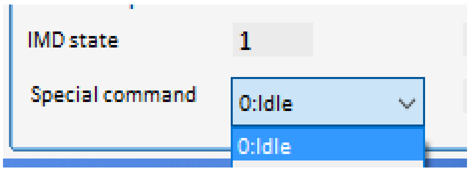
9.11.3 Operation

The IMD will remain in this state and pre-heat the motor until “0” (Idle) is sent to special commands register (reg. 0x03).

If the “Enable dev.” button is changed to off, the IMD goes to state 42 (Pre-heating warning), and stays in this state until the heating is deactivated. While in this state, the heating cannot be activated again.

9.11.4 Deactivation

IMD Manager: Select “0:Idle” in the “States and special commands” in the “Monitor and control” tab.



CAN/CANopen: send “0” to the special commands register (reg. 0x03). The IMD goes back to “Normal operation” state and the “Dev. enable” is changed to off.

9.12 Restarting the IMD (by communication)

It is possible to restart the IMD by sending special commands combination. This feature only applies to IMD 122 C or later.

Attention

This function should not be used unless absolutely necessary.

When used:

- The output to the motor and the brake is stopped immediately (also if in safety run) and the motor is coasting out, only stopped by the motor's brake.
- All outputs are reset.
- Protective actions such as "Mains, disconnect" are reset.

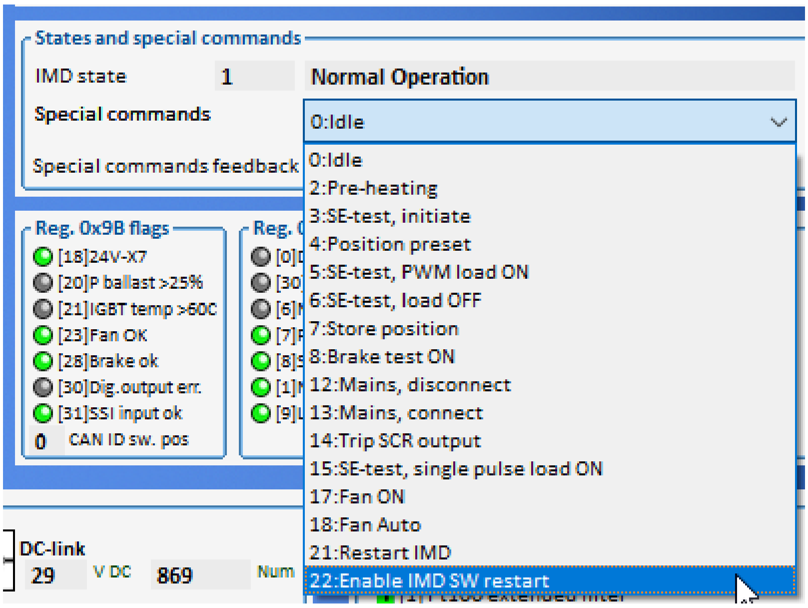
9.12.1 Prerequisites

- None

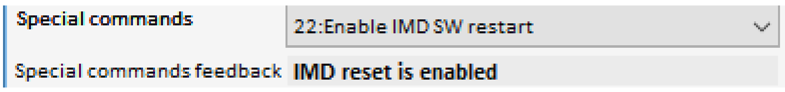
9.12.2 Activation

IMD Manager:

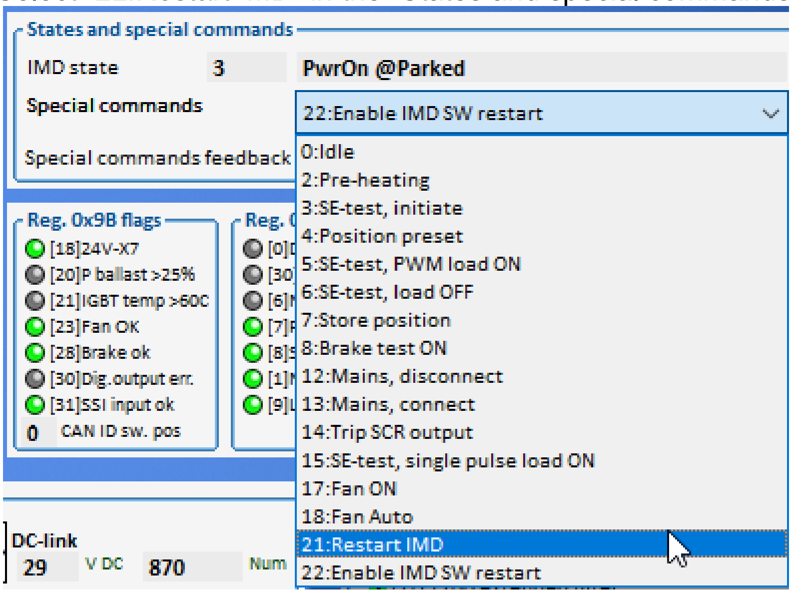
1. Select "22:Enable IMD restart" in the "States and special commands" in the "Monitor and control" tab:



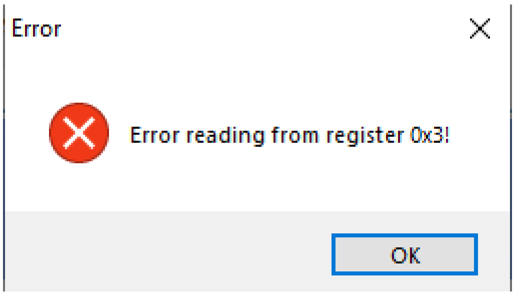
Special commands feedback shows:



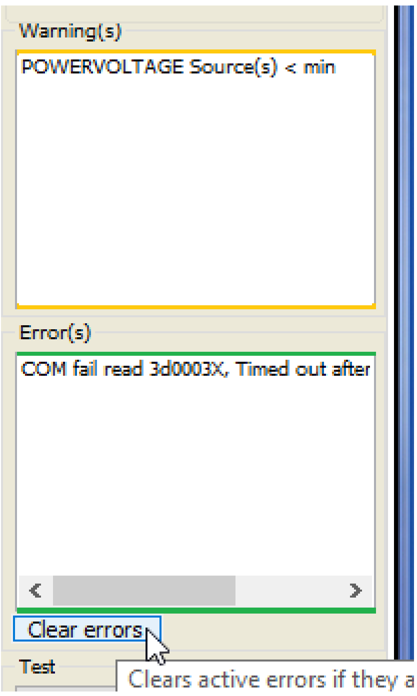
2. Select “21:Restart IMD” in the “States and special commands” in the “Monitor and control” tab:



The IMD Manager will show an error dialog box. Click “OK”:



3. The IMD Manager show a (green) communication error. Click on the “Clear errors” button to clear the communication error.



CAN/CANopen:

1. Send "`22`" to the special commands register (reg. 0x03)
2. Send "`21`" to the special commands register (reg. 0x03)

9.12.3 Operation

N/A

9.12.4 Deactivation

N/A

9.13 Safe energy (ultra-capacitors only) discharging

It is possible to discharge ultra-capacitors for service purposes. Discharging is done using the ballast resistor to discharge the capacitors.

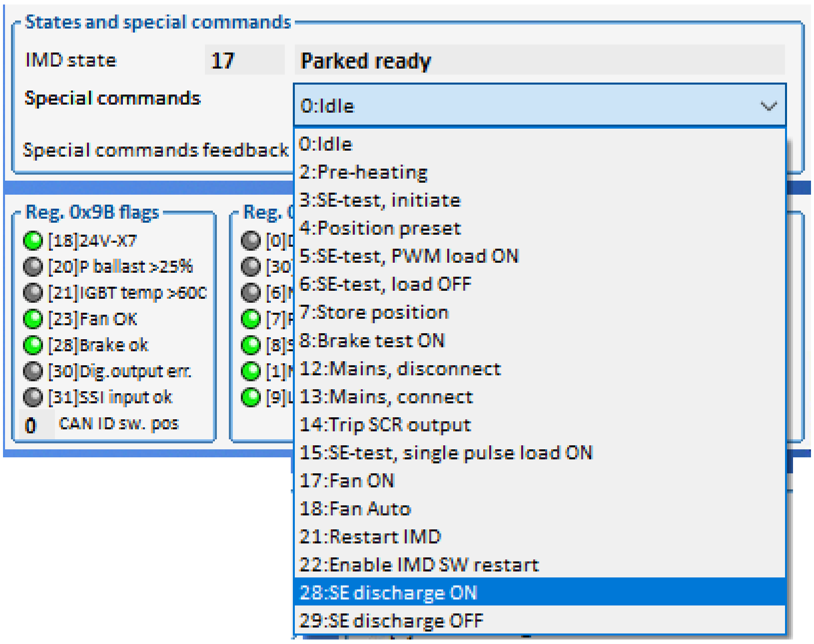
9.13.1 Prerequisites

The IMD must be in one of the following states:

- SCR tripped (10)
- Parked tripped (16)
- Parked ready (17)
- Safety run timeout (18)
- Manual operation (59)

9.13.2 Activation

IMD Manager: Select "28:SE discharge ON" in the "States and special commands" group in the "Monitor and control" tab:

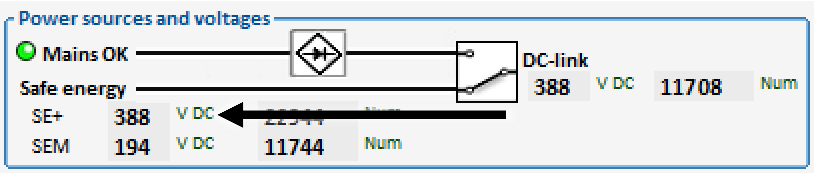


CAN/CANopen: send "`28`" to the special commands register (reg. 0x03).

9.13.3 Operation

When starting the discharge, the IMD disconnect the mains from the DC-link ("Mains, disconnect"), and turn the fan on. The discharge operation does not change the IMD state.

The Actual SE voltage can be monitored continuously in the IMD manger:

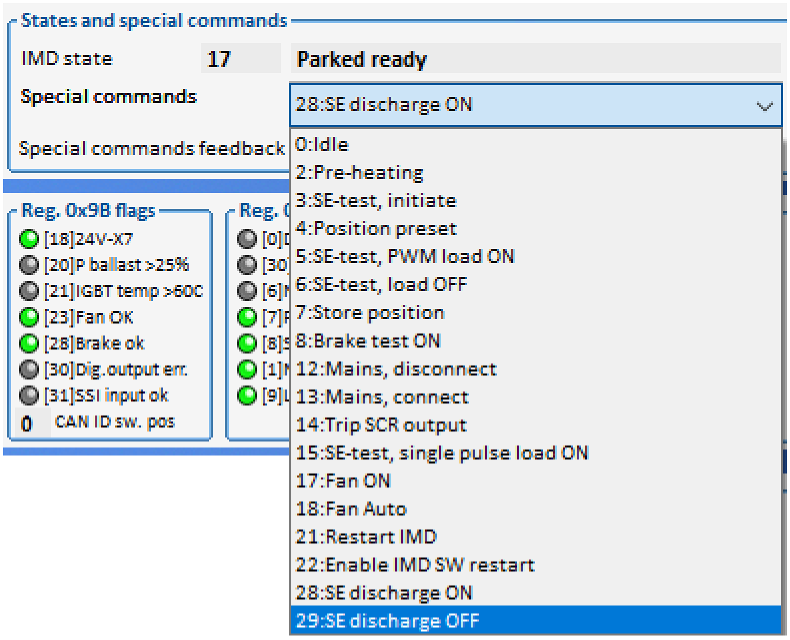


Discharging fully loaded capacitors can take some time. To calculate the approximate time full discharge will take use the following formula:

Formula: $t = \frac{0.5 * C * U^2}{Pb * 0.75}$	t: Total approximate discharge time (to zero) in s C: Total SE capacity in F U: DC-link/SE voltage in V Pb: Ballast resistor rated power in W
Example: $t = \frac{0.5 * 2 * 450^2}{300 * 0.75} = 900s$	C: 2 F U: 450 V Pb: 300 W

9.13.4 Deactivation

IMD Manager: Select "29:SE discharge OFF" or "0: Idle" in the "States and special commands" group in the "Monitor and control" tab:



CAN/CANopen: send "`29`" to the special commands register (reg. 0x03).

The remaining voltage on the capacitors depends on the way the discharge stopped:

- If the discharge is stopped due to missing 24 VDC, the remaining voltage across the ultra-capacitors is approximately 100 V DC.

  NOTE Mains voltage applied on the Mains input, ensures that the internal 24 V DC power supply is functioning, even though the grid is off.

- If the discharged is stopped by a command (“29:SE discharge OFF” or “0: Idle”), the remaining voltage across the ultra-capacitors depends on the capacity and charge level of the ultra-capacitors, discharge time, and the ballast resistor.

NOTE After deactivation the grid remains disconnected.

9.14 Tripping safety-chain outputs

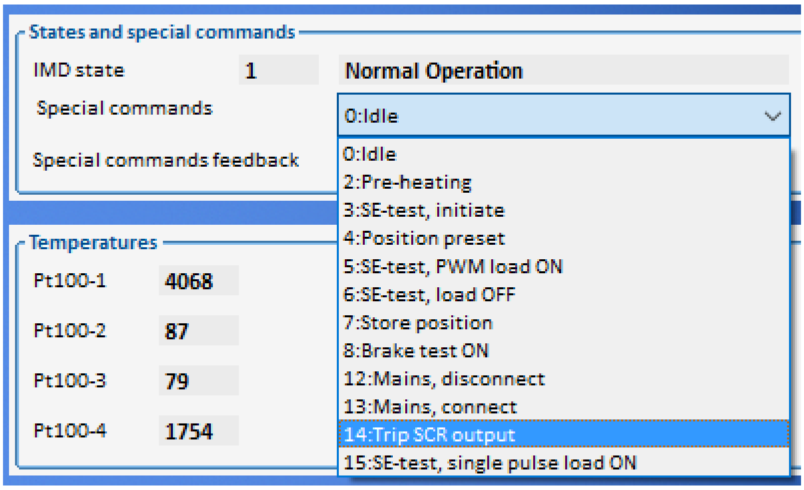
It is possible to trip the safety-chain outputs (SCR1 and SCR 2) manually, which can be used for example to trip the safety chain relay.

9.14.1 Prerequisites

There must be no active errors.

9.14.2 Activation

IMD Manager: Select “14:Trip SCR output” in the “States and special commands” in the “Monitor and control” tab.



CAN/CANopen: send “`14`” to the special commands register (reg. 0x03)

The IMD will trip SCR 1 and SCR 2, and depending on the state it is in, change the state.

9.14.3 Operation

N/A

9.14.4 Deactivation

N/A

9.15 Turning the power to the IMD on

Ensure that all connections to the IMD are made.

Attention
If the safe energy was disconnected from the SE terminals, the mains supply must be turned on before the safe energy is turned on.

1. Switch the supply to X1.MAINS on
2. If there is a separate supply to X7.24V switch it on (can also be turned on at the same time as Mains supply)
3. Switch the supply to X1.SAFE ENERGY on

9.16 Updating Firmware

There are two ways to update the firmware (FW) of the IMD:

1. **Update through the "Service" USB connector:** mainly used in production, service and lab.
2. **Update through CANopen:** mainly used in cases when updating remotely, thus eliminating the need for physical presence in the hub.

When updating through the Service USB connector, an internal bootloader initiated by setting the CAN ID switch to 15 and restarting the IMD is used to load the new firmware.

When updating through CANopen, a special bootloader must be loaded first through the Service connector (one time only), and is initiated when needed by a CANopen command.
Using CANopen update method requires development and implementation (by the customer) of update SW in the Pitch Motion Controller or the turbine's Main Controller.

It is also possible to load both CANopen bootloader and FW through the Service USB connector (the IMD is then prepared for FW update through CANopen in the future).

The full FW package contains different files which are used depending on the update method chosen (the bootloader will typically be released in a separated release package):

Table 23 FW packages and installation methods

Installation method	Files	Description
"Service" USB connector	• `IMD.out`	Only FW application is installed. Internal built-in bootloader is used for the installation. Programming mode (built-in bootloader) is initiated by setting CAN ID to 15 and restarting the IMD. NOTE If the `IMD.out` file is installed after the CANopen bootloader is installed, the bootloader will be erased and overwritten.
CANopen	• `IMD_Bootloader.out` • `CoU_IMD.crc`	In the first time, the bootloader (`IMD_Bootloader.out`) is installed through the "Service" USB connector, followed by FW application (`CoU_IMD.crc`) installation through CANopen. In later updates only the

Installation method	Files	Description
		FW application is installed through CANopen, using the already installed bootloader. The bootloader is initiated by a CAN command.
CANopen files through USB "service" connector	• `IMD_Bootloader.out` • `CoU_IMD.out`	This is an installation of CANopen files installed through the "Service" USB connector. It can be used to prepare the IMD for later CANopen FW updates. Programming mode (built-in bootloader) is initiated by setting CAN ID to 15 and restarting the IMD.

9.16.1 Updating firmware with the Service USB connector method

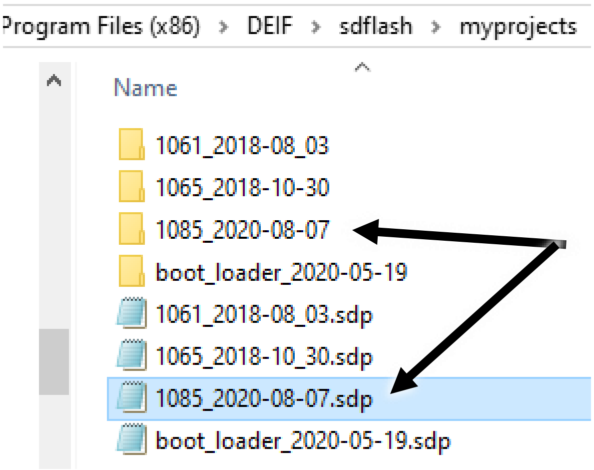
9.16.1.1 Prerequisites

- A computer with Spectrum Digital SDFlash program installed (including V3.3 SDFlash serial patch for flash programming, September 5, 2008), (http://emulators.spectrumdigital.com/utilities/sdflash/)

  Typically, the necessary USB driver will be found automatically if the computer is on-line. Otherwise, go to Silicon Labs home page and download the latest driver for CP210x USB to UART Bridge (http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx).

Info
The links above were valid at the time when this manual was written. If the link does not work anymore, search for "`V3.3 SDFlash serial patch`" or "`CP210x USB to UART Bridge driver`".

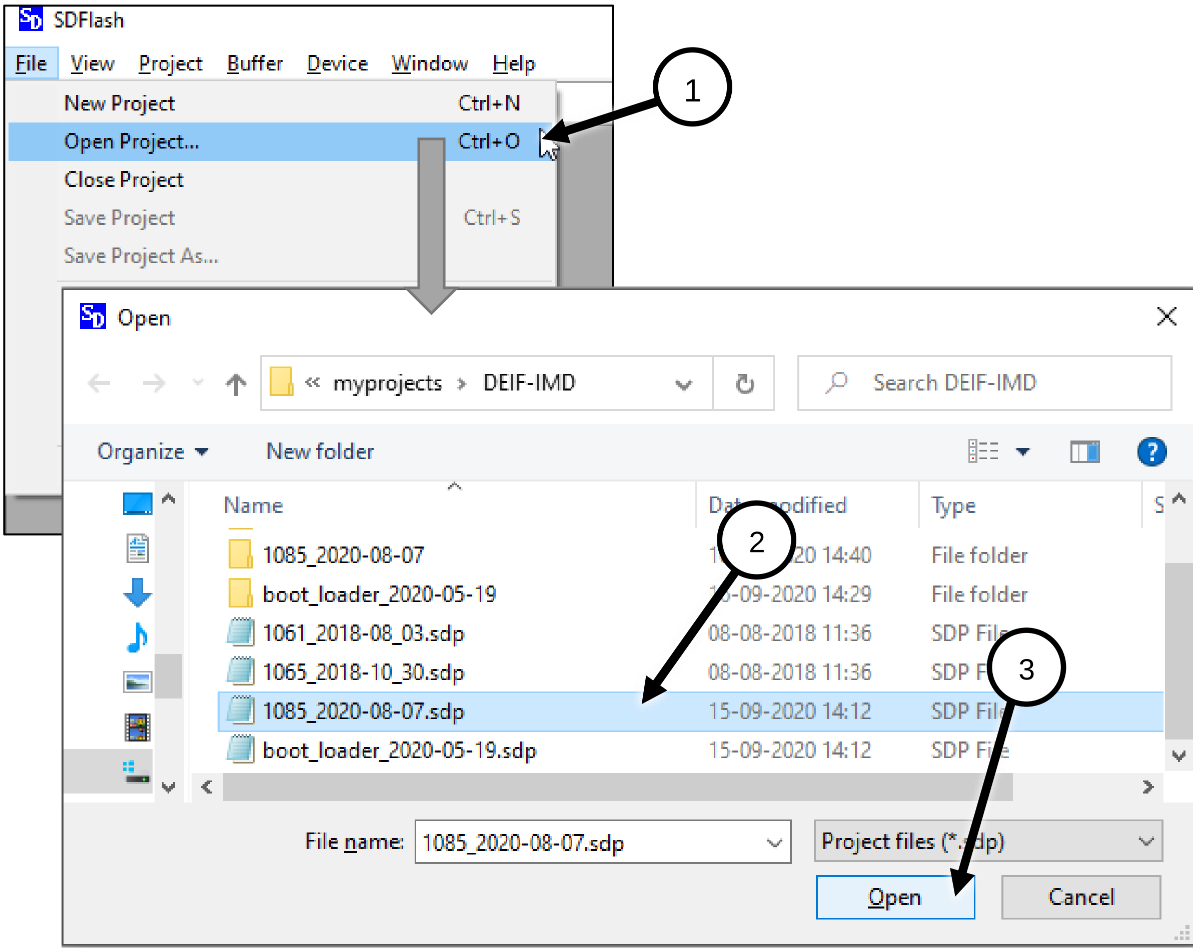
- The computer must be connected to the IMD with USB cable (male type A to male type B).
- Prepare the FW files for use:
  1. Copy the folder of the new FW.
  2. Paste the folder in the folder where other FW is located.
     If the FW files are located at their default location, go to `myprojects` folder in `sdflash` folder (where sdflash was installed) and paste the folder under `myprojects`.
     NOTE The files can be located anywhere. It is possible to brows to the location and sdflash remembers this location.
  3. Copy any of the .sdp files in the folder and paste it (the .sdp.
  4. Rename the .sdp file to the same name as the new FW folder:



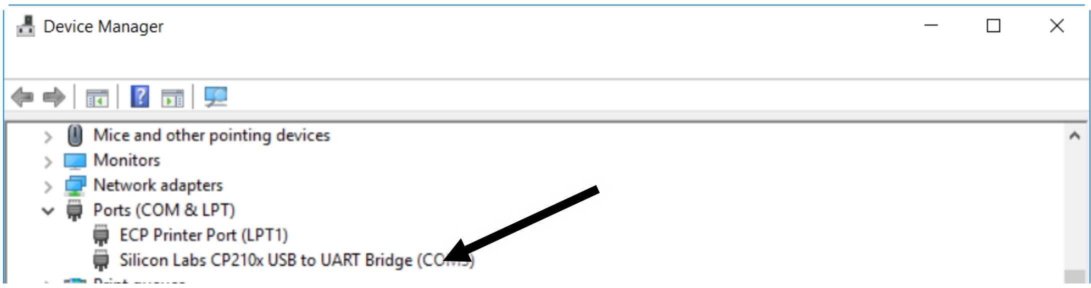
9.16.1.2 *Updating firmware – USB FW*

1. Before turning the power to the IMD ON (24 V DC if the IMD does not have built-in power supply, or 400 V AC if it does have a built-in power supply), ensure that the RFE input is OFF to prevent the IMD from starting the motor unintentionally.
2. Start the SDFlash if it is not started already.
3. Set the IMD into programming mode by doing the following:
   a. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) off.
   b. Set the CAN ID switch to position 15.
   c. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) on.

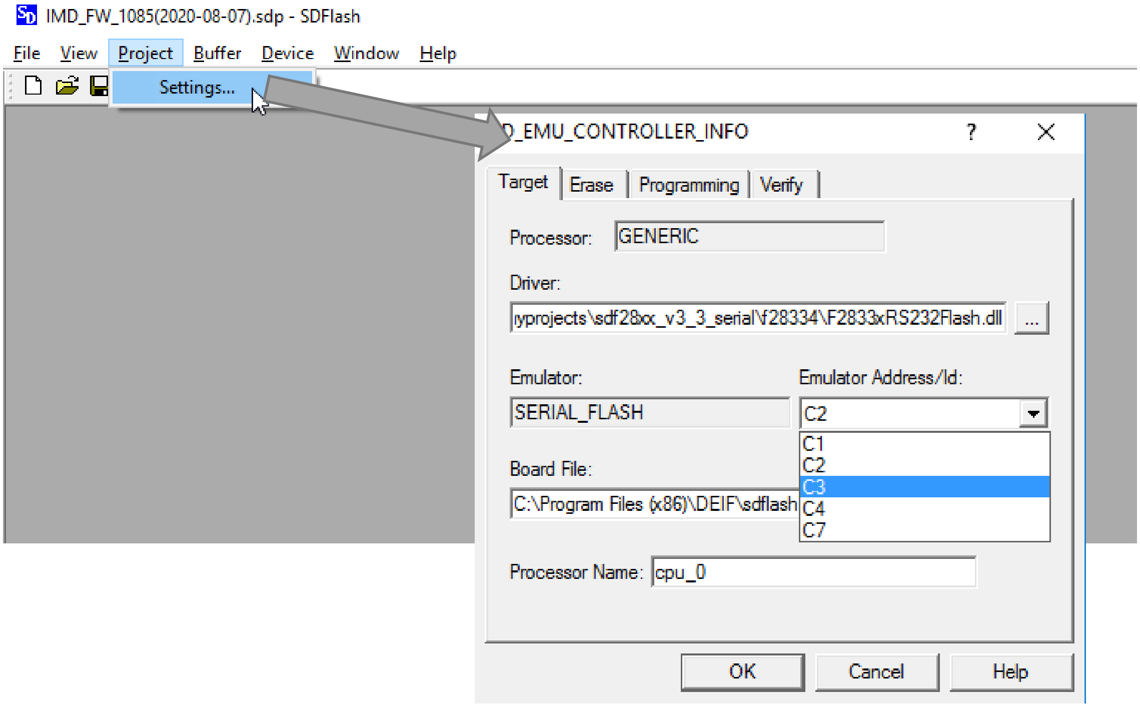
4. Click File→Open Project… (1), select and select the .sdp file that belongs to the FW that should be installed (2) and click Open (3):



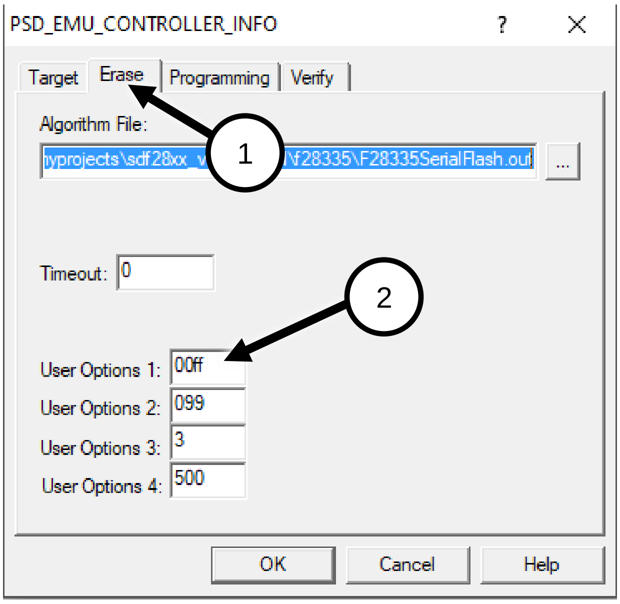
5. Skip this step if the used Com port is known.
Open the "Device manager" in the computer's "Settings" and determine which com port is used for the USB connection (the look and name of the device manager may differ depending on the operating system). Only Com1, Com2, Com3, and Com4 can be used with the SDFlash, if another port is selected by the system, you will need to change it so one of the mentioned ports is used:



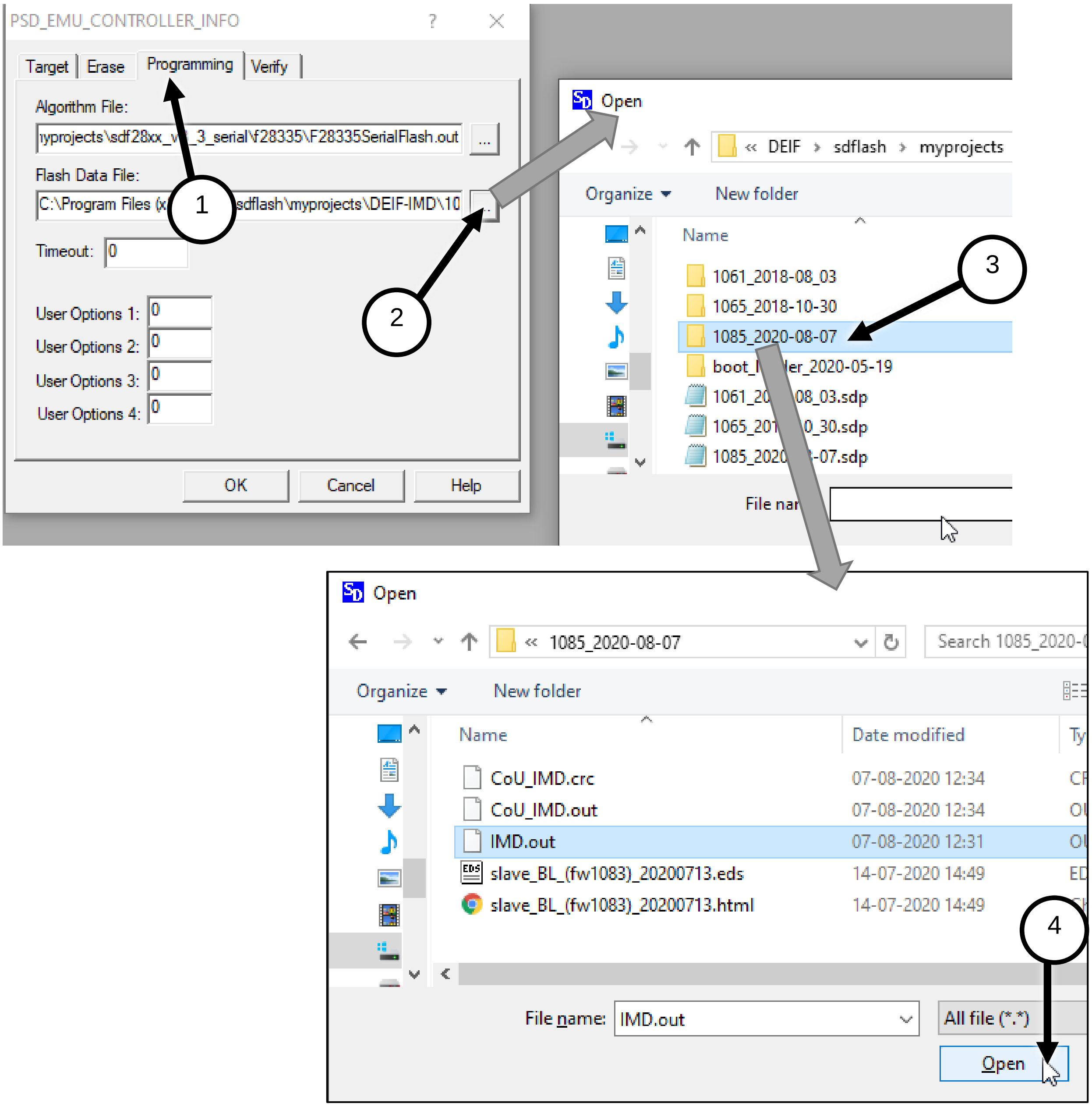
6. Click on Project →Settings… to open the Settings dialogue. Select the same com port as used in the device manager (COM1 → C1):



7. Click on the "Erase" tab (1), and ensure that "User Options 1:" is set to "`00ff`" (2):



8. Click on the "Programming" tab (1), then on the … button of the Flash Data File (2), double click on the FW folder (3), select the `IMD.out` file and click Open (4):

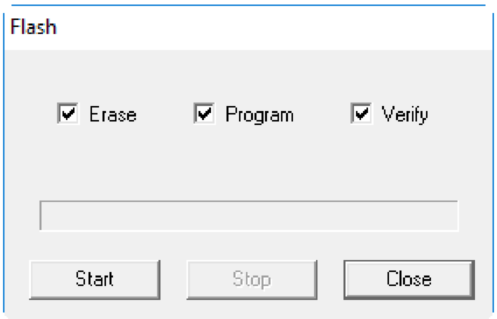


9. Click OK.

Info

If the com port or user option 1 was changed, you will be asked to save you project settings first, when attempting to upgrade the firmware in an IMD.

10. Click on Device → Flash… to open the upgrade dialogue:



11. Ensure that all three checkboxes are ticked and click Start.
12. When the programming cycle is completed, set the IMD back to normal operation mode:
    a. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) off.
    b. Set the CAN ID switch back to its original position.
    c. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) on. Note that the first startup after firmware upgrade might take longer (up to approximately 10 s).
13. The IMD is now updated.

Info

On rare occasions, The SDFlash program will show a “Connection error” after step **11** on page **154** is executed. In such a case, it is necessary to restart the whole process:

1. Close the SDflash program
2. Turn off the IMD
3. Start the SDflash
4. Turn on the IMD
5. Repeat com configuration, and the actions described in steps 4 on page 151 to 13 on page 154 .

9.16.2 Updating firmware with CANopen files through USB “service” connector method

Updating firmware with CANopen files, requires that a bootloader is installed as well. Once the bootloader is installed (see section 9.16.2.2 on page 155), it is enough to install only the FW file (see section 9.16.2.3 on page 160 or section 9.16.3 on page 164 depending on the method).

9.16.2.1 Prerequisites

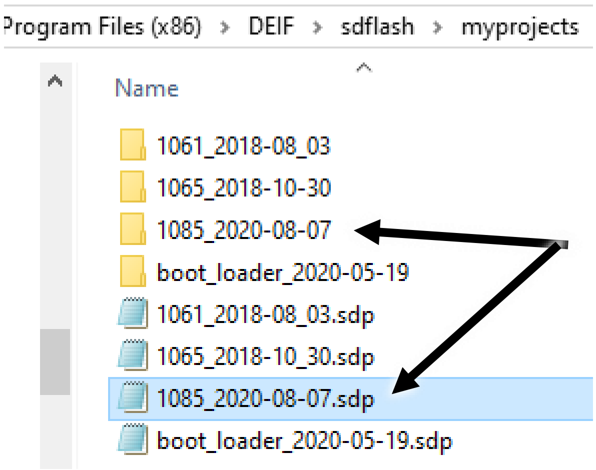
- A computer with Spectrum Digital SDFlash program installed (including V3.3 SDFlash serial patch for flash programming, September 5, 2008), (http://emulators.spectrumdigital.com/utilities/sdflash/)

  Typically, the necessary USB driver will be found automatically if the computer is on-line. Otherwise, go to Silicon Labs home page and download the latest driver for CP210x USB to UART Bridge (http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx).

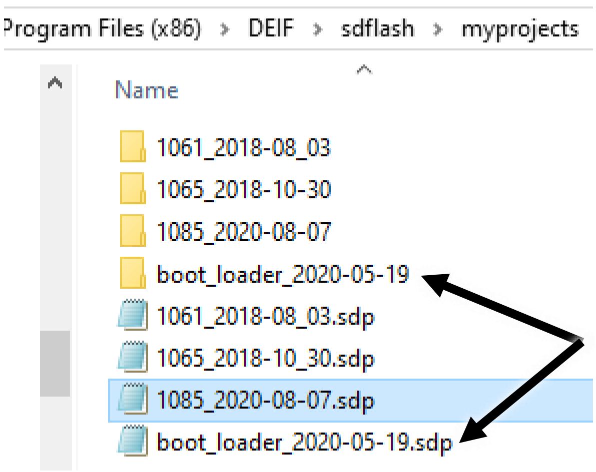
Info

The links above were valid at the time when this manual was written. If the link does not work anymore, search for “V3.3 SDFlash serial patch” or “CP210x USB to UART Bridge driver”.

- The computer must be connected to the IMD with USB cable (male type A to male type B).
- Prepare the FW files for use.
  1. Copy the folder of the new FW.
  2. Paste the folder in the folder where other FW is located. If the FW files are located at their default location, go to `myprojects` folder in `sdflash` folder (where sdflash was installed) and paste the folder under `myprojects`.
     NOTE The files can be located anywhere. It is possible to brows to the location and sdflash remembers this location.
  3. Copy any of the .sdp files in the folder and paste it.
  4. Rename the .sdp file to the same name as the new FW folder:



  5. If there is no bootloader package in the folder, repeat the previous steps (1 to 4) for the bootloader:

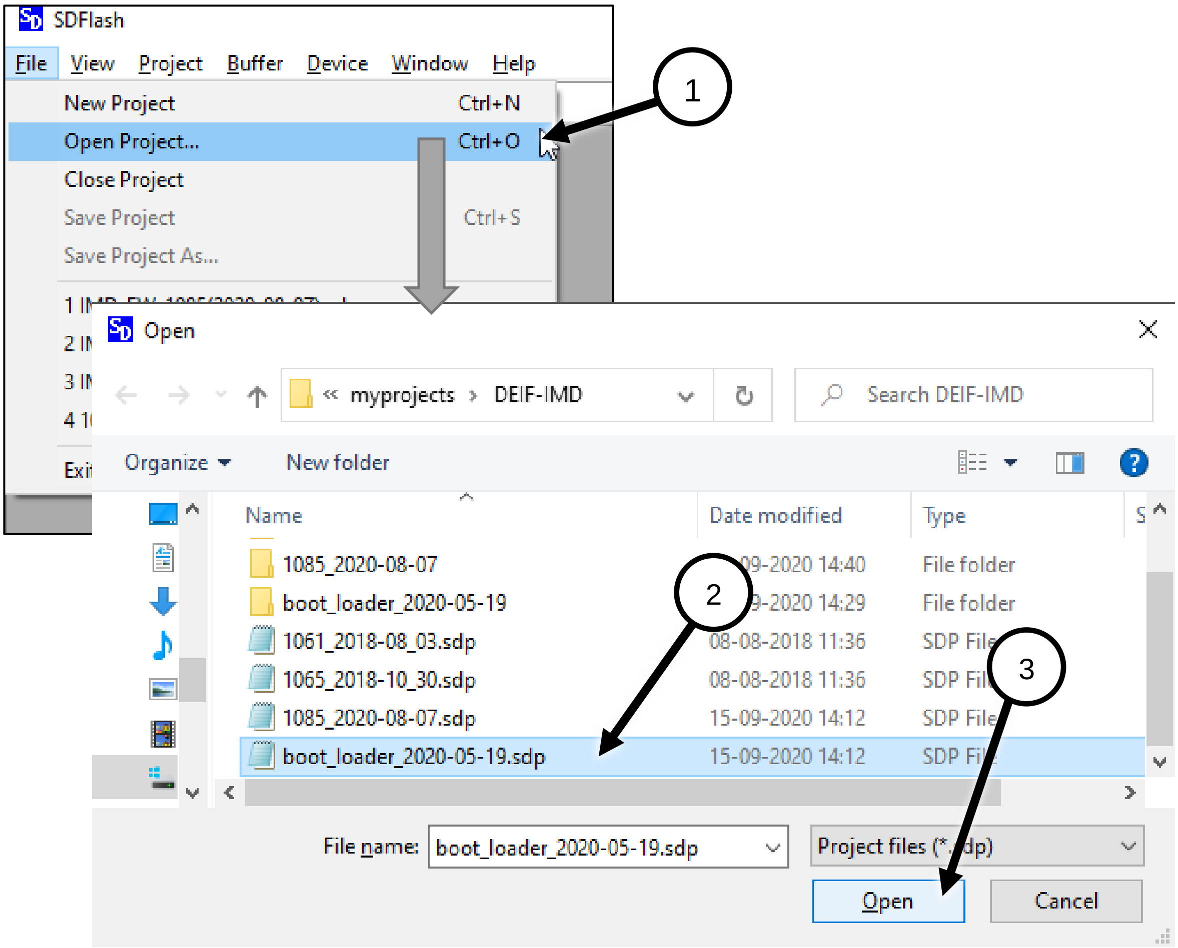


9.16.2.2 Updating CANopen bootloader file

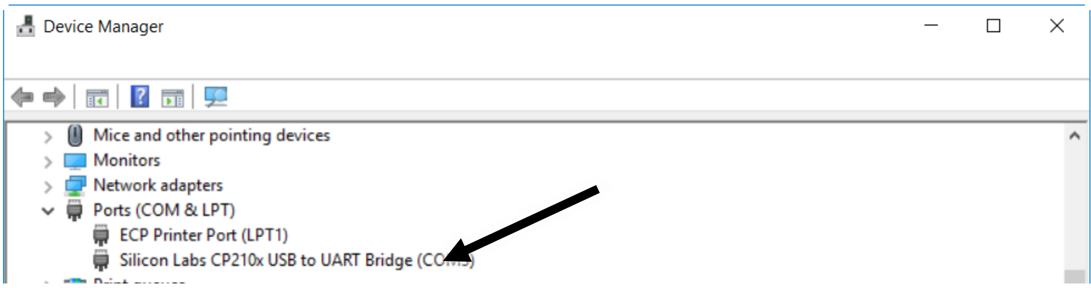
This task needs only to be done once, unless a newer bootloader version than the one already installed is available.

1. Before turning the power to the IMD ON (24 V DC if the IMD does not have built-in power supply, or 400 V AC if it does have a built-in power supply), ensure that the RFE input is OFF to prevent the IMD from starting the motor unintentionally.
2. Connect the computer to the IMD Service connector with USB cable (male type A to male type B).
3. Start the SDFlash if it is not started already.

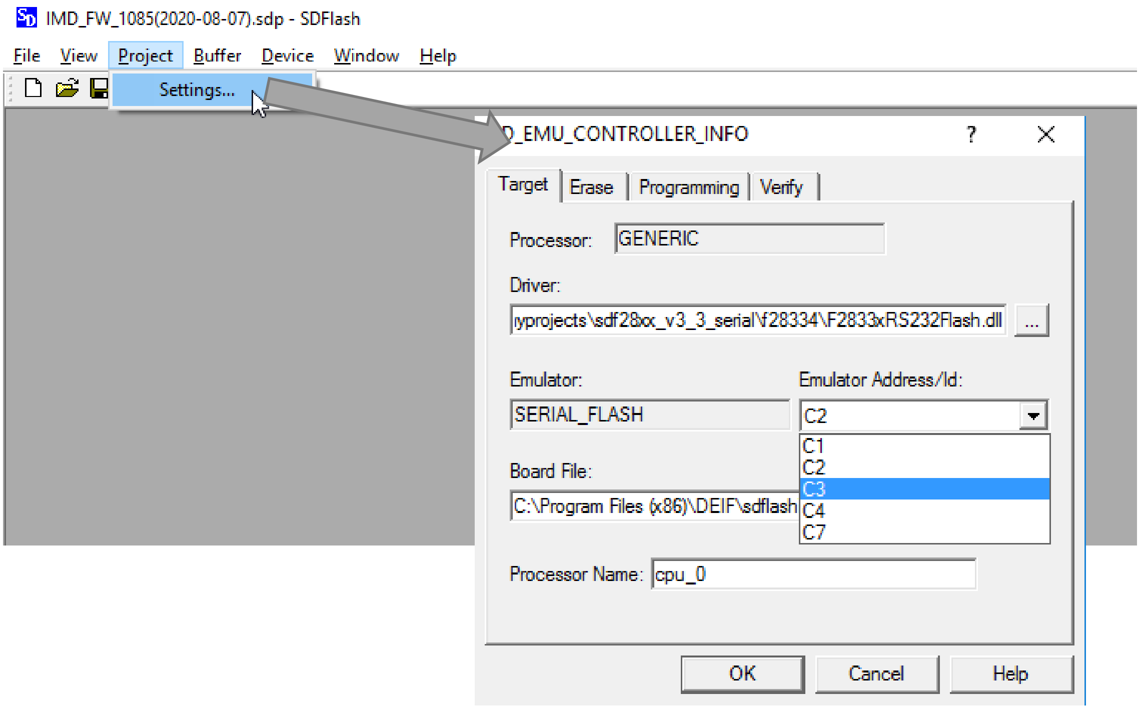
4. Click File→Open Project… (1), select and select the .sdp file that belongs to the bootloader package that should be installed (2), and click Open (3):



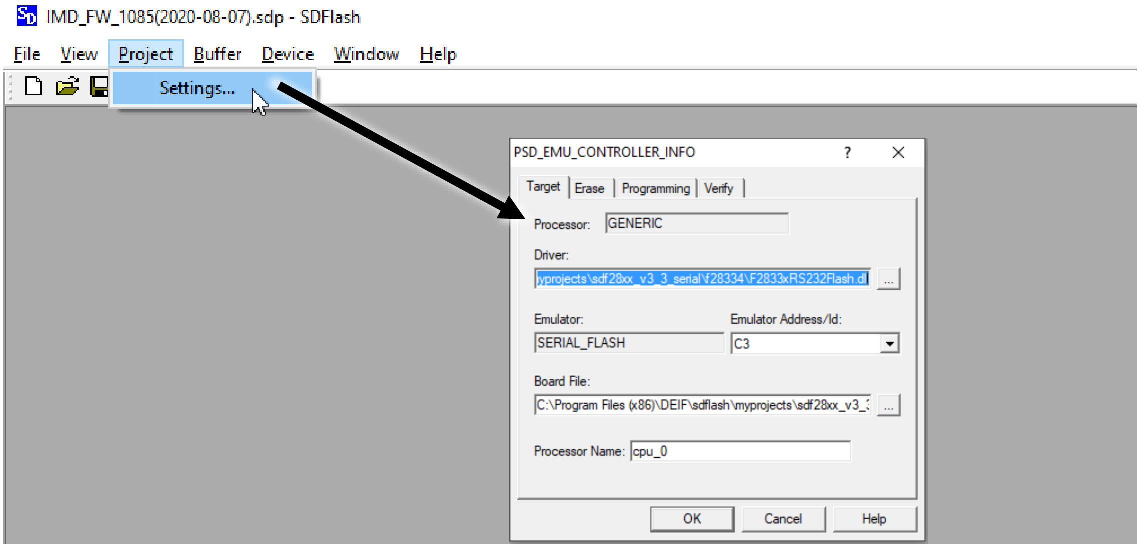
5. Skip this step if the used Com port is known.
   Open the "Device manager" in the computer's "Settings" and determine which com port is used for the USB connection (the look and name of the device manager may differ depending on the operating system). Only Com1, Com2, Com3, and Com4 can be used with the SDFlash, if another port is selected by the system, you will need to change it so one of the mentioned ports is used:



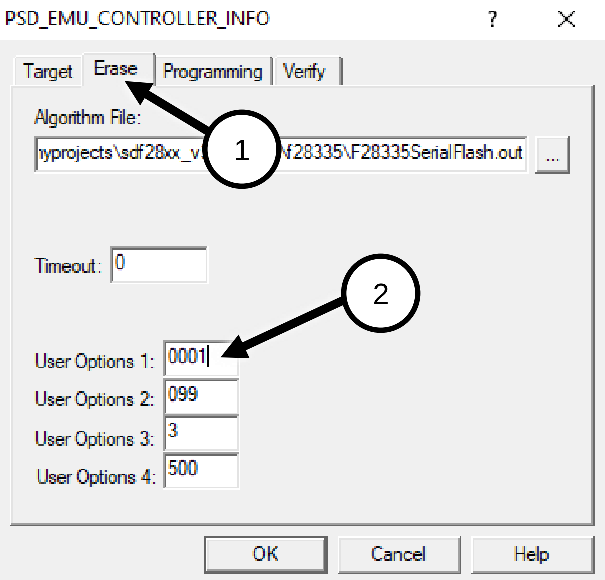
6. Click on Project →Settings… to open the Settings dialogue. Select the same com port as used in the device manager (COM1 → C1):



7. Click on Project →Settings… to open the Settings dialogue.

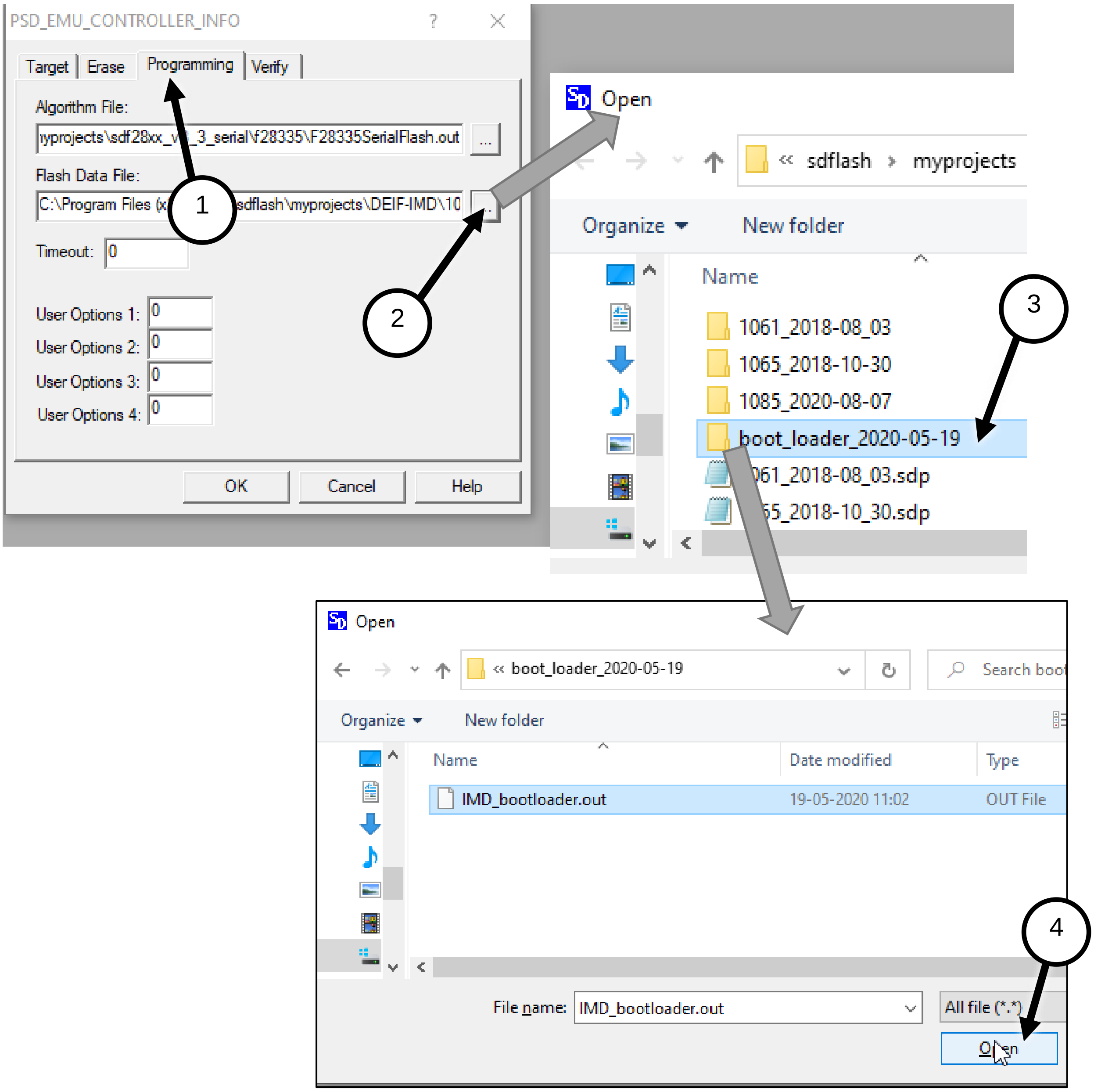


8. Click on the “Erase” tab (1), and ensure that “User Options 1:” is set to “`0001`” (2):



NOTE This step ensures that only the space allocated for the bootloader will be erased.

9. Click on the "Programming" tab (1), then on the … button of the Flash Data File (2), double click on the bootloader folder (3), select the `IMD_bootloader.out` file and click Open (4):

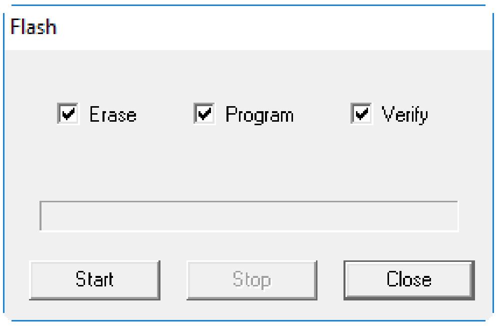


10. Click OK.

Info

If the com port or user option 1 was changed, you will be asked to save you project settings first, when attempting to update the bootloader in an IMD.

11. Set the IMD into programming mode by doing the following:
    a. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) off.
    b. Set the CAN ID switch to position 15.
    c. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) on.
12. Click on Device → Flash… to open the upgrade dialogue:



13. Ensure that all three checkboxes are ticked and click Start.
14. When the programming cycle is completed, click Close.
15. Skip this step if the FW is to be update as well.
    Set the IMD back to normal operation mode:
    a. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) off.
    b. Set the CAN ID switch back to its original position.
    c. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) on. Note that the first startup after firmware upgrade might take longer (up to approximately 10 s).
16. The IMD is now updated.

Info

On rare occasions, The SDflash program will show a “Connection error” after step **11** on page **154** is executed. In such a case, it is necessary to restart the whole process:

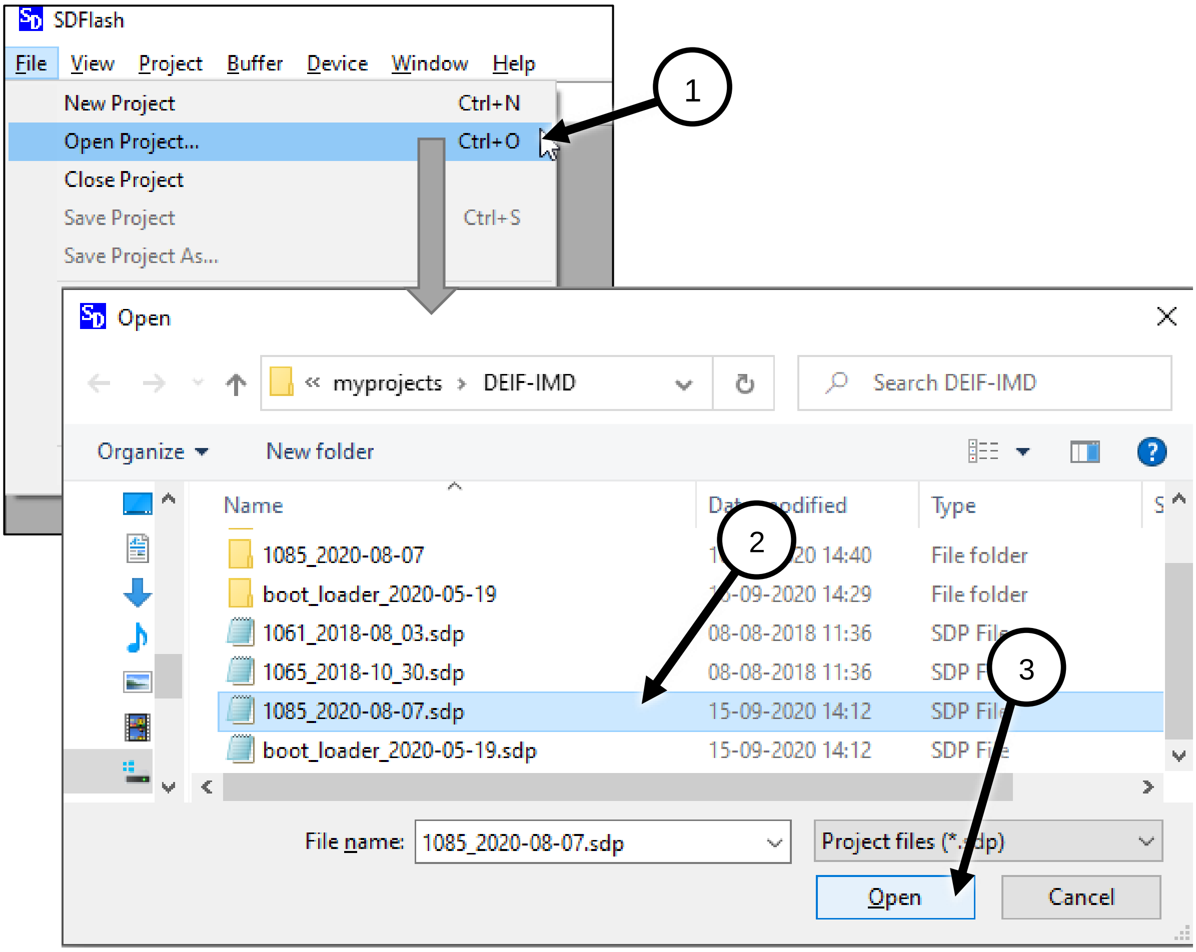
6. Close the SDflash program
7. Turn off the IMD
8. Start the SDflash
9. Turn on the IMD
10. Repeat com configuration, and the actions described in steps 4 on page 151 to 13 on page 154 .

9.16.2.3 Updating CANopen FW file

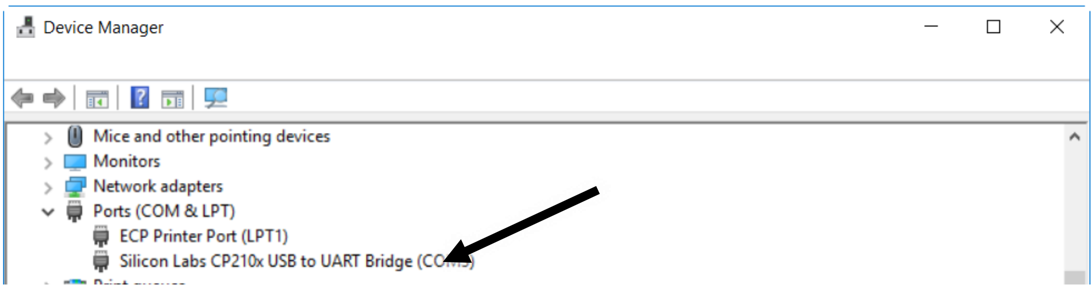
This procedure describes how to update the IMD FW in an IMD prepared for CANopen FW update, through the Service USB connector.

1. Skip this step if the SDFlash is started, and IMD is already turned on in programming mode
   a. Before turning the power to the IMD ON (24 V DC if the IMD does not have built-in power supply, or 400 V AC if it does have a built-in power supply), ensure that the RFE input is OFF to prevent the IMD from starting the motor unintentionally.
   b. Start the SDFlash if it is not started already.
   c. Set the IMD into programming mode by doing the following:
      i. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) off.
      ii. Set the CAN ID switch to position 15.
      iii. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) on.

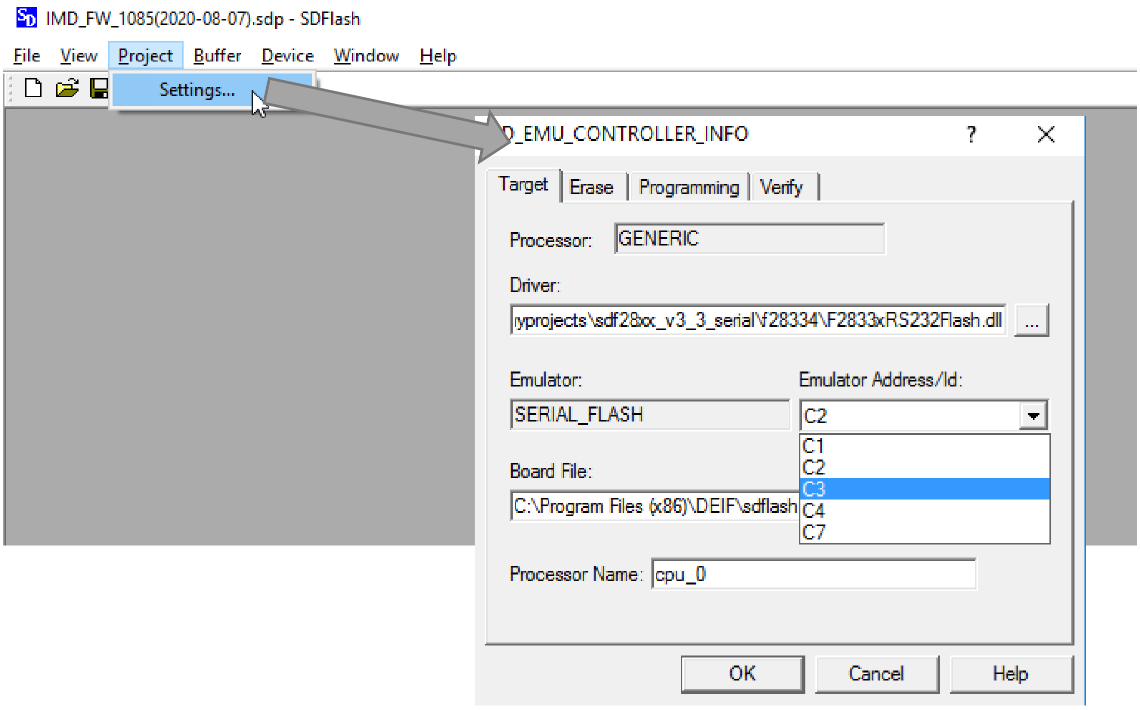
2. Click File→Open Project… (1), select and select the .sdp file that belongs to the FW that should be installed (2) and click Open (3):



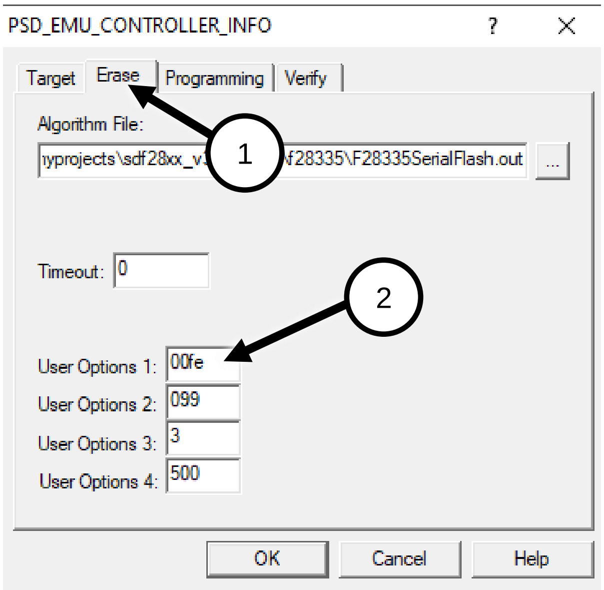
3. Skip this step if the used Com port is known.
Open the “Device manager” in the computer’s “Settings” and determine which com port is used for the USB connection (the look and name of the device manager may differ depending on the operating system). Only Com1, Com2, Com3, and Com4 can be used with the SDFlash, if another port is selected by the system, you will need to change it so one of the mentioned ports is used:



4. Click on Project →Settings… to open the Settings dialogue. Select the same com port as used in the device manager (COM1 → C1):

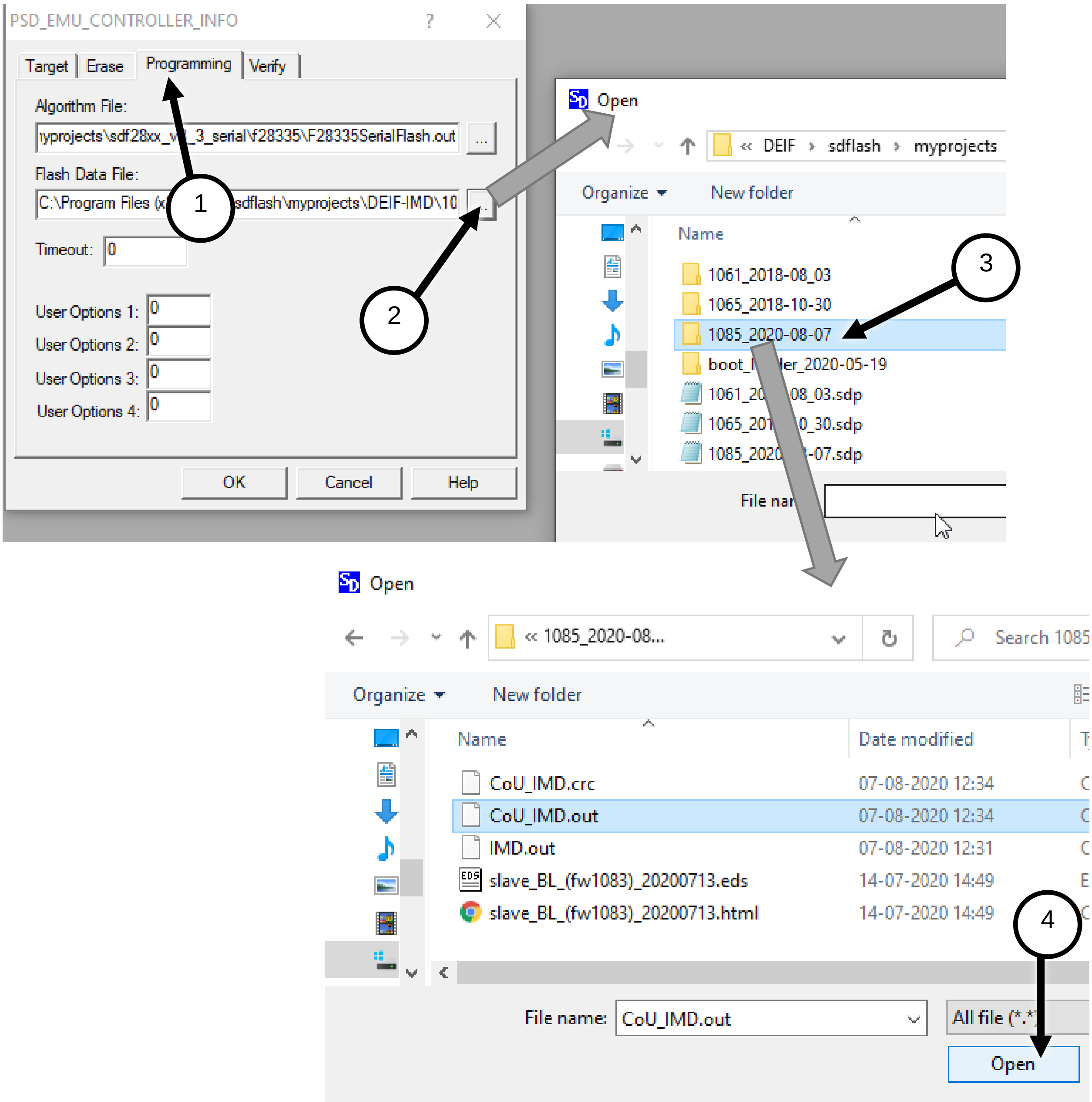


5. Click on the “Erase” tab (1), and ensure that “User Options 1:” is set to “`00fe`” (2):



NOTE This step ensures that the bootloader already installed will not erased.

6. Click on the “Programming” tab (1), then on the … button of the Flash Data File (2), double click on the FW folder (3), select the `CoU_IMD.out` file and click Open (4):

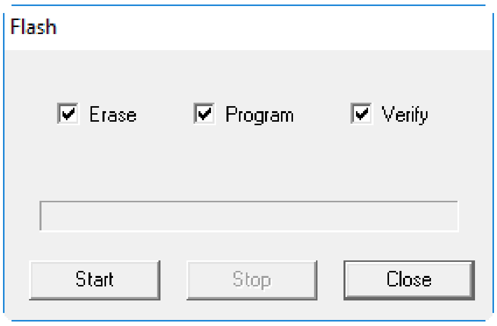


7. Click OK.

Info

If the com port or user option 1 was changed, you will be asked to save you project settings first, when attempting to upgrade the firmware in an IMD.

8. Click on Device → Flash… to open the upgrade dialogue:



9. Ensure that all three checkboxes are ticked and click Start.
10. When the programming cycle is completed, set the IMD back to normal operation mode:
    a. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) off.
    b. Set the CAN ID switch back to its original position.
    c. Turn the 24 V DC (or the 400 V AC if the DC power supply is built-in) on. Note that the first startup after firmware upgrade might take longer (up to approximately 10 s).
11. The IMD is now updated.

Info

On rare occasions, The SDFlash program will show a “Connection error” after step **11** on page **154** is executed. In such a case, it is necessary to restart the whole process:

11. Close the SDflash program
12. Turn off the IMD
13. Start the SDflash
14. Turn on the IMD
15. Repeat com configuration, and the actions described in steps 4 on page 151 to 13 on page 154 .

9.16.3 Updating firmware through CANopen

9.16.3.1 Prerequisites

- A specific “FW updater” SW must be implemented (by the customer) in the Pitch Motion Controller, or Turbine Controller (see section 7.1.3.5 on page 76 for implementation details).
- Instructions on how to use the implemented “FW updater” SW available
- Bootloader for CANopen FW update is installed on the IMD (see section 9.16.2.2 on page 155)
- The turbine must be stopped in a safe position and all blades are in fully feathered position.

9.16.3.2 Updating the firmware

1. Update the firmware according the “FW updater” instructions
2. When all IMDs are updated the turbine can be restarted

9.17 Using digital inputs and outputs

The digital inputs and outputs are not dependent on the state of the IMD. It is possible to read the state of a digital input or output, as well as set or reset a digital output no matter which operational state the IMD is in. Digital outputs D5 to D8 as well as digital inputs 1 and 2 can be also be controlled by mapping (assigning) logical function to them. When this is done, an output will change state or a function will be activated/deactivated when an input change state. See section 8.4.8 on page 100 and the description of how to use in the IMD Manager user manual.

9.17.1 Digital outputs

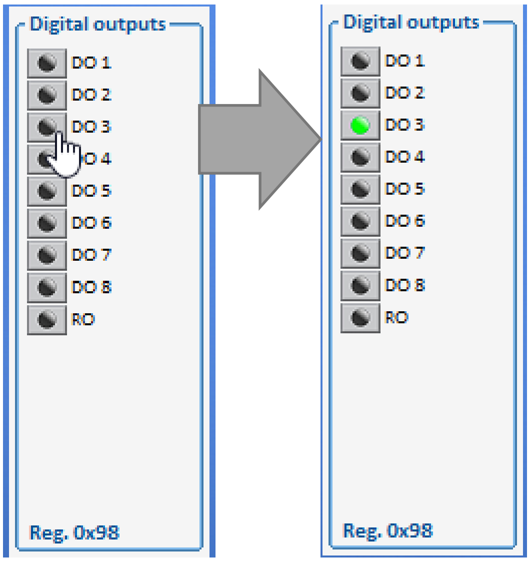
This section describes how to use the digital outputs.

9.17.1.1 Prerequisites

None

9.17.1.2 Activation

IMD Manager: Click on the "DO x" button of the digital output to toggle it:



CAN/CANopen: Set the applicable bit in Reg. 0x98 (see section 13.2.8 on page 207 for bit mapping) to "1" (on).

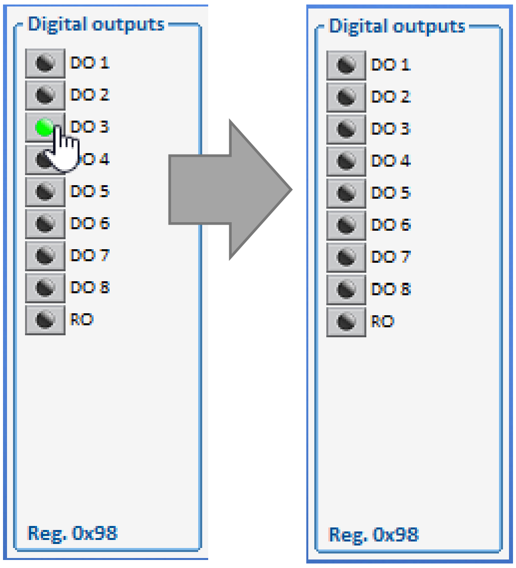
9.17.1.3 Operation

IMD Manager: The state of all digital outputs is represented by LED in the "Monitor and control" tab. The LED is turned ON when the output is ON, and Off when the output is Off.

CAN/CANopen: The state of all digital inputs can be retrieved from object 2098 (see section 13.2.8 on page 207 for bit mapping).

9.17.1.4 Deactivation

IMD Manager: Click on the “DO x” button of the digital output to toggle it:



CAN/CANopen: Reset the applicable bit in object 2098 (see section 13.2.8 on page 207 for bit mapping) to “0” (Off).

9.17.2 Digital inputs

This section describes how to use the digital inputs.

9.17.2.1 Prerequisites

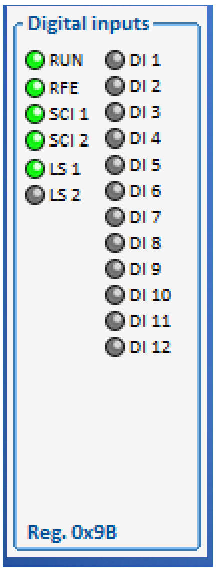
None

9.17.2.2 Activation

None

9.17.2.3 Operation

IMD Manager: The state of all digital inputs is represented by LED in the “Monitor and control” tab. The LED is turned ON when the input is high, and Off when the input is low.



CAN/CANopen: The state of all digital inputs can be retrieved from object 209B (see section 13.2.9 on page 208 for bit mapping).

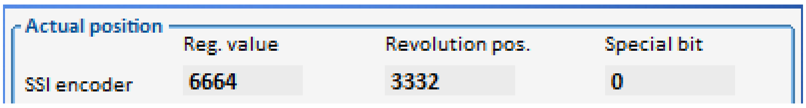
9.17.2.4 Deactivation

None.

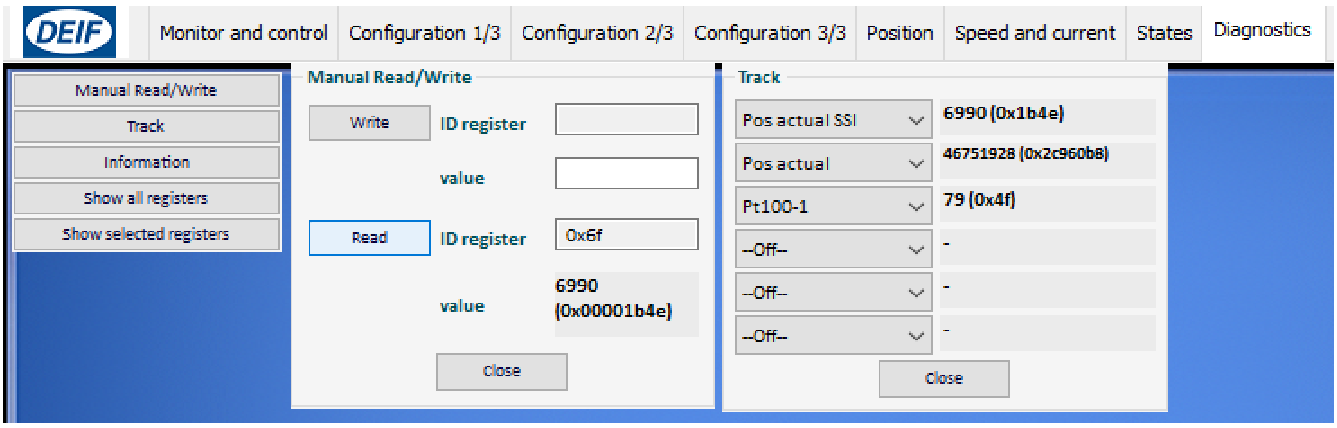
9.18 Using SSI Encoder to determine blade position

9.18.1 Retrieving position from single-turn encoder

The position can be read directly in the “Actual position” group in “Monitor and control” tab. The values shown automatically changes according to selected type of the encoder. Example of single-turn encoder:



The SSI encoder value can also be retrieved by reading the register 0x6F either through CAN / CANopen or in the “Diagnostics” tab “Manual Read/Write” or “Track".



The data format is as follows:

Bits 15…13	Bits (MSB) 12…01 (LSB)	Bit 0
Padding	Position value	Special bit

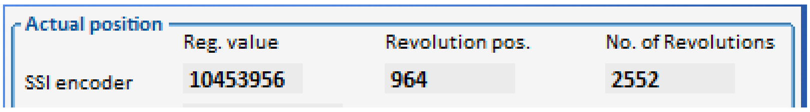
In the example above the decimal reading is 6990. An even number indicates that the special bit is 0.

The position value is INT(6990/2) = 3495 (only the integer portion of the result is used, 6991 will give the same result). See encoder’s manufacturer documentation for interpretation of the special bit.

9.18.2 Retrieving position multi-turn encoder

The position can be read directly in the “Actual position” group in “Monitor and control” tab. The values shown automatically changes according to selected type of the encoder.

Example of multi turn encoder:



The SSI encoder value can also be retrieved by reading the register 0x6F, either through CAN / CANopen or in the IMD Manager**.**

The data format is as follows:

Bits 31…25	Bits (MSB) 24…13 (LSB)	Bits (MSB) 12…00 (LSB)
Padding	Number of revolutions value	Position value

In the IMD Manager this is done in the “Diagnostics” tab either by manually reading 0x6F or by using the “Track” function and setting it to “Pos actual ssi”:

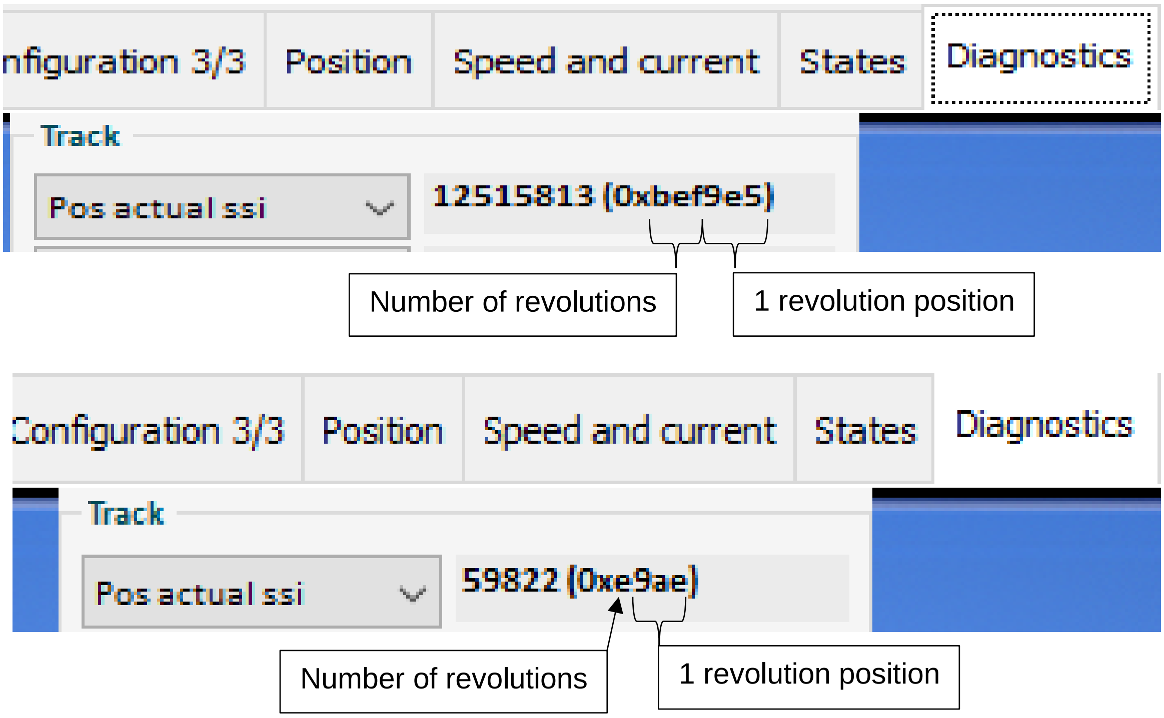


Figure 43 Examples of two readings of multi-turn SSI values using Track

In the first example above, the hexadecimal reading is 0xBEF9E5.

The position value is the lower 3 hexadecimal digits: 0x9E5 = 4745 (decimal).

The number of revolutions is the higher 3 hexadecimal digits (or fewer depending on the value) 0xBEF = 5757 (decimal).

In the second example the hexadecimal reading is 0xE9AE.

The position value is the lower 3 hexadecimal digits: 0x9AE = 2478 (decimal).

The number of revolutions is the higher 3 hexadecimal digits (or fewer depending on the value) 0xE = 14 (decimal).

Info

Even though the format of the encoder data transmission is gray code, it is translated to binary format before it is saved in the IMD register.

After a value of FFF, the next value of number of revolutions (FFF+1) will be zero.

10. Units conversion

All values read from and sent to the IMD are in raw unformatted numbers. This section describes how to convert from raw values to units such as Ampere, Volt and so on.

10.1 Converting position values

The actual position is stored in register 0x6D with a value from the resolver. The value is signed 32 bit, where the low 16 bits is the position (angle) within one revolution and the high 16 bits are the number of revolutions inclusive direction (plus or minus). The number of revolutions is a cumulative value.

10.2 Converting voltage units to volts

Voltage measurements of the internal DC bus and safe energy (batteries or ultra-caps) are retrieved as units. To convert unit values to volts, use the following formulas:

Measurement	Register	Formula
DC-link voltage	0xEB	Volts value = Reg. 0xEB value / 29.8901
Safe energy voltage	0x66	Volts value = Reg. 0x66 value / 59.569

10.3 Converting temperature values

The different sensors have different coefficients and different full scale. Therefore, different tables are needed for the conversion. The conversion is done as a temperature interval linear interpolation.

10.3.1 Converting power module temperature (T-igbt)

The temperature of the power module can be read from register 0x4A or CANopen object 204A. In the following description, the actual temperature read, is called **Actual_temp_raw**.

The following data is needed for the conversion (Temperature is in ºC):

Table 24 Raw IGBT temperature values (NTC)

i	Raw_value	Temperature
1	16333	-30
2	16515	-20
3	16791	-10
4	17190	0
5	17737	10
6	18447	20
7	19323	30
8	20343	40
9	21469	50
10	22647	60
11	23823	70

i	Raw_value	Temperature
12	24946	80
13	25981	90
14	26906	100

Info
The NTC sensor data is defined down to -30ºC.

When converting a temperature given in raw values to centigrade, the interval **i** must be found. Select the first interval (table row) where the **Raw_value** is smaller than the **Actual_temp_raw**.

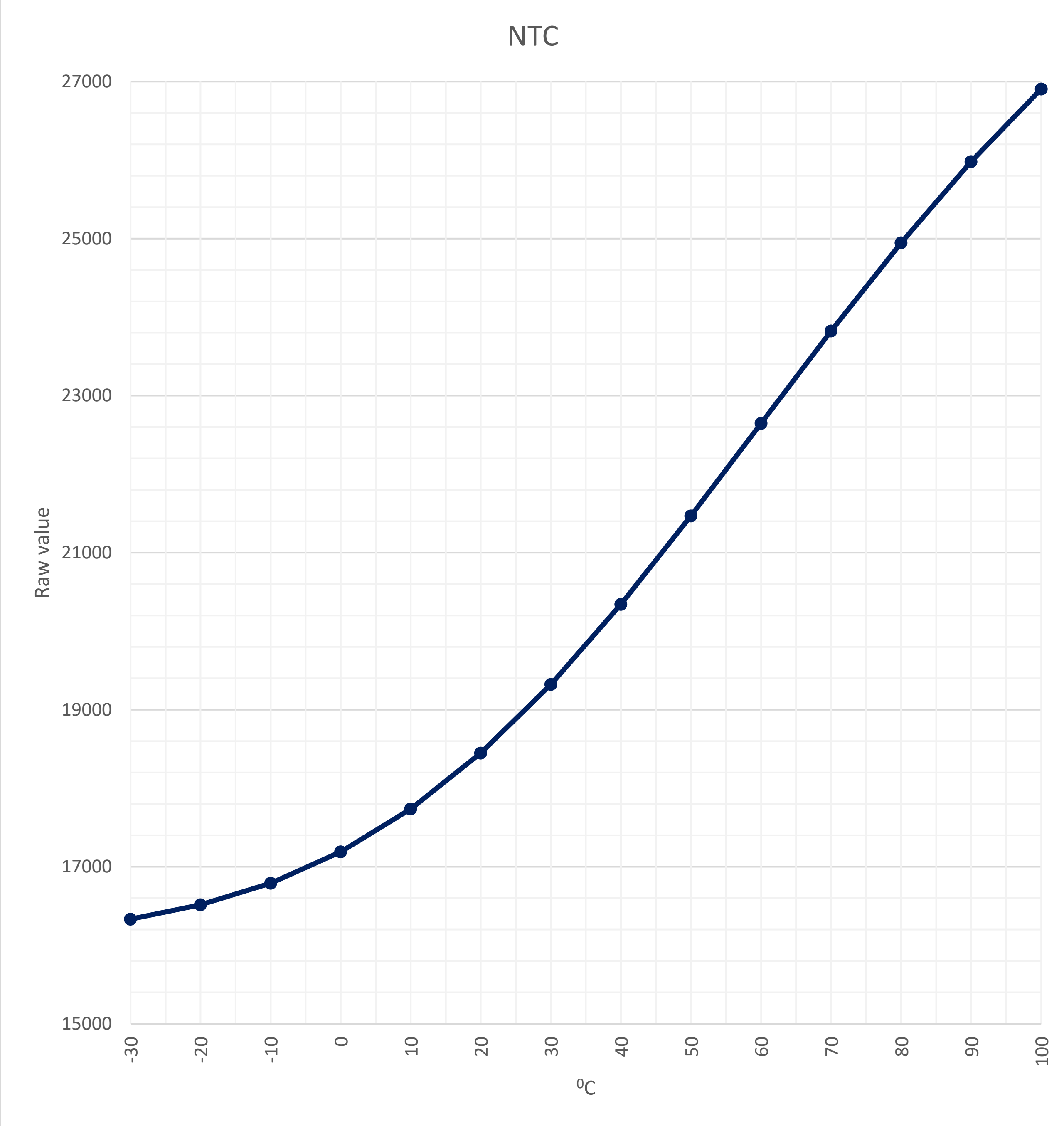
Formula:

$$Actual\ temperature\ ºC =$$
$$Temperature\ [i] + \frac{(Actual\_temp\_raw - Raw\_value[i]) * (temperature\ [i+1] - temperature[i])}{Raw\_value[i+1] - Raw\_value[i]}$$

Example of converting a value of 24000 units to ºC: $$70 + \frac{(24000 - 23823) * (80 - 70)}{24946 - 23823} = 71.6$$ 24000 units = 71.6 ºC	**Actual_temp_raw** = 24000 **i** = row 11 is selected **Temperature[i]** = 70 **Temperature[i+1]** = 80 **Raw_value[i]** = 23823 **Raw_value[i+1]** = 24946

10.3.1.1 Quick conversion chart

The following chart gives a quick view of temperature vs. raw_values.



10.3.2 Converting motor temperature (T-motor, KTY 84 sensor)

The temperature of the motor can be read from register 0x49 or CANopen object 2049. In the following description, the actual temperature read, is called **Actual_temp_raw**.

The following data is needed for the conversion (Temperature is in ºC):

Table 25 Raw motor temperature values (KTY 84)

i	Raw_value	Temperature
1	1063	-60
2	1989	-50
3	2968	-40
4	3993	-30
5	4521	-25
6	5060	-20
7	6164	-10
8	7301	0
9	8467	10
10	9657	20
11	10260	25
12	10868	30
13	12094	40
14	13332	50
15	14579	60
16	15832	70
17	16459	75
18	17086	80
19	18340	90
20	19590	100
31	20834	110
32	22070	120
33	22684	125
34	23295	130
35	24508	140
36	25707	150
37	26891	160
38	28059	170
39	28636	175
40	29209	180
41	30340	190
42	31452	200
43	32543	210

10.3.2.1 Conversion from units to Cº KTY 84

When converting a temperature given in raw values to centigrade, the interval **i** must be found. Select the first interval (table row) in Table 25on page 173 where the **Raw_value** is smaller than the **Actual_temp_raw**.

Formula:

$$Actual\ temperature\ ºC =$$
$$Temperature\ [i] + \frac{(Actual\_temp\_raw - Raw\_value[i]) * (temperature\ [i+1] - temperature[i])}{Raw\_value[i+1] - Raw\_value[i]}$$

Example of converting a value of 24000 units to ºC: $130 + \frac{(24000 - 23295) * (140 - 130)}{24508 - 23295} = 135.81$ 24000 units ≈ 136 ºC	**Actual_temp_raw** = 24000 **i** = row 34 is selected **Temperature[i]** = 130 **Temperature[i+1]** = 140 **Raw_value[i]** = 23295 **Raw_value[i+1]** = 24508

10.3.2.2 Conversion from Cº to units KTY 84

When converting a temperature given in ºC to raw values, the interval **i** must be found. Select the first interval (table row) in Table 25on page 173 where the **Temperature** is smaller than the **Actual temperature ºC**.

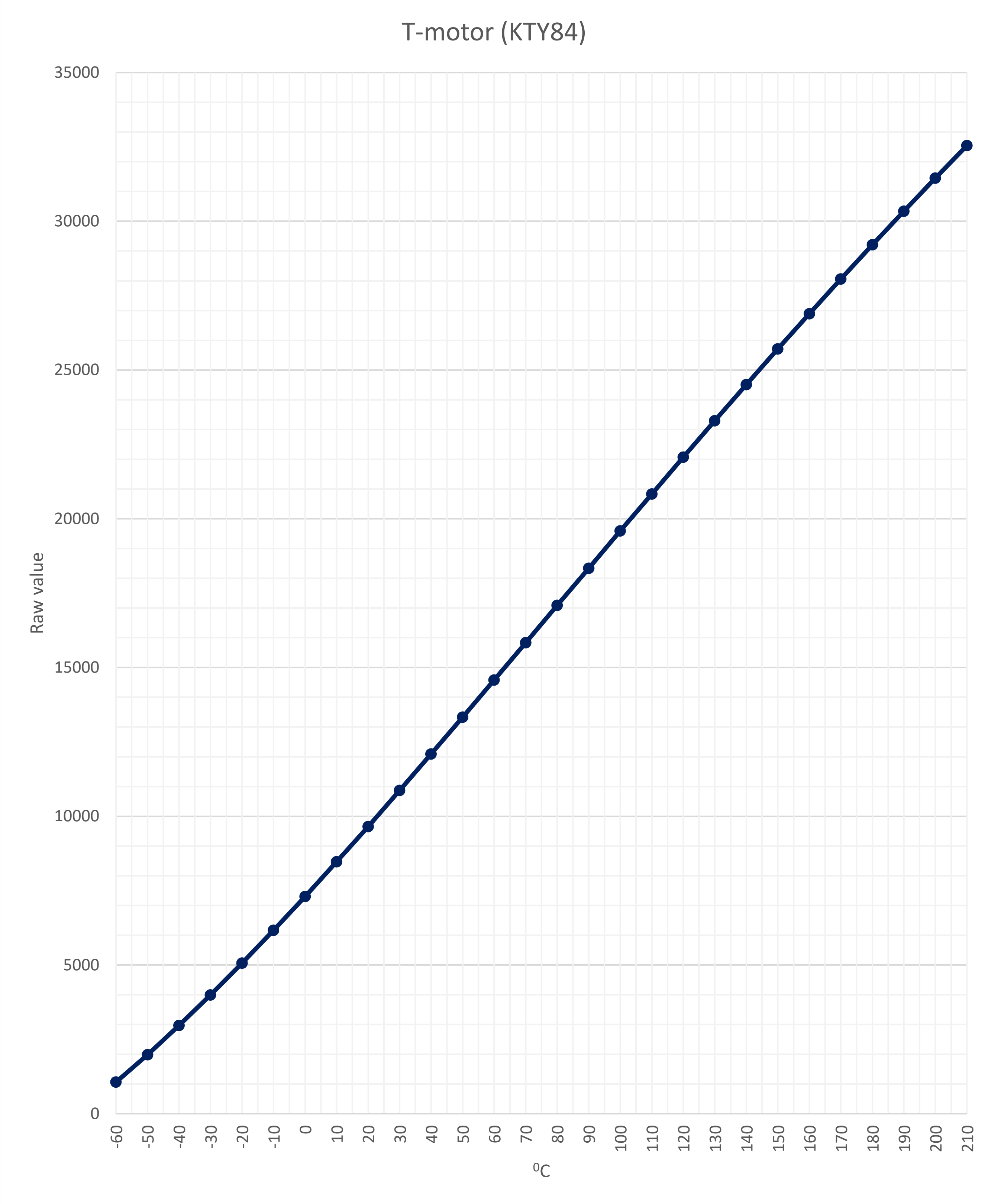
Formula for conversion from ºC to raw temperature:

$$Actual\_temp\_raw =$$
$$Raw\_value[i] + \frac{(Actual\ temperature\ ºC - Temperature\ [i]) * (Raw\_value[i+1] - Raw\_value[i])}{temperature\ [i+1] - temperature[i]}$$

Example of converting a value of 135.8 ºC to units: $23295 + \frac{(135.8 - 130) * (24508 - 23295)}{140 - 130} = 23999.7$ ºC ≈ 24000 units	**Actual temperature ºC** = 135.8 **i** = row 34 is selected **Temperature[i]** = 130 **Temperature[i+1]** = 140 **Raw_value[i]** = 23295 **Raw_value[i+1]** = 24508

10.3.2.3 Quick conversion chart

The following chart gives a quick view of temperature vs. raw_values.



10.3.3 Converting motor temperature (T-motor, Pt100 sensor)

The temperature of the motor can be read from register 0x49 or CANopen object 2049. In the following description, the actual temperature read, is called **Actual_temp_raw**.

The following data is needed for the conversion (Temperature is in ºC):

Table 26 Raw temperature values T-motor (Pt100)

i	Raw_value	Temperature
1	455	-60
2	1678	-50
3	2897	-40
4	4112	-30
5	4718	-25
6	5324	-20
7	6531	-10
8	7735	0
9	8935	10
10	10132	20
11	10729	25
12	11325	30
13	12514	40
14	13700	50
15	14883	60
16	16061	70
17	16650	75
18	17237	80
19	18409	90
20	19577	100
31	20741	110
32	21903	120
33	22482	125
34	23060	130
35	24214	140
36	25365	150
37	26512	160
38	27655	170
39	28225	175
40	28795	180

i	Raw_value	Temperature
41	29931	190
42	31064	200
43	32193	210

10.3.3.1 Conversion from units to Cº T-motor Pt100

When converting a temperature given in raw values to centigrade, the interval **i** must be found. Select the first interval (table row) in Table 26 on page 176 where the **Raw_value** is smaller than the **Actual_temp_raw**.

Formula:

$$Actual\ temperature\ ºC =$$
$$Temperature\ [i] + \frac{(Actual\_temp\_raw - Raw\_value[i]) * (temperature\ [i+1] - temperature[i])}{Raw\_value[i+1] - Raw\_value[i]}$$

Example of converting a value of 24000 units to ºC: $$130 + \frac{(24000 - 23060) * (140 - 130)}{24214 - 23060} = 138.14$$ 24000 units ≈ 138 ºC	**Actual_temp_raw** = 24000 **i** = row 34 is selected **Temperature[i]** = 130 **Temperature[i+1]** = 140 **Raw_value[i]** = 23060 **Raw_value[i+1]** = 24214

10.3.3.2 Conversion from Cº to units Pt100

When converting a temperature given in ºC, the interval **i** must be found. Select the first interval (table row) in Table 26 on page 176 where the **Temperature** is smaller than the **Actual temperature ºC**.

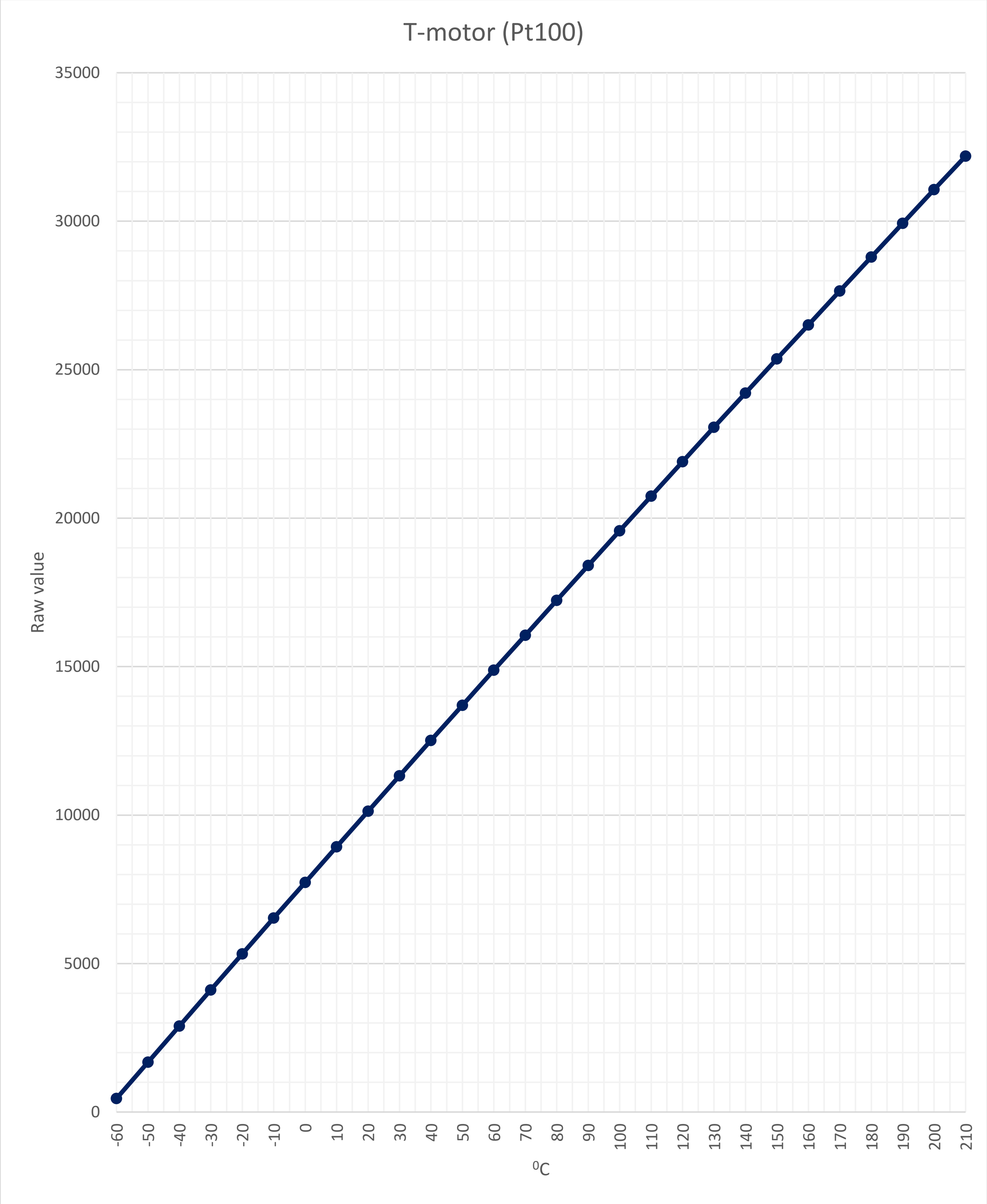
Formula for conversion from ºC to raw temperature:

$$Actual\_temp\_raw =$$
$$Raw\_value[i] + \frac{(Actual\ temperature\ ºC - Temperature\ [i]) * (Raw\_value[i+1] - Raw\_value[i])}{temperature\ [i+1] - temperature[i]}$$

Example of converting a value of 138.1 ºC to units: $$23060 + \frac{(138.1 - 130) * (24214 - 23060)}{140 - 130} = 23995$$ 138.1 ºC ≈ 24000 units	**Actual temperature ºC** = 138.1 **i** = row 34 is selected **Temperature[i]** = 130 **Temperature[i+1]** = 140 **Raw_value[i]** = 23060 **Raw_value[i+1]** = 24214

10.3.3.3 Quick conversion chart

The following chart gives a quick view of temperature vs. raw_values.



10.3.4 Converting temperature Pt100 sensor (Pt1 to Pt4)

The temperature of a Pt100 sensor temperature in raw values can be read from any of the four Pt100 registers (see 0x9C - 0x9F), or CANopen objects 209C to 209F. In the following description, the actual temperature read, is called **Actual_temp_raw**.

The following data is needed for the conversion (Temperature is in ºC):

Table 27 Raw temperature values Pt100

i	Raw_value	Temperature
1	57	-60
2	210	-50
3	362	-40
4	514	-30
5	590	-25
6	665	-20
7	816	-10
8	967	0
9	1117	10
10	1266	20
11	1341	25
12	1416	30
13	1564	40
14	1712	50
15	1860	60
16	2008	70
17	2081	75
18	2155	80
19	2301	90
20	2447	100
31	2593	110
32	2738	120
33	2810	125
34	2882	130
35	3027	140
36	3171	150
37	3314	160
38	3457	170

i	Raw_value	Temperature
39	3528	175
40	3599	180
41	3741	190
42	3883	200
43	4024	210

10.3.4.1 Conversion from units to Cº Pt100 (Pt1-Pt4)

When converting a temperature given in raw values to centigrade, the interval **i** must be found. Select the first interval (table row) in Table 27 on page 179 where the **Raw_value** is smaller than the **Actual_temp_raw**.

Formula:

$$Actual\ temperature\ ºC = Temperature\ [i] + \frac{(Actual\_temp\_raw - Raw\_value[i]) * (temperature\ [i+1] - temperature[i])}{Raw\_value[i+1] - Raw\_value[i]}$$

Example of converting a value of 3000 units to ºC: $130 + \frac{(3000 - 2882) * (140 - 130)}{3027 - 2882} = 138.14$ 3000 units ≈ 138 ºC	**Actual_temp_raw** = 3000 **i** = row 34 is selected **Temperature[i]** = 130 **Temperature[i+1]** = 140 **Raw_value[i]** = 2882 **Raw_value[i+1]** = 3027

10.3.4.2 Conversion from Cº to units Pt100 (Pt1-Pt4)

When converting a temperature given in ºC to raw values, the interval **i** must be found. Select the first interval (table row) in Table 26 on page 176 where the **Temperature** is smaller than the **Actual temperature ºC**.

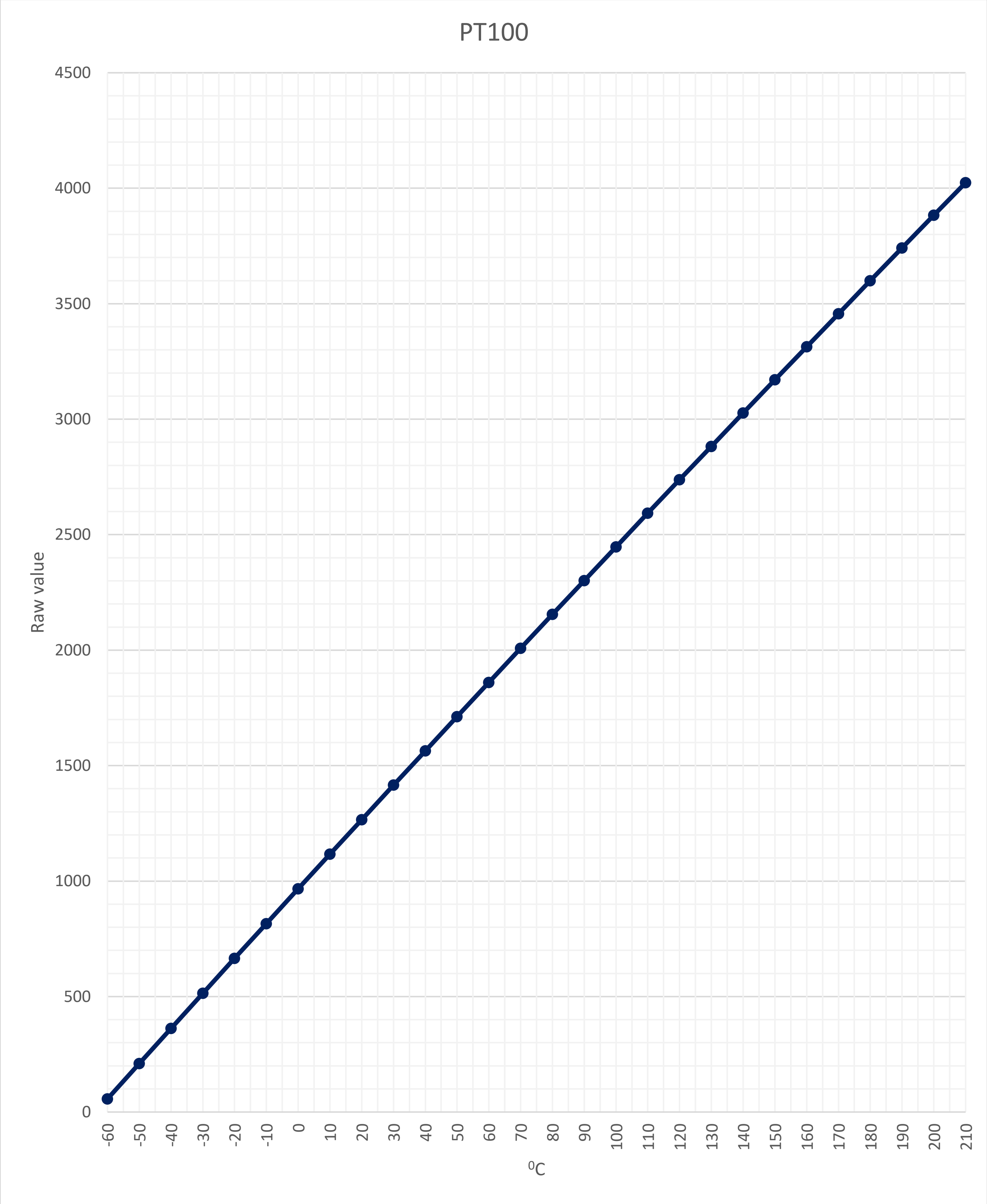
Formula for conversion from ºC to raw temperature:

$$Actual\_temp\_raw = Raw\_value[i] + \frac{(Actual\ temperature\ ºC - Temperature\ [i]) * (Raw\_value[i+1] - Raw\_value[i])}{temperature\ [i+1] - temperature[i]}$$

Example of converting a value of 138.1 ºC to units: $2882 + \frac{(138.1 - 130) * (3027 - 2882)}{140 - 130} = 2999.5$ 138.1 ºC ≈ 3000 units	**Actual temperature ºC** = 138.1 **i** = row 34 is selected **Temperature[i]** = 130 **Temperature[i+1]** = 140 **Raw_value[i]** = 2882 **Raw_value[i+1]** = 3027

10.3.4.3 Quick conversion chart

The following chart gives a quick view of temperature vs. raw_values.



10.3.5 Converting (internal) air temperature (T-air)

This section describes how to convert raw values from a KTY 82 air temperature sensor to ºC. The temperature in raw values can be read from register 0x4B.

In the following description, the actual temperature read in units is called **Actual_temp_raw**.

The following data is needed for the conversion (Temperature is in ºC):

Table 28 Raw air temperature values (KTY 82)

i	Raw_value	Temperature
1	7208	-60
2	7734	-50
3	8268	-40
4	8806	-30
5	9075	-25
6	9344	-20
7	9879	-10
8	10409	0
9	10931	10
10	11442	20
11	11694	25
12	11942	30
13	12430	40
14	12904	50
15	13363	60
16	13807	70
17	14024	75
18	14237	80
19	14655	90
20	15049	100
31	15429	110
32	15773	120
33	15927	125
34	16067	130
35	16298	140
36	16457	150

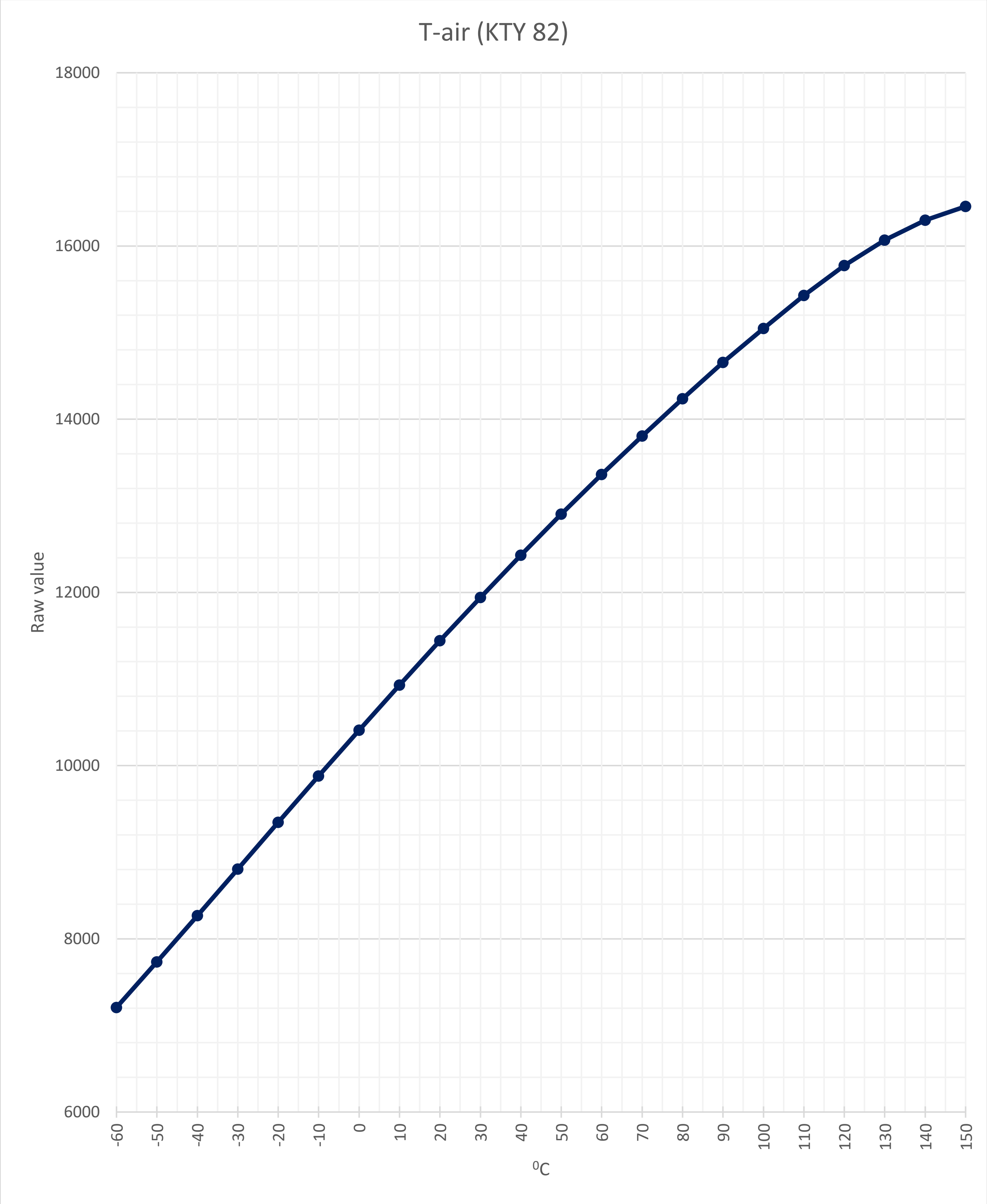
When converting a temperature given in raw values to centigrade, the interval **i** must be found. Select the first interval (table row) where the **Raw_value** is smaller than the **Actual_temp_raw**.

Formula:

$Actual\ temperature\ ºC =$ $Temperature\ [i] + \frac{(Actual\_temp\_raw - Raw\_value[i]) * (temperature\ [i+1] - temperature[i])}{Raw\_value[i+1] - Raw\_value[i]}$	
Example of converting a value of 13000 units to ºC: $130 + \frac{(13000 - 12904) * (60 - 50)}{13363 - 12904} = 52.01$ 24000 units ≈ 52 ºC	**Actual_temp_raw** = 13000 **i** = row 14 is selected **Temperature[i]** = 50 **Temperature[i+1]** = 60 **Raw_value[i]** = 12904 **Raw_value[i+1]** = 13363

10.3.5.1 Quick conversion chart

The following chart gives a quick view of temperature vs. raw_values.



10.4 Converting current values

All current measurements unscaled values. In order to convert current measurements to Ampere it is necessary to scale the values by using the following register values:

- I device (reg. 0xC6, value in 0.1 A). This value is used in internal calculations in the IMD.
- Current 200 pct. (reg. 0xD9). This value is a scaled in raw values and used in internal calculations in the IMD.

10.4.1 Converting current raw values to Ampere

To convert any current reading from the IMD, such as CurrentActual (0x20), CurrentAllowedMax (0x24) and so on, use the following formula (the actual current reading is named ActualReading):

$$Current\ A\ RMS = \frac{I\ Device * ActualReading * 2}{Current\ 200pct * 10}$$

Example of converting a reading from the IMD of 300: $\frac{600 * 300 * 2}{1287 * 10} = 27.97$ 300 units ≈ 28 A $_{RMS}$	**ActualReading** = 300 **I Device (0xC6)** = 600 **Current 200pct (0xD9)** = 1287

Info
It is recommended to read the I device and Current 200 pct at start up and use these values in the conversion.

10.4.2 Converting Ampere to current raw values

To convert any current value in Ampere to its representation in raw values use the following formula (the actual current reading is named “Current A RMS”):

$$Current\ units = \frac{Current\ A\ RMS * Current\ 200pct * 10}{Device\ design\ current * 2}$$

Example of converting a current value of 30: $\frac{30 * 1287 * 10}{600 * 2} = 321.75$ 30 A $_{RMS}$ ≈ 322 units	**Current A RMS** = 30 **I Device (0xC6)** = 600 **Current 200pct (0xD9)** = 1287

Info
It is recommended to read the I device and Current 200 pct at start up and use these values in the conversion.

10.5 Converting speed values

The actual or setpoint for speed stored in the different registers (0x30, 0x31, 0x32, 0x5D, 0xA8) is in numerical values. 0x31 is setpoint for speed. All other mentioned registers contain actual speed as represented in various places in the speed regulation loop. The actual motor speed is stored in 0x30 (N actual) and 0xA8 (N actual (filtered)).

10.5.1 Converting speed values from raw values to RPM

To convert any speed value in raw values to RPM use the following formula:

$RPM = \frac{Speed\_value * Nmax\_100\%}{32767}$	RPM: Motor speed in RPM Nmax_100%: Maximum speed in RPM (0xC8) Speed_value: Raw value representation of a speed
Example of converting a speed value of 20000 units: $\frac{20000 * 3000}{32767} = 1831.1$ 20000 Speed_value ≈ 1831 RPM	**Nmax_100%** = 3000 **Speed_value** = 20000

10.5.2 Converting speed values from RPM to raw values

To convert any speed value in units to RPM use the following formula:

$Speed\_values = \frac{RPM * 32767}{Nmax\_100\%}$	RPM: Motor speed in RPM Nmax_100%: Maximum speed in RPM (0xC8) Speed_ value: Raw value representation of a speed
Example of converting a speed value of 2000 RPM: $\frac{2000 * 32767}{3000} = 21844.7$ 2000 RPM ≈ 21845 Speed_value	**Nmax_100%** = 3000 **RPM** = 2000

10.6 Converting torque values

Torque raw values are used in registers 0x90 (Torque set-point) and 0xA0 (torque actual). To convert the raw values to Nm and vice versa, the specific torque constant of the actual motor (from the data sheet) is used. Note that this constant changes with the speed. If a very accurate result is desired, this must be taken into account.

In order to scale the current measurement, I device (reg. 0xC6, value in 0.1 A) need to be used.

10.6.1 Converting torque raw values to Nm

To convert any torque value in raw values to Nm use the following formula:

$$Nm = \frac{Torque_{raw\_value} * I\ Device * Df * K_T}{32767}$$

Nm: Motor torque in Newton metre

K_T: Specific torque constant of the actual motor

Df: Device factor, depending on the IMD type, I extended bit, and Peak plus option:

Type	Peak plus	I extended	Df
IMD 122 B/C	✗	✗	**1.5**
IMD 122 B/C	✗	✓	**1.725**
IMD 122 C	✓	N/A	**2.25**
IMD 135 C	✗	✗	**2.6**
IMD 135 C	✗	✓	**3**
IMD 135 C	✓	N/A	**4**

Example of converting a torque value of 2000 units:

$$\frac{2000 * 60 * 1.5 * 2.66}{32767} = 14.61$$

2000 $Torque_{raw\_value}$ ≈ 14.6 Nm

I Device (0xC6) / 10 = 600/10 = 60

K_T = 2.66

Df = 1.5

$Torque_{value}$ = 2000

10.6.2 Converting Torque Nm to raw values

To convert any torque value in raw values to Nm use the following formula:

$$Torque_{raw\_value} = \frac{Torque_{Nm} * 32767}{I\ Device * 1.5 * K_T}$$

Nm: Motor torque in Newton metre

K_T: Specific torque constant of the actual motor

Df: The same as in previous section

Example of converting a torque value of 14 Nm:

$$\frac{14 * 32767}{60 * 1.5 * 2.66} = 1916.2$$

14 $Torque_{Nm}$ ≈ 1916 $Torque_{raw\_value}$

I Device (0xC6) / 10 = 600/10 = 60

K_T = 2.66

Df = 1.5

$Torque_{Nm}$ = 14

11. Protection and errors description

11.1 Voltage protection and errors

There are two DC-link voltage error mechanisms:

1. “HW” mechanism (the trigger for the error is a HW signal but the protection and error are executed by the SW)
2. SW mechanism

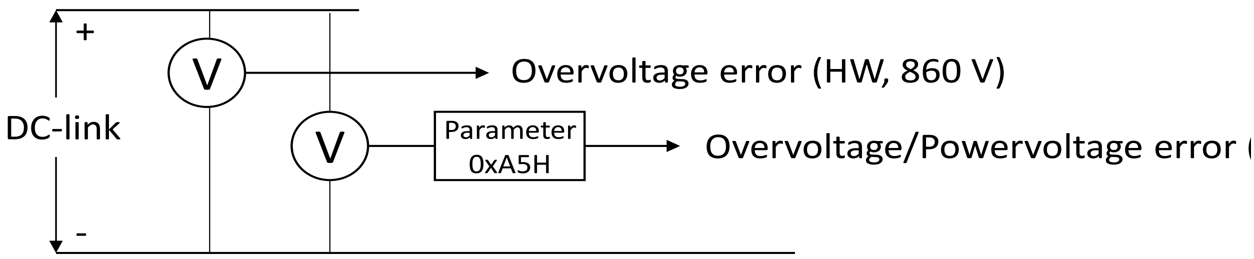


Figure 44 Voltage error and protection mechanisms

11.1.1 Overvoltage error

The overvoltage error can be generated by both SW and HW mechanisms.

The SW mechanism measures the DC-link voltage and triggers the error at the DC-link Vmax threshold (Reg. 0xA5 H, default 789 V).

The HW mechanism generates an error signal when the DC-link voltage exceeds 860 V DC.

Both mechanisms result in error 8 (OVERVOLTAGE), after which the drive is immediately disabled.

11.1.2 Under voltage error

This error is generated only by the SW mechanism. The threshold for this error is set by the DC-link Vmin parameter (Reg. 0xA5 L). The error generated when the DC-link voltage is below DC-link Vmin is error 5 (UNDERVOLTAGE), after which the drive is immediately disabled.

12. Errors and warnings

The IMD has two ways to report faults: Errors and warnings:

	Cause and action	Reset
Warning	Normal parameter limits are beginning to be crossed. No immediate action. If not addressed, some warnings might escalate to errors after a timeout.	Automatically reset when the cause is removed.
Error	Severe violation of limits, causing a safety chain trip, and either an immediate motor stop or initiating a safety run.	Reset is done either from the controller, another USB device, or using the IMD Manager tool. From the application SW or another USB device, writing any value to register 0x8E resets errors. Reset is not possible if the cause is not removed.

Both errors and warnings are displayed on the IMD display and the IMD Manager tool.

12.1 Error list

When an error is active it is displayed in the IMD Manager tool in the “Error(s)” field. Following is a list of errors:

Table 29 Error list and description

IMD display / Error bit no.	IMD Manager Error(s) field	Safety run performed	Error description
0	BADPARAS	No	Checksum (CRC) error when reading parameters from EEPROM. This error can only be reset by a power-cycle (OFF-ON) of the IMD.
1	POWER FAULT	No	A fault condition related to the IGBT module is detected.
2	RFE open	No	RFE (Rotational Field Enable) input is in low state.
3	BUS TIMEOUT	Yes	This error can be caused by three reasons: • Timeout has occurred on the CAN-bus. Timeout period defined in ms in register CAN_TIMEOUT (0xd0). The bus time out error is enabled after the CAN bus has reached operational state. • Communication error with the built-in charger (after the communication was initialised at start-up). • Communication error with the built-in charger (option). When resulting from this reason, the error is generated automatically after warning 3 has been active during the Charger timeout period and not cleared.

IMD display / Error bit no.	IMD Manager Error(s) field	Safety run performed	Error description
4	FEEDBACK	Yes	Bad or no motor feedback signal. The resolver circuit detects a fault.
5	UNDERVOLTAGE	No	DC link voltage is lower than DC-link Vlow or DC-link Vmin.
6	MOTORTEMP	Yes	Motor temperature too high. Motor-temperature reached the limit specified in *M-temp.* This error can be reset after the motor had cooled down.
7	DEVICETEMP	Yes	IMD temperature too high. This error can be reset after the IMD had cooled down.
8	OVERVOLTAGE	Yes/No	DC-link voltage upper limits (HW DC-link overvoltage or DC-link Vmax) exceeded.
9	I_PEAK	No	The current to the motor exceeded the peak current limit for more than 8 ms.
A	MOTOR OUTPUT	No	The motor speed and direction cannot be controlled. The motor either races at full speed or cannot move. This error can be caused by four reasons: • Non coherent parameter configuration. • Mismatch between the direction from the drive and direction from the motor feedback. • The phase sequence (W, V, U) is wrong. • At least one of the phases from the IMD to the motor is disconnected.
B	CHARGER		Error in the charger (option). This error is generated automatically after warning B has been active during the Charger timeout period and not cleared. There are a number of charger errors that caused the warning that was escalated to the error. Possible errors are listed in section 12.1.1 on page 191. The active errors can be determined by reading the charger error register.
C	HIGHVOLTAGE	Yes	HIGHVOLTAGE warning was on more than approximately five seconds.
D	PRE_CHARGE	Yes	Pre-charge circuit failure. Mains power cannot be connected to DC link.

IMD display / Error bit no.	IMD Manager Error(s) field	Safety run performed	Error description
E	HW-ERROR	No	Hardware component failure. Multiple reasons can cause this error. For example: • An internal supply voltage has failed • Internal communication to power-module has timed out • The controller has detected a power-module error-condition • The internal current measurement has failed Determination of the precise reason can only be done by experts, possibly also using the errors log.
F	BALLAST	Yes	This error can be caused by two reasons: • Ballast resistor overload. The ballast resistor load has exceeded the configured value (Ballast-P). This error can be reset after a timeout has elapsed. • Hardware failure in the ballast circuit or resistor

12.1.1 Charger (option) errors

If the built-in charger option is mounted in the IMD, the following errors can be read from the charger warnings register:

Error bit no.	Error text	Error description
0	OPENCIRCUIT	The charger detected open circuit. No safe energy source is connected, or a wire is broken.
1	SHORTCIRCUIT	The SE output is short-circuited. For lead acid this error is raised when the SE voltage is less than 20% of nominal while charging.
2	CHARGERTEMP	The internal temperature of the charger is too high.

12.2 Warning list

When a warning is active it is displayed in the IMD Manager tool in the “Warning(s)” field. Following is a list of warnings:

Table 30 Warning list and description

Warning bit no.	IMD Manager Warning(s) field	Warning description
0	BADPARA	Parameter error. This warning can be caused by the following reasons: • Deceleration ramp too long when “Run” signal is deactivated • Calculation of motor-parameters gives an unlikely result
1	Warning 1	Not used
2	Warning 2	Not used
3	COMCHARGER	Communication error with the built-in charger (option). If this warning persists for the Charger timeout period, and the IMD is configured to escalate charger warnings to error, error 3 will be generated. Sending “clear errors” every 8 seconds will delay error generation (until clearing errors is stopped) if the warning persists.
4	FEEDBACK	Unstable resolver signal. This warning is also active during blind safety run.
5	POWERVOLTAGE	Safe energy voltage is lower than SE Vmin.
6	MOTORTEMP	--Motor temperature high. Motor-temperature reached 87.5% of the limit specified in *M-temp*.
7	DEVICETEMP	IMD temperature high. Internal components temperature exceeded 72 ºC.
8	Warning 8	Not used
9	I_PEAK	Digital output driver is overheated
A	Warning A	Not used
B	CHARGER	Error in the charger (option). There are a number of charger errors that caused the warning that was escalated to the error. These can be determined by reading the charger error register. If this warning persists for the Charger timeout period, and the IMD is configured to escalate charger warnings to error, error 3 will be generated. Sending “clear errors” every 8 seconds will delay error generation (until clearing errors is stopped) if the warning persists.
C	HIGHVOLTAGE	Ballast resistor is on too long (> 100 ms) while the Mains is ON. If the pitch controller does not act for more than 5 seconds, a HIGHVOLTAGE error is generated, and the warning is reset.

Warning bit no.	IMD Manager Warning(s) field	Warning description
D	Warning D	Not used
E	HW-warning	This warning can be caused by the following reasons: • Current offset too high (too far from zero) • Pt100 measurements are wrong, measured value cannot be trusted • DI 10, 11 or 12 is high when not in manual operation mode (and manual mode is enabled).
F	BALLAST	The ballast resistor load is over 50% the configured maximum value.

12.2.1 Charger (option) warnings

If the built-in charger option is mounted in the IMD, the following warnings can be read from the charger warnings register:

Warning bit no.	Warning text	Description
0	BATTEMP	The battery temperature is more than 10ºC outside charging temperature limits (-20ºC to 50ºC). Lead acid only.
1	TEMPCHANNEL	The defined temperature sensor channel is not valid.
2	VinLOW	The input voltage from the DC-link is below 270 V DC.
3	Vin-VseLOW	The input voltage from the DC-link is not at least 15 V DC higher than the SE voltage.
4	LOWCURR.	The output current is too low compared to setpoint.

12.3 Errors log

The IMD has an error log containing up to 20 entries. The log is a rolling log using "First In First Out" principle, which means that it always contain the latest 20 errors generated by the IMD, with the latest error at the top. The log entries are available in the IMD Manager and through CAN/CANopen. Each entry contains the following parameter values at the time the error occurred (see description of the register in the Integration manual for details):

Information	Register	Description
IMD state	0x02	The state of the IMD
T-IGBT	0x4A	The numeric representation of the IGBT temperature
N act (filt)	0xA8	The filtered actual speed value in units
N cmd ramp	0x32	Speed command after ramp in units
I act (filt)	0x5F	Actual filtered current value in units
DC-link voltage	0xEB	The filtered voltage of the DC-link in units

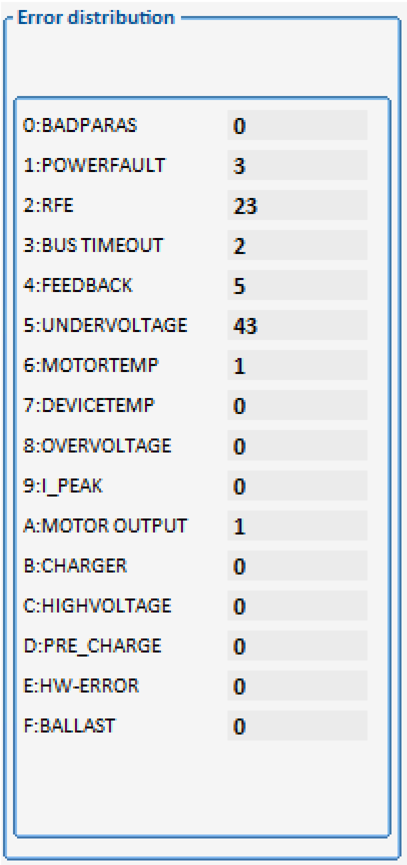
Information	Register	Description
Drive status	0x40	Bit map representation of the state of the internal flags
Logic in block	0x9B	Bit map representation of the state of digital inputs and some internal flags
Out block	0x98	Bit map representation of the state of digital outputs
Power board status	0x63	Status of the power board
Actual current limit	0x48	The current limit used at the time
Special command	0x03	The values of the special commands register. If a command was executed, the register contains the feedback for the command.
Error register value	0x8F	Active errors at the time the error occurred
ID	N/A	Special ID information for the error
Timestamp 1 (Device enabled)	N/A	A relative time stamp (seconds) for the entry indicating the time elapsed since the last time the device enabled flag was set
Timestamp 2 (power)	N/A	A relative time stamp (seconds) for the entry indicating the time elapsed since the last power on of the IMD
Timestamp 3 (life)	N/A	A relative time stamp (seconds) for the entry indicating the time elapsed since the IMD was delivered from the factory, or if the IMD is older, since the first time a firmware supporting error history was installed. This time counter only counts time when the IMD 24 V DC supply (external or internal) is on. For IMDs that were delivered with FW older than 1-08-0 (first FW with error log) the life time stamp is relative to the time when the first FW supporting error log was installed on the IMD.

The last error further contains the following parameter values at the time the error occurred (Extra info):

Information	Register	Description
Actual position	0x6D	The actual position based on the resolver and rounds count
Actual position SSI	0x6F	The actual position based on the SSI encoder count
1st error in power board	0x94	First error (code) on power board since last clear error command.
Ballast energy counter (L) and Current overload integral (H)	0x45	Values of Ballast energy counter (low 16 bits), Current overload integral (High16 bits),
SE voltage	0x66	Numeric value of the safe energy voltage
SE mid-point voltage	0x61	Numeric value of the safe energy mid-point voltage
T-air	0x4B	Numeric value of the air temperature inside the IMD
(dbg) *temp	0x9A	Dynamic pointer register used for debug by DEIF engineers
(dbg) *ptr1	0xB8	Dynamic pointer register used for debug by DEIF engineers

Information	Register	Description
(dbg) *ptr2	0xBA	Dynamic pointer register used for debug by DEIF engineers
(dbg) ptr1	0xB7	Dynamic pointer register used for debug by DEIF engineers
(dbg) ptr2	0xB9	Dynamic pointer register used for debug by DEIF engineers

The error log also contains a distribution representation of all errors occurred during the “Elapsed time:life” (the time elapsed since the first FW supporting error history was installed), showing how many times each error appears in the log:



13. Parameter description

This section describes the parameters and CANopen objects that can be used in the IMD. Internal parameters are not included in this description since they have no value for the user. Where bit mapping is relevant, it is described separately in section 13.2 on page 197. The full parameter list can be found in section 13.3 on page 211.

The parameters are identified by their name. Each parameter is mapped to a specific memory registry address (Reg. ID). The same number as the address is also used as a CANopen object. For example, Motor_Nom_V parameter that has a registry address 0x06, has a CANopen object ID: 2006.

13.1 Parameter types

Parameters are used for different purposes depending on their types. Some parameters are used instead of constants in the SW, some parameters are used to invoke an action, some are for configuration purposes and so on. The purpose of a parameter can be determined by its type. The following table describes the different parameter types:

Table 31 Parameter types

Type	Typical access rights	Description
Configuration	Read / write	Parameters used for static configuration of the system. These parameters are typically only configured once before commissioning. Example of a configuration parameter is Maximum peak current (0xC4).
Status	Read only	Parameters used for information about different states and other information about the current state of the IMD. Typical example of a state parameter is Logic in block, used to determine the state of the digital inputs (0x9B).
Protected	Read only	These parameters are used for values that needs to be configured by the manufacturer, but may not be changed by the users. Even though the seemingly access rights for these parameters are Read/write, it is not possible to write to these parameters. Example of a protected parameter is the Device design current (0xC6).
Set-point	Read / write	Parameters that are typically used by the application SW. They would usually be accessed through CAN/CANopen, but they can also be used from the IMD Manager. It is not necessary to invoke an action after a change. Action will be taken automatically by the IMD. An example of a special parameter is a position destination (0x6E).
Special	Read / write	Parameters that are typically used by the application SW. They would usually be accessed through CAN/CANopen, but they can also be used from the IMD Manager. It is not necessary to invoke an action after a change. Action will be taken automatically by the IMD. An example of a special parameter is a Device enable (0x51).
Function	Read / write	Parameters that invoke and action of the IMD. Typically, it is the write operation to these registers that invokes a specific action. In two functions (EEPROM operations, 0x83 and 0x84) the value of the write operation, defines which configuration to load/save. An example of a function parameter is Cancel Errors (0x8E).

13.2 Parameter bit mapping

This section describes the mapping of bits in parameters where single or multiple bits represent specific setting or state.

Attention
“Not used” or “Reserved” bits must not be changed.

13.2.1 User options (01)

See also general definition of the parameter in the parameter list.

Table 32 Reg. ID 0x01, CANopen Object ID 2001

Bit	Name	Description
Bit 0	TEMP_MOTOR_PT	Motor temperature sensor: 0: KTY 84/PTC 1: Pt100
Bit 1	ON_TIME_PT	PT100 filter: 0: standard low-pass filter 1: extended low-pass filter
Bit 2	SSI_TYPE	Type of SSI encoder: 0: 12+12 (Multi-turn) 1: 12+1 (single-turn)
Bit 3	Not used	
Bit 4	DIRECT_SAFETY_RUN	Device enabled if no limit switch is active at start-up: 0: Drive must be enabled in order to make a safety run 1: No extra command is needed to initiate a safety-run (disabled if motor temperature < -18°C)
Bit 5	SE_TEST_ANYWHERE	Safe energy test initiation: 0: SE test can only be executed if a limit switch is activated 1: SE test can be executed with no regards to limit switch
Bit 6	AC_RESTART_ SAFETY_RUN	Safety run when AC mains return after AC mains missing during safety run: 0: No new safety run 1: A new safety run is automatically initiated when the AC mains returns while the IMD is in state 12 (Safety-run pending). The IMD goes to state 12 if the AC mains is missing during a safety run.
Bit 7	I_MAX_EXTEND	Permissible value of I max peak: 0: I max pk can be maximum 100% 1: I max pk can be maximum 115% (with reduced T-peak)
Bit 8..10	Reserved	

Bit	Name	Description
Bit 11	CHARGER_ERROR_TRIP_S_CHAIN	Behaviour of the IMD on charger error: 0: Charger errors remain as warnings and do not escalate to errors. Safety-chain is not tripped, and safety run is not performed. 1: Charger errors escalate to errors after the Charger timeout, thus tripping safety-chain and causing a safety run.
Bit 12..14	SE_TEST_PWM_TIME	SE test current resistor PWM or time factors: See description in section 8.4.5 on page 97 .
Bit 15	SE_TEST_LONG_SINGLE_PULSE	Enables long single pulse for SE test. See description in section 8.4.5 on page 97
Bit 16..18	PREHEAT_CURRENT	Current used during pre-heat: 0: 1/8 of I con eff 1: 2/8 of I con eff 2: 3/8 of I con eff 3: 4/8 of I con eff 4: 5/8 of I con eff 5: 6/8 of I con eff 6: 7/8 of I con eff 7: 8/8 of I con eff
Bit 19	PREHEAT_MODE	Preheat Mode: 0: Iq from Speed 0 1: Iq from Torque 0
Bit 20.. 21	BALLAST_ENERGY_COOLING	Devisor for adaptation to cooling ability of the ballast resistor. Lowest devisor is for lowest cooling ability. 0: / 8 1: / 6 2: / 4 3: / 2
Bit 22	MANUAL_OP_360_ENABLE	0: The use of manual operation 360 is disabled 1: The use of manual operation 360 is enabled
Bit 23	SCI_STATE_MAN_OP	0: Manual operation can only be used if SCI inputs state is OK 1: Manual operation can only be used if SCI inputs state is not OK
Bit 26..27	LVRT_TIMER	Configuration of LVRT timer: 0: LVRT timer is disabled 1: Safety run is performed 5 seconds after a mains failure 2: Safety run is performed 10 seconds after a mains failure 3: Safety run is performed 15 seconds after a mains failure

Bit	Name	Description
Bit 28	SAFETY_RUN_RESTART_ON_LS1	New safety run after limit switch 1 cycle: 0: No automatic safety run possible after limit switch 1 is activated and the IMD is in state 16 (parked tripped) 1: If limit switch 1 is deactivated while in state 16 (parked tripped) a new safety run is automatically initiated
Bit 29	S-RUN-SPEED_PROFILE	Enables speed profile in safety run
Bit 30	MANUAL_OP_ENABLE	0: The use of manual operation is disabled 1: The use of manual operation is enabled
Bit 31	BRAKE_HALF_POWER	0: Full output power for the brake 1: Half output power for the brake

13.2.2 User state (02)

See also general definition of the parameter in the parameter list and a description in section 6.1 on page 55, where most of the states are described. In the full list that follows, the path states are also listed. Path states are states that are used to get into (xx entry), or get out from another state (xx exit).

Some debug states are omitted from the list.

Table 33 Reg. ID 0x02, CANopen Object ID 2002

Value	State
0	PwrOn Delay
1	Normal Operation
2	PwrOn Checking
3	PwrOn @Parked
4	PwrOn not parked cold
5	PwrOn not parked
6	Start-up Fatal error
7	PwrOn @Parked tripped
8	CAN timeout
9	Blind safety run initiate
10	Error- SCR tripped
11	Safety run step 0
12	Safety run pend.
13	Park not enable
14	Safety run succeeded
15	Safety run timeout
16	Parked tripped
17	Parked ready

Value	State
18	Safety-run timed out
19	Safety run setup
20	Park blind safety run exit
21	SE-test entry
22	SE-test HV
23	SE-test HV rest
24	SE-test ready
25	SE-test PWM ON
26	SE-test rest 0
27	SE-test rest 1
28	SE-test PWN rest
29	SE-test ready PWM
30	SE-test exit
31	Pre-heating entry
32	Pre-heating on
33	Pre-heating exit
34	Pos. Preset entry
35	Pos. Preset
36	Pos. Preset exit
37	Batt SC trip
38	Pos. store cmd
39	Pos. store timed
40	Brake test
41	Brake test exit
42	Pre-heating warning
43	Usr Oper. Mains, disconnect
51	Pos. store timed Mains, disconnect
52	SE-test pulse ON
53	SE-test pulse rest
54	Safety run step 1
55	Safety run step 2
56	Safety run step 3
57	Safety run step 4

Value	State
58	Safety run setup 0
59	Manual operation mode
60	Manual operation mode exit

13.2.3 User demand (03)

See also general definition of the parameter in the parameter list. This is the full list that is also used as feedback.

Table 34 Reg. ID 0x03, CANopen Object ID 2003

Value	Name	Description
0	Idle	Use to terminate present function
1	Illegal / unexpected cmd from this state / condition	A special command that is not legal or from the present state or condition was executed
2	Pre-heating	Starts pre-heat
3	SE-test initiated	Initiates a safe energy test
4	Position preset	Enables preset position
5	SE-test, PWM load ON	Turns output modulation for safe energy test on
6	SE-test load OFF	Turns output for safe energy test off. This command will also stop a pulse.
7	Store position	Stores present position
8	Brake test ON	Initiates a brake test
9	RUN input is low	The requested command cannot be executed because the RUN input is low
10	Enabled is still ON	The requested command cannot be executed because the device is still enabled
11	Enabled is still OFF	The requested command cannot be executed because the device is still disabled
12	Mains disconnect	Disconnects AC mains from the DC-link
13	Mains connect	Connects AC mains to the DC-link
14	Trip SCR output	Turns the Safety-chain relays off
15	SE-test, single pulse load ON	Turns output pulse for safe energy test on
16	Mains OFF HV	Disconnects AC mains from the DC-link, with no possibility of automatic reconnection
17	Fan ON	Turns the fan on
18	Fan OFF	Turns the fan off.
19	USR_DEMAND_19	Not used
20	USR_DEMAND_20	Not used

Value	Name	Description
21	Restart IMD	Restarter the IMD. Se section 9.12 on page 142 for more information.
22	Enable IMD restart	Enables IMD restart through special commands (command 21) in the IMD manager, or through CAN. Se section 9.12 on page 142 for more information.
28	SE discharge ON	Connects the ballast resistor to the safe energy to discharge ultra-capacitors. Se section 9.13 on page 145 for more information.
29	SE discharge OFF	Disconnects the ballast resistor from the safe energy to stop discharging ultra-capacitors. Se section 9.13 on page 145 for more information
31	Clear errors	Clears errors in the IMD. Has the same function as the “Clear errors” button in the IMD manager.
32	Initiate safety-run	Initiates a safety run. Has the same function as the “S-run” button in the IMD manager.

13.2.4 Drive status (40)

See also general definition of the parameter in the parameter list.

This register is read only and indicates the status of different functions in the IMD.

Table 35 Reg. ID 0x40, CANopen Object ID 2040

Bit	Name	Description
Bit 0	Dev.Enabled	0: Drive disabled, 1: Drive enabled (hardware enable)
Bit 1	NcR0	1: Speed control (as well as torque control) is disabled. The switch to the speed ramp is disabled and the N cmd (ramp) is set to zero.
Bit 2	Lim.sw+	1: The logical input assigned as Limit plus is active
Bit 3	Lim.sw-	1: The logical input assigned as Limit minus is active
Bit 4	OK	This flag is turned on (from 0 to 1) the first time the IMD is enabled, and stays on as long as the IMD has power (24 V DC). Once active, it stays active with no regards to the state of the IMD.
Bit 5	I_red_to_I-con-eff	1: Current is limited (reduced) to I-con-eff (I-nom) due to 100% overload energy integral
Bit 6	N-limited T mode	1: when all the following conditions are true: • Speed limit in torque mode is active (M-set, Reg. 0x90 <> 0) • Motor is running • N-limit is < 100%
Bit 7	Position-control	1: Position control is enabled (Pos Kp > 0)
Bit 8	Speed-control	1: Speed control is enabled (Speed Kp > 0)
Bit 9	Low speed	1: Actual speed is very low (almost stopped)

Bit	Name	Description
Bit 10	Ref.sw	1: The logical input assigned as Ref.sw is active. If two inputs are defined as Ref.sw, any of the inputs can turn this ON (1).
Bit 11	Cal0	1: The IMD state is Safety run (state 11)
Bit 12	Cal	1: The IMD state is Normal operation (state 1).
Bit 13	Tol	1: Actual position within the position tolerance window
Bit 14	SCR 1 and 2	0: Safety Chain Relay output is open (tripped) 1: Safety Chain Relay output is closed (OK)
Bit 15	Brake delay on	1: Brake delay is active (only while the delay is actually active)
Bit 16	SignMag	1: The speed value is reversed through logic input (N cmd Reverse)
Bit 17	N limit	1: when all the following conditions are true: • When the N-limit (Reg. 0x34) is configured to < 90% • The IMD is in Normal operation state.
Bit 18	N limit +	1: when all the following conditions are true: • Positive direction speed limit is configured to <100% • N-clip is enabled (either through logic input configuration or through CAN command) • The IMD is in normal operation state.
Bit 19	N limit -	1: when all the following conditions are true: • Negative direction speed limit is configured to <100% • N-clip is enabled (either through logic input configuration or through CAN command) • The IMD is in normal operation state.
Bit 20	I red:I-lim-SE-Dig	1: when all the following conditions are true: • I-lim-SE-Dig limit is configured to <100% I-lim-SE-Dig is enabled (either through logic input configuration or through CAN command or AC mains supply missing
Bit 21	Imax-overl-reached	1: The maximum allowed overload energy integral is reached.
Bit 22	I reduced:I-red-N	1: The current is limited due to speed above I-red-N
Bit 23	I reduced:I-red-TD	1: Current is limited (less than I max) because drive temperature reached I-red-TD
Bit 24	I reduced:I-red-TE	1: Current is limited to I-nom because drive temperature reached I-red-TE
Bit 25	>10Hz	1: Output frequency is higher than 10Hz
Bit 26	I reduced:I-red-TM	1: The current is reduced because motor temperature reached I-red-TM
Bit 27	Ird-Ana	Not used
Bit 28	Overload-warning	1: The overload energy is almost used

Bit	Name	Description
Bit 29	Reserved	Not used
Bit 30	I-limit-M-mode	Configuration state of maximum current limit (configured by 0x52, CAN): 0: Imax pk (0xC4) is used as current limit 1: The smallest value of Motor I max (0x4D) and Imax pk (0xC4) is used as current limit
Bit 31	HndWhl	Not used

13.2.5 Device mode (51)

Changing a bit in this register to one executes a command. The command is executed once and the register keeps the last value written. To execute another command or the same command again, write to the register again. This register is used by the application SW during operation.

See also general definition of the parameter in the parameter list.

Table 36 Reg. ID 0x51, CANopen Object ID 2051

Bit	Name	Description
Bit 0	Reserved	
Bit 1	SPEED = 0	Forced speed command value = 0 (NcR0). No speed command is executed while this bit = 1.
Bit 2	ENABLE OFF	Disable Drive
Bit 3	Reserved	
Bit 4	Reserved	
Bit 5	I-LIMIT-DIG	Activate I-lim-SE-Dig
Bit 6	N-clip	Activate “N limit+” and “N limit-“ speed limiting
Bit 7	Reserved	
Bit 8	Reserved	
Bit 9	Reserved	
Bit 10	Reserved	
Bit 11-15	Not defined	

13.2.6 Device option (5A)

See also general definition of the parameter in the parameter list.

Table 37 Reg. ID 0x5A, CANopen Object ID 205A

Bit	Short symbol	Description
Bit 0	Reserved	
Bit 1	BALLAST_EXT	Overload calculation algorithm. Must always be 1
Bit 2	Reserved	

Bit	Short symbol	Description
Bit 3	CoastStop	0: Coast-stop off. The motor is held in position also when stopped 1: Coast-stop on. The motor is in free run when stopped Use always zero.
Bit 4	Reserved	Protected bit, HW depended setting
Bit 5	Reserved	Do not change
Bit 6	Reserved	Do not change
Bit 7	Reserved	Protected bit, HW depended setting
Bit 8	Start-up DELAY	0: No delay (default) 1: Additional start-up delay (1.8 s)
Bit 9	Reserved	Do not change
Bit 10	Reserved	Do not change
Bit 11	Reserved	Do not change
Bit 12..13	MotorType	0: Sync.Servo 1: Async. V/F (without resolver) 2: Async.Servo 3: DC motor
Bit 14	Reserved	Protected bit, HW depended setting
Bit 15	lowbd	Baud rate for serial/USB connection (always use zero): 0: 115200 1: 9600
Bit 16	Reserved	Do not change
Bit 17	Reserved	Do not change
Bit 18	Reserved	Do not change
Bit 19	Reserved	Protected bit, HW depended setting
Bit 20..22	PWMfr	Switching frequency. Only values 0, 4, 6 and 7 are supported. 0: 8 kHz 1: 24 kHz 2: 20 kHz 3: 16 kHz 4: 12 kHz 5: 8 kHz i16 6: 6 kHz i12 7: 4 kHz i8
Bit 23	NTC	0: Positive motor temperature sensor 1: NTC Temp-motor (SW change of the proportional error and warning limits only)
Bit 24	Reserved	Do not change
Bit 25	DC_1QdirVolt	Protected bit, HW depended setting
Bit 26	DC_field	DC motor with field control. Not supported.
Bit 27	DEAD_2	deadband*2

Bit	Short symbol	Description
Bit 28	Reserved	Not used
Bit 29	DC_1QMV	DC motor related. Do not change.
Bit 30	DC_1Q3P	DC motor related. Do not change.
Bit 31	Reserved	Do not change

13.2.7 Errors/warnings (8F)

See also general definition of the parameter in the parameter list.

See errors and warnings description in section 12.1 on page 189 .

Table 38 Reg. ID 0x8F, CANopen Object ID 208F

Bit	Name
Bit 0	Error 0: BADPARAS
Bit 1	Error 1: POWER FAULT
Bit 2	Error 2: RFE open
Bit 3	Error 3: BUS TIMEOUT
Bit 4	Error 4: FEEDBACK
Bit 5	Error 5: UNDERVOLTAGE
Bit 6	Error 6: MOTORTEMP
Bit 7	Error 7: DEVICETEMP
Bit 8	Error 8: OVERVOLTAGE
Bit 9	Error 9: I _PEAK
Bit 10	Error A: MOTOR OUTPUT
Bit 11	Error B: CHARGER
Bit 12	Error C: HIGHVOLTAGE
Bit 13	Error D: PRE_CHARGE
Bit 14	Error E: HW-ERROR
Bit 15	Error F: BALLAST
Bit 16	Warning 0: BADPARAS
Bit 17	Warning 1: Warning 1 (not used)

Bit	Name
Bit 18	Warning 2: Warning 2 (not used)
Bit 19	Warning 3: COMCHARGER
Bit 20	Warning 4: FEEDBACK
Bit 21	Warning 5: POWERVOLTAGE
Bit 22	Warning 6: MOTORTEMP
Bit 23	Warning 7: DEVICETEMP
Bit 24	Warning 8: Warning 8 (not used)
Bit 25	Warning 9: I_PEAK
Bit 26	Warning A: Warning A (not used)
Bit 27	Warning B: CHARGER
Bit 28	Warning C: HIGHVOLTAGE
Bit 29	Warning D: Warning D (not used)
Bit 30	Warning E: HW-warning
Bit 31	Warning F: BALLAST

13.2.8 Logic Out block (98)

See also general definition of the parameter in the parameter list.

Table 39 Reg. ID 0x98, CANopen Object ID 2098

Bit	Name	Description
Bit 0	DO1	0: Dout 1 OFF, 1: Dout 1 ON
Bit 1	DO2	0: Dout 2 OFF, 1: Dout 2 ON
Bit 2	DO3	0: Dout 3 OFF, 1: Dout 3 ON
Bit 3	DO4	0: Dout 4 OFF, 1: Dout 4 ON
Bit 4	DO5	0: Dout 5 OFF, 1: Dout 5 ON. Can also be mapped from “Logic-5”
Bit 5	DO6	0: Dout 6 OFF, 1: Dout 6 ON. Can also be mapped from “Logic-6”
Bit 6	DO7	0: Dout 7 OFF, 1: Dout 7 ON. Can also be mapped from “Logic-7”
Bit 7	DO8	0: Dout 8 OFF, 1: Dout 8 ON. Can also be mapped from “Logic-8”
Bit 8	RO	0: RO OFF, 1: RO ON
Bit 9 - 15	Not used	

13.2.9 Logic in block (9B)

See also general definition of the parameter in the parameter list.

Table 40 Reg. ID 0x9B, CANopen Object ID 209B

Bit	Short symbol	Description
Bit 0	RFE	0: disable the IGBTs by hardware, 1: enable operation
Bit 1	RUN	0: motor drive is disabled, 1: motor drive is enabled
Bit 2	LS_1	0: limit switch 1 is not activated, 1: limit switch 1 is activated
Bit 3	LS_2	0: limit switch 2 is not activated, 1: limit switch 2 is activated
Bit 4	DI1	0: Input is off, 1: input is on
Bit 5	DI2	0: Input is off, 1: input is on
Bit 6	DI3	0: Input is off, 1: input is on
Bit 7	DI4	0: Input is off, 1: input is on
Bit 8	DI5	0: Input is off, 1: input is on
Bit 9	DI6	0: Input is off, 1: input is on
Bit 10	DI7	0: Input is off, 1: input is on
Bit 11	DI8	0: Input is off, 1: input is on
Bit 12	DI9	0: Input is off, 1: input is on
Bit 13	DI10	0: Input is off, 1: input is on
Bit 14	DI11	0: Input is off, 1: input is on
Bit 15	DI12	0: Input is off, 1: input is on
Bit 16	SCI1	0: Input is off, 1: input is on
Bit 17	SCI2	0: Input is off, 1: input is on
Bit 18	X7 high	0: No voltage in X7, No power to brake output, 1: 24 V on X7
Bit 19		Not used
Bit 20	REGEN_25pc	Ballast load >= 25%
Bit 21	T_IGBT_60	Temp IGBT >= 60°C (hysteresis: off <55°C)
Bit 22		Not used
Bit 23	FAN	0: Fan not turning. 1: Fan turning.
Bit 24..27	SWITCH	Address of CAN ID switch on the front of the IMD (0 to 15)
Bit 28	BRK_OK	Indication of the brake connection status. 0: Impedance not within the expected range. Brake might not be connected, or another brake type is used. 1: Brake is connected.
Bit 29	MAIN_OFF	0: Mains OK. 1: No mains present or IMD in grid-off mode.

Bit	Short symbol	Description
Bit 30	OUT_ERR	0: Digital outputs driver OK. 1: Digital outputs driver overheated and all digital outputs are turned off.
Bit 31	SSI	0: no SSI connection detected, 1: SSI connection detected

13.2.10 User motor options (A4)

See also general definition of the parameter in the parameter list.

Table 41 Reg. ID 0xA4, CANopen Object ID 20A4

Bit	Value	Short symbol	Function
Bit 0..4 Position feedback selection	1	Resolver	Feedback resolver
	12	sensorless	Control without feedback sensor
Bit 5..15			Reserved

Info
Use only the listed values.

13.2.11 Logic in/out block state (D8)

See also general definition of the parameter in the parameter list.

Table 42 Reg. ID 0xD8, CANopen Object ID 20D8

Bit	Name	Description
Bit 0	Limit 1	0: Digital input limit 1 inactive, 1: Digital input limit 1 active
Bit 1	Limit 2	0: Digital input limit 2 inactive, 1: Digital input limit 2 active
Bit 2	Din 2	Result of Din2 logic: 0: Din2 false, 1: Din 2 true
Bit 3	Din 1	Result of Din1 logic: 0: Din1 false, 1: Din 1 true
Bit 4	RUN	0: Hardware enable inactive, 1: Hardware enable active
Bit 5	RFE	0: motor drive disabled, 1: motor drive enabled
Bit 6		Not used
Bit 7		Not used
Bit 8	Dout 1	0: Digital output Dout 1 inactive, 1: Digital output Dout 1 active
Bit 9	Dout 2	0: Digital output Dout 2 inactive, 1: Digital output Dout 2 active
Bit 10	SCR 1 and 2	0: Hardware relay output SCR inactive, 1: Hardware relay output SCR active
Bit 11	GO	0: Internal enable GO inactive, 1: Internal enable GO active
Bit 12	Dout 3	0: Digital output Dout 3 inactive, 1: Digital output Dout 3 active

Bit	Name	Description
Bit 13	Dout 4	0: Digital output Dout 4in active, 1: Digital output Dout 4 active
Bit 14	Mains, disconnect	0: Connection from rectifier to DC-link is ON, 1: Connection from rectifier to DC-link is Off
Bit 15	Brk1	0: brake delay inactive, 1: brake delay active

13.3 Parameter list

Some parameters which are not relevant are not described in this list. When a register is divided into two parts (H and L) each part is half of the register data type. Retrieval of data can only be done on a whole register. If the needed data is only part of the register (high/low), it must be processed after the register data is retrieved. Writing of data can only be done on a whole register. If the needed data is only part of the register (high/low), it must be processed before writing, so the whole 32 bits are written to the register.

In the parameter list table, divided registers are noted as H/L as well as the corresponding CAN objects, to indicate that multiple values are used within the same register.

Table 43 Parameter list

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x01	2001	User_options	Configuration	See bit mapping in section 13.2.1 on page 197	Binary bit mapping	N/A	0x00000002	U32	RW / RW
0x02	2002	User_State	Status	See value definition in section 13.2.2 on page 199	N/A	Num	N/A	U16	RO / RO
0x03	2003	User_demand	Function	See value mapping in section 13.2.3 on page 201.	0..32	Num	N/A	U16	RW / RW
0x05	2005	Fnom	Configuration	Rated motor frequency	1 .. 12000	Hz*10	2000	U16	RW / RW
0x06	2006	Unom	Configuration	Rated motor voltage	0 .. 1000	V	0	U16	RW / RW
0x07 L	2007 L	UF_T-DC	Configuration	Pre-magnetisation time	10 .. 2000	ms	0	U32	RW / RW
0x08 L	2008 L	UF_U-DC	Configuration	Voltage for pre- magnetisation	0.1 .. 100.0	% DC-Bus	0	U32	RW / RW
0x0A L	200A L	UF_Umin	Configuration	Min. voltage (boost)	0 .. 100	% DC-Bus	0	U32	RW / RW
0x0B L	200B L	UF_Fmin	Configuration	Min. frequency	0.0 .. 100.0	Hz	0	U32	RW / RW
0x0C L	200C L	UF_Ucorner	Configuration	Max. voltage	0.0 .. 100.0	%	0	U32	RW / RW
0x0D L	200D L	UF_Fcorner	Configuration	Frequency with max. voltage	1.0 .. 1000.0	Hz	0	U32	RW / RW
0x0E	200E	UF_PowF	Configuration	Motor power factor (cos Φ)	0 .. 65535	%	0	U16	RW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x1B	201B	Kern_Version / Firmware	Status	Firmware version	N/A	N/A	N/A	U16	RO / RO
0x1C	201C	I -Kp	Configuration	Current control Proportional amplification	0 .. 100	Num	10	U16	RW / RW
0x1D	201D	I –Ti	Configuration	Current control Integration time	0 .. 10000	µs	600	U16	RW / RW
0x1E	201E	Dig_CutOff	Configuration	Cutoff digital command in torque control mode	0 .. 32767	Num	0	U16	RW / RW
0x20	2020	I -Actual	Status	Actual current value	See section 10.4 on page 185	Num	N/A	I16	RO / RO
0x21	2021	I set(dig)	Set-point	Current set-point	See section 10.4 on page 185	Num	0	I16	RW / RW
0x22	2022	Icmd(ramp)	Status	Current (I) command value	See section 10.4 on page 185	Num	N/A	I16	RO / RO
0x23	2023	Id-ref	Status	D-current (reactive) reference	See section 10.4 on page 185	Num	N/A	I16	RO / RO
0x24	2024	Imax inuse	Status	Limit of the maximum allowed current at present time.	See section 10.4 on page 185	Num	N/A	U16	RO / RO
0x25	2025	Ramp time	Configuration	Ramp time for 100 % current set point	2000 .. 32000	µs	2000	U16	RW / RW
0x26	2026	Iq -Cmd	Status	Current Command value	See section 10.4 on page 185	Num	N/A	I16	RO / RO
0x27	2027	Iq actual	Status	Q-current actual	See section 10.4 on page 185	Num	N/A	I16	RO / RO
0x28	2028	Id actual	Status	D-current actual	See section 10.4 on page 185	Num	N/A	I16	RO / RO
0x29	2029	Vq	Status	Q-Output voltage	±4095	Num	N/A	I32	RO / RO

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x2A	202A	Vd	Status	D-Output voltage	±4095	Num	N/A	I32	RO / RO
0x2B	202B	I -TiM	Configuration	Limit value for integral component (current controller)	0 .. 100	%	90	U16	RW / RW
0x2C	202C	N -Kp	Configuration	Proportional amplification speed controller	0 .. 200	Num	10	U16	RW / RW
0x2D	202D	N -Ti	Configuration	Integral action time (Integral part) speed controller	0 .. 10000 (0 = off)	ms	6	U16	RW / RW
0x2E	202E	N -Td	Configuration	Advancing-time (Differential part) speed controller	0 .. 65535 (0 = off)	1/ms	0	U16	RW / RW
0x30	2030	N -Actual	Status	Speed actual value	±32767	Num	N/A	I16	RO / RO
0x31	2031	N –Set(dig)	Set-point	Digital Speed Set Point	±32767	Num	N/A	I16	RW / RWW
0x32	2032	N -Cmd Ramp	Status	Speed command value after Ramp	±32767	Num	N/A	I16	RO / RO
0x33	2033	N -Error	Status	Speed setpoint minus actual speed in numeric	±32767	Num	N/A	I16	RO / RO
0x34	2034	N-Limit	Configuration	Global speed limit	±32767	Num	32767 (100%)	I16	RW / RWW
0x35H	2035	Accel.	Configuration	Torque command acceleration value	1 .. 10000	ms	0x0001 (1 ms)	U32	RW / RW
0x35L	2035	Accel.	Configuration	Speed command acceleration value	1 .. 32000	ms	0x012c (300 ms)	U32	RW / RW
0x38	2038	Iq error	Status	Q-current error feedback (active current)	±32767	Num	N/A	I16	RO / RO
0x39	2039	Id error	Status	D-current error feedback (reactive current)	±32767	Num	N/A	I16	RO / RO
0x3B	203B	N -TiM	Configuration	Limit value for integral component (speed controller)	0 .. 100 0 = off	%	10	U16	RO / RW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x3C	203C	I-red-N	Configuration	Speed when current reduction starts	0 .. 32767	Num	0	U16	RO / RW
0x3D	None	READ	Function	Read a specific register, and at the same time it is possible to configure the IMD to auto report through CAN a specific parameter value at the configured auto report interval. Maximum eight registers can be configured to auto report.	**Low byte:** register to read **High byte:** auto-report cycle time in ms. 0 disables auto-read, 255 returns the active auto-read object index for this register.	Num	N/A	N/A	RW / RW
0x3E	203E	N-lim -	Configuration	Negative speed limit. Needs to enabled in 0x51 (bit 6).	-32768 .. 0	Num	-32768 (100%)	I16	RW / RW
0x3F	203F	N-lim +	Configuration	Positive speed limit. Needs to enabled in 0x51 (bit 6).	0 .. 32767	Num	32767 (100%)	I16	RW / RW
0x40	2040	State Bits	Status	State Bits; see section 13.2.4 on page 202	Binary bit mapping	N/A	N/A	U32	RO / RO
0x42	2042	MPOS_Actual_Mech	Status	Actual rotor position	±32767	Num	N/A	I16	RO / RO
0x43	2043	MPOS_Actual_Elec	Status	Actual rotor position within one electrical phase	±32767	Num	N/A	I16	RO / RO
0x44	2044	Resolver Offset	Configuration	Resolver phase angle correction	±3600	0.1 degree	0	I16	RW / RW
0x45 L	2045 L	Monitor_ballast	Status	Ballast energy counter	0 .. 1000	Num	N/A	I32	RO / N/A
0x45 H	2045 H	Monitor_IxT	Status	Current overload integral	0 .. 100	Num	N/A	I32	RO / RO
0x46	2046	I -Lim-Dig	Configuration	Value in percent for the digital current reduction (enables in 0x51, bit 5)	327 .. 32767 (1 .. 100%)	Num	32767 (100%)	U16	RW / RW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x47 L	2047 L	VLMS-low	Configuration	Number of revolutions for the low virtual limit switch. Value of zero in reg 2047 disables virtual limit switches.	0 .. 32767	Revo-lution	0	I32	RW / RW
0x47 H	2047 H	VLMS-high	Configuration	Number of revolutions for the high virtual limit switch. Value of zero in reg 2047 disables virtual limit switches.	0 .. 32767	Revo-lution	0	I32	RW / RW
0x48	2048	I –Lim_inuse	Status	Actual used current limit.	See section 10.4 on page 185 .	Num	N/A	I16	RO / RO
0x49	2049	T -Motor	Status	Motor temperature. See also section 10.3.2 on page 172 (KTY 84) and section 10.3.3 on page 176 (Pt100)..	0 .. 65535	Num	N/A	U16	RO / RO
0x4A	204A	T -IGBT	Status	IGBT module temperature. See also section 10.3.1 on page 170.	0 .. 65535	Num	N/A	U16	RO / RO
0x4B	204B	T -Air	Status	Air temperature in the servo. See also section 10.3.5 on page 182.	0 .. 65535	Num	N/A	U16	RO / RO
0x4C	204C	I-red-TE	Configuration	See section 8.5.3 on page 110.	0 .. 32767 0 = off.	Num	0	U16	RW / RW
0x4D	204D	I -Motor max	Configuration	Peak current limiting for the motor (motor type plate value)	1 .. 65535	0.1 A_{rms}	1200 (120 A)	U16	RW / RW
0x4E	204E	I -Motor con	Configuration	Continuous current rating for the motor (motor type plate value)	1 .. 65535	0.1 A_{rms}	600 (60A)	U16	RW / RW
0x4F	204F	Motor Pole	Configuration	No. of motor poles	2 .. 96	Num	8	U16	RW / RW
0x51	2051	Mode Bit	Special	Mode bits; see bit mapping in section 13.2.5 on page 204	Binary bit mapping	N/A	0x0004	U16	RW / RW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x52	2052	STATUS_Mask	Special	Proprietary CAN only: Bitmask for register 0x40 transmission on update.	Binary bit mapping	N/A	0x0000f811	U32	RO / RW
0x54	2054	I1_actual	Status	Actual current value phase 1	See section 10.4 on page 185 .	Num	N/A	I16	RO / RO
0x55	2055	I2_actual	Status	Actual current value phase 2	See section 10.4 on page 185 .	Num	N/A	I16	RO / RO
0x56	2056	I3_actual	Status	Actual current value phase 3	See section 10.4 on page 185 .	Num	N/A	I16	RO / RO
0x58	2058	I-red-TD	Configuration	See section 8.5.3 on page 110.	0 .. 32767 0 = off	Num	0	U16	RW / RW
0x59	2059	N –Motor nom	Configuration	Rated motor speed according to motor type plate	60 .. 65000	RPM	3000	U16	RW / RW
0x5A	205A	Option bit	Configuration	Option bit; see section 13.2.6 on page 204	Binary bit mapping	N/A	0x00044096	U32	RW / RO
0x5B	205B	Kacc	Configuration	Acceleration amplification (feed forward).	0 .. 100	%	0	U16	RW / RW
0x5D	205D	N cmd (int)	Status	Speed command value before ramp	±32767	Num	N/A	I16	RO / RO
0x5E	205E	N -Filter	Configuration	Speed actual value filter: Averaging level of resolver input	0 .. 15	Num	1	U16	RW / RW
0x5F	205F	I act (filt)	Status	Filtered, actual current value for display in IMD Manager	±32767	Num	N/A	I16	RO / RO
0x61	2061	VDC_BAT_MID	Status	Battery mid-point voltage (SEM terminal)	0 .. 32768 See section 10.2 on page 170	Num	N/A	U16	RO / RO
0x62	2062	SNr.	Configuration	IMD serial number / DEIF order no.	0 .. 4294967295	Num	N/A	U32	RO / RO

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x63	2063	Power board status	Status	Power boards status	0 .. 65535	Num	N/A	U16	RO / RO
0x64	2064	Device mains	Configuration	Device nominal voltage.	N/A	N/A	400	U16	RW / RW
0x65L	2065L	Ballast P	Configuration	Regenerative Resistor – Power rating	25 .. 5000	W	0x012c (300 W)	U32	RW / RW
0x65H	2065H	Ballast R	Configuration	Regenerative Resistor – Resistance value	8 .. 100 (maximum 40 Ω recommended)	Ω	0x0014 (20 Ω)	U32	RW / RW
0x66	2066	Vdc Bat	Status	Filtered battery voltage (“SE+” terminal)	0 .. 32768 See section 10.2 on page 170	Num	N/A	U16	RO / RO
0x67	2067	Device type	Configuration	Device type	Low byte value: 66: IMD 122A 67: IMD 122 B 70: IMD 122 C 71: IMD 135 C	Num	Value of the device type	U32	RO / RO
0x68	2068	CAN Rx ID	Configuration	CAN Receive address / CANopen Node ID	See CAN/CANopen section 7.1 on page 66	COB-ID	513	U32	RW / RW
0x69	NONE	CAN Tx ID	Configuration	CAN Transmit address / (Not used in CANopen)	See CAN/CANopen section 7.1 on page 66	COB-ID	385	U32	RW / RW
0x6A	206A	POS_Kp	Configuration	Position to Speed Proportional amplification	0 .. 500	Num	20	U16	RW / RW
0x6B	206B	POS_Ti	Configuration	Integral action time (Integral part) position controller P-N	0 .. 10000	ms	0	U16	RW / RW
0x6C	206C	POS_KD	Configuration	Advancing-time (differential part) position controller	30 to 2000	Num	N/A	U16	RW / RW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x6D	206D	POS -Actual	Status	Actual position	± 2147483647	Num	N/A	I32	RO / RO
0x6E	206E	POS_Dest	Set-point	Position target command	± 2147483647	Num	N/A	I32	RW / RWW
0x6F	206F	POS_Actual_2	Status	Actual position from SSI encoder	± 2147483647	Num	N/A	I32	RO / RO
0x70	2070	POS -Error	Status	Position actual error	± 2147483647	Num	N/A	I32	RO / RO
0x71	2071	POS–TiM	Configuration	Position to Speed Max integration time memory	0 .. 100	%	0	U16	RW / RW
0x73	NONE	CAN_BTR	Configuration	CAN Bus Transfer Rate	See CAN/CANopen section 7.1 on page 66	Hex	0x21f4 (500 kbps, for CANopen)	U16	RW / RW
0x76 L	2076 L	N-safety run speed	Configuration	Safety run speed	0 .. 32767	Num	0x08ec (7 % of Nmax-100%)	I32	RW / RW
0x76 H	2076 H	N-safety run timeout	Configuration	Safety run timeout	0 .. 70	S	0x0032 (50 s)	I32	RW / RW
0x77 L	2077 L	N-blind safety run speed	Configuration	Used for blind safety run and resolver offset calibration speed	0 .. 32767	Num	0x0 (0 % of Nmax-100%)	I32	RW / RW
0x77 H	2077 H	N-blind safety run timeout	Configuration	Used for blind safety run and resolver offset calibration timeout	0 .. 350	S	0x0096 (150 s)	I32	RW / RW
0x78	2078	Fun_safety run	Function	Initiate or resume safety run	0 .. 65535	Num	N/A	U16	WO / WO
0x79	2079	POS_Tol_window	Configuration	Tolerance window for position	0 .. 32767	Num	8191	U16	RW / RW
0x7A	207A	POS_Preset	Set point	Used together with position preset function. Value in this register will be used as number of rounds.	± 2147483647	Num	N/A	I32	RW / RW
0x7C	207C	Userinfo_Pos_Scale	Configuration	Display-conversion scale	± 2147483647	Num	0	I32	RW / RW
0x7D	207D	Userinfo_Pos_Offset	Configuration	Display-conversion offset	± 2147483647	Num	0	I32	RW / RW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x81 L	2081 L	SE_warn_level	Configuration	Warning level for low SE voltage	0 .. 32767	Num	12288 (≈206 V)	U32	RW / RW
0x81 H	2081 H	DClink_low_level	Configuration	Error level for low DC-link voltage	0..32767	Num	8192 (≈137 V)	U32	RW / RW
0x82	2082	Serial_number_extension	Configuration	Device serial number ext. / DEIF order position no. and counter	0 .. 4294967295	Num	N/A	U32	RO / RO
0x83	2083	FUN_ParaRead	Function	Read parameter-set x from Eeprom into RAM	0 .. 2	Num	N/A	U16	WO / WO
0x84	2084	FUN_ParaWrite	Function	Write parameter-set x from RAM into Eeprom	0 .. 1	Num	N/A	U16	WO / WO
0x85	NONE	FUN_Special	Function	Used for special function select and feedback	N/A	Num	N/A	U16	RW
0x8A	208A	V-out	Status	Relative output voltage	0 .. 4095	Num	N/A	I16	RO / RO
0x8B	208B	V-red	Configuration	Begin of field weakening in percentage of VOUT. 0 or 100 disables field weakening.	0 .. 100	%	0	I16	RW / RWR
0x8C	208C	V-kp	Configuration	Proportional amplification field reduction	0 .. 65535	Num	1000	U16	RW / RW
0x8D	None	V-ti	Configuration	Integral amplification field reduction	0 .. 65535	Num	0	U16	RW / RW
0x8E	208E	FUN_ErrCancel	Function	Initiate clear error	0 .. 65535	Num	N/A	U16	WO / WO
0x8F	208F	Errors_Warnings map	Status	Error bits (0 - 15), and Warning bits (16 - 31), see section 13.2.7 on page 206	Binary bit mapping	N/A	N/A	U32	RO / RO
0x90	2090	M set	Set-point	Torque Set Point (based on the current). 15 bit (+/-) corresponds to 150 % of Device design current.	±32767	Num	N/A	I16	RW / RWW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x91	2091	Pos cmd	Status	Position Command value (int.)	± 2147483647	Num	N/A	I32	RO / RO
0x92	NONE	CAN_Error_BusOff	Status	CAN proprietary: CAN bus off error counter	0 .. 65535	Num	N/A	U16	RO / RO
0x93	NONE	CAN_ErrWriteTime	Status	CAN proprietary: CAN bus framing error counter	0 .. 65535	Num	N/A	U16	RO / RO
0x94	2094	Power_board_error_1	Status	First error (code) on power board since last clear error command.	0 .. 65535	Num	N/A	U16	RO / RO
0x95	NONE	CAN_CountRead	Status	CAN proprietary: CAN bus acknowledge error counter	0 .. 65535	Num	N/A	U16	RO / RO
0x96	NONE	CAN_CountWrite	Status	CAN proprietary: CAN bus CRC error counter	0 .. 65535	Num	N/A	U16	RO / RO
0x97	NONE	CAN_CountRej	Status	CAN proprietary: CAN bus bit error counter	0 .. 65535	Num	N/A	U16	RO / RO
0x98	2098	LOGIC_O_Block	Special	Digital outputs see bit mapping in section 13.2.8 on page 207	Binary bit mapping	N/A	0x0080	U16	RW / RWW
0x9B	209B	LOGIC_I_Block	Status	Digital inputs se bit mapping in section 13.2.9 on page 208	Binary bit mapping	N/A	N/A	U32	RO / RO
0x9C	209C	T_Pt100_1	Status	Pt 100 input 1 value. See also temperature conversion in section 10.3.4 on page 179 .	0 .. 4095	Num	N/A	I16	RO / RO
0x9D	209D	T_Pt100_2	Status	Pt 100 input 2 value. See also temperature conversion in section 10.3.4 on page 179 .	0 .. 4095	Num	N/A	I16	RO / RO
0x9E	209E	T_Pt100_3	Status	Pt 100 input 3 value. See also temperature conversion in section 10.3.4 on page 179 .	0 .. 4095	Num	N/A	I16	RO / RO

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0x9F	209F	T_Pt100_4	Status	Pt 100 input 4 value. See also temperature conversion in section 10.3.4 on page 179 .	0 .. 4095	Num	N/A	I16	RO / RO
0xA0	20A0	M actual	Status	Torque actual (based on the current). 15 bit (+/-) corresponds to 150 % of Device design current.	±32767	Num	N/A	I16	RO / RO
0xA2	20A2	I–red-TM	Configuration	Motor temperature threshold for current reduction	0 .. 32767	Num	5600	U16	RW / RW
0xA3	20A3	M-Temp	Configuration	Motor temperature error is generated and safety run is initiated. Warning is generated at 87.5% of this value.	0 .. 32767	Num	23000	U16	RW / RW
0xA4	20A4	MOTOR_Options	Configuration	Se bit mapping in section 13.2.10 on page 209	Binary bit mapping	N/A	0x2081	I16	RW / RW
0xA5H	20A5	DC-Bus Vmax	Configuration	Maximum DC-Bus voltage (High part of a 32 bits register).	0 .. 32767	Num	0xb850 (789 V)	U32	RW / RW
0xA5L	20A5	DC-Bus VVmin	Configuration	Minimum DC-Bus voltage. (Low part of a 32 bits register). 32767 corresponds to 200%	0 .. 32767	Num	0x4000 (274 V)	U32	RW / RW
0xA7	20A7	Resol. poles	Configuration	No. of resolver poles	2 .. 12	Num	2	U16	RW / RW
0xA8	20A8	N act (filt)	Status	Actual speed value (filtered)	±32767	Num	N/A	I16	RO / RO
0xAC	20AC	PWM1	Status	Pulse width modulation phase 1	4 kHz: 1560 ±1540 8 kHz: 780 ±760 12 kHz: 1520 ± 1520	Num	N/A	I16	RO / RO

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0xAD	20AD	PWM2	Status	Pulse width modulation phase 2	4 kHz: 1560 ±1540 8 kHz: 780 ±760 12 kHz: 1520 ± 1520	Num	N/A	I16	RO / RO
0xAE	20AE	PWM3	Status	Pulse width modulation phase 3	4 kHz: 1560 ±1540 8 kHz: 780 ±760 12 kHz: 1520 ± 1520	Num	N/A	I16	RO / RO
0xB1	20B1	MOTOR_LSig_Q	Configuration	Motor stator leakage inductance	0 .. 4294967295	mH	0	U32	RW / RW
0xB2	20B2	Id nom	Configuration	Nominal magnetising current	EC servo: ±200 Asynch.: 0 .. 500	Num	0	I16	RW / RW
0xB3	20B3	MOTOR_Magn_L	Configuration	Motor magnetising inductance (ASM)	0 .. 4294967295	mH	123	U32	RW / RW
0xB4	20B4	MOTOR_Rotor_R	Configuration	Rotor resistance	0 .. 4294967295	mΩ	0	U32	RW / RW
0xB5	20B5	Id min	Configuration	Minimum magnetising current	EC servo: -1000 .. 0 Asynch.: 0 .. Id nom (0xB2)	Num	-20	I16	RW / RW
0xB6	20B6	MOTOR_TR	Configuration	Time constant rotor	0 .. 4294967295	ms	2000	U32	RW / RW
0xBB	20BB	MOTOR_LSig_D	Configuration	Leakage inductance ph-ph	0 .. 4294967295	mH	0	U32	RW / RW
0xBC	20BC	MOTOR_Stator_R	Configuration	Stator resistance ph-ph	0 .. 4294967295	mΩ	123	U32	RW / RW
0xBD	20BD	MOTOR_Specs_Inertia	Configuration	Time constant stator	0 .. 4294967295	ms	0	U32	RW / RW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0xBE	20BE	DEFINE_Logic_End1	Configuration	Configuration of input logic function for Limit S. 1 (configured with IMD Manager)	N/A	N/A	32771	U16	RW / RW
0xBF	20BF	DEFINE_Logic_End2	Configuration	Configuration of input logic function for Limit S. 2 (configured with IMD Manager)	N/A	N/A	32771	U16	RW / RW
0xC0	20C0	DEFINE_Logic_DIn1	Configuration	Configuration of input logic function for Logic1<=DI 1 (configured with IMD Manager)	N/A	N/A	32768	U16	RW / RW
0xC1	20C1	DEFINE_Logic_DIn2	Configuration	Configuration of Input logic function for Configuration of input logic function for Logic2<=DI 2 (configured with IMD Manager)	N/A	N/A	32768	U16	RW / RW
0xC2	20C2	DEFINE_Logic_DOut 1	Configuration	Configuration of Output logic function for Logic-8<=DO 8 (configured with IMD Manager)	N/A	N/A	43078	U16	RW / RW
0xC3	20C3	DEFINE_Logic_DOut 2	Configuration	Configuration of Output logic function for Logic-7<=DO 7 (configured with IMD Manager)	N/A	N/A	19	U16	RW / RW
0xC4	20C4	I -Max	Configuration	Current limit, peak current. 100% = 16384 corresponds to 1.5*I device	0 .. 32767 (limited by device)	Num	16383	U16	RW / RWW
0xC5	20C5	I-continuous	Configuration	Current limit, continuous current 100% = 16384 corresponds to I device	0 .. I -Device	Num	16383	U16	RW / RWW
0xC6	20C6	I -Device	Configuration (protected)	Device design current (60A = 600)	0 .. 65535	0.1 A	600 (60 A)	U16	RO
0xC7 L	20C7 L	Fast dec. time	Configuration	Emergency stops time ramp, limit switch for 100 % speed command	1 .. 10000	ms	300	U32	RW / RWW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0xC7 H	20C7 H	Blind S-run acc..	Configuration	maximum speed during blind safety run (safety run without resolver feedback). Defined as percent of Nmax-100%. A negative value in this parameter means that the motor will run the other way.	1500 .. 25000	ms	2500	U32	RW / RWW
0xC8	20C8	Nmax 100%	Configuration	Maximum RPM for 100% (as Parameter)	1 .. 12000	rpm	3000	U16	RW
0xC9	20C9	xKp2	Configuration	Proportional amplification on overshoot current controller	0 or 100 .. 500	%	100	U16	RW / RWW
0xCB	20CB	Kf	Configuration	Feedforward amplification current controller	0 .. 65535	Num	0	U16	RW / RW
0xD0	20D0	CAN_TimeOut	Configuration	Timeout for the CAN/CANopen communication	0: No time out 1 .. 65535	ms	0	U16	RW / RW
0xD1	20D1	VAR1	Configuration	Comparison reference value 1	± 2147483647	Num	10000	I32	RW / RW
0xD2	20D2	VAR2	Configuration	Comparison reference value 2	± 2147483647	Num	3	I32	RW / RW
0xD3	20D3	VAR3	Configuration	Comparison reference value 3	± 2147483647	Num	10	I32	RW / RW
0xD4	20D4	VAR4	Configuration	Comparison reference value 4	± 2147483647	Num	661654959	I32	RW / RW
0xD8	20D8	LOGIC_IO_BitMap	Status	Logic assignment, see bit mapping in section 13.2.11 on page 209	Binary bit mapping	N/A	N/A	U16	RO / RO
0xD9	20D9	Current_200Pc	Status	Calibration value for 200 % nominal current (see 0xc6)	0 .. 65535	N/A	N/A	U16	RO / RO
0xDA	20DA	DEFINE_Logic_DOut 3	Configuration	Configuration of Output logic function for Logic-6<=DO 6 (configured with IMD Manager)	N/A	N/A	58899	U16	RW / RW

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0xDB	20DB	DEFINE_Logic_DOut 4	Configuration	Configuration of Output logic function for Logic-5<=DO 5 (configured with IMD Manager)	N/A	N/A	59155	U16	RW / RW
0xDD	20DD	JOGGING	Configuration	Configuration of manual operation parameters:				U32	RW / RW
				Bits 0-11: Speed for manual operation in % of Nmax-100 (max 12%)	0 .. 3932 (0 .. 12%)	Num			
				Bits 12-23 Acceleration ramp for manual operation (given as acceleration from 0 to Nmax-100)	0 .. 4095	mS			
				Bits 24-28: Max motor operation time	0 .. 31	S			
				Bits 29-31: Brake delay after operation	0 .. 7	S			
0xDE	20DE	Logic-6	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xDF	20DF	Logic-5	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE0	20E0	Logic-8	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE1	20E1	Logic-7	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE2	20E2	SCR 1 and 2	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE3	20E3	O_Go	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE4	20E4	LOGIC_I_Lmt1	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE5	20E5	LOGIC_I_Lmt2	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE6	20E6	LOGIC_I_In1	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE7	20E7	LOGIC_I_In2	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0xE8	20E8	LOGIC_I_RUN	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xE9	20E9	LOGIC_I_Fault	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xEA	20EA	LOGIC_I_Ballast	Status	See section 6.2 on page 61	0 .. 1	Num	N/A	U16	RO / RO
0xEB	20EB	V -DCBus	Status	DC-link voltage	0 .. 32767	Num	N/A	U16	RO / RO
0xEC	20EC	LOGIC_I_Los	Status	Resolver signal missing or faulty (2 bits)	0: OK 1: Resolver decoder error 2: HW detected loss of signal (LoS) 3: Both faults detected	Num	N/A	U16	RO / RO
0xED L	20ED L	Dec_time_torque	Configuration	Deceleration time for torque control	1 .. 32000	ms	300	U32	RW / RWW
0xED H	20ED H	Dec_time_speed	Configuration	Deceleration time for speed control	1 .. 10000	ms	1	U32	RW / RWW
0xEE	20EE	I -100Pct	Configuration	Current sensor adjustment	50 .. 2000	mV	842	U16	RO / RO
0xEF	20EF	LOGIC_O_NoFault	Status	No fault output	0 .. 1	Num	N/A	U16	RO / RO
0xF0	20F0	TIME_IPeak	Configuration	Over-current time. See also I max extended (0x01)	1 .. 6	s	5	U16	RW / RW
0xF1	20F1	Brake delay	Configuration	Response time motor brake	1 .. 1000	ms	250	U32	RW / RW
0xF2	20F2	Brake output	Status	Brake delay time is active (1 while the delay is on)	0 .. 1	Num	N/A	U16	RO / RO
0xF3	20F3	LOGIC_VO_Icns	Status	Current reduced to configured continuous current	0 .. 1	Num	N/A	U16	RO / RO
0xF4	20F4	LOGIC_VO_Toler	Status	Position is within tolerance window	0 .. 1	Num	N/A	U16	RO / RO

Reg ID	CAN open object	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access Mem/CAN
0xF5	20F5	LOGIC_VO_Less_N0	Status	Speed is almost zero	0 .. 1	Num	N/A	U16	RO / RO
0xF6	20F6	PowerOut	Status	Calculated power in use	0 .. 65535	Num	N/A	U16	RO / RO
0xF7	20F7	WorkOut	Status	Calculated work (accumulated power over time). After FFFF it starts with zero again.	0 .. 65535	Num	N/A	U16	RO / RO
0xF8	20F8	Axis label	Configuration	Axis Label, 4 ASCII characters	Bit 0 -7: first character Bit 8 .. 15: second character Bit 16 .. 23: third character Bit 24 .. 31: forth character	Binary	0	U32	RW / RW
0xFB L	20FB L	SAFTY_RUN_P_S1	Configuration	Safety run speed profile step 1: Bit 0 to 10:number of revolutions Bit 11 to 15:speed	Rev.: 0 .. 2048 Speed: 0 .. 32	0-10: revol. 11-15: num	0	U32	RW / RW
0xFB H	20FB H	SAFTY_RUN_P_S2	Configuration	Safety run speed profile step 2: Bit 0 to 10:number of revolutions Bit 11 to 15:speed	Rev.: 0 .. 2048 Speed: 0 .. 32	0-10: revol. 11-15: num	0	U32	RW / RW
0xFC L	20FC L	SAFTY_RUN_P_S3	Configuration	Safety run speed profile step 3: Bit 0 to 10:number of revolutions Bit 11 to 15:speed	Rev.: 0 .. 2048 Speed: 0 .. 32	0-10: revol. 11-15: num	0	U32	RW / RW
0xFC H	20FC H	SAFTY_RUN_P_S4	Configuration	Safety run speed profile step 4: Bit 0 to 10:number of revolutions Bit 11 to 15:speed	Rev.: 0 .. 2048 Speed: 0 .. 32	0-10: revol. 11-15: num	0	U32	RW / RW

13.3.1 Charger parameters

Info

The charger must be in Setup mode (Sub-object 7) to be configured.

All charger parameters have the same CANopen object ID: **2811** (for proprietary CAN see section 7.1.2.1 on page 68). Sub object is used to identify the different parameters. The following table lists all available parameters:

Sub object ID	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access
1	CHARGE_VOLTAGE_SCALED	Status	Charger actual output voltage	0 .. 65535	0.1 V	N/A	U16	RO
2	CHARGE_CURRENT_SCALED	Status	Charger actual output current	0 .. 65535	0.01 A	N/A	U16	RO
3	UC_CAP	Status	Ultra-capacitor capacity measurement value	0 .. 65535	1 mF	N/A	U16	RO
4	UC_ESR	Status	Ultra-capacitor total resistance measurement value	0 .. 65535	1 mΩ	N/A	U16	RO
5	MON_STATE	Status	Actual state of the charger. Note: When the charger is in state zero when in setup mode.	0: Disabled (Initialise) 1: Disabled (Off) 2: Disabled (idle) 3: Disabled (ready) 4: Charging (bulk) 5: Charging (absorption) 6: Charging (float) 7: SE test 8: Disabled (error)	N/A	N/A	U16	RO
6	MON_STAT_TIME	Status	Elapsed present state time.	0 .. 65535	s	N/A	U16	RO

Sub object ID	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access
7	SETUP_MODE	Configuration	Sets the charger in and out of Setup mode.	0x5555: Setup mode Any other value: not in programming mode	NUM	0	U16	RW
8	BUCONTROL	Configuration	Save and load parameters to / from EEPROM.	0x1111: Save parameters from RAM to EEPROM 0x1113: Load parameters from EEPROM to RAM	NUM	0	U16	RW
10	START_STOP	Function	Start and stop charging. When stop is executed, state changes to ready and waits for start command.	0: Stop 1: Start	NUM	1	U16	rW
14	VOLTAGE_IMD_SE	Status	SE voltage measurement by the IMD.	0 .. 65535	0.1 V	N/A	U16	RO
15	SE_STORAGE_TYPE	Configuration	Selection of SE storage type.	0: None 1: Lead acid 2: Lithium Ion 3: Ultra capacitor	N/A	0	U16	RW
16	SE_NOM_VOLTAGE	Configuration	The nominal voltage of the SE from which all other voltage limits are derived.	0 .. 65535	0.1 V	0	U16	RW
17	SE_MAX_CURRENT	Configuration	Base current from which all other current limits are derived.	0 .. 65535	0.01 A	0	U16	RW
18	BULKCHARGEENDVOLTAGE	Configuration	End voltage for bulk stage in percentage of SE_NOM_VOLTAGE (Values above 100% can also be used).	0 .. 65535	0.01%	0	U16	RW
19	BULKCHARGECURRENT	Configuration	Bulk stage constant current in percentage SE_MAX_CURRENT.	0 .. 65535	0.01%	0	U16	RW

Sub object ID	Parameter name Ser. / CAN	Type	Function	Range	Unit	Factory default	Data type	Access
20	ABSORBCHARGEVOLTAGE	Configuration	Voltage limit in absorption stage in percentage of SE_NOM_VOLTAGE (Values above 100% can also be used). For Lead acid, reaching this limit ends bulk stage and starts absorption stage.	0 .. 65535	0.01%	0	U16	RW
21	ABSORBCHARGECURRENT	Configuration	Absorption stage constant current in percentage of SE_MAX_CURRENT.	0 .. 65535	0.01%	0	U16	RW
22	ABSORBCHARGEENDCURRE NT	Configuration	Current limit that ends the absorption stage in percentage of SE_MAX_CURRENT. For Lithium Ion this limit stops float active charging.	0 .. 65535	0.01%	0	U16	RW
23	FLOATCHARGEVOLTAGE	Configuration	Voltage limit in float stage in percentage of SE_NOM_VOLTAGE (Values above 100% can also be used).	0 .. 65535	0.01%	0	U16	RW
24	FLOATCHARGECURRENT	Configuration	Current limit for float stage in percentage of SE_MAX_CURRENT.	0 .. 65535	0.01%	0	U16	RW
31	CHARGER_ERROR	Status	Bit mapped register showing charger errors status. 0: Not active, 1: Set. The status of the error remains until “Clear errors” is sent to the charger.	Bit 0: OPENCIRCUIT Bit 1: SHORTCIRCUIT Bit 2: CHARGERTEMP	N/A	N/A	U16	RO
32	CHRGER_WARNING	Status	Bit mapped register showing charger warnings status. 0: Not active, 1: Active. Warning are automatically cleared when they reason for the warning is not present.	Bit 0: BATTEMP Bit 1: TEMPCHANNEL Bit 2: VinLOW Bit 3: Vin-VseLOW	N/A	N/A	U16	RO

13.3.2 Error history parameters

The following table lists available parameters for error history. While all data type is either I32 or U32, and the range is a standard range for these types, the actual values have the same range as the register where the data is fetched from. For example 2881[6] which has an I32 data type (range -2147483647 .. +2147483647) will always contain values with the range of 0 .. 32768 because this is the range of the register where the data is fetched from (0x61).

CANopen Object ID	Sub object ID	Parameter name Ser. / CAN	Type	Function	Range	Unit	Data type	Access
2881	1	eHist.X-Actual position	Status	Value of Reg. 0x6D at the time the last error occurred	±2147483647	Num	I32	RO
2881	2	eHist.X-Actual position SSI	Status	Value of Reg. 0x6F at the time the last error occurred	±2147483647	Num	I32	RO
2881	3	eHist.X-1st error in power board	Status	Value of Reg. 0x94 at the time the last error occurred	±2147483647	Num	I32	RO
2881	4	eHist.X-IxT & regen.energy	Status	Value of Reg. 0x45 at the time the last error occurred	±2147483647	Num	I32	RO
2881	5	eHist.X-SE+	Status	Value of Reg. 0x66 at the time the last error occurred	±2147483647	Num	I32	RO
2881	6	eHist.X-SEM	Status	Value of Reg. 0x61 at the time the last error occurred	±2147483647	Num	I32	RO
2881	7	eHist.X-T-air	Status	Value of Reg. 0x4B at the time the last error occurred	±2147483647	Num	I32	RO
2881	8	eHist.X-dbg*temp	Status	Value of Reg. 0x9A at the time the last error occurred	±2147483647	Num	I32	RO
2881	9	eHist.X-dbg*ptr1	Status	Value of Reg. 0xB8 at the time the last error occurred	±2147483647	Num	I32	RO
2881	10	eHist.X- dbg*ptr2	Status	Value of Reg.0xBA at the time the last error occurred	±2147483647	Num	I32	RO
2881	11	eHist.X-dbg ptr1	Status	Value of Reg. 0xB7 at the time the last error occurred	±2147483647	Num	I32	RO

CANopen Object ID	Sub object ID	Parameter name Ser. / CAN	Type	Function	Range	Unit	Data type	Access
2881	12	eHist.X- dbg ptr2	Status	Value of Reg. 0xB9 at the time the last error occurred	±2147483647	Num	I32	RO
2882	1	eHist.E-IMD state	Status	Value of Reg. 0x02 at the time the last error occurred	±2147483647	Num	I32	RO
2882	2	eHist.E-Device mode	Status	Value of reg. 0x51 at the time the last error occurred	±2147483647	Num	I32	RO
2882	3	eHist.E-N act (filt)	Status	Value of Reg. 0xA8 at the time the last error occurred	±2147483647	Num	I32	RO
2882	4	eHist.E-N cmd ramp	Status	Value of reg. 0x32 at the time the last error occurred	±2147483647	Num	I32	RO
2882	5	eHist.E-I act (filt)	Status	Value of reg. 0x5F at the time the last error occurred	±2147483647	Num	I32	RO
2882	6	eHist.E-DC-link voltage	Status	Value of reg. 0xEB at the time the last error occurred	±2147483647	Num	I32	RO
2882	7	eHist.E-Drive status	Status	Value of reg. 0x40 at the time the last error occurred	±2147483647	Num	I32	RO
2882	8	eHist.E-Logic in block	Status	Value of reg. 0x9B at the time the last error occurred	±2147483647	Num	I32	RO
2882	9	eHist.E-Out block	Status	Value of reg. 0x98 at the time the last error occurred	±2147483647	Num	I32	RO
2882	10	eHist.E-Power board status	Status	Value of reg. 0x63 at the time the last error occurred	±2147483647	Num	I32	RO
2882	11	eHist.E-Actual current limit	Status	Value of reg. 0x48 at the time the last error occurred	±2147483647	Num	I32	RO
2882	12	eHist.E-Current overload integral (H), and ballast energy counter	Status	Value of reg. 0x45) at the time the last error occurred	±2147483647	Num	I32	RO
2882	13	eHist.E-Error map	Status	Bit 0-15: Value of the error map (Reg. 0x8F bit 0 to 15) at the time the last error occurred	Binary bit mapping	Num	I32	RO

CANopen Object ID	Sub object ID	Parameter name Ser. / CAN	Type	Function	Range	Unit	Data type	Access
				Bit 16-31: ID information for the last error (for debugging).		N/A		
2882	14	eHist.E-Elapsed time Dev.enable	Status	Value of elapsed time since RUN was ON at the time the last error occurred	±2147483647	s	I32	RO
2882	15	eHist.E-Elapsed time Power ON	Status	Value of elapsed time since the IMD was powered ON at the time the last error occurred	±2147483647	s	I32	RO
2882	16	eHist.E-Elapsed time Life	Status	Value of elapsed time since the IMD was commissioned at the time the last error occurred	±2147483647	s	I32	RO
2883	1	eHist.P-IMD state	Status	Value of Reg. 0x02 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	2	eHist.P-Device mode	Status	Value of Reg. 0x51 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	3	eHist.P-N act (filt)	Status	Value of Reg. 0xA8 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	4	eHist.P-N cmd ramp	Status	Value of Reg. 0x32 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	5	eHist.P-I act (filt)	Status	Value of Reg. 0x5F at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	6	eHist.P-DC-link voltage	Status	Value of Reg. 0xEB at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	7	eHist.P-Drive status	Status	Value of Reg. 0x40 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	8	eHist.P-Logic in block	Status	Value of Reg. 0x9B at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	9	eHist.P-Out block	Status	Value of Reg. 0x98 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	10	eHist.P-Power board status	Status	Value of Reg. 0x63 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO

CANopen Object ID	Sub object ID	Parameter name Ser. / CAN	Type	Function	Range	Unit	Data type	Access
2883	11	eHist.P-Actual current limit	Status	Value of Reg. 0x48 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	12	eHist.P-Current overload integral (H), and ballast energy counter	Status	Value of Reg. 0x45 at the time the error defined in 0x888[6] occurred	±2147483647	Num	I32	RO
2883	13	eHist.P-Error map	Status	Bit 0-15: Value of the error map (Reg. 0x8F bit 0 to 15) at the time the error defined in 0x888[6] occurred Bit 16-31: ID information for the error defined in 0x888[6] (for debugging).	Binary bit mapping	Num N/A	I32	RO
2883	14	eHist.P-Elapsed time Dev.enable	Status	Value of elapsed time since RUN was ON at the time the error defined in 0x888[6] occurred	±2147483647	s	I32	RO
2883	15	eHist.P-Elapsed time Power ON	Status	Value of elapsed time since the IMD was powered ON at the time the error defined in 0x888[6] occurred	±2147483647	s	I32	RO
2883	16	eHist.P-Elapsed time Life	Status	Value of elapsed time since the IMD was commissioned at the time the error defined in 0x888[6] occurred	±2147483647	s	I32	RO
2884	1	eHist.NC-err0_cnt	Status	Number of Errors of “Error 0” type in the error history	0 .. 4294967295	Num	U32	RO
2884	2	eHist.NC-err1_cnt	Status	Number of Errors of “Error 1” type in the error history	0 .. 4294967295	Num	U32	RO
2884	3	eHist.NC-err2_cnt	Status	Number of Errors of “Error 2” type in the error history	0 .. 4294967295	Num	U32	RO
2884	4	eHist.NC-err3_cnt	Status	Number of Errors of “Error 3” type in the error history	0 .. 4294967295	Num	U32	RO
2884	5	eHist.NC-err4_cnt	Status	Number of Errors of “Error 4” type in the error history	0 .. 4294967295	Num	U32	RO
2884	6	eHist.NC-err5_cnt	Status	Number of Errors of “Error 5” type in the error history	0 .. 4294967295	Num	U32	RO

CANopen Object ID	Sub object ID	Parameter name Ser. / CAN	Type	Function	Range	Unit	Data type	Access
2884	7	eHist.NC-er6r_cnt	Status	Number of Errors of “Error 6” type in the error history	0 .. 4294967295	Num	U32	RO
2884	8	eHist.NC-err7_cnt	Status	Number of Errors of “Error 7” type in the error history	0 .. 4294967295	Num	U32	RO
2884	9	eHist.NC-err8_cnt	Status	Number of Errors of “Error 8” type in the error history	0 .. 4294967295	Num	U32	RO
2884	10	eHist.NC-err9_cnt	Status	Number of Errors of “Error 9” type in the error history	0 .. 4294967295	Num	U32	RO
2884	11	eHist.NC-errA_cnt	Status	Number of Errors of “Error A” type in the error history	0 .. 4294967295	Num	U32	RO
2884	12	eHist.NC-errB_cnt	Status	Number of Errors of “Error B” type in the error history	0 .. 4294967295	Num	U32	RO
2884	13	eHist.NC-errC_cnt	Status	Number of Errors of “Error C” type in the error history	0 .. 4294967295	Num	U32	RO
2884	14	eHist.NC-errD_cnt	Status	Number of Errors of “Error D” type in the error history	0 .. 4294967295	Num	U32	RO
2884	15	eHist.NC-errE_cnt	Status	Number of Errors of “Error E” type in the error history	0 .. 4294967295	Num	U32	RO
2884	16	eHist.NC-errF_cnt	Status	Number of Errors of “Error F” type in the error history	0 .. 4294967295	Num	U32	RO
2888	2	eHist.SP-T-run	Status	Value of elapsed time since RUN was ON	0 .. 4294967295	s	U32	RO
2888	3	eHist.SP-T-pwr	Status	Value of elapsed time since the IMD was powered ON	0 .. 4294967295	s	U32	RO
2888	4	eHist.SP-T-life	Status	Value of elapsed time since the IMD was commissioned	0 .. 4294967295	s	U32	RO
2888	6	eHist.SP-Index	Configuration	Index number for the error in the log to be presented in 0x883[1 – 12]	1..20	Num	U32	RO

14. Revision history

Apart from editorial changes the following changes have been made in this revision:

Date	Revision	Changes
2020-09-25	G	• “Updating Firmware” and “Turning the power to the IMD on” added to “Operational procedures” • “Digital inputs and outputs” title in “Operational procedures” changed to “Using digital inputs and outputs” • “Firmware update through CANopen implementation guidelines” added to “CANopen interface” • “Safe energy connection requirements” in “Power connections (X1)” updated • “Connecting the safe energy” in “Avoiding damage to the IMD” updated • “Charger (option) warning” in “Warning list” updated • “Pre-heating the motor” in “Operational procedures” updated • “Parameter list” updated • IMD states chart and description updated • “Configuring motor data” in “Configuring general parameters” updated • “Brake control” description in “Function Description” updated • “User demand (03)” in “Parameter bit mapping” updated
2020-06-29	F	• Ballast OFF calculation corrected in “Configuring the general servo fields” • “Parameter list” updated with regards to retrieval of high/low part of registers through CAN/CANopen • IMD states chart updated • “Converting torque values” updated • “Configuring speed parameters” updated • “Converting voltage units to volts” updated • Screen dumps in “Configuring general parameters” and “Configuring the control parameters data” updated • “Charger parameters” in “Parameter list” updated. • “Charger (option) warnings” and “Charger (option) errors” added to “Errors and warnings” • “Configuring the general servo fields” updated • “Disconnecting AC mains from DC-link (Mains, disconnect)” updated • "Safe energy (ultra-capacitors only) discharging” added to “Operational procedures”

		• Changing actual position value (Pos. preset) updated • Updated with IMD 135: "Temperature considerations", "Mounting of the IMD in the cabinet", "Electrical HW connections and requirements" (overview), "Power connections (X1)" • "Error log" added to "Errors and warnings" • "Error history parameters added to "Parameter list". • Changing actual position value (Pos. preset) updated
-2020-01-31	E	• "Configuring SE charger parameters (option)" updated • "Environmental requirements" updated • "Configuring general servo (IMD) fields" in "Configuring general parameters" updated • "Configuring virtual limit switches" added to "Configuring general parameters" • "Manual operation" in "Operational procedures" updated • New procedure for "Manual operation 360" added to "Operational procedures" • New procedure for "Restarting the IMD" added to "Operational procedures" • "User options (01)" in "Parameter bit mapping" updated • "Brake control" section in "Functions description" updated • "Connecting 24V (X7)" in "Connecting 24V, digital and safety I/O (X7, X8, X9)" updated • IMD states chart updated • Section "Free space around the IMD" is updated with IMD 122 C • "Motor connection requirements" updated • "Configuring input-output logic" updated • "Error and warning lists" section renamed to "Errors and warnings" • "Errors/warnings (8F)" section updated • Figure 13IMD 122 C / 135 updated
2019-09-03	D	• "Parameter list" updated and "Charger parameters" added • State flowchart and description updated • "Converting torque values" added to "Units conversion" • Error and warning lists updated
2019-08-19	C	• "Avoiding damage to the IMD" section added • "Power connection (X1)" is updated with IMD 122 C • PTC resistor added to "Motor connections requirements" and "Connecting temperature sensors" sections

		• Specifications for digital output corrected • “Connecting 24 V (X7)” updated • “Motor brake requirement” added to “Connecting the motor brake” section • Manual operation added in “Connecting digital inputs (X9)” and “Operational procedures” sections • Manual activation of fan added to operational procedures • Configuring manual operation and Ballast resistor energy thermal factor added to “Configuring general servo fields” section • Pictures from IMD Manager updated • IMD states description updated with states 58 and 59. Conditions to proceed updated with manual operation where applicable, and conditions priority removed • “Brake control” section moved from the “Function description” manual to the “Functions description” section. • “User options (01)” bit mapping section updated • “User state (02)” section updated • “User demand (03)” section updated • “Logic IN block (9B)” section updated • “Parameter list” section updated • Ballast ON calculation in “Configuring the general servo fields” corrected • Speed parameter configuration updated (S-run speed profile) • “Safe energy monitoring” added to “Functions description” • “Configuring SE charger parameters (option)” added to “IMD configuration”
2018-06-01	B	• Connecting 24V (X7) section updated • Configuring General servo fields section updated • Terms and abbreviation section updated
2018-03-16	A	This is the first version of the document.

15. Product user documentation

The IMD product has an extensive user documentation, targeted towards different audience and product use stages.

The following documents are part of the user documentation:

Table 44 IMD user documentation

Document	Target audience	Content
IMD 100 datasheet Document no.: 4921260015	Buyers and technicians of customers	Describes relevant specifications and give an overview of the IMD functions
IMD 100 function description Document no.: 4189360013	Mainly technicians and engineers of customers.	Describes the functions of the IMD. Gives the reader an understanding of the purpose of the IMD in a system, and which functions can be utilised in a pitch system. The functions are described so that the reader can understand what each function is used for.
IMD 100 integration manual Document no.: 4189360015	Engineers at customer R&D department	Describes how to integrate the IMD in a pitch system. Gives extensive knowledge about: IMD SW (parameters and how to achieve specific functionality) How to create customized parameter file for use in production Requirements for external interfaces/components
IMD Manager installation instructions Document no.: 4189360018	Engineers at customer R&D department, as well as commissioners and service personnel	Describes how to install the IMD Manager. The IMD Manager is an application used to configure and control the IMD using the Service USB connector.
IMD Manager user manual Document no.: 4189360019	Engineers at customer R&D department, as well as commissioners and service personnel	Describes how to use the IMD Manager. The IMD Manager is an application used to configure and control the IMD using the Service USB connector.
IMD 100 installation instructions Document no.: 4189360005	Technicians at production site where the IMD is mounted in the cabinet/hub	Describes how to mount, connect and perform initial start, test, and configuration (using a configuration file) of the IMD at production.
IMD 100 initial configuration and verification manual Document no.: 4189360016	Commissioners or other personnel with similar qualifications, as well as service personnel (for SW upgrade)	Describes how to upgrade the IMD SW, how to load configuration file, and how to verify the IMD installation to the possible extent.
IMD 100 service and maintenance manual Document no.: 4189360017	Service and warehouse personnel	Describes preventive (scheduled) and corrective maintenance of the IMD, as well as storage requirements.
IMD 100 installation checklist Document no.: 4189360021	Technicians at production site where the IMD is mounted in the cabinet/hub	Installation tasks with check boxes to document the tasks done during installation

Document	Target audience	Content
IMD 100 configuration and verification checklist Document no.: 4189360022	Commissioners or other personnel with similar qualifications, as well as service personnel (for SW upgrade)	configuration and verification tasks with check boxes to document the tasks done during configuration and verification
Addendum to installation manual Document no.: 4189360023	Integration and installation personnel	Describes the how to replace a pitch drive when the IMD is equipped with Retrofit wiring harness var.1

The IMD 100 documentation is written anticipating an OEM (original equipment manufacturer) product use-cycle in a wind turbine. The envisioned cycle is described in the following figure. The description also explains the tasks, who is expected to execute the task, the location where the execution takes place and the supporting DEIF documentation for the task. Many details in these tasks depends on the actual implementation, which is why the IMD documentation will never stand alone.

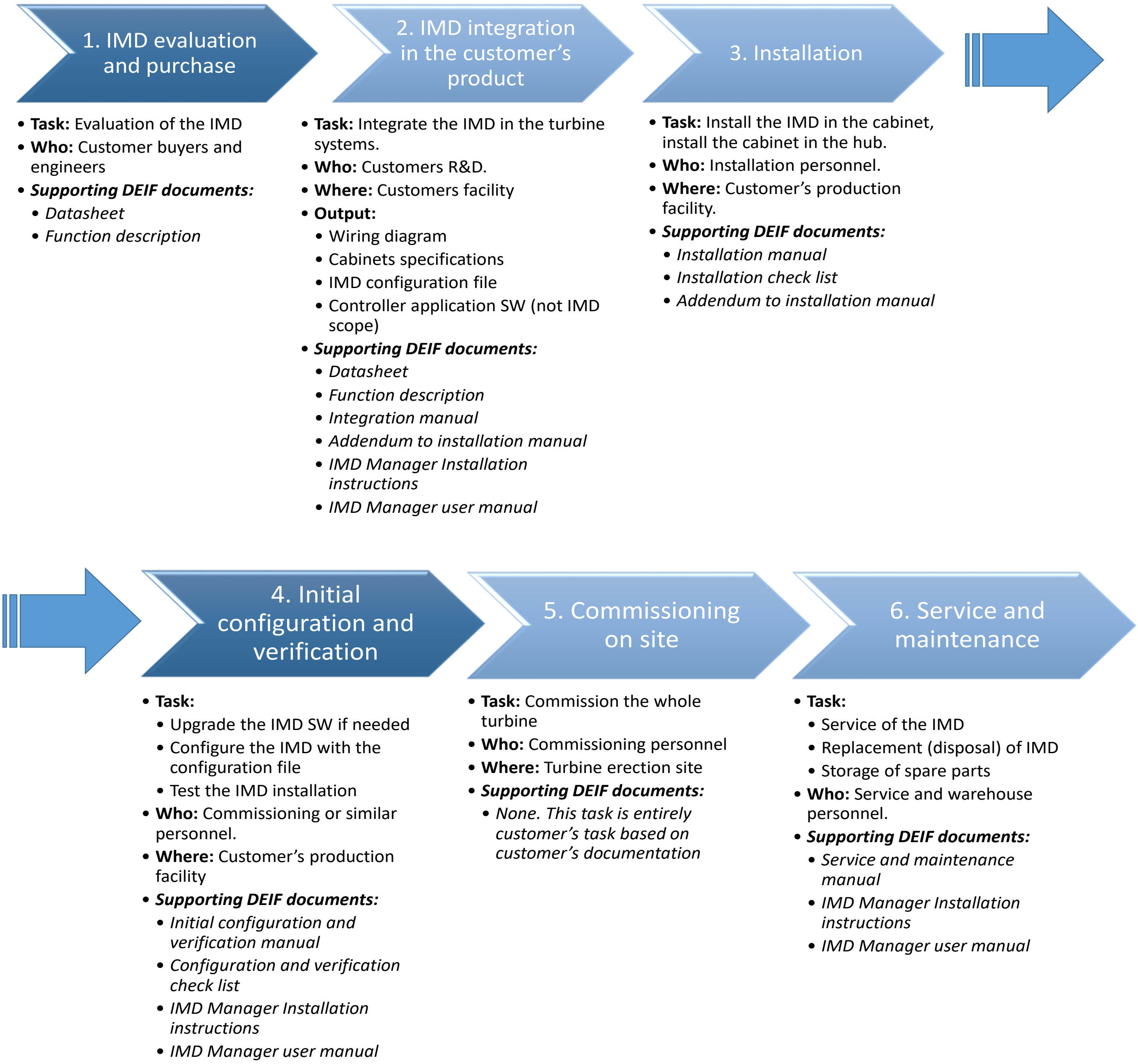


Figure 45 Tasks and documentation overview

The described product use-cycle might not apply as is for all customers, but the tasks are universal and can therefore be adapted. For example, if the SW upgrade, configuration and verification is done during the turbine commissioning, the applicable documentation can be used at this stage instead of a separate stage at the end of production.

16. Glossary

16.1 Terms and abbreviations

Async.	Asynchronous
CAN	Controller Area Network
COB ID	Communication Object Identifier (CAN/CANopen interface)
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ID	Identification
IMD	Integrated Motor Drive
LoS	Loss of Signal
LSB	Least Significant Bit/Byte
MSB	Most Significant Bit/Byte
N/A	Not Applicable
PDO	Process Data Object (CAN/CANopen interface)
PE	Protective Earthing
PID	Proportional Integral Derivative (controller)
PMC	Pitch Motor Controller
PWM	Pulse Width Modulation
RFE	Rotational Field Enable
RMS	Root Mean Square
RPDO	Receive Process Data Object (CAN/CANopen interface)
RPM	Revolutions Per Minute
RWW	Read, write and mappable to RPDO
SCI	Safety-Chain Input
SCR	Safety-Chain Relay
SDO	Service Data Object (CAN/CANopen interface)
SE	Safe Energy
SSI	Synchronous Serial Interface
TPDO	Transmit Process Data Object (CAN/CANopen interface)

16.2 Units

Unit	Unit Name	Quantity name	US unit	US name	Conversion	Alternative units
A	ampere	Current				
Bar	bar	Pressure	psi	pounds per square inch	1 bar = 14.5 psi	1 bar = 0.980665 atmosphere (atm) 1 bar = 100,000 Pascal (Pa)
ºC	degrees Celsius	Temperature	ºF	Fahrenheit	T(°F) = T(°C) × 1.8 + 32	
dB	decibel	Noise or interference (a logarithmic scale)				
g	gram	Weight	oz	ounce	1 g = 0.03527 oz	
Hz	hertz	Frequency (cycles per second)				
bps	Bits per second	Data transmission speed				
kg	kilogram	Weight	lb	pound	1 kg = 2.205 lb	
m	metre	length	ft	foot (or feet)	1 m = 3.28 ft	
mA	milliampere	Current				
mm	millimetre	Length	in	inch	1 mm = 0.0394 in	
mm2	Square millimetre	Wire cross section	AWG	American wire gauge	Look up in available conversion tables	
ms	millisecond	Time				
Nm	Newton metre	Torque	Lb-in	pound-force inch	1 Nm = 8.85 lb-in	
RPM	revolutions per minute	Frequency of rotation (rotational speed)				
s	second	Time				
V	volt	Voltage				
V AC	volt (alternating current)	Voltage (alternating current)				
V DC	volt (direct current)	Voltage (direct current)				
W	watt	Power				
Ω	ohm	Resistance				