SERVICE AND MAINTENANCE 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.deifwindpower.com

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Contents

1. Introduction

This document describes the preventive (scheduled) service recommended for the IMD as well as corrective maintenance and storage requirements. Furthermore, the display, errors and warning as well as some operational procedures that can be used in trouble shooting are described. Although this manual stands on its own, it is expected that turbine manufactures using the IMD will incorporate parts of this document in their service and maintenance documentation.

The document can be printed on a monochrome printer. However, the details in the pictures will be better if a colour printer is used.

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
Blue underlined font	Used to indicate that the text is also a hyperlink
␣ ↵	Used to illustrate a space and Enter characters
	A yellow symbol 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 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

1.2 Referenced documents

Document no.	Title
4189360016	IMD 100 initial configuration and verification manual
4189360015	IMD 100 integration manual
4189360019	IMD manager user manual

2. Safety precautions

Attention

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

International standards such as IEC 364 and any other relevant international or national standard regarding safety must be observed. Only qualified personnel who is fully capable of recognizing, understanding and judging the dangers of the task at hand may perform the work.

Danger!

Service of the IMD is always done in a turbine. Follow the turbine manufacture's instruction to ensure safe conditions for your work.

2.1 Mechanical work

Caution!

Assess the weight of the IMD (see datasheet) with regards to lifting and placing it in the designated location in the cabinet. Use lifting aid or a second person if necessary.

2.2 Electrical work

Disconnect power

Ensure that all power is disconnected when working with the IMD, except for during 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 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 9) 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 9) is cooled down.

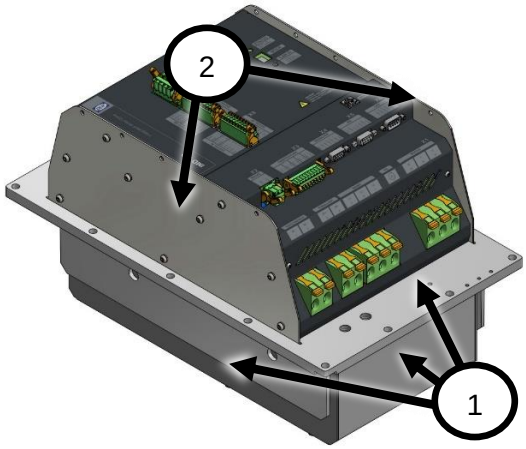


Figure 1 Hot surface areas

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. IMD maintenance schedule

The maintenance of the IMD is performed either as preventive or corrective maintenance. Preventive maintenance is performed at scheduled intervals to prevent faults from occurring. Corrective maintenance is performed either after a fault occurred, or because of an early warning given by the IMD or the pitch system.

This section lists the preventive and corrective maintenance.

Table 1 Maintenace actions list

Action	Type	Interval	Fault condition indication
Cleaning the IMD	Preventive	1 year	IGBT / rectifier too hot (fault can also be caused by too high ambient temperature).
Checking electrical connections	Preventive	1 year	Motor not functioning, no safe energy. The same faults can occur from other reasons.
Checking the fan	Preventive	1 year	IGBT / rectifier too hot (fault can also be caused by too high ambient temperature).
Checking corrosion	Preventive	1 year	Holes in the IMD, large debris in the IMD.
Replacing the fan	Corrective	None	IGBT / rectifier too hot (fault can also be caused by too high ambient temperature). Fan not working warning (IMD 122C or later, IMD 135).

The fault condition indication in Table 1 describe most common consequences if the action is not performed, or indications that the action should be performed. The given intervals are based on normal operating conditions as expected in a win turbine's hub, within the environmental limits, specified in the IMD 100 datasheet.

NOTE Other corrective actions not mentioned in Table 1 should be performed by DEIF or its representative.

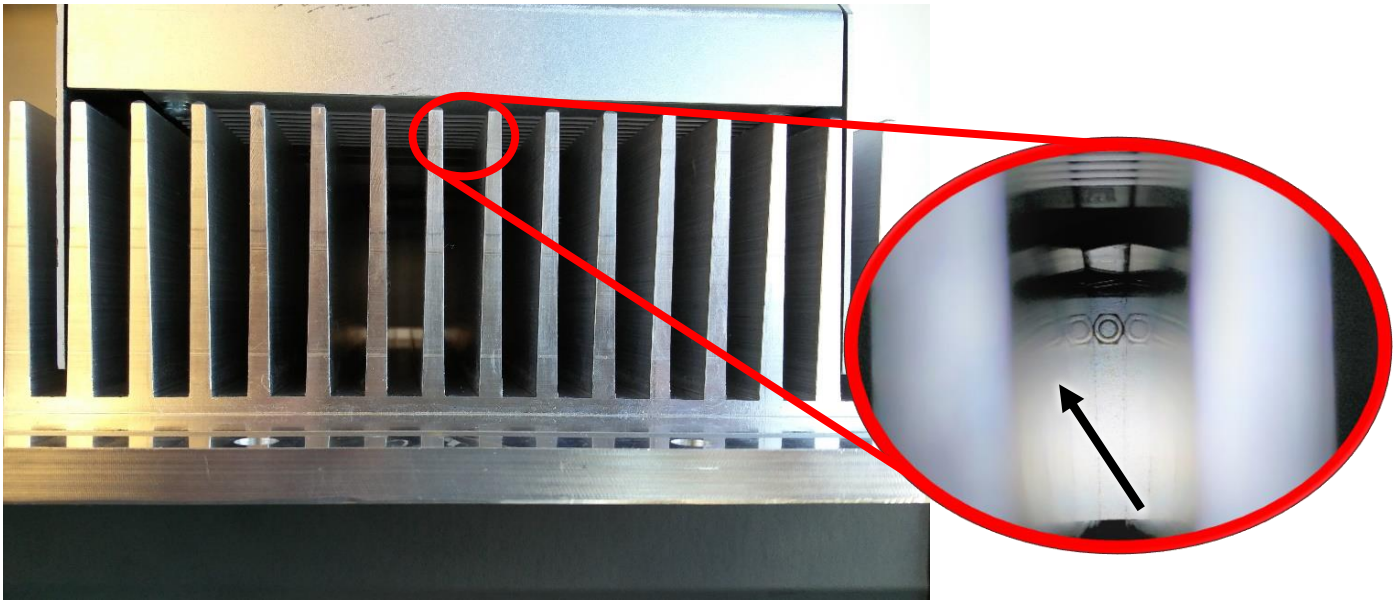
5. Preventive maintenance of the IMD

The following tasks are recommended to be performed once a year:

Disconnect power
Disconnect the power to the IMD

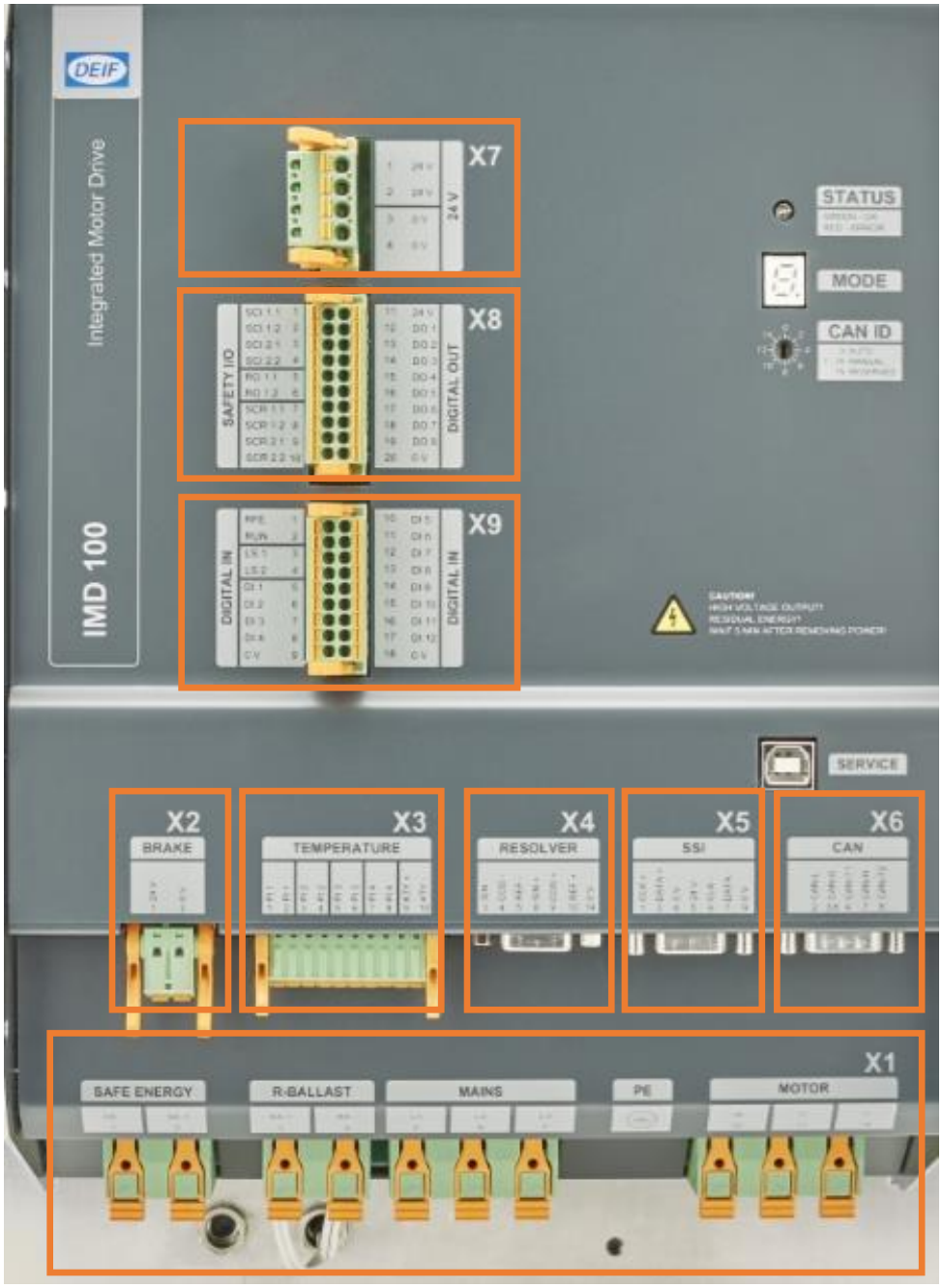
5.1 Cleaning the IMD

Clean the IMD parts that are outside the cabinet from dust, oil and debris. Look inside the heatsink to ensure that no debris are trapped inside. The following picture depicts a loose nut inside the heatsink that can damage the fan and therefore must be removed.

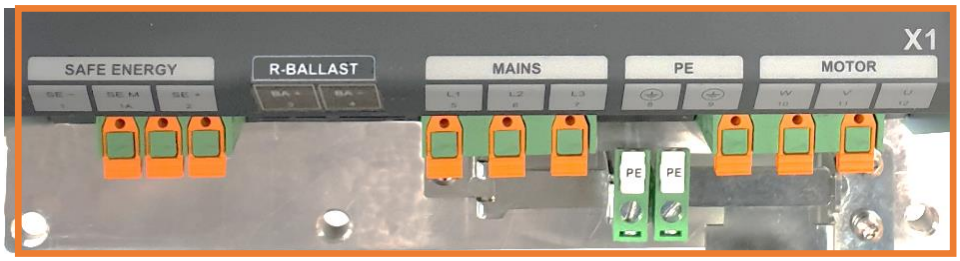


NOTE: The fan cover may look different from the fan cover depicted in the picture.

5.2 Checking electrical connections



IMD 122 B



X1 in IMD 122 C

Figure 2 IMD 122 connections overview

NOTE Heatsink, fan house, PE connections of early production units of the IMD 122 C are the same as in IMD 122 B.

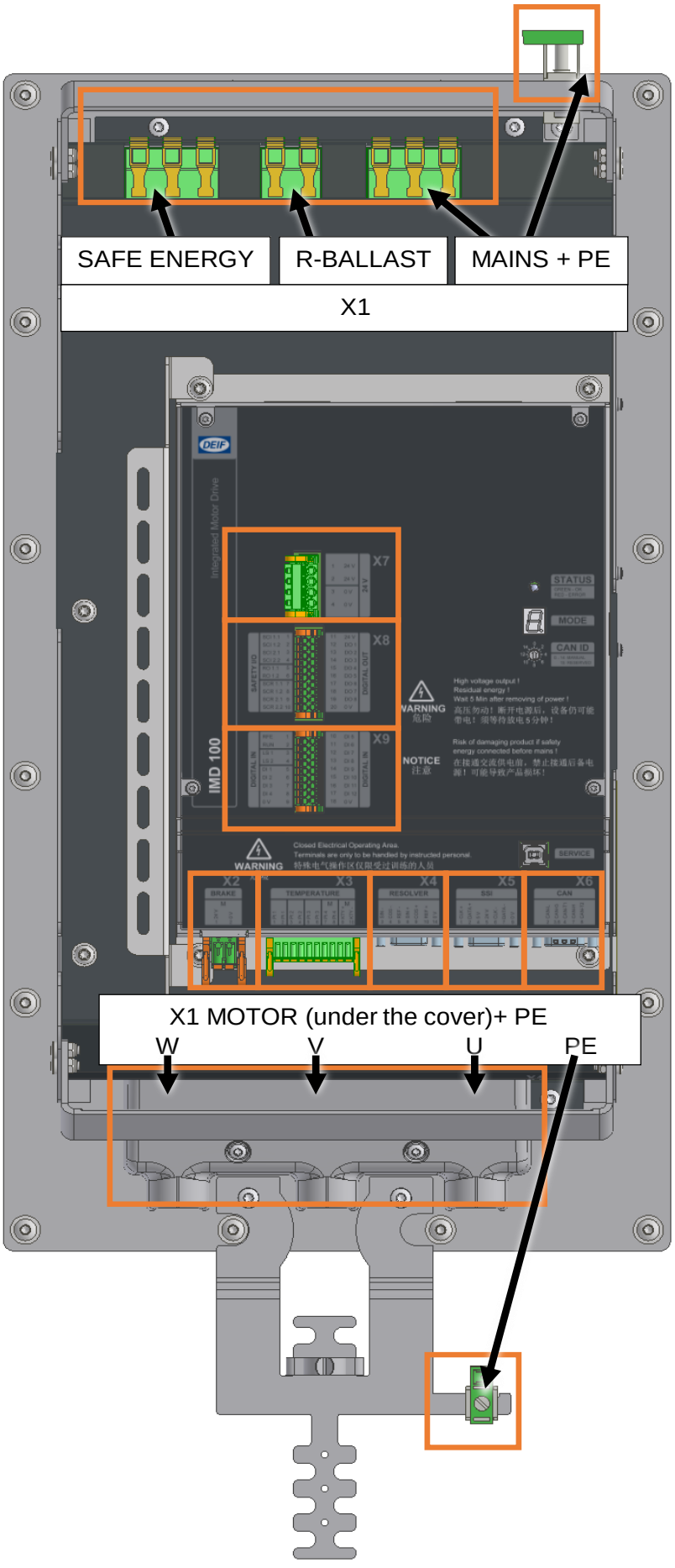
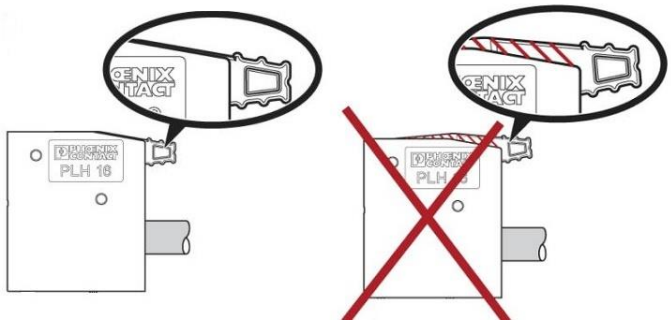


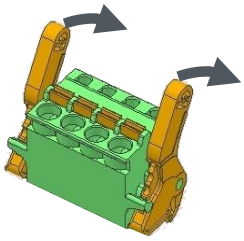
Figure 3 IMD 135 C connections overview

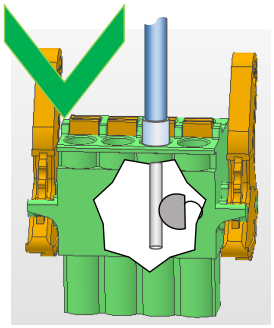
Check that all electrical connections are ok:

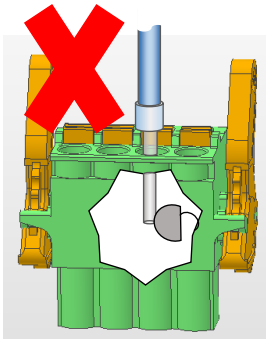
1. Check that all X1 PLH 16 connectors are pressed all the way down. Pull all wires gently to ensure that none of them is loose.



2. Check that X2, X3, X7, X8, and X9 connectors are pressed all the way down. Check that none of the orange locking handles is loose or broken. Pull the wires gently to ensure that none of them is loose.







3. Check that all D-sub connectors used are hand tightened.

5.3 Checking the fan

1. Check that no fan blades are missing
2. Verify that the fan at the back of the IMD (outside the cabinet) is turning and does not make an unusual noise (for example if the cover touches the fan). The fan must be activated to check this. Activating the fan can be done in two ways:
   a. Use the IMD manager to turn the fan on. Full description can be found in *IMD 100 initial configuration and verification manual.*
   b. Connecting 24 V DC directly to the fan (how to connect depends on the integration in the turbine and will most likely be different from customer to customer).

Warning!
This task requires electrical power. Be sure to take the necessary steps to avoid electrical shock and moving objects.

5.4 Checking corrosion

Check the IMD for visible corrosion such as rusty or salty pitting from area around connectors and screws.

6. Corrective maintenance of the IMD

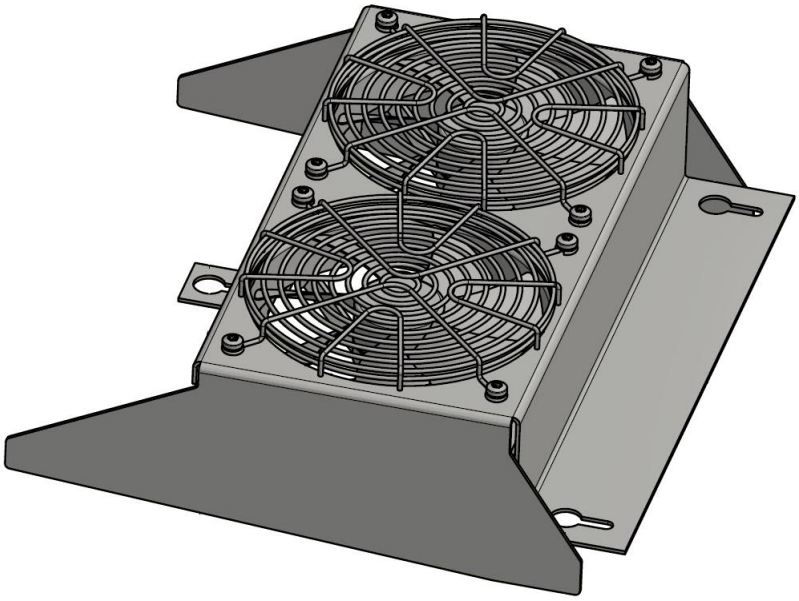
The tasks described in this section might be necessary to perform within the lifetime of the IMD.

6.1 Replacing the fan

The fan is the only moving part in the IMD. In the event that the fan needs to be replaced follow the procedure described in this section. The fan comes already mounted on a new fan plate, which is replaced together with the fan. The type of the fan and fan plate depends on the IMD type:

IMD 122 B / early production C type fan

IMD 122 C type fan



IMD 135 C type fan

NOTE Some IMD 122 C units might have IMD 122 B fan

6.1.1 Replacing IMD 122 B fan

6.1.1.1 Required tools and accessories

The tools and accessories in the following table are required for the fan replacement.

Table 2 Required tools and accessories

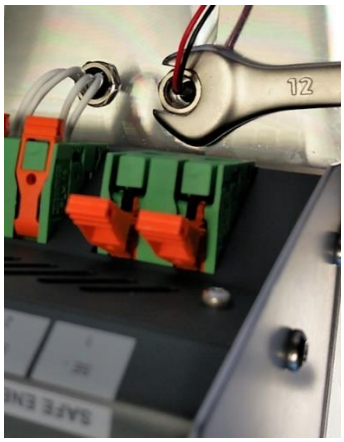
	Tool or accessory	Torque	Used to
	Torque hexagon screwdriver 2.5 mm	2.35 Nm	Dismounting and fastening screws of the fan plate
	Wrench, 12 mm	Hand tight	Dismounting and fastening cable gland for fan wire
	Long nose pliers	N/A	Insert and pull cable tie
	Small cutter	N/A	Cut cable tie
	Press tool for ferrules	N/A	Press ferrules on wires (optional)
	Ferrules	N/A	Terminate wires to connectors (recommended, different size according to wire size)
	Small cable ties, approximately 2.5 mm	N/A	Tie the cable to the heatsink cover

6.1.1.2 Procedure for replacement of the fan

Disconnect power

Disconnect the power to the IMD

1. Disconnect the fan wires from their terminals (either DO terminal on the IMD or other connectors in the cabinet.
2. Open the cable gland (inside the cabinet) that the fan wire is led through to the cabinet using a 12 mm wrench. Keep all parts at hand.

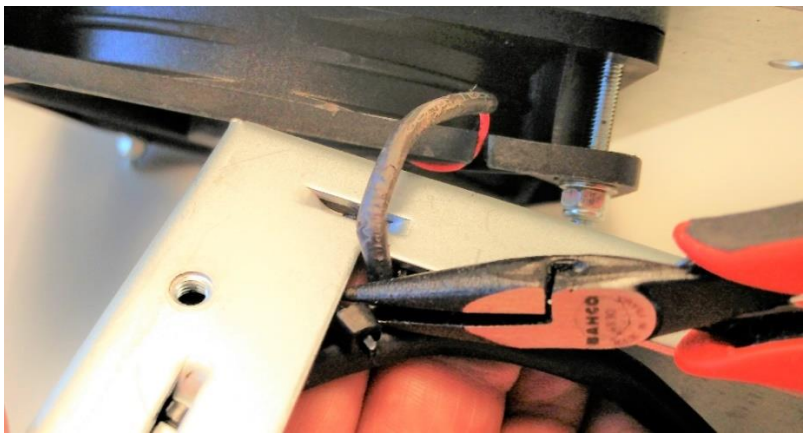


3. From the outside of the cabinet, open the four fastening screws of the fan cover using a 2.5 hexagon screwdriver. The fan cover may look slightly different depending on the model, but the procedure is the same.

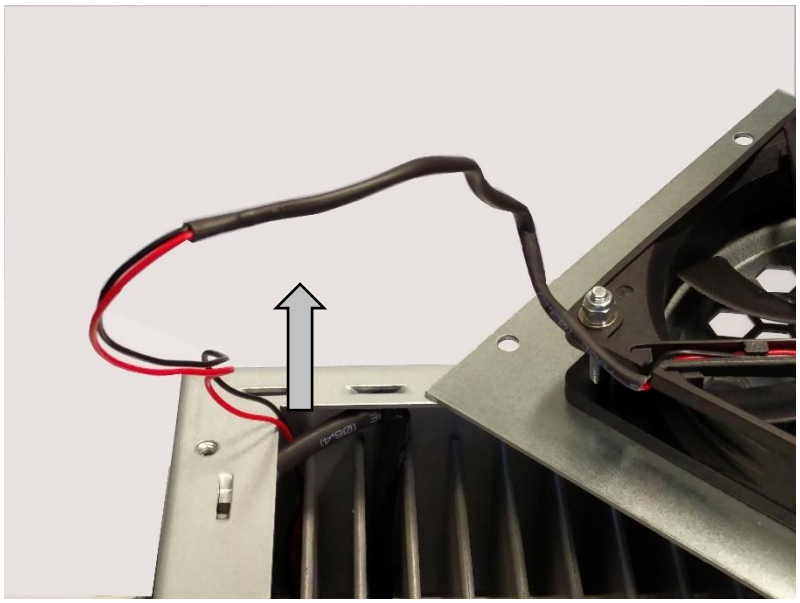
4. Open the fan plate

5. Cut the cable tie holding the fan wire

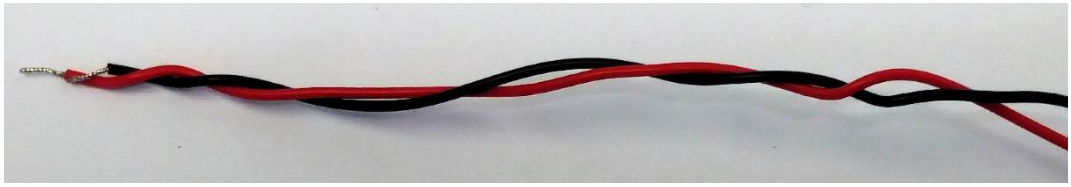
6. Use the long nose pliers to take the used cable tie out. Be careful that it doesn't fall into the heat sink.



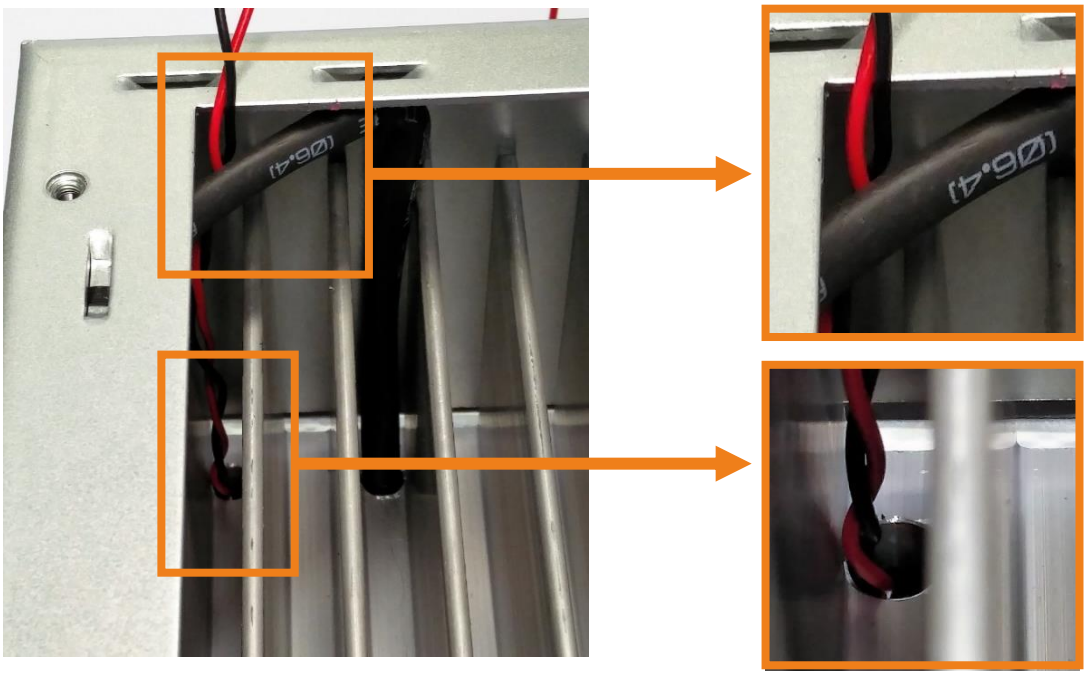
7. Pull the fan wire out and put the old fan plate (including the fan) away.



8. Twist the ends of the new fan wires



9. Insert the wires behind the ballast resistor cable and into the hole in the heat sink



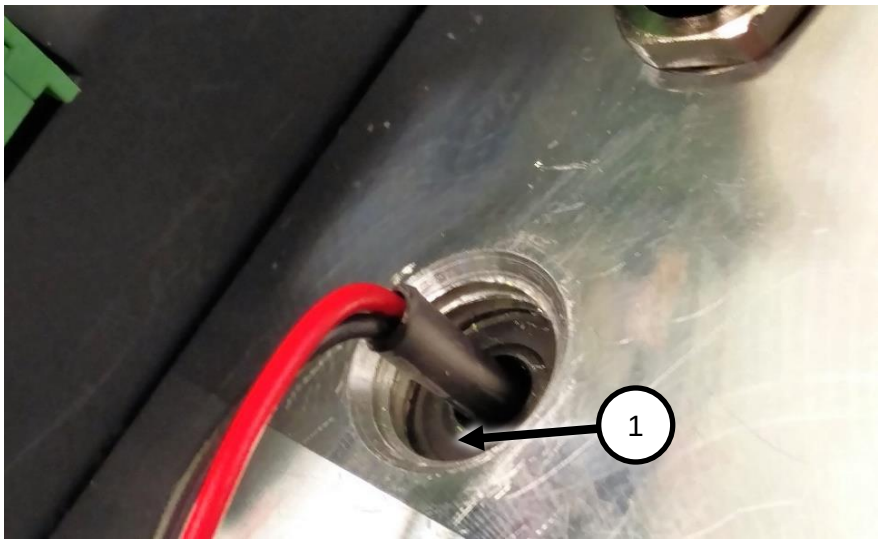
10. Push the fan wire as much as possible through the hole. Thread a cable tie through the cable tie holder (the picture on the right shows the cable tie holder and cable tie from the inside without heat sink).

11. Use the long nose pliers to close the cable tie and tighten it.

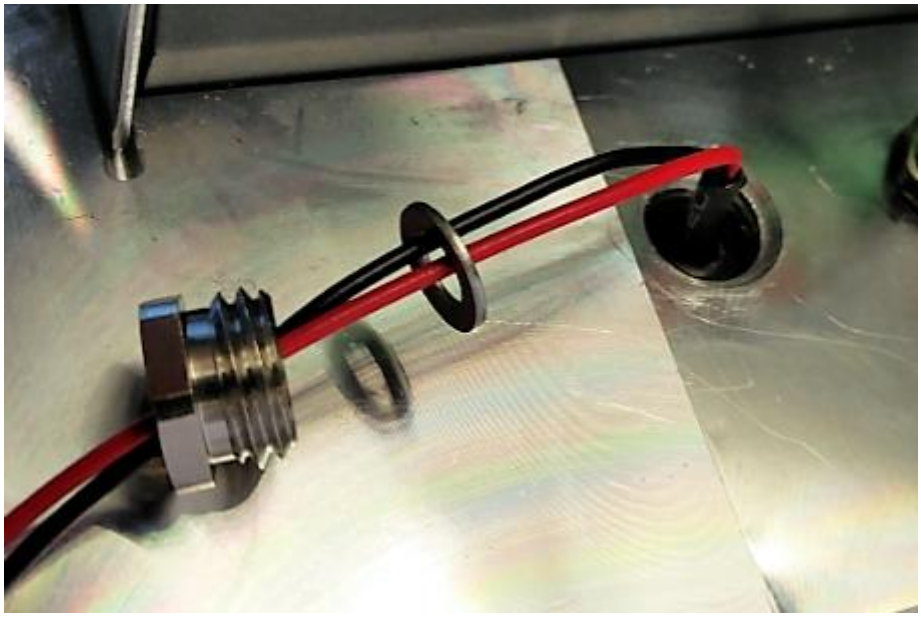
12. Cut the excess cable tie with the cutter. Ensure that the cut piece does not fall into the heat sink.

13. Mount the fan plate onto the heat sink cover using the 2.5 mm torque hexagon screwdriver.

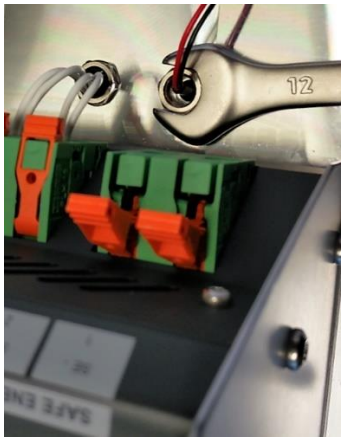
14. Pull the fan wire inside the cabinet until the insulation is higher than the heat sink. Ensure that the rubber sealer (pos. 1) is inside the hole.



15. Thread the fan wire through the washer and gland nut



16. Assemble the cable gland and hand tighten



17. Test the fan as described in section 5.3 on page 15. Ensure the fan is blowing into the heat sink and not out of it.

Warning!
This task requires electrical power. Be sure to take the necessary steps to avoid electrical shock and moving objects.

6.1.2 Replacing IMD 122 C fan

6.1.2.1 Required tools and accessories

The tools and accessories in the following table are required for the fan replacement.

Table 3 Required tools and accessories

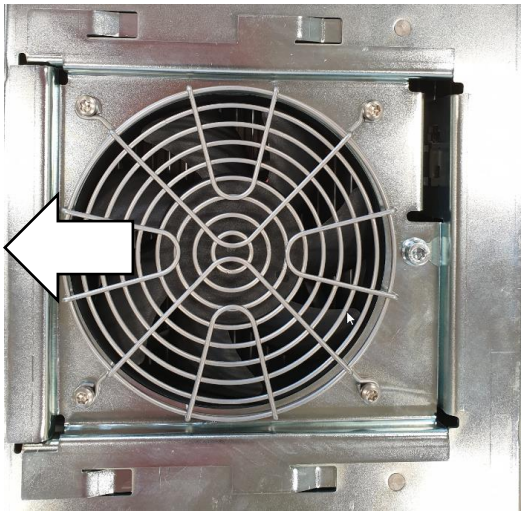
	Tool or accessory	Torque	Used to
	Torque Torx Tx25 screwdriver	3 Nm	Dismounting and fastening screw of the fan plate

6.1.2.2 Procedure for replacement of the fan

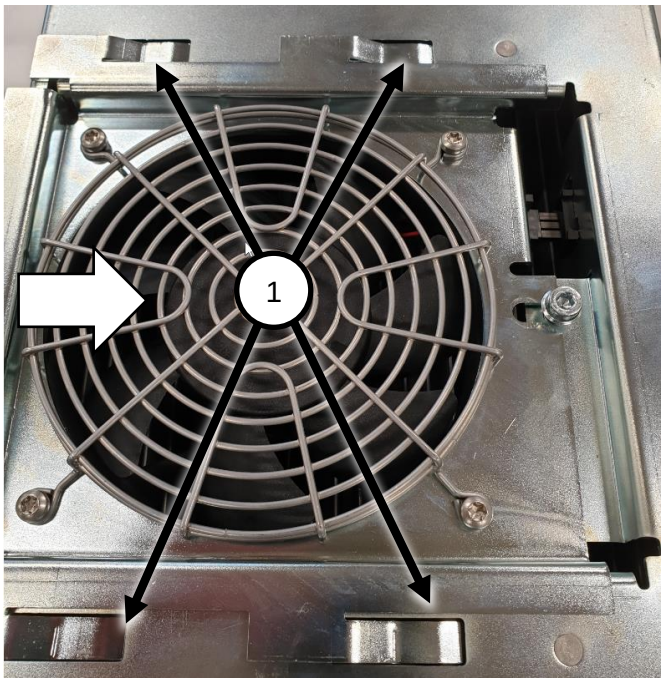
Disconnect power
Disconnect the power to the IMD

1. Loosen the lock screw:

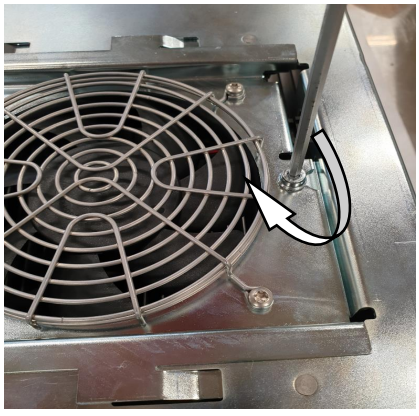
2. Pull the fan away from the locking screw and lift it from the left side:



3. Insert the new fan into the fan house holding it on the left side and slide the fan into place. Make sure that all four holders are sliding under the holes (1) in the fan house:



4. Fasten the lock screw according to torque in Table 3 on page 24:



6.1.3 Replacing IMD 135 C fan

6.1.3.1 Required tools and accessories

The tools and accessories in the following table are required for the fan replacement.

Table 4 Required tools and accessories

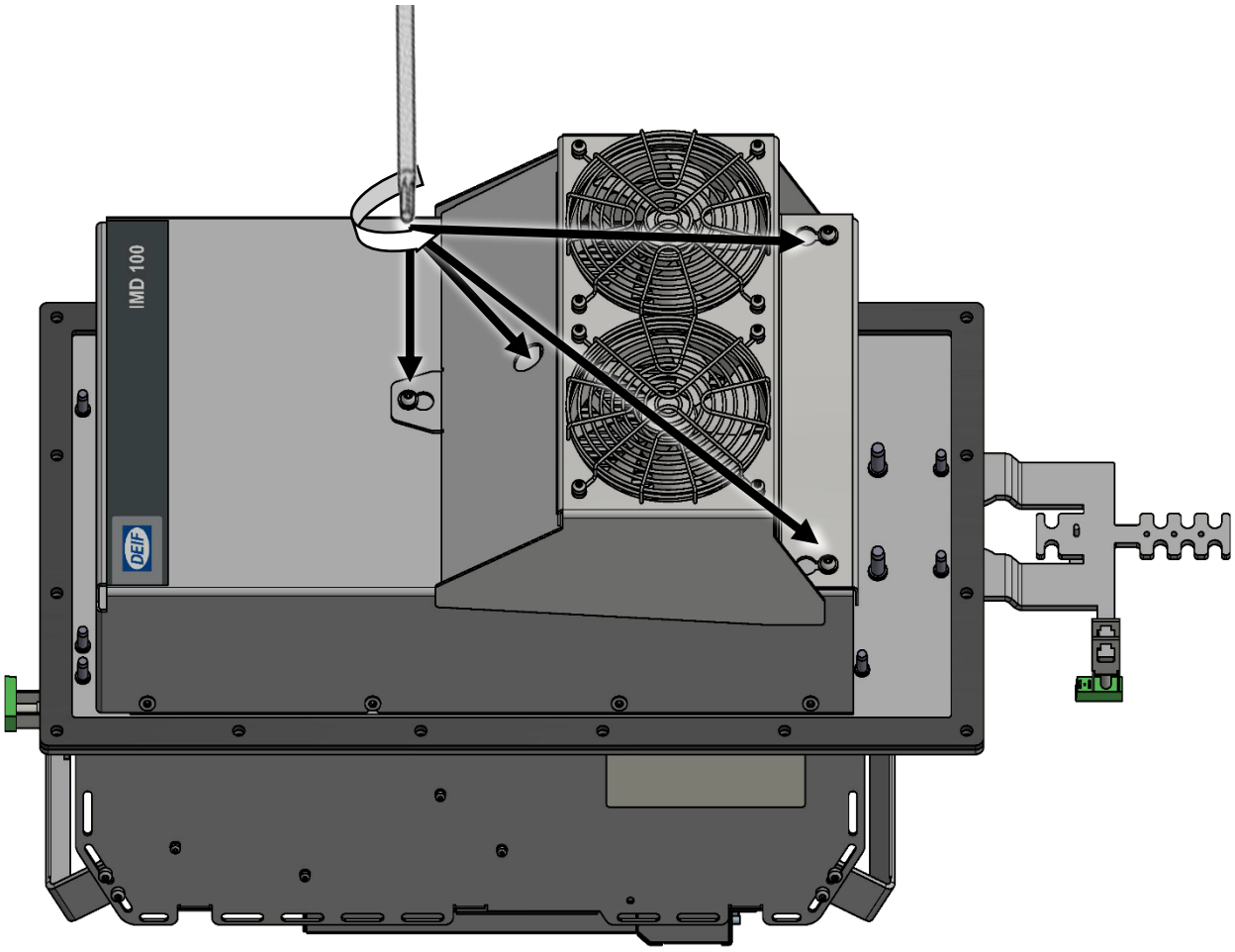
	Tool or accessory	Torque	Used to
	Torque Torx Tx25 screwdriver	4 Nm	Dismounting and fastening screw of the fan house

6.1.3.2 Procedure for replacement of the fan

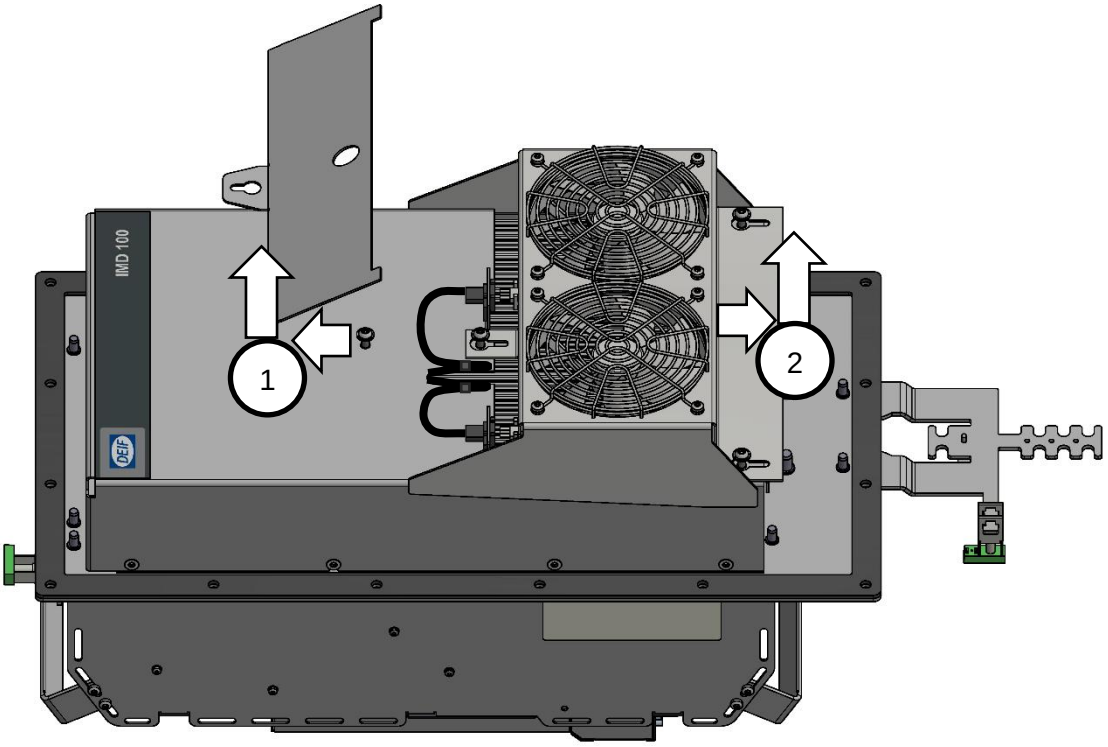
Disconnect power

Disconnect the power to the IMD

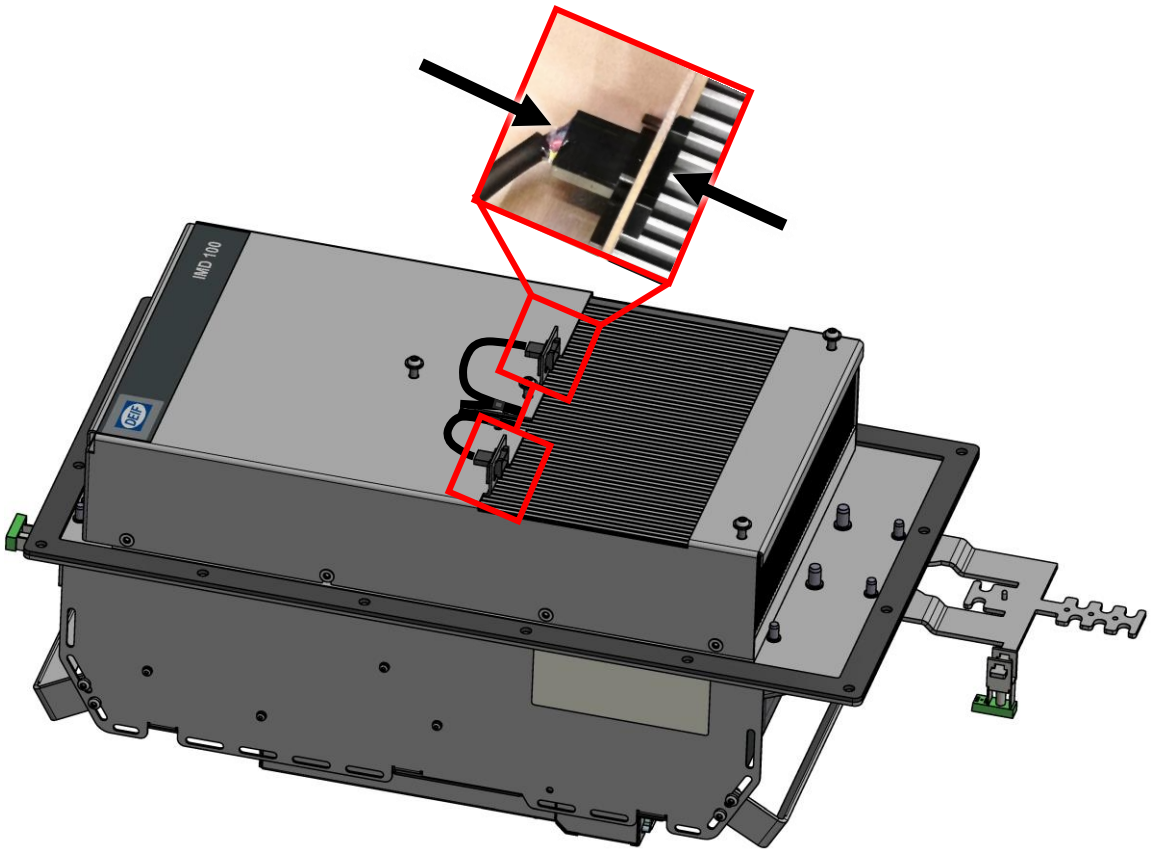
1. Loosen the four lock screws:



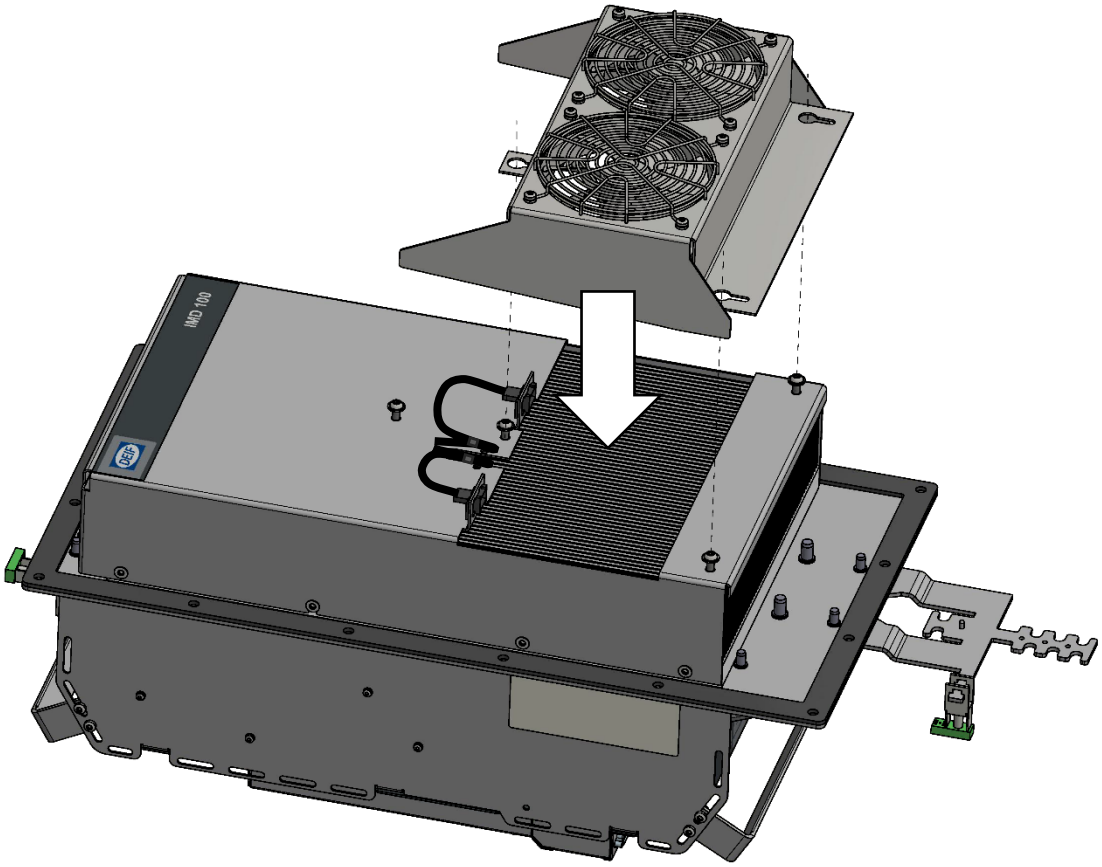
2. Pull the cover away from the locking screw, lift it and put it aside (1). It will be used again.
   Pull the fan house to the right, lift it and discard it (2):



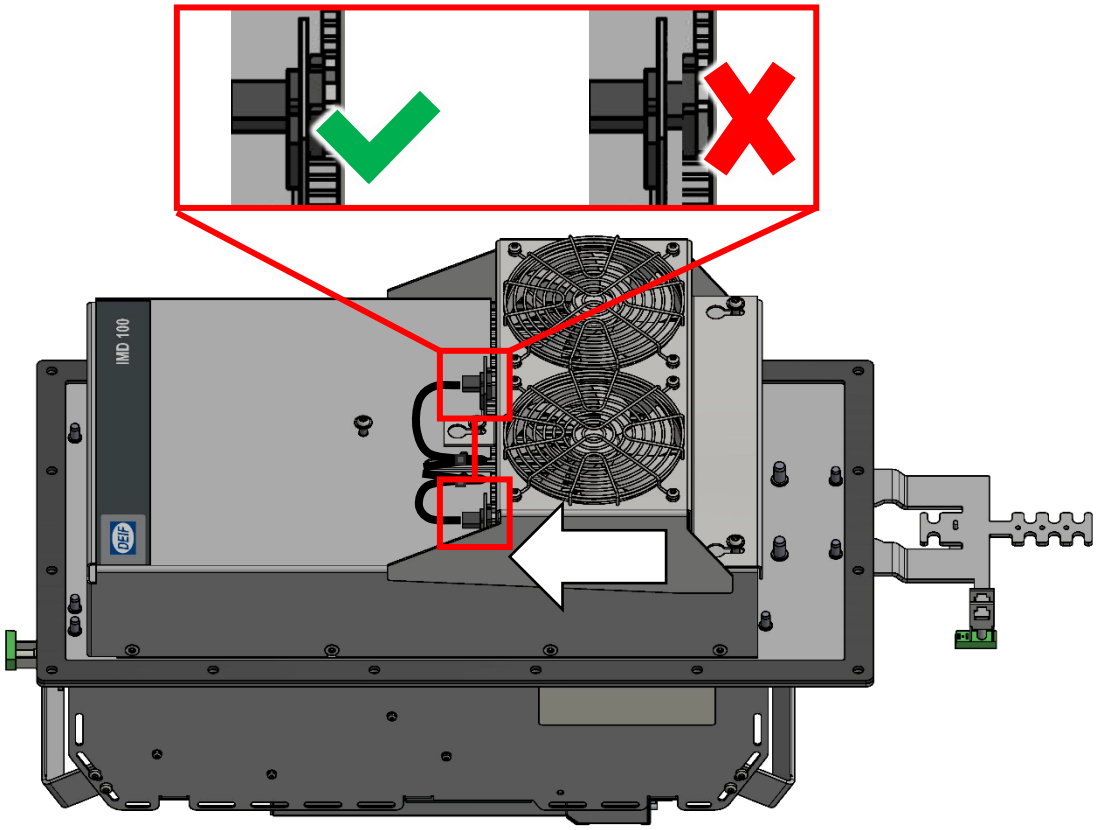
3. Lubricate both contacts mounted on the heatsink cover on both sides with Nyogel 760G or similar silica-based lubricant:



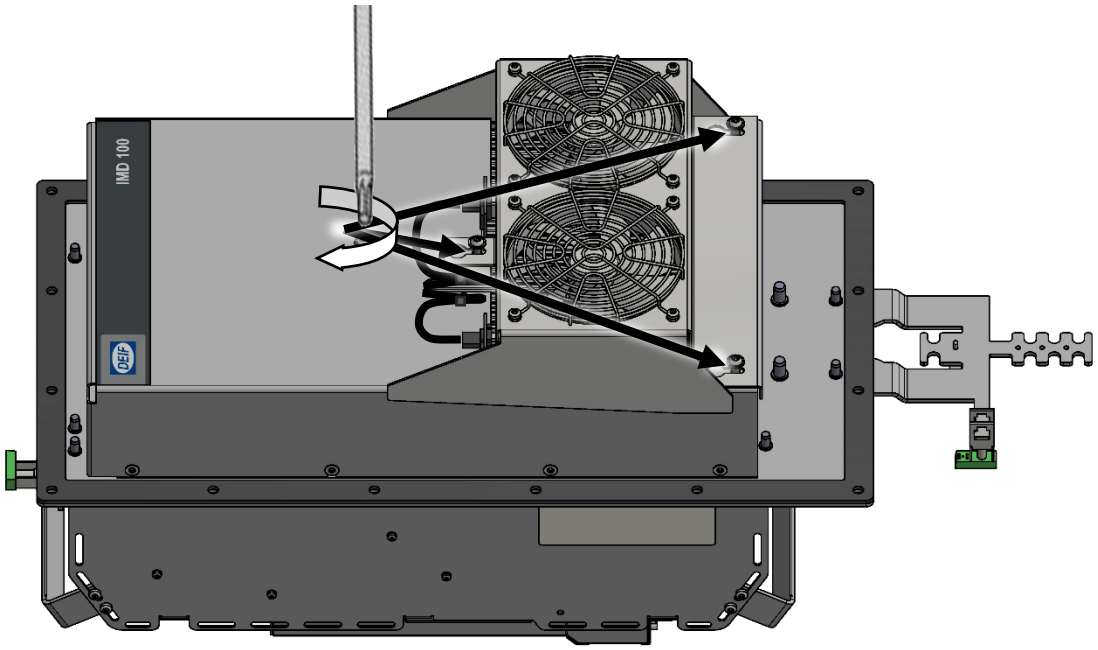
4. Insert the new fan house onto the heatsink cover:



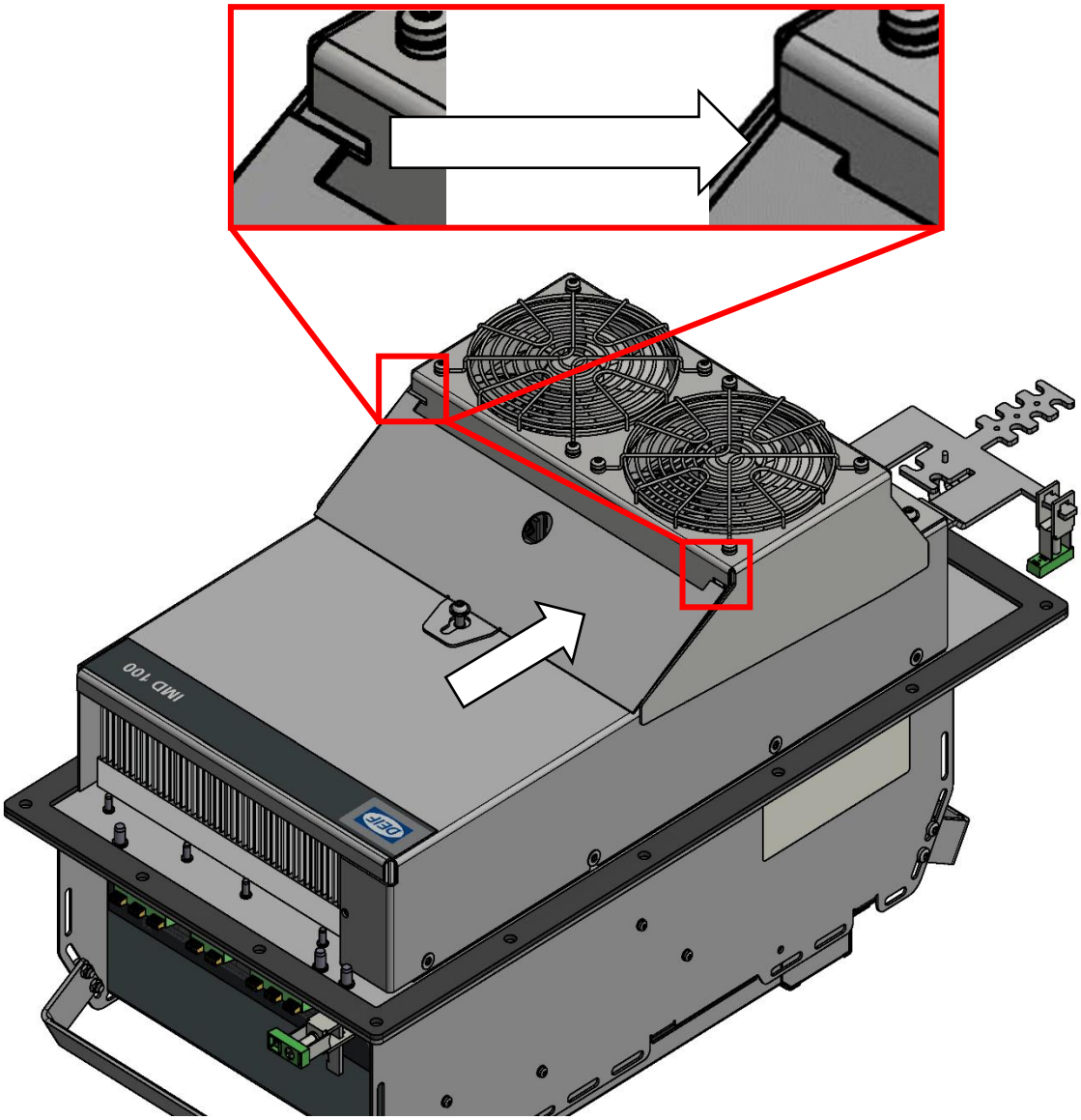
5. Push the fan house to the left. Ensure that the both fans' male contacts are completely pushed into the female contacts on the heatsink cover:



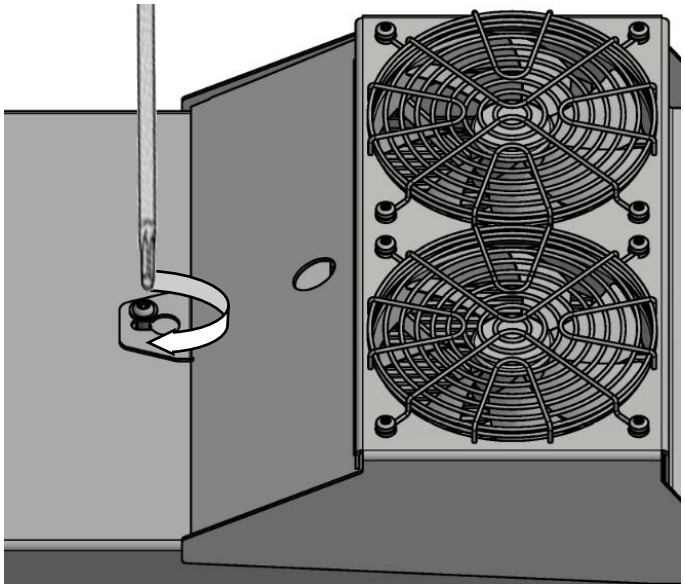
6. Fasten the lock screw according to torque in Table 4 on page 26:



7. Mount the cover through the screw and push it to the right, ensuring that the cover ends are in the fan house slots:



8. Fasten the lock screw according to torque in Table 4 on page 26:



7. Operational procedures (how to)

Info

IMD with internal power supply must be powered by at least one of the following sources to operate:

- Mains
- Safe energy
- External 24 V DC through X7

Many of the procedures described in this section require power, and may result in movement of mechanical parts.

Attention

Only instructed and qualified personnel who is fully capable of recognizing, understanding and judging the dangers of the task at hand may perform the work.

Danger!

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

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.

Warning!

Risk of crashed bodily parts due to moving parts in the nacelle or hub.

Be sure to stay away from moving parts, when being inside the nacelle or hub.

7.1 Brake test

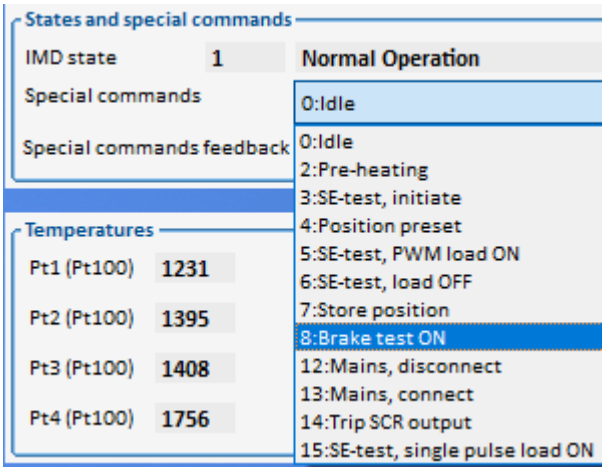
It is possible to manually test the brake output in order to verify that the brake is released and the motor can turn. Activating the brake test is done by using function 08 in the special commands.

7.1.1 Prerequisites

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

7.1.2 Activation

X4: 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 X4 to on.

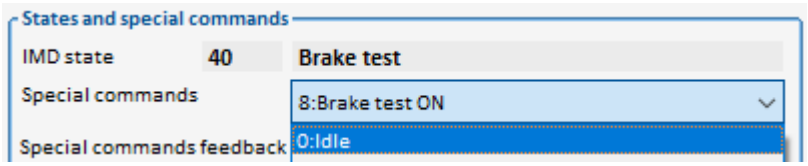
7.1.3 Operation

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.

7.1.4 Deactivation

X4: 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 X4 to off.

7.2 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.

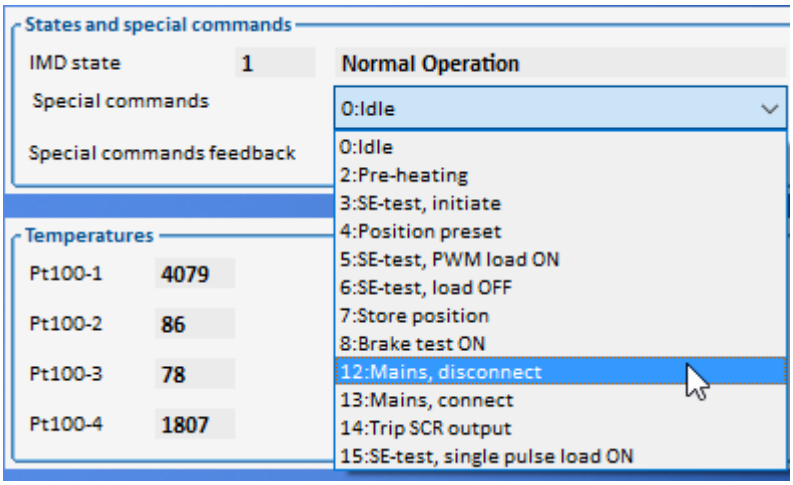
“Mains, disconnect” also cancels the LVRT timer if it is active.

7.2.1 Prerequisites

- SE Vlow warning is not active

7.2.2 Activation

X4: 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.

7.2.3 Operation

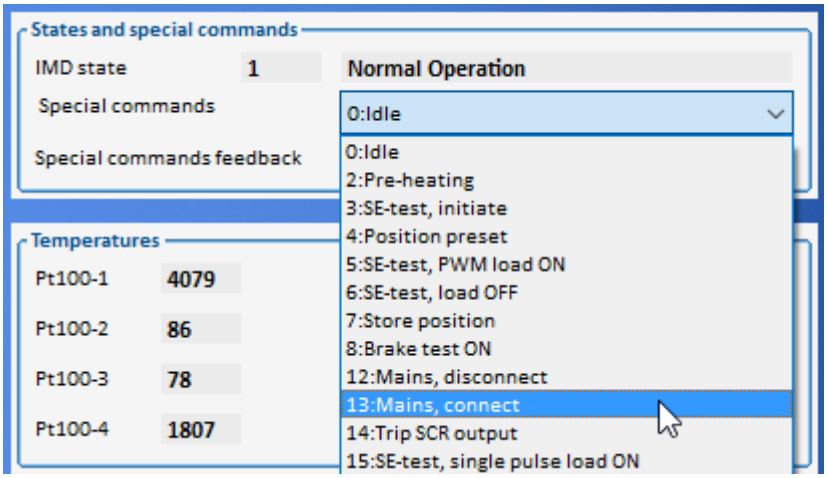
After the “Mains, disconnect” command is executed, the Mains stays disconnected, and the IMD is using the safe energy. The IMD will not reconnect the mains automatically unless a safety run is performed, and the DC-link voltage is below DC-link Vlow.

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

7.2.4 Deactivation

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

X4: 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.

7.3 Function verification

Refer to *IMD 100 initial configuration and verification manual* (Document no.: 4189360016) for description of how to test or verify different inputs and outputs of the IMD.

7.4 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 Virtual limit switches (VLMS) are used, it is not possible to pitch past them in this mode. See section 7.5 on page 35 for pitching past the VLMS.

7.4.1 Prerequisites

- Manual operation must be enabled in the configuration.
- Three switches must be connected to Digital inputs 10, 11 and 12 and 24 V DC.
- The IMD must be in one of the states that allow entry to manual operation. This will be the case in most states. The SCI state must be according to the configured state (OK or Not OK).

7.4.2 Activation

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

7.4.3 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.

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

7.4.4 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.

7.5 Manual operation 360

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

7.5.1 Prerequisites

- The IMD is in manual operation mode
- Reg. 0x01 bit 22 (Manual operation 360) must be enabled.

7.5.2 Activation

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

7.5.3 Operation

The VLMS are ignored.

7.5.4 Deactivation

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

Deactivate (low) DI 12. To go back to normal operation state. If DI 12 is deactivated the state of DI 9 does not matter.

7.6 Manually activating the fan

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

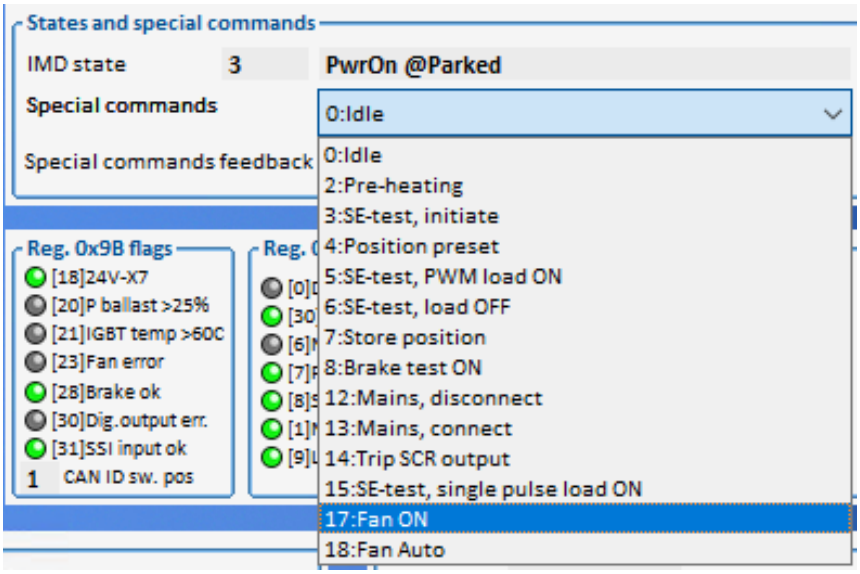
Info
This function is not supported on IMD 122 A and IMD 122 B.

7.6.1 Prerequisites

None.

7.6.2 Activation

X4: 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)

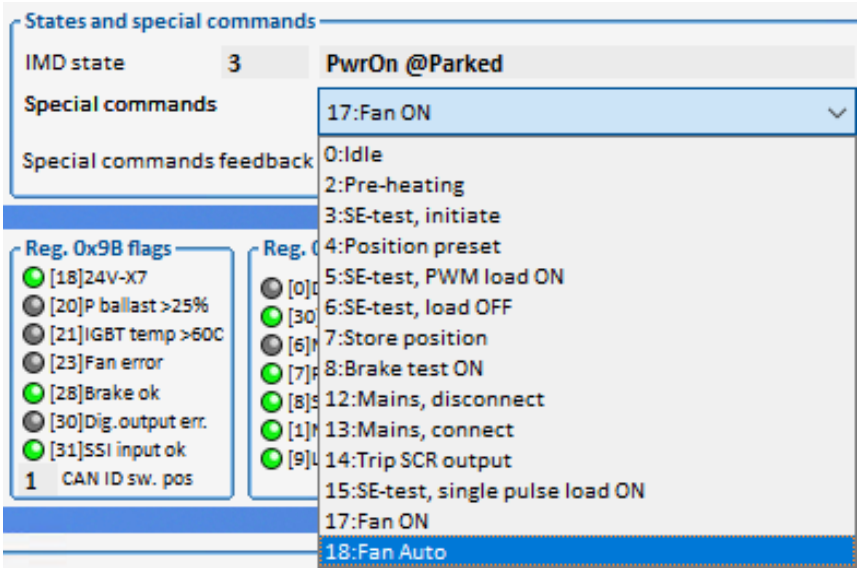
The IMD will turn on the fan.

7.6.3 Operation

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

7.6.4 Deactivation

X4: 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).

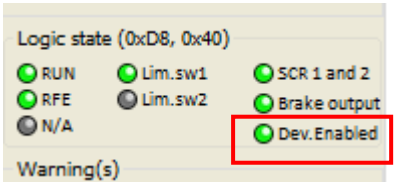
The fan will be back to in automatic control.

7.7 Manually initiating a Safety run

A safety run can be initiated manually either through CAN/CANopen command, or from the X4.

7.7.1 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.

7.7.2 Activation

X4: 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.

7.7.3 Operation

N/A

7.7.4 Deactivation

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

7.8 Normal operation

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

7.8.1 Prerequisites

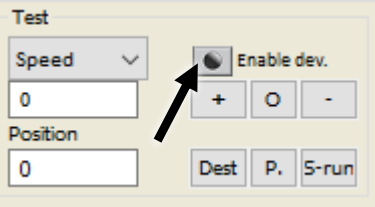
The IMD must be in either Start up at park (3) or Parked ready (17) states.

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

Safety chain inputs must be OK.

7.8.2 Activation

X4: Click on the “Enable dev.” button:



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

7.8.3 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.

7.8.4 Deactivation

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

7.9 Pre-heating the motor

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

7.9.1 Prerequisites

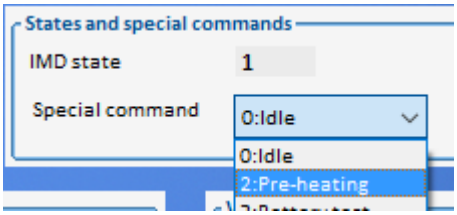
The Device must be disabled (reg. 0x51 bit 2 = 1).

The IMD must be in one of the following states:

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

7.9.2 Activation

X4: 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 X4 to on.

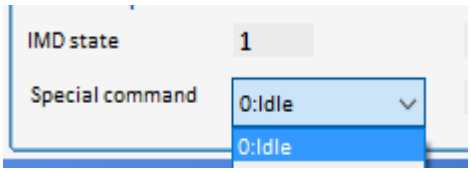
7.9.3 Operation

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.

7.9.4 Deactivation

X4: 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.

7.10 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.

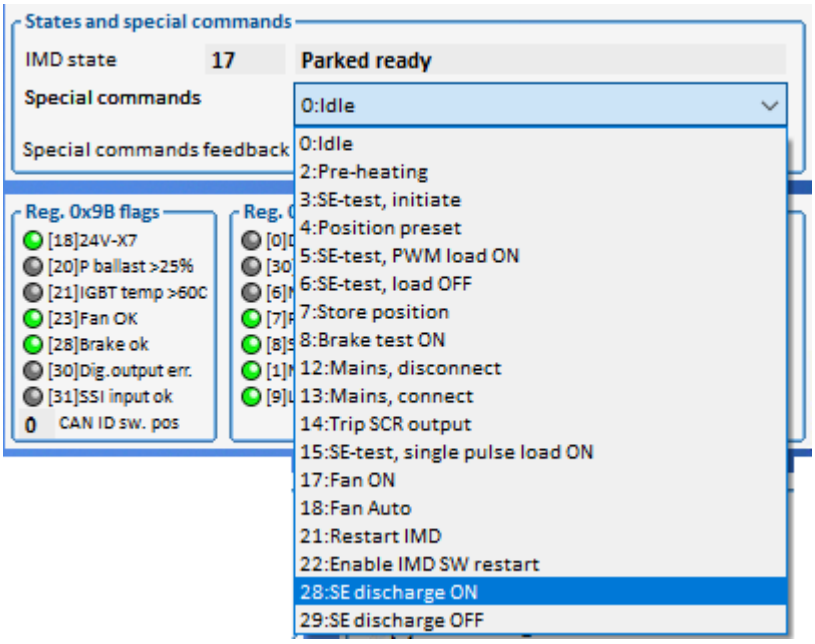
7.10.1 Prerequisites

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)

7.10.2 Activation

X4: Select "28:SE discharge ON" in the "States and special commands" group in the "Monitor and control" tab:

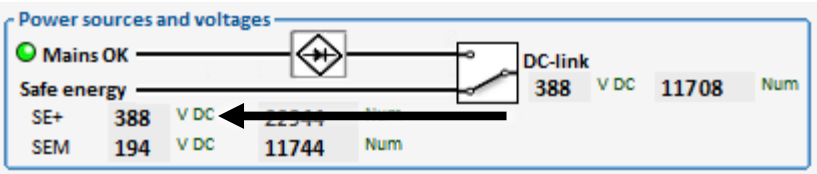


CAN/CANopen: send "28" to the special commands register (reg. 0x03).

7.10.3 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:

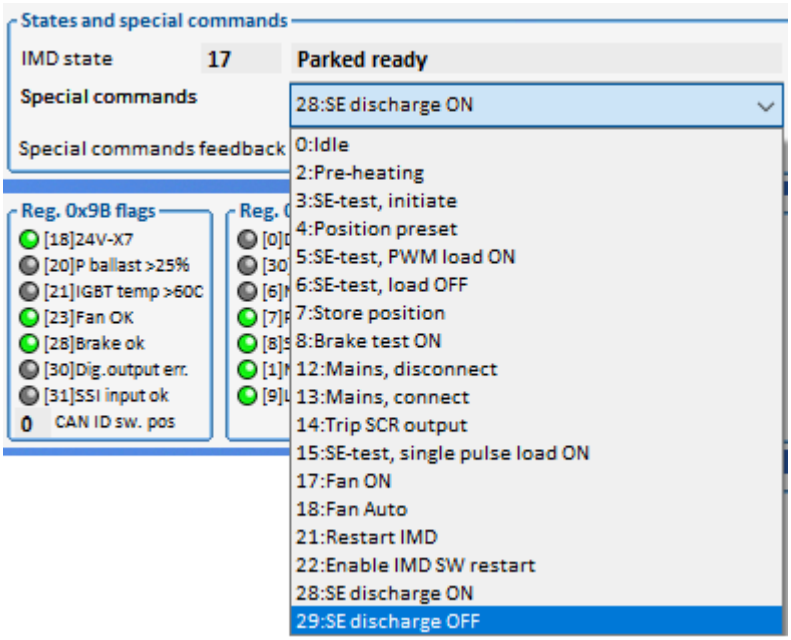


Discharging fully loaded capacitors can take some time. To calculate the approximate time full discharge will take use the following formula:

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

7.10.4 Deactivation

X4: 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.

7.11 Tripping safety-chain outputs

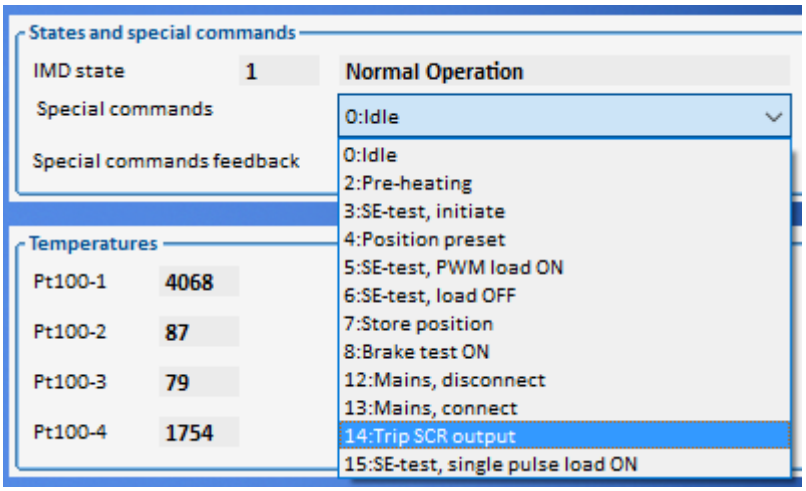
It is possible to trip the safety-chain outputs (SCR1 and SCR 2) manually, which can be used for example to trip the safety chain relay.

7.11.1 Prerequisites

There must be no active errors.

7.11.2 Activation

X4: 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.

7.11.3 Operation

N/A

7.11.4 Deactivation

N/A

7.12 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

7.13 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 5 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 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.

7.13.1 Updating firmware with the Service USB connector method

7.13.1.1 Prerequisites

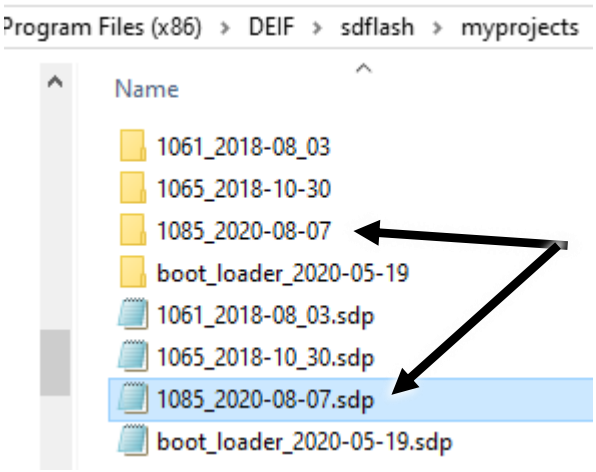
- A computer with Spectrum Digital SDFlash program installed (including V3.3 SDFlash serial patch for flash programming, September 5, 2008), (http://emulators.spectrumdigital.com/utilities/sdflash/)

  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`".

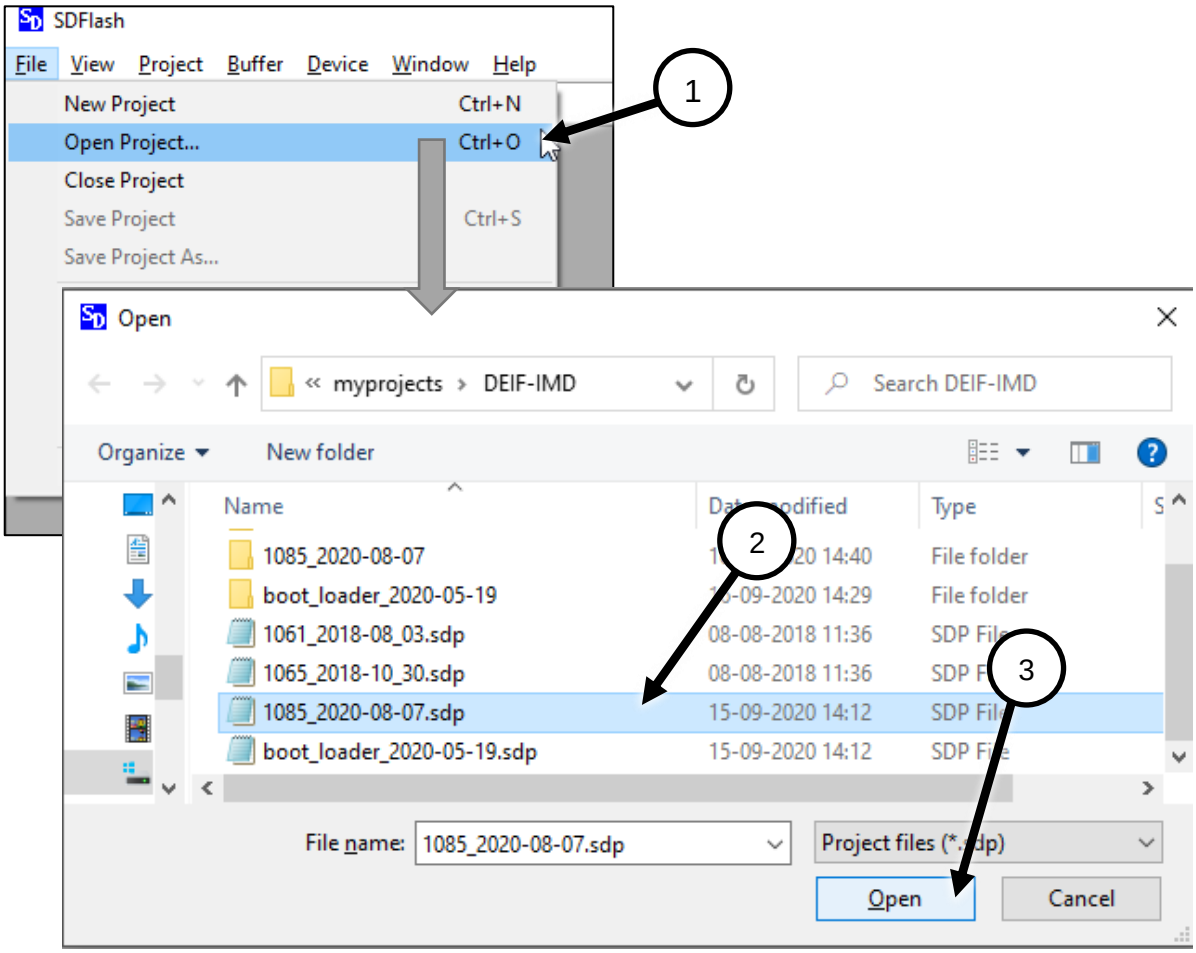
- The computer must be connected to the IMD with USB cable (male type A to male type B).
- Prepare the FW files for use:
  1. Copy the folder of the new FW.
  2. Paste the folder in the folder where other FW is located.
     If the FW files are located at their default location, go to `myprojects` folder 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:



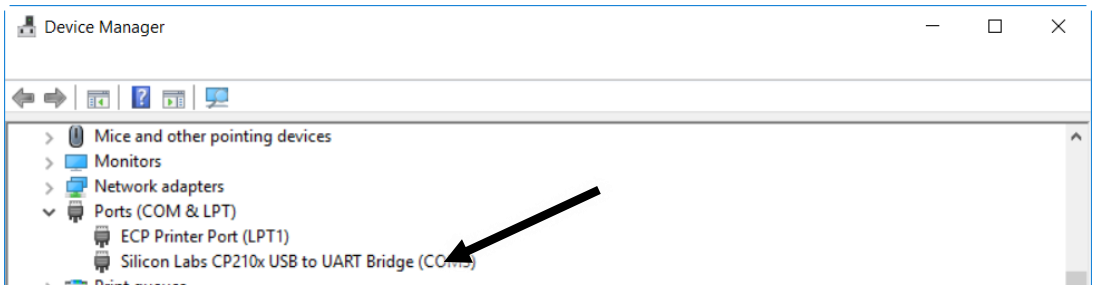
7.13.1.2 Updating firmware – USB FW

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.

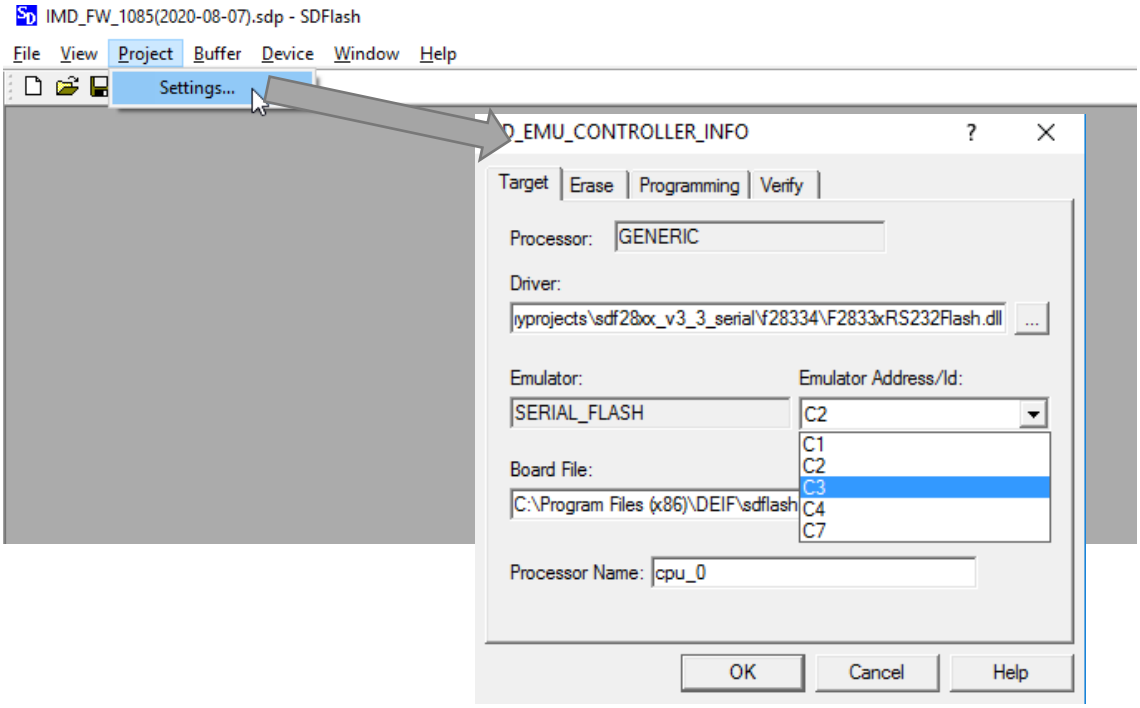
4. Click File→Open Project… (1), select and select the .sdp file that belongs to the FW that should be installed (2) and click Open (3):



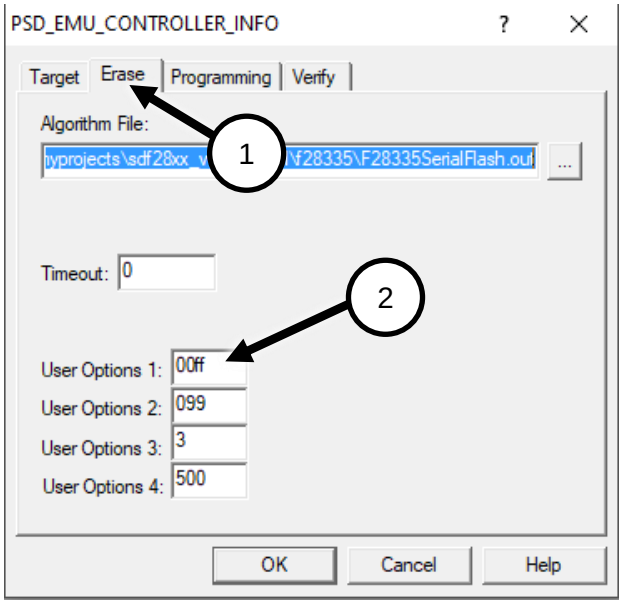
5. Skip this step if the used Com port is known.
   Open the “Device manager” in the computer’s “Settings” and determine which com port is used for the USB connection (the look and name of the device manager may differ depending on the operating system). Only Com1, Com2, Com3, and Com4 can be used with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



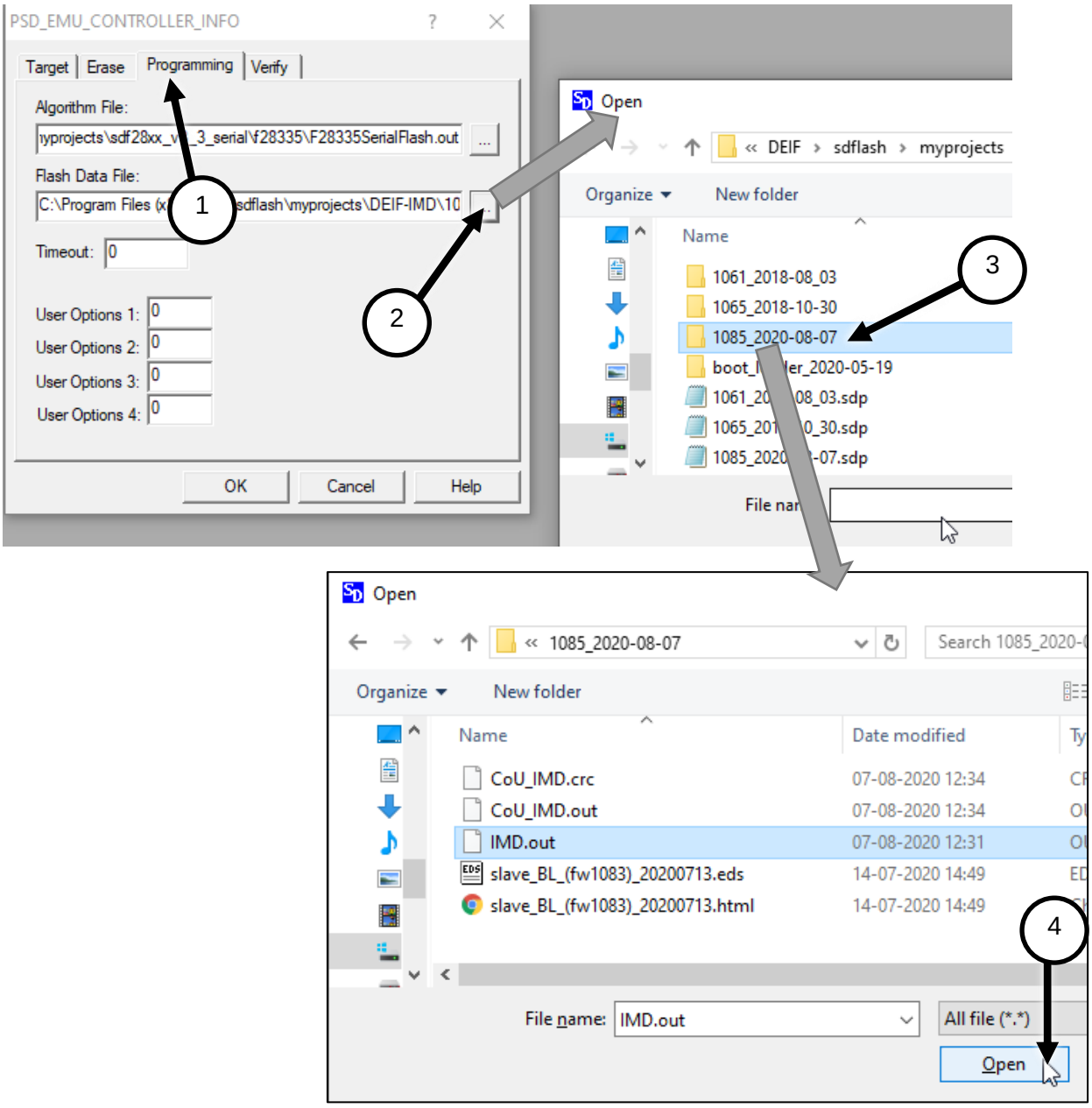
6. Click on Project →Settings… to open the Settings dialogue. Select the same com port as used in the device manager (COM1 → C1):



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):

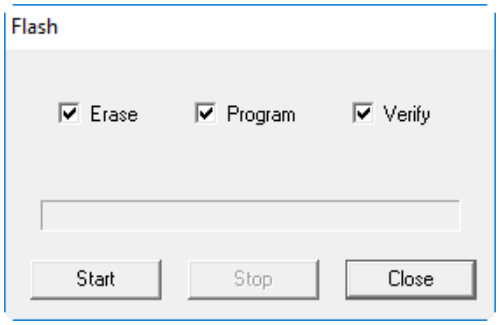


9. Click OK.

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 **48** 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 45 to 13 on page 48 .

7.13.2 Updating firmware with CANopen files using service USB connector method

Updating firmware with CANopen files, requires that a bootloader is installed as well. Once the bootloader is installed (see section 7.13.2.2 on page 49), it is enough to install only the FW file (see section 7.13.2.3 on page 54 or section 7.13.3 on page 58 depending on the method).

7.13.2.1 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/)

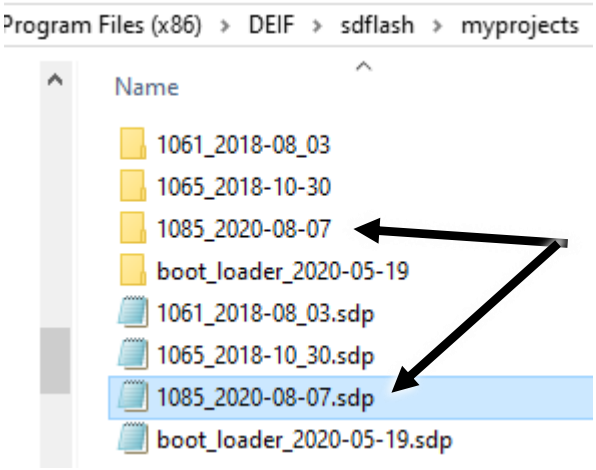
  Typically, the necessary USB driver will be found automatically if the computer is on-line. Otherwise, go to Silicon Labs home page and download the latest driver for CP210x USB to UART Bridge (http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx).

  Info

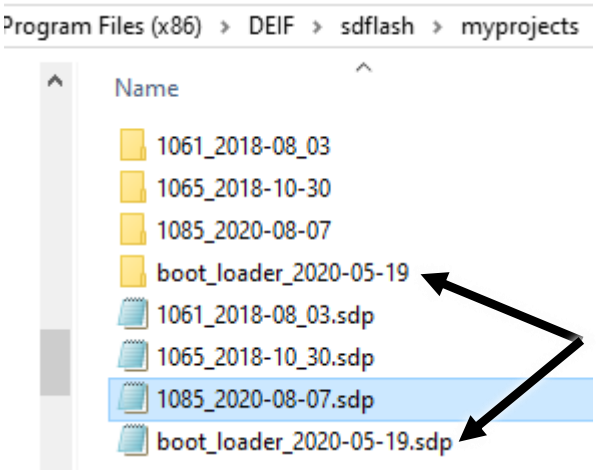
  The links above were valid at the time when this manual was written. If the link does not work anymore, search for **“**V3.3 SDFlash serial patch” or “CP210x USB to UART Bridge driver”.

- 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:

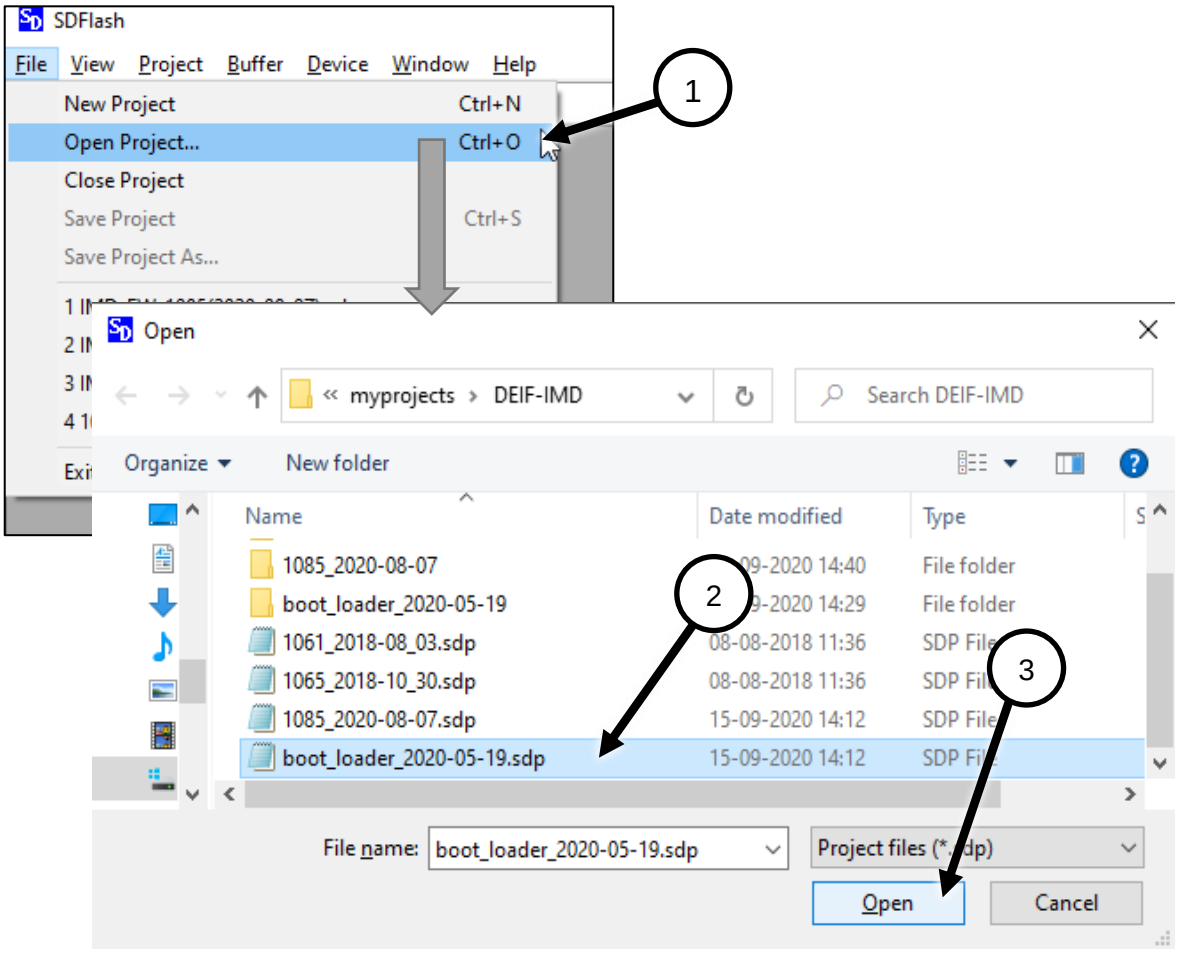


7.13.2.2 Updating CANopen bootloader file

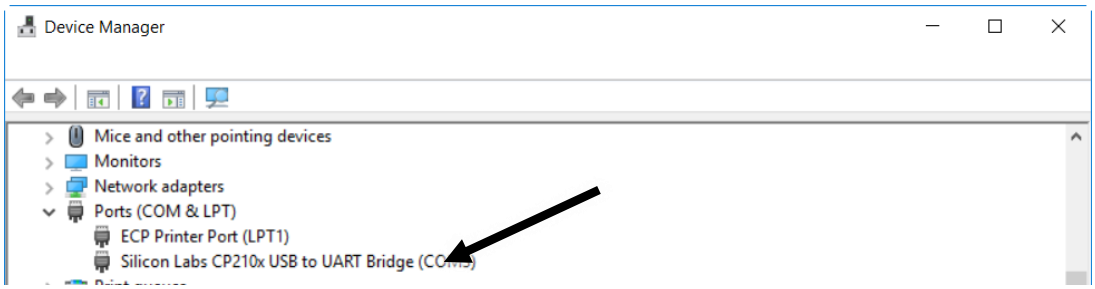
This task needs only to be done once, unless a newer bootloader version than the one already installed is available.

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.

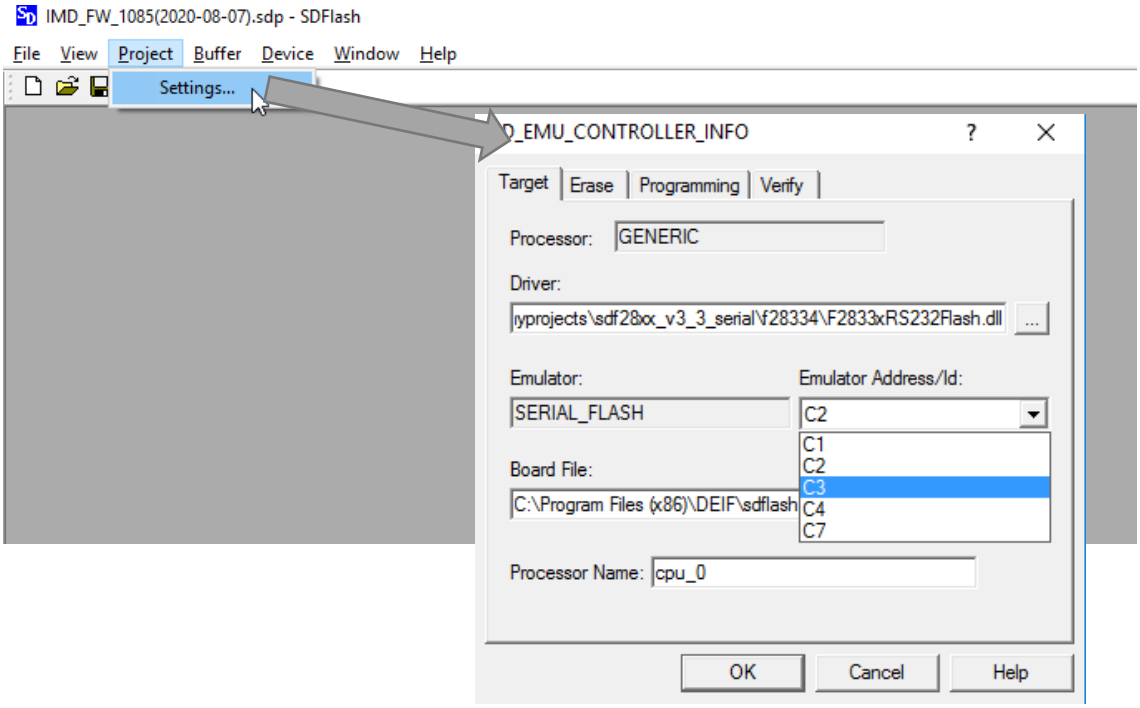
4. Click File→Open Project… (1), select and select the .sdp file that belongs to the bootloader package that should be installed (2), and click Open (3):



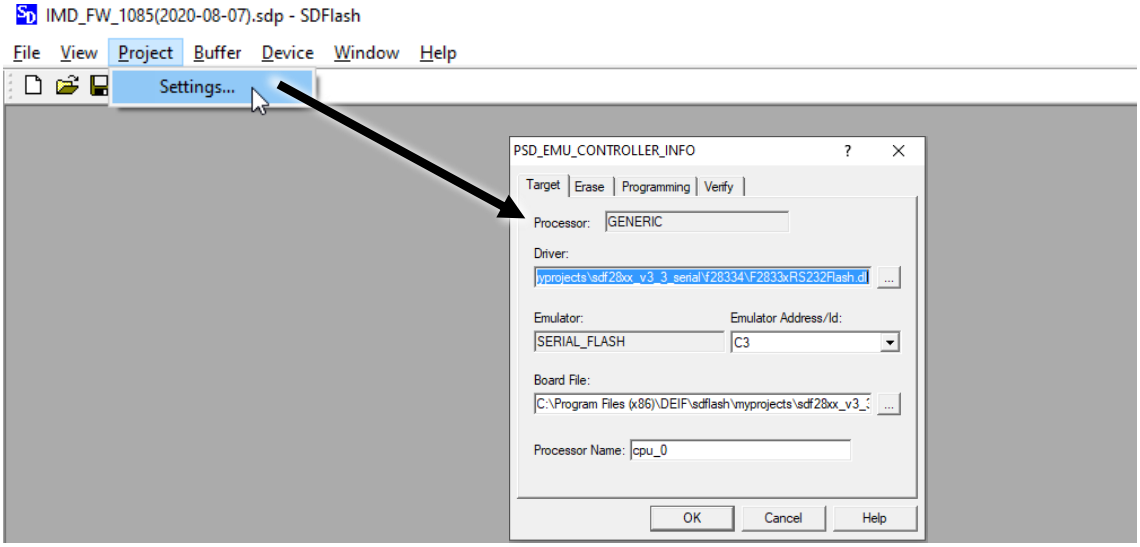
5. Skip this step if the used Com port is known.
   Open the “Device manager” in the computer’s “Settings” and determine which com port is used for the USB connection (the look and name of the device manager may differ depending on the operating system). Only Com1, Com2, Com3, and Com4 can be used with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



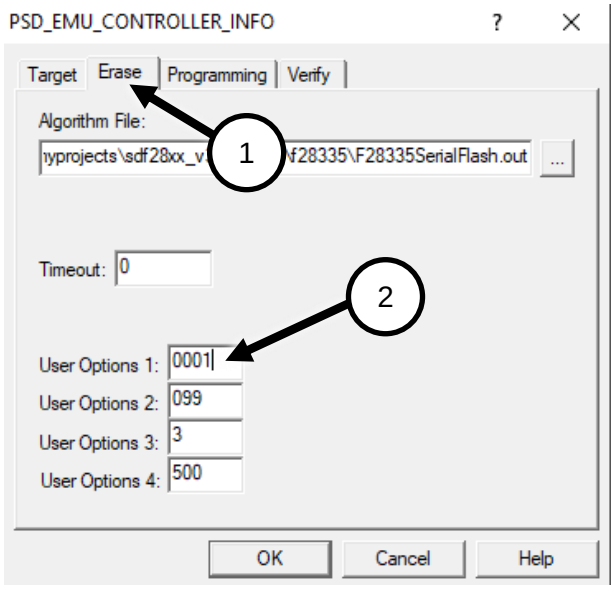
6. Click on Project →Settings… to open the Settings dialogue. Select the same com port as used in the device manager (COM1 → C1):



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

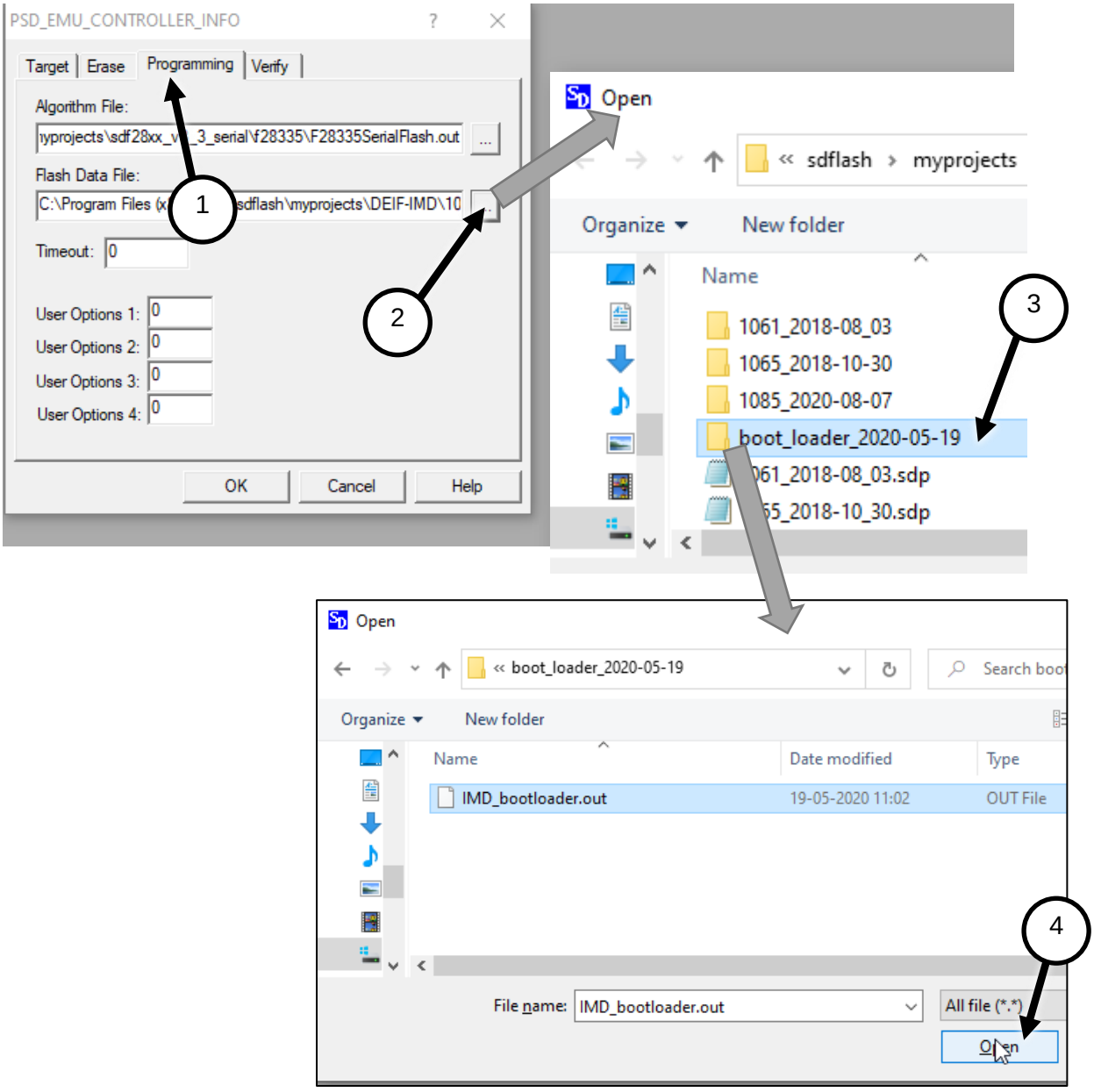


8. Click on the “Erase” tab (1), and ensure that “User Options 1:” is set to “0001” (2):



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):

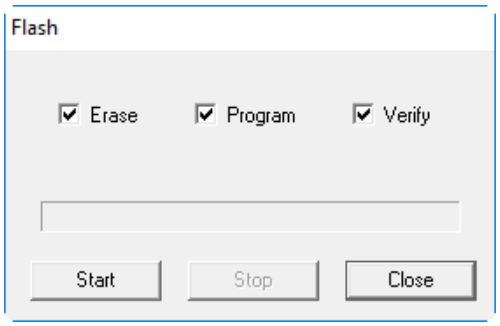


10. Click OK.

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 **48** is executed. In such a case, it is necessary to restart the whole process:

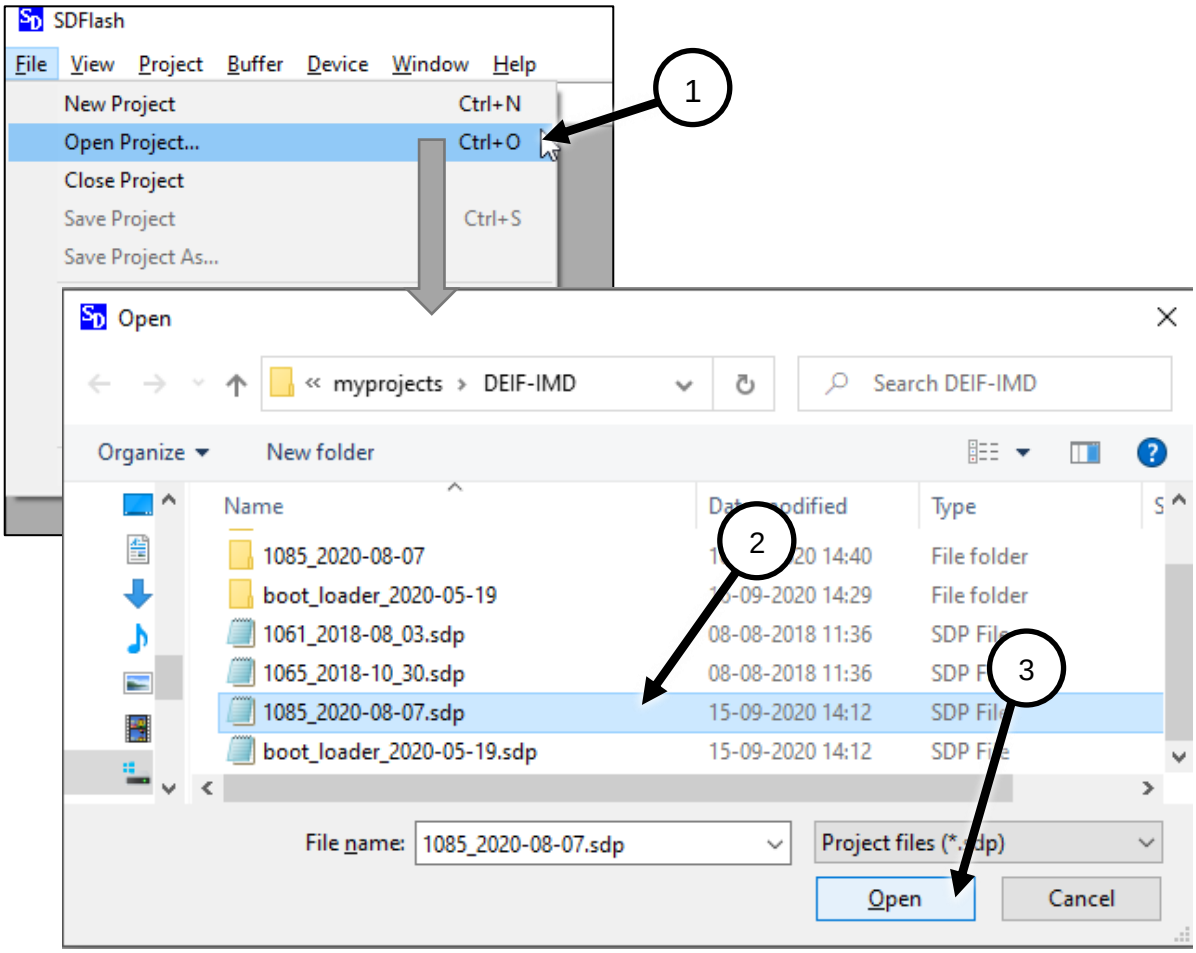
6. Close the SDflash program
7. Turn off the IMD
8. Start the SDflash
9. Turn on the IMD
10. Repeat com configuration, and the actions described in steps 4 on page 45 to 13 on page 48 .

7.13.2.3 Updating CANopen FW file

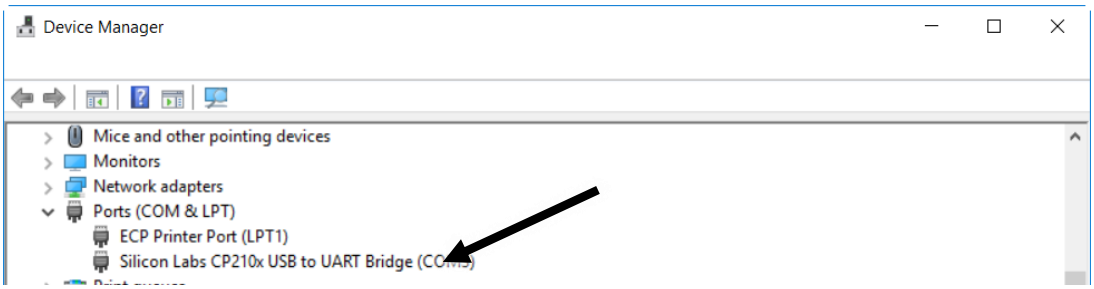
This procedure describes how to update the IMD FW in an IMD prepared for CANopen FW update, through the Service USB connector.

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.

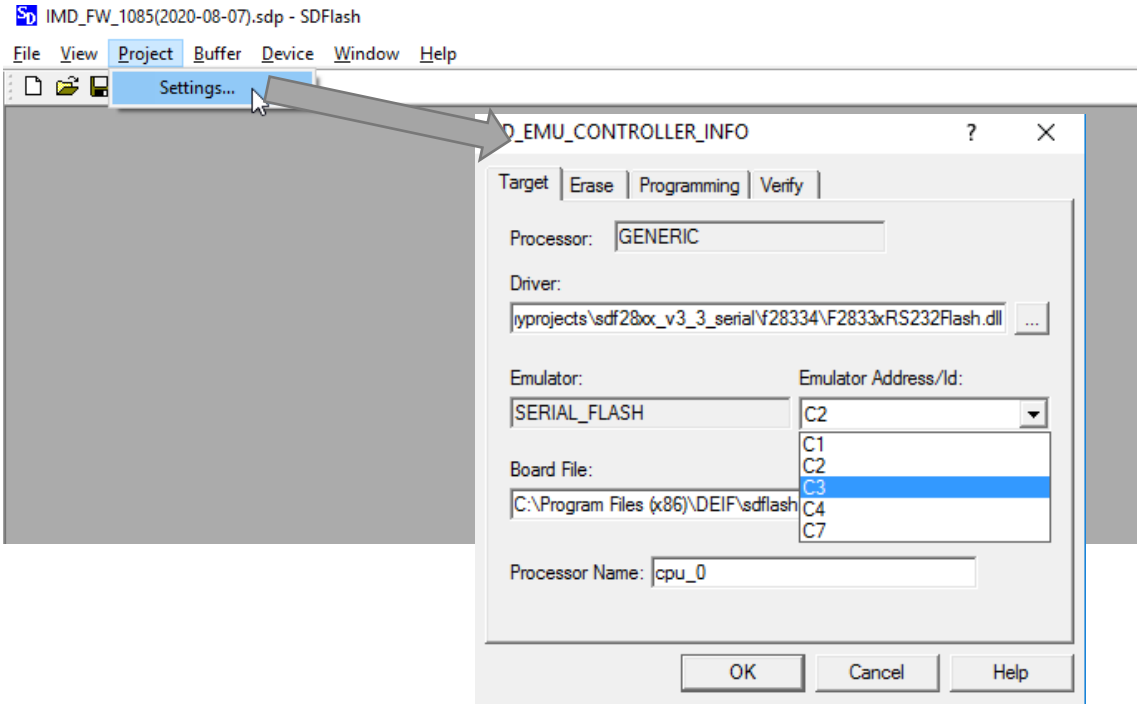
2. Click File→Open Project… (1), select and select the .sdp file that belongs to the FW that should be installed (2) and click Open (3):



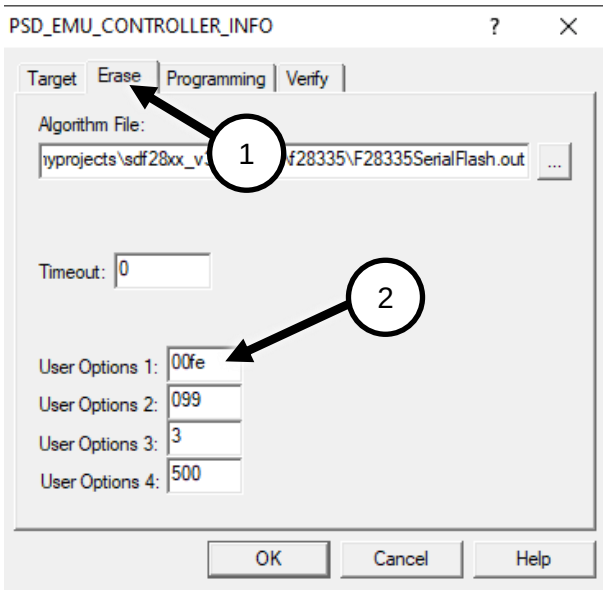
3. Skip this step if the used Com port is known.
Open the “Device manager” in the computer’s “Settings” and determine which com port is used for the USB connection (the look and name of the device manager may differ depending on the operating system). Only Com1, Com2, Com3, and Com4 can be used with 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):

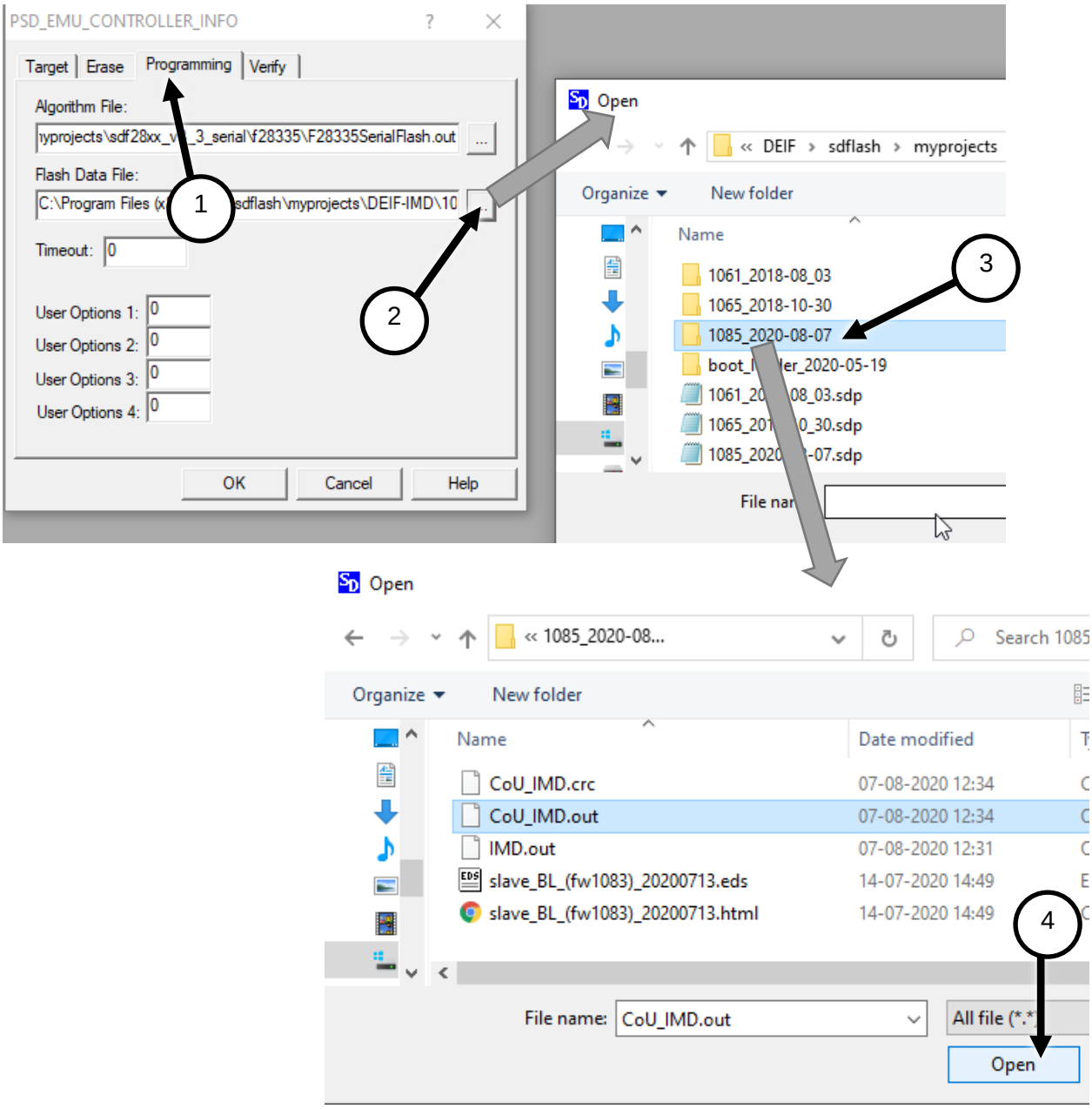


5. Click on the “Erase” tab (1), and ensure that “User Options 1:” is set to “`00fe`” (2):



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):

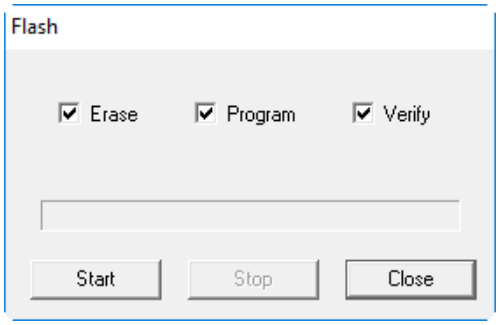


7. Click OK.

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 **48** 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 45 to 13 on page 48 .

7.13.3 Updating firmware through CANopen

7.13.3.1 Prerequisites

- A specific “FW updater” SW must be implemented (by the customer) in the Pitch Motion Controller, or Turbine Controller.
- Instructions on how to use the implemented “FW updater” SW available
- Bootloader for CANopen FW update is installed on the IMD (see section 7.13.2.2 on page 49)
- The turbine must be stopped in a safe position and all blades are in fully feathered position.

7.13.3.2 Updating the firmware

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

7.14 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 the description of how to use in the IMD manager user manual.

7.14.1 Digital outputs

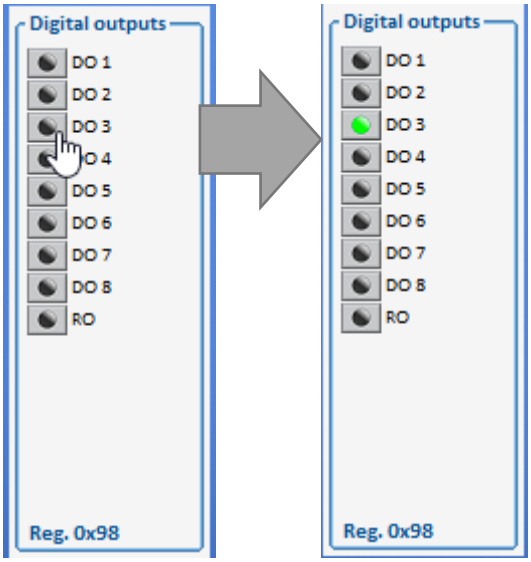
This section describes how to use the digital outputs.

7.14.1.1 Prerequisites

None

7.14.1.2 Activation

X4: Click on the “DO x” button of the digital output to toggle it:



CAN/CANopen: Set the applicable bit in Reg. 0x98 (see IMD 100 integration manual for bit mapping) to “1” (on).

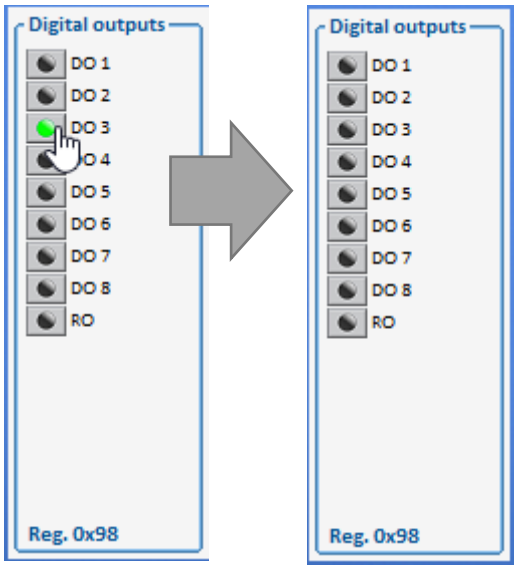
7.14.1.3 Operation

X4: 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 IMD 100 integration manual for bit mapping).

7.14.1.4 Deactivation

X4: Click on the “DO x” button of the digital output to toggle it:



CAN/CANopen: Reset the applicable bit in object 2098 (see IMD 100 integration manual for bit mapping) to “0” (Off).

7.14.2 Digital inputs

This section describes how to use the digital inputs.

7.14.2.1 Prerequisites

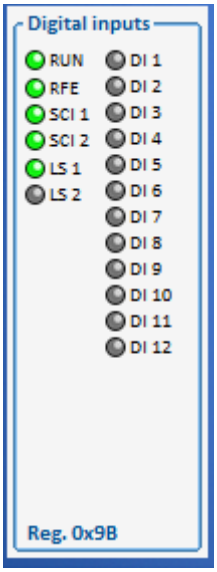
None

7.14.2.2 Activation

None

7.14.2.3 Operation

X4: 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 IMD 100 integration manual for bit mapping).

7.14.2.4 Deactivation

None.

7.15 Retrieving error additional information (error snapshot)

The error snapshot function records additional information about the conditions just before the last error occurred. The records are saved in the RAM of the IMD as an oscilloscope capture. However, it is not possible to view the records in the IMD manager oscilloscope. The parameter set for recording is chosen to provide maximum of information in the event of a fault, and cannot be changed.

The settings of the built-in oscilloscope are automatically set when the IMD starts. A capture is made in the event of every error except for RFE missing. The recorded information always start before the error event, in order to have information about the conditions leading to the error. If the oscilloscope is used through the IMD manager, these settings are overwritten and the snapshot function is disabled, until the IMD restarts.

When an error occurs, the IMD saves the information in the RAM. The recorded information must be exported manually. If the oscilloscope is used before the snapshot information is exported, the information is lost.

The data is recorded as raw data of the registers. Some data is given as hexadecimal (indicated with 0x), and some as decimal. The exported information is exported in two files:

- A .csv file containing all the recorded error history information as well as the capture information
- A .txt file containing the oscilloscope settings and capture

7.15.1 Prerequisites

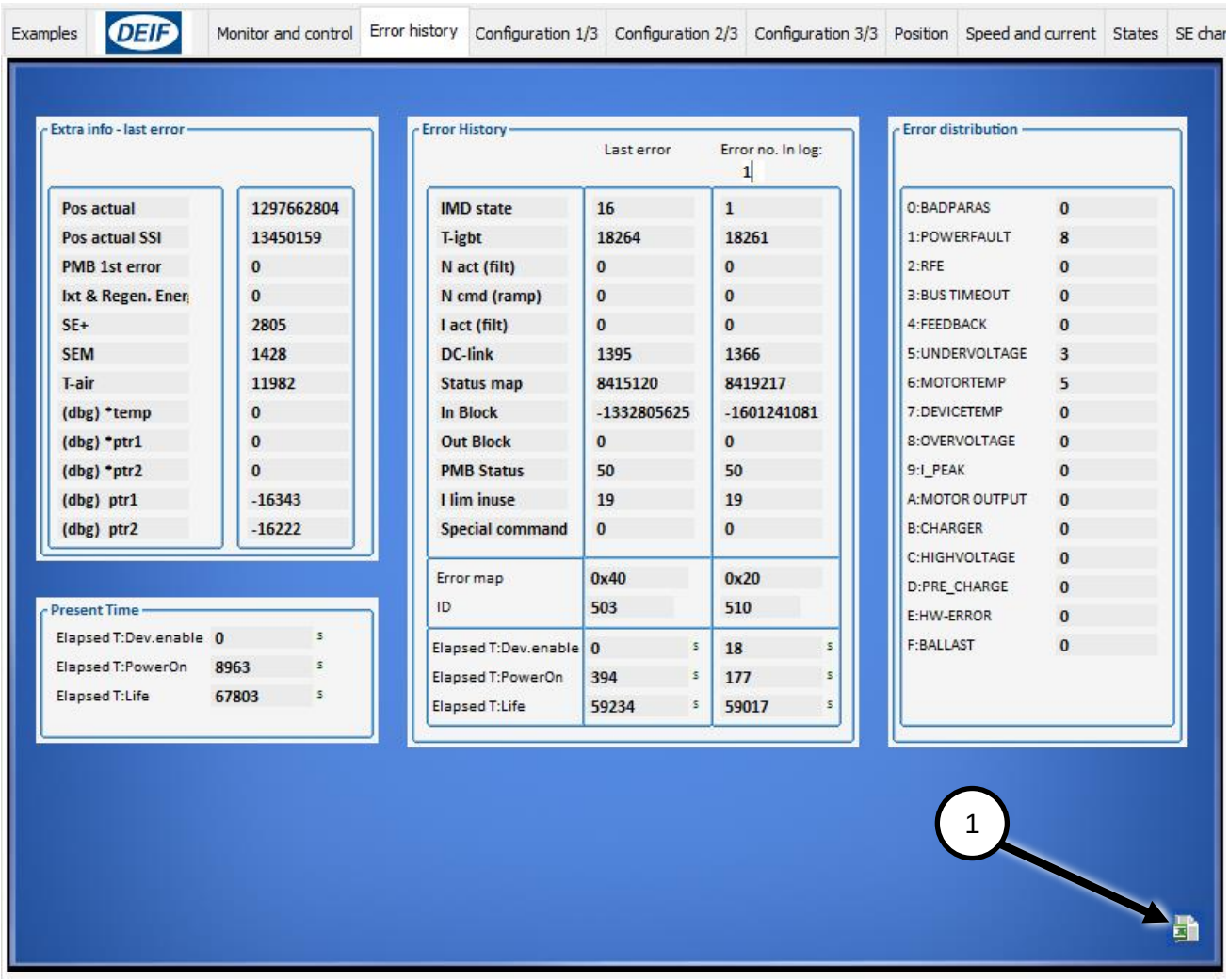
- The IMD FW is 1-08-9 or later
- The oscilloscope was not used since the IMD started
- IMD manager is available, to be able to export the information

7.15.2 Activation

The activation of the error snapshot is automatic, whenever an error occurs except for RFE missing (error 2).

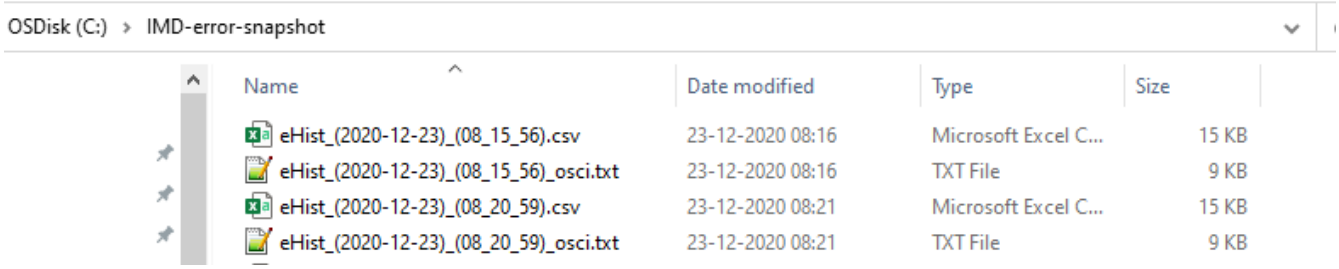
7.15.3 Operation

3. After the error, export the data by clicking in the icon in the Error history tab of the IMD manager (1):



The icon changes to  and the “Error no. in log” counts up through all the recorded errors in the error history. This may take some time.

When the icon changes back to  , the two files are saved in `C:\IMD-error-snapshot` folder:



Each file name contains a date and time stamp, and contains the parameters values, and all data from all errors in the Error history log.

4. The data can be processed with any tool available.

7.15.4 Deactivation

The snapshot function is deactivated if the oscilloscope in the IMD manager is used.

8. Storage

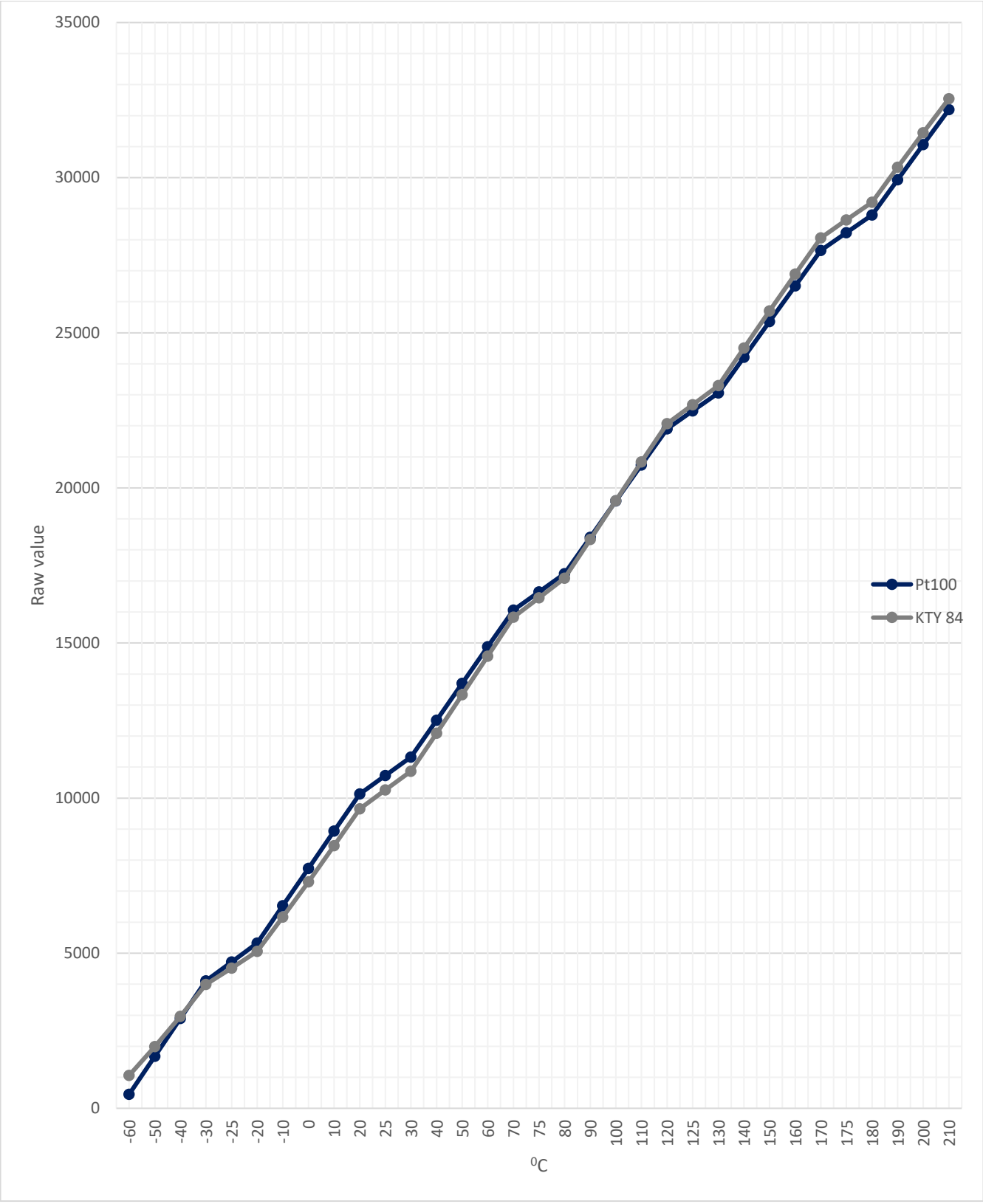
Handle the IMD as any electronic equipment.

IMD storage requirements:

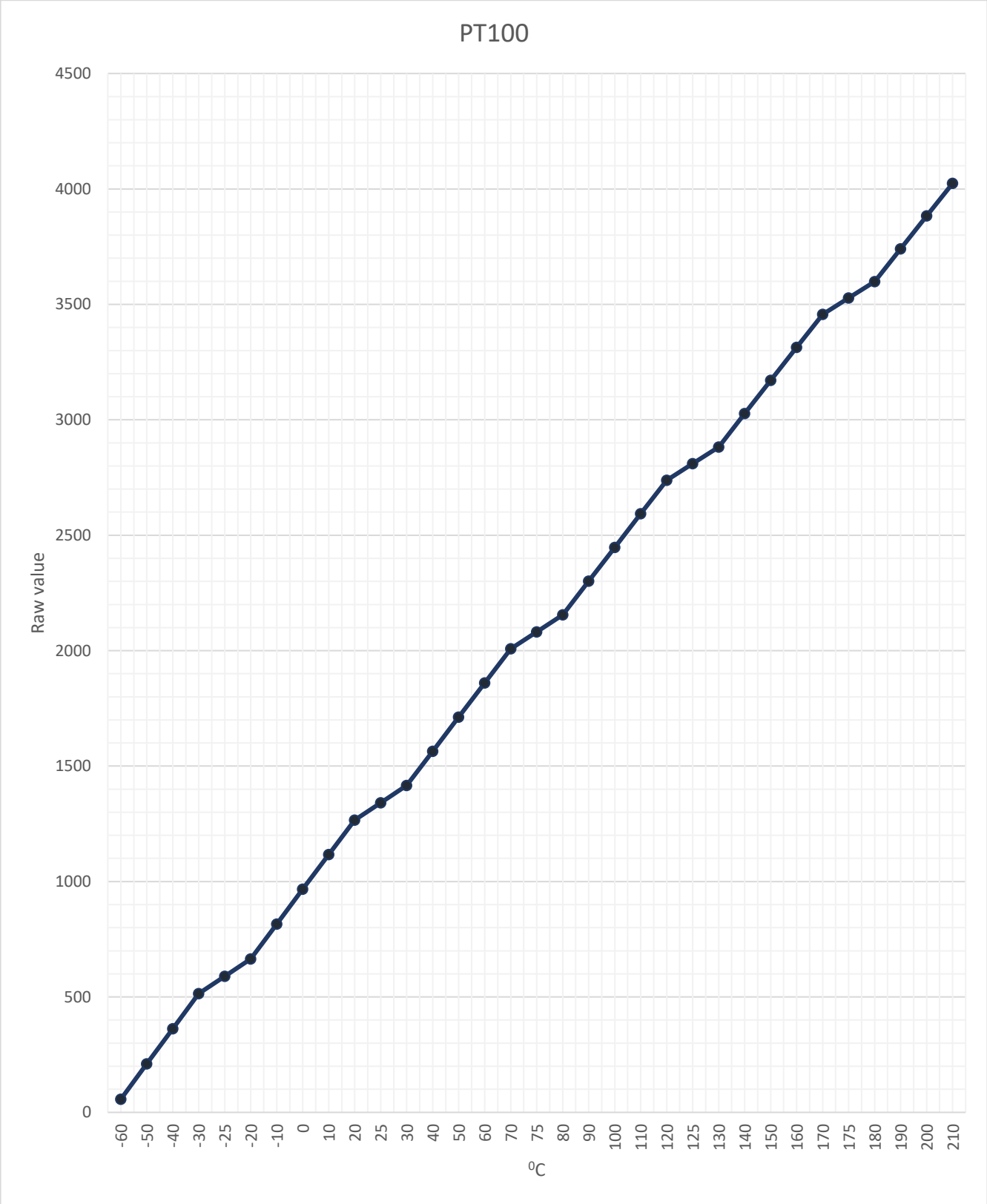
Temperature	-40...85 °C	IEC 60068-2-1/2, IEC/EN 61800-5-1
Humidity	95% non-condensing	IEC/EN 61800-5-1

9. Quick temperature conversion charts

9.1 Motor temperature



9.2 Pt1 to Pt4 (Pt100 sensors)



10. IMD display description

The IMD display indicates the status of the IMD. The display contains a seven-segment display and a multicolour LED. Interpretation of the information is a combination of both display and LED.

NOTE In boot mode (firmware upgrade) the display and LED state are totally random, and may even be turned off. This is normal behaviour and does not indicate any error or faulty condition.

10.1 Status LED

The LED on the front panel of the IMD indicates the status of errors, warnings and safety chain inputs,

Table 6 Status LED states

LED state	Active error	Active warning	Safety chain inputs
Off	None	None	Not OK
Green continuous	None	None	OK
Orange*/green flashing alternately The display alternates between warning and operational state: Orange (1/4 of cycle): the display shows warning number Green (3/4 of cycle): the display shows operational state	None	Active warning. Display shows warning no.	OK
Red flashing	None	Active warning. Display shows warning no	Not OK
Red continuous	Active error. Display shows error no.	Don’t care	Not OK
Orange* continuous	Active error. Display shows error no.	Don’t care	OK

* Orange may look like red or yellow depending on the angle of viewing.

10.2 MODE seven segment display

The seven-segment display shows the state of the IMD as well as which error or warning are active. See Status LED states table on page 66 for information about the relations between the LED and display.

10.2.1 The seven-segment display in normal state operation

The following table shows how to interpret the display information for normal state (LED green or off while flashing):

Table 7 Display of operational state

MODE display	Dot / Line	Description
	Flashing Off	Normal operation – IMD is active. IMD is not operating. Missing Voltage or hardware failure
	Flashing On Off	The IMD is starting after a reset. Drive enabled Drive is disabled
	on	The IMD is holding the blade motor in position (speed is zero)
	on	The drive is turning in positive direction
	on	The drive is turning in negative direction
	Flashing On Off	The current is limited to *I-nom* The current is limited to *I-max* Normal operation, the current is equal to or bellow *I-nom*
	On for 0.1 s	A new command was received through the CAN bus or the USB.

The display will show any combination of the operational states. For example, when the motor turns in the positive direction:

Example: 	Normal operation – IMD is active (dot flashing). The drive is enabled (Bottom line on) The motor is now turning in positive direction (right lower line)

10.2.2 The seven-segment display when a warning is active

When a warning is active the display switches between showing the warning number/letter as described in the Warning list and description table on page 72 (when the LED is flashing orange and in on state), and the operational state as described in the Display of operational state table on page 67 (when the LED is in off state). The dot will be flashing as well.

The LED and display cycle is as follows:

Dot	Status LED	7 Segment display
ON	Orange	Warning number
OFF	Green	Operational state number
ON	Green	Operational state number
OFF	Green	Operational state number

10.2.3 The seven-segment display when an error is active

When an error is active the display shows the error number/letter as described in the Error list and description table on page 69. The dot will be flashing as well.

11. 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.

11.1 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 8 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.
4	FEEDBACK	Yes	Bad or no motor feedback signal. The resolver circuit detects a fault.

IMD display / Error bit no.	IMD Manager Error(s) field	Safety run performed	Error description
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 11.1.1 on page 71. 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

11.1.1 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.

11.2 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 9 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.
D	Warning D	Not used

Warning bit no.	IMD Manager Warning(s) field	Warning description
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.

11.2.1 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.

11.3 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
Drive status	0x40	Bit map representation of the state of the internal flags

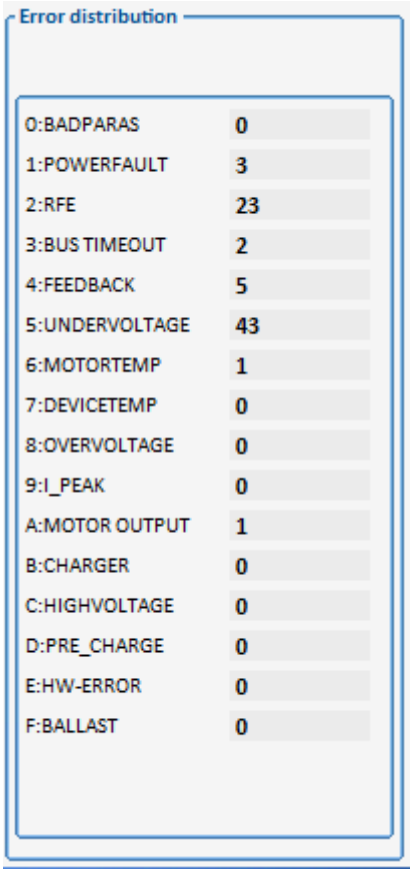
Information	Register	Description
Logic in block	0x9B	Bit map representation of the state of digital inputs and some internal flags
Out block	0x98	Bit map representation of the state of digital outputs
Power board status	0x63	Status of the power board
Actual current limit	0x48	The current limit used at 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

Information	Register	Description
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
(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

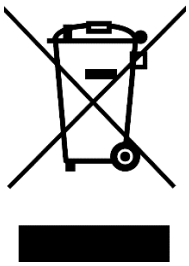
The error log also contains a distribution representation of all errors occurred during the “Elapsed time:life” (the time elapsed since the first FW supporting error history was installed), showing how many times each error appears in the log:



12. Troubleshooting

See troubleshooting in the IMD 100 initial configuration and verification manual (4189360016).

13. Disposal of the IMD



All products that are marked with the crossed-out wheeled bin (the WEEE symbol) are electrical and electronic equipment (EEE). EEE contains materials, components and substances that can be dangerous and harmful to people's health and to the environment. Waste electrical and electronic equipment (WEEE) must therefore be disposed of properly. In Europe, the disposal of WEEE is governed by the WEEE directive issued by the European Parliament. DEIF complies with this directive.

You must not dispose of WEEE as unsorted municipal waste. Instead, WEEE must be collected separately, to minimise the load on the environment, and to improve the opportunities to recycle, reuse and/or recover the WEEE. In Europe, local governments are responsible for facilities to receive WEEE. If you need more information on how to dispose of DEIF WEEE, please contact DEIF.

14. Revision history

Apart from editorial changes the following changes have been made in this revision:

Date	Revision	Changes
2021-01-29	E	• “Manual operation and function verification” renamed to “Operational procedures (how to)” • “Operational procedures (how to)” updated with: - General information regarding power supply - Safety information - New operational procedures (copied from “IMD 100 Integration manual”) • IMD 135 added to “Checking electrical connections” • “Replacing IMD 135 C fan” added in “Replacing the fan"
2020-09-25	D	• “Connecting the safe energy” in “Avoiding damage to the IMD” updated • “Charger (option) warning” in “Warning list” updated
2020-06-29	C	• “IMD maintenance schedule” section added. • “Disclaimer” and “Introduction” updated • “Replacing the fan” structure changed (two types of fan). “Replacing IMD 122 C type fan” added. • “Checking corrosion” section added in “Preventive maintenance of the IMD” • Referenced documents section added • Note added when describing the fan cover to allow for different cover • “Manual operation and “function verification” section added • Checking electrical connections updated with IMD 122C • Errors and warnings updated • “Disposal of the IMD” section added • “Error and warning lists” section renamed to “Errors and warnings” • “Errors and warnings log” section added to “Errors and warnings” section
2018-04-19	B	Description of LED display, errors and warnings updated.
2017-03-03	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 10 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.

Document	Target audience	Content
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
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.

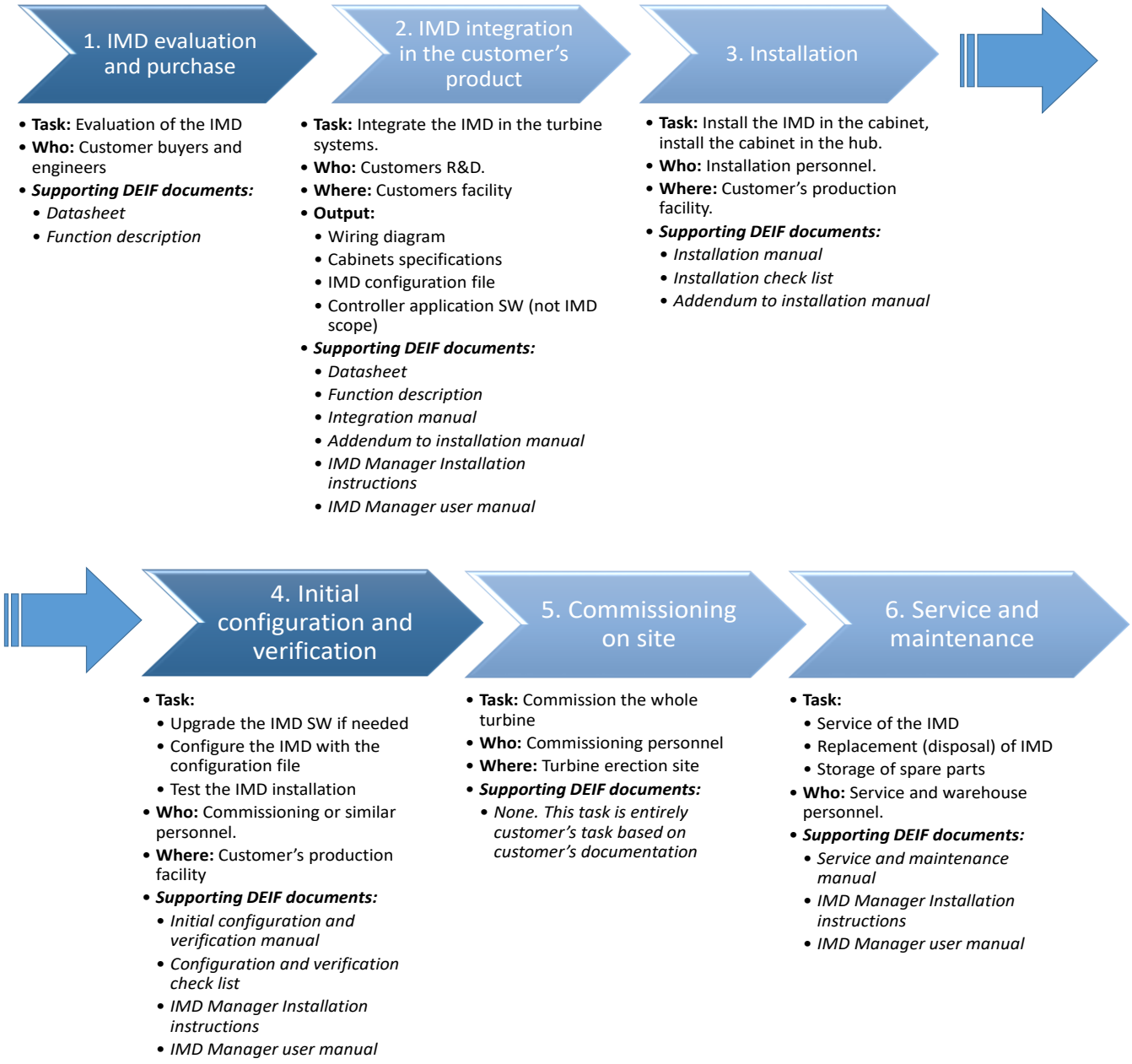


Figure 4 Tasks and documentation overview

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

CAN	Controller Area Network (communication protocol)
IMD	Integrated Motor Drive
SCI	Safety-Chain Input
SCR	Safety-Chain Relay
SE	Safe Energy
SSI	Synchronous Serial Interface
USB	Universal Serial Bus
VLMS	Virtual limit switches. SW limit switches based on resolver revolutions.

16.2 Units

Unit	Unit Name	Quantity name	US unit	US name	Conversion	Alternative units
A	ampere	Current				
ºC	degrees Celsius	Temperature	ºF	Fahrenheit		
g	gram	Weight	oz	ounce	1 g = 0.03527 oz	
Hz	hertz	Frequency (cycles per second)				
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	
ms	millisecond	Time				
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				