4.6.5 Control connections

The control unit of the AC drive consists roughly of the control board and additional boards connected to the five slot connectors (A to E) of the control board. The control board is connected to the power unit through a D-connector or fibre optic cables.

Usually, when the frequency converter is delivered from the factory, the control unit includes at least the standard compilation of two basic boards (I/O board and relay board) which are normally installed in slots A and B.

The control board can be powered externally (+24 V, ±10%) by connecting the external power source to either of the bidirectional terminals. This voltage is sufficient for parameter setting and for keeping the fieldbus active.

The tightening torques for the control unit terminals:

- Relay and thermistor terminals (screw M3): 0.5 Nm.
- Other terminals (screw M2.6): 0.2 Nm.

For more detailed cabling instructions, see the corresponding user manual (see Chapter 1.5).

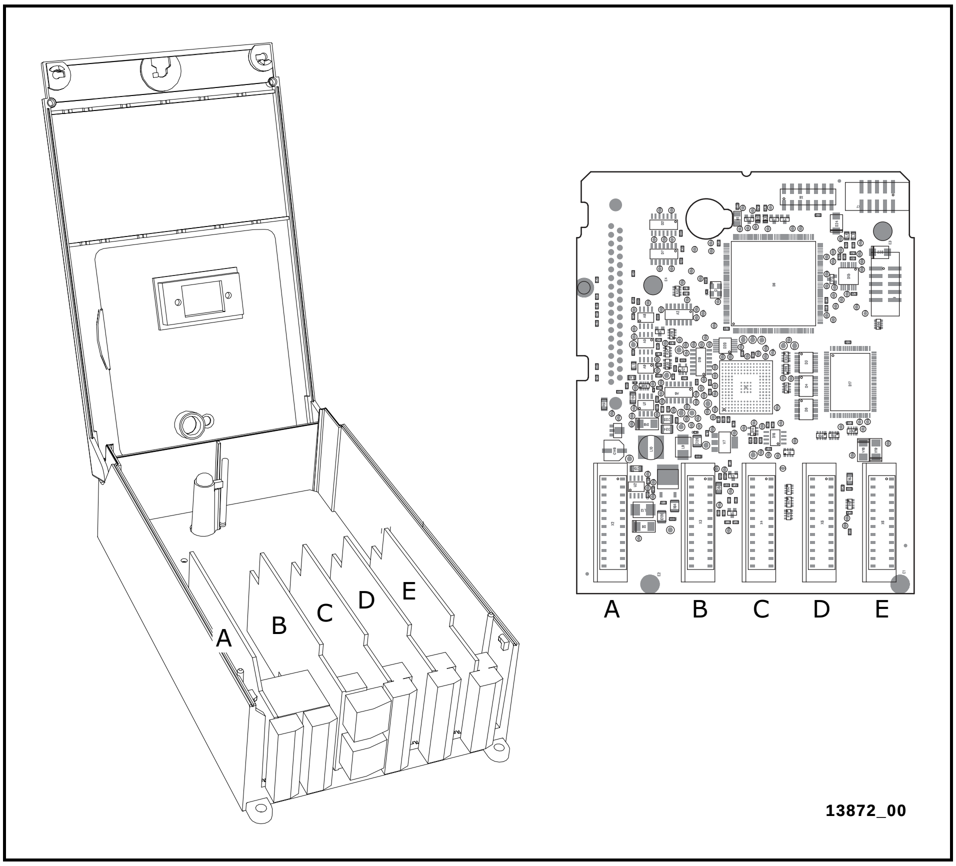


Figure 28. Control unit, control board (right) and option boards (A-E)

4.6.6 Auxiliary low-voltage connections

The auxiliary low-voltage connections between cabinets can be done with wiring or with busbars.

For transport, the wires between two separately transported cabinets are disconnected from the terminals. The wiring diagrams for the connections are delivered with the system drive.

Auxiliary low-voltage busbars (Auxigaine) are available as an option. In this case, the busbars of two cabinets are connected with quick-connect bridge connectors. The bridge connectors are installed by simply pressing them into place.

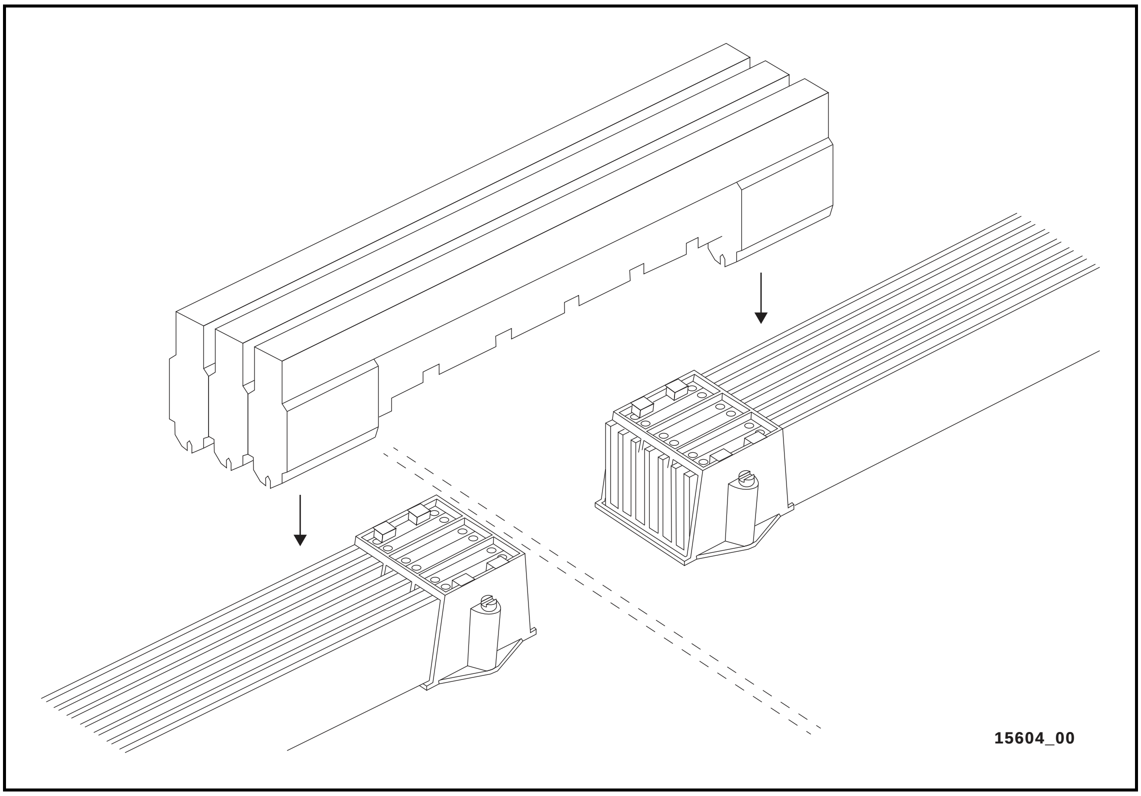


Figure 29. Installing the bridge connectors on the auxiliary low-voltage busbars

4.7 SCREW TIGHTENING TORQUES

Table 14. Tightening torques

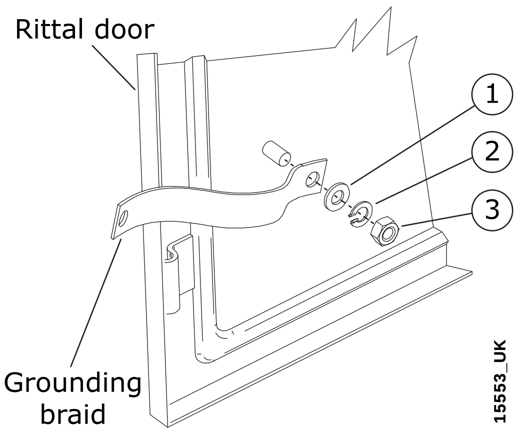
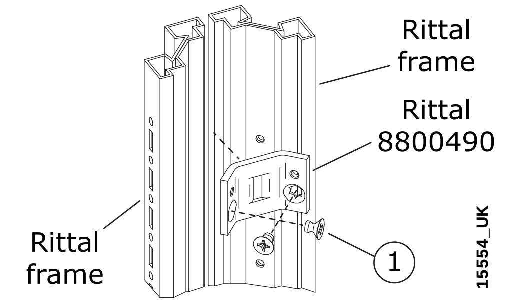
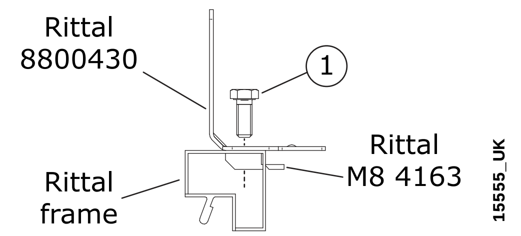
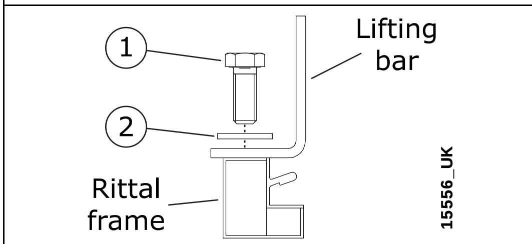
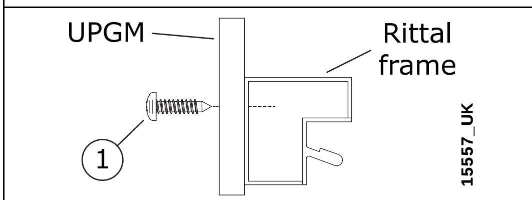
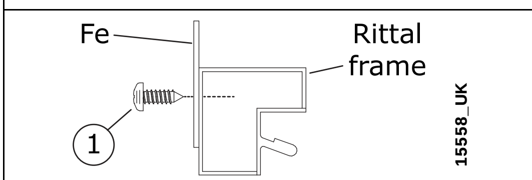
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Plain washer, DIN 125		-
	2	Spring washer, DIN 128		-
	3	Nut, DIN 934	M8	10
	1	Rittal tapered thread forming screw M6x8	M6	9
	1	Rittal hex head bolt 8x16 with toothed neck	M8	9
	1	Hex head bolt, DIN 933	M12	20
	2	Rittal IP rubber washer		-
	1	Self tapping screw, DIN 7049		ST 5.5 5
	1	Self tapping screw, DIN 7049		ST 5.5 5

Table 14. Tightening torques

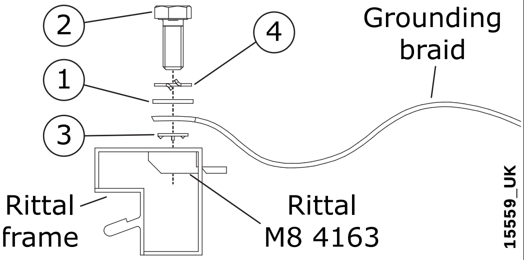
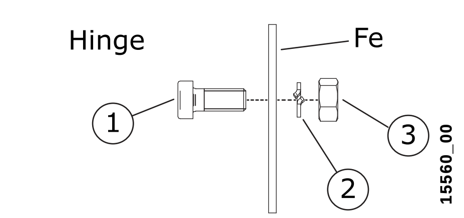
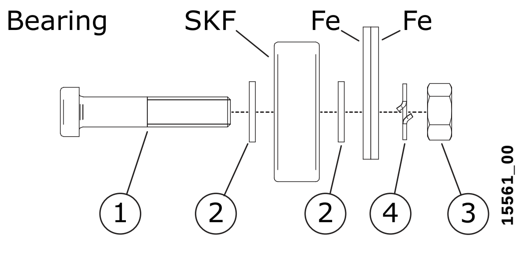
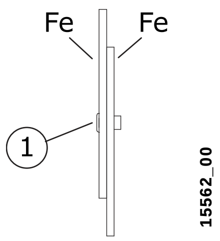
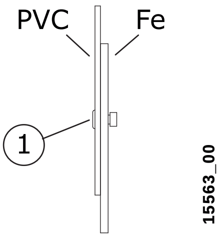
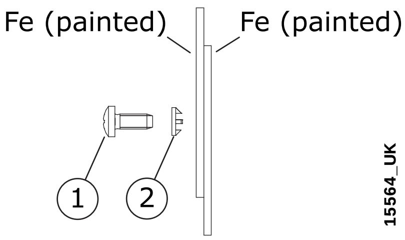
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Plain washer, DIN 125		-
	2	Hex head bolt, DIN 933	M8	9
	3	Toothed washer, DIN 6797		-
	4	Spring washer, DIN 128		-
	1	Socket head bolt, DIN 912	M6	6
			M8	20
			M10	40
			M12	70
	2	Spring washer, DIN 128		-
	3	Nut, DIN 934		-
	1	Socket head bolt, DIN 7984	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Spring washer, DIN 128		-
	1	Rivet		-
	1	Rivet		-
	1	Self-tapping screw, DIN 7500	M4	1.5
			M5	3
			M6	6
	2	Toothed washer, DIN 6797		-

Table 14. Tightening torques

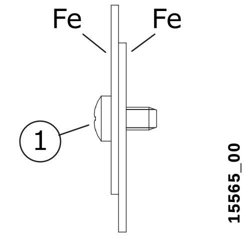
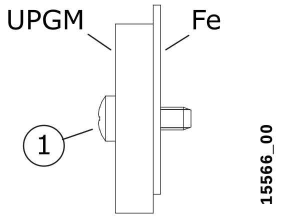
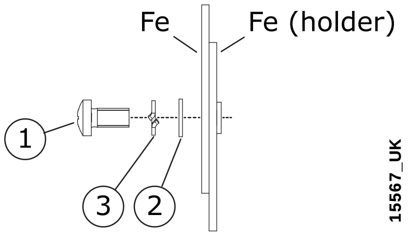
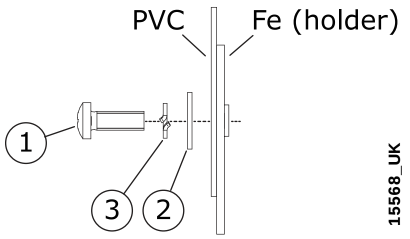
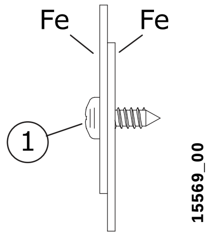
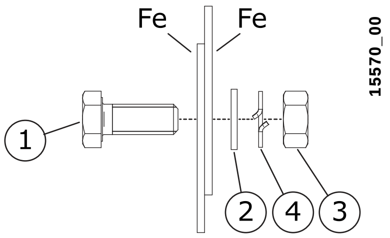
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Self-tapping screw, DIN 7500	M4	1.5
			M5	3
			M6	6
	1	Self-tapping screw, DIN 7500	M4	1.5
			M5	3
			M6	6
	1	Screw, DIN 7045	M4	1.5
			M5	3
			M6	6
	2	Plain washer, DIN 125		-
	3	Spring washer, DIN 128		-
	1	Screw, DIN 7045	M4	1.5
			M5	3
			M6	6
	2	Plain washer large, DIN 9021		-
	3	Spring washer, DIN 128		-
	1	Self-tapping screw, DIN 7049		ST 5.5 5
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Spring washer, DIN 128		-

Table 14. Tightening torques

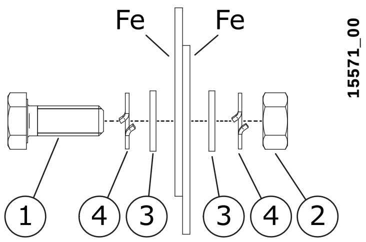
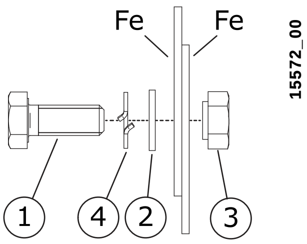
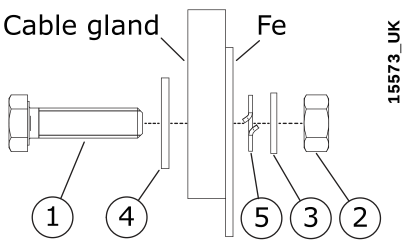
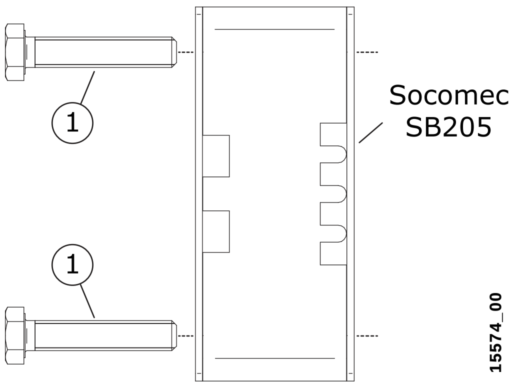
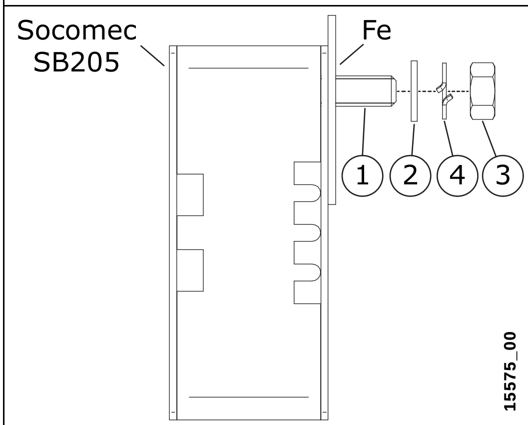
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Plain washer, DIN 125		-
	4	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Press nut		-
	4	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M8	2
	2	Nut, DIN 934		-
	3	Plain washer, DIN 125		-
	4	Plain washer large, DIN 9021		-
	5	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M8	10
	1	Hex head bolt, DIN 933	M8	10
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Spring washer, DIN 128		-

Table 14. Tightening torques

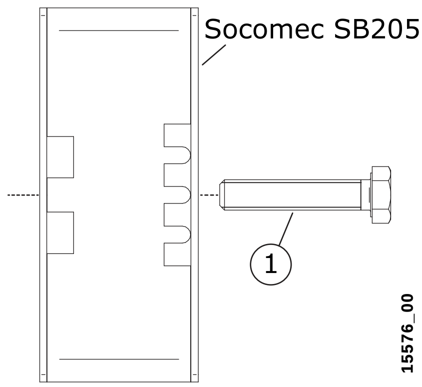
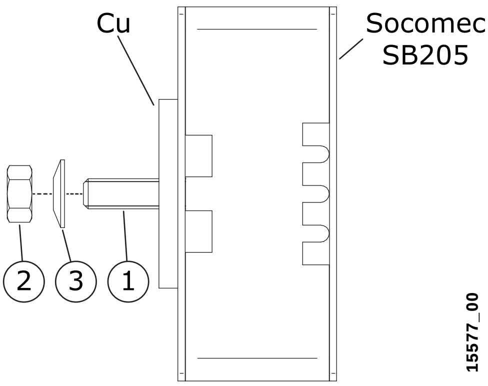
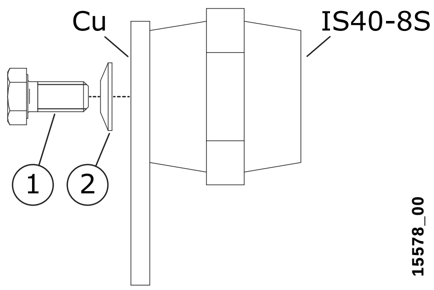
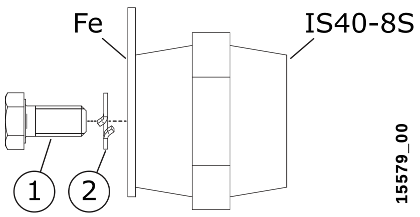
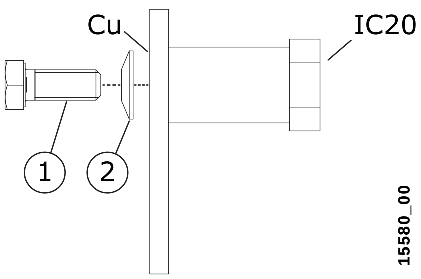
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Hex head bolt, DIN 933	M8	10
	1	Hex head bolt, DIN 933	M8	10
	2	Nut, DIN 934		-
	3	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Conical spring washer, DIN 6796		-

Table 14. Tightening torques

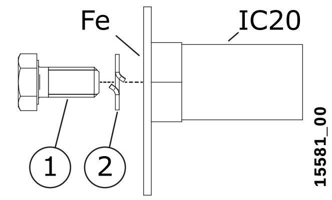
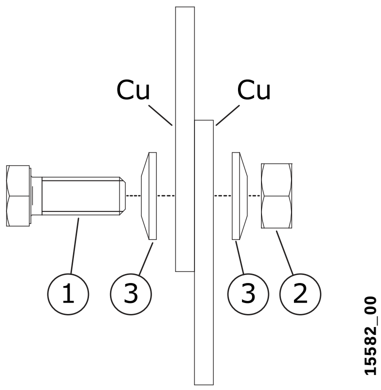
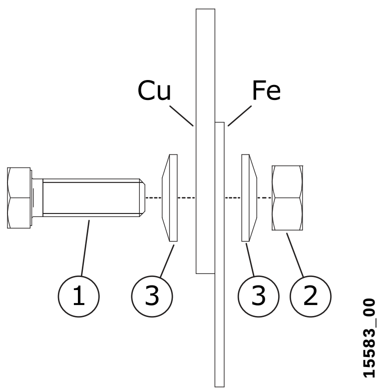
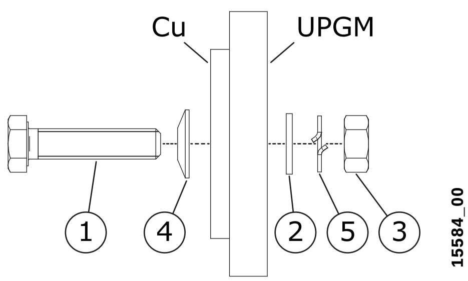
<table>
<tr><th>Detail</th><th>#</th><th>Part</th><th>Size</th><th>Tightening torque (Nm), ±15%</th></tr>
<tr><td rowspan="5"></td><td rowspan="4">1</td><td rowspan="4">Hex head bolt, DIN 933</td><td>M6</td><td>6</td></tr>
<tr><td>M8</td><td>20</td></tr>
<tr><td>M10</td><td>40</td></tr>
<tr><td>M12</td><td>70</td></tr>
<tr><td>2</td><td>Spring washer, DIN 128</td><td></td><td>-</td></tr>
<tr><td rowspan="6"></td><td rowspan="4">1</td><td rowspan="4">Hex head bolt, DIN 933</td><td>M6</td><td>6</td></tr>
<tr><td>M8</td><td>20</td></tr>
<tr><td>M10</td><td>40</td></tr>
<tr><td>M12</td><td>70</td></tr>
<tr><td>2</td><td>Nut, DIN 934</td><td></td><td>-</td></tr>
<tr><td>3</td><td>Conical spring washer, DIN 6796</td><td></td><td>-</td></tr>
<tr><td rowspan="6"></td><td rowspan="4">1</td><td rowspan="4">Hex head bolt, DIN 933</td><td>M6</td><td>6</td></tr>
<tr><td>M8</td><td>20</td></tr>
<tr><td>M10</td><td>40</td></tr>
<tr><td>M12</td><td>70</td></tr>
<tr><td>2</td><td>Nut, DIN 934</td><td></td><td>-</td></tr>
<tr><td>3</td><td>Conical spring washer, DIN 6796</td><td></td><td>-</td></tr>
<tr><td rowspan="8"></td><td rowspan="4">1</td><td rowspan="4">Hex head bolt, DIN 933</td><td>M6</td><td>6</td></tr>
<tr><td>M8</td><td>20</td></tr>
<tr><td>M10</td><td>40</td></tr>
<tr><td>M12</td><td>70</td></tr>
<tr><td>2</td><td>Plain washer, DIN 125</td><td></td><td>-</td></tr>
<tr><td>3</td><td>Nut, DIN 934</td><td></td><td>-</td></tr>
<tr><td>4</td><td>Conical spring washer, DIN 6796</td><td></td><td>-</td></tr>
<tr><td>5</td><td>Spring washer, DIN 128</td><td></td><td>-</td></tr>
</table>

Table 14. Tightening torques

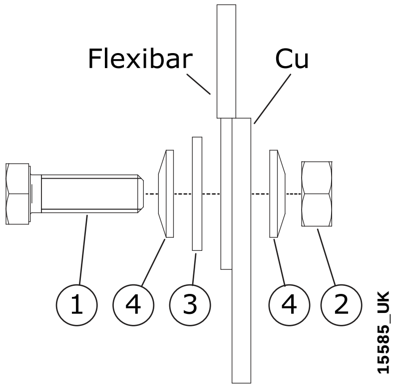
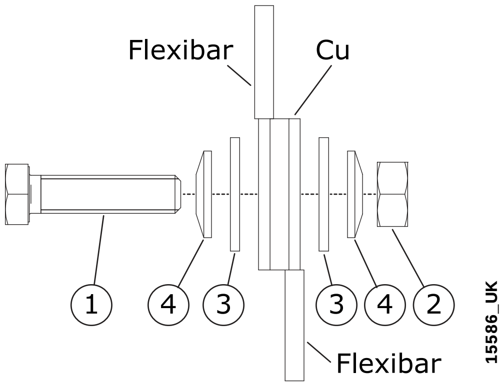
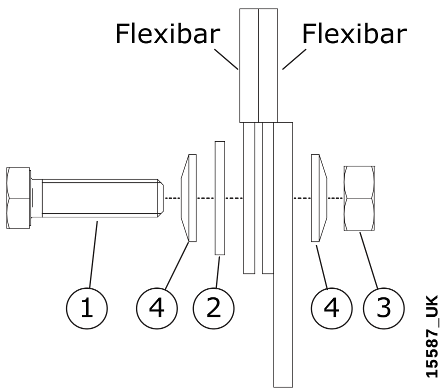
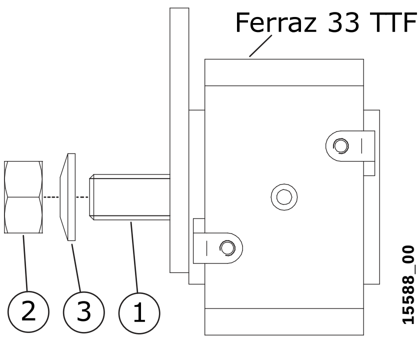
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Plain washer large, DIN 9021		-
	4	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Plain washer large, DIN 9021		-
	4	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer large, DIN 9021		-
	3	Nut, DIN 934		-
	4	Conical spring washer, DIN 6796		-
	1	Stud, DIN 913	M8	10
			M10	15
			M12	15
	2	Nut, DIN 934	M8	13.5
			M10	26
			M12	46
	3	Conical spring washer, DIN 6796		-

Table 14. Tightening torques

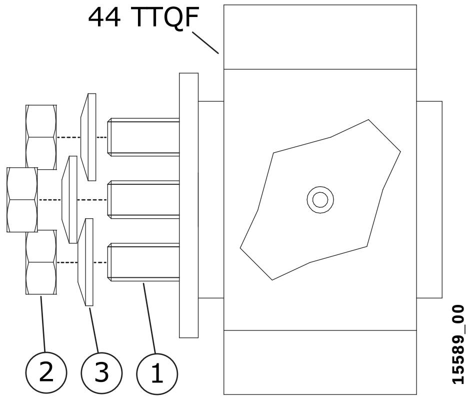
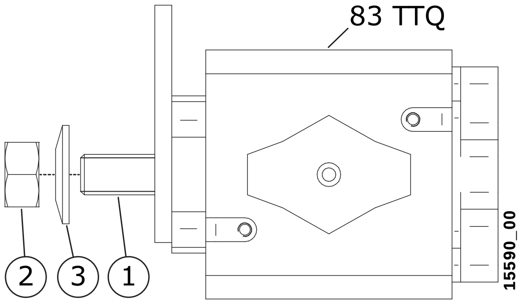
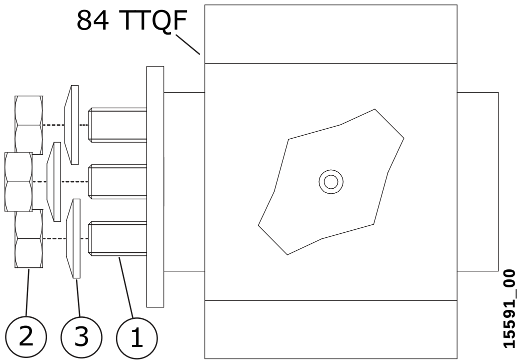
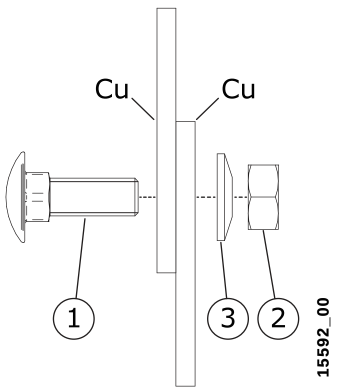
<table>
<tr><th>Detail</th><th>#</th><th>Part</th><th>Size</th><th>Tightening torque (Nm), ±15%</th></tr>
<tr><td rowspan="7"></td><td rowspan="3">1</td><td rowspan="3">Stud, DIN 913</td><td>M8</td><td>10</td></tr>
<tr><td>M10</td><td>15</td></tr>
<tr><td>M12</td><td>15</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Nut, DIN 934</td><td>M8</td><td>13.5</td></tr>
<tr><td>M10</td><td>26</td></tr>
<tr><td>M12</td><td>46</td></tr>
<tr><td>3</td><td>Conical spring washer, DIN 6796</td><td></td><td>-</td></tr>
<tr><td rowspan="7"></td><td rowspan="3">1</td><td rowspan="3">Stud, DIN 913</td><td>M8</td><td>10</td></tr>
<tr><td>M10</td><td>15</td></tr>
<tr><td>M12</td><td>15</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Nut, DIN 934</td><td>M8</td><td>13.5</td></tr>
<tr><td>M10</td><td>26</td></tr>
<tr><td>M12</td><td>46</td></tr>
<tr><td>3</td><td>Conical spring washer, DIN 6796</td><td></td><td>-</td></tr>
<tr><td rowspan="7"></td><td rowspan="3">1</td><td rowspan="3">Stud, DIN 913</td><td>M8</td><td>10</td></tr>
<tr><td>M10</td><td>15</td></tr>
<tr><td>M12</td><td>15</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Nut, DIN 934</td><td>M8</td><td>13.5</td></tr>
<tr><td>M10</td><td>26</td></tr>
<tr><td>M12</td><td>46</td></tr>
<tr><td>3</td><td>Conical spring washer, DIN 6796</td><td></td><td>-</td></tr>
<tr><td rowspan="6"></td><td rowspan="4">1</td><td rowspan="4">Cup square neck bolt, DIN 603</td><td>M6</td><td>6</td></tr>
<tr><td>M8</td><td>20</td></tr>
<tr><td>M10</td><td>40</td></tr>
<tr><td>M12</td><td>70</td></tr>
<tr><td>2</td><td>Nut, DIN 934</td><td></td><td>-</td></tr>
<tr><td>3</td><td>Conical spring washer, DIN 6796</td><td></td><td>-</td></tr>
</table>

Table 14. Tightening torques

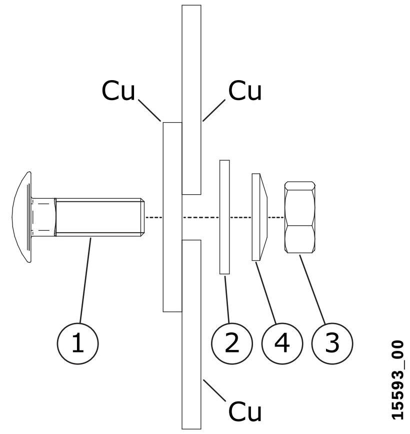
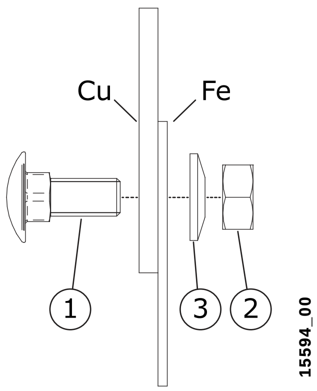
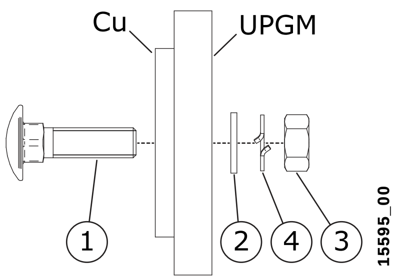
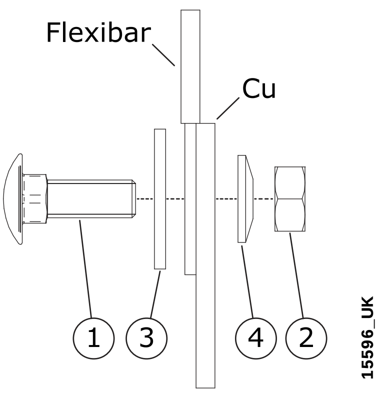
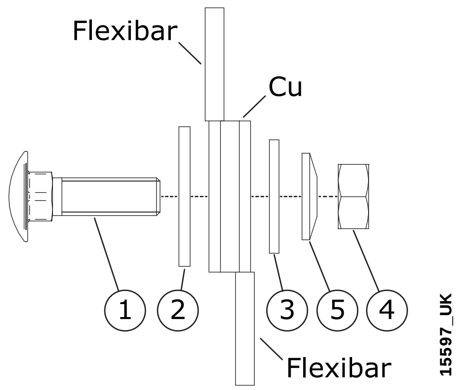
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer large, DIN 9021		-
	3	Nut, DIN 934		-
	4	Conical spring washer, DIN 6796		-
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Conical spring washer, DIN 6796		-
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Spring washer, DIN 128		-
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Plain washer large, DIN 9021 (1 size bigger)		-
	4	Conical spring washer, DIN 6796		-

Table 14. Tightening torques

<table>
<tr><th>Detail</th><th>#</th><th>Part</th><th>Size</th><th>Tightening torque (Nm), ±15%</th></tr>
<tr><td rowspan="8">
</td><td rowspan="4">1</td><td rowspan="4">Cup square neck bolt,
DIN 603</td><td>M6</td><td>6</td></tr>
<tr><td>M8</td><td>20</td></tr>
<tr><td>M10</td><td>40</td></tr>
<tr><td>M12</td><td>70</td></tr>
<tr><td>2</td><td>Plain washer large,
DIN 9021 (1 size bigger)</td><td></td><td>-</td></tr>
<tr><td>3</td><td>Plain washer large,
DIN 9021</td><td></td><td>-</td></tr>
<tr><td>4</td><td>Nut, DIN 934</td><td></td><td>-</td></tr>
<tr><td>5</td><td>Conical spring washer,
DIN 6796</td><td></td><td>-</td></tr>
</table>

5. Service

5.1 Warranty

Only manufacturing defects are covered by the warranty. The manufacturer assumes no responsibility for damages caused during or resulting from transport, receipt of the delivery, installation, commissioning or use.

The manufacturer shall in no event and under no circumstances be held responsible for damages and failures resulting from misuse, wrong installation, unacceptable ambient temperature, dust, corrosive substances or operation outside the rated specifications.

Neither can the manufacturer be held responsible for consequential damages.

The Manufacturer's warranty period is 18 months from the delivery or 12 months from the commissioning whichever expires first (Danfoss general terms and conditions of sale).

The local distributor may grant a warranty time different from the above. This warranty time shall be specified in the distributor's sales and warranty terms. Danfoss assumes no responsibility for any other warranties than that granted by Danfoss itself.

In all matters concerning the warranty, please contact your distributor first.

5.2 Maintenance

All technical devices, drives as well, need a certain amount of care-taking and failure preventive maintenance. To maintain trouble-free operation of the VACON® drives, environmental conditions, as well as load, line power, process control, etc. have to be within specifications, determined by manufacturer.

If all conditions are in accordance with the manufacturer's specifications, there are no other concerns, but to provide a cooling capacity high enough for the power- and control circuits. This requirement can be met by making sure, that the cooling system works properly. Operation of cooling fans and cleanness of the heat sink should be verified regularly.

Regular maintenance is recommended to ensure trouble free operation and long lifetime of the VACON® drives. At least the following things should be included in the regular maintenance.

Table 15. Maintenance schedule

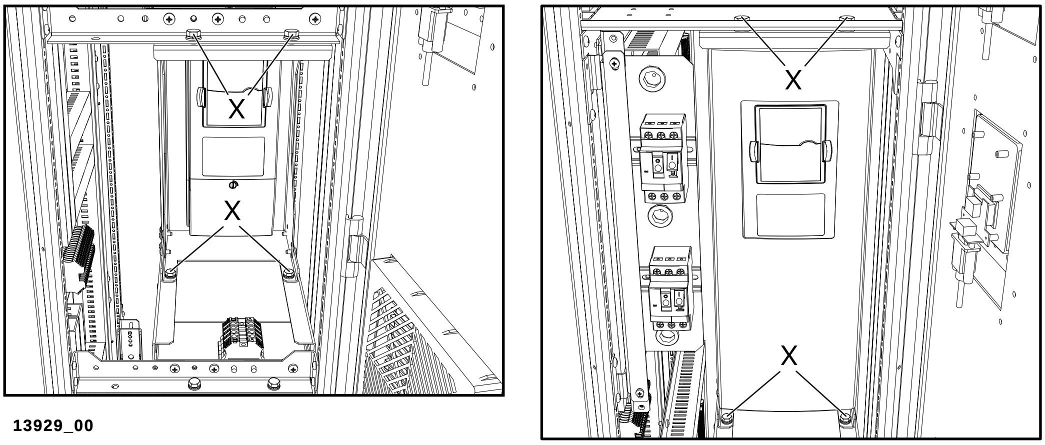
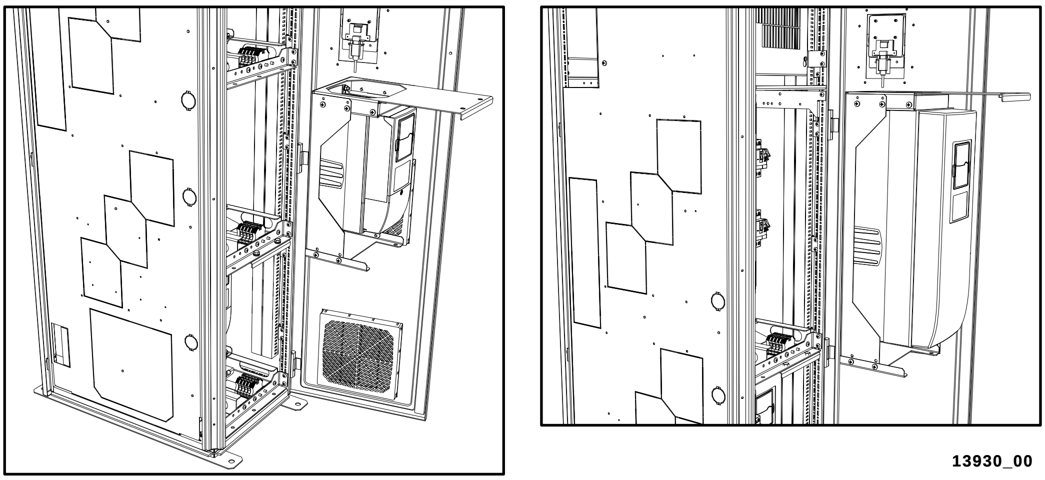
Interval	Maintenance
12 months (if unit is stored)	Reform the capacitors
6-24 months (depending on environment)	Check the tightening torques of the input and output terminals and I/O terminals. Clean the cooling tunnel. Check operation of the cooling fan, check for corrosion on terminals, busbars and other surfaces.
5-7 years	Change the cooling fans: • Cabinet fans • Drive fans • LCL filter fans
5-10 years	Change the DC-link capacitors if DC voltage ripple is high.

It is also recommended to record all actions and counter values with dates and time for follow up of maintenance.

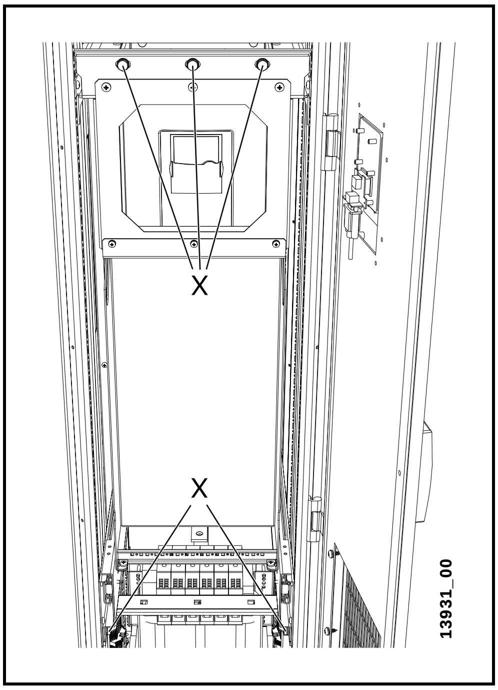
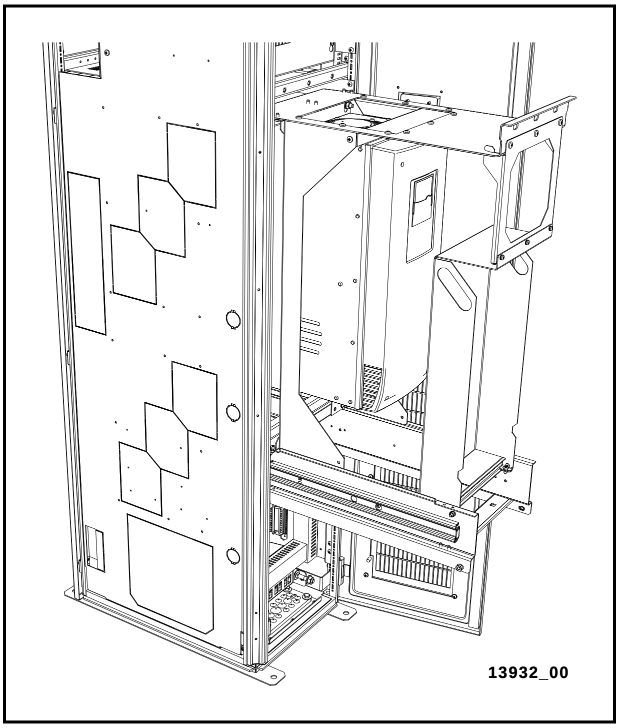
5.3 REMOVING THE DRIVES FROM THE CABINET

Servicing is only permitted to be carried out by Danfoss-trained service personnel!

5.3.1 IUS_4 / IUS_6

1	Open the cabinet door.
2	Disconnect all cables from the drive. See Chapter 4.6.
3	Release the drive assembly. Remove the four M8x20 bolts (tightening torque 20 Nm).  *Figure 30. Drive assembly mounting bolts (X) in IUS_4 (left) and IUS_6 (right)*
4	Pull out the drive assembly.  *Figure 31. Pulling the drive assembly in IUS_4 (left) and IUS_6 (right)*

5.3.2 IUS_7 / IUS_8

1	Open the cabinet door.
2	Release the drive assembly. Remove the five M8x20 bolts (tightening torque 20 Nm).  *Figure 32. Drive assembly mounting bolts (X)*
3	Pull out the drive assembly.  *Figure 33. Pulling the drive assembly out of the cabinet*
4	Disconnect all cables from the drive. See Chapter 4.6.

5.3.3 IUS_9 / IUS_10

<table>
<tr><td>1</td><td>Open the cabinet door.</td></tr>
<tr><td>2</td><td>Release the service ramp and turn it down in front of the drive.

NOTE! The height of the surface in front of the cabinet should not differ more than 5 mm from the level of the cabinet installation.

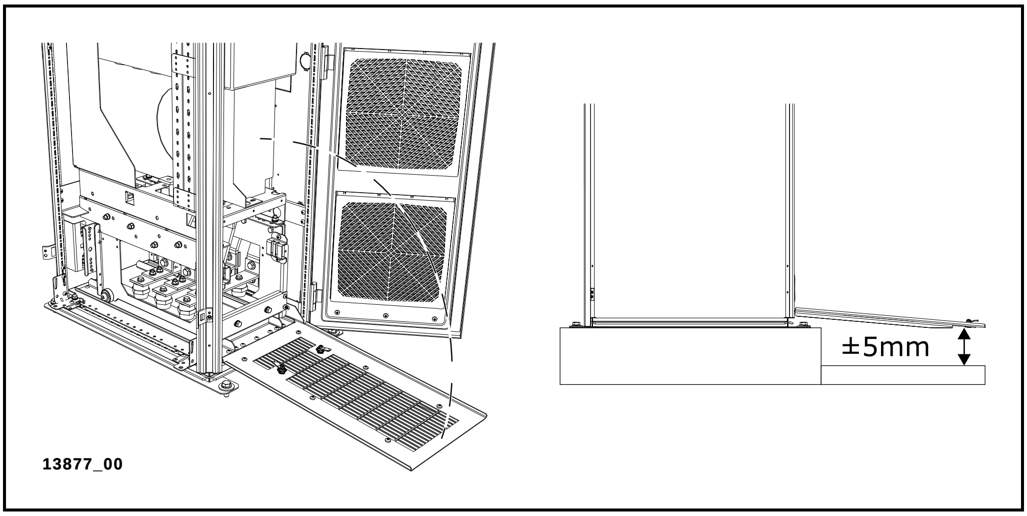


Figure 34. Lowering the service ramp</td></tr>
<tr><td>3</td><td>1. Loosen the four M5 screws (tightening torque 3 Nm) and remove the touch cover.
2. Remove the six M8 screws (torque 20 Nm) and remove the upper holder plate.
3. Remove the two M8 screws (torque 20 Nm) from the drive bottom holder plate.

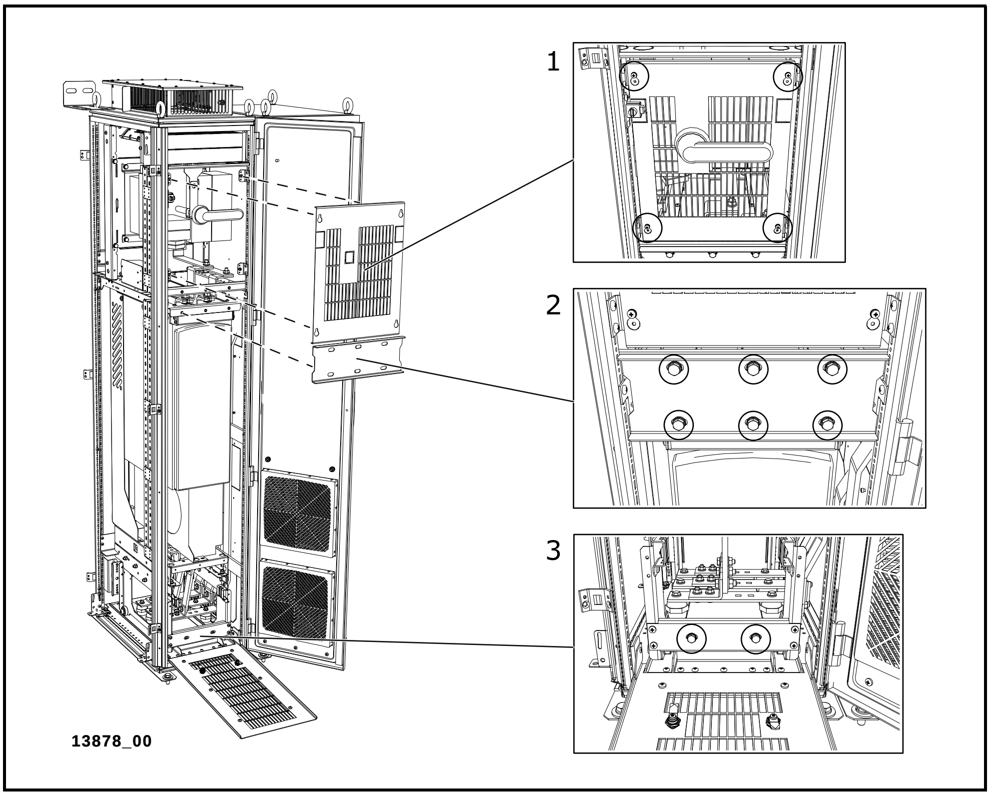
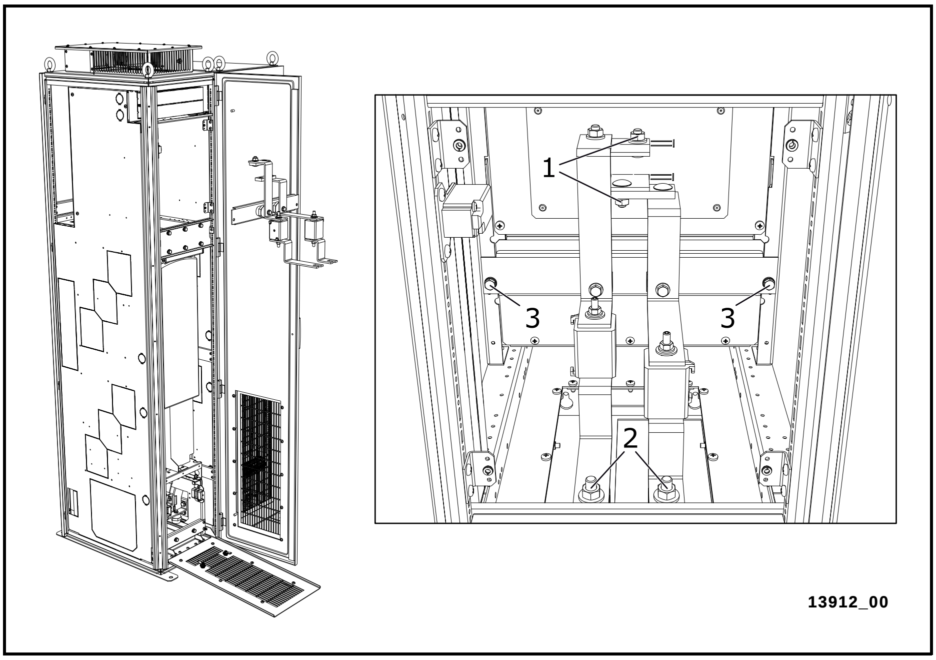
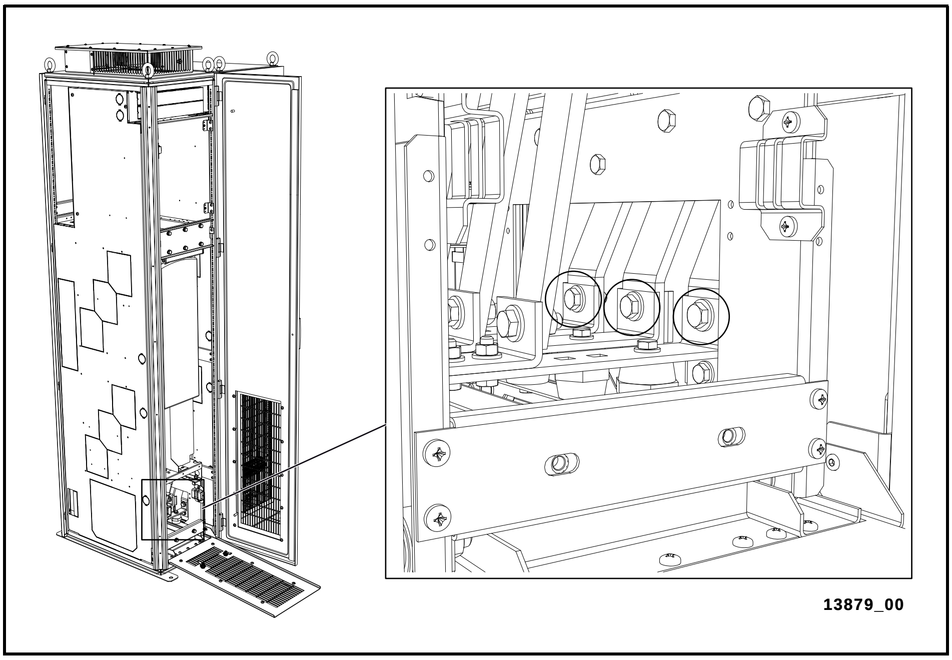
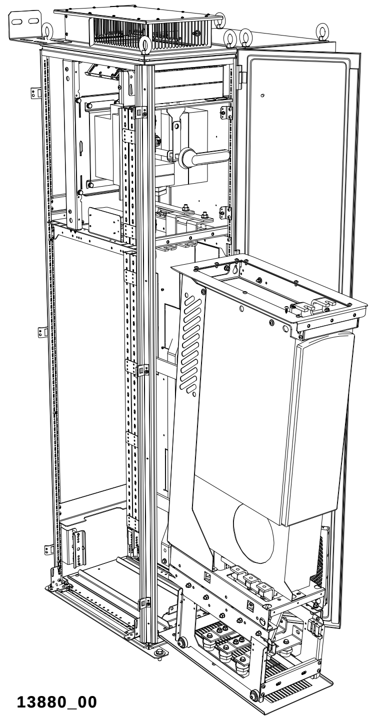
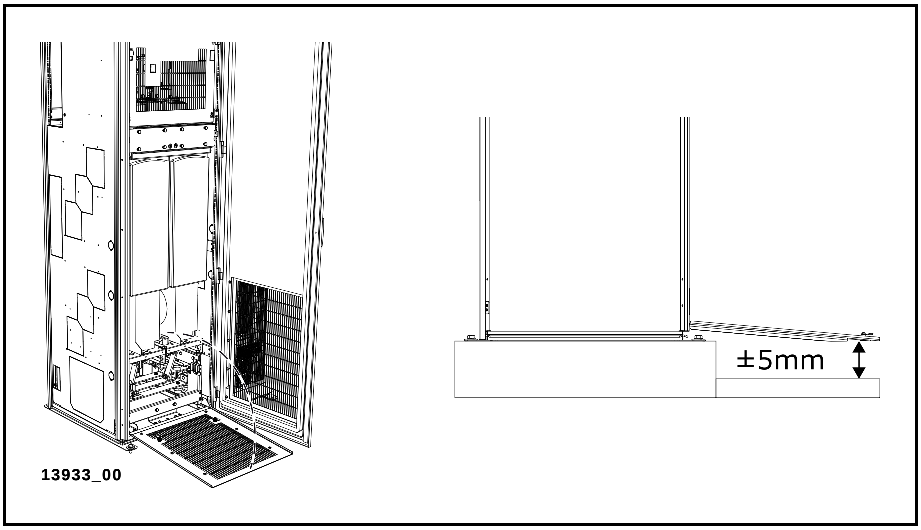
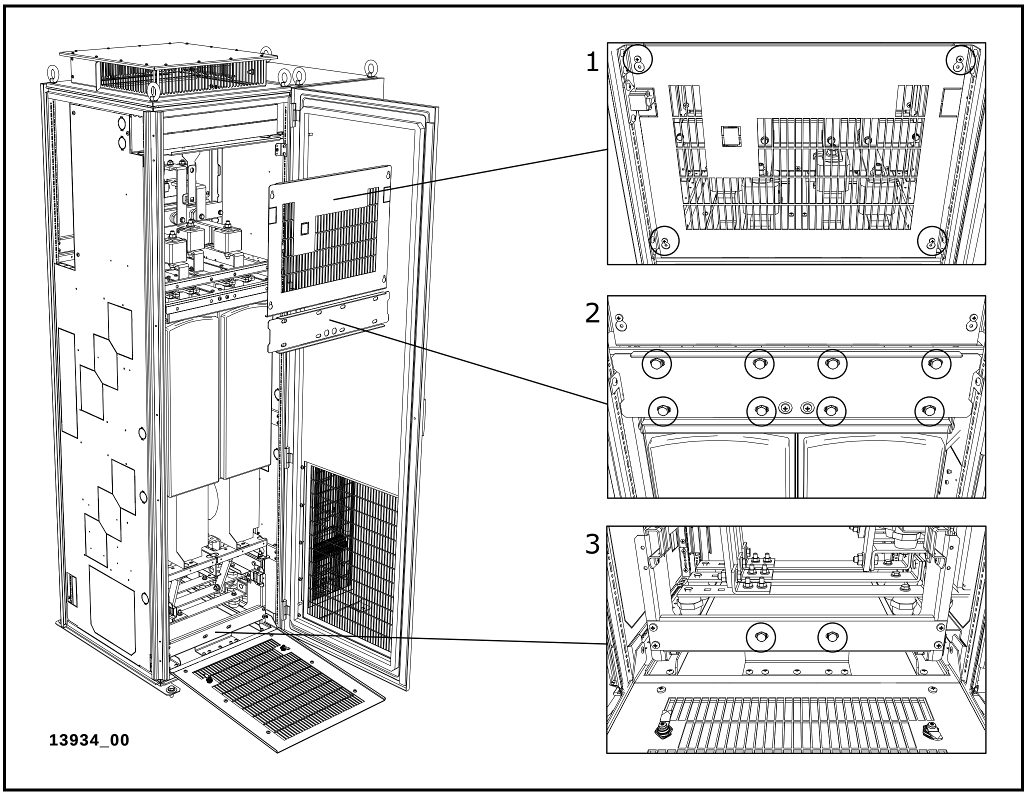


Figure 35. Removing the drive touch cover and holder plates</td></tr>
</table>

4	Release the input busbar assemblies. Remove: 1. two M10 nuts and M10x30 bolts (torque 40 Nm) from the upper busbars, 2. two M12 nuts and M12x40 bolts (torque 70 Nm) from the lower busbars, 3. two M8x20 screws (torque 20 Nm) from the back plate. Take out the busbar assemblies, including the fuses.  *Figure 36. Releasing the input busbar assembly*
5	Release the output busbars. Remove three M10 nuts/bolts (tightening torque 40 Nm).  *Figure 37. Busbar mounting screws*

6	Pull the drive out on the service ramp.  *Figure 38. Pulling the drive out of the cabinet*

5.3.4 IUS_12

1	Open the cabinet door.
2	Release the service ramp and turn it down in front of the drive. **NOTE!** The height of the surface in front of the cabinet should not differ more than 5 mm from the level of the cabinet installation.  *Figure 39. Lowering the service ramp*
3	1. Loosen the four M5 screws (tightening torque 3 Nm) and remove the touch cover. 2. Remove the eight M8 screws (torque 20 Nm) and remove the upper holder plate. 3. Remove the two M8 screws (torque 20 Nm) from the drive bottom holder plate.  *Figure 40. Removing the drive touch cover and holder plates*

<table>
<tr>
<td>4</td>
<td>
Release the input busbar assembly. Remove:

1. four M10 nuts and M10x30 bolts (torque 40 Nm) from the upper busbars,
2. four M12 nuts and M12x40 bolts (torque 70 Nm) from the lower busbars,
3. two M8x20 screws (torque 20 Nm) from the back plate.

Take out the busbar assemblies, including the fuses.

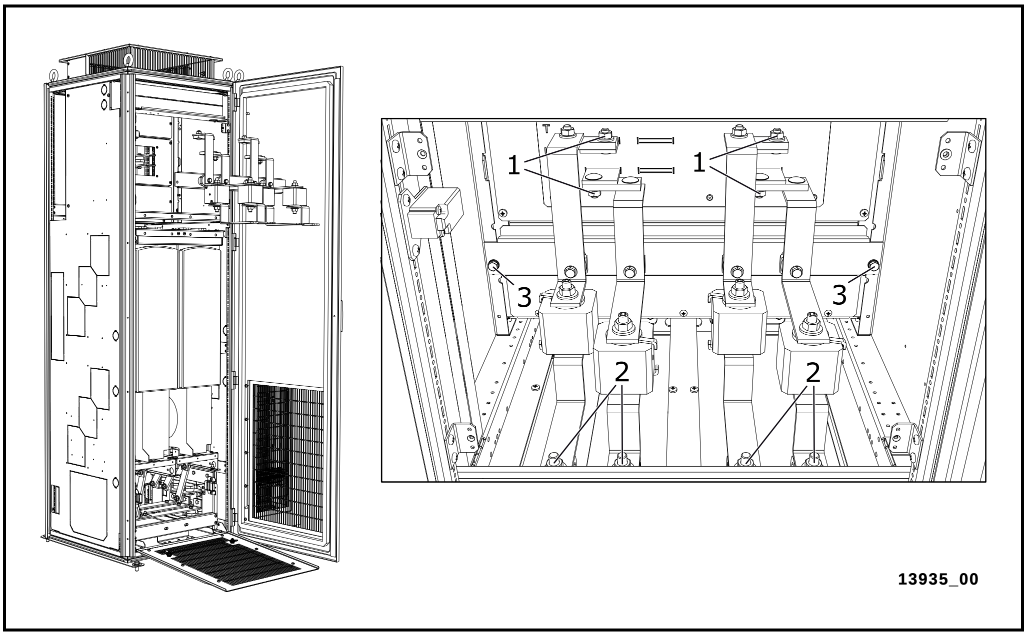


Figure 41. Releasing the input busbar assembly
</td>
</tr>
<tr>
<td>5</td>
<td>
Release the output busbars. Remove six M10 nuts/bolts (tightening torque 40 Nm).

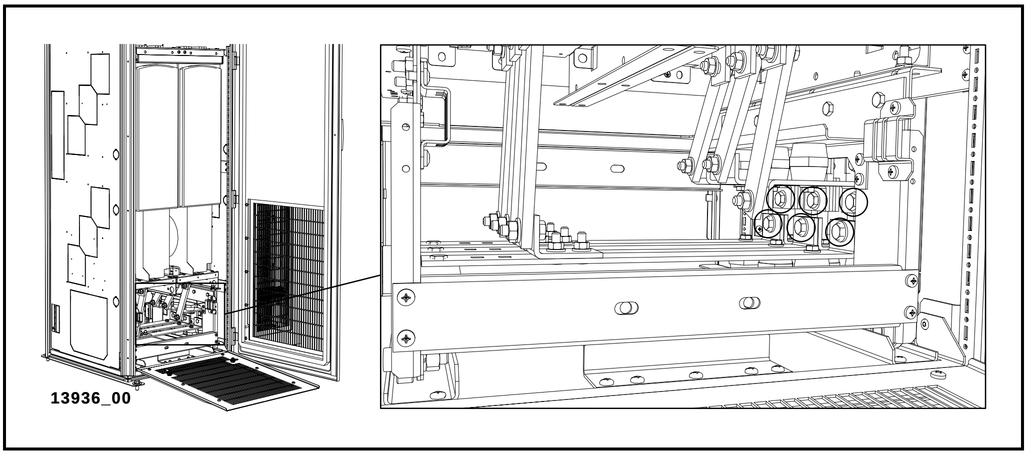
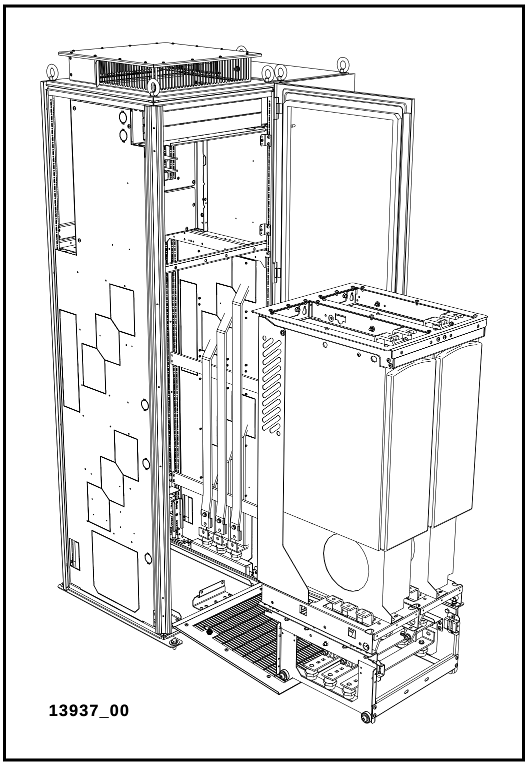
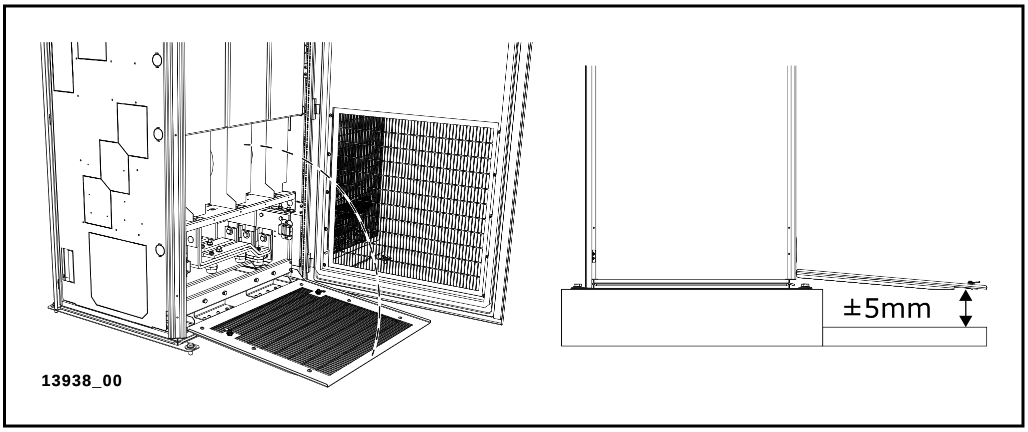
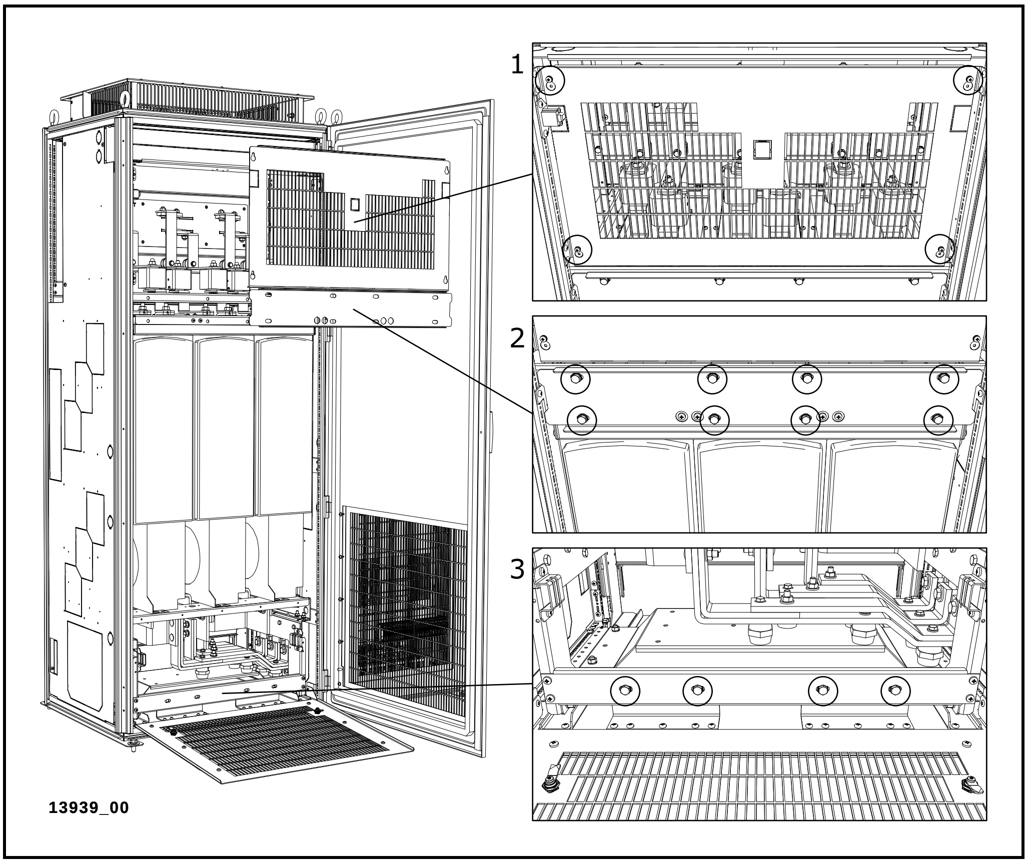


Figure 42. Output busbar mounting screws
</td>
</tr>
</table>

6	Pull the drive out on the service ramp.  *Figure 43. Pulling the drive out of the cabinet*

5.3.5 IUS_13 / IUS_14

1	Open the cabinet door.
2	Release the service ramp and turn it down in front of the drive. **NOTE!** The height of the surface in front of the cabinet should not differ more than 5mm from the level of the cabinet installation.  *Figure 44. Lowering the service ramp*
3	1. Loosen the four M5 screws (tightening torque 3 Nm) and remove the touch cover. 2. Remove the eight M8 screws (torque 20 Nm) and remove the upper holder plate. 3. Remove the four M8 screws (torque 20 Nm) from the drive bottom holder plate.  *Figure 45. Removing the drive touch cover and holder plates*

<table>
<tr>
<td>4</td>
<td>
Release the input busbar assembly. Remove:

1. six M10 nuts and M10x30 bolts (torque 40 Nm) from the upper busbars,
2. six M12 nuts and M12x40 bolts (torque 70 Nm) from the lower busbars,
3. two M8x20 screws (torque 20 Nm) from the back plate.

Take out the busbar assemblies, including the fuses.

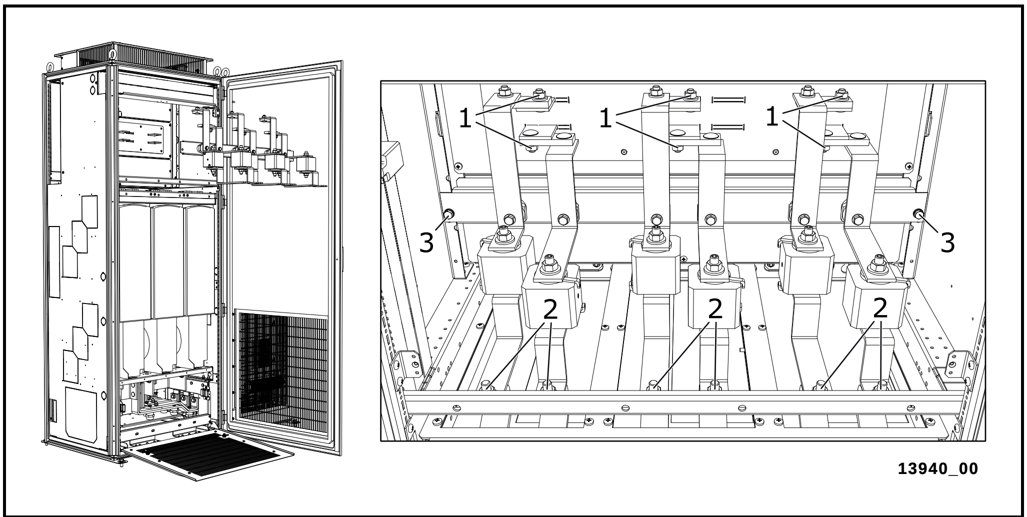


Figure 46. Releasing the input busbar assembly
</td>
</tr>
<tr>
<td>5</td>
<td>
Release the output busbars. Remove three M12 nuts/bolts (tightening torque 70 Nm).

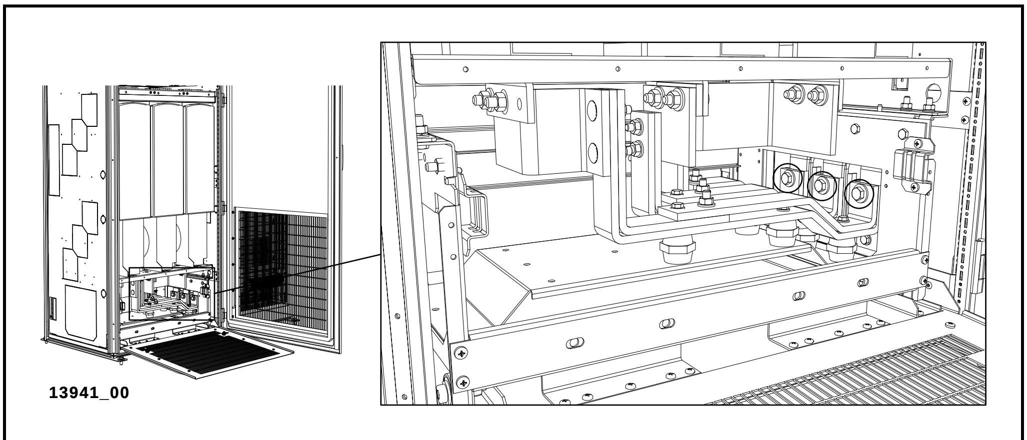
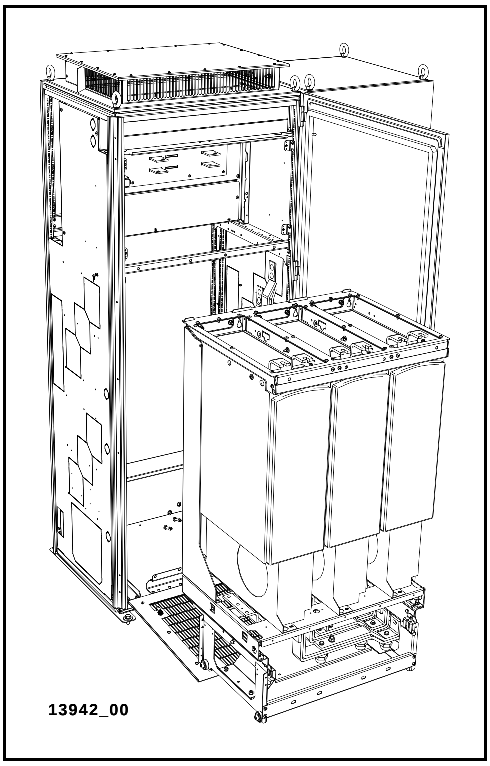


Figure 47. Output busbar mounting screws
</td>
</tr>
</table>

6	Pull the drive out on the service ramp.  Figure 48. Pulling the drive out of the cabinet

6. TECHNICAL INFORMATION

6.1 CONTROL AND INTERFACE

Speed and/or torque control functions are available in the drive. Speed and/or torque reference as well as command word is generated by the overriding line control system and individually transmitted to each drive either via fieldbus or hardwired signals. The drive transmits selected actual values as well as status words back to the line control system.

6.1.1 CONTROL WITHOUT SPEED FEEDBACK (OPEN LOOP)

- Speed error in steady state typically <0.5%
- Torque rise time <10 ms
- Torque error in steady state typically <3%
- Suitable also for multimotor configuration

6.1.2 CONTROL WITH SPEED FEEDBACK (CLOSED LOOP)

Full torque control at zero speed cannot be maintained without speed feedback. When a speed error of less than 0.5% or full torque control at all speeds is required, motor control based on feedback from an encoder is a necessity. This capability is incorporated into the VACON® NXP drive. In addition to the current measurement system used, the NXP drive utilizes feedback values from the encoder to determine the motor state. The enhanced microprocessor provided with the NXP drive is capable of calculations every 150 microseconds. This control can be used for applications requiring high precision, such as sectional drives.

- Speed error in steady state typically <0.01% (pulse encoder type dependent)
- Pulse encoder: 250-5000 ppr at 5, 12 or 24 V (option board dependent)
- Torque rise time <10 ms
- Torque error in steady state typically <3%

6.2 LOAD DEFINITIONS

The drives are normally selected based on the load definition shown in the drive list, where:

- n_{min} = minimum speed [RPM], beginning of the continuous constant torque load speed range
- n_{base} = base speed [RPM], end of the continuous constant torque load speed range (and beginning of the continuous constant power load speed range)
- n_{max} = maximum speed [RPM], end of the continuous constant power load speed range (also maximum allowed motor speed)
- $P[n_{\mathrm{base}}]$ = base power [kW], motor shaft power at the end of the continuous constant torque load speed range (also motor shaft power of the continuous constant power load speed range)
- $T[n_{\mathrm{base}}]$ = base torque [Nm], motor shaft torque of the continuous constant torque load speed range (also motor shaft torque at the beginning of the continuous constant power load speed range)
- OL = overload [%], short time maximum load, 1 min. / 10 min. (100% = no overload)

NOTE! Load is defined based on the information received. Danfoss is not responsible for verifying that the information is sufficient and accurate.

There are various possibilities to define the load curve. Below are some examples.

6.2.1 Pump and fan load

Set all speeds to the same value (n_{min} = n_{base} = n_{max}) to have the typical pump and fan curve, i.e. quadratically increasing load.

The overload is now set as starting torque and as OL at maximum speed (the overload is now defined as percent of torque at maximum speed).

The calculation of current is also here done assuming nominal flux in the motor from 0 to field weakening point (current calculation according to "optimized flux curve" is not available).

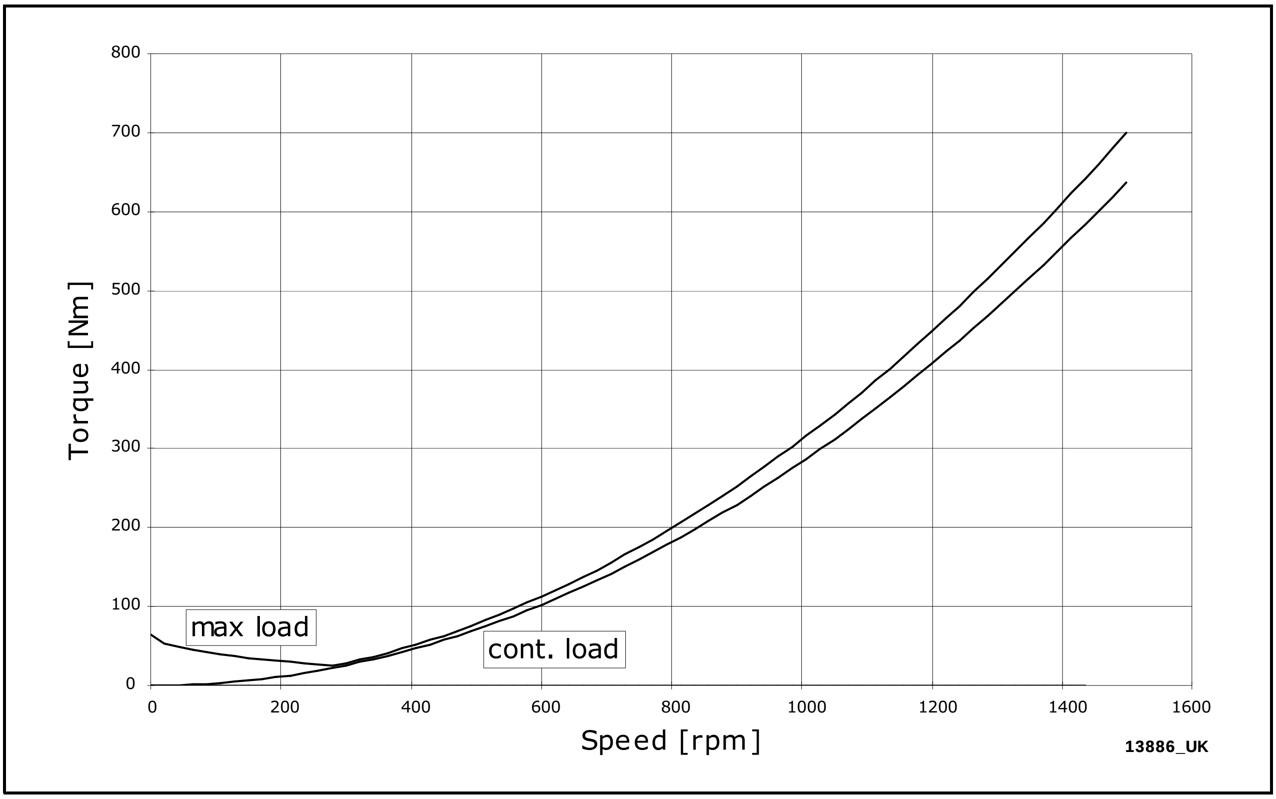


Figure 49. Example: pump and fan load

6.2.2 OL(n_{base}) > OL(n_{max}) for constant torque load

It is possible to set the overload at base speed smaller than the overload at maximum speed, i.e. OL(n_{base}) < OL(n_{max}).

This can be useful when selecting the correct AC drive for constant torque drives where the overload demand at low speeds is higher than at high speeds.

This possibility is usually used when the field weakening point is higher than base speed.

The benefit from this can be the possibility to use a size smaller AC drive.

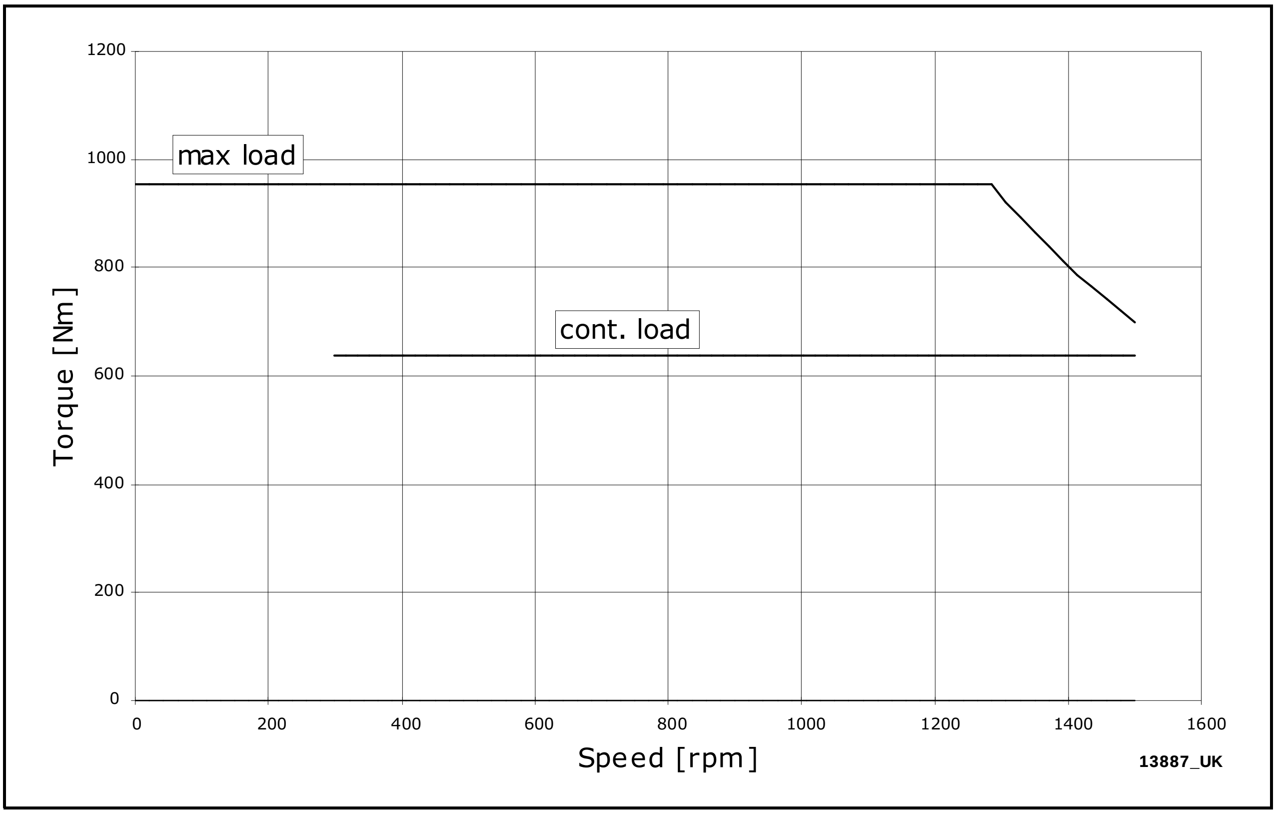


Figure 50. Example: OL(n_{base}) > OL(n_{max}) for constant torque load

6.2.3 Starting torque >> OL(n_{max}) for constant torque load

It is possible to set the starting torque higher than the overload at maximum speed, i.e. OL(n_{base}) < OL(n_{max}).

This can be useful when selecting the correct AC drive for constant torque drives where the starting torque requirement is much higher than the maximum load requirement at maximum speed.

This possibility is usually used when the field weakening point is higher than base speed and when the starting torque is needed for a very short time.

The benefit from this can be the possibility to use a size smaller AC drive.

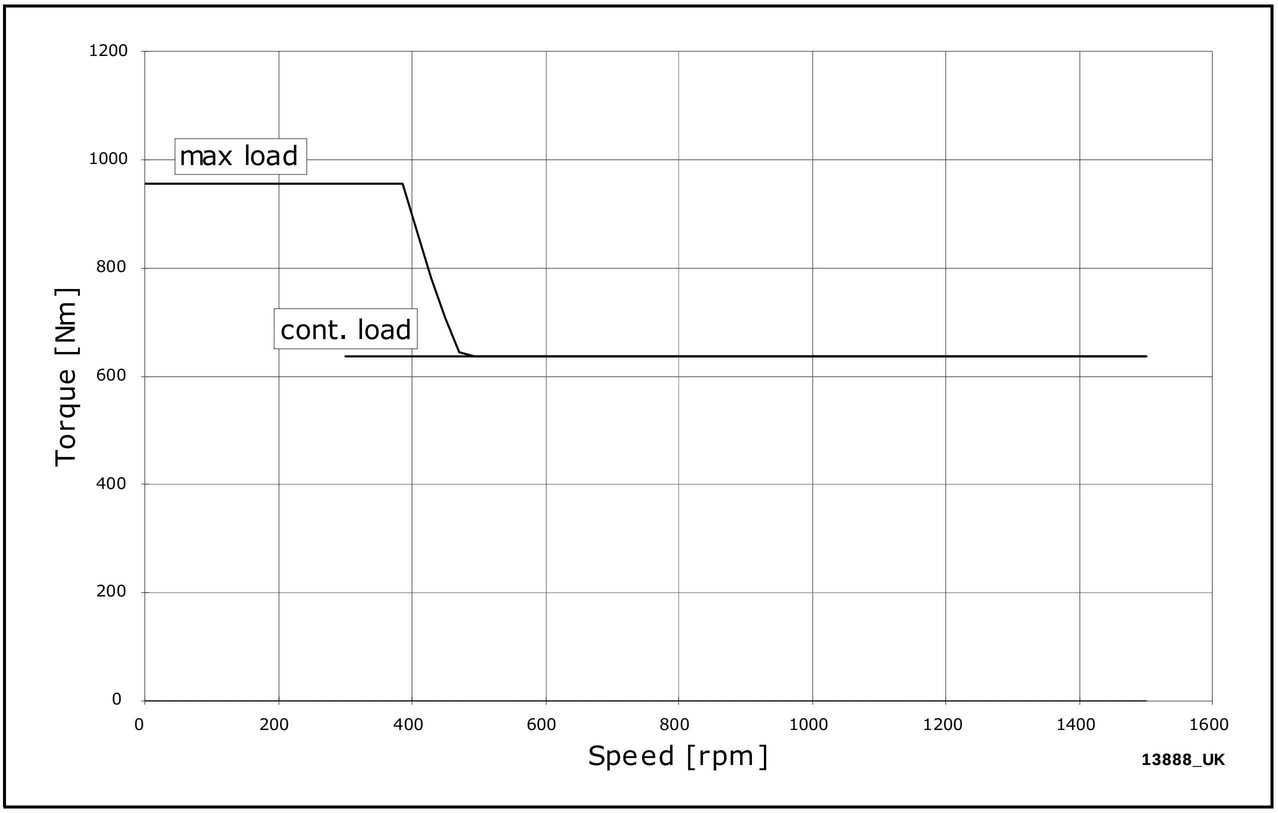


Figure 51. Example: Starting torque >> OL(n_{max}) for constant torque load

6.2.4 OL(n_{base}) > OL(n_{max}) for constant power load

Some constant power drives require less overload at max speed than at lower speeds. It is therefore possible to set the relative overload at base speed higher than the relative overload at maximum speed, i.e. OL(n_{base}) > OL(n_{max}).

This will decrease the size of the motor when/if thermal loadability is not the dimensioning limit.

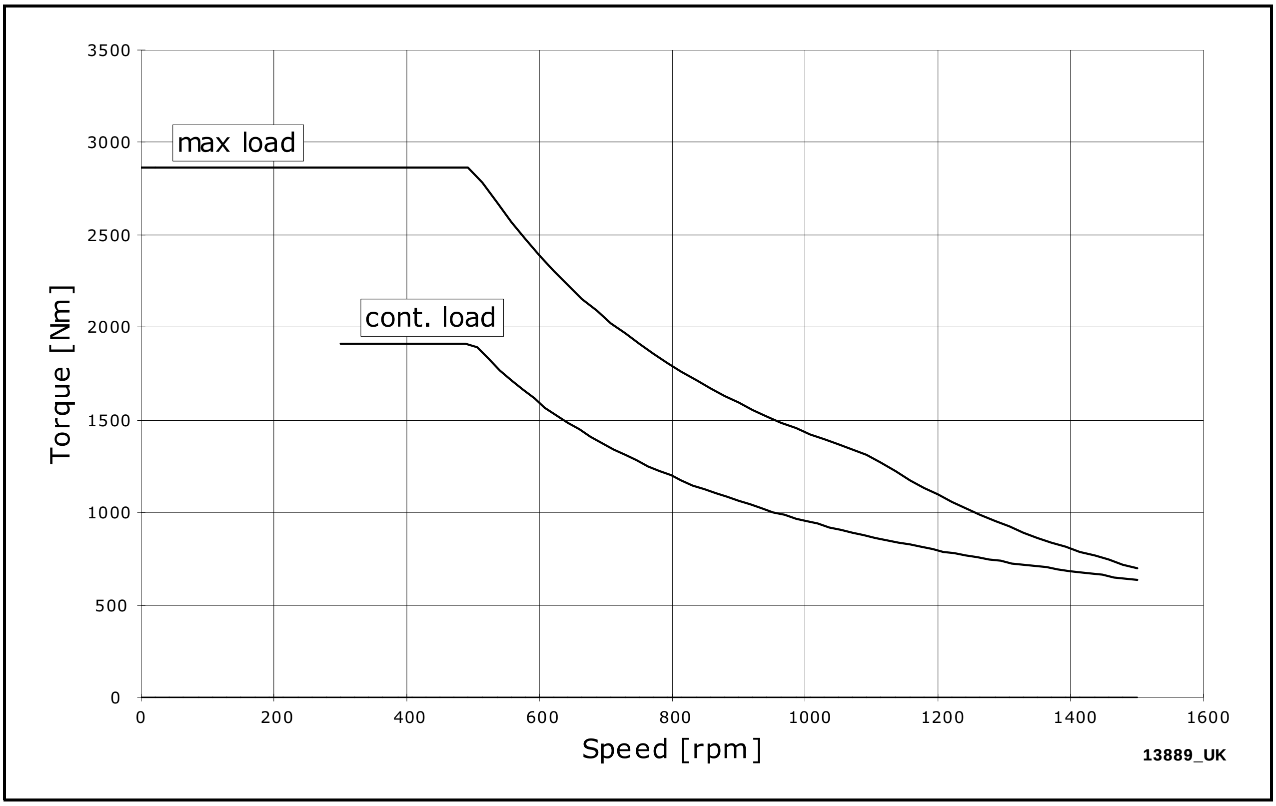


Figure 52. Example: OL(n_{base}) > OL(n_{max}) for constant power load

6.2.5 OL(n_{base}) < OL(n_{max}) for constant power load

It is possible to set the overload at base speed smaller than the overload at max speed, i.e. OL(n_{base}) < OL(n_{max}).

This can be useful when selecting the correct motor and AC drive for constant power drives where the relative OL requirement is higher at maximum speed than the relative OL requirement at base speed.

The benefit from this can be the possibility to use a size smaller AC drive.

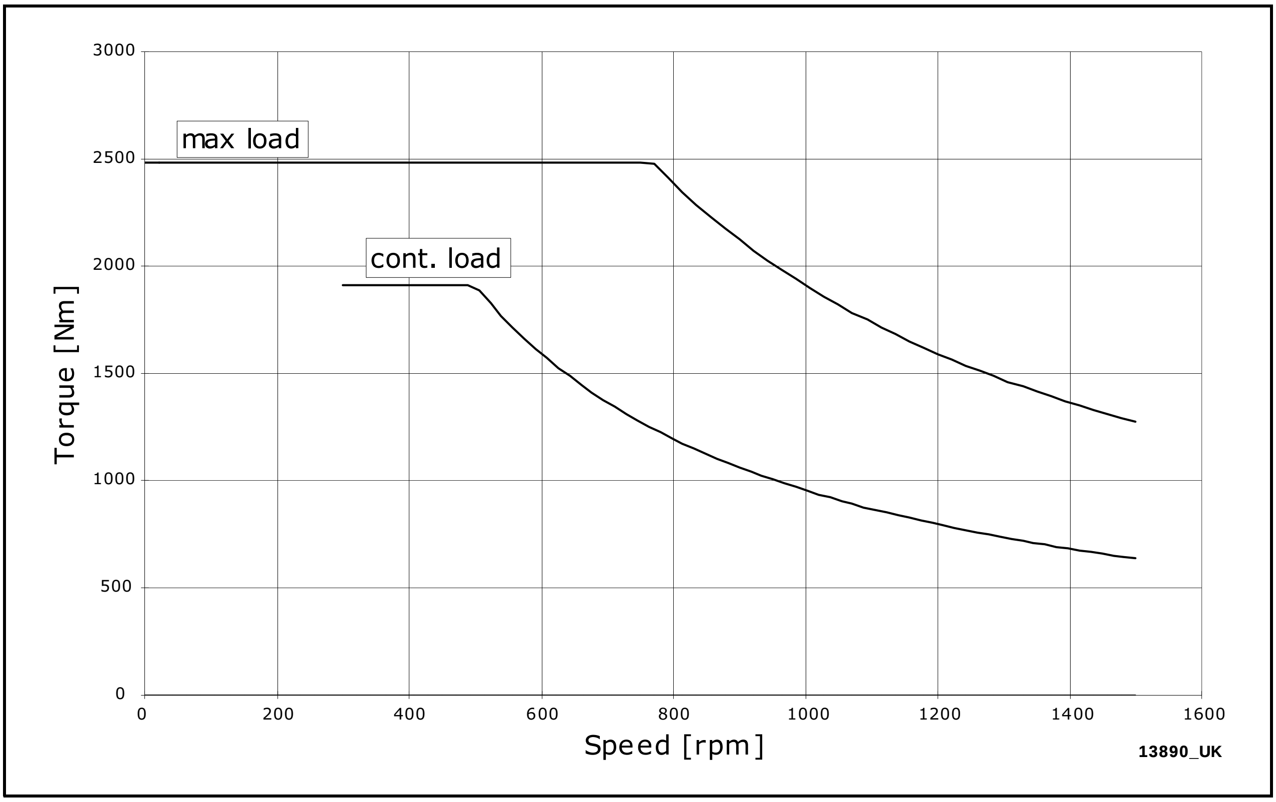


Figure 53. Example: OL(n_{base}) < OL(n_{max}) for constant power load

6.3 TECHNICAL SPECIFICATIONS FOR VACON® DRIVES

6.3.1 NXN - NON-REGENERATIVE FRONT END UNITS

Table 16. Technical specifications for non-regenerative front-end (NFE) drives

Mains connection	Input voltage U_{in}	380-690 V AC; -15%...+10%, EN 60204-1
	Input frequency f_{in}	45-66 Hz
	Continuous input current	I_H: Ambient temperature max. +40°C, overloadability 1.5 x I_H (1 min./10 min.) I_L: Ambient temperature max. +40°C, overloadability 1.1 x I_L (1 min./10 min.)
	Connection to mains	Unlimited (internal overload protections)
	Current THD	Depends on additional chokes (normal case < 40%)
	Starting delay	Depend on DC bus capacitance (max. 10 s)
	Unexpected input power break	Shorter breaks than 40 ms work normally if DC does not drop remarkably. A longer break means normal starting operation (charging current varies according to load).
DC connection	Output voltage U_{out}	465-800 V DC (380-500 V AC) 640-1100 V DC (525-690 V AC)
	Efficiency	>98%
	DC bank capacitance	6.8 µF (includes 10 MΩ discharging resistor)
Control characteristics	Control method	NFE is an independent power unit. Charging and protections are controlled by the NFE itself.
Ambient conditions	Ambient operating temperature	–10°C (no frost)...+40°C: I_H –10°C (no frost)...+40°C: I_L
	Storage temperature	–40°C...+70°C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mechanical particles	 IEC 721-3-3, unit in operation, class 3C2 IEC 721-3-3, unit in operation, class 3S2
	Altitude	100% load capacity (no derating) up to 1000 m, 1% derating for each 100 m above 1000 m; max. 2000 m
	Vibration EN50178, EN60068-2-6	5-150 Hz Vibration amplitude 0.25 mm (peak) at 5-31 Hz Max acceleration 1 G at 31-150 Hz
	Shock EN50178, EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max. 15 G, 11 ms (in package)
	Cooling air required	1150 m^3/h
	Enclosure class	IP00
EMC (at default settings)	Immunity	Fulfil all EMC immunity requirements. Can be chosen N-, L- or T-level.

Table 16. Technical specifications for non-regenerative front-end (NFE) drives

Safety		CE, UL, CUL EN 61800-5-1 (2003) (see unit nameplate for more detailed approvals)
Control connections	Display	7-segment (optional)
	Trip information	Relay I/O (optional)
Protection	Unit over temperature protection	Trips if temperature rises over trip level (default)
	Current measurement	Trips if current rises over trip level (default)
	Supply phase supervision	Trips if any of the output phases is missing (default)

6.3.2 NXA - Active front-end units

Table 17. Technical specifications for active front-end (AFE) drives

AC input connection	Input voltage U_{in}	380-500 V AC; 525-690 V AC; -10%...+10%
	Input frequency f_{in}	48-63 Hz
	Starting delay	FI9-FI13: 5 s
DC output connection	Output voltage U_{out}	1.35 x U_{in} x 1.1 (default DC bus voltage boosting is 110%)
	Continuous output current	I_H: Ambient temperature max. +40°C, overloadability 1.5 x I_H (1 min./10 min.) I_L: Ambient temperature max. +40°C, overloadability 1.1 x I_L (1 min./10 min.)
Control characteristics	Control method	Open loop vector control
	Switching frequency	NXA_xxxx 5: 3.6 kHz NXA_xxxx 6: 3.6 kHz
Ambient conditions	Ambient operating temperature	–10°C (no frost)...+40°C: I_H –10°C (no frost)...+40°C: I_L 1.5% derating for each 1°C above +40°C; maximum temperature +50°C.
	Storage temperature	–40°C...+70°C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mechanical particles	EN 60721, unit in operation, Class 3C3. IEC 721-3-3, unit in operation, Class 3S2.
	Altitude	100% load capacity (no derating) up to 1000 m, 1.5% derating for each 100m above 1000 m. Max. 2000 m (525-690 V AC) and 4000 m (380-500V AC), Relay I/O: max. 3000 m (240 V) and 4000 m (120 V)
	Vibration EN50178, EN60068-2-6	5-150 Hz Vibration amplitude 1 mm (peak) at 3-15.8 Hz Max acceleration 1 G at 15.8-150 Hz
	Shock EN50178, EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max. 15 G, 11 ms (in package)
	Enclosure class	IP00/NEMA1 standard size in the kW/HP range.
EMC (at default settings)	Immunity	EN 61800-3 (2nd edition 2004), second environment
Safety		EN 50178 (1997), EN 60204-1 (1996-2009), EN 60950 (2000, 3. edition, as relevant), CE, UL, cUL, FI, GOST R, IEC-EN 61800-5 (for approvals, see the unit nameplate)

Table 17. Technical specifications for active front-end (AFE) drives

Control connections	Analogue input voltage	0...+10 V, R_i = 200 kΩ. Resolution 0.1%, accuracy ±1%
	Analogue input current	0(4)...20 mA, R_i = 250 Ω differential
	Digital inputs (6)	Positive or negative logic; 18-30 V DC
	Auxiliary voltage	+24 V, ±15%, max. 250 mA
	Output reference voltage	+10 V, +3%, max. load 10 mA
	Analogue output (1)	0(4)...20 mA; R_L max. 500 Ω; Resolution 10 bit; Accuracy ±2%
	Digital outputs	Open collector output, 50 mA / 48 V
	Relay outputs	2 programmable change over relay outputs Switching capacity: 24 V DC / 8 A, 250 V AC / 8 A, 125 V DC / 0.4 A. Min. switching load: 5 V / 10 mA.
Protection	Overvoltage protection Undervoltage protection	NXA_5: 911 V DC; NXA_6: 1200 V DC NXA_5: 333 V DC; NXA_6: 460 V DC
	Ground fault protection	In case of an ground fault in the supply cable, the ground fault protection only protects the NX AFE itself.
	Input phase monitoring	Trips if any of the input phases is missing.
	Over current protection	Yes
	Unit over temperature protection	Yes
	Short circuit protection of +24 V and +10 V reference voltages	Yes

6.3.3 NXI - Inverter units

6.3.3.1 Drive sizes FR4-FR8

Table 18. Technical specifications for size FR4-FR8 inverter units (INU)

AC input connection	Input voltage U_{in}	465-800 V DC; 640-1100 V DC; –0%...+0% , The ripple voltage of the inverter supply voltage generated during the rectification of the fundamental frequency AC voltage must be less than 50 V peak-to-peak.
	Connection to DC supply	Once per minute or less (normal)
	Starting delay	2 s
Motor connection	Output voltage U_{out}	3~ 0 - U_{in} / 1.4
	Continuous output current	I_H: Ambient temperature max. +50°C, overloadability 1.5 x I_H (1 min./10 min.) I_L: Ambient temperature max. +40°C, overloadability 1.1 x I_L (1 min./10 min.)
	Starting torque	I_S for two seconds, depends on the motor
	Peak current	I_S for 2 s every 20 s
	Output frequency	0-320 Hz; 7200 Hz (special use)
	Frequency resolution	Depends on application
Control characteristics	Control method	Frequency control U/f Open loop sensorless vector control Closed loop frequency control Closed loop vector control
	Switching frequency	NXI_xxxx 5: 1-16 kHz; Factory default 10 kHz (NXI_0072 and greater: 1-10 kHz; Factory default 3.6 kHz) NXI_xxxx 6: 1-6 kHz; Factory default 1.5 kHz
	Frequency reference: - Analogue input - Panel reference	 Resolution 0.1% (10-bit), accuracy ±1% Resolution 0.01 Hz
	Field weakening point	30-320 Hz
	Acceleration time	0-3000 s
	Deceleration time	0-3000 s

Table 18. Technical specifications for size FR4-FR8 inverter units (INU)

Ambient conditions	Ambient operating temperature	–10°C (no frost)...+50°C: I_H –10°C (no frost)...+40°C: I_L
	Storage temperature	–40°C...+70°C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mechanical particles	 IEC 721-3-3, unit in operation, Class 3C2. IEC 721-3-3, unit in operation, Class 3S2.
	Altitude	100% load capacity (no derating) up to 1000 m, 1% derating for each 100 m above 1000 m; max. 3000 m
	Vibration EN50178, EN60068-2-6	5-150 Hz Vibration amplitude 0.25 mm (peak) at 5-15.8 Hz Max acceleration 1 G at 15.8-150 Hz
	Shock EN50178, EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max. 15 G, 11 ms (in package)
	Enclosure class	FR4-FR7: IP21/NEMA1 standard FR8: IP00 standard
EMC (at default settings)	Immunity	Fulfils all EMC standards
Safety		EN 50178 (1997), EN 60204-1 (1996), EN 60950 (2000, 3rd edition, as relevant), CE, UL, CUL, FI, GOST R, IEC 61800-5; (see unit nameplate for more detailed approvals)
Control connections	Analogue input voltage	0...+10 V, R_i = 200 kΩ, (–10 V...+10 V joystick control) Resolution 0.1%, accuracy ±1%
	Analogue input current	0(4)...20 mA, R_i = 250 Ω differential
	Digital inputs (6)	Positive or negative logic; 18-30 V DC
	Auxiliary voltage	+24 V, ±15%, max. 250 mA
	Output reference voltage	+10 V, +3%, max. load 10 mA
	Analogue output	0(4)...20 mA; R_L max. 500 Ω; Resolution 10 bit; Accuracy ±2%
	Digital outputs	Open collector output, 50 mA / 48 V
	Relay outputs	2 programmable change over relay outputs Switching capacity: 24 V DC / 8 A, 250 V AC / 8 A, 125 V DC / 0.4 A. Min. switching load: 5 V / 10 mA.

Table 18. Technical specifications for size FR4-FR8 inverter units (INU)

Protection	Overvoltage protection Undervoltage protection	NXI_5: 911 V DC; NXI_6: 1200 V DC NXI_5: 333 V DC; NXI_6: 460 V DC
	Ground fault protection	In case of an ground fault in the motor or motor cable, only the inverter is protected
	Output phase supervision	Trips if any of the output phases is missing
	Over current protection	Yes
	Unit over temperature protection	Yes
	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
	Short circuit protection of +24 V and +10 V reference voltages	Yes

6.3.3.2 Drive sizes FI9-FI14

Table 19. Technical specifications for size FI9-FI14 inverter units (INU)

AC input connection	Input voltage U_{in}	465-800 V DC (380-500 V AC) 640-1100 V DC (525-690 V AC) The ripple voltage of the inverter supply voltage generated during the rectification of the fundamental frequency AC voltage must be less than 50 V peak-to-peak.
	Input current I_{in}	$(\sqrt{3} \times U_{mot} \times I_{mot} \times \cos\varphi) / (U_{in} \times 0.98)$
	DC bank capacitance	FI9_5: 4950 µF; FI9_6: 3733 µF FI10_5: 9900 µF; FI10_6: 7467 µF FI12_5: 19800 µF; FI12_6: 14933 µF FI13_5: 29700 µF; FI13_6: 22400 µF FI14_5: 2 x 29700 µF; FI14_6: 2 x 22400 µF
	Starting delay	5 s
Motor connection	Output voltage U_{out}	3~ 0 - U_{in} / 1.4
	Continuous output current	I_H: Ambient temperature max. +40°C, overloadability 1.5 x I_H (1 min./10 min.) I_L: Ambient temperature max. +40°C, overloadability 1.1 x I_L (1 min./10 min.)
	Starting torque	I_S for two seconds, depends on the motor
	Peak current	I_S for 2 s every 20 s
	Output frequency	0-320 Hz; 7200 Hz (special use)
	Frequency resolution	Depends on application
Control characteristics	Control method	Frequency control U/f Open loop sensorless vector control Closed loop frequency control Closed loop vector control
	Switching frequency	NXI_5: 1-10 kHz; Factory default 3.6 kHz NXI_6: 1-6 kHz; Factory default 1.5 kHz
	Frequency reference: - Analogue input - Panel reference	 Resolution 0.1% (10-bit), accuracy ±1% Resolution 0.01 Hz
	Field weakening point	30-320 Hz
	Acceleration time	0-3000 s
	Deceleration time	0-3000 s
	Braking torque	DC brake: 30% x T_N (without brake)

Table 19. Technical specifications for size FI9-FI14 inverter units (INU)

Ambient conditions	Ambient operating temperature	–10°C (no frost)...+40°C
	Storage temperature	–40°C...+70°C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mechanical particles	 IEC 721-3-3, unit in operation, Class 3C2 IEC 721-3-3, unit in operation, Class 3S2
	Altitude	100% load capacity (no derating) up to 1000 m, 1% derating for each 100 m above 1000 m; max. 2000 m
	Vibration EN50178, EN60068-2-6	Vibration amplitude 0.25 mm (peak) at 5-31 Hz Max acceleration 1 G at 31-150 Hz
	Shock EN50178, EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max. 15 G, 11 ms (in package)
	Heat loss	P_{loss} [kW] ≈ P_{mot} [kW] × 0.02
	Cooling air required	FI9: 1150 m^3/h FI10: 1400 m^3/h FI12: 2800 m^3/h FI13: 4200 m^3/h FI14: 2×4200 m^3/h
	Enclosure class	IP00
EMC (at default settings)	Immunity	Fulfil all EMC immunity requirements, Level T
Safety		CE, UL, CUL EN 61800-5-1 (2003) (see unit nameplate for more detailed approvals)
Control connections	Analogue input voltage	0...+10 V, R_i = 200 kΩ, (–10 V...+10 V joystick control) Resolution 0.1%, accuracy ±1%
	Analogue input current	0(4)...20 mA, R_i = 250 Ω differential
	Digital inputs (6)	Positive or negative logic; 18-30 V DC
	Auxiliary voltage	+24 V, ±15%, max. 250 mA
	Output reference voltage	+10 V, +3%, max. load 10 mA
	Analogue output	0(4)...20 mA; R_L max. 500 Ω; Resolution 10 bit; Accuracy ±2%
	Digital outputs	Open collector output, 50 mA / 48 V
	Relay outputs	2 programmable change over relay outputs Switching capacity: 24 V DC / 8 A, 250 V AC / 8 A, 125 V DC / 0.4 A. Min. switching load: 5 V / 10 mA.

Table 19. Technical specifications for size FI9-FI14 inverter units (INU)

Protection	Overvoltage protection Undervoltage protection	NXI_5: 911 V DC; NXI_6: 1200 V DC NXI_5: 333 V DC; NXI_6: 460 V DC
	Ground fault protection	In case of an ground fault in the motor or motor cable, only the inverter is protected
	Output phase supervision	Trips if any of the output phases is missing
	Over current protection	Yes
	Unit over temperature protection	Yes
	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
	Short circuit protection of +24 V and +10 V reference voltages	Yes

6.3.4 NXB - Brake chopper units

Brake chopper units are available in frame sizes FI9-FI14. The technical specifications for brake chopper units are the same as for inverter units (see Chapter 6.3.3.2).

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