ENGINEERING TOMORROW

Operating Guide

VACON® 1000

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Contents

1 Introduction

1.1 Purpose of this Operating Guide

This Operating Guide provides information for safe installation and commissioning of the AC drive. It is intended for use by qualified personnel.

Read and follow the instructions to use the drive safely and professionally.

Pay particular attention to the safety instructions and general warnings. Always keep this Operating Guide with the drive.

1.2 Additional Resources

Other resources are available to understand advanced AC drive functions, programming, and options.

- The VACON® 1000 Application Guide provides greater detail on how to work with the application and how to set the parameters of the AC drive.
- User guides for product options.

Supplementary publications and manuals are available from Danfoss. See www.danfoss.com for listings.

1.3 Manual Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this manual is English.

Table 1: VACON® 1000 Operating Guide Version

Version	Release date	Remarks
A	11.06.2021	First version

2 Safety

2.1 Safety Symbols

The following symbols are used in this manual:

⚠ D A N G E R ⚠
Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ W A R N I N G ⚠
Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ C A U T I O N ⚠
Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

N O T I C E
Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

2.2 Qualified Personnel

To allow trouble-free and safe operation of the unit, only qualified personnel with proven skills are allowed to transport, store, assemble, install, program, commission, maintain, and decommission this equipment.

Persons with proven skills:

- Are qualified electrical engineers, or persons who have received training from qualified electrical engineers and are suitably experienced to operate devices, systems, plant, and machinery in accordance with pertinent laws and regulations.
- Are familiar with the basic regulations concerning health and safety/accident prevention.
- Have read and understood the safety guidelines given in all manuals, especially the instructions given in the operating guide of the unit.
- Have good knowledge of the generic and specialist standards applicable to the specific application.
- Are familiar with the structure and operation of medium-voltage drives and the related risks. Special training for medium-voltage installations may be necessary.

2.3 Danger and Warnings

⚠ D A N G E R ⚠

SHOCK HAZARD FROM POWER UNIT COMPONENTS

The power unit components are live when the drive is connected to mains. Contact with this voltage can result in death or serious injury.

- Do not touch the components of the power unit when the drive is connected to mains.
  Do not do any work on live equipment.
  Before doing any work on internal drive components, follow proper lock out and tag out procedure.
  Before connecting the drive to mains, make sure that all covers are installed on the drive and the enclosure doors are closed.

⚠ D A N G E R ⚠

SHOCK HAZARD FROM TERMINALS

The motor terminals U, V, W, and the DC-link terminals must be treated as live when the drive is connected to mains. Contact with this voltage can lead to death or serious injury.

- Do not touch the motor terminals U, V, W, or the DC terminals when the drive is connected to mains.
  Do not do any work on live equipment.
  Before doing any work on the drive, follow proper lock out and tag out procedure.
  Before connecting the drive to mains, make sure that all covers are installed on the drive and the enclosure doors are closed.

⚠ DANGER ⚠

SHOCK HAZARD FROM DC LINK OR EXTERNAL SOURCE

The terminal connections and the components of the drive can be live several minutes after the drive is disconnected from the mains and the motor has stopped. The load side of the drive can also generate voltage. A contact with this voltage can lead to death or serious injury.

- Do not do touch the main circuit of the drive or the motor before the system is powered off and grounded.
  Disconnect the drive from the mains and make sure that the motor has stopped.
  Disconnect the motor.
  Lock out and tag out the power source to the drive.
  Make sure that no external source generates unintended voltage during work.
  Ground the drive for work.
  Wait at least 15 minutes for the DC-link capacitors to discharge fully before opening the cabinet door or the cover of the AC drive.
  Use a measuring device to make sure that there is no voltage.

⚠ WARNING ⚠

SHOCK HAZARD FROM CONTROL TERMINALS

The control terminals can have a dangerous voltage also when the drive is disconnected from mains. A contact with this voltage can lead to injury.

- Make sure that there is no voltage in the control terminals before touching the control terminals.

⚠ WARNING ⚠

ACCIDENTAL MOTOR START

When there is a power-up, a power break, or a fault reset, the motor starts immediately if the start signal is active, unless the pulse control for Start/Stop logic is selected. If the parameters, the applications or the software change, the I/O functions (including the start inputs) can change. If you activate the auto reset function, the motor starts automatically after an automatic fault reset. See the Application Guide. Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage.

- Disconnect the motor from the drive if an accidental start can be dangerous. Make sure that the equipment is safe to operate under any condition.

⚠ WARNING

ELECTRICAL SHOCK HAZARD - LEAKAGE CURRENT HAZARD >3.5 MA

Leakage currents exceed 3.5 mA. Failure to connect the drive properly to protective earth (PE) can result in death or serious injury.

- Ensure reinforced protective earthing conductor according to IEC 60364-5-54 cl. 543.7 or according to local safety regulations for high touch current equipment. The reinforced protective earthing of the drive can be done with:
- a PE conductor with a cross-section of at least 10 mm^2 (8 AWG) Cu or 16 mm^2 (6 AWG) Al.
- an extra PE conductor of the same cross-sectional area as the original PE conductor as specified by IEC 60364-5-54 with a minimum cross-sectional area of 2.5 mm^2 (14 AWG) (mechanical protected) or 4 mm^2 (12 AWG) (not mechanical protected).
- a PE conductor completely enclosed with an enclosure or otherwise protected throughout its length against mechanical damage.
- a PE conductor part of a multi-conductor power cable with a minimum PE conductor cross-section of 2.5 mm^2 (14 AWG) (permanently connected or pluggable by an industrial connector. The multi-conductor power cable shall be installed with an appropriate strain relief).
- NOTE: In IEC/EN 60364-5-54 cl. 543.7 and some application standards (for example IEC/EN 60204-1), the limit for requiring reinforced protective earthing conductor is 10 mA leakage current.

2.4 Cautions and Notices

⚠ CAUTION ⚠

DAMAGE TO THE AC DRIVE FROM INCORRECT SPARE PARTS

Using spare parts that are not from the manufacturer can damage the drive.

- Do not use spare parts that are not from the manufacturer.

⚠ CAUTION ⚠

DAMAGE TO THE AC DRIVE FROM CHANGES TO DRIVE COMPONENTS

Doing electrical or mechanical changes to the drive components can cause malfunctions and can damage the AC Drive.

- Do not make electrical or mechanical changes to the drive components.

⚠ CAUTION ⚠

DAMAGE TO THE AC DRIVE FROM INSUFFICIENT GROUNDING

Not using a grounding conductor can damage the drive.

- Always ground the AC drive with a grounding conductor that is connected to the grounding terminal that is identified with the PE symbol.

⚠ CAUTION ⚠

DAMAGE TO THE AC DRIVE DUE TO DISCONNECTED CONTROL POWER

Disconnecting the control auxiliary power when the AC drive is connected to mains or when the power indicator is on can cause abnormalities in the function of the power cells and damage the cells.

- Do not disconnect the control auxiliary power supply when the AC drive is connected to mains or if the power indicator is on.

⚠ CAUTION ⚠

CUT HAZARD FROM SHARP EDGES

There can be sharp edges in the AC drive that can cause cuts.

- Wear protective gloves when mounting, cabling, or doing maintenance operations.

⚠ CAUTION ⚠

BURN HAZARD FROM HOT SURFACES

Touching surfaces, which are marked with the 'hot surface' sticker, can result in injury.

- Do not touch surfaces which are marked with the 'hot surface' sticker.

NOTICE

DAMAGE TO THE AC DRIVE FROM STATIC VOLTAGE

Some of the electronic components inside the AC drive are sensitive to ESD. Static voltage can damage the components.

- Use ESD protection when working with electronic components of the AC drive. Do not touch the components on the circuit boards without proper ESD protection.

NOTICE

DAMAGE TO THE AC DRIVE FROM INCORRECT EMC LEVEL

The EMC level requirements for the AC drive depend on the installation environment. An incorrect EMC level can damage the drive.

- Before connecting the AC drive to the mains, make sure that the EMC level of the AC drive is correct for the mains.

NOTICE

MAINS DISCONNECTION DEVICE

If the AC drive is used as a part of a machine, the machine manufacturer must supply a mains disconnection device (refer to EN 60204-1).

NOTICE

MALFUNCTION OF FAULT CURRENT PROTECTIVE SWITCHES

Because there are high capacitive currents in the AC drive, it is possible that the fault current protective switches do not operate correctly.

NOTICE

VOLTAGE WITHSTAND TESTS

If done improperly, doing voltage withstand tests can damage the drive.

- Megohmmeter testing is the only recommended test type for field installations.
  Only a qualified field service engineer is allowed to perform this test.
  Refer to the proper high potential/megohmmeter testing instructions in the service guide.

NOTICE

PERSONAL PROTECTIVE EQUIPMENT AND APPROVED TOOLS

When doing electrical work on the AC drive, always use personal protective equipment (PPE) and tools which are approved for work with medium-voltage devices.

3 Product Overview

3.1 Product Characteristics

The VACON® 1000 medium-voltage drive is an alternating current speed regulating device from Danfoss. The drive features include excellent performance, easy and convenient operation, and a wide range of applications using IGBT power devices and complete digital control.

High efficiency and low distortion

- The used multi-pulse input rectification transformer technology efficiently lowers the content of the input side distortion current to less than 5%. It meets the IEEE 519-1992 standard and the strict requirements of electric grids for distortion, and enhances the power factor to more than 0.96 lagging.
- With the used cell-cascaded multilevel technology, there is normally no need for an output filter, and the output voltage waveform is similar to a sine-wave.
- System efficiency >98.5% (at rated frequency, excluding transformer).

Tolerant to power disturbances and wide applicable scope

- When the input voltage is as low as 70%, the system can still continue derated operation.
- With automatic output voltage adjusting function, when the input voltage fluctuates between 90–110%, the output voltage can still be kept steady. Thus, safe and steady operation of the motor is possible.

High reliability

- SOA (Service-oriented architecture) design ensures that the system operates in a wide safe range:
  - Sufficient design margin makes sure that each device operates in the middle area of the safe operating area.
  - Optimized thermal design ensures temperature margin for the devices.
  - The DC-link capacitors are designed for long lifetime service.
- Redundant auxiliary control power.
- The system provides a self-diagnosis function to show the position and type of failure and warn the user about the fault occurrence.
- Automatic detection and warning function for cooling fan failure or excessive dust in the inlet air filter notifying the user to conduct maintenance.
- Production quality management, control flow process, and perfect test equipment and methods ensure the effective implementation of each test item for devices, components, and units during the manufacturing process at Danfoss.

Site flexibility

- The compact structure and high power density of VACON® 1000 can reduce the space requirements on site.
- The electric connections between the cabinets use highly reliable connectors which are easy to install and maintain.
- Easy-to-operate human-machine interface.
- Sufficient communication interfaces, which can be professionally configured in accordance with the application requirements.
- All PCBs are coated to avoid problems with pollution and corrosive environments.

3.2 Applications

VACON® 1000 is used for the speed control of square torque loads such as fans, pumps, and compressors, as well as for mills, crushers, and conveyor belts that require constant torque operation over the entire speed range. Accurate speed and torque controls result in better energy saving, improved process quality, and prolonged equipment lifetime. Various industries that require reliable and stable operation can benefit from the high performance of VACON® 1000.

- Power generation: Coal mills, blower fans, and water pumps.
- Metallurgy: Conveyor belts, positive displacement pumps, fans, and water pumps.
- Mining: Crushers, conveyor belts, PD pumps, fans, and water pumps.
- Petrochemical: Compressors, PD pumps, centrifugal pumps, fans, and water pumps.
- Cement and materials: Crushers, mixers, extruders, rotary kilns, drying furnaces, fans, and water pumps.
- Sugar and ethanol: Mills, pumps, and fans.
- Municipal works: Water supply pumps, sewage pumps, heat network pumps.

3.3 System Hardware

The VACON® 1000 medium-voltage drive consists of a controller cabinet, power cell cabinet, transformer cabinet, and junction cabinet. Other cabinets can be configured in accordance with customer requirements in the actual application.

There are two types of drive enclosure:

- Standalone type with current ratings up to 215 A
- Line-up type with current ratings 215–680 A (IEC ratings up to 11 kV, UL ratings up to 6.9 kV)

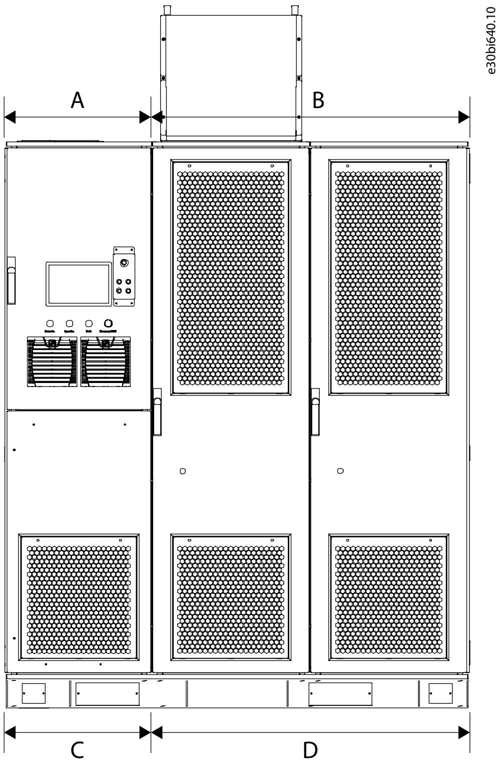

Illustration 1: Standalone System Structure

A	Control cabinet	C	Junction cabinet
B	Power cell cabinet	D	Transformer cabinet

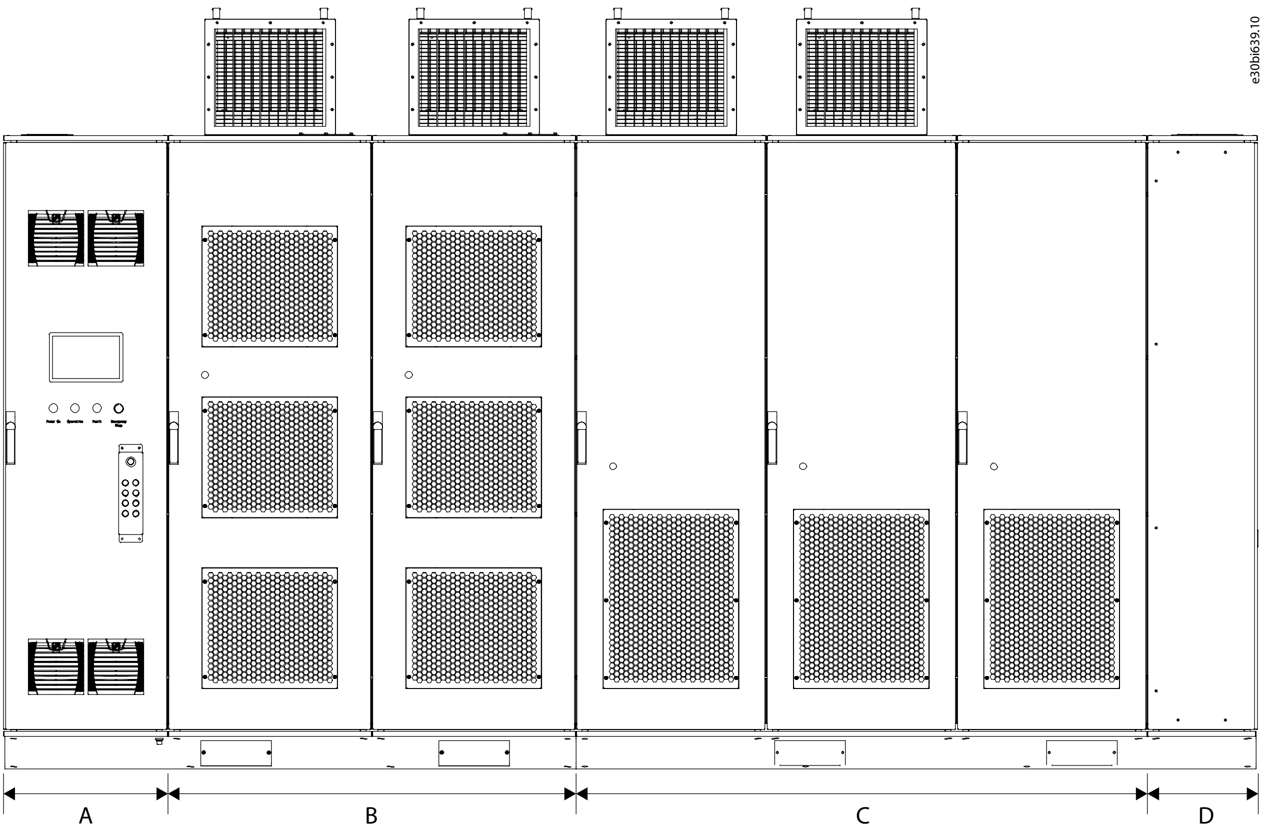

Illustration 2: Line-up System Structure

A	Control cabinet	C	Transformer cabinet
B	Power cell cabinet	D	Junction cabinet

3.3.1 Control Cabinet

The control cabinet includes:

- Main control system
- PLC
- HMI
- Battery
- Other accessories

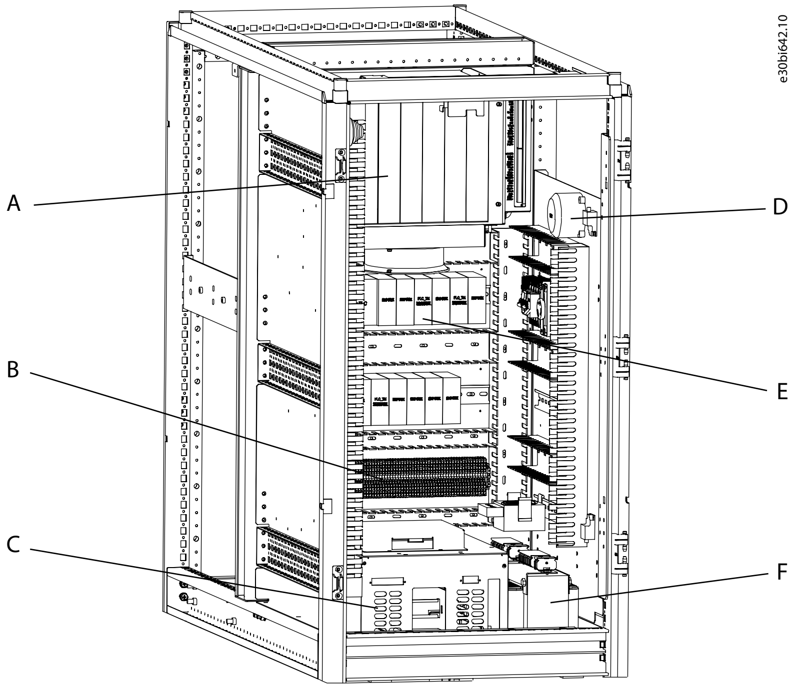

Illustration 3: Control Cabinet in VACON® 1000 Standalone Systems

A	Control rack	D	Airflow pressure switch
B	Terminal block	E	PLC
C	UPS	F	Isolation transformer

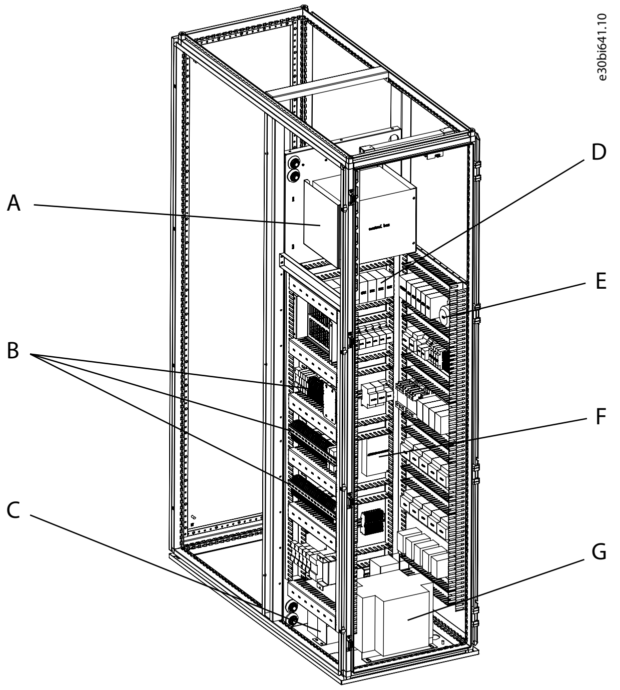

Illustration 4: Control Cabinet in VACON® 1000 Line-up Systems

A	Control rack	E	Airflow pressure switch
B	Terminal block	F	DC power supply
C	Battery	G	Isolation transformer
D	PLC		

The main control system is mounted in the control rack and consists of:

- Main control board
- I/O board
- A/D board
- Two fiber optical boards (extendable)
- Power supply board
- Bus motherboard, which connects the boards to each other.

A
B
C
D
E

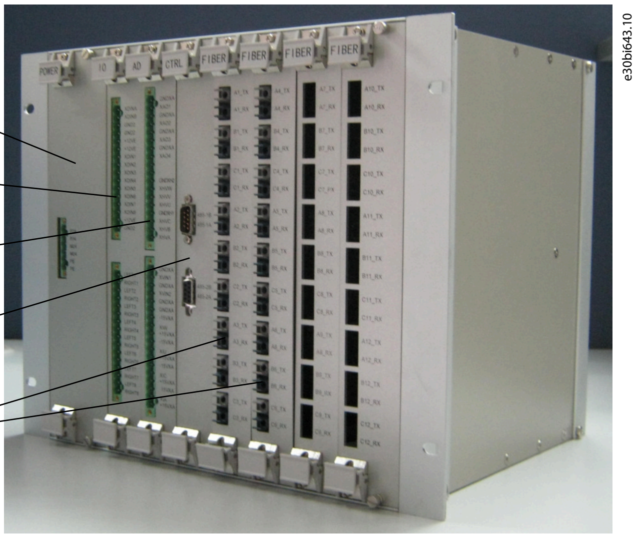

Illustration 5: Main Control System

A	Power supply board	D	Main control board
B	I/O board	E	Fiber optical boards
C	A/D board		

3.3.1.1 Controls and Indicators

The following are mounted on the control cabinet door:

- High voltage power-on indicator: A green indicator, which indicates high voltage applied to the drive.
- Operation indicator: A green indicator, which indicates that the drive is in operation.
- Fault indicator: A red indicator, which indicates that the system is in “failure” state.
- Emergency Stop button (E-stop): This button is used to break the high-voltage power of the drive when the system has an emergency (such as unexpected incidents threatening the safety of the personnel or equipment). The button has a self-locking function. Turn the button clockwise to reset and to turn power on again.
- Human-machine interface: See 7 Human-Machine Interface.
- Mechanical interlocking system: Standard in UL type drives and available as option +MMKI for IEC type drives. See 8.6.2 Mechanical Interlocking System.

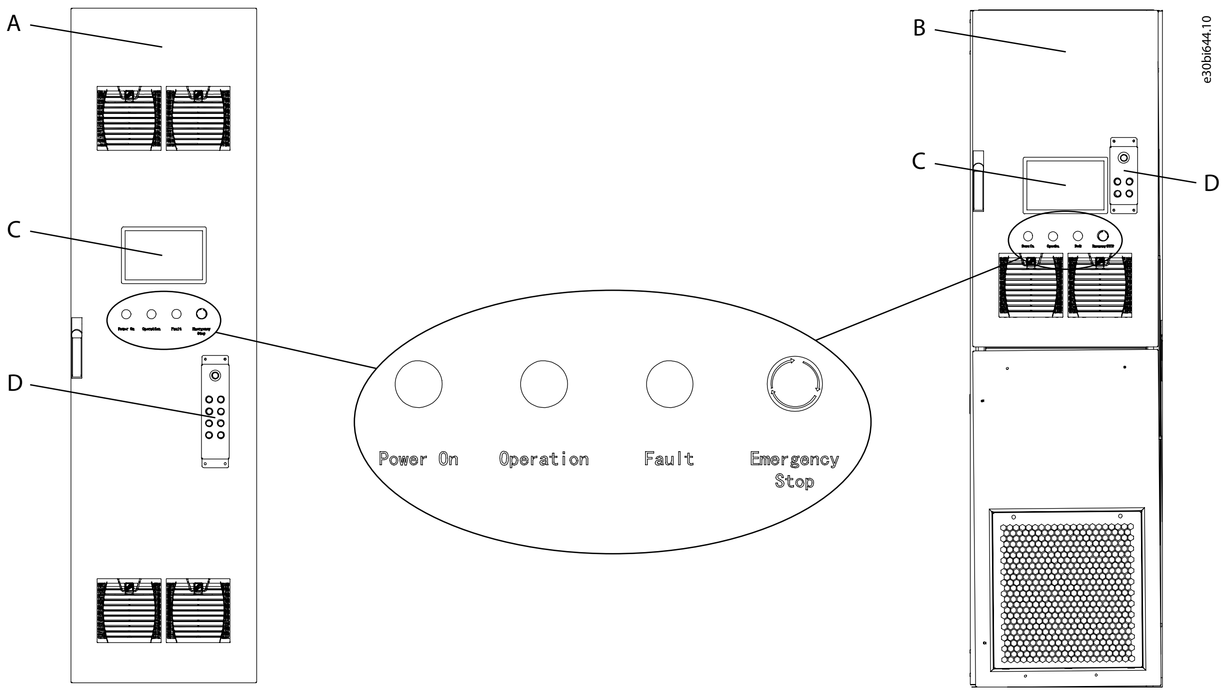

Illustration 6: Controls and Indicators on the Door of the Control Cabinet

A	Line-up cabinet	C	HMI
B	Standalone cabinet	D	Mechanical interlocking system

3.3.2 Power Cell Cabinet

The power cell cabinet contains the power cells and their accessories.

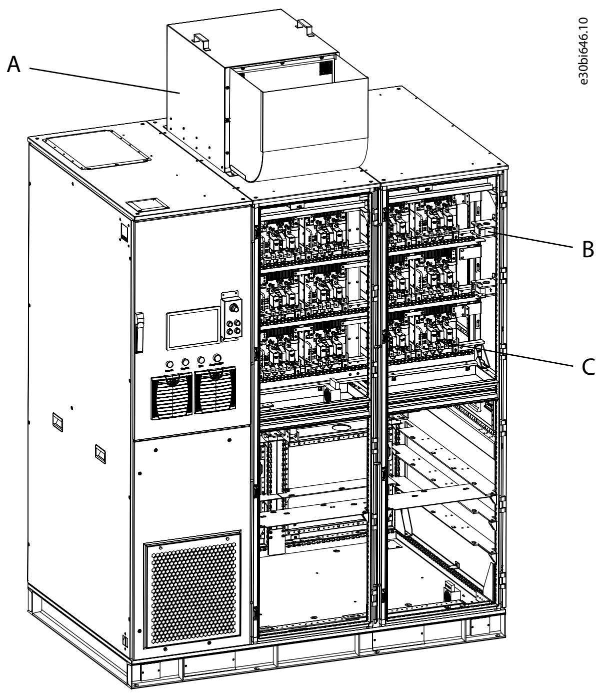

Illustration 7: Power Cell Cabinet in VACON® 1000 Standalone Systems

A	Cooling fan
B	Output current Hall sensor

C	Power cell

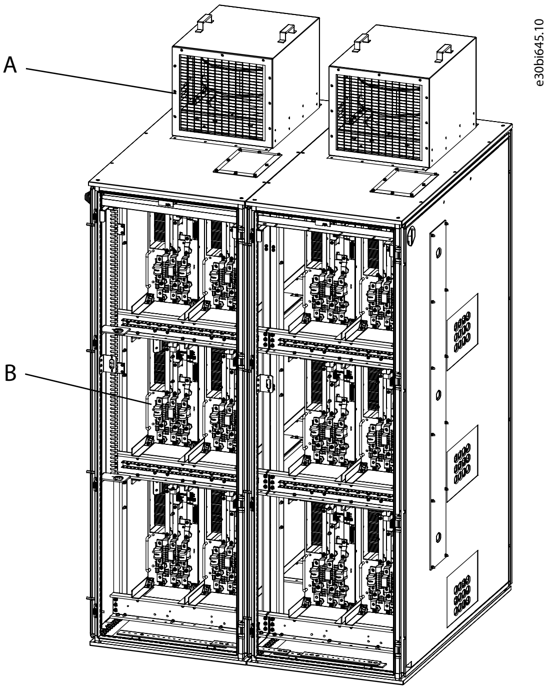

Illustration 8: Power Cell Cabinet in VACON® 1000 Line-up Systems

A	Cooling fan
B	Power cell

The power cells in the cabinet have the same electrical and mechanical parameters and can be replaced by each other.

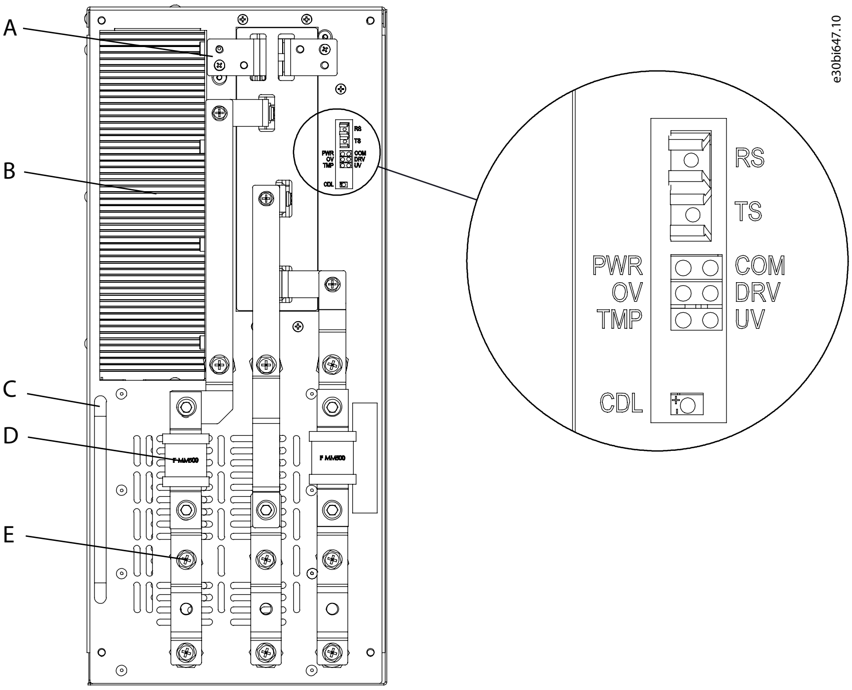

Illustration 9: Power Cell

A	Output terminal	COM	Communication fail indicator
B	Heat sink	DRV	Drive fault indicator
C	Handle	UV	Undervoltage indicator
D	Fuse	TMP	Overtemperature indicator
E	Input terminal	PWR	Power indicator
RS	Optical fiber (receive)	OV	Overvoltage indicator
TS	Optical fiber (transmit)	CDL	50 V DC-link voltage indicator

3.3.3 Transformer Cabinet

The transformer cabinet includes the phase-shift transformer and its accessories.

The transformer is integrated with the cabinet base through screws for the convenience of transportation and installation. The system default setting is that, when the transformer temperature exceeds 95°C, the system reports an excessive high temperature alarm but does not shut down. When the temperature exceeds 110°C, the system reports an extra-high temperature fault and shuts down.

In standalone systems, the same fan is used to cool the transformer and power cell cabinets.

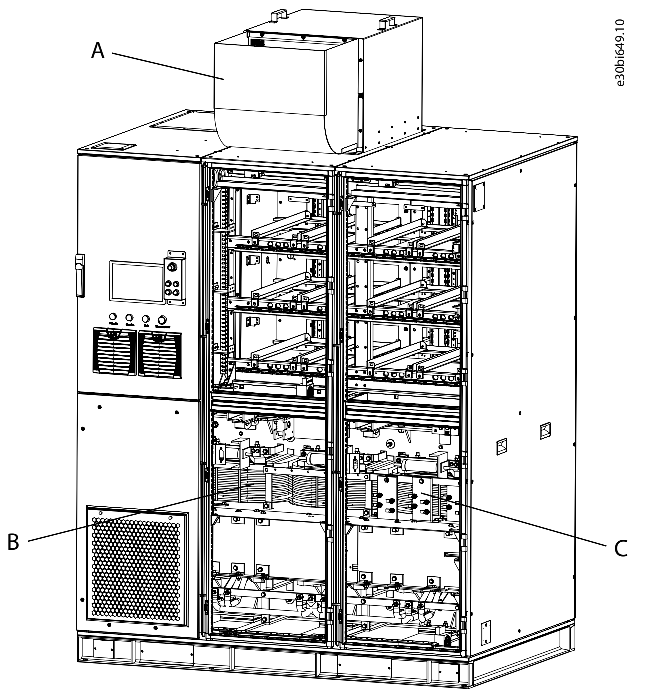

Illustration 10: Transformer Cabinet in VACON® 1000 Standalone Systems

A	Cooling fan	C	Input current Hall sensor
B	Phase-shift transformer		

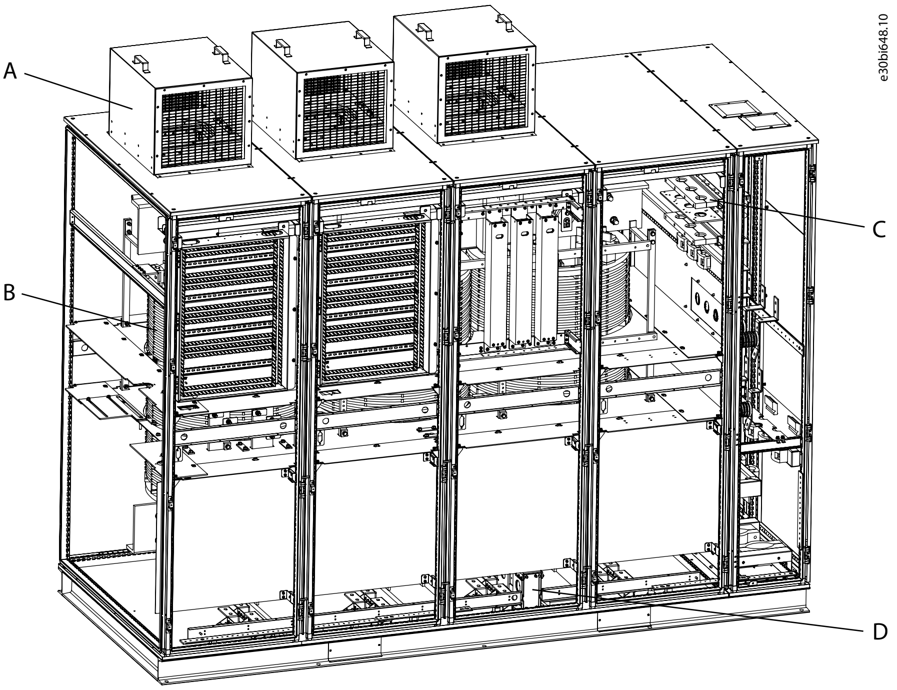

Illustration 11: Transformer Cabinet in VACON® 1000 Line-up Systems

A	Cooling fan	C	Input current Hall sensor
B	Phase-shift transformer	D	Output current Hall sensor

3.3.4 Junction Cabinet

The junction cabinet is used for field cable connections. See 6.5 Cable Entry and Termination.

3.3.5 Start-up Cabinet

The start-up cabinet (+PSTC) is an option for the VACON® 1000 line-up systems. The main function of the start-up cabinet is to depress inrush currents that can lead to a dip in the supply voltage:

- A phase-shifting transformer with a large capacity can produce a magnetizing surge as high as 6–8 times the rated current of the transformer itself.
- The power cells of the drive contain several capacitors, which require a large precharge current when high voltage is applied.

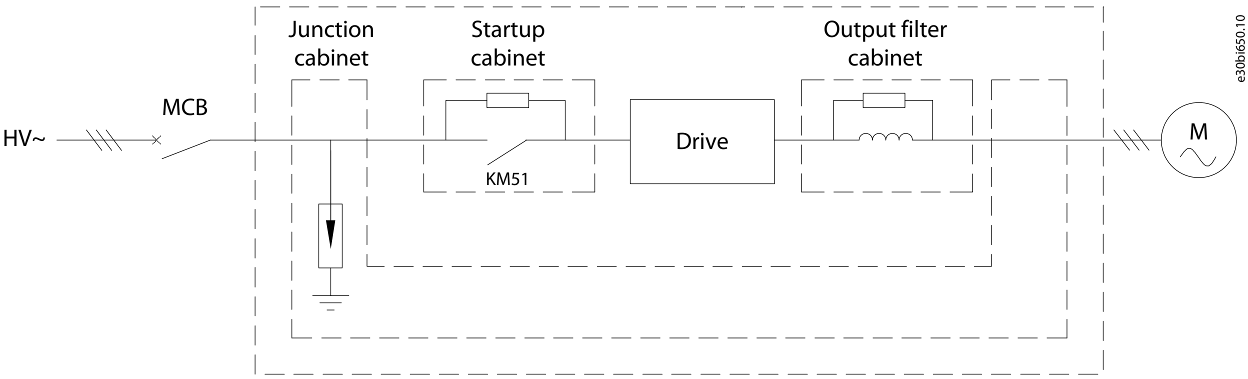

Illustration 12: Start-up Cabinet Primary Side Diagram

Install the start-up cabinet between the high-voltage power input and phase-shifting transformer. When the MCB of the drive is closed, the start-up cabinet limits the magnetizing surge and charge current of the capacitance quickly and efficiently. After the drive is powered up, the current-limiting resistance passes through the KM51 bypass, and the drive can function normally.

The main electrical components of the start-up cabinet are a high-voltage switch (vacuum contactor or vacuum breaker) and a current-limiting resistor.

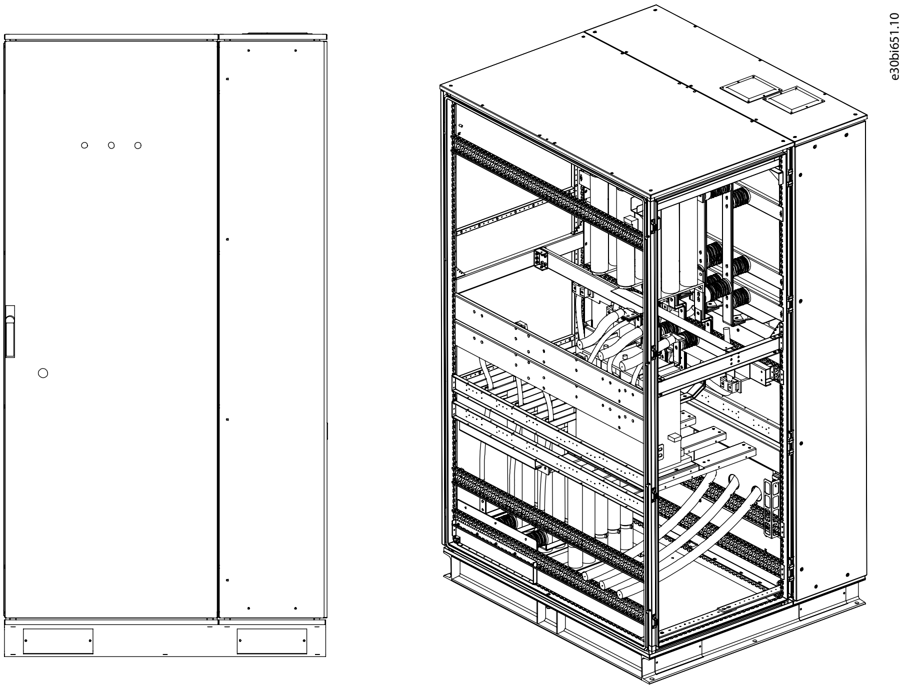

Illustration 13: Start-up Cabinet

The function of current-limiting resistance is to limit the primary current when a high voltage is connected. Each resistor can bear a 30 kJ energy during the power-up. The capacity of the drive defines how much resistance is needed in the start-up cabinet: the larger the capacity, the more current-limiting resistors are needed.

The function of the high-voltage switch is to bypass the current-limiting resistor after the powering-up procedure, making the drive function under normal load. If the rated current is small, a vacuum contactor can be used. If the rated current is large, a vacuum breaker can be used.

Operation process

- Power up the drive.
- The control program confirms if the system is ready and if the cabinet switch is separated or not.
- Power up the start-up cabinet and the control program counts the time it takes to complete the process. The process requires about 5 s.
- The closing of the start-up cabinet switch bypasses the charged resistor and the drive has status 'running allowed'.

When to select the Start-up cabinet option?

The MCB protection at the installation site must not trip because of the inrush current when the drive is powered up or in normal overload conditions. The overcurrent protection of the MCB must be set in the grey area shown in Illustration 14.

If the MCB meets these requirements, the start-up cabinet is not required. It is important to verify this condition, especially in retrofit applications where a circuit breaker is already installed at the motor control center panel.

Even if it is not required, a start-up cabinet can still be installed to:

- Reduce inrush current.
- Reduce stresses in the electrical installation during the drive power-up operation.

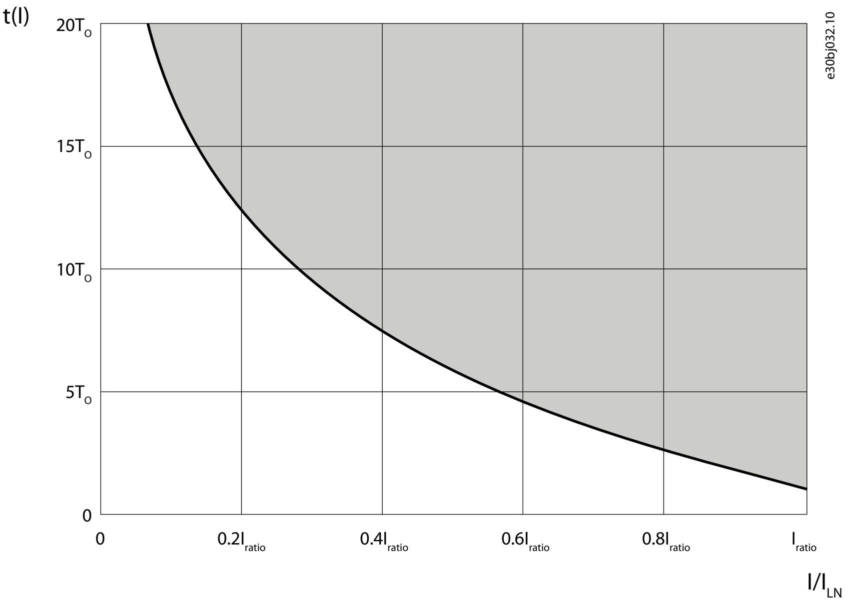

Illustration 14: Overcurrent Protection Setting Area

I	Inrush current	t(I)	Time of the inrush current decay
I_{LN}	Rated input current of the drive	T_O	The basic period: 20 ms for 50 Hz or 16.7 ms for 60 Hz
I_{ratio}	I/I_{LN}		

3.3.6 Output Filter Cabinet

The output filter cabinet is an optional cabinet which is connected at the output of the drive, between the inverter and motor. The filter is used to:

- Reduce the dU/dt of the voltage waveform.
- Prevent resonance/overvoltage caused by motor cables.
- Reduce the charging current of the cable.

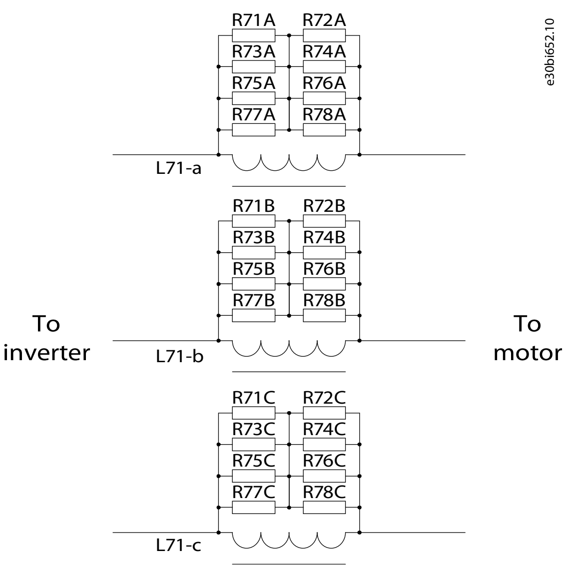

Illustration 15: Output Filter Cabinet Circuit Diagram

Install the output filter cabinet between the drive and motor. The filter consists of a reactor and paralleling damping resistors. The reactor decreases the rising edge of the PWM. The resistor damps the resonance caused by the reactor and stray inductance.

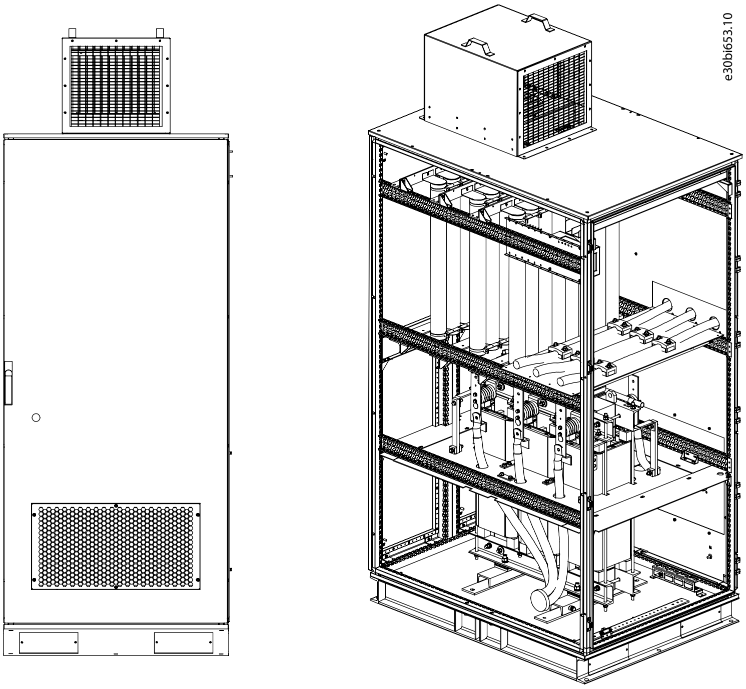

Illustration 16: Output Filter Cabinet

When to select the Output Filter cabinet option?
The need for an output filter is application and case specific. Several things must be considered to find out if a dU/dt Filter is required:

- The type of the motor.
- The type of the motor cable.
- The length of the motor cable.

To evaluate if a dU/dt Filter is required, contact Danfoss.

3.3.7 Bypass Cabinet

Different bypass cabinets are available as options:

- Manual bypass cabinet
- Automatic bypass cabinet
- Synchronous transfer cabinet

3.3.7.1 Manual Bypass Cabinet

Illustration 17 shows a typical bypass cabinet configuration, where:

- QS41 is a single-pole isolation switch with a manual grounding knife gate.
- QS42 and QS43 are double-pole double-throw manual knife gate isolation switches.

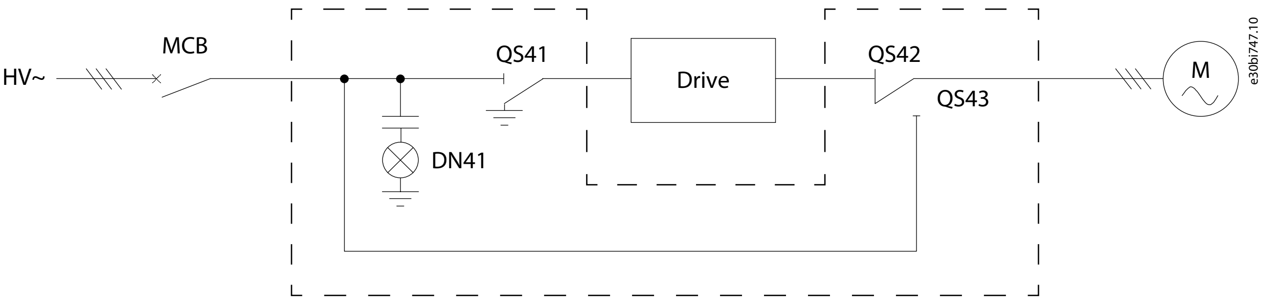

Illustration 17: Manual Bypass Cabinet Circuit Diagram

The bypass cabinet includes an isolation switch, which:

- Realizes the electrical isolation between the phase-shift transformer and the power distribution system.
- Provides the power frequency and variable frequency switching function and related electrical protection measures.

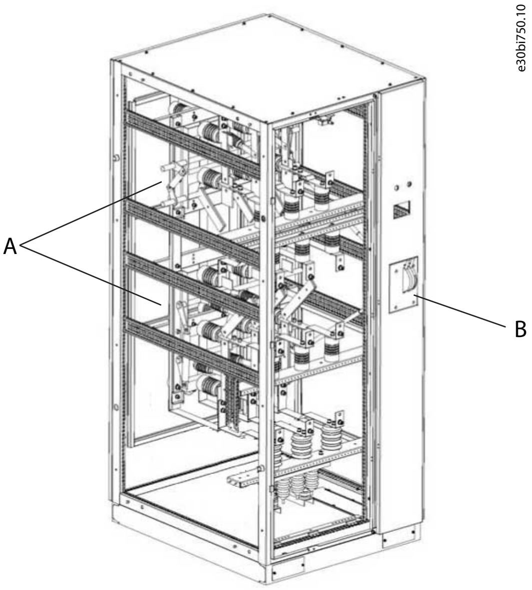

Illustration 18: Manual Bypass Cabinet

A	Manual knife gate switch
B	Dual-isolation switch panel

3.3.7.2 Automatic Bypass Cabinet

Illustration 19 shows an automatic bypass cabinet configuration, where:

- KM41–KM43, high-voltage vacuum contactors.
- QS41–QS42, manual separation knife switches.

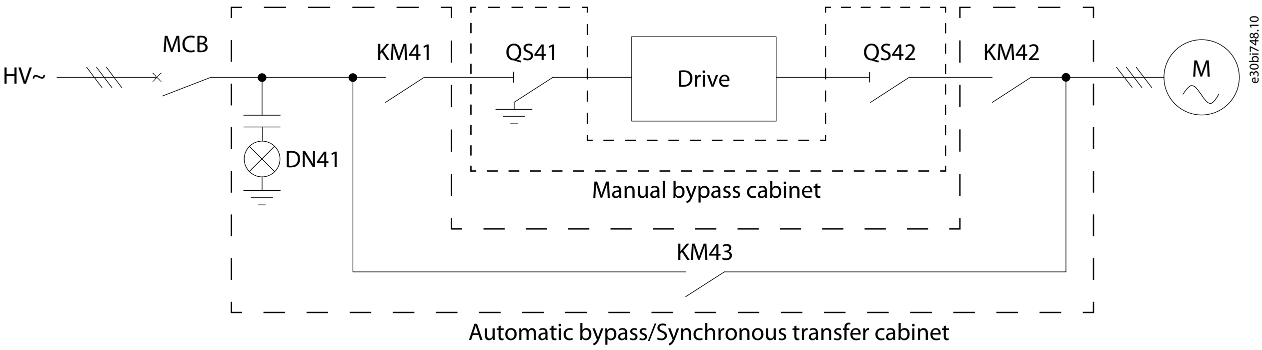

Illustration 19: Automatic Bypass Cabinet Circuit Diagram

When the drive is running:

- QS41 and QS42 are closed.
- KM41 and KM42 are closed.
- KM43 is open.

When the drive is bypassed:

- KM41 and KM42 are open.
- KM43 is closed.

When maintenance is performed on the drive:

- QS41 and QS42 are open.
- KM41 and KM42 are open.
- KM43 is closed.

The sequence in which the drive is switched from running to bypassed:

- 1. KM41 is opened.
- 2. KM42 is opened.
- 3. KM43 is closed.

Secondary Control Logic
The three switches KM41–KM43 use assistant contact interlock to ensure that the time course is followed.

- KM41 does not open and KM42 does not act when the normally closed contactor of KM41 is connected into the opening circuit of KM42.
- The normally closed contactor of KM42 is connected to the MCB-closed circuit of KM43.
- The normally closed contactor of KM43 is connected to the MCB-closed circuit of KM42.
- KM43 is not able to close the MCB when KM42 is not opening.
- KM42 is not able to close MCB when KM43 is not opening.

The status of the five switches KM41–KM43 and QS41–QS42 is monitored through the PLC.

- If any switch is not at the right working position, the system does not allow the MCB to close, and powering up high voltage to the system is forbidden.
- If the drive goes into fault, the system breaks the switch automatically to cut off the HV input for safety, if KM41 is not able to open during the process of VF switching to working frequency automatically.

The two switches KM42 and KM43 control the function of reserving postponed action in the circuit, which can adjust the action interval of the switch during the process of VF switching to working frequency. It can be more convenient to calibrate the machine on site according to the status of the electric motor and load, to switch speed reasonably to avoid an overcurrent malfunction because of the electric motor remanence.

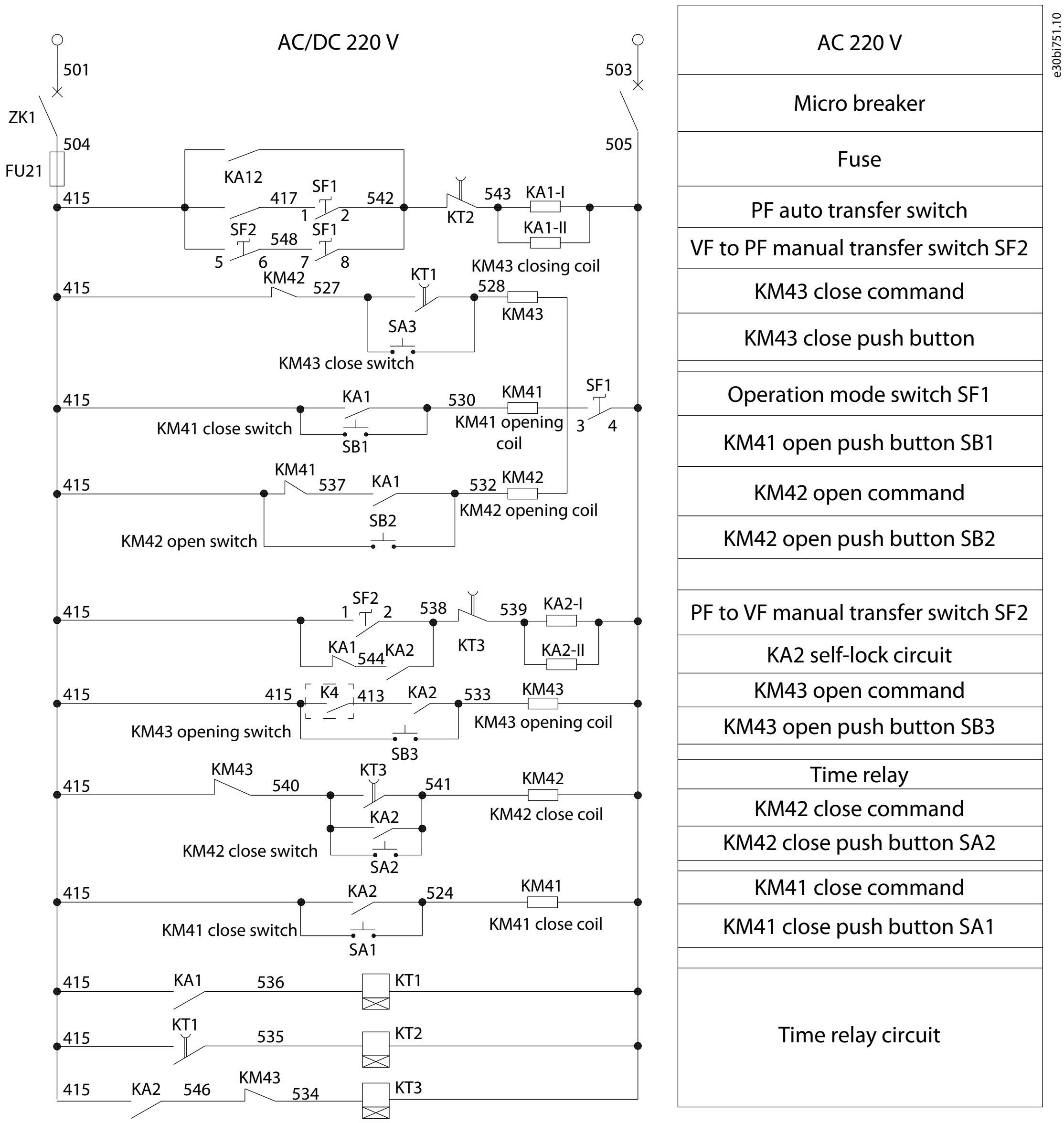

Illustration 20: Secondary Control Logic Diagram of VF Switching to PF

Operation Mode Switches

Switch SF1 is used to select the working mode to prevent incorrect operation.

- *Auto*: Allows switching to PF bypass automatically when the drive is in a serious fault.
- *Manual*: Allows manual switching to working-frequency bypass according to the real production requirements when the drive is normally running.
- *Forbidden*: If the production conditions do not allow the switching to working-frequency bypass, this mode can be selected to prevent incorrect operation.

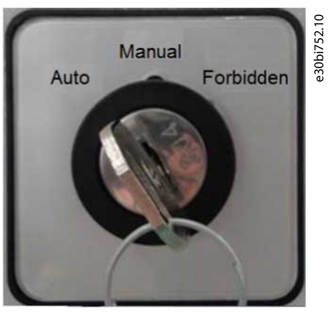

Illustration 21: Working Mode Selection Switch SF1

Switch SF2 is used to select between variable-frequency (VF) and power-frequency (PF) switching.

- When the automatic bypass cabinet is in manual operation mode, and switch SF2 is in PF position, the drive switches the system to PF bypass status automatically.
- When switch SF2 is in VF position, the drive can switch from power-frequency bypass status to variable-frequency mode automatically (QS41 and QS42 must be closed). This function needs the coordination of engine racing starting-up. Therefore, engine racing must be enabled and must comply with all the related electric motor parameters.
- VF logic sequence:
  - KM41 is closed.
  - If self-detection shows normal after 10 s, bypass switch KM43 is opened.
  - KM42 is closed.
  - Automatic engine racing of the drive starts up.
  - PF is switched to VF.

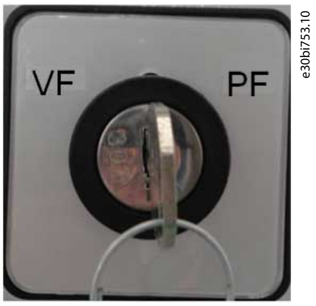

Illustration 22: Switching Mode Selection Switch SF2

3.3.7.3 Synchronous Transfer Cabinet

The synchronous transfer function can realize undisturbed transfer between the grid and the drive, and reduce the impact on the motor and grid. The primary circuit is shown in Illustration 23. The switching devices and cabinets are the same as in the automatic bypass cabinet. QS41 and QS42 are for drive maintenance use and are closed during operation.

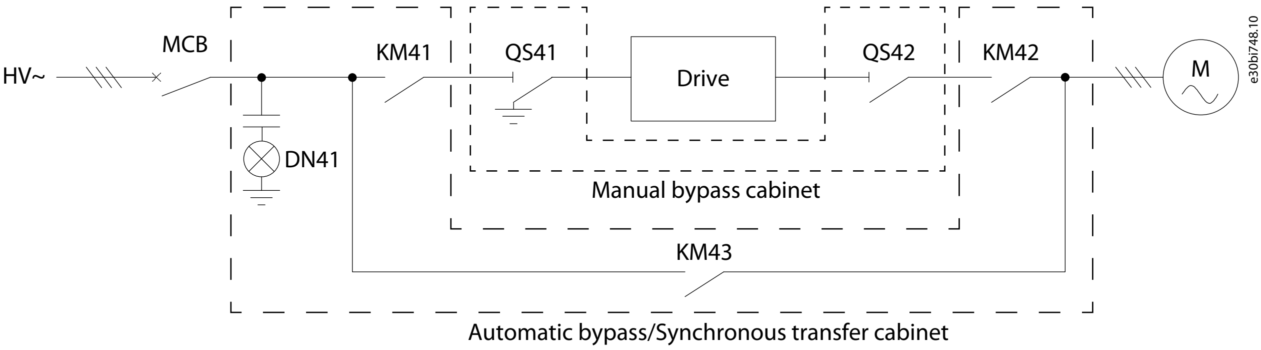

Illustration 23: Synchronous Transfer Cabinet Circuit Diagram

Process sequence of load transfer from the drive to the grid

- Initial state: KM41 and KM42 are closed, and KM43 is open.
- Phase lock: The drive runs to grid frequency and starts to lock phase to grid voltage.
- Synchronous transfer: After phase lock, KM43 is closed and the load transfer to grid is started.
- Synchronous transfer finished: After the load transfer, KM42 and KM41 are opened.

Process sequence of load transfer from the grid to the drive

- Initial state: KM41 and KM42 are open, and KM43 is closed.
- Phase lock: KM41 is closed. The drive runs to grid frequency and starts to lock phase to grid voltage.
- Synchronous transfer: After phase lock, KM42 is closed and the load transfer to the drive is started.
- Synchronous transfer finished: After the load transfer, KM43 is opened.

3.4 System Operation

3.4.1 Main Circuit

The typical main circuit topological structure diagram of VACON® 1000 medium-voltage drive is shown in Illustration 24.

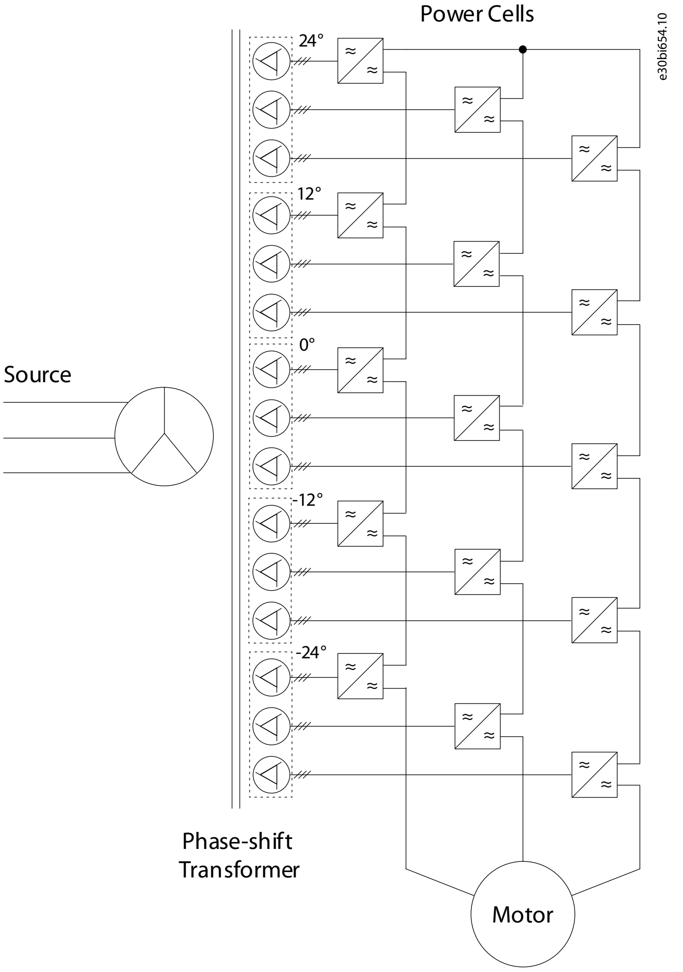

Illustration 24: Main Circuit Diagram of VACON® 1000

The phase-shift rectifier transformer is a 3-phase air-cooled dry-type transformer directly connected with the incoming high voltage. The secondary windings use an extended delta connection, which can lower the content of the input side current distortion. The phase-shift angle between the secondary windings can be calculated according to the following formula:

$$\text{Phase} - \text{shift angle} = \frac{60°}{\text{Number of power cells}}$$

The secondary windings of the transformer provide input power for each power cell respectively. The number of secondary windings and the phase-shift angle between the windings are determined according to the voltage level and structure of the drive, as shown in Table 2.

Table 2: Power Cell Configuration for VACON® 1000

Drive series	Number of power cells per phase	System cell number	Output phase voltage (V)	Output line voltage (V)
2.4 kV	3	9	1385	2400
3 kV	3	9	1732	3000
3.3 kV	3	9	1905	3300
4.16 kV	4	12	2400	4160
6 kV	5	15	3464	6000

Drive series	Number of power cells per phase	System cell number	Output phase voltage (V)	Output line voltage (V)
6.6 kV	6	18	3810	6600
6.9 kV	6	18	3984	6900
10 kV	8	24	5774	10000
11 kV	9	27	6351	11000

3.4.2 Power Cells

The power cell is the basic module of the medium-voltage drive, which produces a variable voltage and frequency output. It is composed of fast acting fuses, a rectification bridge, DC-link capacitance, IGBT inverting bridge, and so on.

The input terminals of the power cells are connected with the 3-phase winding of the secondary side of the phase-shift transformer. The 3-phase diode provides full-wave rectification to charge the DC-link capacitance, and the voltage on the capacitance is provided to the H-bridge 1-phase bridge inverter circuit formed by 4 IGBTs.

The power cell receives signals through optical fibers, and controls the closing and opening of the S1–S4 IGBTs by using PWM modulation mode to output a 1-phase impulse modulated waveform. Each cell has only 3 possible output states:

- When S1 and S4 are closed, the state of the output voltage V_{UV} is V_{DC}.
- When S2 and S3 are closed, the output voltage V_{UV} is $-V_{DC}$.
- When S1 and S3 or S2 and S4 are closed, the output voltage V_{UV} is 0.

Illustration 25 shows the waveform diagram of the output voltage of each power cell and the superimposed output phase voltage waveform when 6 cells are connected in series. As shown in the figure, 13 voltage levels are obtained through connecting the 6 power cells in series. The increasing number of the voltage levels reduces the distortion content of the output voltage and simultaneously lowers the risk of damaging the motor insulation caused by dU/dt. Illustration 26 and Illustration 27 are the waveform diagrams of the output voltage and current of the drive when loaded by a motor.

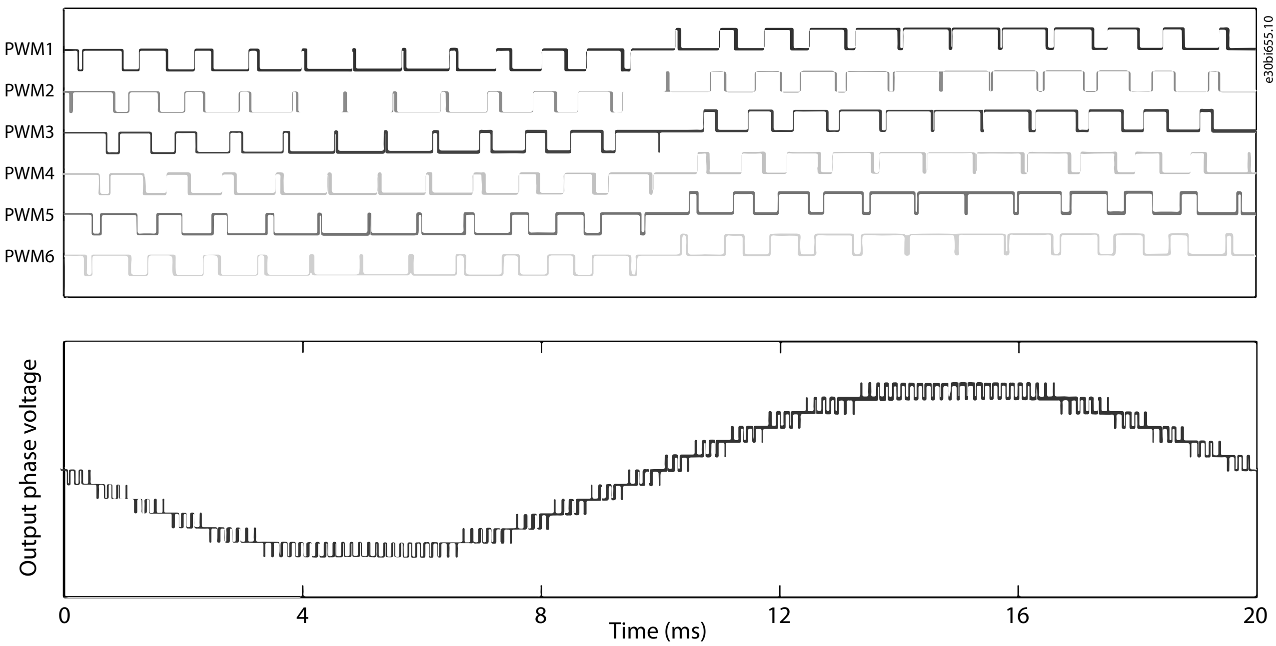

Illustration 25: Output and Phase-Voltage Diagrams

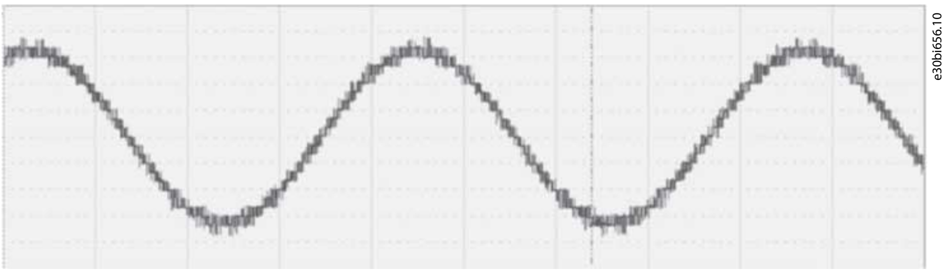

Illustration 26: Output Line-to-line Voltage Waveform

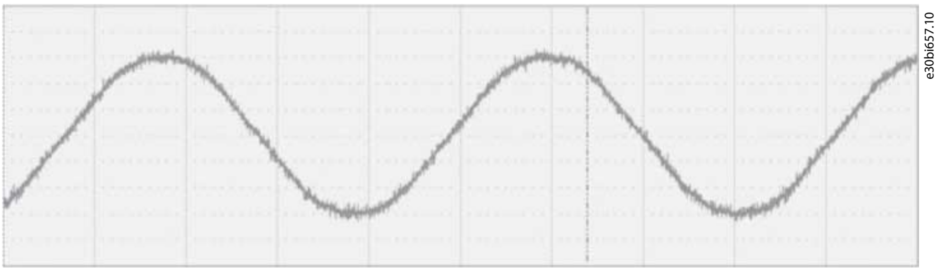

Illustration 27: Output Current Waveform

Each power cell has an independent cell control board and driver board. The cell control board receives the PWM signal transmitted by the main control system through optical fiber to control the IGBT. Simultaneously, the status information of each power cell is fed back to the main control system by the cell control board through optical fiber. The driver board is used to drive the IGBT and feedback the failure signal of the IGBTs to the cell control board, such as short-circuit protection.

3.4.3 Control System

An example structure diagram of the control system is shown in Illustration 28. The number of power cells depends on the nominal voltage of the drive.

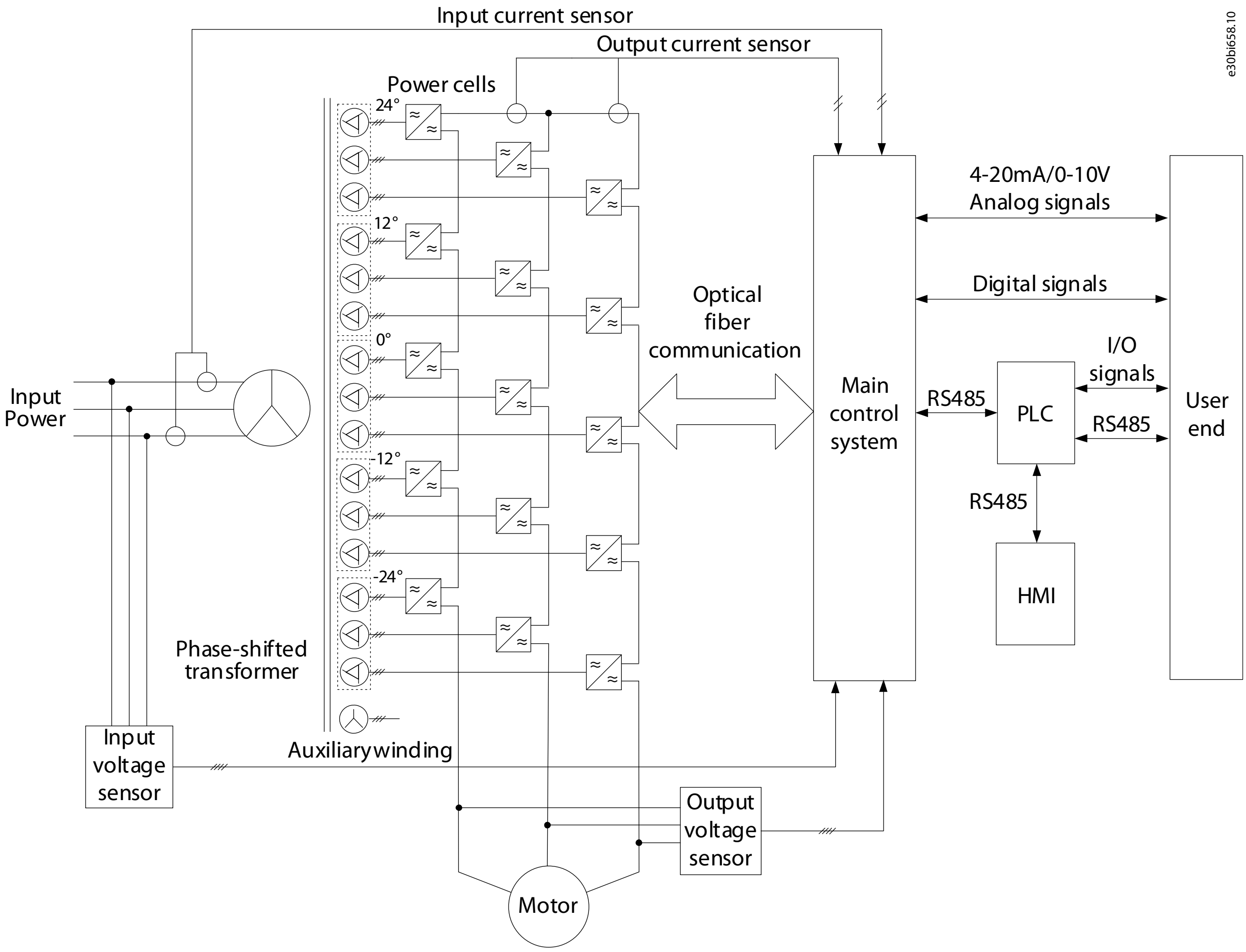

Illustration 28: Structure Diagram of the Control System

The main functions of the main control system include:

- Digital input and output
- Analog input and output
- PWM control signal generation of each power cell
- Encoding and decoding of the control signal
- System self-diagnosis
- Delivery of various implementation instructions
- Collection and handling of various failures
- Communication with external systems

To enhance the flexibility at the site application, a PLC is used for the logical processing of the internal switching signals, site operation signals, and status signals of the medium-voltage drive. The VACON® 1000 medium-voltage drive uses a high-quality PLC to:

- Accomplish the input and output drive signal control
- Protection and interlocking
- External failure detection
- Communication with the main control system
- Control of the human-machine interface

The HMI (Human-machine interface) is based on a high-definition liquid-crystal touch-type screen. It is easy to operate and is used to set functional parameters, display and record the system status, operation status, and faults through the connection to the PLC. See 7 Human-Machine Interface.

VACON® 1000 delivers high performance control accuracy using Vector Control. The ability to control motor flux and speed independently yields fast dynamic response to load fluctuations and high torque at low speeds, including during motor startup. The control diagram is shown in Illustration 29.

Both encoder and sensorless Vector Control approaches are available for selection. The speed sensors can be installed depending on actual application conditions. For cases without the speed sensors, the system can still provide fast dynamic responses and high output torque when the motor is running at low speed.

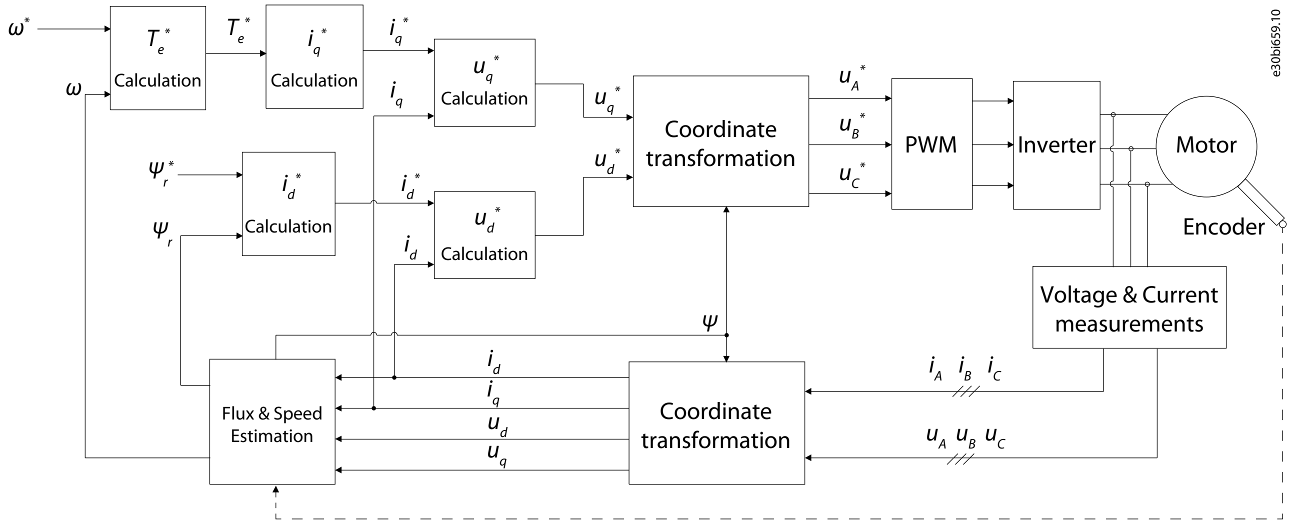

Illustration 29: Vector Control Diagram

3.5 Type Code Description

The type code for VACON® 1000 has four basic parts and option codes.

- **VACON1000-ED-019-024+____+____**

1. Product series

VACON® 1000. This part of the code is always the same.

2. Product type

The VACON® 1000 product.

- **ED**: Enclosed Drive

3. Nominal output current

For example, -040 = 40 A. See the available output currents in 11.2 Power Ratings and Dimensions.

4. Nominal system voltage

Table 3: Available System Voltages

Code	Voltage (V)	Frequency (Hz)
024	2400	60
030	3000	60
033	3300	50
041	4160	60
060	6000	50
066	6600	50
069	6900	60
100	10000	50
110	11000	50

5. Options
Optional components or specifications.
See the available codes in 3.6 Available Options.

3.6 Available Options

Table 4: Available Options for VACON® 1000

Option	Description
Degree of protection	
+IP42	Protection rating IP42
Input frequency	
+LS50	50 Hz input frequency
+LS60	60 Hz input frequency
I/O options	
+IAF1	Synchronous transfer I/O (8DI/8DO)
+IBF2	Advanced control module
+ICF3	Excitator control I/O
+IDF4	PID control module
+IEF5	Motor temperature module (8 channels)
I/O PLC options	
+IAP1	PLC DI module (16 DI)
+IBP2	PLC DIO module (8DI/8DO)
+ICP3	PLC AIO module (2AI/4AO)
+IDP4	Motor temperature module (8 channels); Not compatible with all bypass options
Fieldbus options	
+S_E2	Modbus RTU
+S_E5	PROFIBUS DP-V0
+S_E6	CANopen
+S_E7	DeviceNetô
+S_EC	EtherCAT
+S_EI	Modbus TCP
+S_EL	POWERLINK
+S_EN	ControNetô
+S_EP	PROFINET I/O
+S_EQ	EtherNet/IPô
User interface	

Option	Description
+MHMI	HMI 10"
System firmware	
+F101	Induction motor
+F102	Synchronous motor (external exciter)
Cell bypass	
+PPCB	Power cell bypass
Cell redundancy[(1)]	
+PPCR	Power cell redundancy
Cabinet bypass[(1)]	
+PMBP	Manual motor bypass
+PABP	Automatic motor bypass
+PSBP	Synchronous transfer (1 motor only)
+PSB2	Engineered synchronous transfer
Input devices[(1)]	
+PSTC	Start-up cabinet available for drives >215 A
Output devices[(1)]	
+POCK	Reactor for synchronous transfer
+PODU	dU/dt filter for cable <2000 m
Cabinet options	
+QDFR	Cooling fan redundancy
+QDEX	External cooling fan supply
+QSPD	Surge protection device (standard for UL, optional for IEC variants)
+QT01	Control power without heater XFMR
+QT02	Control power with heater XFMR
Mechanical options	
+MHET	Heater + Thermostat
+MHEH	Heater + Humidity sensor
+MMKI	Mechanical key interlock (standard for UL, optional for IEC variants)
Input voltage options[(1)]	
+I023	Input voltage: 2300 V
+I024	Input voltage: 2400 V
+I030	Input voltage: 3000 V

Option	Description
+I033	Input voltage: 3300 V
+I040	Input voltage: 4000 V
+I041	Input voltage: 4160 V
+I042	Input voltage: 4200 V
+I048	Input voltage: 4800 V
+I050	Input voltage: 5000 V
+I060	Input voltage: 6000 V
+I063	Input voltage: 6300 V
+I066	Input voltage: 6600 V
+I069	Input voltage: 6900 V
+I072	Input voltage: 7200 V
+I084	Input voltage: 8400 V
+I100	Input voltage: 10000 V
+I110	Input voltage: 11000 V
+I114	Input voltage: 11400 V
+I120	Input voltage: 12000 V
+I124	Input voltage: 12400 V
+I132	Input voltage: 13200 V
+I138	Input voltage: 13800 V
Environment	
+THAL	High altitude, >2000 m above sea level
+T50C	50°C ambient temperature operation
Seismic zone	
+SZ04	Zone 4
Factory Acceptance Test	
+QFAT	FAT
+QFNO	No-load FAT

[1] If this option is selected, it can impact the overall dimensions and weight of the product.

3.6.1 Cabinet Bypass

See 3.3.7 Bypass Cabinet.

3.6.2 Input Devices

See 3.3.5 Start-up Cabinet.

3.6.3 Output Devices

See 3.3.6 Output Filter Cabinet.

3.6.4 Mechanical Options

Heater Options +MHET/+MHEH

Table 5: Heater Options +MHET and +MHEH

Option	+MHET	+MHEH
Devices	Heater and thermostat	Heater and hygrostat
Application area	Low operation temperature area (-5 °C...0 °C)	High relative humidity and condensation area
Purpose	To warm up the drive before turning it on if the temperature is lower than 0 °C (but higher than -5 °C). The low temperatures exceed the rated operation temperature of the micro chips and capacitors inside control cabinet and power cells.	To prevent devices and cabinets from condensation and corrosion in a high relative humidity operation environment, otherwise break down or flashover can occur during operation.
Location	Control cabinet and power cell cabinet	Power cell cabinet, transformer cabinet, junction cabinet, or any other cabinets with high voltage parts
Key parameters	Thermostat setting range: -10...50°C (14–122 °F), 0 °C as default preset value. Heater power: 220 V, 400/150 W, depending on the cabinet size.	Hygrostat setting range: 35–95% RH, 80% as default preset value. Heater power: 220 V, 400/150 W, depending on the cabinet size.

Mechanical Interlocking System, +MMKI

See 8.6.2 Mechanical Interlocking System.

3.7 VACON® 1000 PC Tool

The VACON® 1000 PC Tool is an Ethernet-based computer-assisted software. Only one network cable is needed, and the monitoring and fault diagnosis of the drive can be completed with this software.

The VACON® 1000 PC Tool integrates some auxiliary functions that are often used during normal operation and commissioning.

- The status display panel shows the running status of the drive in real time.
- The waveform display function allows the direct observation of the internal variables when the drive is running.
- The parameter management function allows the direct modification or saving of the current system parameters on the computer.
- The fault analysis function can process the fault information in the DSP cache, list the fault content of the system, and the time of occurrence, and show the waveform of the system input and output near the fault point.

In addition to these functions, the VACON® 1000 PC Tool also provides commissioning auxiliary functions and DSP program update functions.

Minimum requirements for the VACON® 1000:

- Operating system: Windows 10
- Processor: Intel®Core™ i5-6300U CPU @2.40 GHz 2.50 GHz
- RAM: 8.00 GB

4 Receiving the Delivery

4.1 Checking the Delivery

1. Before unpacking, check the number of packing boxes according to the shipping list and then check whether the appearance of the packing boxes is in good condition.
2. After removing the packaging, check the product and enclosed documents according to the shipping list to see whether anything is missing or does not match the order. Compare the type code for the order to the type code on the package label. See 3.5 Type Code Description.
   - If the delivery does not agree with the order, speak to the vendor immediately.
3. Examine the product for any transport damage.
   - If the drive was damaged during the shipping, speak to the cargo insurance company or the carrier.

4.2 Storage

The storage temperature range of the VACON® 1000 drive is between -40°C to 70°C, and the relative humidity must not exceed 95%. The storage environment must be out of direct sunlight, corrosion, inflammable gas, conductive dust, salt smog, oil smoke, and so on.

Keep the equipment sealed in its packaging until installation. In its packaging, the drive can be stored in a dry and ventilated place for more than one year. If the drive is required to be stored for a longer period, contact Danfoss.

If the drive is unpacked, apply desiccant on the drive when stored again. The wrapped product with VCI bag can be put on the wooden pallet and stored for more than one year in a dry and ventilated place.

4.3 Lifting and Moving the Drive

⚠ W A R N I N G ⚠

LIFTING HEAVY EQUIPMENT

Follow local safety regulations for lifting heavy weights. Failure to follow recommendations and local safety regulations can result in death or serious injury.

- Ensure that the lifting equipment is in proper working condition.

Move the cabinets in vertical position. To lift the cabinets, use a lifting device that can lift the weight of the cabinets. Refer to the shipping marks on the package for more information, such as weight, center of gravity, and lifting positions.

Move the drive to the installation location before removing the packaging material.

VACON® 1000 standalone cabinets are delivered in one piece, but line-up designs are delivered in separate sections:

- Control cabinet
- Power cell cabinet
- Transformer cabinet
- Options cabinet

To divide the weight of the cabinets equally, and to prevent damage to the equipment, always use 4 lifting holes. Align the lifting locations with the center of gravity, which is marked on the package.

Move the cabinets slowly and carefully. Switchgear parts can easily fall because their center of gravity is high up at the back of the cabinets.

4.3.1 Lifting the Standalone Cabinets

After the packaging of the cabinets is removed, a crane or forklift is required to lift them off the wooden pallets and to the installation location.

1. Use a crane to lift the cabinet from the bottom.

   The distance (D) between crane hook and cabinet top must be more than 1.5 m (4.92 ft).
   The minimum angle between two lifting ropes must be 45°.

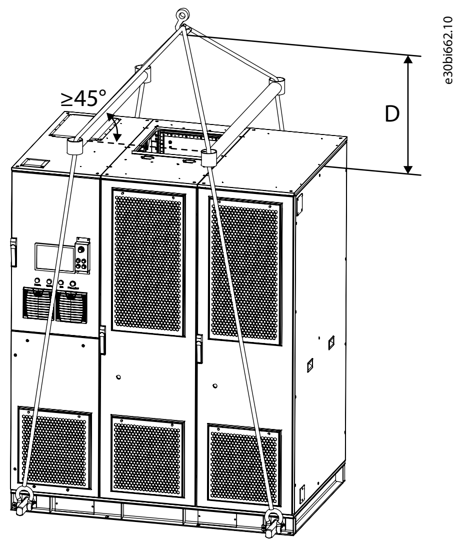

Illustration 30: Lifting the Standalone Cabinets

2. Use the shackles in the holes of the lifting bar.

Use only 33 mm (1.3 in) diameter holes and 30 mm (0.75–1.125 in) width for the shackles.

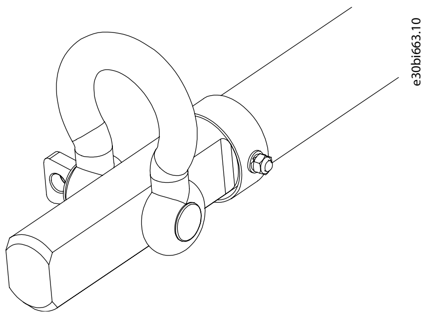

Illustration 31: Shackle Attached to Lifting Bar

3. Make sure that the crane lifting ropes do not compress the cabinet and damage it. Use spreader bars or a block of wood between the ropes on the top of the cabinet.

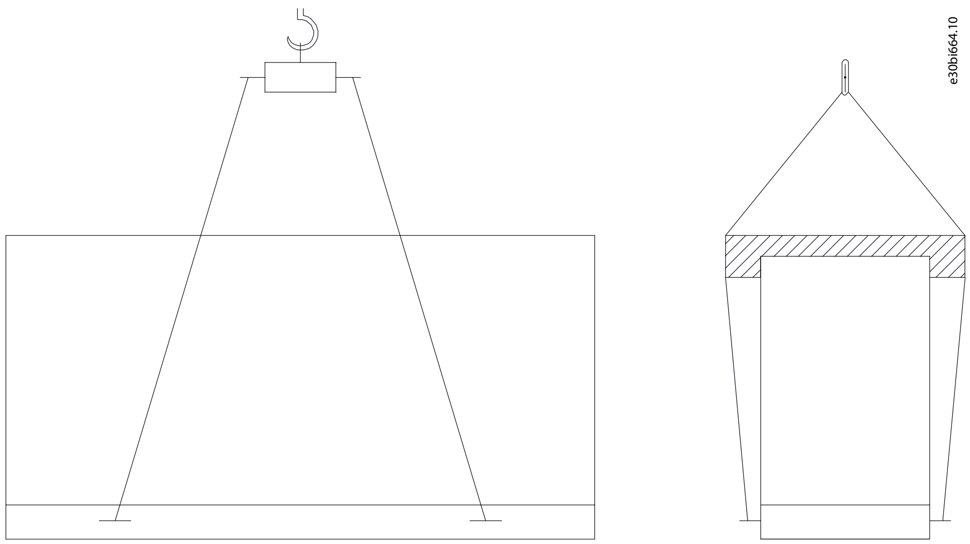

Illustration 32: Lifting Ropes Spread with a Block of Wood

4. Lift the cabinet slowly and without jerking. Lower in the same manner to a standstill position.

4.3.2 Lifting the Line-up Cabinets

After the packaging of the cabinets is removed, a crane or forklift is required to lift them off the wooden pallets and to the installation location.

1. To lift the power cell cabinet and control cabinet, use the four holes of angle steels on the top of the cabinet.

The distance (D) between crane hook and cabinet top must be more than 1.5 m (4.92 ft). Remove the angle steels after the lifting.

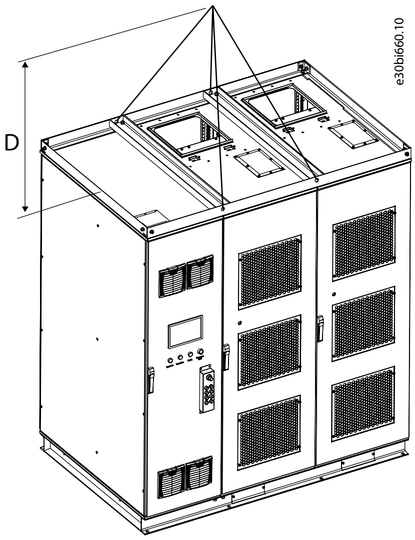

Illustration 33: Lifting Points of the Power Cell Cabinet

2. To lift the options cabinet, use the eyebolts at the four corners on the top of the cabinet.
3. Since the transformer cabinet is heavy, do not lift it from the lifting rings on the top of the cabinet. Instead, use the lifting rings of the transformer.

The distance (D) between crane hook and cabinet top must be more than 1.5 m (4.92 ft).

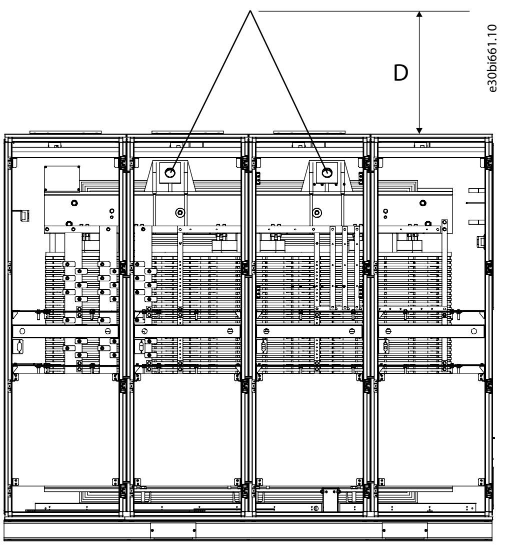

Illustration 34: Lifting Points of the Transformer

4. Lift the cabinet slowly and without jerking. Lower in the same manner to a standstill position.

4.3.3 Using a Forklift

The forklift must be able lift and bear the weight of the cabinet.

1. To prevent the truck arm from scratching the cabinet, add a block of wood or something similar between the forklift and the cabinet.

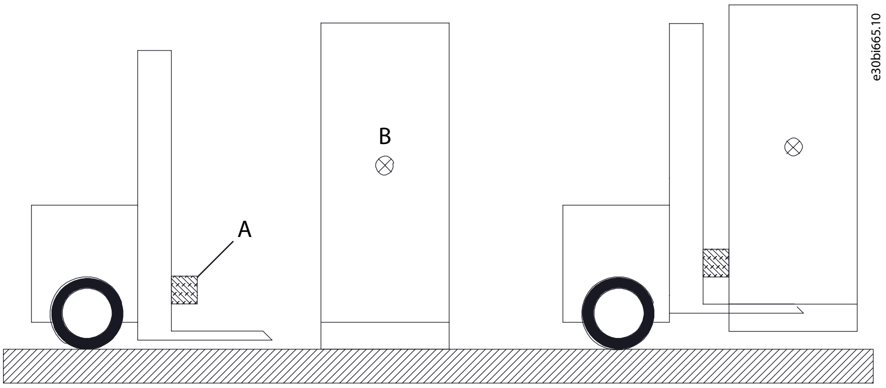

Illustration 35: Using a Forklift to move a Cabinet

A	Block of wood
B	Center of gravity

2. Lift the cabinet slowly and reduce vibration as much as possible.

   Consider the center of gravity of the cabinet before lifting.

5 Mechanical Installation

5.1 Operating Environment

N O T I C E

CONDENSATION

Moisture can condense on the electronic components and cause short circuits. Avoid installation in areas subject to frost. Install an optional space heater when the drive is colder than the ambient air.

N O T I C E

EXTREME AMBIENT CONDITIONS

Hot or cold temperatures compromise unit performance and longevity.

To ensure the long-term and reliable operation of the drive, the installation environment must meet the following requirements:

- The temperature in the normal operating environment must be between -5°C...+40°C. If the ambient temperature exceeds these values, the equipment must be used in derated operation or equipped with corresponding air conditioning equipment.
- The installation altitude must be less than 1000 m above sea level. If the altitude is higher than 1000 m, use the equipment in derated operation.
- The relative humidity must be within 5% to 95% without condensation.
- Pollution degree: II
  - Chemical gas: IEC 721-3-3, class 3C1
  - Solid particle: IEC 721-3-3, class 3S2

5.2 Cabinet Installation

Installation guidelines:

- To keep motor cable length as short as possible, locate the drive close to the motor.
- Ensure unit stability by mounting the enclosure on a solid surface.
- Ensure that the strength of the mounting location supports the unit weight.
- For safety and easier cabling, it is recommended to install the cabinet on a cable trench.
- Do not install the cabinet on top of inflammable objects.
- Ensure that there is enough space around the unit for proper cooling.
- Ensure that there is enough room to open the cabinet doors and for working on the equipment.
- Remove the moving and lifting parts from the cabinet before installation.

5.2.1 Attaching the Cabinets

Once the cabinets are in position and aligned, attach the cabinets to each other.

For line-up cabinets, secure the power cell cabinet with control part and the transformer cabinets with junction part to each other. Install the optional cabinets on the right side of the transformer cabinet in sequence.

For standalone cabinets, install the optional cabinets on the left side of the cabinet.

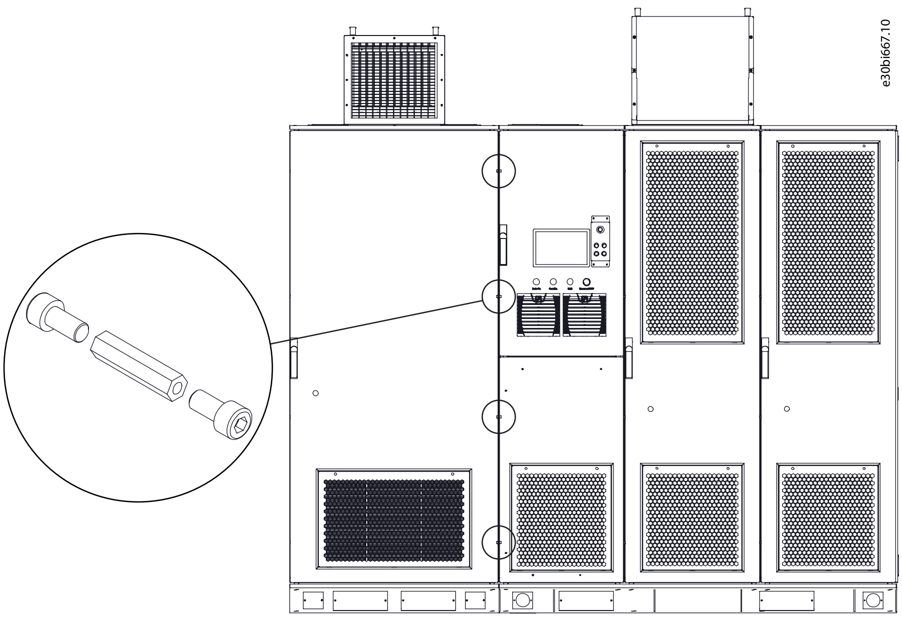

Illustration 36: Attachment Points in Standalone Cabinets

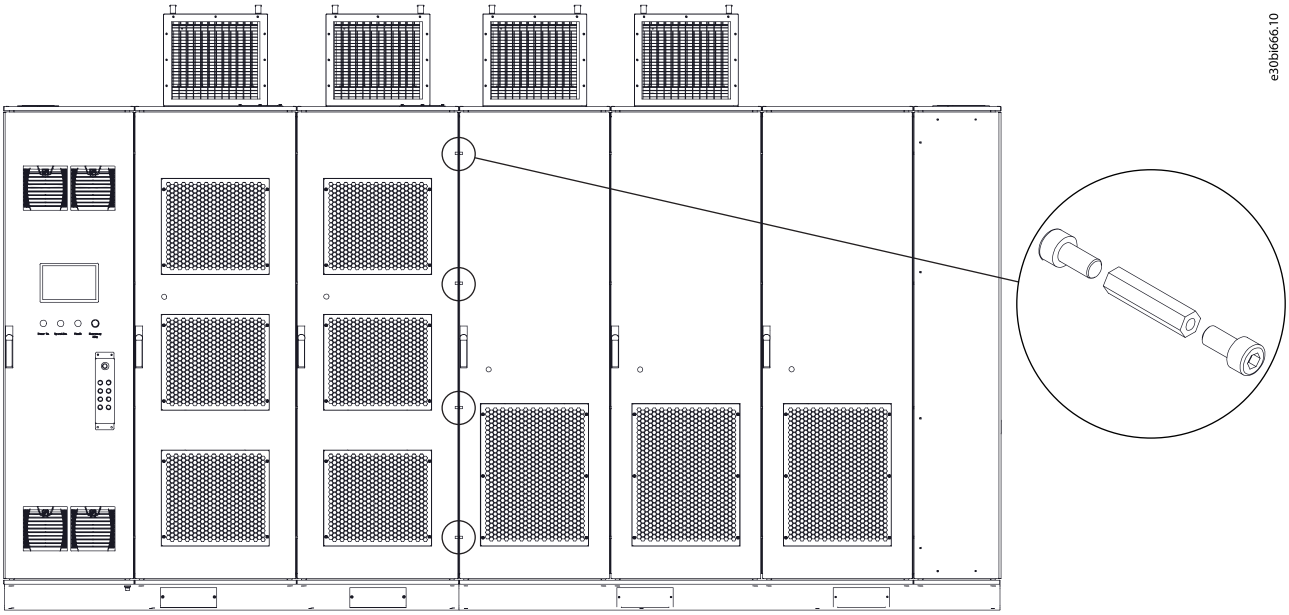

Illustration 37: Attachment Points in Line-up Cabinets

Notice the following points:

- When handling and installing the cabinet, consider safety protection measures, such as shockproof and moisture proof, to avoid deformation of the frame and damage to the paint coating.
- Align the cabinets well before attachment.
- When attaching the cabinets, the bases of the two cabinets can be leaned against each other completely by using a lifting truck or chain-reversing hoist before they are fixed.
- Use M6×40 hexagonal spacers and M6×10 screws to connect the adjacent cabinets.
- The cabinets must be grounded reliably.
- The fastening parts used in installation must be standard parts with Zn-Ni alloy plating.
- If the cabinet is placed against the wall or the depth of the cabinets is different, the hexagonal spacers cannot be used for attaching the back side of the cabinet. In this case, use angle steel parts to connect the cabinets.

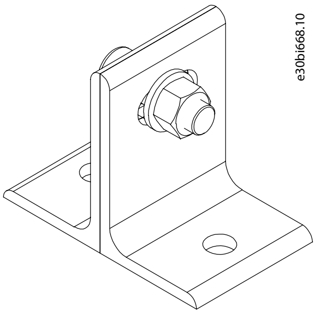

Illustration 38: Angle Steel

5.2.2 Mounting the Cabinets

Connect and fix the round hole on each channel steel base with the trench channel steel. Use M12×35 screws. The cabinet can also be welded to the channel steel base.

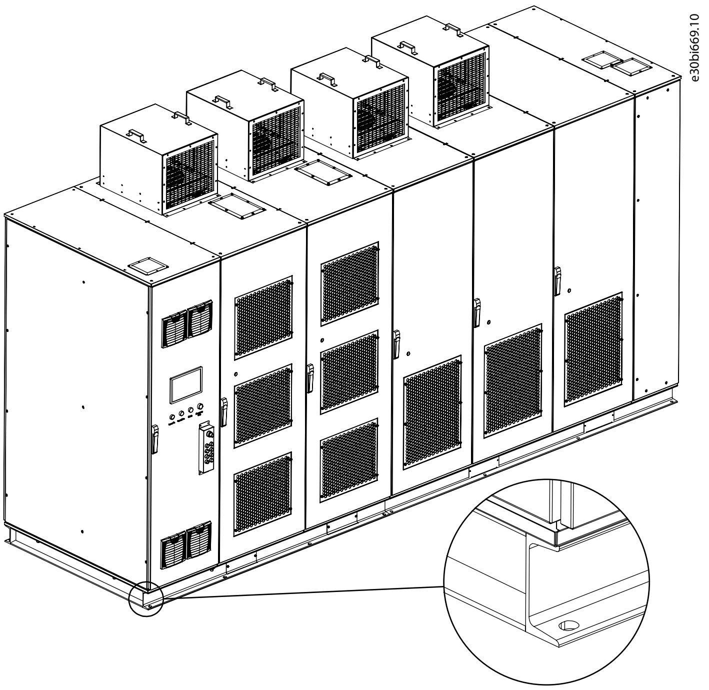

Illustration 39: Mounting the Cabinets to the Foundation

5.3 Installing the Power Cells

At least two persons are required for cooperation during the installation.

A power cell lifting cart is available from Danfoss as an option.

1. Once the power cell is removed from the package, make sure that it is not damaged.
2. Use the power cell lifting cart or other lifting device to move and lift the power cell.

   The lifting device must:
   - Be able to lift the weight of the power cells.
   - Be able to lift the power cells to the required height.
   - Have a locking mechanism.

3. Push the power cell completely into the fixing support slot in the cabinet.

4. After the power cell is in place, use M6 screws to fix the corners to the fixing support.

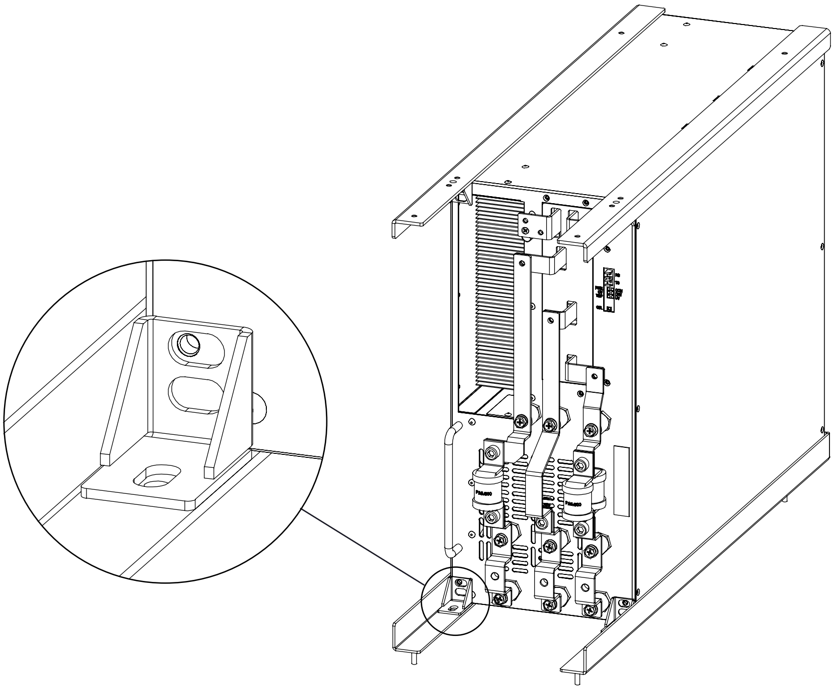

Illustration 40: Power Cell Installation

5.4 Dimensions of the Enclosed Drive

See the dimensions of the drive cabinet in 11.2 Power Ratings and Dimensions.

Always refer to the delivery-specific information for the accurate dimensions.

5.5 Cooling and Free Space Around the Enclosed Drive

The AC drive produces heat in operation. VACON® 1000 uses forced air cooling to control the temperature of the transformer, power cells, and other components. Fans on the top of the cabinet provide the airflow. The cool air is drawn into the cabinet through the inlet and directed out from the outlet as shown in the picture.

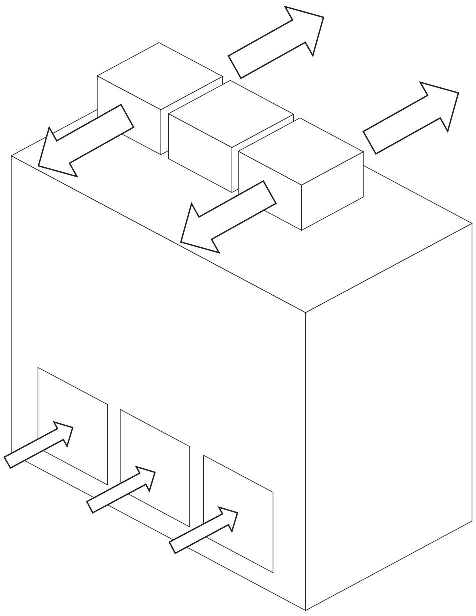

Illustration 41: Flow of Cooling Air

Make sure that the temperature of the cooling air does not become higher than the maximum ambient operating temperature or lower than the minimum ambient operating temperature of the drive. See 5.1 Operating Environment.

Make sure that the hot air goes out of the cabinet and does not come back into the cabinet. There must be free space above the cabinet without obstacles that can stop the airflow. Some free space in front of the cabinet is also necessary to be able to open the cabinet doors and for maintenance.

- The back side of the cabinet can be placed against a wall.
- The distance between the cabinet front and walls ≥1500 mm.
- The distance between the cabinet fan cover top and ceiling:
  - ≥400 mm for non-ducted drives.
  - ≥1000 mm for ducted drives.

The power loss of the AC drive can change significantly, when the load, the output frequency or the switching frequency changes. It is useful to know the power loss, when planning the cooling equipment in an electrical room.

To calculate the power loss, use the ecoSmart tool. See http://ecosmart.danfoss.com/#/app/intro.

5.5.1 Air Ducting Guidelines

Air ducts can be used to direct the warm outlet air from the VACON® 1000 out from the electrical room.

Guidelines for using an air duct:

- The outlet area of the air duct must be larger than the sum of the cabinet fan outlet areas.
- The air inlet area of the cabinet location must be larger than 1.2–1.5 times the sum of the fan outlet areas. The air inlet must have a primary air filter.
- The outlet of the air duct must be waterproof to prevent water entering the air duct.
- The recommended maximum length of the air duct is 3 m. For longer air ducts, support brackets and an induced draft fan are required.

6 Electrical Installation

6.1 The Main Circuit

The typical main circuit of VACON® 1000 is shown in Illustration 42.

- The circuit breaker (MCB), the motor, and the mains and motor cables are not included in the delivery.
- The start-up cabinet and output filter cabinet are optional.

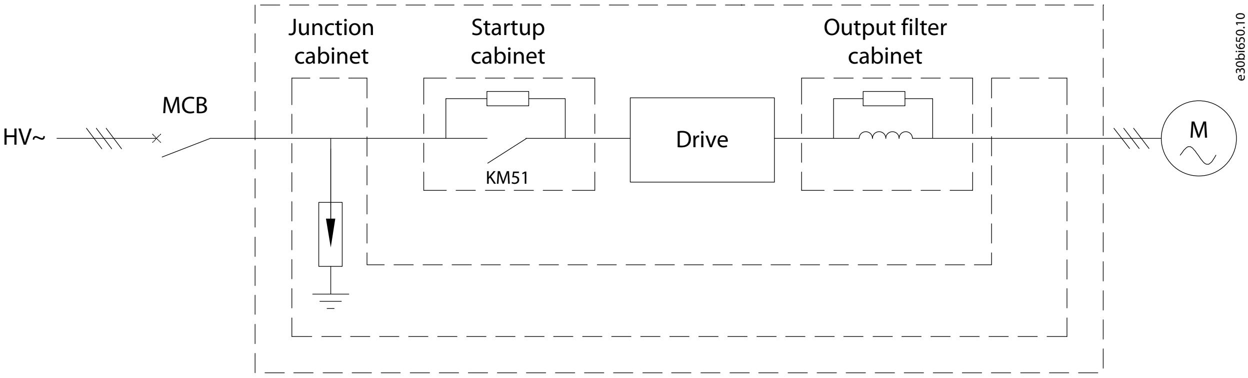

Illustration 42: Main Circuit of VACON® 1000

6.2 Main Circuit Breaker and Fuses

For the short-circuit protection of the drive, install fuses or a circuit breaker on the grid side of the equipment in accordance with all applicable installation codes.

When selecting the size of the fuses or mains circuit breaker, refer to the available

- Short circuit power
- Continuous current
- Supply voltage

6.3 Galvanic Isolation Between the MV and LV Sections

There is galvanic isolation between the low-voltage (LV) and medium-voltage (MV) sections of the cabinets. The insulation between the sections protects the devices in the LV section from the medium voltages.

Most of the LV components are in the control cabinet. Only the current sensors (HECS) and some optional components, such as space heaters, humidity sensors, and thermostat controllers are in the other cabinets. The connections between the LV and MV devices are done either through optical fibers or are electrically isolated.

6.4 Terminals

6.4.1 Terminal Locations in the Standalone Cabinet

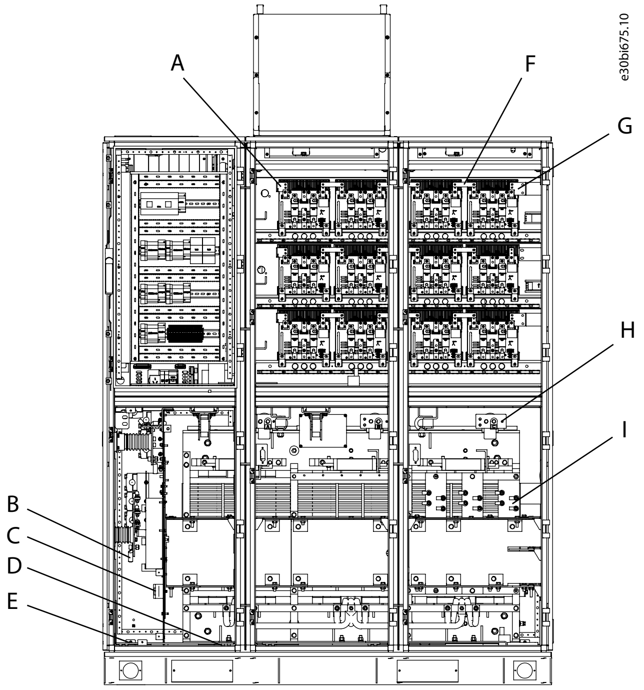

Illustration 43: Terminals in the Standalone Cabinet

A	Output power terminal	F	Busbars for connecting power cells in series
B	Motor connection terminal	G	Output neutral point terminal
C	Power connection terminal	H	Transformer input terminal
D	Grounding connection between cabinets	I	Transformer output terminal
E	System grounding terminal		

6.4.2 Terminal Locations in the Line-up Cabinet

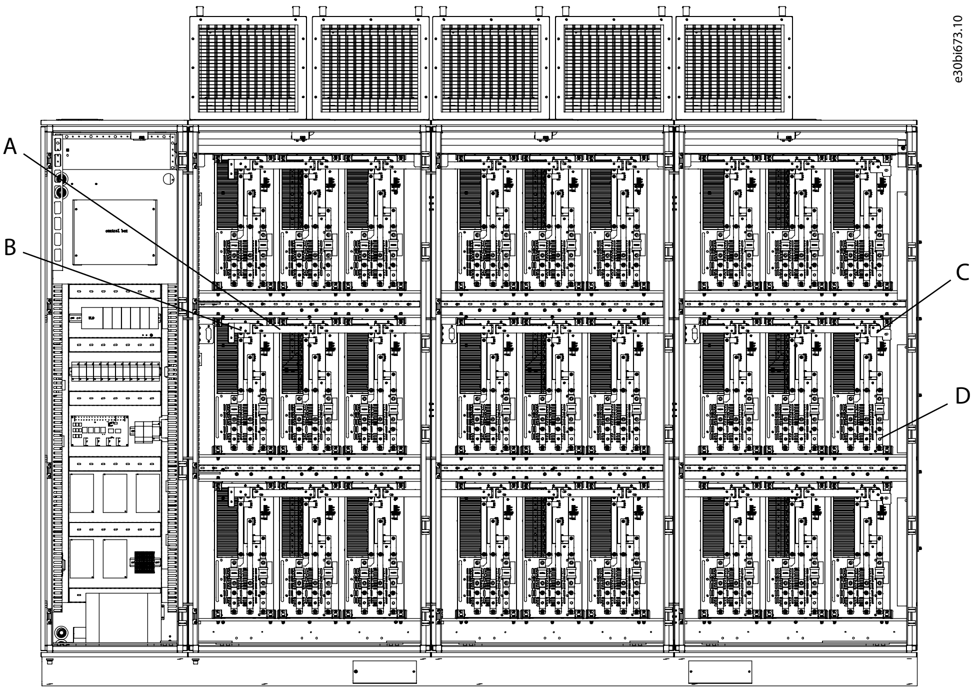

Illustration 44: Terminals in the Control and Power Cell Cabinets

A	Busbars for connecting power cells in series	C	Output power terminal
B	Output neutral point terminal	D	Transformer output terminal

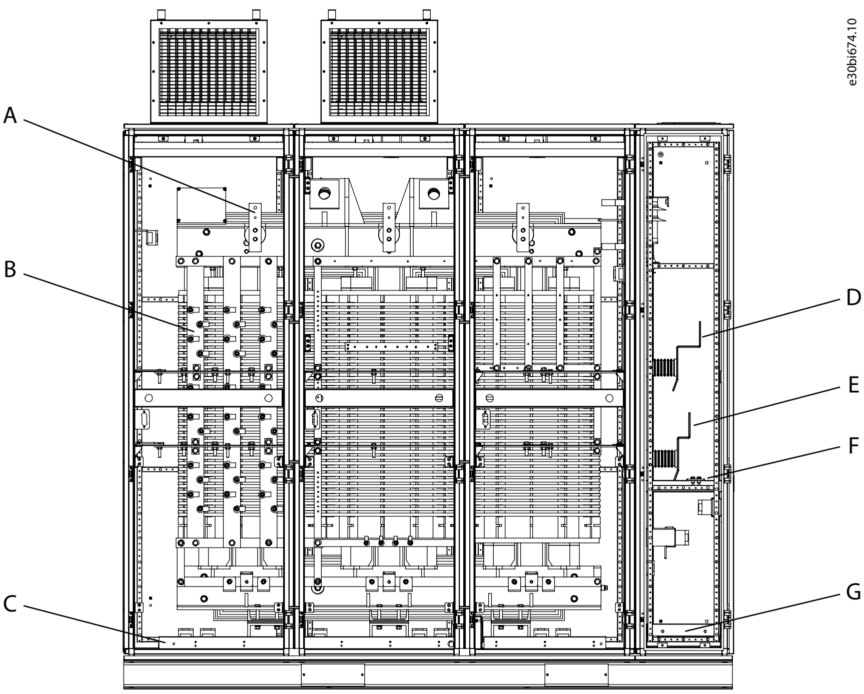

Illustration 45: Terminals in the Transformer Cabinet

A	Transformer input terminal	E	Motor connection terminal
B	Transformer output terminal	F	Output power terminal
C	Grounding connection between cabinets	G	System grounding terminal
D	Power connection terminal		

6.5 Cable Entry and Termination

6.5.1 Power Cable Entry of Standalone Cabinet

Bottom entry and top entry are possible to the input/output cabinet. The cable routing is assembled for bottom entry or top entry according to customer requirement.

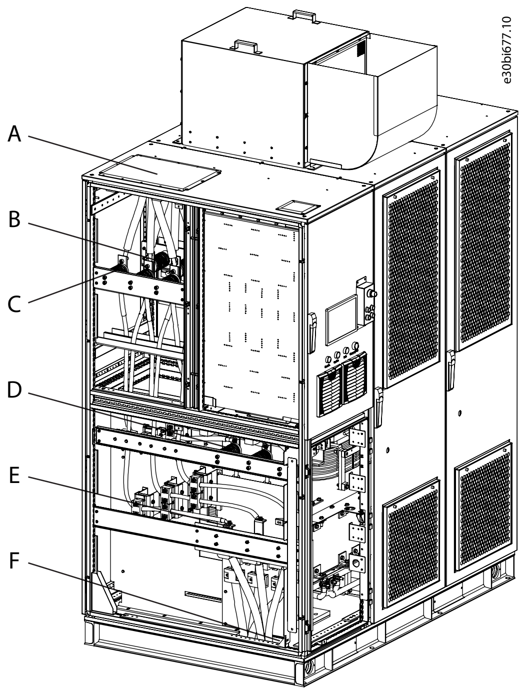

Illustration 46: Bottom Entry and Top Entry

A	Top cable entry cover	D	Input terminal (bottom cable entry)
B	Output terminal (top cable entry)	E	Output terminal (bottom cable entry)
C	Input terminal (top cable entry)	F	Bottom cable entry cover

6.5.2 Power Cable Entry of Line-up Cabinet

Bottom entry and top entry are possible to the input/output cabinet. The cable routing is assembled for bottom entry or top entry according to customer requirement.

If it is necessary to change the cable entry way on site, rotate the position of two mechanical parts by 180°:

- The output busbar (part B)
- The cable clamp and supporting bracket (part D)

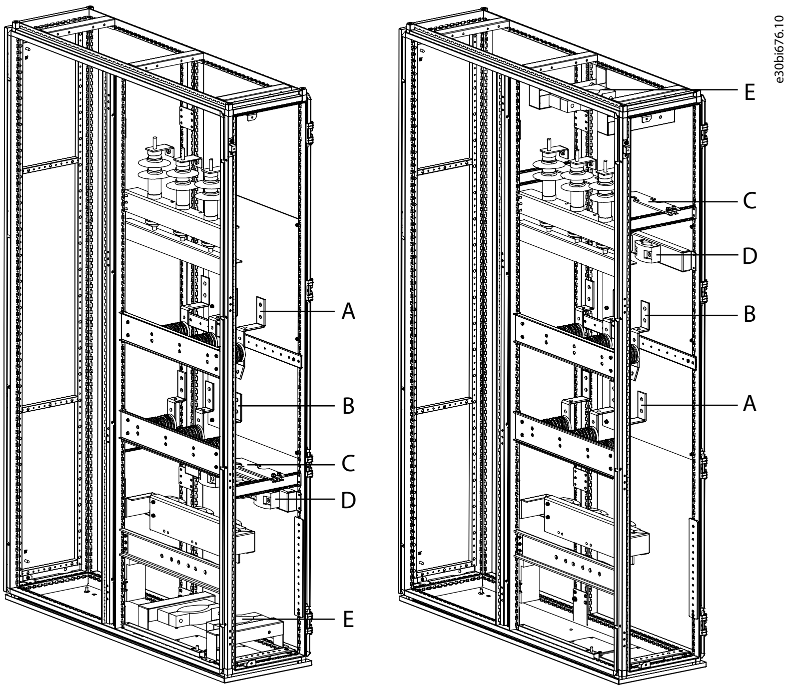

Illustration 47: Bottom Entry (Left) and Top Entry (Right)

A	Input busbar	D	Cable clamp and supporting bracket
B	Output busbar	E	Clamp for three-core cable and supporting bracket
C	Insulation barrier and supporting bracket		

6.5.3 Power Cable Termination

Wiring kits including the recommended lugs, bolts, washers, and nuts are provided and delivered with cabinets.

Connect the lugs to the power cables and mount them to the input and output terminals with the parts included in the wiring kits.

6.5.4 Control Cable Entry

Both bottom entry and top entry are possible to the control cabinet. No modifications are required.

Once cable routing is finished, tie the control cables on the wire duct/bracket.

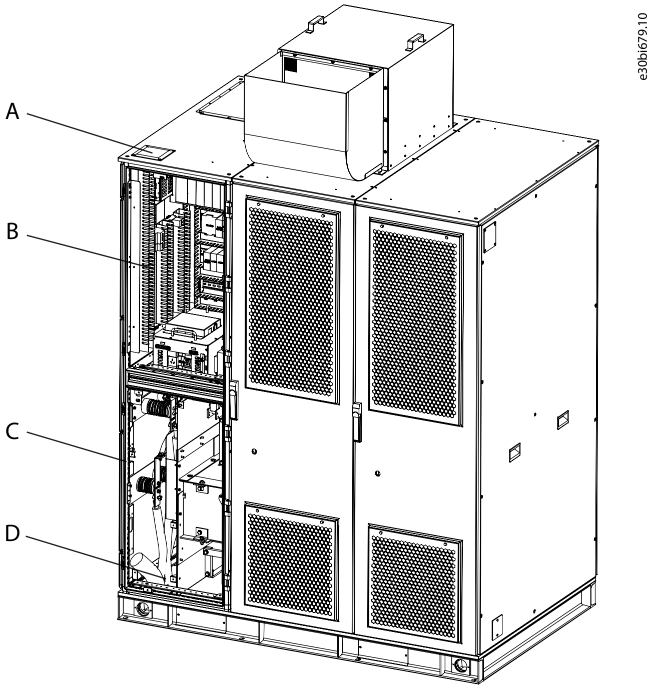

Illustration 48: Control Cable Entry to Standalone Cabinet

A	Top cable entry	C	Bracket for bundling cable
B	Wire duct for bundling cable	D	Bottom cable entry

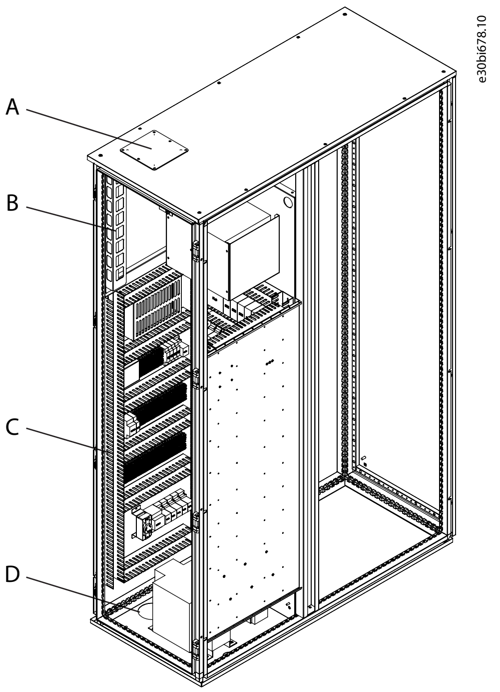

Illustration 49: Control Cable Entry to Line-up Cabinet

A	Top cable entry	C	Wire duct for bundling cable
B	Bracket for bundling cable	D	Bottom cable entry

6.6 Grounding

Use interconnection busbars to connect the ground busbars in each cabinet.

In installations following the IEC standard, the cross-sectional area of the interconnection busbars must be at least:

- Standalone type: 25 mm × 3 mm.
- Lineup type <350 A: 40 mm × 3 mm.
- Lineup type 350–680 A: 50 mm × 4 mm.

In installations following the UL standard, the cross-sectional area of the interconnection busbars must be at least 50 mm × 6 mm.

Connect the main grounding busbar of the cabinet to the system grounding cable. The recommended minimum cross-sectional area for the connection is 95 mm^2.

The cross-sectional area of the grounding cables must be ≥16 mm^2 and no more than half of the cross-sectional area of the high voltage phase wires. In addition, the grounding resistance of the grounding connection must be lower than 4 Ω.

The ground leakage current value must be lower than 3.5 mA AC or 10 mA DC and must meet the safety specifications related to high leakage current equipment.

The PE of the system grounding terminal must be grounded reliably to prevent accidents.

Do not use the same grounding wire with other power equipment or welding machine. Ground each drive independently where there are multiple drives in the same room. Series connection to the ground is forbidden.

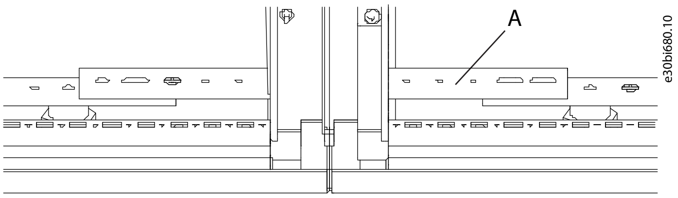

Illustration 50: Grounding Connection Between Cabinets

A	Interconnection busbar

6.7 Power Cable Selection

- Use armored three-core copper cable with XLPE or ERP insulation and metallic shield.
- The wire sectional area recommended for the power and motor cables is based on the single-cable method of the three-core cable and an ambient temperature of 40°C. If the conditions change (cable configuration, cable bundle, and ambient temperature), refer to the design information according to the cable configuration.
- The highest temperature of the cables in the cabinet when operating continuously is 90°C.
- The motor cable in the cabinet is copper-core with ethylene-propylene rubber insulation and chloroethene jacket.
- If the input voltage is larger than the output voltage, the nominal voltage of the output power cable must be equal to the input voltage.

Table 6: Recommended Power Cable Sizes

Input/output current rating	Conductor specification, IEC	Conductor specification, UL
≤100 A	25 mm^2	2 AWG
≤120 A	35 mm^2	2 AWG
≤150 A	50 mm^2	1 AWG
≤190 A	70 mm^2	1/0 AWG
≤240 A	95 mm^2	2/0 AWG
≤270 A	120 mm^2	4/0 AWG
≤310 A	150 mm^2	250 kcmil
≤350 A	185 mm^2	350 kcmil

Input/output current rating	Conductor specification, IEC	Conductor specification, UL
≤410 A	240 mm^2	500 kcmil
≤460 A	300 mm^2	500 kcmil
≤530 A	400 mm^2	750 kcmil
≤600 A	500 mm^2	750 kcmil
≤680 A	630 mm^2	1000 kcmil

6.8 Additional Instructions for Cable Installation

For the specific wiring scheme, see the site wiring diagram. Note the following during cabling:

- Only use symmetrically EMC shielded cables between the drive and other equipment (high voltage power cabinet and motor).
- To avoid interference, route the control signals, communication, power source cables, and power motor separately rather than in the same cabling slot. If separate routing is impossible, the spacing between the control, signal, communication and power source cables, and power motor cables must be >30 cm.
- If it is possible, do not put the motor cables in long parallel lines with other cables.
- For the control signals, use multi-core wire with a shielding layer, wherein the shielding layer is equipotentially grounded at both ends and is not too long.
- The wires used to transmit different signals must be routed in an alternative and mutually vertical way, for example AC signal and DC signal.

6.9 Control Wiring

6.9.1 Control Cable Selection

Control power cables

Use low-voltage cables with PVC or XLPE insulations of copper, with shield, and in single or multi-core constructions.

Cable specification for input voltage 208–600 V:

- Solid type cable, 2.5–6.0 mm^2, or 14–10 AWG.
- Flexible type cable, 4.0 mm^2, or 12 AWG.

Cable specification for input voltage 120 V:

- Solid type cable, two parallel connected cables, 2.5–6.0 mm^2, or 14–10 AWG.
- Flexible type cable, two parallel connected cables, 4.0 mm^2, or 12 AWG.

Control signal cables

Use control cables with XLPE or PVC insulation, with screening, and in multi-core constructions.

- Solid type cable, 1.0–4.0 mm^2, or 17–12 AWG.
- Flexible type cable, 2.5 mm^2, or 13 AWG.

6.9.2 Control Power Wiring

Connect L and N of the control power to terminals 1 and 7 in terminal block X12. See Table 7.

Table 7: Connections to Terminal Block X12

Terminal	Definition	Description
1	L1	220 V AC, 1-phase, 50 Hz 230 V AC, 1-phase, 60 Hz 600 V AC, 1-phase, 50/60 Hz
2	L1	
3	L2	
4	L2	

Terminal	Definition	Description
5	L3	
6	L3	
7	N	
8	N	
9	A	External cooling fan power (optional): 380 V AC 3-phase, 50 Hz 460 V AC 3-phase, 60 Hz
10	A	
11	B	
12	B	
13	C	
14	C	
15	PE	Grounding

The drive has a double supply circuit. If external power is lost, the supply switches to the auxiliary winding of the phase-shift transformer to output 1-phase power, and the drive can still operate normally. When the external power is restored, the supply switches back to the external power.

Protection Requirements for the Supply Circuit

TT networks: If the neutral point of the control power is directly grounded, connect the frame to the grounding terminal (the grounding terminal has no connection with the neutral point grounding).

IT networks: The neutral point of the control power is not directly grounded.

6.9.3 Control Circuit Wiring

The wiring terminals of the control circuit are as shown in table.

- The digital input terminals must be passive nodes with a capacity of 1 A/24 V DC.
- The digital output terminals provided by the system are passive nodes with a capacity of 5 A/220 V AC or 5 A/220 V DC.
- The definitions of all the I/O terminals are defaults, and can be defined and configured again according to requirements.

Table 8: Control Circuit Wiring

Terminal	Definition	Signal	Signal type	Note
1	Coast stop	DI	Normal open: Effective by closing	Standard configuration
2				
3	Start	DI	Normal open: Effective by closing	Standard configuration
4				
5	Ramp stop	DI	Normal open: Effective by closing	Standard configuration
6				
7	Reset	DI	Normal open: Effective by closing	Standard configuration
8				
9	MCB closed/open status 2	DI	Normal open: Effective by closing	Optional
10				

Termi-nal	Definition	Signal	Signal type	Note
11	PE	–	Grounding	–
12	MCB closed/open status	DI	Normal open: Effective by closing	Standard configuration
13				
14	MCB Trip	DO	Normal open: Effective by closing	Standard configuration
15				
16	MCB Closing Allowed	DO	Normal open: Effective by closing	Standard configuration
17				
18	PE		Grounding	–
19	Ready	DO	Normal open: Effective by closing	Standard configuration
20				
21	Running	DO	Normal open: Effective by closing	Standard configuration
22				
23	HV Power on	DO	Normal open: Effective by closing	Standard configuration
24				
25	Remote Mode/Local Mode	DO	Normal open: Effective by closing	Standard configuration
26				
27	Fault	DO	Normal open: Effective by closing	Standard configuration
28				
29	Alarm	DO	Normal open: Effective by closing	Standard configuration
30				
31	MCB trip 2	DO	Normal open: Effective by closing	Optional
32				
33	Exciting Current Feedback	AI	+	Standard configuration. 0–10 V voltage signal or 4–20 mA current signal according to requirements.
34			-	
35	Speed Reference (AI)	AI	+	
36			-	
37	Analog Output 1	AO	+	Standard configuration. 0–10 V voltage signal or 4–20 mA current signal according to requirements. If the analog output signal is voltage type, the load impedance must be higher than 20 kΩ. If the analog output signal is current type, the load impedance must be lower than 500 Ω.
38			-	
39	Analog Output 2	AO	+	
40			-	
41	Analog Output 3	AO	+	
42			-	

Termi-nal	Definition	Signal	Signal type	Note
43	Analog Output 4	AO	+	
44			-	
45	PE	–	Grounding	–
46	PE	–	Grounding	–
47	RS485	D+	–	Standard configuration
48		D-	–	
49		SG	–	
50	External fault	DI	Normal open: Effective by closing	Optional
51				
52	Emergency Stop	DI	Normal open: Effective by closing	Optional
53				
54	Grid Mode	DO	Normal open: Effective by closing	Optional
55				
56	Drive Mode	DO	Normal open: Effective by closing	Optional
57				
58	Reserved	DO	Normal open: Effective by closing	Optional
59				
60	Auto Bypass-Manual	DO	Normal open: Effective by closing	Optional
61				
62	Auto Bypass-Auto	DO	Normal open: Effective by closing	Optional
63				
64	Drive to Grid	DI	Normal open: Effective by closing	Optional
65				
66	Grid to drive (to By-pass Cabinet)	DI	Normal open: Effective by closing	Optional
67				
68	Grid to drive (to PLC)	DI	Normal open: Effective by closing	Optional
69				
70	PE	–	–	–
71	Encoder PE	PE	–	Optional
72	Encoder A-	DI	–	Optional
73	Encoder A+	DI	–	Optional
74	Encoder B-	DI	–	Optional

Termi-nal	Definition	Signal	Signal type	Note
75	Encoder B+	DI	–	Optional
76	Encoder GND	–	–	Optional
77	Encoder Z-	DI	–	Optional
78	Encoder Z+	DI	–	Optional
79	Speed Ramp Selection Bit0	DI	Normal open: Effective by closing	Optional
80				
81	Speed Ramp Selection Bit1	DI	Normal open: Effective by closing	Optional
82				
83	Motor Selection Bit0	DI	Normal open: Effective by closing	Optional
84				
85	Motor Selection Bit1	DI	Normal open: Effective by closing	Optional
86				
87	Motor Selection Bit2	DI	Normal open: Effective by closing	Optional
88				
89	PE	–	Grounding	–
90	JOG Forward	DI	Normal open: Effective by closing	Optional
91				
92	JOG reverse	DI	Normal open: Effective by closing	Optional
93				
94	Forward/Reverse	DI	Normal open: Effective by closing	Optional
95				
96	Spare	–	–	–
97	Spare	–	–	–
98	Spare	–	–	–
99	Spare	–	–	–
100	Spare	–	–	–
101	Spare	–	–	–
102	Spare	–	–	–
103	Spare	–	–	–
104	Spare	–	–	–
105	Spare	–	–	–
106	Spare	–	–	–

Termi-nal	Definition	Signal	Signal type	Note
107	Spare	–	–	–
108	Spare	–	–	–
109	Spare	–	–	–
110	Spare	–	–	–
111	Spare	–	–	–
112	Spare	–	–	–
113	Spare	–	–	–
114	Spare	–	–	–
115	Spare	–	–	–
116	Spare	–	–	–
117	Spare	–	–	–
118	Spare	–	–	–
119	Spare	–	–	–
120	Spare	–	–	–

6.9.4 Application Wiring Example

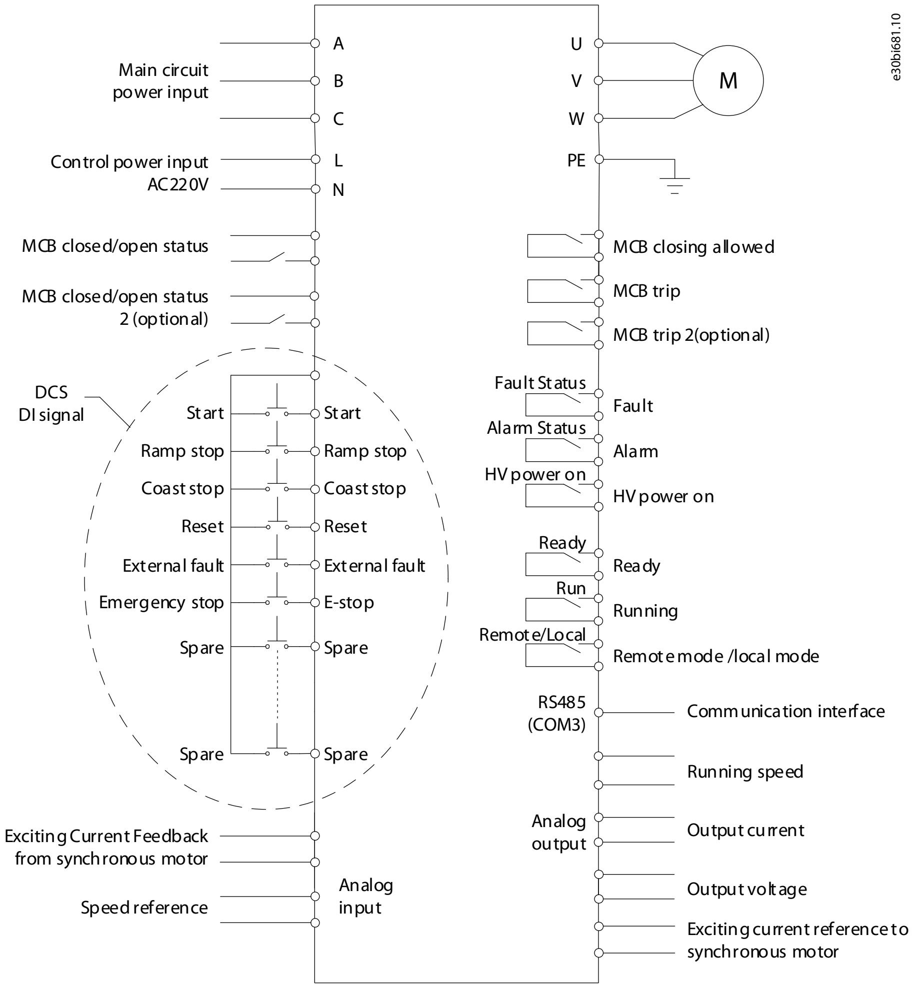

Illustration 51: Typical Application Wiring Diagram

6.9.5 PLC Configuration

6.9.5.1 PLC Basic Configuration

The basic configuration for the PLC is shown in Illustration 52.

Basic drive modules

- C1： RS485 (Modbus RTU follower default)
- DI_M: System control
- DO_M: System control
- DI: System control
- TM1: Transformer
- T31 temperature monitoring
- DIDO1: Fan control 1
- DIDO2: Fan control 2
- DIDO3: Fan control 3
- TM2: Transformer
- T32 temperature monitoring

Standard option modules

- DIDO4: Synchronous Transfer
- DIDO5: Multi-motor selection/speed ramps selection/others
- DIDO6: Excitation cabinet
- AIAO1: PID
- TM3: Motor temperature monitoring
- TM4: Motor temperature monitoring

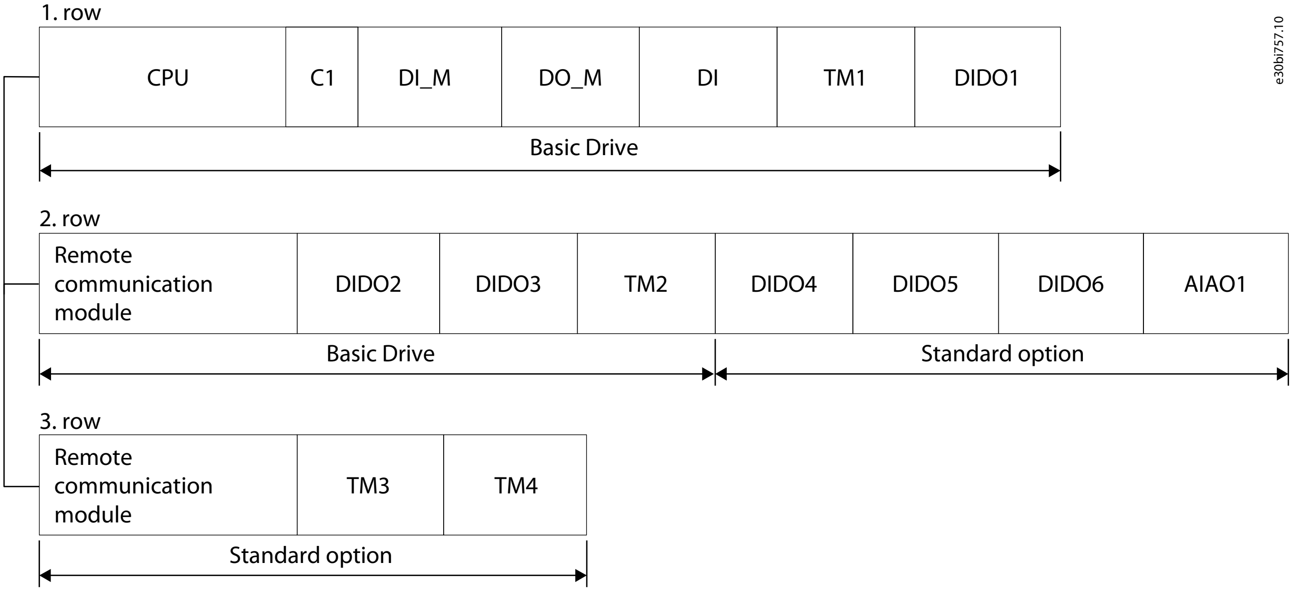

Illustration 52: PLC Basic Configuration

6.9.5.2 Options and Customized Designs

Some of the options can be installed in the basic drive part of the PLC, some in the Standard options part, and some require a customized design.

PROFINET: This communication module can be installed in the CPU slot as shown in Illustration 53, but this slot is standard for basic drive (RS485 and remote I/O card).

CANopen/DeviceNet/RS485: These communication modules can be placed at the far right in the first row with the basic drive modules as shown in Illustration 53. Only one of them can be selected because of the space constraints. Also, the PLC firmware needs customized design.

Basic drive module

- C1： RS485 (Modbus RTU follower default)

Standard options module

- C2: Ethernet (Modbus TCP/EtherNetIP)
- C3: CANopen
- C4: PROFINET I/O
- C5: DeviceNet
- C6: RS485 to PROFIBUS DP
- C7: RS485 to EtherCAT
- C8: RS485 to ControNet

Customized design

- C9: RS485 to POWERLINK. C1 must change to Modbus RTU master.
- C10: RS485 extension module, maximum 2 ports.

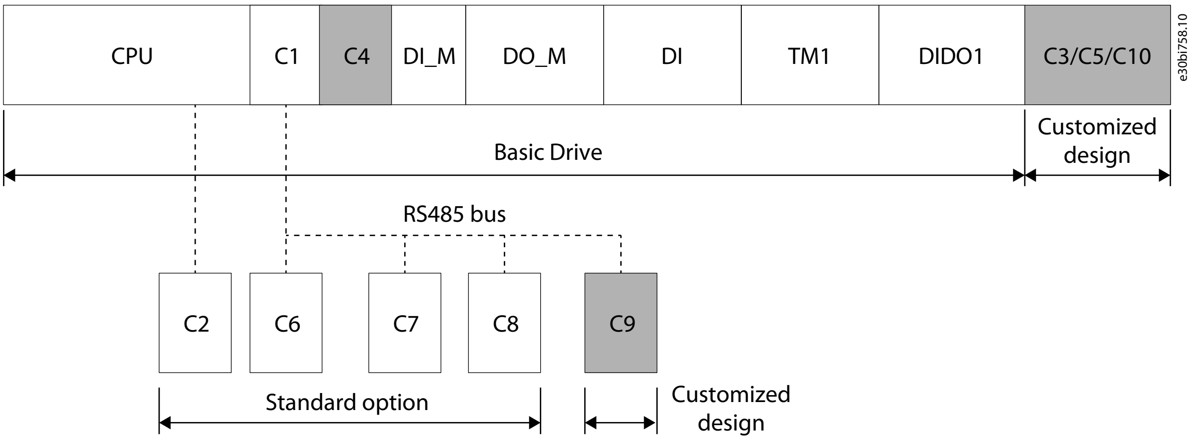

Illustration 53: PLC Configuration Example 1

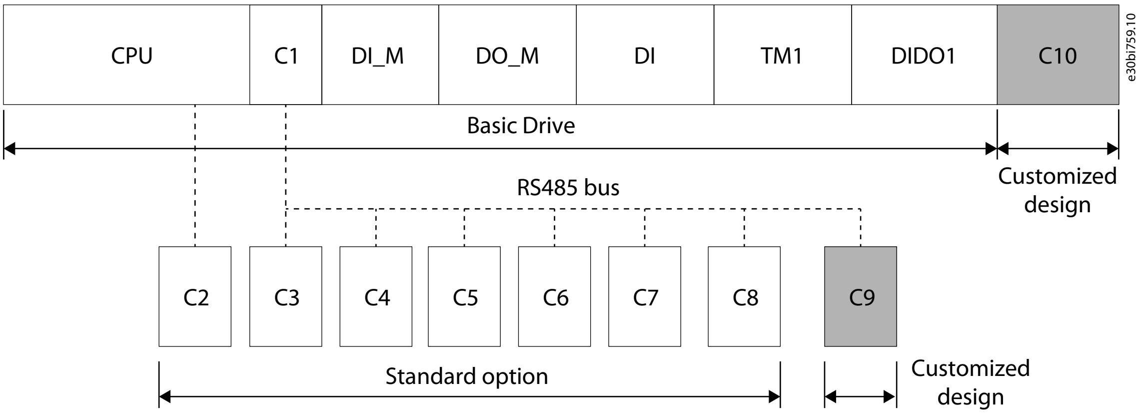

Illustration 54: PLC Configuration Example 2

7 Human-Machine Interface

7.1 The VACON® 1000 HMI

By using a high-quality touch-screen HMI (human-machine interface), simple and visual operation are possible to achieve for all the functions of VACON® 1000, such as:

- Parameter setting
- Operation status
- Fault diagnosis

To ensure operation safety, the user interface is protected by password that only opens up for authorized operators.

7.2 HMI Homepage

The homepage of the VACON® 1000 HMI is shown in Illustration 55. The homepage shows:

- Single-line diagram
- System status
- Dashboard

Access the submenus from the menu on the left side of the homepage, and the control panel from the icon in the lower right corner.

Illustration 55: HMI Homepage

A	Status	F	Administration
B	Graphs & Reports	G	Tool Settings
C	Setup & Service	H	System Status
D	Events	I	Dashboard
E	Single-line diagram	J	Control panel

7.2.1 System Status

When the system is in a specific state, the indicator of this state turns from gray to green.

- Emergency stop: The emergency Stop button on the control cabinet is pressed down.
- MCB close allowed: The system is ready, but the HV breaker is not closed.
    - The MCB can be closed.

- MCB closed: The input HV breaker is closed.
- Startup ready: HV power of the drive is on and internal diagnosis is done.
  - There is a delay of 22 s after the HV power is turned on. The DSP transmits the "operation request" signal after transmitting the main control ready state.
- VFD running: The VACON® 1000 is running and the main control system has no active faults.

7.2.2 Dashboard

The dashboard shows real-time values of the drive status:

- Grid voltage
- Input current
- Output voltage
- Output current
- Reference speed
- Input power
- Transformer temperature values
- Output speed

7.2.3 Single-line Diagram

The single-line diagram shows the status of each switch connected to the drive, such as breakers and contactors.

7.3 Control Panel

The control side panel includes the main controls for the drive. These controls can be used in HMI operation mode:

- To unlock the other function buttons in the control panel, press the *REQUEST* button. Otherwise the other function buttons are disabled.
- To start the drive, press the *START* button (in HMI operation mode). When the drive is running, this button is disabled. If the drive is at ramp stop state or stop state, this button is enabled, and can be used to restart the drive.
- To stop the drive, press the *STOP* button. Select either ramp stop or coast stop.
- Make the speed setting by numerical setting or slider.
- To reset the fault status of the drive, press the *RESET* button. When the drive is running, this button is disabled.

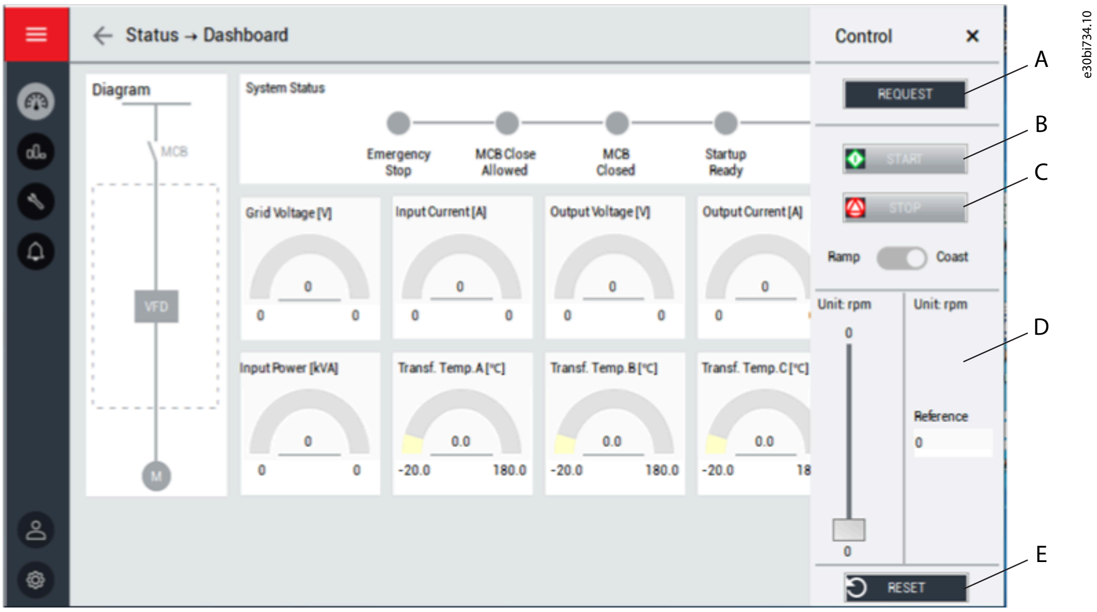

Illustration 56: Control Panel

A	Request	D	Speed setting
B	Start	E	Reset
C	Stop		

7.4 Status

To select one of the status submenus, press the *Status* button in the HMI menu:

- Dashboard
- Power cell status submenu
- Cooling fan status submenu

7.4.1 Power Cell

The power cell submenu shows the DC-link voltages and active fault codes of the power cells.

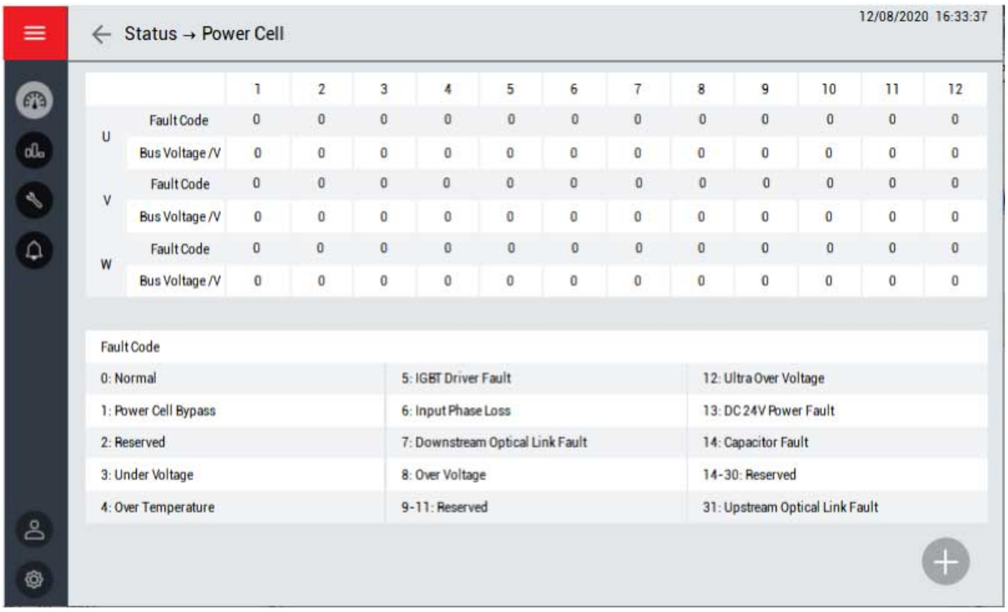

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Illustration 57: Power Cell Submenu

7.4.2 Cooling Fan

The cooling fan submenu shows the status of all the cooling fans in the drive cabinets. The fans of the different cabinets are shown on separate tabs.

Actions available in this menu:

- Manual operation of the fans.
- Changing the running cycle/day.
- Recovery confirmation.

7.5 Graphs & Reports

The Graphs & reports submenu shows historical graphs of selected parameters. Four channels are available.

Each channel can show different parameters, such as:

- Input voltage
- Output voltage
- Input current
- Output current
- Reference speed

- Speed command
- Input power

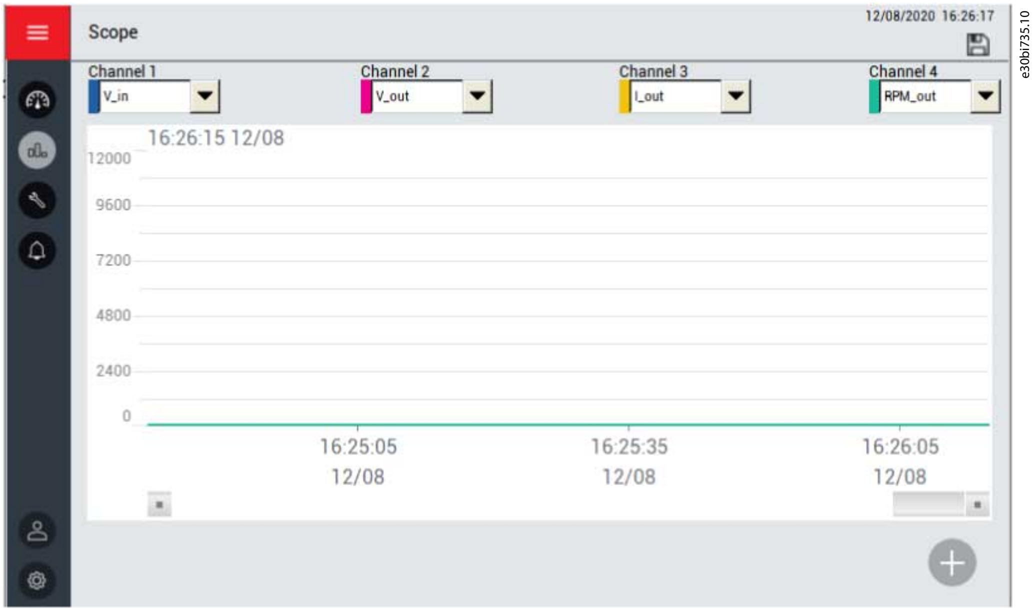

Illustration 58: Graphs & Reports Submenu

7.6 Setup & Service

The *Setup & Service* button in the HMI menu opens a submenu with the following system function settings:

- Operation mode
- Motor parameter
- Functions
- Protections
- I/O configuration
- System configuration
- PID setup
- Commissioning

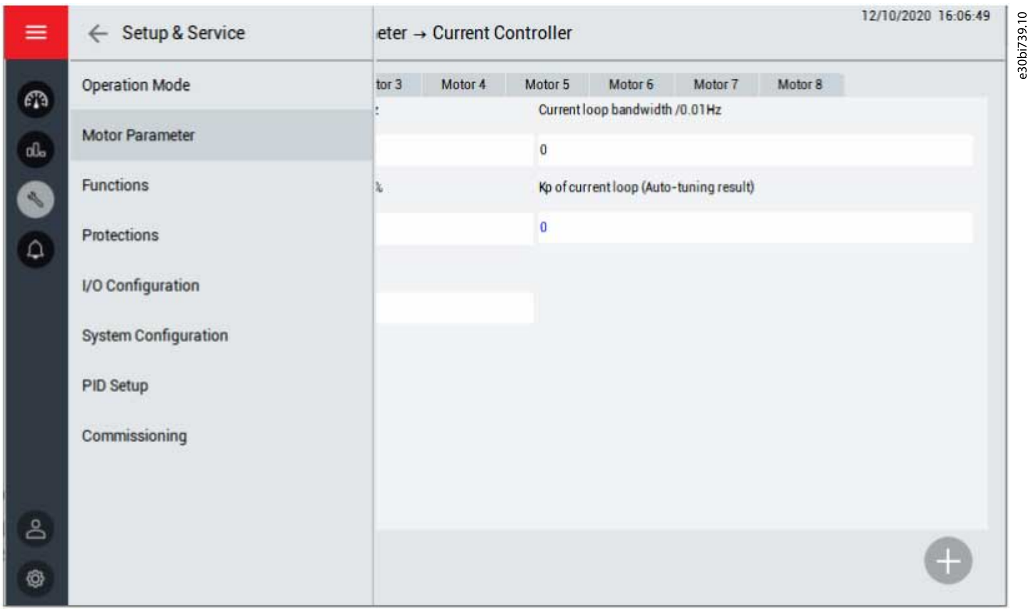

Illustration 59: Setup & Service Submenu

7.6.1 Operation Mode

Use this submenu to select the operation mode and the reference set.

Operation mode options:

- HMI: The drive is operated by HMI.
- Digital: The drive is operated by DCS (the remote digital control of the drive, see 6.9.4 Application Wiring Example for the specific interface definition).
- Communication: The drive is operated by communication, such as RS485 or Ethernet.

Reference set options:

- HMI: Speed is set by HMI.
- Analog: Speed is set by analog input.
- Digital: Speed is set by DCS (the remote digital control of the drive, see 6.9.4 Application Wiring Example for the specific interface definition).
- Communication: Speed is set by communication, such as RS485 or Ethernet.
- PID: Speed is adjusted automatically by PID module.

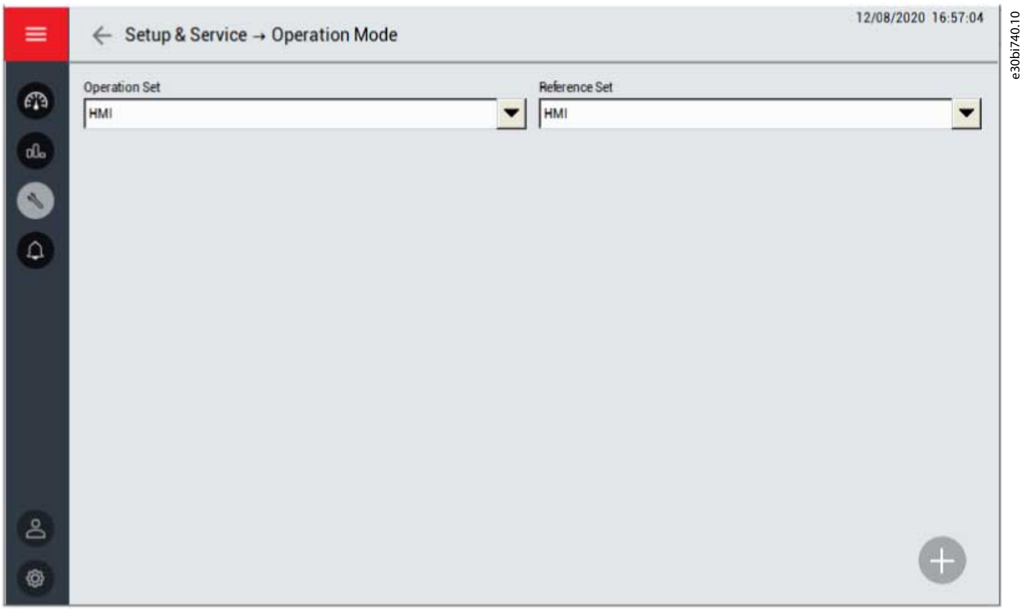

Illustration 60: Operation Mode Submenu

7.6.2 Motor Parameter

Use this submenu to select the motor parameters:

- Multi-motor configuration
  - Select different motors through HMI, digital input, or communication.
  - Set the maximum number of motors.
- Rated parameter
  - Set the rated frequency, rated speed, pole number, rated voltage, and rated current for different motors.
- Speed operation configuration
  - Set the rotation direction, maximum speed, and minimum speed for different motors.
- Auto tuning parameter
  - Check the parameters regarding auto tuning.
- Speed controller
- Flux controller

- Current controller
- Encoder
  - Input the specifications of the encoder for each motor.

7.6.3 Functions

Use this submenu to set the parameters for different functions. The parameters are divided into groups according to the functions.

7.6.4 Protections

Use this submenu to set the parameters for different protection functions. The parameters are divided into groups according to the protection functions.

7.6.5 PID Setup

Use this submenu to set the PID parameters.

- Analog Input Range: The range of the sensor.
- Proportional Gain (Kp): The magnified proportional value of the SV-PV error.
  - Unit: %
  - Set range: 0–30000
- Integral Gain (Ki): The magnified proportional value of an accumulation of each sampling time unit times the error value.
  - Unit: %
  - Set range: 0–30000
- Differential Gain (Kd): The magnified proportional value of an error variable of each sampling time unit.
  - Unit: %
  - Set range: 0–30000
- Upper Limit: If the upper limit is 900 RPM, the PID output stays at 900 RPM when the adjusting output value is above 900 RPM.
- Lower Limit: If the lower limit is 300 RPM, the PID output stays at 300 RPM when the adjusting output value is below 300 RPM.
- Error Band: The error band value is equal to the SV-PV deviation. If the difference between SV and PV is smaller than the error band, PID stops output and the drive maintains the current output speed.
- PID Output: The display of the actual PID output results.
- SV: The expected values of the user set.
- PV: The real value of the system output.
- Output Enable/Disable switch
- Start/Stop switch

Illustration 61: PID Setup Submenu

7.6.6 System Configuration

Use this submenu to set the system configuration parameters. The parameters are divided into groups according to the functions.

7.7 Events

Two submenus can be accessed by pushing the *Events* button in the HMI menu:

- Warning & Fault
- Event Log

7.7.1 Warning & Fault

The warning & fault submenu lists the real-time alarm and fault record of the drive during operation.

There are 2 different types of notification.

- An **alarm** informs of unusual operation on the drive. The alarm does not stop the drive. The system can be powered on, started, and operated normally.
- A **fault** stops the drive immediately. Reset the drive and find a solution to the problem. Do not operate the system until the problem has been found and corrected.

This page only shows general faults. To check the actual faults, see the "Event Log".

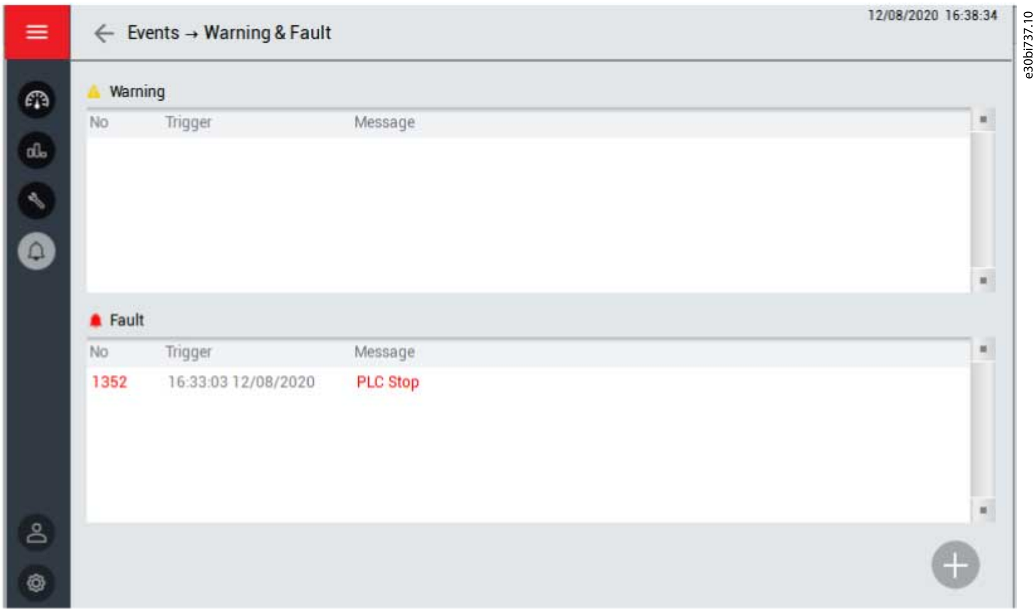

Illustration 62: Warning & Fault Submenu

7.7.2 Event Log

The event log submenu shows a record of all:

- Alarms
- Faults
- Operations (for example, starting and stopping the drive)

To save the event log, push the *Save* button in the upper right corner. The event log information is saved as a CSV-file to a USB storage device, which must be inserted separately. The USB port is at the back side of the HMI.

To delete the event log, push the *Delete* button in the upper right corner. This operation needs higher operation authority.

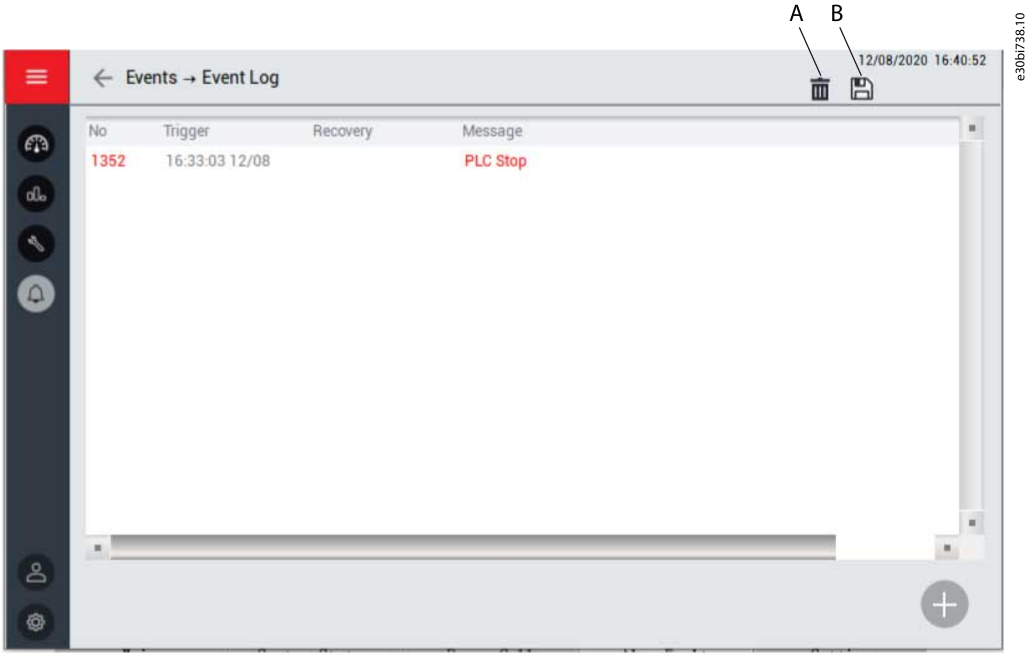

Illustration 63: Event Log Submenu

A	Delete event log
B	Save event log

7.8 Administration

Use the Administration submenu for password management. Two actions can be done in this submenu:

- Relogin
- Change password

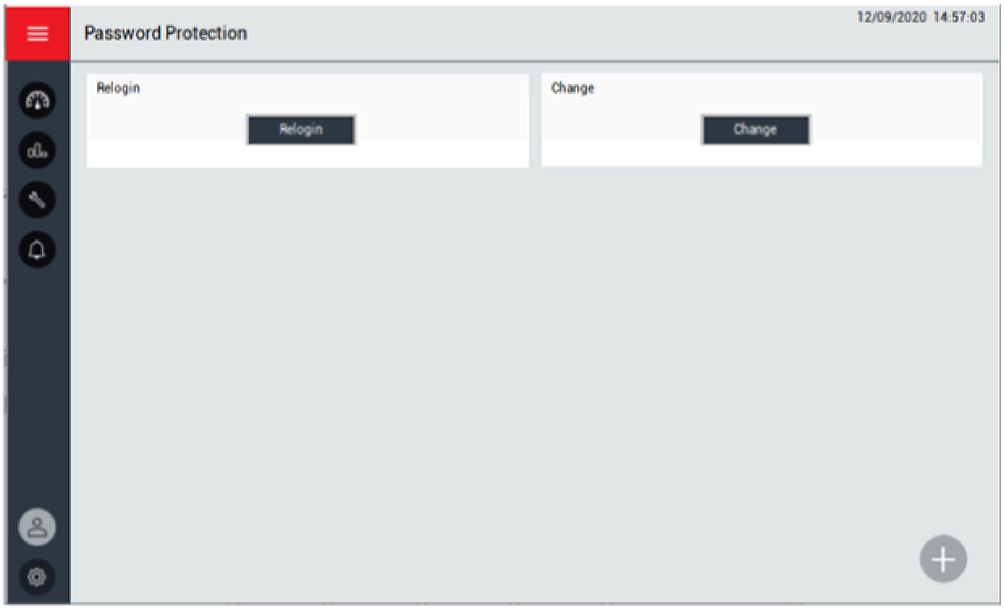

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Illustration 64: Administration Submenu

To bring up the password dialog box, press the *Relogin* button. If the password input is incorrect, the dialog box remains until the password input is correct. The original password is provided in the product delivery.

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Illustration 65: Password Dialog Box

VACON® 1000 has 3 user authority levels. To prevent malfunctions, the drive restricts important parameter changes by users without authorization.

- Level 1 authority limits operation to the buttons in the main interface. Parameter changes are not allowed.
- Level 2 authority limits operation to the buttons in the main interface, and changes to level 2 parameters.
- Level 3 authority limits operation to the buttons in the main interface, and changes to level 2 and 3 parameters.

To change the password, press the *Change* button. Users at a higher authority level can see and change the password of the user at a lower level.

Users at different levels can carry on corresponding operation on the system after entering the correct password. If the user forgets to exit the loading manually, the system is locked automatically in 5 minutes.

The required passwords are delivered during the commissioning of the drive.

If a password is lost, contact Danfoss.

7.9 Tool Settings

The tool settings submenu includes settings for the HMI.

- Language setting
- Software version
- HMI set

7.9.1 Language

Select the language of the HMI according to requirements.

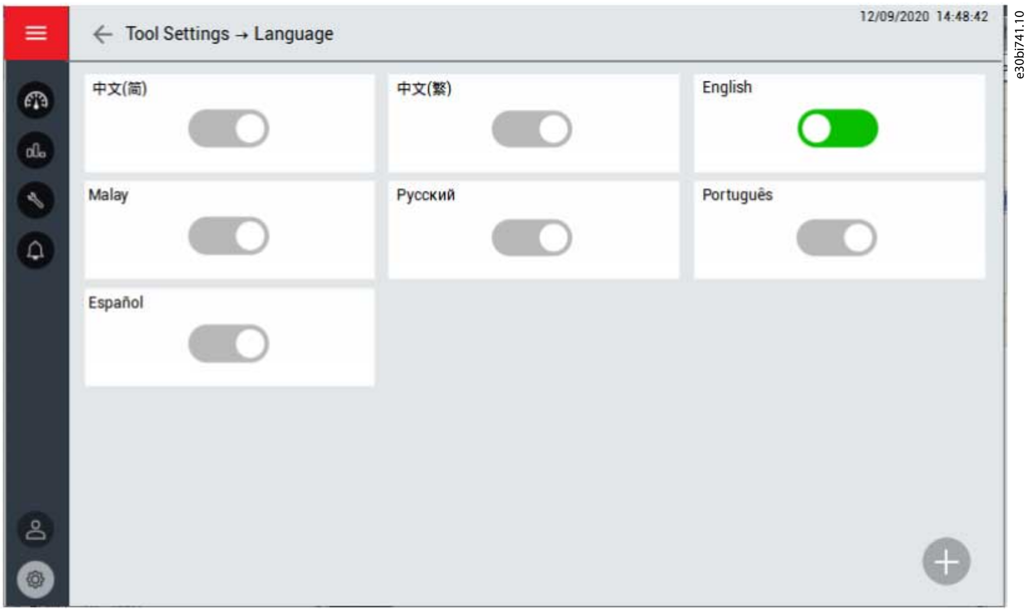

Illustration 66: Language Submenu

7.9.2 Software Version

This menu shows the software version information for the HMI, PLC, and DSP. Also the power cell version and optical fiber board version are available.

7.9.3 HMI Set

To adjust the brightness of the HMI screen, select *Brightness*.

To adjust the date and time setting, select *Date/Time*.

Illustration 67: HMI Set Submenu

8 Commissioning

8.1 Safety Checks before Starting the Commissioning

Only qualified and trained engineers authorized by Danfoss are allowed to do the commissioning of the VACON® 1000 medium-voltage drive.

Functional tests, commissioning, and primary parameter calibration must be executed by professional engineers in coordination with the end users to make sure that the final test and performance are according to the end users requirements.

Before starting the commissioning, read these warnings.

⚠ D A N G E R ⚠

SHOCK HAZARD FROM POWER UNIT COMPONENTS

The power unit components are live when the drive is connected to mains. A contact with this voltage can lead to death or serious injury.

- Do not touch the components of the power unit when the drive is connected to mains. Before connecting the drive to mains, make sure that the covers of the drive are closed.

⚠ D A N G E R ⚠

SHOCK HAZARD FROM TERMINALS

The motor terminals U, V, W are live when the drive is connected to mains, also when the motor does not operate. A contact with this voltage can lead to death or serious injury.

- Do not touch the motor terminals U, V, W when the drive is connected to mains. Before connecting the drive to mains, make sure that the covers of the drive are closed.

⚠ D A N G E R ⚠

SHOCK HAZARD FROM DC LINK OR EXTERNAL SOURCE

The terminal connections and the components of the drive can be live several minutes after the drive is disconnected from the mains and the motor has stopped. The load side of the drive can also generate voltage. A contact with this voltage can lead to death or serious injury.

- Disconnect the drive from the mains and make sure that the motor has stopped.
  Disconnect the motor.
  Lock out and tag out the power source to the drive.
  Make sure that no external source generates unintended voltage during work.
  To ground the drive input and DC link, close the grounding switch. If there is no grounding switch, make sure that the drive input and DC link are grounded for work. Also ground the motor terminals for work.
  Wait for the DC-link capacitors to discharge fully before opening the cabinet door or the cover of the AC drive.
  Use a measuring device to make sure that there is no voltage.

8.2 Personnel Requirements

At least two professional electrical technicians are necessary as the operators for commissioning. The operators must meet the following conditions.

- Must be familiar with the low, medium, and high-voltage electrical equipment and the related safety regulations.
- Must be familiar with the distribution system on site.
- Must be authorized to operate low and medium-voltage equipment (high-voltage power breaker and other medium and low-voltage transmission switches).
- Must be authorized to operate the distribution equipment in the premises.

8.3 Commissioning Checks

After the VACON® 1000 is installed, follow these instructions to commission the AC drive.

Read the safety instructions in 8.1 Safety Checks before Starting the Commissioning and obey them.

Visual inspection
Input and output inspection
Cabling inspection
Grounding inspection
Insulation inspection
Other preparations

1. Check that there is no damage, deformation, or other defects on the cabinet.
2. Open the controller cabinet door and check for problems such as loose wires or switches in the wrong position.
3. Check that the terminal boards on the main control box are in the right positions.
4. Check that the optical fiber connections are in good condition.
5. Open the transformer cabinet and check that the connections of the wiring terminals are in good condition.
6. Make sure that there is no contact between the high and low-voltage circuits.
7. Check that the temperature sensor installation is in good condition.
8. Open the power cell cabinet and check that the connections in the front of the power cell are solid.
9. Check that the installation of the voltage and current sensors is correct and that the jacks of the signal wires are firmly connected.
10. Check that the grounding copper busbars are connected reliably.
11. Make sure that there is no condensation on the surfaces of the AC drive.
12. Make sure that there are no unwanted objects in the installation space.
13. Check that the input power of the drive meets the drive specification.
14. Check that the output voltage of the drive matches the rated voltage of the motor.
15. Check that the control power supply matches the drive specification.
16. Check that the rated power of the drive matches the motor specification.
17. Check that the secondary transformer wiring is correct according to the secondary wiring diagram.
18. Check that the primary wiring is correct according to the primary wiring diagram.
19. Make sure that the motor cable shield is grounded at the drive and motor ends of the cable.
20. Make sure that the control cables are as far as possible from the power cables.
21. Make sure that the cables do not touch the electrical components of the drive.
22. Do a check of the tightening torques of all the terminals.
23. Make sure that the AC drive and the motor are grounded.
24. Make sure that the shields of the shielded cables are connected to a grounding terminal that is identified with the grounding symbol.
25. Check that the resistances of the grounding copper busbars match the requirements.

    - Control system grounding: ≤0.5 Ω
    - System safety grounding: ≤0.5 Ω
    - Machine cabinet support: ≤0.5 Ω
    - Transformer support: ≤0.5 Ω
    - External housing of the cooling fans: ≤0.5 Ω
    - Door locks: ≤0.5 Ω

26. Check that all cables meet the requirements.

    See 6.7 Power Cable Selection.

27. Do an insulation test for the control power.
    a. Disconnect the control power input.
    b. Measure the insulation resistance of the 220 V AC terminal at the outgoing parts of the bypass switches QF11, QF12, and QF13.

       Use a 2500 V insulation resistance tester.

       ➔ The insulation resistance must be higher than 1 MΩ.

28. Provide an auxiliary AC supply.
29. Make sure that the installation follows EMC guidelines.

30. Do a check of the quality and quantity of the cooling air.
31. Before connecting the drive to the mains, do a check of the installation and the condition of all the protective devices.
32. Collect all the necessary device instruction manuals, drawings, and materials, and save them.

8.4 Commissioning Report

After the commissioning is finished, the user and the commissioning engineer from Danfoss must accept and sign the commissioning report. The Danfoss commissioning engineer must write two duplicate commissioning reports, one copy is for the user and the other for Danfoss.

8.5 Operating the Drive

8.5.1 Powering the Drive

Only personnel who have been trained professionally can operate the VACON® 1000 medium-voltage drive.

Procedure

1. Switch on the auxiliary control supply.
2. Input the correct password to the HMI.
3. Set and check the system function and start-up parameters.

   See the VACON® 1000 Application Guide.

   ⚠ CAUTION ⚠

   - To ensure the safety and normal operation of the drive, the important parameters must be confirmed carefully.

4. Close all cabinet doors.

   All the cabinet doors must be closed reliably, otherwise the drive does not start.

5. If a bypass cabinet is configured, check the main circuit configuration.
   a. Close the input isolation switch.
   b. Close the output isolation switch.

   Live operation of the knife gate isolation switch is prohibited.

6. Check that the VACON® 1000 is ready.
   a. The HMI display is normal, and no failure warning information is shown.

      If a warning is shown, see 10 Fault Tracing.

   b. The "MCB close allowed" indicator in the VACON® 1000 status interface blinks.
7. Close the high voltage breaker.

   ➔ The "MCB closed" indicator in the VACON® 1000 status interface blinks.

8. The VACON® 1000 is ready, and the "Start-up ready" indicator in the status interface blinks.

8.5.2 Starting the Drive

The steps for starting the VACON® 1000 depend on the operation mode and reference mode.

Make sure that it is safe to start the motor.

Procedure

1. Set the speed.
   - **HMI**: Input the reference speed in the HMI.
   - **Analog**: Input the speed setting through the analog input.
   - **Digital**: Input the speed setting through DCS digital signal.
   - **Communication**: Input the speed setting through communication.
   - **PID**: Input PID reference value.

2. Send the start command.
   - **HMI**: Press the *START* button.
   - **Digital**: Start the equipment through DCS digital signal.
   - **Communication**: Start the drive through communication.

8.5.3 Stopping the Drive

The procedure for stopping the drive depends on the selected operation mode.

- **HMI**: In the control panel, select Ramp or Coast, and press the *STOP* button. The drive stops according to the corresponding stop mode, while the main circuit breaker is still closed.
- **Digital**: Stop the drive through DCS digital signal.
- **Communication**: Stop the drive through communication.

Two different stop modes are possible: Ramp stop and coast stop.

Ramp stop

- The drive stops the motor according to the preset deceleration time. For setting the decelerated stop time, see the VACON® 1000 Application Guide.

Coast stop

- The drive stops the voltage output, and the motor rotates freely and decelerates gradually through the load and friction until it stops.
- Consider carefully according to the operation condition whether the motor is allowed to stop freely.

⚠ DANGER ⚠

SHOCK HAZARD

During a coast stop, there can still be voltage in the motor cables due to the back EMF generated by the motor. Contact with this voltage can lead to death or serious injury.

- Do not touch the motor terminals or cables when the drive is connected to mains.

8.5.4 Powering Off the Drive

⚠ DANGER ⚠

SHOCK HAZARD

The terminals and the components of the drive can be live several minutes after the drive is disconnected from the mains and the motor has stopped. The load side of the drive can also generate voltage. A contact with this voltage can lead to death or serious injury.

- Keep the cabinet doors closed for 15 minutes after the high voltage is cut off.

Procedure

1. Stop the drive. See 8.5.3 Stopping the Drive.
2. Command the input high-voltage breaker to open.
3. If a bypass cabinet is installed, disconnect the input and output isolation switch.
4. After the power cells finish discharging, power off the control power.

⚠ CAUTION ⚠

- Do not cut off the control power when the drive is powered on or the LED indicators of the power cells are on.

8.6 Interlocking System

8.6.1 Electromagnetic Interlocking System

N O T I C E

The electromagnetic interlocking system is installed as standard in IEC type drives.

The electromagnetic interlocking system ensures that the cabinet doors cannot be opened during operation of the drive.

Operation of the electromagnetic interlocking system

- Before HV power on: All electromagnetic locks are energized, all doors are unlocked, and can be opened or closed. Only after all doors are closed, and after self-diagnosis, the PLC can send out the "MCB closing allowed" signal.
- HV power on: Once the MCB is closed to power the drive, the electromagnetic locks are de-energized, the doors are locked, and cannot be opened during operation of the drive. If the doors are opened despite the locking (for example, by force), an "MCB trip" signal is immediately sent to trip the MCB.
- HV power off: After the drive is powered off and the power cell discharge process is completed (15 minutes), the electromagnetic locks are energized, the doors are unlocked, and can be opened.

8.6.2 Mechanical Interlocking System

N O T I C E

The mechanical interlocking system is installed as standard in UL type drives. It is available as an option for IEC variants.

The interlock system ensures that a process is followed and cannot be circumvented or short cut. The transfer of a key ensures that wherever personnel find themselves, in either starting or shutting down operations, they can be assured that they are safe.

The interlock device contains three main parts:

- Main key for the isolating means (only one)
- Door keys (one for each cabinet door)
- Key exchange box

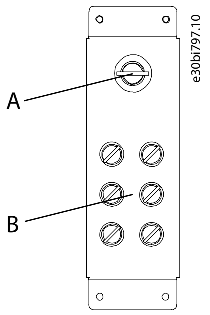

Illustration 68: Key Exchange Box

A	Main key
B	Door keys

Operation of the interlock system

- While the main key for the isolating means is free from the key exchange box, the other door keys are locked in the box.
- To release the door keys sequentially, insert and turn the main key in the key exchange box. The released keys can then be used to open the cabinet doors and to access the hazardous areas.
- The inserted main key stays locked in the key exchange box until all the released door keys are returned to their original positions.
- The drive cannot be restarted until all the door keys are returned to the key exchange box and the main key is removed and taken to the isolating means.

9 Maintenance

9.1 Safety

CAUTION

Only authorized trained personnel can conduct service on the VACON® 1000 medium-voltage drive.

- Do not conduct any service, spare parts replacements, or other related operations which are not described in this manual.
  Do not revise the system software or connect other equipment with the drive. If changes are required, contact Danfoss.
  Do not modify or scratch the labels and markings of the drive, as these are provided for the safety of the users and for the use of the product.

DANGER

SHOCK HAZARD FROM DC LINK OR EXTERNAL SOURCE

The terminal connections and the components of the drive can be live several minutes after the drive is disconnected from the mains and the motor has stopped. The load side of the drive can also generate voltage. A contact with this voltage can lead to death or serious injury.

- Do not do touch the main circuit of the drive or the motor before the system is powered off and grounded.
  Disconnect the drive from the mains and make sure that the motor has stopped.
  Disconnect the motor.
  Lock out and tag out the power source to the drive.
  Make sure that no external source generates unintended voltage during work.
  Ground the drive for work.
  Wait 15 minutes for the DC-link capacitors to discharge fully before opening the cabinet door or the cover of the AC drive.
  Use a measuring device to make sure that there is no voltage.

WARNING

SHOCK HAZARD

Output voltage detection signals are wired from the voltage divider board to the AD board in the control unit. If any of these wires are disconnected while MV power is on, a transient high voltage is generated.

- Do not disconnect any wires from the AD board terminals while MV power is on.

- More than one disconnect switch can be required to de-energize the equipment before maintenance.
- Low-voltage fuses that are accessible with the control transformer can be energized. Cut off the supply to the control transformer before replacing the fuses.
- There are bulk DC-link capacitors in the drive, which must be discharged to a level below 50 V DC for safe maintenance work.
- The socket in the control cabinet is only for maintaining or repairing equipment. The current rating is 10 A. Any equipment with rated current larger than 10 A is prohibited. This equipment does not provide isolation. Separate isolating means are required.
  - The isolating means listed in Table 9 or equivalent can be used.

Table 9: Recommended Isolating Means

Type of isolating means	Manufacturer	Model name	Rating
Medium-voltage controller	ROCKWELL AUTOMATION CANADA INC (E102991)	1512A-1	400 A/7.2 kV
Medium-voltage switchgear	ABB INC POWER TECHNOLOGY PRODUCTS MEDIUM VOLTAGE (E143324)	ADVANCE Series	3000 A/ 1000 MVA/ 27 kV max.
		SAFEGEAR Series	4000 A/1000 MVA/ 15 KV
Circuit breakers and metal-clad switchgear	EATON (E146558)	VC-W series	3000 A/15 kV max.

9.2 Standard Maintenance Process

To ensure safe maintenance, follow the described steps.

Procedure

1. Familiarize with the safety measures and cautions described in this manual, and obey them.
2. Cut off the system power and shut down the UPS. If a bypass cabinet is installed, cut off the power of the bypass cabinet.

   All maintenance tasks must be conducted with the mains and auxiliary power disconnected.
3. Conduct the necessary maintenance.

   Refer to the maintenance plan and the specific instructions.
4. After maintenance, check before power-on.
   a. Make sure that the connections to the mains and the motor are in good condition.
   b. Make sure that the connections to the auxiliary power and the control circuit are in good condition.
   c. Make sure that no tools or foreign objects are left in the cabinets.
   d. Make sure that all the cabinet doors including protective isolation facilities are closed and ready in position.
5. Restart the drive. Follow the instructions in 8.5.1 Powering the Drive and make sure that there is nothing abnormal in the operation.
6. Make a record of the maintenance done to the VACON® 1000 drive.

   The maintenance record must include:
   - The date and time.
   - The maintenance actions performed according to the maintenance plan.
   - Any special situation or work (planned or unplanned spare parts replacement).

9.3 Maintenance Schedule

To ensure the long-term steady operation of the equipment, conduct correct operation and maintenance. The daily protective maintenance and inspections must be conducted in a planned way. In addition to the emergency system maintenance, predictive maintenance must be conducted, including daily, weekly, monthly, quarterly, and annual inspections and maintenance.

The daily maintenance tasks are limited to various visual inspections, air filter cleaning, and keeping the installation room as clean as possible. Other maintenance tasks are only allowed for authorized trained personnel.

9.3.1 Daily Maintenance

Table 10: Daily Maintenance Tasks

Maintenance item	Maintenance interval	Maintenance task
Environment	Daily	Check that the temperature inside the drive cabinets is -5...+40°C, preferably 25°C. Check that humidity is below 95% and that there is no condensation.

Mainte-nance item	Mainte-nance in-terval	Maintenance task
		Check the condition of the ventilation and air ducts. Record the environment parameters daily, and note if there are abnormal conditions.
Operating parameters	Daily	Check that the drive input voltage is correct. Check that the drive operating parameters are normal. Check the drive for warnings/faults. Check the indicator lights of the drive. Check that the temperature of the transformer, shown on HMI, is below 90°C. Check that there is no abnormal sound, vibration, fire, or smell.
Cooling fans	Daily	Check that there is no abnormal vibration or sound. Check that there are no cooling fan overtemperature or cooling fan power supply drop alarms.
Air filters	Daily	Check that the air filters are not blocked. Check that there is no air pressure alarm.
	Weekly	Clean the filters at least once a week. If the dust is heavy, the cleaning interval must be shorter. To remove dust, gently tap the filters or blow slightly with compressed air outside the electrical room. To remove caked on dirt, rinse the filters with water and a gentle detergent. Dry the filters before installing back on the drive. If necessary, replace the filters with new ones.
Drive room	Daily	Check the drive room daily. Remove any foreign items.
	Weekly	Clean the drive room once a week. Use a vacuum cleaner or mop to clean any dust or ash.

9.3.2 Yearly Maintenance

Table 11: Yearly Maintenance Tasks

Maintenance item	Maintenance interval	Maintenance task
Cabling	Yearly	Check the tightening torques of the terminals. Check that the insulation layer of cables is not damaged. Check the grounding.
Transformer	Yearly	Measure the insulation resistance between primary/secondary to ground.
	Every 2 years	Perform dielectric withstand tests between primary/secondary to ground.
Drive cabinets	Yearly	Clean inside the drive cabinets with a vacuum cleaner. Clean the dust on the surface of components, and clean the dust in the heat sinks of power cells.
Components	Yearly	Use a multimeter to check that the output voltage of power supply in control cabinet is 26±0.5 V DC. Check that the output voltage of the UPS is 25±0.5 V DC. Check that the relay works normally and there is no abnormal sound. Check that the indicators work normally. Check that the electromagnetic interlocks work normally.

Maintenance item	Maintenance interval	Maintenance task
		Check the heater and humidistat. Set the threshold of the humidistat below the ambient humidity and check that the heater starts working. After testing, set the threshold to 80%. Check the high voltage electric display light and that the second locked circuit is normal. Check that the thermal relay setting value is correct. Do a close test for the vacuum contactor or breaker, and check that the operation and feedback status is correct. Check that the fuse and breaker is normal and there are no burn marks.
UPS battery	Every 3 years	Change the battery every 3 years for reliable operation.
	Every 3 months	If the drive is stored for over 3 months and is not turned on during that time, charge the UPS battery for 8 hours. Charge spare storage batteries every 3 months.
HMI	Depending on condition	The brightness of the HMI decays over time. The lifetime depends on the use conditions.
High voltage electric display device	Every 4 years	Change every 4 years for reliable operation.
Cooling fan	Every 4 years	Change every 4 years.
Indicator	Every 5 years	Change every 5 years.
Switching power supply	Every 10 years	Change every 10 years.
Power cells	1 year	If a stored power cell has not been energized in the last 1 year, the electrolytic capacitors must be reformed. If the drive is stored for more than 2 years, high voltage cannot be applied directly to the drive. Raise the input voltage gradually to wait until the capacitors are charged properly.

9.4 Replacing the Air Filters

9.4.1 Air Filters of Standalone Cabinets

Procedure

1. Loosen the screws on the air filter cover.

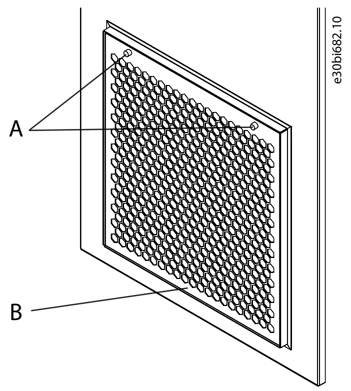

Illustration 69: Releasing the Filter Cover

A	Screws

B	Filter cover

2. Remove the air filter cover.

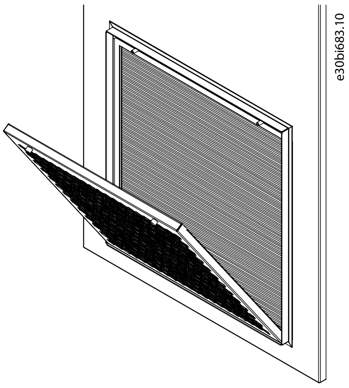

Illustration 70: Removing the Filter Cover

3. Remove the filter and replace it with a new one.

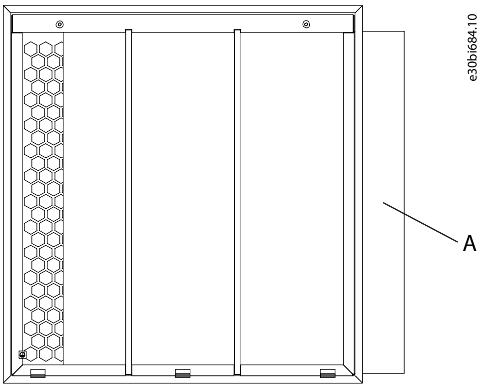

Illustration 71: Replacing the Air Filter

A	Air filter

4. Reinstall the filter cover and tighten the screws.
5. Note the filter replacement date.

9.4.2 Air Filters of Transformer and Power Cell Cabinets

Procedure

1. Loosen the screws on the air filter cover.

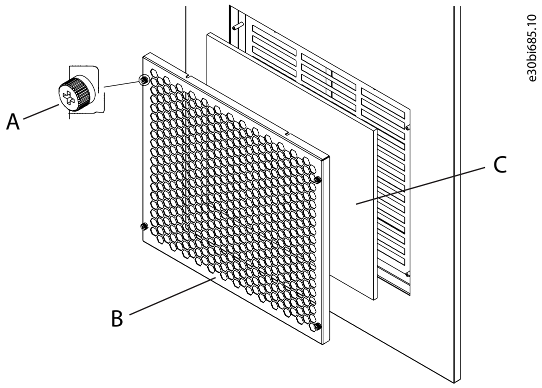

Illustration 72: Air Filter Replacement

A	Screws	C	Air filter
B	Filter cover		

2. Remove the air filter cover and remove the old filter.
3. Install a new air filter in place of the old one.
4. Reinstall the filter cover and tighten the screws.
5. Note the filter replacement date.

9.4.3 Air Filters of Control Cabinet

Procedure

1. Press the button and pull back the top part of the filter cover.

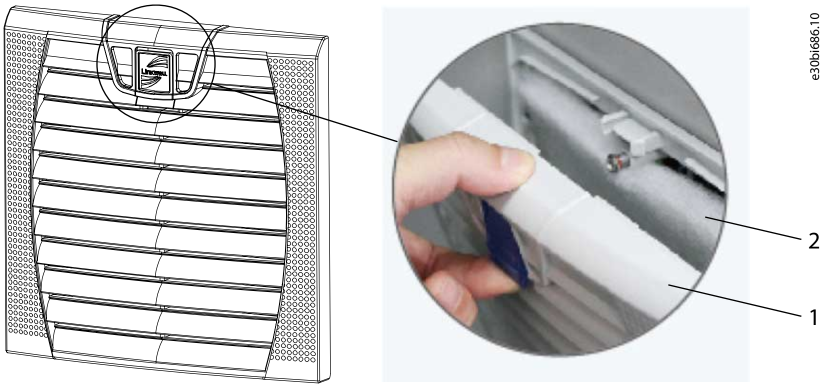

Illustration 73: Releasing the Filter Cover

1	Filter cover
2	Air filter

2. Remove the air filter cover.
3. Remove the filter and replace it with a new one.
4. Reinstall the filter cover.
5. Note the filter replacement date.

9.5 Replacing the HMI Battery

Procedure

1. Remove the screws at the back side of the HMI.

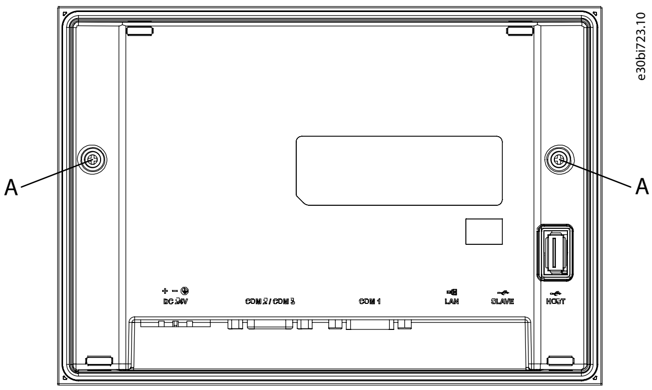

Illustration 74: Locations of the HMI Cover Mounting Screws

A	Cover mounting screws

2. Open the HMI back cover plate.
3. Replace the battery.

   The HMI uses a 3 V lithium battery, type CR2032×1.

Illustration 75: Location of the Battery Inside the HMI

9.6 Replacing the Cooling Fans

Cut off the system power according to 9.2 Standard Maintenance Process and take all the safety measures.

NOTICE

The cooling fans have different models according to power levels.

Procedure

1. If an air duct is used to exhaust hot air outside the installation room, disassemble the interface between the air duct and the cooling fan.
2. Remove the front and back grates (A). Each is mounted with 9 M6x16 hexagonal combination screws. Retain the screws.

   See 9.6.1 Diagram of the Cooling Fan Replacement.

3. Remove the cooling fan cover (B). Remove and retain 16 M4x8 countersunk head screws.
4. Remove the bottom grate (C). Remove and retain ten M6x16 hexagonal combination screws.

   The bottom grate is only available in optional configurations.

5. Remove the wiring cover and disconnect the fan wiring.
6. Remove the fan bracket (D). Remove and retain 8 M8x20 hexagonal combination screws.
7. Remove the fan (E). Remove and retain 5 M6x16 and 4 M4x12 hexagonal combination screws.
8. Install the new fan and fasten all screws in reverse sequence.
9. Finish up the maintenance and replacement by reinstalling the parts in reverse order.

   Finish the installation of the fan power and cable interface before fastening the cooling fan mounting screws.

10. If there is an air duct, restore and fix the interface of the air duct.

11. Check that the fan is in normal operation after power-on. Pay special attention to the rotation direction of the fan. The fan must suck air from the inlet window frame and blow air outwards from the top of the cabinet.

9.6.1 Diagram of the Cooling Fan Replacement

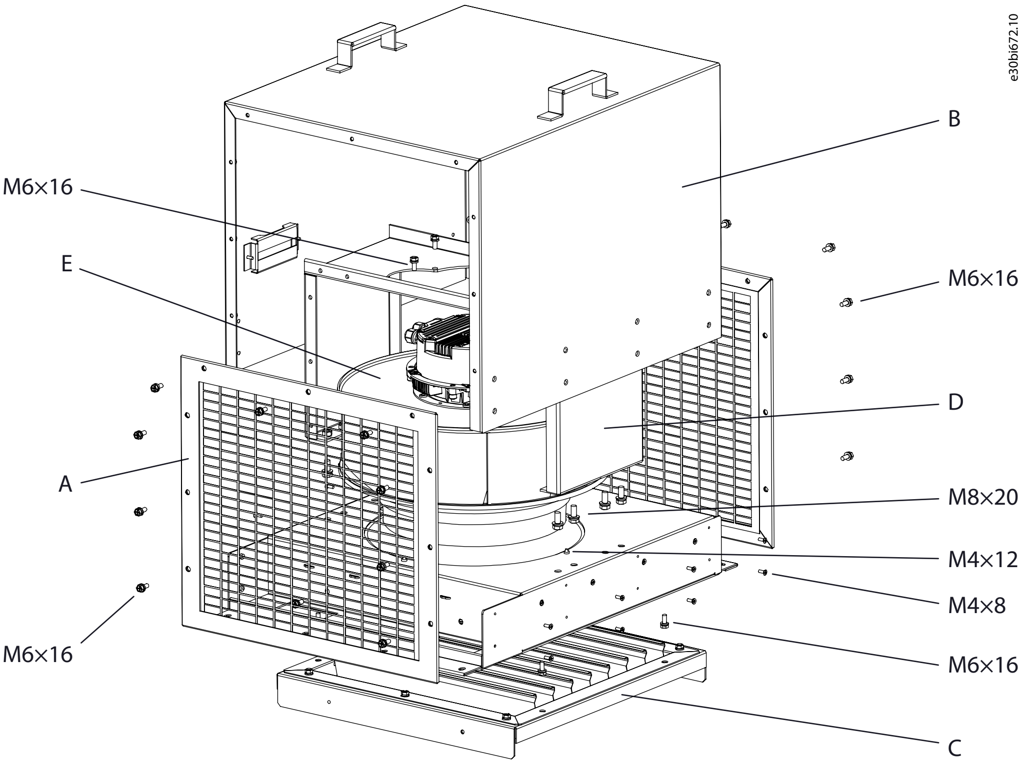

Illustration 76: Cooling Fan Replacement

A	Front and back grates	D	Fan bracket
B	Cooling fan cover	E	Cooling fan
C	Bottom grate		

9.7 UPS Battery

9.7.1 Replacing the UPS Battery

Procedure

1. Switch off QF15.
2. Remove the cover of the UPS battery. The cover is mounted with 4 screws.
3. Disconnect the wires from the battery terminals.
4. Install the new UPS battery and reconnect the wires.

   Note the polarity of the battery, and make sure that the wires are connected correctly.

9.7.2 UPS Battery Maintenance

If the UPS battery is not used in the long term, a scheduled periodical maintenance of the battery is highly recommended.

Table 12: Maintenance Schedule

Storage temperature	Maintenance interval
<20ºC	Every six months
20–30ºC	Every three months
>30ºC	Storage above this temperature in the long term is strictly forbidden.

A power supply with a tunable DC output and an output current limit function, is required for the maintenance.

Procedure

1. Tune the output voltage of the DC power to 14.4–14.7 V.
2. Set the output current limit to 1.3 A.
3. Connect the positive/negative poles of the DC power to the correspondent sides of the battery.

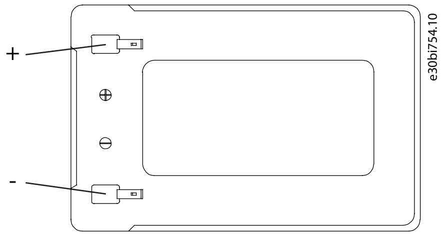

Illustration 77: UPS Battery Terminals

4. Switch on the DC power to charge the battery.
5. Charge each battery for at least 16–24 hours.
6. After charging, cut off the DC power and disconnect the wires between UPS battery and DC power.

9.8 Power Cells

9.8.1 Power Cell Maintenance

Procedure

1. Take the power cell out of the drive cabinet, or if in storage, out of its insulated plastic bag.
2. Place the power cell on an insulated location.

   The withstand voltage level must exceed the input power.

3. Connect a 3-phase power to the power cell input terminals though a 3-phase current-limiting resistor.

   Different power cells have different mechanical designs.
   Connect to the hung-up side of the fuses.

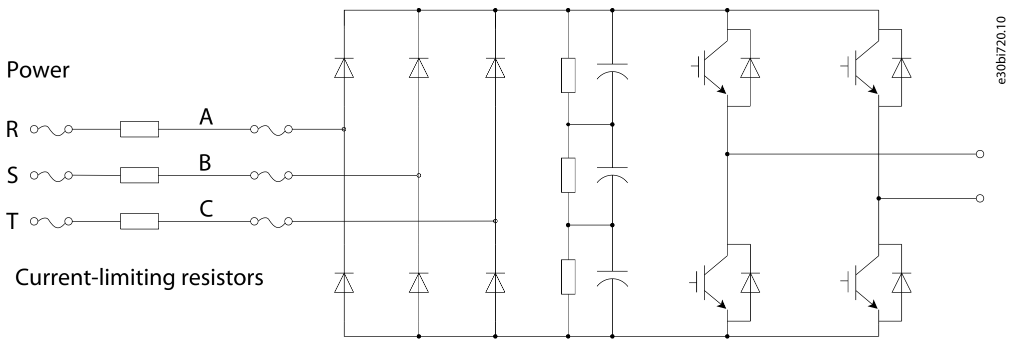

Illustration 78: Power Cell Circuit Diagram

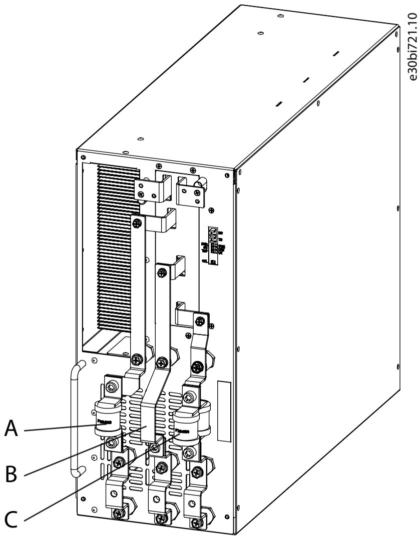

Illustration 79: Power Cell Input Terminals A, B, C

4. Power up the power cell and check the indicator lights on the power cell.

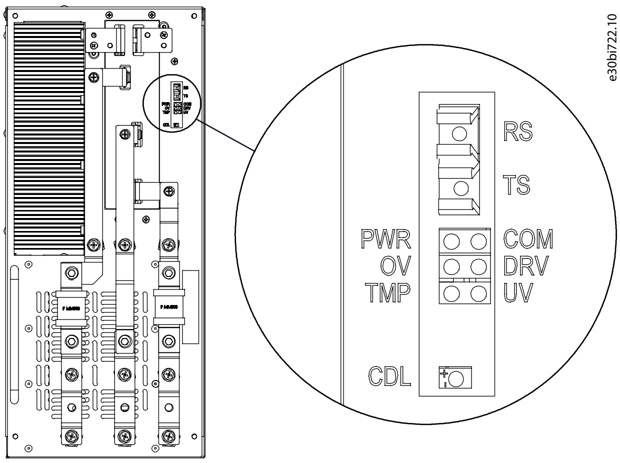

Illustration 80: Power Cell Indicator Locations

> The status of the power cell is normal if the indicators PWR and COM are on.
> If any other LED indicators are on, further inspection is necessary. Contact Danfoss.

5. Keep the power cell powered up for one hour.

> If after one hour there is nothing abnormal shown by the power cell indicators, the maintenance is done.

6. Turn off the power and remove the connections.
7. Put power cell back in the drive cabinet, or if stored, in its insulated plastic bag.
8. If there are any problems, contact Danfoss.

9.8.2 Replacing the Power Cells

Cut off the system power according to 9.2 Standard Maintenance Process and take all the safety measures.

Procedure

1. Disconnect the fiber optical wiring (A) from the power cell.

   See 9.8.2.1 Diagram of the Power Cell Replacement.

2. Remove the combination screws from the interconnection busbars (B) on the two sides of the power cells. Retain the screws carefully.

   Use an M6/M8 torque sleeve wrench.

3. Remove the fixed screws on the 3-phase input terminals (C). Retain the screws carefully.

   Use an M8/M10 torque sleeve wrench.

4. To release the power cell from the brackets (D), remove the screws in front of the power cell. Save the screws carefully.

   Use an M6 torque wrench.

5. Pull out the power cell along the guide rails (E).
6. Check the nameplate of each power cell. Confirm that the nameplate of the new power cell matches the old one.
7. Push the new power cell into place on along the guide rail.
8. Mount the power cell on the brackets.

   Use an M6 torque wrench to install the screws. Tighten the screws to torque 9.8±0.2 Nm.

9. Mount the 3-phase input cables on the power cell terminals.

   Use an M8/M10 torque sleeve wrench. The fixing order from outside to inside is flat washer, spring washer, screw nut.
   Tightening torques:
   - M8 screws: 9.8±0.2 Nm.
   - M10 screws: 24.5±0.5 Nm.

10. Mount the combination screws on the interconnection busbars.

    Use an M6/M8 torque sleeve wrench.
    Tightening torques:
    - M6 screws: 7.8±0.2 Nm.
    - M8 screws: 9.8±0.2 Nm.

11. Connect the fiber optical wiring on the power cell.

9.8.2.1 Diagram of the Power Cell Replacement

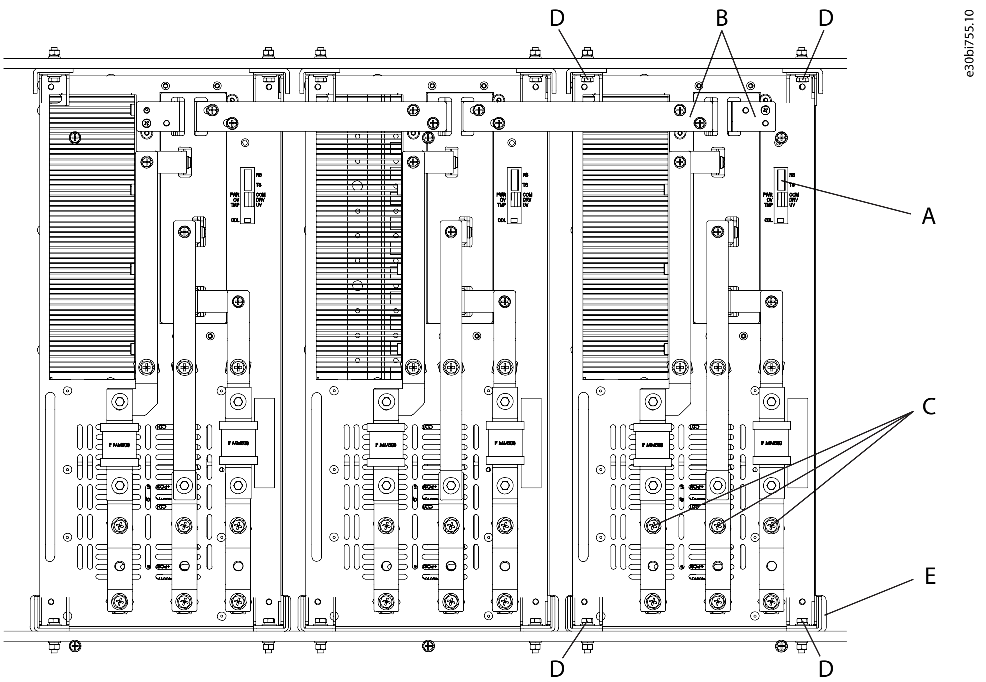

Illustration 81: Power Cell Replacement

A	Fiber optic connectors	D	Bracket
B	Interconnection busbars	E	Guide rail
C	Input terminals		

9.8.3 Reforming the Power Cell Capacitors

If a stored power cell has not been energized in the last 1 year, the electrolytic capacitors must be reformed. The reforming can be done with an AC or DC supply.

9.8.3.1 Reforming with an AC Supply

Required equipment:

- Three-phase voltage regulator, 0–750 V AC, ≥500 VA
- MCB, ≥380 V AC (460 V AC), ≥20 A

CAUTION

- During the reforming, observe whether there is any abnormal phenomenon. If there is anything abnormal, open the MCB immediately.
Make sure that the wiring for the reforming is done correctly.
Check that the power cell fuses are OK.
If there still are problems, contact Danfoss for assistance.

Procedure

1. Isolate the power cell from earth ground and separate it from personnel. Make sure that no wires are connected to the power cell output.
2. Connect the wires as shown in Illustration 82. Install the MCB between the AC supply and the voltage regulator. Connect the voltage regulator secondary winding to the power cell 3-phase input.

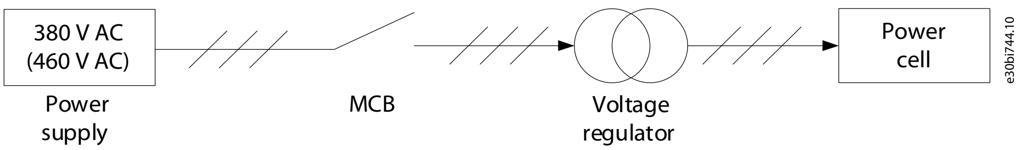

Illustration 82: AC Supply Wiring Diagram

3. Close the MCB. Turn on the voltage regulator, and bring up the input voltage slowly to 30% of the power cell nominal voltage (690 V AC). Maintain 30% voltage for 5 minutes.

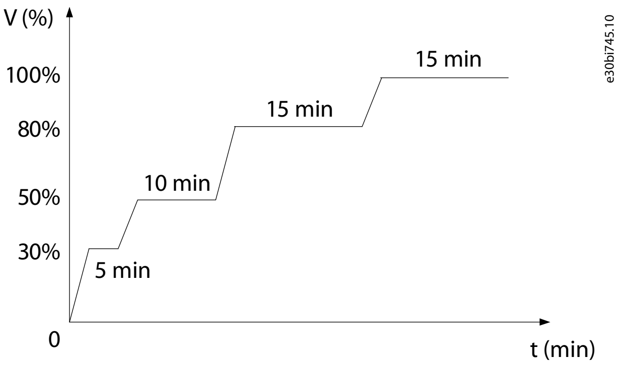

Illustration 83: Reforming Process Diagram

4. Slowly increase the regulator input voltage to 50%. Maintain the voltage for 10 minutes.
5. Slowly increase the regulator input voltage to 80%. Maintain the voltage for 15 minutes.
6. Slowly increase the regulator input voltage to 100%. Maintain the voltage for 15 minutes.
7. Once the process is complete, decrease the voltage source to zero and open the MCB.
8. Disconnect the voltage regulator from power cell and AC supply.

9. Wait for 15 minutes for the power cell capacitors to discharge fully.
10. Use a measuring device to make sure that there is no voltage.
11. Restore the original wiring.

9.8.3.2 Reforming with a DC Supply

Required equipment:

- DC supply, 0–1000 V DC adjustable, ≥1000 VA

CAUTION

- During the reforming, observe whether there is any abnormal phenomenon. If there is anything abnormal, open the MCB immediately.
  Make sure that the wiring for the reforming is done correctly.
  Check that the power cell fuses are OK.
  If there still are problems, contact Danfoss for assistance.

Procedure

1. Isolate the power cell from earth ground and separate it from personnel. Make sure that no wires are connected to the power cell output.
2. Connect the wires as shown in Illustration 84. Connect the DC supply to any 2 of the power cell input phases.

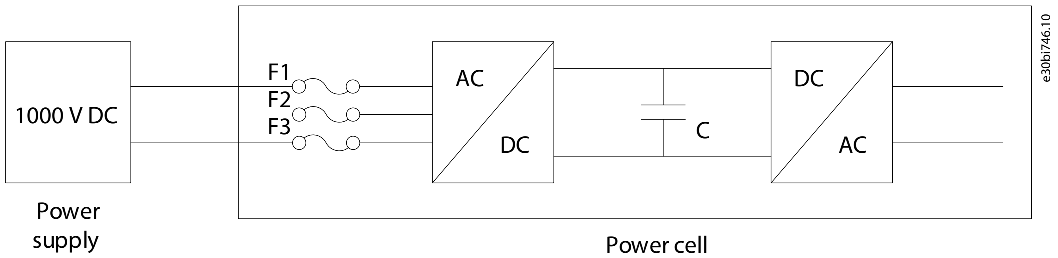

Illustration 84: DC Supply Wiring Diagram

3. Turn on the DC supply. To prevent DC supply overcurrent protection, step up the input voltage slowly to 30% of the power cell nominal voltage 975 V DC. Maintain 30% voltage for 5 minutes.
   See Illustration 83.
4. Slowly increase the DC supply input voltage to 50%. Maintain the voltage for 10 minutes.
5. Slowly increase the DC supply input voltage to 80%. Maintain the voltage for 15 minutes.
6. Slowly increase the DC supply input voltage to 100%. Maintain the voltage for 15 minutes.
7. Once the process is complete, decrease the voltage source to zero and turn off the DC suppply.
8. Disconnect the wires from the power cell and DC supply.
9. Wait for 15 minutes for the power cell capacitors to discharge fully.
10. Use a measuring device to make sure that there is no voltage.
11. Restore the original wiring.

9.9 Dielectric Withstand Test

Procedure

1. Disconnect the input and output cables.
2. Short the input terminals (3 phases).
3. Short the output terminals (3 phases).
4. Short the transformer auxiliary winding terminals (3 phases) and grounding.
5. Short all power cell input terminals and output terminals.
6. If installed, disconnect the neutral grounding resistor connected to power cell U1/V1/W1.
7. If installed, disconnect the surge arrestor, and the input and output voltage divider from the HV terminal.
8. Test the input and output voltages.
   - If the input voltage and output voltage ratings are not the same, conduct the dielectric withstand test separately.

- If the input voltage and output voltage rating are the same, conduct the dielectric withstand test covering both input and output.

9.9.1 Testing Input and Output Together

Procedure

1. Connect the shorted input and output terminals to ground.
2. Measure the insulation resistance between the input terminals and ground with a 1000 V megohmmeter. The resistance must be >100 MΩ.
3. Apply power frequency high voltage at the input terminal referred to ground for 5 s. No breakdown and flashover are required.
4. Measure the insulation resistance again. The resistance must be >100 MΩ, and the variation must be less than 30% compared with the first measurement result.
5. After the test, restore the drive to its original state. Restore the wiring connections and remove the shorting.

9.9.2 Testing Input and Output Separately

Procedure

1. Connect the shorted input and output terminals to ground.
2. Measure the insulation resistance between the input terminals and ground with a 1000 V megohmmeter. The resistance must be >100 MΩ.
3. Apply power frequency high voltage (see table) at the input terminal referred to ground for 60 s. No breakdown and flashover are required.

System voltage (kV)	Dielectric withstand voltage (kV)
2.3/2.4	8
3	9
3.3	10
4/4.16/4.2	12
4.8/5	14
6	17
6.3	18
6.6	19
6.9/7.2	20
8.4	22
10	25
11	27
11.4	28
12	29
12.47	30
13.2	32
13.8	34

4. Measure the insulation resistance again. The resistance must be >100 MΩ, and the variation must be less than 30% compared with the first measurement result.
5. Disconnect the short circuit wire between the output terminal to ground, and short the input terminal to ground.
6. Repeat the measurements in steps 2–4 for the output terminals.

7. After the test, restore the drive to its original state. Restore the wiring connections and remove the shorting.

10 Fault Tracing

10.1 Fault Types

When the control diagnostics of the drive find an unusual condition in the operation of the drive, the drive shows a notification about it. The notification can be seen on the display of the control panel. The display shows the number, the name, and a short description of the fault or alarm.

There are 2 different types of notification.

- An **alarm** informs of unusual operation on the drive. The alarm does not stop the drive. The system can be powered on, started, and operated normally.
- A **fault** stops the drive immediately. Reset the drive and find a solution to the problem. Do not operate the system until the problem has been found and corrected.

It is possible to configure different responses for some faults in the application. See 10.2 Fault Response Configuration.

To view specific information about alarms or faults, click *AlarmFault*.

Before contacting the distributor or the factory because of unusual operation, prepare some data. Write down the fault number and all other information on the display.

10.2 Fault Response Configuration

It is possible to configure different responses for some faults in the application. There are 9 valid combinations for alarm and fault action configuration.

Table 13: Fault Response Configurations for VACON® 1000

Configuration value	Detection enable	Alarm/Fault	Action (not running)	Action (running)
0	Disable	–	–	–
1	Enable	Alarm	No action	No action
2	Enable	Fault	No action	Coast stop
3	Enable	Fault	No action	Coast stop, and bypass system
4	Enable	Fault	No action	Deceleration and stop
5	Enable	Fault	No action	Trip MCB
6	Enable	Fault	No action	Trip MCB, and bypass system
7	Enable	Fault	Trip MCB	Trip MCB
8	Enable	Fault	Trip MCB	Trip MCB, and bypass system

10.3 Faults and Alarms

10.3.1 Fault Code 1 - Input Overcurrent (Software Fault)

Cause

The input current is higher than 150% of the rated current.

System default operation: Trip

Troubleshooting

- Check the input current.
- Check the set value.

10.3.2 Fault Code 2 - Input Phase Loss

Cause

One or more high-voltage input cables cannot supply primary power to the input transformer.

System default operation: Trip

Troubleshooting

- Check the input voltage.
- Check if the input cables are loose or disconnected.

10.3.3 Fault Code 3 - Input Power Loss

Cause

The voltage values of the 3 input phases are all lower than 70% of the rated value.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Check the input voltage.

10.3.4 Fault Code 4 - Input Undervoltage

Cause

The effective value of the input voltage is lower than 90% of the rated value.

System default operation: Alarm. System operation is configurable.

Troubleshooting

- Check the input voltage.

10.3.5 Fault Code 5 - Input Overvoltage

Cause

The effective value of the input voltage is higher than 110% of the rated value.

System default operation: Trip

Troubleshooting

- Check the input voltage.

10.3.6 Fault Code 6 - Input Grounding

Cause

Input grounding occurs, and the duration time is above 5 s.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Check the input cables, copper busbars, and transformer.

10.3.7 Fault Code 7 - Input Sequence Fault

Cause

The input cables are connected in reverse.

System default operation: Alarm. System operation is configurable.

Troubleshooting

- Check the sequence of the input cables.

10.3.8 Fault Code 8 - Output Overcurrent (Software Fault)

Cause

The output current is higher than 150% of the rated current.

System default operation: Coast stop. System operation is configurable.

Troubleshooting

- Check the output current.
- Check the set value.

10.3.9 Fault Code 9 - Output Overload

Cause

Constant torque: When the output current is higher than 150% of the rated current, allow for 1 minute overload every 10 minutes.

Variable torque: When the output current is higher than 120% of the rated current, allow for 1 minute overload every 10 minutes.

System default operation: Coast stop. System operation is configurable.

Troubleshooting

- Check the power grid voltage.
- Reset the rated current of the motor.
- Check the load and adjust the torque increase.
- Select proper motor.

10.3.10 Fault Code 10 - Output Phase Loss

Cause

The software detects that the output phase from the drive to motor is disconnected.

System default operation: Coast stop. System operation is configurable.

Troubleshooting

- Check if the output cables are loose or disconnected.

10.3.11 Fault Code 11 - Output Grounding

Cause

The software detects a grounding fault which is usually caused by an output grounding fault (phase-to-ground fault).

System default operation: Coast stop. System operation is configurable.

Troubleshooting

- Check that the external cables and the motor are grounded.
- Check the insulation of the motor and its cables.

10.3.12 Fault Code 12 - Output Phase Imbalance Alarm

Cause

During 10 minutes of continuous running time, the output imbalance is above 15‰ for a cumulative time of more than 30 s.

System default operation: Alarm. System operation is configurable.

Troubleshooting

- Check that the capacitance of the DC-link capacitors matches the specifications.
- Check that the voltage of the transformer secondary windings is balanced.

10.3.13 Fault Code 13 - Output Phase Imbalance Fault

Cause

The output imbalance is above 30‰ for over 1 s.

System default operation: Coast stop. System operation is configurable.

Troubleshooting

- Check that the capacitance of the DC-link capacitors matches the specifications.
- Check that the voltage of the transformer secondary windings is balanced.

10.3.14 Fault Code 14 - Output Underload

Cause

The software detects the motor operating in the underload area for longer than 20 s.

System default operation: Not detected. System operation is configurable.

Troubleshooting

- Check if the load of motor is too light.

10.3.15 Fault Code 15 - Electronic Motor Thermal Protection

Cause

The calculated temperature or temperature rise is higher than the setting value.

System default operation: Not detected. System operation is configurable.

Troubleshooting

- Check if the ambient temperature is high.
- Check if the load of the motor is heavy.

10.3.16 Fault Code 16 - Motor Stall

Cause

- The motor frequency/speed is below the set value.
- A torque limit condition is present.
- Both conditions occur simultaneously and the duration is above the stall time setting.

System default operation: Not detected. System operation is configurable.

Troubleshooting

- Check if the motor is overloaded.
- Check if there is a mechanical failure.
- Check if there are any other problems which make the motor jam.

10.3.17 Fault Code 17 - Motor Reverse

Cause

The motor is rotating in reverse.

System default operation: Not detected. System operation is configurable.

Troubleshooting

- Check the motor rotating status.

10.3.18 Fault Code 18 - Motor Overspeed

Cause

The speed of the motor is 120% of the maximum operational speed for longer than 10 s.

System default operation: Coast stop. System operation is configurable.

Troubleshooting

- Check the motor status.
- Check if the speed encoder is broken.

10.3.19 Fault Code 19 - Motor Underspeed

Cause

The speed of the motor is 6% of the minimum operational speed for longer than 60 s.

System default operation: Not detected. System operation is configurable.

Troubleshooting

- Check the motor status.
- Check if the speed encoder is broken.

10.3.20 Fault Code 20 - Analog Reference Loss

Cause

The analog input is disconnected.

System default operation: Alarm. System operation is configurable. The system continues to operate and keeps the last reference speed.

Troubleshooting

- Check the analog circuit.

10.3.21 Fault Code 21 - Encoder Abnormal

Cause

The encoder signal is lost or the error between encoder speed and estimated speed is higher than 5%.

System default operation: Coast stop during SVC, not detected during SLVC. System operation is configurable.

Troubleshooting

- Check if the encoder is operating normally.

10.3.22 Fault Code 22 - Input Overcurrent (Hardware Fault)

Cause

The input current is larger than 210% of the input current sample rating.

System default operation: Trip

Troubleshooting

- Check the input current.

10.3.23 Fault Code 23 - Output Overcurrent (Hardware Fault)

Cause

The output current is larger than 210% of the output current sample rating.

System default operation: Trip

Troubleshooting

- Check the output current.

10.3.24 Fault Code 24 - Current Sensor Power Fault

Cause

The LEM power board is not energized.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Check the supply of the LEM power board.

10.3.25 Fault Code 25 - Bypassed Cell Quantity Over Limit

Cause

The quantity of bypassed power cells in one phase is above the setting value.

System default operation: Coast stop

Troubleshooting

- Check the power cells for faults.
- Check the quantity of bypassed power cells.
- Repair or replace the failed power cell.

10.3.26 Fault Code 26 - System Running with MCB Open

Cause

During operation, the MCB status digital input in the main controller I/O board is open.

System default operation: Coast stop

Troubleshooting

- Check the status of the MCB.

10.3.27 Fault Code 27 - Synchronous Switch Status Error

Cause

KM2 and KM4 are closed at the same time before synchronous transfer start.

System default operation: Trip

Troubleshooting

- Check the status of switches.

10.3.28 Fault Code 28 - Auto Tuning Failure

Cause

During auto tuning, a fault occurs or a stop command is received.

System default operation: Coast stop

Troubleshooting

- Check the fault record.

10.3.29 Fault Code 29 - Flying Start Failure

Cause

During flying start, a speed search failure occurs or any other fault is generated.

System default operation: Coast stop

Troubleshooting

- If a speed search failure caused the flying start failure, check the parameter of the flying start result for the reason for the flying start failure.
- If some other fault caused the flying start failure, check the fault record.

10.3.30 Fault Code 30 - Automatic Restart Failure

Cause

During the trial time of the automatic restart, the number of faults is higher than the maximum number of trials, or a permanent fault occurs.

System default operation: Trip

Troubleshooting

- Check the fault record.

10.3.31 Fault Code 31 - Synchronous Transfer Failure

Cause

One of the following occurs during synchronous transfer:

- Switch status/close/open failure.
- Speed stable timeout. Caused by load fluctuation, which can occur during acceleration to grid frequency in the drive to grid synchronization process.
- Voltage synchronous timeout. Caused by electric network fluctuation, which can occur during the voltage synchronization process.
- Load transfer timeout. Caused by load fluctuation, which can occur during the load transfer process.

System default operation: Trip

Troubleshooting

- If there is a switch status/close/open failure:
  - Check the status of the switches.
  - Check the wiring of the digital inputs/outputs.
  - Make sure that there are no problems with the breaker.
- If there is a speed stable timeout, modify parameter “Speed err threshold of synchronous transfer” (P0772).
- If there is a voltage synchronous timeout, modify one of these parameters:
  - “Phase error threshold of synchronous transfer” (P0767)
  - “Voltage error threshold of synchronous transfer” (P0771)
  - “Maximum voltage synchronize time of synchronous transfer” (P0778)
- If there is a load transfer timeout, modify one of these parameters:
  - “Current error threshold of synchronous transfer” (P0353)
  - “Maximum load transfer time of synchronous transfer” (P0779)

10.3.32 Fault Code 32 - Failure Of Motor Selection

Cause

The serial number of selected motor is wrong.

System default operation: Coast stop

Troubleshooting

- Check if the value of parameter “Motor selection” is larger than parameter “Maximum number of motor”.
- Check that the motor connected to the drive is the motor specified by parameter “Motor selection”.

10.3.33 Fault Code 33 - LVRT Failure

Cause

One of the following occurs during the low voltage ride through:

- The duration of power loss is more than 1 s.
- The DC-capacitor voltage is below 400 V.
- The motor speed is below 5%.

System default operation: Trip

Troubleshooting

- Check the parameter "Fault flag of low voltage ride through".
- Modify the related parameters according to parameter "Fault flag of low voltage ride through".

10.3.34 Fault Code 34 - Bypass Derating Failure

Cause

During bypass derating, another power cell bypass occurs.

System default operation: Coast stop

Troubleshooting

- If the quantity of bypassed power cells is not over the limit, reset and start the system.
- If the quantity of bypassed power cells is over the limit:
  - Check the fault of the power cell.
  - Check the quantity of the bypassed power cells.
  - Repair or replace the failed power cell.

10.3.35 Fault Code 35 - Input Current Sampling Fault

Cause

Input current is out of the current sampling scope.

System default operation: Trip

Troubleshooting

- Check the input current.

10.3.36 Fault Code 36 - Output Current Sampling Fault

Cause

Output current is out of the current sampling scope.

System default operation: Coast stop. System operation is configurable.

Troubleshooting

- Check the output current.

10.3.37 Fault Code 37 - Internal Control Power Loss

Cause

The back-up control power provided by the phase-shift transformer auxiliary winding is lost.

System default operation: Alarm

Troubleshooting

- Check the wiring and voltage of the back-up control power.
- Check that the corresponding switches are closed.
- Check that the corresponding relays work normally.

10.3.38 Fault Code 38 - External/Customer Control Power Loss

Cause

The external control power is lost.

System default operation: Alarm

Troubleshooting

- Check the wiring and voltage of the external control power.
- Check that the corresponding switches are closed.
- Check that the corresponding relays work normally.

10.3.39 Fault Code 39 - Control Power Loss Overtime

Cause

Both the external control power and the back-up power from the phase-shift transformer are lost simultaneously for more than 30 minutes.

System default operation: Trip

Troubleshooting

- Check the wiring and voltage of the external control power.
- Check the wiring and voltage of the internal back-up control power.
- Check that the corresponding switches are closed.
- Check that the corresponding relays work normally.

10.3.40 Fault Code 40 - UPS Undervoltage

Cause

The fault information is reported when the battery voltage is low.

System default operation: Alarm

Troubleshooting

- Check if the voltage of each battery is above 12 V.
- Check if the switch mode power supply module output voltage is 26 V.

10.3.41 Fault Code 41 - UPS Undervoltage Overtime

Cause

After the external control power and the back-up power from the phase-shift transformer are lost, the UPS undervoltage occurs for over 1 minute.

System default operation: Trip

Troubleshooting

- Check the wiring and voltage of the external control power.
- Check the wiring and voltage of the internal back-up control power.
- Check that the corresponding switches are closed.
- Check that the corresponding relays work normally.
- Find the reasons for UPS failure and restore the supply as soon as possible.

10.3.42 Fault Code 42 - HV Cabinet Door Open

Cause

The high-voltage cabinet door is open.

System default operation: Trip

- If the drive cabinet door is open before the high-voltage power-on, the closing allowed signal cannot be sent.
- If the drive cabinet door is opened during operation, the system stops immediately.

Troubleshooting

- Check the state of the drive cabinet doors.
- Check the position switch of the cabinet door and its contacts.

10.3.43 Fault Code 43 - Air Filter Clogged

Cause

Comparison with the set value of the internal cabinet air pressure: $P_{under} < P_{set}$ -25 pa. The reason can be the clogging of the air filter.

System default operation: Alarm

Troubleshooting

- Check if the air filter is clogged.
- Check if the air pressure sensor works normally.

10.3.44 Fault Code 44 - Cooling Fan Abnormal

Cause

Cooling fan motor winding overheating. To indicate this fault, the normally closed contact is opened.

System default operation: Alarm. System operation is configurable.

Troubleshooting

- Check if the fan rotates in reverse direction.
- Check if the fan is blocked.

10.3.45 Fault Code 45 - Fan Internal Power Loss

Cause

When the power of the cooling fan has a failure, the normally closed contact of the fan breaker is opened.

System default operation: Alarm. System operation is configurable.

Troubleshooting

- Check the fan breaker.
- Check whether the power supply circuit is normal.

10.3.46 Fault Code 46 - Fan External Power Loss

Cause

When there is a phase loss or undervoltage of the external fan power, this alarm is triggered.

System default operation: Alarm. System operation is configurable.

Troubleshooting

- Check the wiring and voltage of the external fan power.

10.3.47 Fault Code 47 - Cooling Fan Failure

Cause

The fan breaker is tripped or fan interior thermal relay is opened.

System default operation: Alarm

Troubleshooting

- Check the fan breaker.
- Check if the thermal relay is opened.
- Check if the fan is blocked.

10.3.48 Fault Code 48 - Transformer Overtemperature Alarm

Cause

The failure information is reported when the temperature of the transformer exceeds 95°C.

System default operation: Alarm

Troubleshooting

- Check if the ambient temperature is too high.
- Check that the cooling fans on top of the transformer are working normally.
- Check if the air filter is clogged.
- Check if the drive is in overload operation for a long time.
- Check if the temperature sensor is in good condition.

10.3.49 Fault Code 49 - Transformer Overtemperature Fault

Cause

The failure information is reported when the temperature of the transformer exceeds 110°C.

System default operation: Trip

Troubleshooting

- Check if the ambient temperature is too high.
- Check that the cooling fans on top of the transformer are working normally.
- Check if the air filter is clogged.
- Check if the drive is in overload operation for a long time.
- Check if the temperature sensor is in good condition.

10.3.50 Fault Code 50 - Transformer Temperature Sensor Loss

Cause

The three PT100 thermal resistors in transformer windings A, B, and C are connected to the PT thermometric module in the PLC. If the connection is loose, or one of the PT100 resistors in the transformer is damaged, the PLC detects the malfunction and reports the fault.

System default operation: Alarm. System operation is configurable.

Troubleshooting

- Check that the wiring is firmly connected.
- Check if one of the PT100 resistors is damaged.

10.3.51 Fault Code 51 - Emergency Stop

Cause

The emergency stop push button on the control cabinet door is pressed.

System default operation: Trip

Troubleshooting

- Release the emergency stop push button on control cabinet door.

10.3.52 Fault Code 52 - Remote Emergency Stop

Cause

The external emergency stop command is effective.

System default operation: No operation

Troubleshooting

- Release the remote emergency stop push button.

10.3.53 Fault Code 53 - PLC–DSP Communication Failure

Cause

The PLC disconnects with the main control system.

System default operation: Alarm. System operation is configurable. The system continues to operate at the reference speed set before the disconnection.

Troubleshooting

- Check the communication circuit.

10.3.54 Fault Code 54 - PLC–HMI Communication Failure

Cause

The PLC disconnects with the HMI.

System default operation: Alarm

Troubleshooting

- Check the communication circuit.

10.3.55 Fault Code 55 - Upstream Main Circuit Breaker Abnormal Open

Cause

When running, the drive receives the open signal of the high-voltage circuit breaker.

System default operation: Coast stop

Troubleshooting

- Check if the input high voltage exists.
- Check that the internal cabling is firm and correct.

10.3.56 Fault Code 56 - Upstream Main Circuit Breaker Open Failure

Cause

The upstream main circuit breaker did not open in over 3 s after receiving the opening signal.

System default operation: Alarm

Troubleshooting

- Check if the input high voltage exists.
- Check that the internal cabling is firm and correct.
- Check if the opening command is sent correctly.

10.3.57 Fault Code 57 - Startup Cabinet Switch Abnormal Open

Cause

After the drive high voltage is on and the start-up cabinet switch is closed, the start-up cabinet switch opens unexpectedly before the upstream main circuit breaker opens.

System default operation: Trip

Troubleshooting

- Check that the startup cabinet switch is normal.
- Check that the internal cabling is firm and correct.

10.3.58 Fault Code 58 - Startup Cabinet Switch Open Failure

Cause

The start-up cabinet switch did not open in over 3 s after receiving the opening signal.

System default operation: Trip

Troubleshooting

- Check that the start-up cabinet switch is normal.
- Check that the internal cabling is firm and correct.

10.3.59 Fault Code 59 - Startup Cabinet Switch Close Failure

Cause

The start-up cabinet switch did not close in over 3 s after receiving the closing signal.

System default operation: Trip

Troubleshooting

- Check that the start-up cabinet switch is normal.
- Check that the internal cabling is firm and correct.

10.3.60 Fault Code 60 - PLC–DSP Communication failure

Cause

Unable to close start-up cabinet. After the drive high voltage is on, and before the start-up cabinet switch is closed, the PLC disconnects with the main control system.

System default operation: Trip

Troubleshooting

- Check the wiring of the communication circuit.

10.3.61 Fault Code 61 - Auto Bypass Failure

Cause

Bypass cabinet switches did not operate correctly after receiving auto bypass signal.

System default operation: Trip

Troubleshooting

- Check that the bypass cabinet switch is normal.
- Check that the internal cabling is firm and correct.

10.3.62 Fault Code 62 - Auto Bypass Condition is not Satisfied

Cause

The operation status of the drive does not meet the bypass condition.

System default operation: Trip

Troubleshooting

- None.

10.3.63 Fault Code 63 - External Fault

Cause

To realize an external motor protection, the motor protection relay can be connected to one preset protection input of the drive.

System default operation: Coast stop. System operation is configurable.

Troubleshooting

- Check if the user terminal has fault signal output.
- Check that the wiring of the signal circuit is correct.

10.3.64 Fault Code 64 - Power Cell DC-link Undervoltage

Cause

The DC-link voltage is higher than 300 V, but lower than 580 V.

System default operation: Alarm

Troubleshooting

- Check if the high-voltage input is lower than the minimum allowed value.
- Check if the 3-phase input to the power cell is loose.
- Check that the fuse is in good condition.

10.3.65 Fault Code 65 - Power Cell Overtemperature

Cause

If the temperature of the cooling heat sink near the IGBT is higher than the designed value, the normally closed contact of the temperature sensor switch is disconnected.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Check if the ambient temperature exceeds the allowed value.
- Check that the cooling fan on the top of the cabinet is working normally.
- Check if the inlet air filter is clogged.
- Check if the drive is in overload operation for a long time.
- Check that the power cell temperature relay works normally.

10.3.66 Fault Code 66 - Power Cell IGBT Driver Fault

Cause

The IGBT has a failure.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Check that the power cell fault indicator is working normally.

10.3.67 Fault Code 67 - Power Cell Input Phase Loss

Cause

One of the three input phases is lost.

System default operation: Alarm. System operation is configurable. Detected in PL. Not detected in PU.

Troubleshooting

- Check if the 3-phase input of the power cell is loose.
- Check if the fuse is in good condition.
- Check the input voltage.

10.3.68 Fault Code 68 - Downstream Fiber Communication Fault

Cause

The power cell has not received the signals from the optical fiber communication board.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Check that the optical fibers are in normal condition.
- Check if the joints of the optical fibers are loose or falling off.

10.3.69 Fault Code 69 - Power Cell DC-link Overvoltage

Cause

The DC-link voltage exceeds 1150 V.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Check if the high-voltage input exceeds the maximum allowed value.
- If overvoltage occurs during deceleration, make the deceleration time of the drive longer.

10.3.70 Fault Code 70 - Power Cell DC-link Ultra Overvoltage

Cause

The DC-link voltage exceeds 1300 V.

System default operation: Trip

Troubleshooting

- Check if the high-voltage input exceeds the maximum allowed value.
- If overvoltage occurs during deceleration, make the deceleration time of the drive longer.

10.3.71 Fault Code 71 - Power Cell Control Power Fault

Cause

Power cell auxiliary power supply is abnormal.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Power on again. If the cell still reports this fault, replace the power cell.

10.3.72 Fault Code 72 - Power Cell Capacitor Voltage Abnormal

Cause

The voltage of the middle capacitors is 40 V higher or lower than one third of DC-link voltage.

System default operation: Trip. System operation is configurable. Detected in PL. Not detected in PU.

Troubleshooting

- Check that the balance resistors are in good condition.
- Check that the DC-link capacitors are in good condition.

10.3.73 Fault Code 73 - Upstream Fiber Communication Fault

Cause

The optical fiber communication board has not received the signals from the power cell unit.

System default operation: Trip. System operation is configurable.

Troubleshooting

- Check if the optical fibers are damaged.
- Check if the joints of the optical fibers are loose.

11 Specifications

11.1 Technical Data

Table 14: Technical Data for VACON® 1000

System technology	Topology type	Multilevel IGBT topology (Cascade H-Bridge)
	Technology	Voltage source inverter (VSI)
	Inverter configuration	Pulse-width modulated (PWM) power modules
Input	Voltage range	-10%...+10% (normal operation) -10%...-30% (derated continuous operation)
	Input frequency	50/60 Hz (±5% transients)
	Input voltage tolerance	±10% of nominal, unbalance up to 3% per IEC 610002-4
	Input voltage sag	-30% of nominal without tripping Continuous operation with reduced power, derated power 70–90%.
	Short-circuit current rating (SCCR)	31.5 kA, 100 ms
	Control voltage with circuit protection	1-phase 230 V AC, 50 Hz 1-phase 220 V AC, 60 Hz
	Control power	1-phase AC 120–240 V 3-phase AC 240–480 V Capacity 5 kVA (other voltages available)
	Input current distortion	Meets IEEE 519 standard, without input filter
	Input current THD	<5% (at rated load)
	Input voltage THD	<5% (at rated load)
Input transformer	Input impedance device	Multiphase isolation transformer integrated into the drive
	Transformer type of construction	Dry type, phase shifting, Cu/Cu; Forced air cooling Al/Cu or Al/Al available as an engineered option.
	Transformer insulation type	Class 180 (H)
	Transformer inrush current limitation	I_n >215 A limited with start-up cabinet (optional, +PSTC)
	Transformer secondary for auxiliaries	3-phase, 460 V AC with neutral and with a 380 V AC tap, 50/60 Hz
	Temperature sensors in transformer windings	3x PT100, one in each winding
Grounding	Grounding system	As per IEC61936-1
	Ground busbar	Tin-plated grounding busbar section
Output	Output voltage range	2.4–11 kV
	Output current THDi (1st…49th)	<2% at rated speed

	Output dU/dt	<3000 V/µs
	Output frequency range	0–75 Hz (higher frequencies, for example, 120 Hz can be evaluated)
	Loading	Squared torque Constant torque Constant torque and/or power
	Motor type	Induction (asynchronous) motor Synchronous motor (with separate excitation)
	Power factor	>0.96 (at rated load)
	System efficiency	>98.5% (at rated load, excluding transformer) >96.5% (at rated load, including transformer)
	Overload capacity	110% for 1 min every 10 min (variable torque applications) 150% for 1 min every 10 min (constant torque applications) For other overload capacity requirements, contact Danfoss.
	Start-up torque	>120% rated torque If higher start-up torque is required, contact Danfoss.
	Frequency resolution	0.01 Hz
	Speed control range	1–100% (with Closed-loop Vector Control) 5–100% (with Sensorless Vector Control)
	Steady state speed control accuracy (% of rated speed)	±0.01% (with Closed-loop Vector Control, depending on sensor accuracy) ±0.5% (with Sensorless Vector Control)
	Speed response bandwidth	60 rad/s (with closed loop control) 20 rad/s (with sensorless control)
	Current response bandwidth	600 rad/s
	Design operating time	24 hours/day
	Minimum availability per 12 months	99.97%
	Product lifetime	20 years
	MTBF	Up to 200000 hours of nonstop operation depending on the voltage class and current rating
Control parameters	Motor control method	U/F control Sensorless Vector Control Vector Control with speed feedback Speed and torque control
	PID function	Built-in PID regulator with configurable parameters
	Modulation method	SPWM/SVPWM
	Acceleration/deceleration time	0–3000 s (configurable)

	Protections	Input overcurrent, input phase loss, input power loss, input undervoltage, input overvoltage, input grounding, input sequence fault, output overcurrent, output overload, output phase loss, output grounding, output phase imbalance, output underload, electronic motor thermal protection, motor stall, motor reverse, motor overspeed, motor underspeed, speed setting analog loss, encoder abnormal, external fault, current sensor power fault, input current sampling fault, output current sampling fault, motor winding over temperature, motor bearing overtemperature, air filter clogged, upstream main circuit breaker abnormal open, HV cabinet door open, control power loss, transformer overtemperature, PLC-DSP communication failure, cooling fan abnormal, UPS undervoltage, fan power loss, transformer temperature sensor loss, PLC battery voltage low, PLC-HMI communication failure, upstream main circuit breaker close/open failure, startup cabinet switch abnormal open, startup cabinet switch close/open failure, cooling fan failure
	Functions	Speed ramps selection, S-curve, frequency skip, multi-point V/F, torque boost, AVR, dead-band compensation, Jog, flying start, DC braking, field weakening, energy saving operation, droop control, speed feedforward control, overvoltage prevention during deceleration, power cell symmetrical bypass, negative sequence compensation, input undervoltage derating, low voltage ride through, automatic restart, synchronous transfer, multi motor parameter storage, system auto bypass
	Analog input	0–10 V/4–20 mA, 2 channels
	Analog output	0–10 V/4–20 mA, 4 channels
	Digital input/output	7 sets input (standard, expandable) 10 sets output (standard, expandable)
	Human-machine interface	7" touch screen (standard) 10" touch screen available as option
	Display parameters	Target speed Output speed Input/output currents Operation status indication
	Communication interface	Standard: Modbus RTU
		Options: PROFIBUS DP (DP-V0), DeviceNetô , Modbus TCP, PROFINET I/O, EtherNet/IPô , EtherCATÆ, CANopenÆ, POWERLINK, ControlNetô
	Communication protocol	MODBUS, PROFIBUS (optional)
Operation environment	Ambient temperature (operation)	0°C...+40°C (normal operation) +40°C...+50°C (derated operation)
	Ambient temperature (storage/transportation)	-40°C...+70°C
	Relative humidity (operation)	5–95%, no condensation
	Relative humidity (storage/transportation)	10–95%, no condensation
	Altitude	<1000 m (standard) 1000–2000 m (derating)

		>2000 m (on request)
	Chemical environment conditions	IEC 60721-3-3: Class 3C2
	Environment corrosion category	According to ISO/EN 12944-2: C1 as default; C4 as an engineered option
	Electromagnetic compatibility environment	IEC 61000-2-5: Industrial
	Seismic zone/Ground acceleration	Zone 2 (standard) Zone 4 (optional, +SZ04)
	System burn-in at factory before delivery	4 h minimum, according to IEEE 1566
	ATEX area: Flammable product/Zone	IEC 60079-10-1/2: as an engineered option, certified per EN 50495:2010
	Noise level	≤85 dB(A) at 1 m from the enclosure
Structure	Dimension and weight	See 11.2 Power Ratings and Dimensions.
	Cabinet sheet metal thickness	Doors and panels: 1.5 mm Base: 5 mm
	Cable entry	Input, motor, and control cables: Bottom and top
Cooling system	Type	Forced air cooling including fan monitoring. Fan redundancy available as option, +QDFR.
	External auxiliary AC voltage for cooling fans (optional, +QDEX)	380–460 V AC, 50 Hz 380–460 V AC, 60 Hz
Protection level	IEC	IP31 (standard) IP42 (optional, +IP42)
	UL	NEMA 1
Auxiliaries	Cabinet lights	In the control cabinet
	Power cell bypass	Automatic via IGBT, 1 ms bypass time (optional, +PPCB)
	UPS for control voltage (DC)	30 min running time

11.2 Power Ratings and Dimensions

11.2.1 IEC Ratings

Table 15: Nominal Voltage 3000 V, 18-pulse, 3 Power Cells per Phase, 50 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-030+G2CE	36	180	26	130	1210	1250	2796	2000
VACON1000-ED-050-030+G2CE	50	250	36	180	1210	1250	2796	2050
VACON1000-ED-070-030+G2CE	70	360	51	260	1210	1250	2796	2100
VACON1000-ED-090-030+G2CE	90	460	66	340	1610	1250	2888	2850
VACON1000-ED-100-030+G2CE	100	510	73	370	1610	1250	2888	2900
VACON1000-ED-120-030+G2CE	120	620	88	450	1610	1250	2888	2950
VACON1000-ED-140-030+G2CE	140	720	102	530	1610	1250	2888	3000
VACON1000-ED-150-030+G2CE	150	770	110	570	1910	1250	2888	4350
VACON1000-ED-180-030+G2CE	180	930	132	680	1910	1250	2888	4400
VACON1000-ED-190-030+G2CE	190	980	139	720	1910	1250	2888	4450
VACON1000-ED-215-030+G2CE	215	1110	157	810	1910	1250	2888	4500
VACON1000-ED-250-030+G2CE	250	1290	183	950	3810	1400	2796	5100
VACON1000-ED-305-030+G2CE	305	1580	223	1150	4110	1400	2796	5500
VACON1000-ED-350-030+G2CE	350	1810	256	1330	4110	1400	2796	5800
VACON1000-ED-438-030+G2CE	438	2270	321	1660	4710	1400	2796	6950
VACON1000-ED-560-030+G2CE	560	2900	410	2130	5010	1400	2796	8300
VACON1000-ED-680-030+G2CE	680	3530	498	2580	5010	1400	2796	9350

Table 16: Nominal Voltage 3300 V, 18-pulse, 3 Power Cells per Phase, 50 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-033+G2CE	36	200	26	140	1210	1250	2796	2200
VACON1000-ED-050-033+G2CE	50	280	36	200	1210	1250	2796	2250
VACON1000-ED-070-033+G2CE	70	400	51	290	1210	1250	2796	2300
VACON1000-ED-090-033+G2CE	90	510	66	370	1610	1250	2888	3050
VACON1000-ED-100-033+G2CE	100	570	73	410	1610	1250	2888	3100
VACON1000-ED-120-033+G2CE	120	680	88	500	1610	1250	2888	3150
VACON1000-ED-140-033+G2CE	140	800	102	580	1610	1250	2888	3200
VACON1000-ED-150-033+G2CE	150	850	110	620	1910	1250	2888	4550
VACON1000-ED-180-033+G2CE	180	1020	132	750	1910	1250	2888	4600
VACON1000-ED-190-033+G2CE	190	1080	139	790	1910	1250	2888	4650
VACON1000-ED-215-033+G2CE	215	1220	157	890	1910	1250	2888	4700
VACON1000-ED-250-033+G2CE	250	1420	183	1040	4110	1400	2796	5300
VACON1000-ED-305-033+G2CE	305	1740	223	1270	4110	1400	2796	5800
VACON1000-ED-350-033+G2CE	350	2000	256	1460	4110	1400	2796	6100
VACON1000-ED-438-033+G2CE	438	2500	321	1830	4710	1400	2796	7450
VACON1000-ED-560-033+G2CE	560	3200	410	2340	5010	1400	2796	8700
VACON1000-ED-680-033+G2CE	680	3880	498	2840	5010	1400	2796	9950

Table 17: Nominal Voltage 4160 V, 24-pulse, 4 Power Cells per Phase, 50 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-041+G2CE	36	250	26	180	1210	1250	2796	2400
VACON1000-ED-050-041+G2CE	50	360	36	250	1210	1250	2796	2450
VACON1000-ED-070-041+G2CE	70	500	51	360	1210	1250	2796	2500
VACON1000-ED-090-041+G2CE	90	640	66	470	1610	1250	2888	3250
VACON1000-ED-100-041+G2CE	100	720	73	520	1610	1250	2888	3300
VACON1000-ED-120-041+G2CE	120	860	88	630	1610	1250	2888	3350
VACON1000-ED-140-041+G2CE	140	1000	102	730	1610	1250	2888	3400
VACON1000-ED-150-041+G2CE	150	1080	110	790	1910	1250	2888	4750
VACON1000-ED-180-041+G2CE	180	1290	132	950	1910	1250	2888	4800
VACON1000-ED-190-041+G2CE	190	1360	139	1000	1910	1250	2888	4850
VACON1000-ED-215-041+G2CE	215	1540	157	1130	1910	1250	2888	4900
VACON1000-ED-250-041+G2CE	250	1800	183	1310	4610	1400	2796	6150
VACON1000-ED-305-041+G2CE	305	2190	223	1600	4610	1400	2796	6850
VACON1000-ED-350-041+G2CE	350	2520	256	1840	4610	1400	2796	7450
VACON1000-ED-438-041+G2CE	438	3150	321	2310	5410	1400	2796	9000
VACON1000-ED-560-041+G2CE	560	4030	410	2950	5410	1400	2796	10700
VACON1000-ED-680-041+G2CE	680	4890	498	3580	5810	1400	2796	11950

Table 18: Nominal Voltage 6000 V, 30-pulse, 5 Power Cells per Phase, 50 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-060+G2CE	36	370	26	270	2310	1250	2796	3500
VACON1000-ED-050-060+G2CE	50	510	36	370	2310	1250	2796	3550
VACON1000-ED-070-060+G2CE	70	720	51	530	2310	1250	2796	3600
VACON1000-ED-090-060+G2CE	90	930	66	680	2710	1250	2888	4850
VACON1000-ED-100-060+G2CE	100	1030	73	750	2710	1250	2888	4900
VACON1000-ED-120-060+G2CE	120	1240	88	910	2710	1250	2888	4950
VACON1000-ED-140-060+G2CE	140	1450	102	1060	2710	1250	2888	5000
VACON1000-ED-150-060+G2CE	150	1550	110	1140	3010	1250	2888	5850
VACON1000-ED-180-060+G2CE	180	1870	132	1370	3010	1250	2888	5900
VACON1000-ED-190-060+G2CE	190	1970	139	1440	3010	1250	2888	5950
VACON1000-ED-215-060+G2CE	215	2230	157	1630	3010	1250	2888	6000
VACON1000-ED-250-060+G2CE	250	2590	183	1900	5160	1400	2796	7700
VACON1000-ED-305-060+G2CE	305	3160	223	2310	5160	1400	2796	8600
VACON1000-ED-350-060+G2CE	350	3630	256	2660	5160	1400	2796	9200
VACON1000-ED-438-060+G2CE	438	4550	321	3330	6410	1400	2796	11500
VACON1000-ED-560-060+G2CE	560	5810	410	4260	6610	1400	2796	13750
VACON1000-ED-680-060+G2CE	680	7060	498	5170	7210	1600	2796	15500

Table 19: Nominal Voltage 6600 V, 36-pulse, 6 Power Cells per Phase, 50 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-066+G2CE	36	410	26	290	2310	1250	2796	3700
VACON1000-ED-050-066+G2CE	50	570	36	410	2310	1250	2796	3750
VACON1000-ED-070-066+G2CE	70	800	51	580	2310	1250	2796	3800
VACON1000-ED-090-066+G2CE	90	1020	66	750	2710	1250	2888	5050
VACON1000-ED-100-066+G2CE	100	1140	73	830	2710	1250	2888	5100
VACON1000-ED-120-066+G2CE	120	1370	88	1000	2710	1250	2888	5150
VACON1000-ED-140-066+G2CE	140	1600	102	1160	2710	1250	2888	5200
VACON1000-ED-150-066+G2CE	150	1710	110	1250	3010	1250	2888	6050
VACON1000-ED-180-066+G2CE	180	2050	132	1500	3010	1250	2888	6100
VACON1000-ED-190-066+G2CE	190	2170	139	1580	3010	1250	2888	6150
VACON1000-ED-215-066+G2CE	215	2450	157	1790	3010	1250	2888	6200
VACON1000-ED-250-066+G2CE	250	2850	183	2090	5410	1400	2796	8800
VACON1000-ED-305-066+G2CE	305	3480	223	2540	5410	1400	2796	9800
VACON1000-ED-350-066+G2CE	350	4000	256	2920	5410	1400	2796	10700
VACON1000-ED-438-066+G2CE	438	5000	321	3660	6810	1400	2796	13050
VACON1000-ED-560-066+G2CE	560	6400	410	4680	7010	1400	2796	15050
VACON1000-ED-680-066+G2CE	680	7770	498	5690	7610	1600	2796	18550

Table 20: Nominal Voltage 10000 V, 48-pulse, 8 Power Cells per Phase, 50 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-100+G2CE	36	620	26	450	3410	1250	2796	4100
VACON1000-ED-050-100+G2CE	50	860	36	620	3410	1250	2796	4400
VACON1000-ED-070-100+G2CE	70	1210	51	880	3410	1250	2796	4700
VACON1000-ED-090-100+G2CE	90	1550	66	1140	3910	1250	2888	6250
VACON1000-ED-100-100+G2CE	100	1730	73	1260	3910	1250	2888	6550
VACON1000-ED-120-100+G2CE	120	2070	88	1520	3910	1250	2888	6850
VACON1000-ED-140-100+G2CE	140	2420	102	1760	3910	1250	2888	7250
VACON1000-ED-150-100+G2CE	150	2590	110	1900	4660	1250	2888	10100
VACON1000-ED-180-100+G2CE	180	3110	132	2280	4660	1250	2888	10400
VACON1000-ED-190-100+G2CE	190	3290	139	2400	4660	1250	2888	10700
VACON1000-ED-215-100+G2CE	215	3720	157	2710	4660	1250	2888	11100
VACON1000-ED-250-100+G2CE	250	4330	183	3160	6560	1400	2796	11600
VACON1000-ED-305-100+G2CE	305	5280	223	3860	6560	1400	2796	13100
VACON1000-ED-350-100+G2CE	350	6060	256	4430	6760	1400	2796	14400
VACON1000-ED-438-100+G2CE	438	7580	321	5550	9810	1400	2796	18200
VACON1000-ED-560-100+G2CE	560	9690	410	7100	10610	1400	2796	21900
VACON1000-ED-680-100+G2CE	680	11770	498	8620	11010	1400	2796	25350

Table 21: Nominal Voltage 11000 V, 54-pulse, 9 Power Cells per Phase, 50 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-110+G2CE	36	680	26	490	3410	1250	2796	4400
VACON1000-ED-050-110+G2CE	50	950	36	680	3410	1250	2796	4800
VACON1000-ED-070-110+G2CE	70	1330	51	970	3410	1250	2796	5200
VACON1000-ED-090-110+G2CE	90	1710	66	1250	3910	1250	2888	6550
VACON1000-ED-100-110+G2CE	100	1900	73	1390	3910	1250	2888	6850
VACON1000-ED-120-110+G2CE	120	2280	88	1670	3910	1250	2888	7150
VACON1000-ED-140-110+G2CE	140	2660	102	1940	3910	1250	2888	7550
VACON1000-ED-150-110+G2CE	150	2850	110	2090	4660	1250	2888	10600
VACON1000-ED-180-110+G2CE	180	3420	132	2510	4660	1250	2888	10900
VACON1000-ED-190-110+G2CE	190	3610	139	2640	4660	1250	2888	11200
VACON1000-ED-215-110+G2CE	215	4090	157	2990	4660	1250	2888	11500
VACON1000-ED-250-110+G2CE	250	4760	183	3480	6810	1400	2796	12950
VACON1000-ED-305-110+G2CE	305	5810	223	4240	7010	1400	2796	14750
VACON1000-ED-350-110+G2CE	350	6660	256	4870	7010	1400	2796	16750
VACON1000-ED-438-110+G2CE	438	8340	321	6110	10810	1400	2796	20550
VACON1000-ED-560-110+G2CE	560	10660	410	7810	11410	1400	2796	24550
VACON1000-ED-680-110+G2CE	680	12950	498	9480	12210	1600	2796	28600

11.2.2 UL Ratings

Table 22: Nominal Voltage 2400 V, 18-pulse, 3 Power Cells per Phase, 60 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-024+GAUL	36	180	26	130	1210	1250	2796	2000
VACON1000-ED-050-024+GAUL	50	250	36	180	1210	1250	2796	2050
VACON1000-ED-070-024+GAUL	70	360	51	260	1210	1250	2796	2100
VACON1000-ED-090-024+GAUL	90	460	66	340	1610	1250	2888	2850
VACON1000-ED-100-024+GAUL	100	510	73	370	1610	1250	2888	2900
VACON1000-ED-116-024+GAUL	116	600	85	440	1610	1250	2888	2925
VACON1000-ED-120-024+GAUL	120	620	88	450	1610	1250	2888	2950
VACON1000-ED-140-024+GAUL	140	720	102	530	1610	1250	2888	3000
VACON1000-ED-160-024+GAUL	160	830	117	600	1910	1250	2888	4350
VACON1000-ED-180-024+GAUL	180	930	132	680	1910	1250	2888	4400
VACON1000-ED-215-024+GAUL	215	1110	157	810	1910	1250	2888	4300
VACON1000-ED-230-024+GAUL	230	1190	168	870	3810	1400	2796	4600
VACON1000-ED-250-024+GAUL	250	1290	183	950	3810	1400	2796	4700
VACON1000-ED-265-024+GAUL	265	1370	194	1000	3810	1400	2796	4800
VACON1000-ED-285-024+GAUL	285	1480	209	1080	3810	1400	2796	4900
VACON1000-ED-305-024+GAUL	305	1580	223	1150	3810	1400	2796	5000
VACON1000-ED-325-024+GAUL	325	1680	238	1230	4110	1400	2796	5100
VACON1000-ED-350-024+GAUL	350	1810	256	1330	4110	1400	2796	5300
VACON1000-ED-378-024+GAUL	378	1960	277	1430	4710	1400	2796	5850
VACON1000-ED-408-024+GAUL	408	2120	299	1550	4710	1400	2796	6050
VACON1000-ED-438-024+GAUL	438	2270	321	1660	4710	1400	2796	6250
VACON1000-ED-475-024+GAUL	475	2460	348	1800	4710	1400	2796	6600
VACON1000-ED-515-024+GAUL	515	2670	377	1950	4710	1400	2796	6900
VACON1000-ED-560-024+GAUL	560	2900	410	2130	5010	1400	2796	7400
VACON1000-ED-600-024+GAUL	600	3110	440	2280	5010	1400	2796	7550
VACON1000-ED-640-024+GAUL	640	3320	469	2430	5010	1400	2796	7850
VACON1000-ED-680-024+GAUL	680	3530	498	2580	5010	1400	2796	8250

Table 23: Nominal Voltage 3000 V, 18-pulse, 3 Power Cells per Phase, 60 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-030+GAUL	36	180	26	130	1210	1250	2796	2100
VACON1000-ED-040-030+GAUL	40	200	29	150	1210	1250	2796	2125
VACON1000-ED-050-030+GAUL	50	250	36	180	1210	1250	2796	2150
VACON1000-ED-061-030+GAUL	61	310	44	220	1210	1250	2796	2175
VACON1000-ED-070-030+GAUL	70	360	51	260	1210	1250	2796	2100
VACON1000-ED-077-030+GAUL	77	400	56	290	1610	1250	2888	2900
VACON1000-ED-090-030+GAUL	90	460	66	340	1610	1250	2888	2950
VACON1000-ED-095-030+GAUL	95	490	69	350	1610	1250	2888	2975
VACON1000-ED-100-030+GAUL	100	510	73	370	1610	1250	2888	3000
VACON1000-ED-118-030+GAUL	118	610	86	440	1610	1250	2888	3025
VACON1000-ED-120-030+GAUL	120	620	88	450	1610	1250	2888	3050
VACON1000-ED-140-030+GAUL	140	720	102	530	1610	1250	2888	3100
VACON1000-ED-180-030+GAUL	180	930	132	680	1910	1250	2888	4500
VACON1000-ED-186-030+GAUL	186	960	136	700	1910	1250	2888	4525
VACON1000-ED-215-030+GAUL	215	1110	157	810	1910	1250	2888	4600
VACON1000-ED-230-030+GAUL	230	1190	168	870	3810	1400	2796	5000
VACON1000-ED-250-030+GAUL	250	1290	183	950	4110	1400	2796	5100
VACON1000-ED-265-030+GAUL	265	1370	194	1000	4110	1400	2796	5100
VACON1000-ED-285-030+GAUL	285	1480	209	1080	4110	1400	2796	5300
VACON1000-ED-305-030+GAUL	305	1580	223	1150	4110	1400	2796	5500
VACON1000-ED-325-030+GAUL	325	1680	238	1230	4110	1400	2796	5600
VACON1000-ED-350-030+GAUL	350	1810	256	1330	4110	1400	2796	5800
VACON1000-ED-378-030+GAUL	378	1960	277	1430	4710	1400	2796	6450
VACON1000-ED-408-030+GAUL	408	2120	299	1550	4710	1400	2796	6750
VACON1000-ED-438-030+GAUL	438	2270	321	1660	4710	1400	2796	6950
VACON1000-ED-475-030+GAUL	475	2460	348	1800	5010	1400	2796	7500
VACON1000-ED-515-030+GAUL	515	2670	377	1950	5010	1400	2796	7800
VACON1000-ED-560-030+GAUL	560	2900	410	2130	5010	1400	2796	8300

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-600-030+GAUL	600	3110	440	2280	5010	1400	2796	8550
VACON1000-ED-640-030+GAUL	640	3320	469	2430	5010	1400	2796	8850
VACON1000-ED-680-033+GAUL	680	3530	498	2580	5010	1400	2796	9350

Table 24: Nominal Voltage 3300 V, 18-pulse, 3 Power Cells per Phase, 60 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-033+GAUL	36	200	26	140	1210	1250	2796	2200
VACON1000-ED-040-033+GAUL	70	400	51	290	1210	1250	2796	2225
VACON1000-ED-050-033+GAUL	50	280	36	200	1210	1250	2796	2250
VACON1000-ED-061-033+GAUL	61	340	44	250	1210	1250	2796	2275
VACON1000-ED-070-033+GAUL	70	400	51	290	1210	1250	2796	2300
VACON1000-ED-077-033+GAUL	77	440	56	320	1610	1250	2888	3000
VACON1000-ED-090-033+GAUL	90	510	66	370	1610	1250	2888	3050
VACON1000-ED-095-033+GAUL	95	540	69	390	1610	1250	2888	3075
VACON1000-ED-100-033+GAUL	100	570	73	410	1610	1250	2888	3100
VACON1000-ED-118-033+GAUL	118	670	86	490	1610	1250	2888	3125
VACON1000-ED-120-033+GAUL	120	680	88	500	1610	1250	2888	3150
VACON1000-ED-140-033+GAUL	140	800	102	580	1610	1250	2888	3200
VACON1000-ED-180-033+GAUL	180	1020	132	750	1910	1250	2888	4600
VACON1000-ED-186-033+GAUL	186	1060	136	770	1910	1250	2888	4625
VACON1000-ED-215-033+GAUL	215	1220	157	890	1910	1250	2888	4700
VACON1000-ED-230-033+GAUL	230	1310	168	960	4110	1400	2796	5100
VACON1000-ED-250-033+GAUL	250	1420	183	1040	4110	1400	2796	5300
VACON1000-ED-265-033+GAUL	265	1510	194	1100	4110	1400	2796	5300
VACON1000-ED-285-033+GAUL	285	1620	209	1190	4110	1400	2796	5500
VACON1000-ED-305-033+GAUL	305	1740	223	1270	4110	1400	2796	5800
VACON1000-ED-325-033+GAUL	325	1850	238	1360	4110	1400	2796	5800
VACON1000-ED-350-033+GAUL	350	2000	256	1460	4110	1400	2796	6100
VACON1000-ED-378-033+GAUL	378	2160	277	1580	4710	1400	2796	6750
VACON1000-ED-408-033+GAUL	408	2330	299	1700	4710	1400	2796	7150

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-438-033+GAUL	438	2500	321	1830	5010	1400	2796	7450
VACON1000-ED-475-033+GAUL	475	2710	348	1980	5010	1400	2796	7900
VACON1000-ED-515-033+GAUL	515	2940	377	2150	5010	1400	2796	8200
VACON1000-ED-560-033+GAUL	560	3200	410	2340	5010	1400	2796	8700
VACON1000-ED-600-033+GAUL	600	3420	440	2510	5010	1400	2796	9050
VACON1000-ED-640-033+GAUL	640	3650	469	2680	5010	1400	2796	9450
VACON1000-ED-680-033+GAUL	680	3880	498	2840	5410	1400	2796	9950

Table 25: Nominal Voltage 4160 V, 24-pulse, 4 Power Cells per Phase, 60 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-036-041+GAUL	36	250	26	180	1210	1250	2796	2400
VACON1000-ED-040-041+GAUL	40	280	29	200	1210	1250	2796	2425
VACON1000-ED-050-041+GAUL	50	360	36	250	1210	1250	2796	2450
VACON1000-ED-053-041+GAUL	53	380	38	270	1210	1250	2796	2475
VACON1000-ED-059-041+GAUL	59	420	43	300	1210	1250	2796	2500
VACON1000-ED-070-041+GAUL	70	500	51	360	1210	1250	2796	2500
VACON1000-ED-078-041+GAUL	78	560	57	410	1610	1250	2888	3200
VACON1000-ED-090-041+GAUL	90	640	66	470	1610	1250	2888	3250
VACON1000-ED-100-041+GAUL	100	720	73	520	1610	1250	2888	3300
VACON1000-ED-105-041+GAUL	105	750	77	550	1610	1250	2888	3325
VACON1000-ED-116-041+GAUL	116	830	85	610	1610	1250	2888	3325
VACON1000-ED-120-041+GAUL	120	860	88	630	1610	1250	2888	3350
VACON1000-ED-128-041+GAUL	128	920	93	670	1610	1250	2888	3375
VACON1000-ED-140-041+GAUL	140	1000	102	730	1610	1250	2888	3400
VACON1000-ED-160-041+GAUL	160	1150	117	840	1910	1250	2888	4750
VACON1000-ED-180-041+GAUL	180	1290	132	950	1910	1250	2888	4800
VACON1000-ED-193-041+GAUL	193	1390	141	1010	1910	1250	2888	4850
VACON1000-ED-215-041+GAUL	215	1540	157	1130	1910	1250	2888	4900
VACON1000-ED-230-041+GAUL	230	1650	168	1210	4610	1400	2796	5850
VACON1000-ED-250-041+GAUL	250	1800	183	1310	4610	1400	2796	6150

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-265-041+GAUL	265	1900	194	1390	4610	1400	2796	6350
VACON1000-ED-285-041+GAUL	285	2050	209	1500	4610	1400	2796	6550
VACON1000-ED-305-041+GAUL	305	2190	223	1600	4610	1400	2796	6850
VACON1000-ED-325-041+GAUL	325	2340	238	1710	4610	1400	2796	7050
VACON1000-ED-350-041+GAUL	350	2520	256	1840	4910	1400	2796	7450
VACON1000-ED-378-041+GAUL	378	2720	277	1990	5410	1400	2796	8200
VACON1000-ED-408-041+GAUL	408	2930	299	2150	5410	1400	2796	8500
VACON1000-ED-438-041+GAUL	438	3150	321	2310	5410	1400	2796	9000
VACON1000-ED-475-041+GAUL	475	3420	348	2500	5410	1400	2796	9400
VACON1000-ED-515-041+GAUL	515	3710	377	2710	5810	1400	2796	9900
VACON1000-ED-560-041+GAUL	560	4030	410	2950	5810	1400	2796	10700
VACON1000-ED-600-041+GAUL	600	4320	440	3170	5810	1400	2796	10950
VACON1000-ED-640-041+GAUL	640	4610	469	3370	5810	1400	2796	11450
VACON1000-ED-680-041+GAUL	680	4890	498	3580	5810	1400	2796	11950

Table 26: Nominal Voltage 6000 V, 30-pulse, 5 Power Cells per Phase, 60 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-025-060+GAUL	25	250	18	180	2310	1250	2796	3450
VACON1000-ED-036-060+GAUL	36	370	26	270	2310	1250	2796	3500
VACON1000-ED-040-060+GAUL	40	410	29	300	2310	1250	2796	3525
VACON1000-ED-050-060+GAUL	50	510	36	370	2310	1250	2796	3550
VACON1000-ED-060-060+GAUL	60	620	44	450	2310	1250	2796	3575
VACON1000-ED-070-060+GAUL	70	720	51	530	2310	1250	2796	3600
VACON1000-ED-080-060+GAUL	80	830	58	600	2710	1250	2888	4800
VACON1000-ED-090-060+GAUL	90	930	66	680	2710	1250	2888	4850
VACON1000-ED-100-060+GAUL	100	1030	73	750	2710	1250	2888	4900
VACON1000-ED-110-060+GAUL	110	1140	80	830	2710	1250	2888	4925
VACON1000-ED-120-060+GAUL	120	1240	88	910	2710	1250	2888	4950
VACON1000-ED-140-060+GAUL	140	1450	102	1060	2710	1250	2888	5000
VACON1000-ED-150-060+GAUL	150	1550	110	1140	3010	1250	2888	5850

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-170-060+GAUL	170	1760	124	1280	3010	1250	2888	5875
VACON1000-ED-180-060+GAUL	180	1870	132	1370	3010	1250	2888	5900
VACON1000-ED-190-060+GAUL	190	1970	139	1440	3010	1250	2888	5950
VACON1000-ED-200-060+GAUL	200	2070	146	1510	3010	1250	2888	5975
VACON1000-ED-210-060+GAUL	210	2180	154	1600	3010	1250	2888	5975
VACON1000-ED-215-060+GAUL	215	2230	157	1630	3010	1250	2888	6000
VACON1000-ED-223-060+GAUL	223	2310	163	1690	4860	1400	2796	7100
VACON1000-ED-236-060+GAUL	236	2450	173	1790	4860	1400	2796	7400
VACON1000-ED-250-060+GAUL	250	2590	183	1900	5160	1400	2796	7700
VACON1000-ED-263-060+GAUL	263	2730	192	1990	5160	1400	2796	7800
VACON1000-ED-276-060+GAUL	276	2860	202	2090	5160	1400	2796	8000
VACON1000-ED-290-060+GAUL	290	3010	212	2200	5160	1400	2796	8300
VACON1000-ED-305-060+GAUL	305	3160	223	2310	5160	1400	2796	8600
VACON1000-ED-325-060+GAUL	325	3370	238	2470	5160	1400	2796	8800
VACON1000-ED-350-060+GAUL	350	3630	256	2660	5160	1400	2796	9200
VACON1000-ED-370-060+GAUL	370	3840	271	2810	6010	1400	2796	10200
VACON1000-ED-390-060+GAUL	390	4050	286	2970	6410	1400	2796	10500
VACON1000-ED-415-060+GAUL	415	4310	304	3150	6410	1400	2796	11000
VACON1000-ED-438-060+GAUL	438	4550	321	3330	6410	1400	2796	11500
VACON1000-ED-460-060+GAUL	460	4780	337	3500	6410	1400	2796	11950
VACON1000-ED-483-060+GAUL	483	5010	354	3670	6410	1400	2796	12250
VACON1000-ED-507-060+GAUL	507	5260	371	3850	6410	1400	2796	12650
VACON1000-ED-532-060+GAUL	532	5520	390	4050	6610	1400	2796	13150
VACON1000-ED-560-060+GAUL	560	5810	410	4260	6610	1400	2796	13750
VACON1000-ED-588-060+GAUL	588	6110	431	4470	6610	1400	2796	14100
VACON1000-ED-617-060+GAUL	617	6410	452	4690	6610	1400	2796	14500
VACON1000-ED-648-060+GAUL	648	6730	475	4930	7210	1600	2796	15100
VACON1000-ED-680-060+GAUL	680	7060	498	5170	7210	1600	2796	15500

Table 27: Nominal Voltage 6300 V, 36-pulse, 6 Power Cells per Phase, 60 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-025-063+GAUL	25	270	18	190	2310	1250	2796	3600
VACON1000-ED-030-063+GAUL	30	310	22	220	2310	1250	2796	3625
VACON1000-ED-036-063+GAUL	36	370	26	270	2310	1250	2796	3625
VACON1000-ED-045-063+GAUL	45	460	33	340	2310	1250	2796	3650
VACON1000-ED-050-063+GAUL	50	510	36	370	2310	1250	2796	3650
VACON1000-ED-065-063+GAUL	65	670	47	480	2310	1250	2796	3675
VACON1000-ED-070-063+GAUL	70	720	51	530	2310	1250	2796	3700
VACON1000-ED-085-063+GAUL	85	880	62	640	2710	1250	2888	4950
VACON1000-ED-100-063+GAUL	100	1030	73	750	2710	1250	2888	5000
VACON1000-ED-115-063+GAUL	115	1190	84	870	2710	1250	2888	5050
VACON1000-ED-125-063+GAUL	125	1290	91	940	2710	1250	2888	5075
VACON1000-ED-140-063+GAUL	140	1450	102	1060	2710	1250	2888	5100
VACON1000-ED-160-063+GAUL	160	1660	117	1210	3010	1250	2888	5950
VACON1000-ED-170-063+GAUL	170	1760	124	1280	3010	1250	2888	5975
VACON1000-ED-180-063+GAUL	180	1870	132	1370	3010	1250	2888	6000
VACON1000-ED-190-063+GAUL	190	1970	139	1440	3010	1250	2888	6050
VACON1000-ED-205-063+GAUL	205	2130	150	1550	3010	1250	2888	6075
VACON1000-ED-210-063+GAUL	210	2180	154	1600	3010	1250	2888	6075
VACON1000-ED-215-063+GAUL	215	2230	157	1630	3010	1250	2888	6100
VACON1000-ED-230-063+GAUL	230	2390	168	1740	5410	1400	2796	8300
VACON1000-ED-250-063+GAUL	250	2590	183	1900	5410	1400	2796	8800
VACON1000-ED-265-063+GAUL	265	2750	194	2010	5410	1400	2796	9000
VACON1000-ED-285-063+GAUL	285	2960	209	2170	5410	1400	2796	9300
VACON1000-ED-305-063+GAUL	305	3160	223	2310	5410	1400	2796	9800
VACON1000-ED-325-063+GAUL	325	3370	238	2470	5410	1400	2796	10000
VACON1000-ED-350-063+GAUL	350	3630	256	2660	5810	1400	2796	10700
VACON1000-ED-378-063+GAUL	378	3920	277	2870	6810	1400	2796	11650
VACON1000-ED-408-063+GAUL	408	4240	299	3100	6810	1400	2796	12250
VACON1000-ED-438-063+GAUL	438	4550	321	3330	6810	1400	2796	13050
VACON1000-ED-475-063+GAUL	475	4930	348	3610	7010	1400	2796	13750

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-515-063+GAUL	515	5350	377	3910	7010	1400	2796	14550
VACON1000-ED-560-063+GAUL	560	5810	410	4260	7610	1600	2796	15050
VACON1000-ED-600-063+GAUL	600	6230	440	4570	7610	1600	2796	16250
VACON1000-ED-640-063+GAUL	640	6650	469	4870	7610	1600	2796	16950
VACON1000-ED-680-063+GAUL	680	7060	498	5170	9610	1400	2796	18550

Table 28: Nominal Voltage 6600 V, 36-pulse, 6 Power Cells per Phase, 60 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-025-066+GAUL	25	280	18	200	2310	1250	2796	3650
VACON1000-ED-032-066+GAUL	32	360	23	260	2310	1250	2796	3675
VACON1000-ED-036-066+GAUL	36	410	26	290	2310	1250	2796	3700
VACON1000-ED-040-066+GAUL	40	450	29	330	2310	1250	2796	3725
VACON1000-ED-050-066+GAUL	50	570	36	410	2310	1250	2796	3750
VACON1000-ED-055-066+GAUL	55	620	40	450	2310	1250	2796	3775
VACON1000-ED-065-066+GAUL	65	740	47	530	2310	1250	2796	3775
VACON1000-ED-070-066+GAUL	70	800	51	580	2310	1250	2796	3800
VACON1000-ED-080-066+GAUL	80	910	58	660	2710	1250	2888	5050
VACON1000-ED-100-066+GAUL	100	1140	73	830	2710	1250	2888	5100
VACON1000-ED-120-066+GAUL	120	1370	88	1000	2710	1250	2888	5150
VACON1000-ED-140-066+GAUL	140	1600	102	1160	2710	1250	2888	5200
VACON1000-ED-155-066+GAUL	155	1770	113	1290	3010	1250	2888	6050
VACON1000-ED-160-066+GAUL	160	1820	117	1330	3010	1250	2888	6075
VACON1000-ED-180-066+GAUL	180	2050	132	1500	3010	1250	2888	6100
VACON1000-ED-200-066+GAUL	200	2280	146	1660	3010	1250	2888	6150
VACON1000-ED-210-066+GAUL	210	2400	154	1760	3010	1250	2888	6175
VACON1000-ED-215-066+GAUL	215	2450	157	1790	3010	1250	2888	6200
VACON1000-ED-230-066+GAUL	230	2620	168	1920	5410	1400	2796	8300
VACON1000-ED-250-066+GAUL	250	2850	183	2090	5410	1400	2796	8800
VACON1000-ED-265-066+GAUL	265	3020	194	2210	5410	1400	2796	9000
VACON1000-ED-285-066+GAUL	285	3250	209	2380	5410	1400	2796	9300

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-305-066+GAUL	305	3480	223	2540	5410	1400	2796	9800
VACON1000-ED-325-066+GAUL	325	3710	238	2720	5410	1400	2796	10000
VACON1000-ED-350-066+GAUL	350	4000	256	2920	5810	1400	2796	10700
VACON1000-ED-378-066+GAUL	378	4320	277	3160	6810	1400	2796	11650
VACON1000-ED-408-066+GAUL	408	4660	299	3410	6810	1400	2796	12250
VACON1000-ED-438-066+GAUL	438	5000	321	3660	6810	1400	2796	13050
VACON1000-ED-475-066+GAUL	475	5420	348	3970	7010	1400	2796	13750
VACON1000-ED-515-066+GAUL	515	5880	377	4300	7010	1400	2796	14550
VACON1000-ED-560-066+GAUL	560	6400	410	4680	7610	1600	2796	15050
VACON1000-ED-600-066+GAUL	600	6850	440	5020	7610	1600	2796	16250
VACON1000-ED-640-066+GAUL	640	7310	469	5360	7610	1600	2796	16950
VACON1000-ED-680-066+GAUL	680	7770	498	5690	9610	1400	2796	18550

Table 29: Nominal Voltage 6900 V, 36-pulse, 6 Power Cells per Phase, 60 Hz

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-025-069+GAUL	25	290	18	210	2310	1250	2796	3750
VACON1000-ED-032-069+GAUL	32	380	23	270	2310	1250	2796	3800
VACON1000-ED-036-069+GAUL	36	430	26	310	2310	1250	2796	3825
VACON1000-ED-040-069+GAUL	40	470	29	340	2310	1250	2796	3850
VACON1000-ED-050-069+GAUL	050	590	36	430	2310	1250	2796	3875
VACON1000-ED-060-069+GAUL	060	710	44	520	2310	1250	2796	3900
VACON1000-ED-065-069+GAUL	065	770	47	560	2310	1250	2796	3900
VACON1000-ED-070-069+GAUL	070	830	51	600	2310	1250	2796	3900
VACON1000-ED-080-069+GAUL	080	950	58	690	2710	1250	2888	5300
VACON1000-ED-100-069+GAUL	100	1190	73	870	2710	1250	2888	5300
VACON1000-ED-120-069+GAUL	120	1430	88	1050	2710	1250	2888	5300
VACON1000-ED-140-069+GAUL	140	1670	102	1210	2710	1250	2888	5300
VACON1000-ED-150-069+GAUL	150	1790	110	1310	3010	1250	2888	6100
VACON1000-ED-160-069+GAUL	160	1910	117	1390	3010	1250	2888	6150
VACON1000-ED-180-069+GAUL	180	2150	132	1570	3010	1250	2888	6200

AC Drive type	Low overload rating 110% (Variable torque)		High overload rating 150% (Constant torque)		Cabinet dimensions			Weight
	I_L [A]	P [kVA]	I_{HD} [A]	P [kVA]	W [mm]	D [mm]	H [mm]	[kg]
VACON1000-ED-190-069+GAUL	190	2270	139	1660	3010	1250	2888	6275
VACON1000-ED-200-069+GAUL	200	2390	146	1740	3010	1250	2888	6275
VACON1000-ED-210-069+GAUL	210	2500	154	1840	3010	1250	2888	6300
VACON1000-ED-215-069+GAUL	215	2560	157	1870	3010	1250	2888	6300
VACON1000-ED-230-069+GAUL	230	2740	168	2000	5410	1400	2796	8500
VACON1000-ED-250-069+GAUL	250	2980	183	2180	5410	1400	2796	9000
VACON1000-ED-265-069+GAUL	265	3160	194	2310	5410	1400	2796	9200
VACON1000-ED-285-069+GAUL	285	3400	209	2490	5410	1400	2796	9500
VACON1000-ED-305-069+GAUL	305	3640	223	2660	5410	1400	2796	10000
VACON1000-ED-325-069+GAUL	325	3880	238	2840	5810	1400	2796	10300
VACON1000-ED-350-069+GAUL	350	4180	256	3050	5810	1400	2796	11000
VACON1000-ED-378-069+GAUL	378	4510	277	3310	6810	1400	2796	11950
VACON1000-ED-408-069+GAUL	408	4870	299	3570	7010	1400	2796	12550
VACON1000-ED-438-069+GAUL	438	5230	321	3830	7010	1400	2796	13350
VACON1000-ED-475-069+GAUL	475	5670	348	4150	7010	1400	2796	14250
VACON1000-ED-515-069+GAUL	515	6150	377	4500	7010	1400	2796	15050
VACON1000-ED-560-069+GAUL	560	6690	410	4890	7610	1600	2796	16050
VACON1000-ED-600-069+GAUL	600	7170	440	5250	7610	1600	2796	16650
VACON1000-ED-640-069+GAUL	640	7640	469	5600	9610	1400	2796	18050
VACON1000-ED-680-069+GAUL	680	8120	498	5950	9610	1400	2796	19050

11.3 Internal Cables and Terminals

Table 30: Specifications for the Internal Power Cables and Terminals

Cable/busbar	Cable/busbar size	Terminal type	Screw type	Tightening torque (Nm)
Busbars for connecting power cells in series	30 mm^2	N/A	M6×16	5.0–10.0
	40 mm^2	N/A	M6×16	5.0–10.0
	90 mm^2	N/A	M6×16	5.0–10.0
	160 mm^2	N/A	M8×25	12.0–15.0
Output neutral point cable	9 AWG	TLK10-8	M8×25	12.0–15.0
	5 AWG	TLK25-8	M8×25	12.0–15.0
	2 AWG	TLK35-8	M8×25	12.0–15.0

Cable/busbar	Cable/busbar size	Terminal type	Screw type	Tightening torque (Nm)
	2/0 AWG	TLK70-8	M8×25	12.0–15.0
	3/0 AWG	TLK95-10	M10×35	30.0–50.0
	4/0 AWG	TLK120-10	M10×35	30.0–50.0
	250 kcmil	TLK150-10	M10×35	30.0–50.0
	300 kcmil	TLK185-10	M10×35	30.0–50.0
	400 kcmil	TLK240-10	M10×35	30.0–50.0
	600 kcmil	TLK400-12	M10×35	30.0–50.0
	750 kcmil	TLK400-12	M10×35	30.0–50.0
Output power cable	9 AWG	TLK10-8	M8×25	12.0–15.0
	5 AWG	TLK25-8	M8×25	12.0–15.0
	2 AWG	TLK35-8	M8×25	12.0–15.0
	2/0 AWG	TLK70-8	M8×25	12.0–15.0
	3/0 AWG	TLK95-10	M10×35	30.0–50.0
	4/0 AWG	TLK120-10	M10×35	30.0–50.0
	250 kcmil	TLK150-10	M10×35	30.0–50.0
	300 kcmil	TLK185-10	M10×35	30.0–50.0
	400 kcmil	TLK240-10	M10×35	30.0–50.0
	600 kcmil	TLK400-12	M10×35	30.0–50.0
	750 kcmil	TLK400-12	M10×35	30.0–50.0
Transformer input cable	9 AWG	TLK10-8	M8×25	12.0–15.0
	5 AWG	TLK25-8	M8×25	12.0–15.0
	2 AWG	TLK35-8	M8×25	12.0–15.0
	2/0 AWG	TLK70-8	M8×25	12.0–15.0
	3/0 AWG	TLK95-10	M10×35	30.0–50.0
	4/0 AWG	TLK120-10	M10×35	30.0–50.0
	250 kcmil	TLK150-10	M10×35	30.0–50.0
	300 kcmil	TLK185-10	M10×35	30.0–50.0
	400 kcmil	TLK240-10	M10×35	30.0–50.0
	600 kcmil	TLK400-12	M10×35	30.0–50.0
	750 kcmil	TLK400-12	M10×35	30.0–50.0
Transformer output cable	9 AWG	TLK10-8	Nut M8	12.0–15.0
	5 AWG	TLK25-8	Nut M8	12.0–15.0

Cable/busbar	Cable/busbar size	Terminal type	Screw type	Tightening torque (Nm)
	2 AWG	TLK35-8	Nut M8	12.0–15.0
	1/0 AWG	TLK50-10	Nut M10	30.0–50.0
	2/0 AWG	TLK70-10	Nut M10	30.0–50.0
	3/0 AWG	TLK95-10	Nut M10	30.0–50.0
	250 kcmil	TLK150-10	Nut M10	30.0–50.0
	300 kcmil	TLK185-10	Nut M10	30.0–50.0
Power connection cable	9 AWG	TLK10-8	M8×25	12.0–15.0
	5 AWG	TLK25-8	M8×25	12.0–15.0
	2 AWG	TLK35-8	M8×25	12.0–15.0
	2/0 AWG	TLK70-8	M8×25	12.0–15.0
	3/0 AWG	TLK95-10	M10×35	30.0–50.0
	4/0 AWG	TLK120-10	M10×35	30.0–50.0
	250 kcmil	TLK150-10	M10×35	30.0–50.0
	300 kcmil	TLK185-10	M10×35	30.0–50.0
	400 kcmil	TLK240-10	M10×35	30.0–50.0
	600 kcmil	TLK400-12	M10×35	30.0–50.0
	750 kcmil	TLK400-12	M10×35	30.0–50.0
Motor connection cable	9 AWG	TLK10-8	M8×25	12.0–15.0
	5 AWG	TLK25-8	M8×25	12.0–15.0
	2 AWG	TLK35-8	M8×25	12.0–15.0
	2/0 AWG	TLK70-8	M8×25	12.0–15.0
	3/0 AWG	TLK95-10	M10×35	30.0–50.0
	4/0 AWG	TLK120-10	M10×35	30.0–50.0
	250 kcmil	TLK150-10	M10×35	30.0–50.0
	300 kcmil	TLK185-10	M10×35	30.0–50.0
	400 kcmil	TLK240-10	M10×35	30.0–50.0
	600 kcmil	TLK400-12	M10×35	30.0–50.0
	750 kcmil	TLK400-12	M10×35	30.0–50.0
Grounding connection between cabinets	75 mm^2	N/A	M8×25	12.0–15.0
	120 mm^2	N/A	M8×25	12.0–15.0

Cable/busbar	Cable/busbar size	Terminal type	Screw type	Tightening torque (Nm)
	200 mm^2	N/A	M8×25	12.0–15.0
	300 mm^2	N/A	M8×25	12.0–15.0
System grounding cable	100 mm^2	TLK120-8	M8×20	12.0–15.0

11.4 Replacement Fuses

Table 31: Fuses in the Power Cell Cabinet for Standalone Type (Power Cell Current ≤215 A)

Power cell current rating	Fuse model	Fuse rating
36 A	170M1367	700 V AC, 100 A
	170M2614	700 V AC, 100 A
	170M4810	1000 V AC, 100 A
50 A	170M1368	700 V AC, 125 A
	170M2615	700 V AC, 125 A
	170M4811	1000 V AC, 125 A
70 A	170M1369	700 V AC, 160 A
	170M2616	700 V AC, 160 A
	170M4812	1000 V AC, 160 A
100 A	170M1371	700 V AC, 250 A
	170M2618	700 V AC, 250 A
	170M4813	1000 V AC, 200 A
140 A	170M1372	700 V AC, 315 A
	170M2619	700 V AC, 315 A
	170M4814	1000 V AC, 250 A
180 A	170M2620	700 V AC, 350 A
215 A	170M2621	700 V AC, 400 A

Table 32: Fuse in Power Cell Cabinet for Lineup Type (Power Cell Current >215 A)

Power cell current rating	Fuse category	Fuse rating
350 A	500FMM or WHFMM	500 A
680 A	700FMM or WHFMM	700 A

Table 33: Fuses in the Start-up Cabinet

Input voltage	Output current rating	Fuse type
2.4 kV, 3 kV, 3.3 kV, 4.16 kV,	210–250 A	A051B2DARO-18R
	263–350 A	A051B2DARO-24R
	370–438 A	A051B2DARO-32R

Input voltage	Output current rating	Fuse type
	460–560 A	A072B3DBRO-48X
	588–680 A	A072B3DBRO-57X
6 kV, 6.6 kV, 7.2 kV	210–250 A	A072B2DARO-18R
	263–350 A	A072B2DARO-24R
	370–438 A	A072B2DORO-32R
	460–560 A	A072B3DBRO-48X
	588–680 A	A072B3DBRO-57X

Table 34: Fuses in the Control Cabinet

Component ID	Type	Rating
FU11, FU13	Supplemental fuse	600 V AC/ 10 A
FU12	Supplemental fuse	600 V AC/ 15 A
FU14	Supplemental fuse	600 V AC/ 2 A
FU15	Class CC or equivalent	600 V AC/ 1 A
FU16, FU17	Class CC or equivalent	600 V AC/ 20 A

11.5 Standards

Table 35: Standards

Standard number	Standard Name
GB/T 156-2007	Standard Voltages
GB/T 1980-2005	Standard Frequencies
GB/T 2423.10-2008	Environmental testing for electric and electronic products - Part 2: Test methods - Test Fc: Vibration (sinusoidal)
GB 2681-81	Colors of insulated conductors used in electrical assembly devices
GB 2682-1981	Colors of indicator lights and push-buttons used in electrical assembly devices
GB/T 3797-2005	Electrical control assemblies
GB/T 3859.1-93	Semiconductor convertors - Specification of basic requirements
GB/T 3859.2-93	Semiconductor convertors - Application guide
GB/T 3859.3-93	Semiconductor convertors - Transformers and reactors
GB 4208-2008	Degrees of protection provided by enclosures (IP code)
GB/T 4588.1-1996	Sectional specification: Single and double sided printed boards without plain holes
GB/T 4588.2-1996	Sectional specification: Single and double sided printed boards with plated-through holes
GB 7678-87	Semiconductor self-commutated convertors
GB/T 10233-2005	Basic testing method for low-voltage switchgear and control-gear assemblies

Standard number	Standard Name
GB 12668-90	General specification for speed control assembly with semiconductor adjustable frequency for A.C. motor
GB/T 15139-94	General technical standard for electrical equipment structure
GB/T 13422-92	Power semiconductor converters — Electrical test methods
GB/T 14549-93	Quality of electric energy supply-Harmonics in public supply network
GB/T 12668.3-2003	Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods
GB/T 12668.4-2006	Adjustable speed electrical power drive systems — Part 4: General requirements — Rating specifications for A.C. power drive systems above 1000 V A.C. not exceeding 35 kV
IEEE 519-1992	IEEE recommended practices and requirements for harmonic control in electrical power systems
IEC 60038	IEC standard voltages
IEC 60050-551:1998	International Electrotechnical Vocabulary – Part 551: Power electronics
IEC 60071-1:2006	Insulation coordination - Part 1: Definitions, principles and rules
IEC 60071-2:1996	Insulation coordination – Part 2: Application guide
IEC 60068-2-11	Basic environmental testing procedures - Part 2-11: Tests - Test Ka: Salt mist
IEC 60146-1-1:2009	Semiconductor converters – General requirements and line commutated converters – Part 1-1: Specification of basic requirements
IEC 60146-1-2:2011	Semiconductor converters - General requirements and line commutated converters - Part 1-2: Application guide
IEC 60146-1-3:1991	Semiconductor convertors – General requirements and line commutated convertors – Part 1-3: Transformers and reactors
IEC 60146-2:1999	Semiconductor converters - Part 2: Self-commutated semiconductor converters including direct d.c. converters
IEC 60204-11:2000	Safety of machinery – Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1000 V a.c. or 1500 V d.c. and not exceeding 36 kV
IEC 60529:1989 +AMD1:1999 +AMD2:2013 CSV	Degrees of protection provided by enclosures (IP Code)
IEC 60721-3-1:1997	Classification of environmental conditions – Part 3 Classification of groups of environmental parameters and their severities – Section 1: Storage
IEC 60721-3-2:1997	Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: transportation vibration random, free fall and shock-packaged
IEC 60721-3-3:1994 +AMD1:1995 +AMD2:1996 CSV	Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weather protected locations
IEC 60757:1983	Code for designation of colors
IEC 60947-5-5:1997 +AMD1:2005 +AMD2:2016 CSV	Low-voltage switchgear and controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function

Standard number	Standard Name
IEC 60076-1	Power transformers - Part 1: General
IEC 60076-11	Power transformers - Part 11: Dry-type transformers
IEC 60076-12	Power transformers - Part 12: Loading guide for dry-type power transformers
IEC 60076-2	Power transformers - Part 2: Temperature rise
IEC 60076-3	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 61378-1:2011	Converter transformers – Part 1: Transformers for industrial applications
IEC 61378-3:2015	Converter transformers – Part 3: Application guide
UL 1562	Transformers, Distribution, Dry-Type – Over 600 Volts
C57.12.01-2015	General Requirements for Dry-Type Distribution and Power Transformers
C57.12.60-2009	Test Procedure for Thermal Evaluation of Insulation Systems for Dry-Type Power and Distribution Transformers, Including Open-Wound, Solid-Cast, and Resin-Encapsulated Transformers
C57.12.91-2011	IEEE Standard Test Code for Dry-Type Distribution and Power Transformers
C57.12.58-2017	Draft Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer Coil
C57.124-1991	Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers.
IEC 60721-3-1	Classification of environmental conditions - Part 3 Classification of groups of environmental parameters and their severities - Section 1: Storage
IEC 60721-3-2	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transportation
IEC 60721-3-3	Classification of environmental conditions - Part 3-3: Classification of groups of environmental parameters and their severities - Stationary use at weather protected locations
IEC 61000-2-1:1990	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 1: Description of the environment - Electromagnetic environment for low-frequency conducted disturbances and signaling in public power supply systems (Immunity only)
IEC 61000-2-4	Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances
EN 61000-4-2:2009	Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrostatic discharge immunity test (Immunity only)
EN 61000-4-4:2004 +A1:2010	Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrical fast transient/ burst immunity test (Immunity only)
EN 61000-4-5:2006	Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test (Immunity only)
EN 61000-4-6:2009	Electromagnetic compatibility (EMC). Testing and measurement techniques. Immunity to conducted disturbances, induced by radio-frequency fields (Immunity only)
IEC 61000-4-7:2002 +AMD1:2008 CSV	Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and inter-harmonics measurements and instrumentation, for power supply systems and equipment connected thereto
EN 61000-4-8:2010	Electromagnetic compatibility (EMC). Testing and measurement techniques. Power frequency magnetic field immunity test (Immunity only)

Standard number	Standard Name
EN 61000-4-11:2004	Electromagnetic compatibility (EMC). Testing and measurement techniques. Voltage dips, short interruptions and voltage variations immunity tests (Immunity only)
IEC 61000-2-5:2017 RLV	Electromagnetic compatibility (EMC) – Part 2-5: Environment – Description and classification of electromagnetic environments
IEC 61800-3	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
IEC 61800-4	Adjustable speed electrical power drive systems - Part 4: General requirements - Rating specifications for a.c. power drive systems above 1000 V a.c. and not exceeding 35 kV
IEC 61800-5-1	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical , thermal and energy
IEC61800-9-2	Adjustable speed electrical power drive systems - Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications-Energy efficiency indicators for power drive systems and motor starters
ISO/EN 12944-2	Paints and varnishes- corrosion protection of steel structures by protective paint system – Part 2: Classification of environments
GR-63, Issue 4:2012	NEBS Requirements: Physical Protection
NR-10	Safety in electrical Installations and Services
NEMA MG 1-2016	Motors and Generators: Part 30 Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used With Adjustable-Voltage or Adjustable-Frequency Controls or Both
ASCE/SEI 7-10	Minimum Design Loads for Buildings and Other Structures
UL 61800-5-1	Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy
UL347A	Standard for safety-Medium voltage power conversion equipment
C22.2 No. 274-17	Standard for Adjustable Speed Drives

11.6 Abbreviations

Term	Definition
AFE	Active front end
AI	Analog input
AO	Analog output
CPU	Central processing unit
DCS	Digital control signal
DI	Digital input
DO	Digital output
DSP	Digital signal processor
EMC	Electromagnetic compatibility
EMF	Electromotive force
ESD	Electrostatic discharge

Term	Definition
GND	Ground
HMI	Human machine interface
HV	High voltage
IGBT	Insulated-gate bipolar transistor
IP	Ingress protection, for example, IP00, IP21, or IP54
LED	Light emitting diode
LV	Low voltage
MCB	Mains circuit breaker
MV	Medium voltage
PCB	Printed circuit board
PE	Protective earth
PID	Proportional integral derivative
PLC	Programmable logic controller
PPE	Personal protective equipment
PVC	Polyvinyl chloride
PWM	Pulse width modulation
SLVC	Sensorless Vector Control
SVC	Space Vector Control
THD	Total harmonic distortion
UPS	Uninterruptible power supply
USB	Universal serial bus
VCI	Volatile corrosion inhibitor
XLPE	Cross-linked polyethylene

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