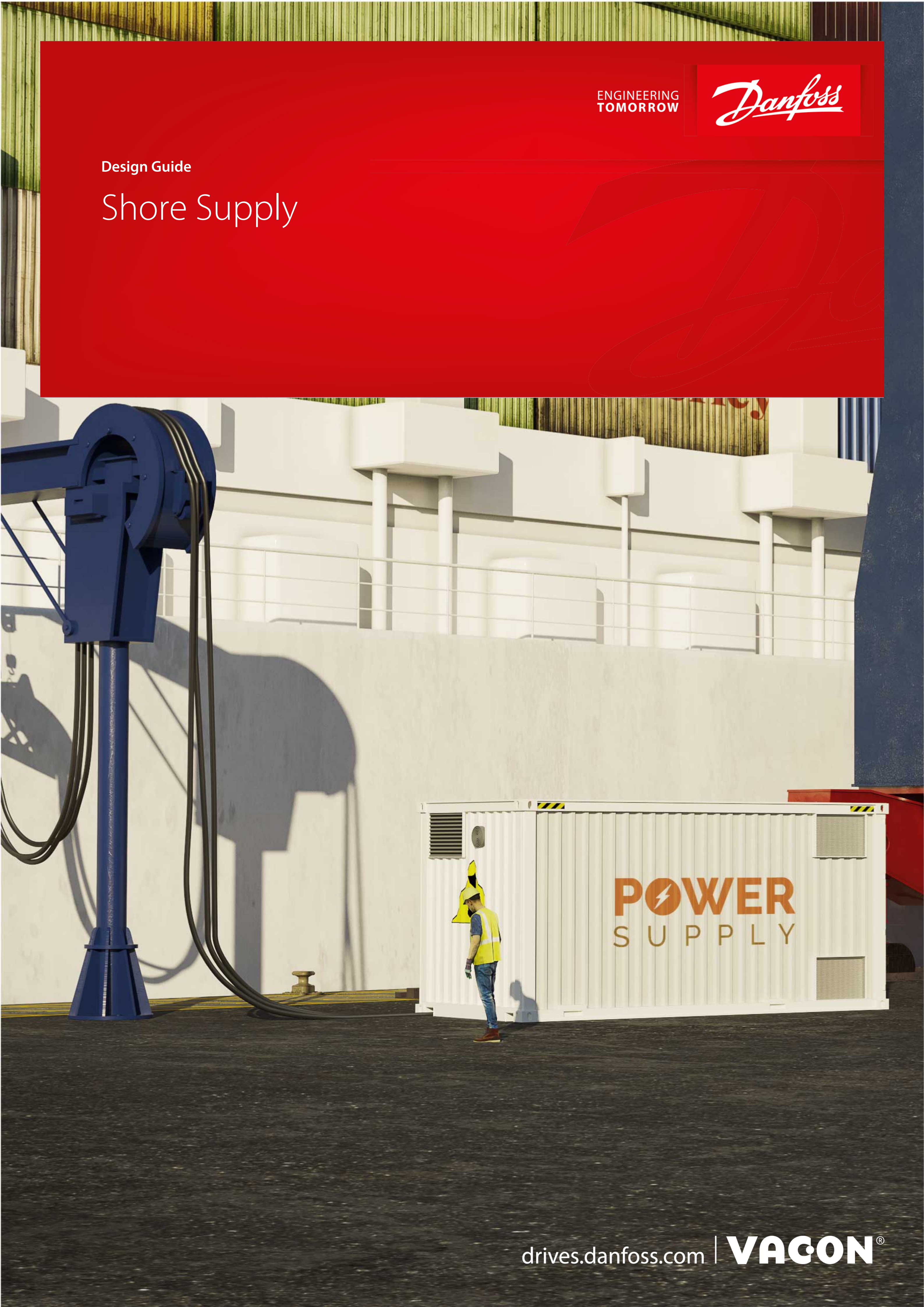
ENGINEERING TOMORROW

Danfoss

Design Guide

Shore Supply



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1 Introduction

1.1 Purpose of this Design Guide

This design guide is intended for qualified personnel, such as:

- Marine sales engineers.
- Project and systems engineers.
- Application and product specialists.

The design guide provides technical information to understand how to use VACON® NXP products in Shore Supply applications.

This manual is meant to be a high-level guideline on how to design the Shore Supply system. Danfoss takes no liability for any defects, costs, losses, damages, or claims related to making a shore supply system according to this guideline.

1.2 Additional Resources

Other resources are available to understand installation, programming, operation, and options.

- The Shore Supply Reference design.
- Shore Supply case stories give examples of successful implementations of the application.
- VACON® NXP user manuals provide detailed information for the installation, commissioning, and operation of the AC drive modules.
- The operating and installation guides for VACON® options give detailed information about specific drive 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: Shore Supply Design Guide Version

Version	Release date	Remarks
A	27.09.2019	First release

1.4 Approvals And Certifications

1.4.1 Marine Type Approvals

VACON® NXP drives have several marine type approvals. For a list of the approvals and certifications, see the Shore Supply product page at www.danfoss.com.

1.4.2 Relevant Regulations And Standards

ISO, IEC, IEEE

Today, there are two relevant publications for shore supply systems:

- ISO/IEC/IEEE 80005-1:2012, Utility Connections in Port, Part 1: High Voltage Shore Connection (HVSC) Systems - General Requirements.
- IEC/PAS 80005-3:2014, Utility Connections in Port, Part 3: Low Voltage Shore Connection (LVSC) Systems - General Requirements.

DNV-GL

DNV-GL have published two different rules for shore supply systems:

- Rules for classification of Ships/High Speed, Light Craft and Naval Surface Craft, Part 6, Chapter 29: Electrical Shore Connections (July 2014)
- Standard for certification, No. 2.25: Electrical Shore Connections/Cold Ironing (January 2012)

2 Safety

2.1 Safety Instructions

A safety guide is included in the product delivery. Read the safety instructions carefully before starting to work in any way with the system or its components.

The warnings and cautions in the safety guide give important information on how to prevent injury and damage to the equipment or the system. Read the warnings and cautions carefully and obey their instructions.

The product manuals with applicable safety, warning, and caution information can be downloaded from https://www.danfoss.com/en/service-and-support/.

3 Product Overview

3.1 Shore Supply

More and more harbors around the world are looking for ways to decrease emissions. One of the most effective ways of accomplishing this decrease, is by connecting each ship to the local power grid when it docks. This connection allows the ship to shut off its diesel engines and power its electrical, cooling, and ventilation systems smoothly from an external source. This simple shift in power source not only helps dramatically cut emissions in the harbor but also in the entire city surrounding it.

Many port authorities prohibit, or at least strictly limit, the use of diesel generators while ships are docked. VACON® NXP Grid Converter technology ensures that the frequency of the ship matches that of the local grid. This allows the entire electrical network of the ship to be powered via a set of cables linking the ship to the shore. The main engine can be shut down, which prevents unnecessary carbon emissions and noise pollution, and allows maintenance work to take place when necessary. All in all, it is a far cleaner, more economical solution than before and is set to become a standard requirement in the future.

A shore supply system is normally on shore, not too far away from the ship that is to be connected to the shore supply system.

Shore supply is known under several different names:

- Shore power.
- Low Voltage Shore Connection (LVSC).
- Cold ironing.
- Shore to Ship power.
- Shore connection.

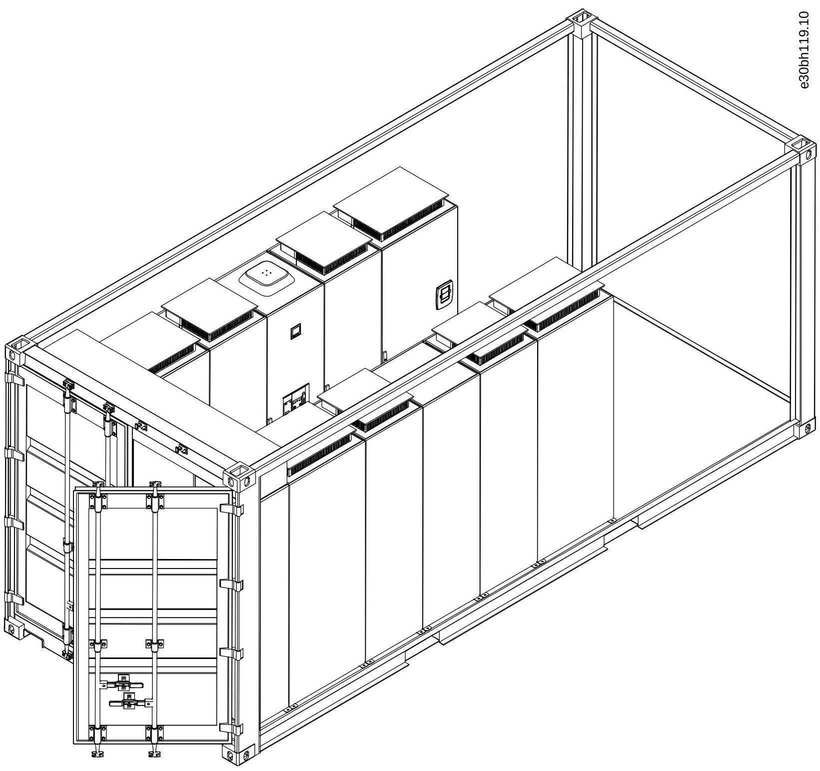
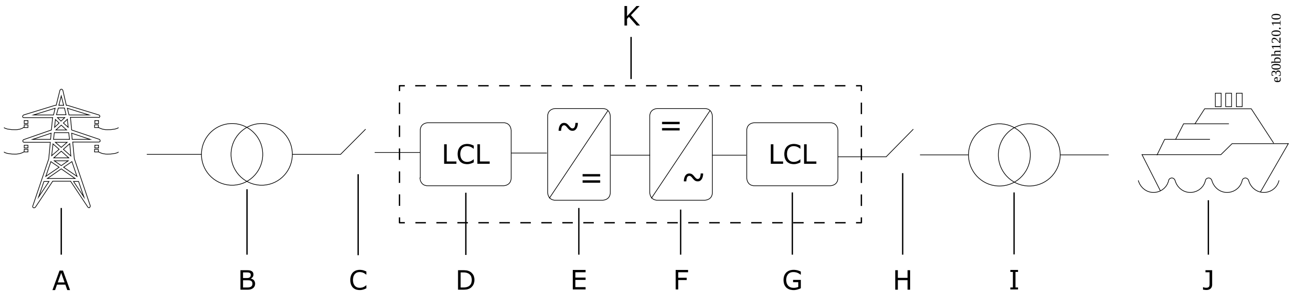


Illustration 1: Example of a Shore Supply Installed in a Container

3.2 Shore Supply System

The main purpose for the shore supply system is to convert the voltage and frequency in the shore grid to match the voltage and frequency which is onboard in the ship grid. A complete shore supply system is made from many smaller building blocks or components. illustration 2 gives an overview of the main components in a shore supply system.



A Supply grid	**B** Shore supply transformer
C Supply breaker	**D** Input filter (LCL)
E Active front end	**F** Grid converter
G Output filter (LCL or sine-wave)	**H** Output breaker
I Isolation transformer	**J** Ship
K Items typically supplied by Danfoss	

Illustration 2: The Main Components of a Shore Supply System

4 Component Overview

4.1 Shore Supply Transformer

Description

If the supply grid voltage is different from the specified shore supply voltage range, a transformer must be used to ensure a correct supply voltage to the shore supply system. The shore supply transformer is typically located close to the shore supply system.

Dimensioning

- Primary winding voltage: Supply grid voltage.
- Secondary winding voltage: Shore supply system voltage.
- The transformer must be able to supply the required power.
- The transformer must be able to handle the THD caused by the shore supply system.

Component Example

Suitable transformers for the shore supply are available, for example, from Hammond Power Solutions.

4.2 Supply Breaker

Description

The supply breaker has two main tasks:

- To ensure a correct pre-charge sequence. For more information, see 4.3.1 Pre-Charge Sequence.
- To connect and disconnect the shore supply system to and from the supply grid.

Dimensioning

The supply breaker must:

- Be able to handle the required voltage.
- Be able to handle the required current.
- Be able to handle the THD caused by the shore supply system.
- Be electrically operated (by AFE or pre-charge circuit).

Component Example

For example, the X1 by Emax low-voltage air circuit-breaker from ABB SACE is a suitable supply breaker for the shore supply. It has the following switch settings:

- Frequency
- Over load
- Short circuit
- Instant trip

4.3 Pre-Charge Circuit

Description

To ensure a safe and correct start-up of the AFE, a pre-charge circuit is required. The AFE usually controls the pre-charge circuit.

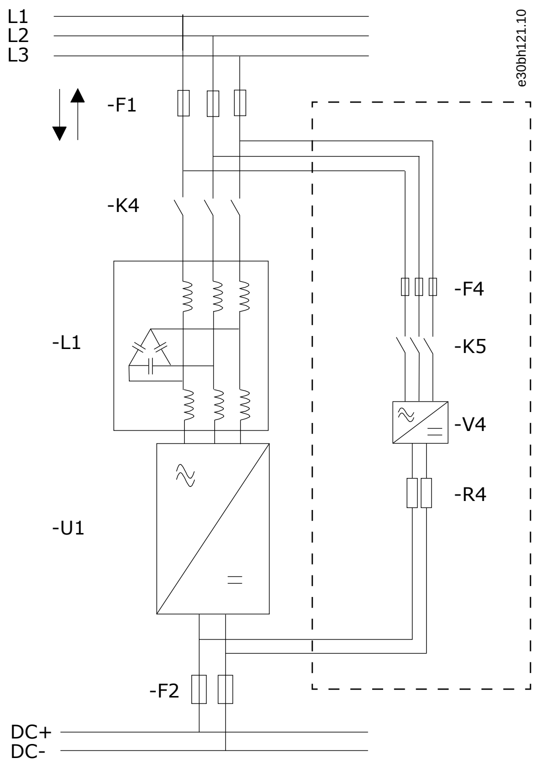
Dimensioning

The pre-charge circuit must be able to handle:

- The required voltage.
- The required current.

Component Example

illustration 3 shows the pre-charge circuit for an AFE.



-F1 AC fuses	**-F2** DC fuses
-F4 AC fuses	**-K4** Supply breaker
-K5 Pre-charge circuit breaker	**-L1** LCL filter
-R4 Pre-charge resistors	**-V4** Pre-charge rectifier
-U1 AFE	

Illustration 3: The Pre-Charge Circuit of an AFE

4.3.1 Pre-Charge Sequence

The flowchart in illustration 4 is an example of an AFE start sequence, including a pre-charge sequence.

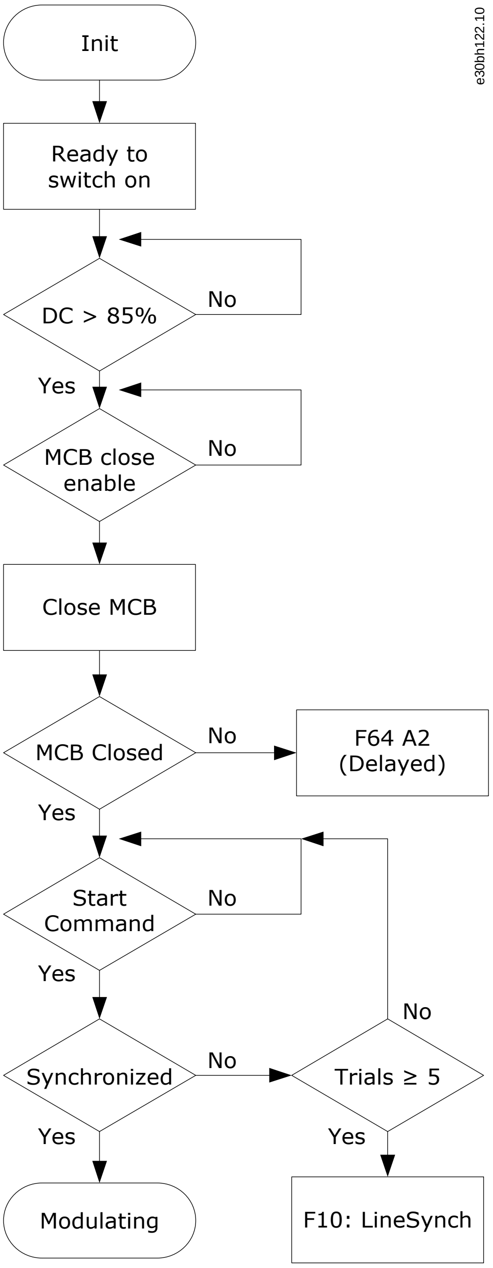


Illustration 4: Example of an AFE Start Sequence

4.4 Input Filter

Description

An LCL input filter is required to reduce switching noise and to ensure the correct functionality of the AFE.

Dimensioning

The input filter must be able to handle:

- The required voltage.
- The required current.

VACON® NX AFE units include a matching LCL filter as default.

Component Example

Suitable LCL filters for the shore supply are available from Danfoss.

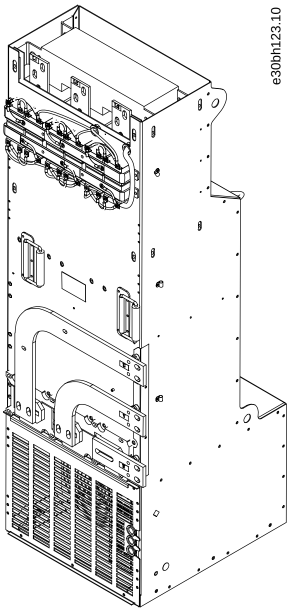


Illustration 5: Example of a VACON® LCL Filter

4.5 Active Front-End

Description

The main task of the active front end (AFE) is to maintain a constant DC voltage in the DC link.

Dimensioning

The AFE must be able to handle:

- The required voltage.
- The required current (power).
    - The AFE supplies the shore supply system with the required amount of power (kW). Therefore, if the supply voltage is lower, the needed current is higher to get the same amount of power.

Component Example

Air-cooled and liquid-cooled VACON® NX AFE units are available in 380–500 V AC and in 525–690 V AC input voltages. See the VACON® NX AFE User Manual and the VACON® NX Liquid-Cooled Drives User Manual for details.

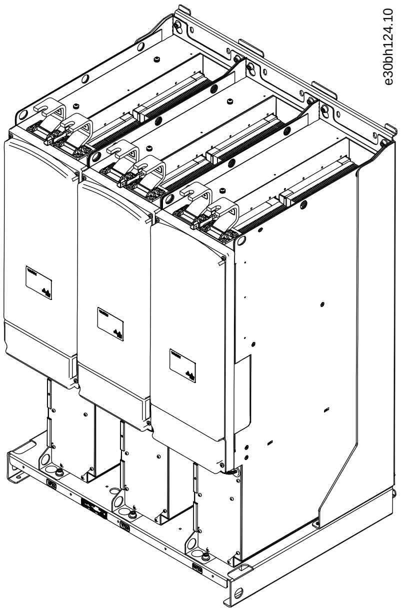


Illustration 6: Example of VACON® NX AFE Module

4.6 Grid Converter

Description

The main task of the grid converter is to maintain a correct AC voltage and frequency on the secondary winding of the isolation transformer.

For closed loop control, install option board OPTD7 in the VACON® NXP grid converter. The option board can measure voltage and frequency on the secondary side of the isolation transformer. See 4.6.1 OPTD7.

Dimensioning

The grid converter must be able to handle:

- The required voltage.
- The required current (power).
  - The grid converter supplies the isolation transformer with the required amount of power (kW). Therefore, if the supply voltage is lower, the needed current is higher to get the same amount of power.

Component Example

Air-cooled and liquid-cooled VACON® NXP Grid Converters are available in 380–500 V AC and in 525–690 V AC output voltages.

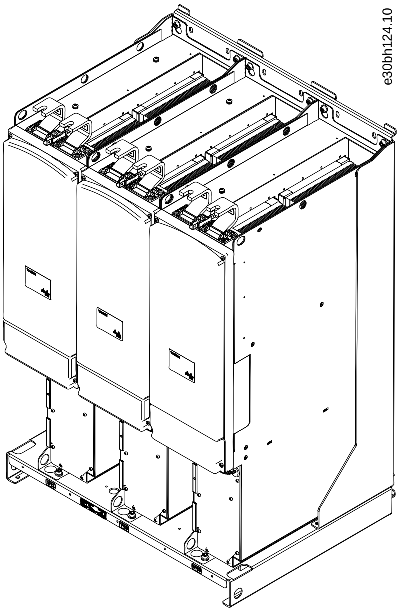


Illustration 7: Example of VACON® NXP Grid Converter Module

4.6.1 OPTD7

The VACON® OPTD7 option board is an AC-sinusoidal voltage measurement board. With this board, the drive measures the mains voltage, the frequency, and the voltage angle information. The drive can compare this information with its output voltage angle when it runs. This feature can be used to make synchronizations to the grid that is measured.

In a Micro Grid application the option board can be used:

- To synchronize to an existing external grid while the drive is running, to enable bumpless transfer from a generator operation to a shore powered operation in a ship.
- To control the grid voltage (voltage loss compensation).
- To enable a zero power connection to an existing grid.
- To help in the commissioning of drive active power and reactive power voltage loss compensation when the actual grid voltage is visible in VACON® NCDrive.

The OPTD7 board is delivered with a transformer which is suitable for a voltage range up to 690 V AC. The transformer cannot be used with a pulse-width modulated (PWM) voltage input.

The OPTD7 transformer requires protective fuses. Sizing of the fuses is case-specific and must be done carefully.

It is possible to use a customized transformer when the input voltage to be measured is not within the voltage range of the default OPTD7 transformer. The transformation ratio parameter can be adjusted according to the transformer primary to secondary ratio. See more details in the VACON® OPTD7 user manual.

4.7 Output Filter

Description

To ensure correct functionality of the grid converter an output filter is required. Usually the grid converter requires an LCL filter. If the isolation transformer has an input impedance ≥4%, the LCL filter can be replaced with a sine-wave filter.

Dimensioning

The output filter must be able to handle:

- The required voltage.
- The required current.

Component Example

Suitable LCL filters and sine-wave filters for the shore supply are available from Danfoss.

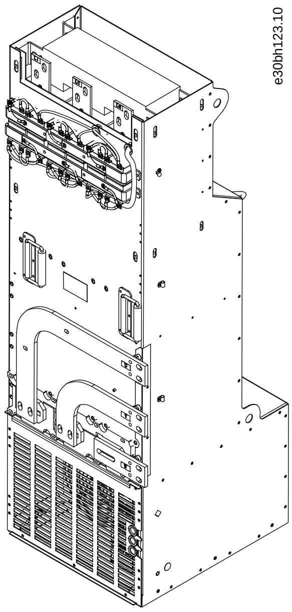


Illustration 8: Example of a VACON® LCL Filter

4.8 Output Breaker

Description

The output breaker has two main tasks:

- To prevent unintentional powering of the grid converter, in case the isolation transformer is powered from the ship.
- To connect and disconnect the shore supply system to and from the ship.

Dimensioning

The output breaker must:

- Be able to handle the required voltage.
- Be able to handle the required current.
- Be able to handle the THD caused by the shore supply system.
- Be electrically operated (by the grid converter).

Component Example

For example, the X1 by Emax low-voltage air circuit-breaker from ABB SACE is a suitable output breaker for the shore supply. It has the following switch settings:

- Frequency
- Over load
- Short circuit
- Instant trip

4.9 Isolation Transformer

Description

The main purpose of the isolation transformer is to make a galvanic isolation between the ship and the supply grid. IEC/PAS 80005-3 requires an isolation transformer: "Galvanic separation between the shore and on-board system shall be provided on shore".

When creating a 3-phase grid with a Grid converter, there are always common-mode voltage issues. The Isolation transformer is a barrier to prevent the common-mode voltage to reach the ship grid.

Dimensioning

- The recommended transformer type is DY11 or DYN11.
- The transformer must be able to supply the required voltage.
- The transformer must be able to supply the required current.
- The transformer must be able to handle the THD caused by the ship.
- It is recommended to order the isolation transformer with ±5% voltage tapping on the primary winding.
- If the input impedance of the isolation transformer ≥4%, the LCL filter can be replaced with a sine-wave filter.

Component Example

Suitable transformers for the shore supply are available, for example, from Hammond Power Solutions.

4.10 Fuses

Fuses are intended for limiting the damage to the drive if there is an internal fault causing overcurrent or arcing. After the specified I2t energy dissipation, the fuse opens the circuit and neutralizes the short circuit.

The drives fuses are not intended to protect the load. The load must have its own protection. For further information, refer to the manuals of the load devices.

AC Supply Fuses

- AC fuses are required in all 3 phases of the supply to the AFE.
- See the fuse selection instructions in the VACON® NX AFE User Manual.

DC Fuses

- Inverter units must have aR-type fuses in both DC supply lines.
- See the fuse selection instructions in the VACON® NXP User Manuals.

4.11 Cables From Shore To Ship

Description

Cable handling equipment can be required to lift and connect the cables to the ship.

Dimensioning

The cable handling equipment must be able to handle, lift, and connect the cables from the shore to the ship.

Component Example

For example, the AMPTelescopic from Cavotec is a suitable cable handling solution for the shore supply.

4.12 Ground Fault Protection

Description

A ground fault is a serious fault. It is therefore required to have correct ground fault detection equipment installed in the system.

IEC/PAS 80005-3 also requires ground fault equipment : "Earth fault protection, monitoring, and alarm devices shall be of a type designed to operate effectively when connected to an LVSC supply with distribution system."

Dimensioning

The ground fault protection equipment must be:

- Suitable for use in a shore supply system.
- Suitable for the maximum system AC or DC voltage.

Component Example

Examples of ground fault detection equipment suppliers:

- Bender
- Deif

4.13 Safety Circuit

Description

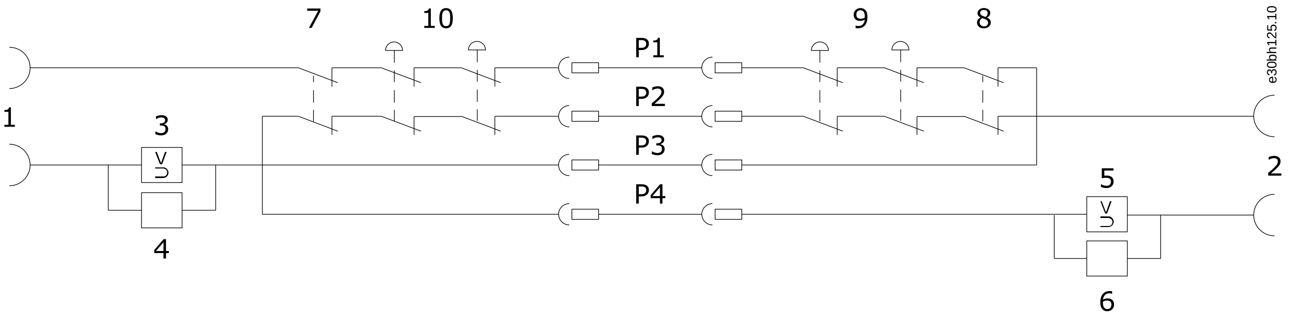
To ensure a safe power cut off in an unexpected situation, it is recommended to have an emergency circuit between the shore supply system and the ship.

IEC/PAS 80005-3 also requires a safety circuit: "Emergency shutdown facilities shall be provided. When activated, they will instantaneously open circuit breakers on shore and on-board ship."

For more information about the safety options available for VACON® NXP drives, see the related user manuals available at www.danfoss.com.

Component Example

The figure shows how the safety circuit is described in IEC/PAS 80005-3.



1 Control power pilot loop, shore supply	**2** Control power pilot loop, ship
3 Feeder circuit breaker undervoltage coil, shore supply	**4** Safety circuit coil, shore supply
5 Main circuit breaker undervoltage coil, ship	**6** Safety circuit coil, ship
7 Control emergency shutdown, shore supply	**8** Control emergency shutdown, ship
9 Manual emergency shutdown, ship	**10** Manual emergency shutdown, shore supply

Illustration 9: Safety Circuit, as Described in IEC/PAS 80005-3

4.14 Control And Power Management System

Description

The control and power management system can either be a separate PLC or the drive control module.

The main functionalities of the shore supply control system:

- Start/stop
- 50/60 Hz selection
- Voltage selection
- Recording of delivered energy (kWh)

5 Specifications

5.1 Software

5.1.1 Firmware Software

The latest versions of the firmware software for Danfoss drives can be downloaded from https://www.danfoss.com/en/service-and-support/downloads/dds/ac-drive-firmware/.

5.1.2 Application Software

The latest versions of the VACON® NXP application software for AFE and Grid Converter can be downloaded from https://www.danfoss.com/en/service-and-support/downloads/dds/drives-application-software/.

The VACON® NXP Grid Converter application requires a license. To acquire a license, contact the local Danfoss representative.

6 Mechanical Installation Guidelines

6.1 Drive Enclosure

There are different AFE and Grid converter components available for a Shore Supply system. For more information, see the manuals for the drives, which are available at https://www.danfoss.com/.

6.1.1 Drive Modules

The VACON® NXP product family includes air-cooled and liquid-cooled AFE and grid converter modules. The drive modules have protection rating IP00 and must be installed in a metal cabinet or other applicable enclosure. The enclosure must have the correct level of protection against the ambient conditions in the installation area. Make sure that the cabinet gives protection against:

- Water,
- Humidity,
- Dust,
- Other contaminations.

6.1.2 Enclosed Drives

The VACON® NXP product family includes air-cooled and liquid-cooled enclosed drives, which include an AFE, grid converter, filters, and breakers required for the shore supply:

- VACON® NXC
- VACON® NXP System Drive
- VACON® NXP Liquid Cooled Enclosed Drive

6.2 Container

In case an outdoor installation is necessary, it is possible to install the Shore Supply in a container. The guidelines for a container installation are discussed in this chapter.

Danfoss is not a system integrator (SI), but can help customers by providing tools and reference designs to ease the system design. For example, configurable 3D models and 2D general arrangement drawings are available from Danfoss.

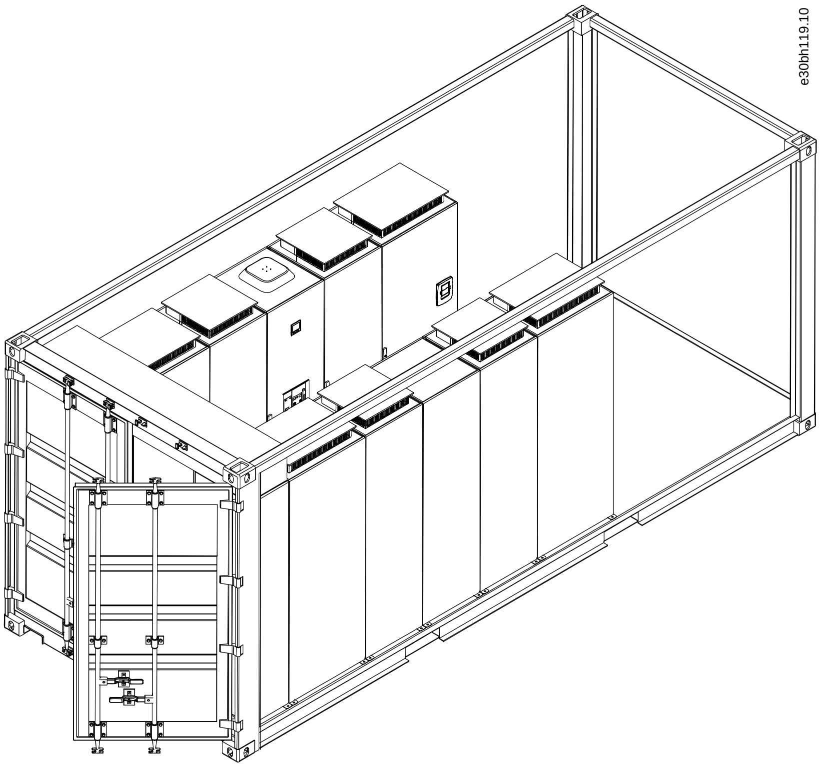


Illustration 10: Example of a Shore Supply Installed in a Container

6.2.1 General Design Guidelines

For the Shore Supply, the most important requirement in the container installation is that the ambient conditions for the system are according to the requirements for safe operation. Some things to consider in the design:

- The ambient conditions (temperature, humidity) outside the container are different in different parts of the world, but inside the container the conditions must be according to the requirements. See 6.2.3 Cooling.
- Cable inlets to the container and cabling inside the container. See 6.2.2 Cabling.
- Protection rating (IP) for the Shore Supply and the container.
- Separation of LV and MV components (for example, supply transformer).
- Possible vibration and vibration damping of the drive components.
- Service access for large components (for example, a service hatch, double doors, or doors at both ends of the container).
- Proper mounting of the container (for example, a proper foundation, or welding the container on the deck of a ship).
- Weight restrictions for the container (is it possible to use a standard shipping container or is a custom container required?).
- Possible fire extinguishing or smoke detecting system.
- Surge and overvoltage protection (for example, surge arresters according to the applicable Lightning Protection Zone, LPZ).
- Requirements from the utility (for example, circuit breakers).
- Lighting inside the container.

Always follow applicable standards and local regulations in the design.

For more detailed installation instructions and requirements for Danfoss drives, see the applicable product manuals. See www.danfoss.com for listings.

6.2.2 Cabling

Things to consider in the design of the cabling in the container:

- Obey all applicable standards and local regulations.
- Cable entry to the container must have sufficient insulation and clearance to conducting parts.
- Sufficient space inside the container for making the cable connections to the Shore Supply components.
- Sufficient space inside the container for servicing the Shore Supply components.
- Sufficient clearance between cables.
- Separation of high and low-voltage cables.
- Grounding according to applicable standards and local regulations.
- Cable routing inside the container (for example, cable trays or cabling under the container floor).

For recommended cable types and sizes, see the user guide for the AC drive.

6.2.3 Cooling

The Shore Supply components generate heat during operation. Therefore, cooling is required to remove the heat from the container. The cooling must be designed so that the ambient conditions in the container stay within the specifications for all the components. If the components become too hot or cold, it puts the operation of the Shore Supply at risk and can decrease the life time of the components.

Things to consider:

- Enough space around the Shore Supply components for the air to move freely inside the container.
- Sufficient intake for the cooling air.
- Sufficient outlet for the warm air.
- Directing the cooling air to the components and the warm air out of the container with, for example, a cooling duct arrangement.
- Is passive (natural airflow) cooling enough or is active cooling (for example, fans or heat exchangers) required to maintain the required operating conditions?

For information on heat loss and airflow calculations, see the user guide of the AC drive.

7 How to Select the VACON® NXP Grid Converter

7.1 VACON® Select Web Tool

The VACON® Select Web Tool is a useful and easy-to-use tool for selecting the correct VACON® NXP Grid Converter for Shore Supply applications. Select the work mode AFE/uGRID. The web tool has a simple form which gives the correct drive based on the input values. See illustration 11.

The tool gives the following information:

- Recommended VACON® NXP Grid Converter (AFE or µGrid)
- Recommended filter
- Recommended fuses
- Efficiency calculation
- Drawings
- Report

The web tool is accessible to Danfoss Drives personnel and is available at http://select.corp.intra.vacon.com/sizing/login.jspx. Contact the nearest Danfoss Drives representative for more information.

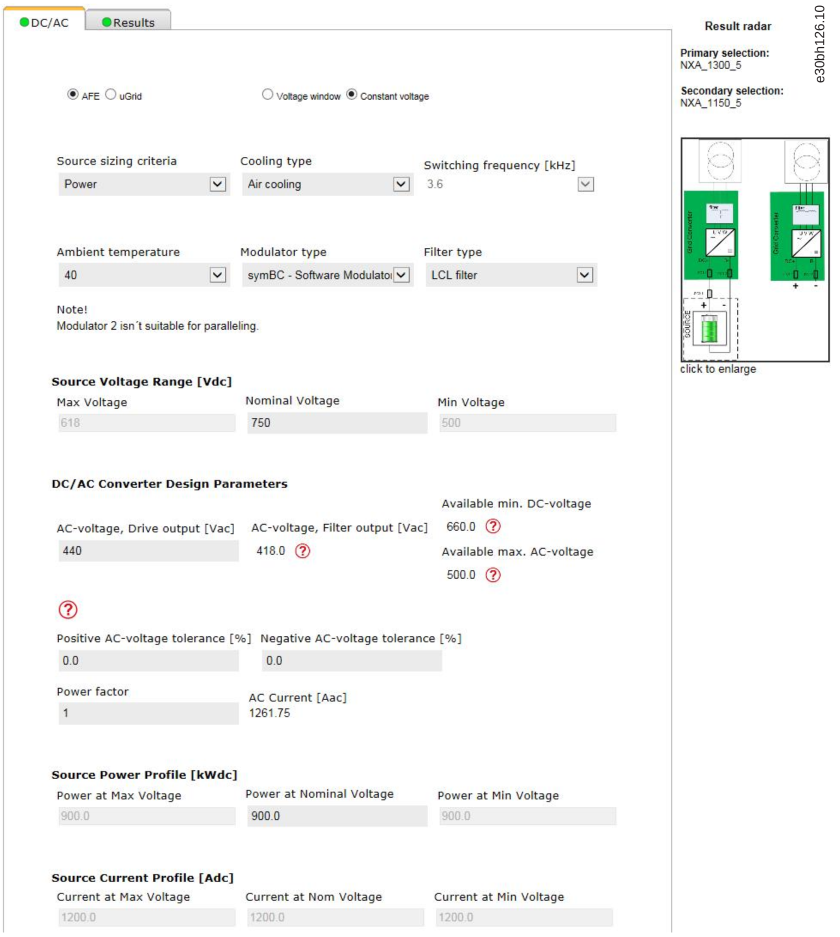


Illustration 11: Screenshot from the VACON® Select Web Tool

7.2 Design Example 1: 300 kVA Shore Supply

This example shows how to select the correct drive for a 300 kVA shore supply system.

- 7.2.1 Technical Datasheet lists the necessary technical data needed for the drive selection.
- 7.2.2 Selection Instructions shows how to use the VACON® Select Web Tool to make the drive selection.
- 7.2.3 Drawing of The Selected Arrangement shows a drawing of the selected drive arrangement.

7.2.1 Technical Datasheet

Table 2: Technical Datasheet for a 300 kVA Shore Supply

Specification	Active front end (AFE)	Comments
Supply voltage	440–500 V, 50/60 Hz	<440 V limits the kVA capacity of the AFE. Lower voltage gives higher AFE current.
Supply frequency	45–66 Hz	50/60 Hz ±10%.
Supply current harmonics (THD)	<5%	AFE causes less than 5% THD on the AC supply
Ambient temperature	-10˚C (no frost) … +40˚C	Ambient temperature for IP00 units. Enclosure can add ~5˚C to the temperature inside the container. Higher ambient temperature requires current derating for AFE and µGrid.
Humidity	0–95% RH, non-condensing, non-corrosive, no dripping water	
Altitude	100% load capacity (no derating) up to 1000 m. 1% derating for each 100 m above 1000 m. Maximum altitude: 3000 m	
Cooling	VACON® NXP inverters: forced air or liquid cooling.	
Output isolation transformer	Type: DY11 Primary winding: 470 V Secondary winding: System dependent	Galvanic separation between the shore supply and the ship. 750 V DC gives maximum 470 V on the primary winding. Lower DC-link voltage gives lower AC voltage out to the filter. DC-link voltage = 1.5 × AC voltage Lower voltage (<470 V) on primary side of the isolation transformer requires higher current to have the same kVA.
Output capacity	300 kVA 255 kW (cos φ = 0.85)	Limited by 40˚C ambient temperature and 440 V supply.

Specification	Active front end (AFE)	Comments
Output current to primary winding of isolation transformer (1)	Continuous: 374 A 2 s overload: 693 A	NXA1300-5 FI13 inverter 2 s overload can be utilized as a fuse burning functionality. (2)
Example 1: Output current 440 V	Continuous: 400 A 2 s overload: 740 A	Transformer ratio: 470/440 V 2 s overload can be utilized as a fuse burning functionality. (2)
Example 2: Output current at 690 V	Continuous: 255 A 2 s overload: 472 A	Transformer ratio: 470/690 V 2 s overload can be utilized as a fuse burning functionality. (2)
Output voltage distortion at no load	<3% THDU	Typically 2.5% THDU at no load condition
Output frequency accuracy	<0.1%	Excluding frequency drooping for load sharing of active current (if activated)
Output voltage accuracy	1%	Excluding frequency drooping for load sharing of reactive current (if activated).
EMC	Compliant to EN 61800-3	
Efficiency (including transformers)	>94% (typically)	Excluding active cooling

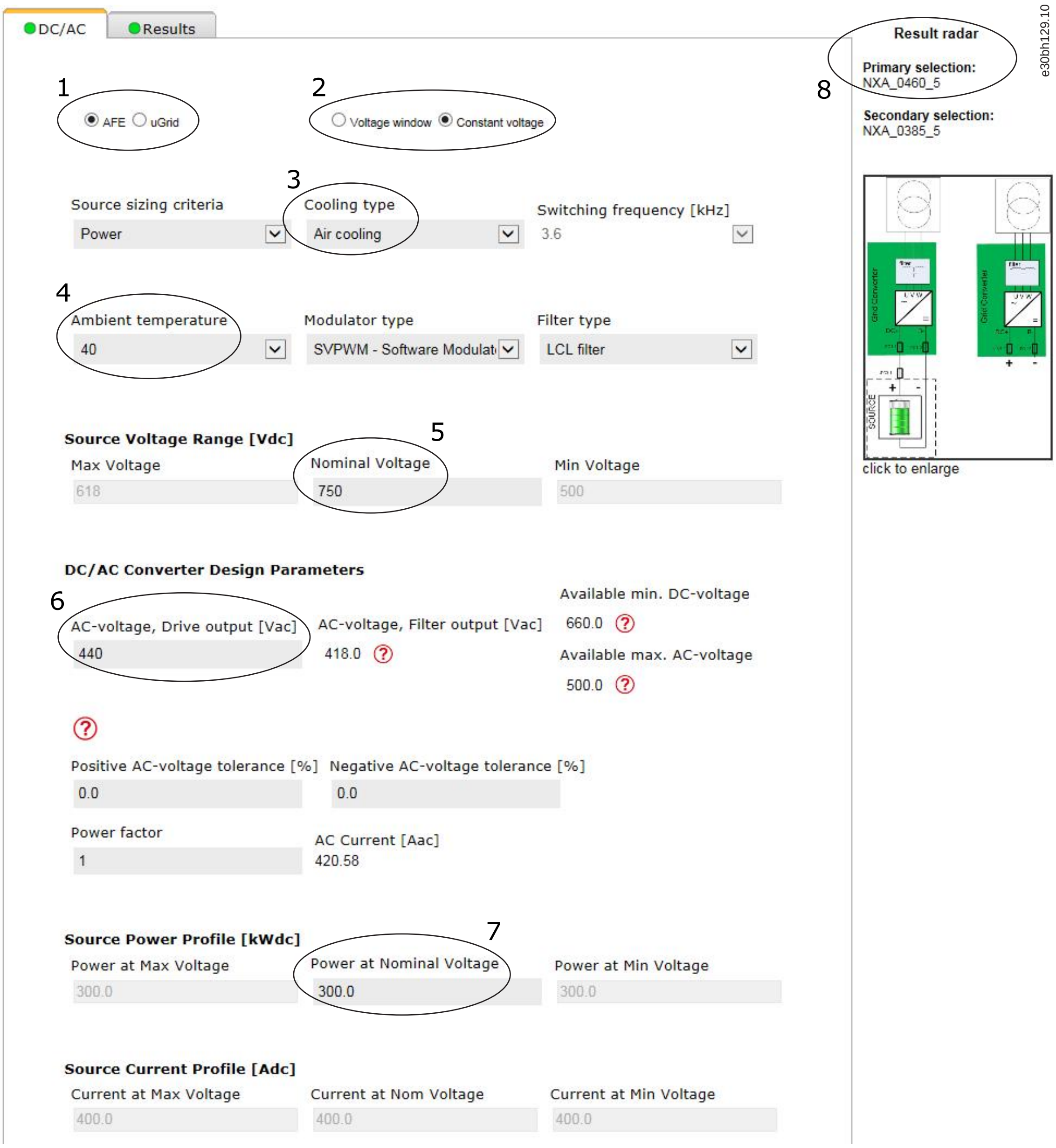
[1] *For more current ratings, see the user manual for the AFE.*

[2] *If a short circuit occurs on the AC grid supplied by the grid converter, the grid converter detects the short circuits and injects reactive current to burn the fuses nearest to the fault.*

7.2.2 Selection Instructions

The AFE and Grid converter selection can be done easily with the VACON® Select Web Tool. See 7.1 VACON® Select Web Tool. To do the selection, use the information in the technical datasheet.

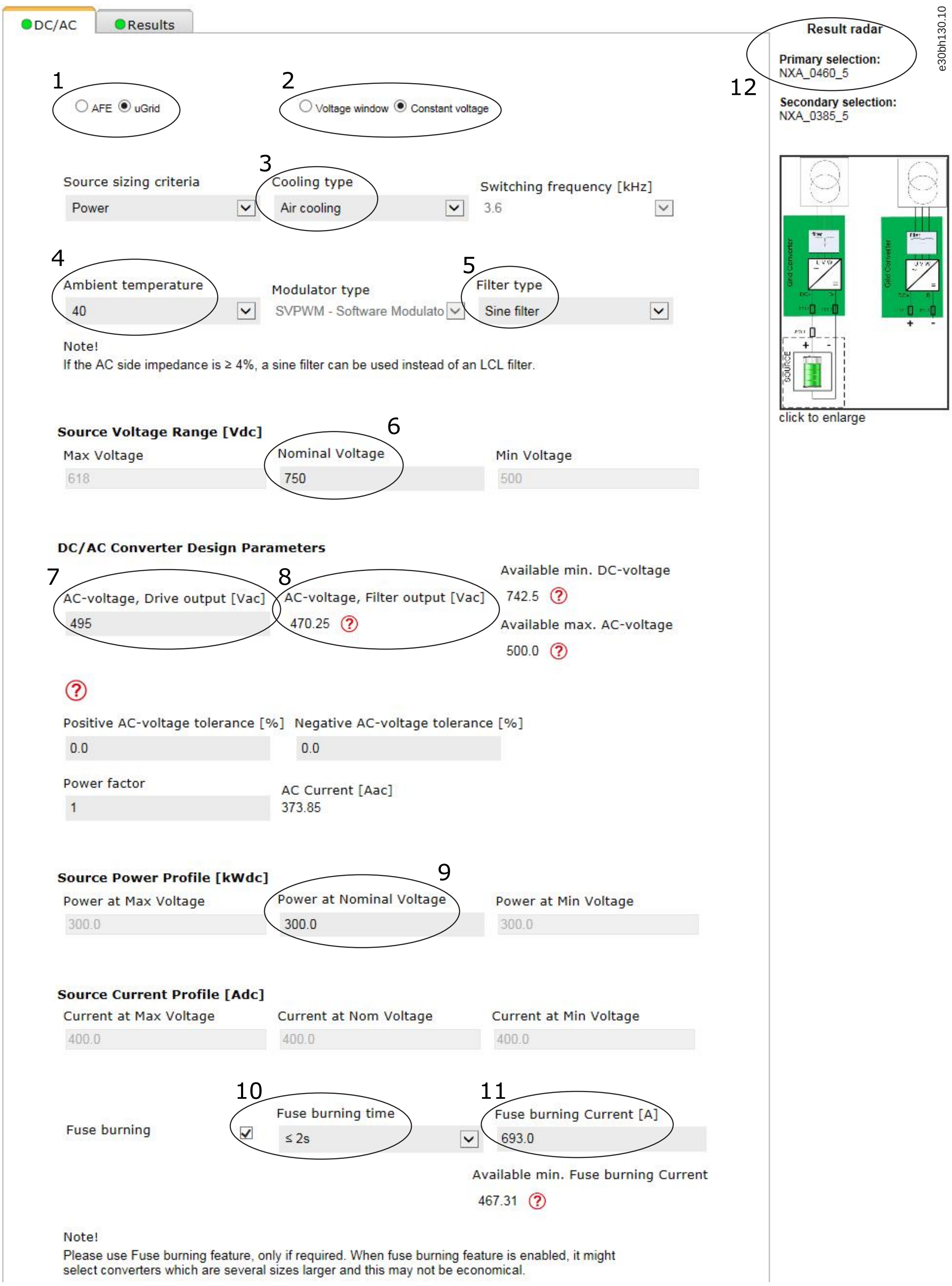
AFE Selection



1	Select AFE.	2	Select Constant voltage.
3	Select Cooling type: Air cooling.	4	Set the maximum Ambient temperature: 40˚C.
5	Set the required DC-link voltage, Nominal voltage: 750 V.	6	Set the required minimum AC supply voltage, Drive output: 440 V.
7	Set the required Power at nominal voltage: 300.0 kVA.	8	The Result radar shows the selected AFE.

Illustration 12: Design Example 1: AFE Selection

Grid Converter Selection



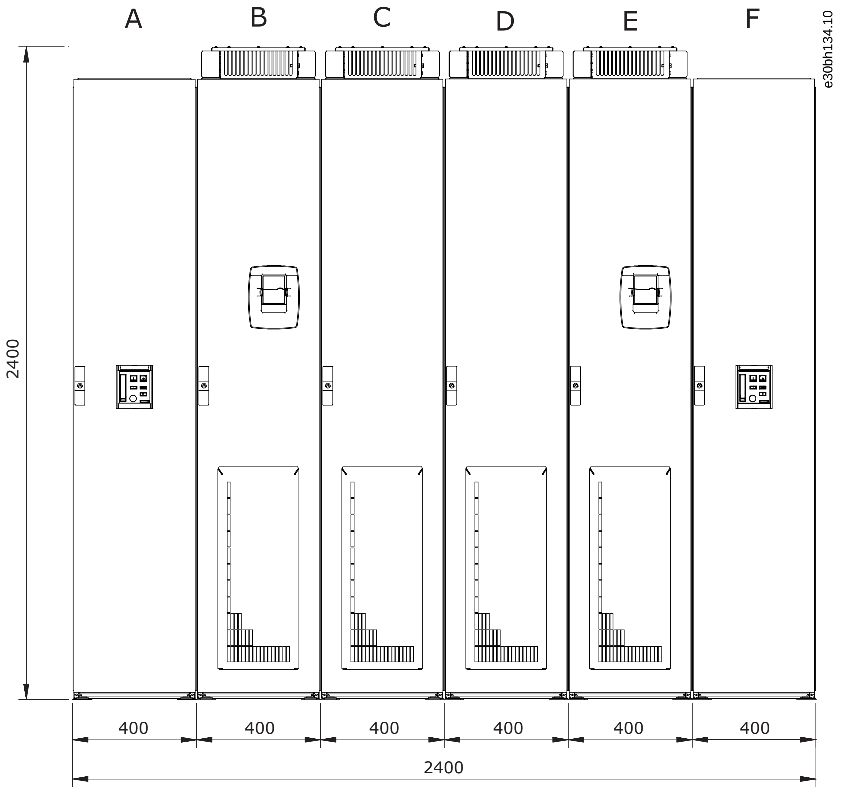
1 Select uGRID.	**2** Select Constant voltage.

3	Select Cooling type: Air cooling.	4	Set the maximum Ambient temperature: 40˚C.
5	Set the Filter type: Sine filter.	6	Set the required DC-link voltage, Nominal voltage: 750 V.
7	Set the required minimum AC supply voltage to the sine-wave filter, Drive output: 495 V.	8	Check that the required minimum AC supply voltage to the isolation transformer primary winding is correct.
9	Set the required Power at nominal voltage: 300.0 kVA.	10	Select Fuse burning, and set the Fuse burning time: ≤ 2 s.
11	Set the required maximum Fuse burning current (Is): 693.0 A.	12	The Result radar shows the selected Grid Converter.

Illustration 13: Design Example 1: Grid Converter Selection

7.2.3 Drawing of The Selected Arrangement

The illustration shows an example of the dimensions and components of the selected VACON® NXC arrangement. The dimensions are in mm.



A	Input section with supply breaker	B	Input filter section with LCL filter
C	Active front end	D	Grid converter
E	Output filter section with LCL or sine-wave filter	F	Output section with output breaker

Illustration 14: Example of the Selected VACON® NXC Arrangement, NXA_460_5

7.3 Design Example 2: 900 kVA Shore Supply

This example shows how to select the correct drive for a 900 kVA shore supply system.

- 7.3.1 Technical Datasheet lists the necessary technical data needed for the drive selection.
- 7.3.2 Selection Instructions shows how to use the VACON® Select Web Tool to make the drive selection.
- 7.3.3 Drawing of The Selected Arrangement shows a drawing of the selected drive arrangement.

7.3.1 Technical Datasheet

Table 3: Technical Datasheet for a 900 kVA Shore Supply

Specification	Active front end (AFE)	Comments
Supply voltage	440–500 V, 50/60 Hz	<440 V limits the kVA capacity of the AFE. Lower voltage gives higher AFE current.
Supply frequency	45–66 Hz	50/60 Hz ±10%.
Supply current harmonics (THD)	<5%	AFE causes less than 5% THD on the AC supply
Ambient temperature	-10°C (no frost) … +40°C	Ambient temperature for IP00 units. Enclosure can add ~5°C to the temperature inside the container. Higher ambient temperature requires current derating for AFE and µGrid.
Humidity	0–95% RH, non-condensing, non-corrosive, no dripping water	
Altitude	100% load capacity (no derating) up to 1000 m. 1% derating for each 100 m above 1000 m. Maximum altitude: 3000 m	
Cooling	VACON® NXP inverters: forced air or liquid cooling.	
Output isolation transformer	Type: DY11 Primary winding: 470 V Secondary winding: System dependent	Galvanic separation between the shore supply and the ship. 750 V DC gives maximum 470 V on the primary winding. Lower DC-link voltage gives lower AC voltage out to the filter. DC-link voltage = 1.5 × AC voltage Lower voltage (<470 V) on primary side of the isolation transformer requires higher current to have the same kVA.
Output capacity	900 kVA 765 kW (cos φ = 0.85)	Limited by 40°C ambient temperature and 440 V supply.

Specification	Active front end (AFE)	Comments
Output current to primary winding of isolation transformer [(1)]	Continuous: 1120 A 2 s overload: 2070 A	NXA1300-5 FI13 inverter 2 s overload can be utilized as a fuse burning functionality. [(2)]
Example 1: Output current 440 V	Continuous: 1196 A 2 s overload: 2211 A	Transformer ratio: 470/440 V 2 s overload can be utilized as a fuse burning functionality. [(2)]
Example 2: Output current at 690 V	Continuous: 763 A 2 s overload: 1410 A	Transformer ratio: 470/690 V 2 s overload can be utilized as a fuse burning functionality. [(2)]
Output voltage distortion at no load	<3% THDU	Typically 2.5% THDU at no load condition
Output frequency accuracy	<0.1%	Excluding frequency drooping for load sharing of active current (if activated)
Output voltage accuracy	1%	Excluding frequency drooping for load sharing of reactive current (if activated).
EMC	Compliant to EN 61800-3	
Efficiency (including transformers)	>94% (typically)	Excluding active cooling

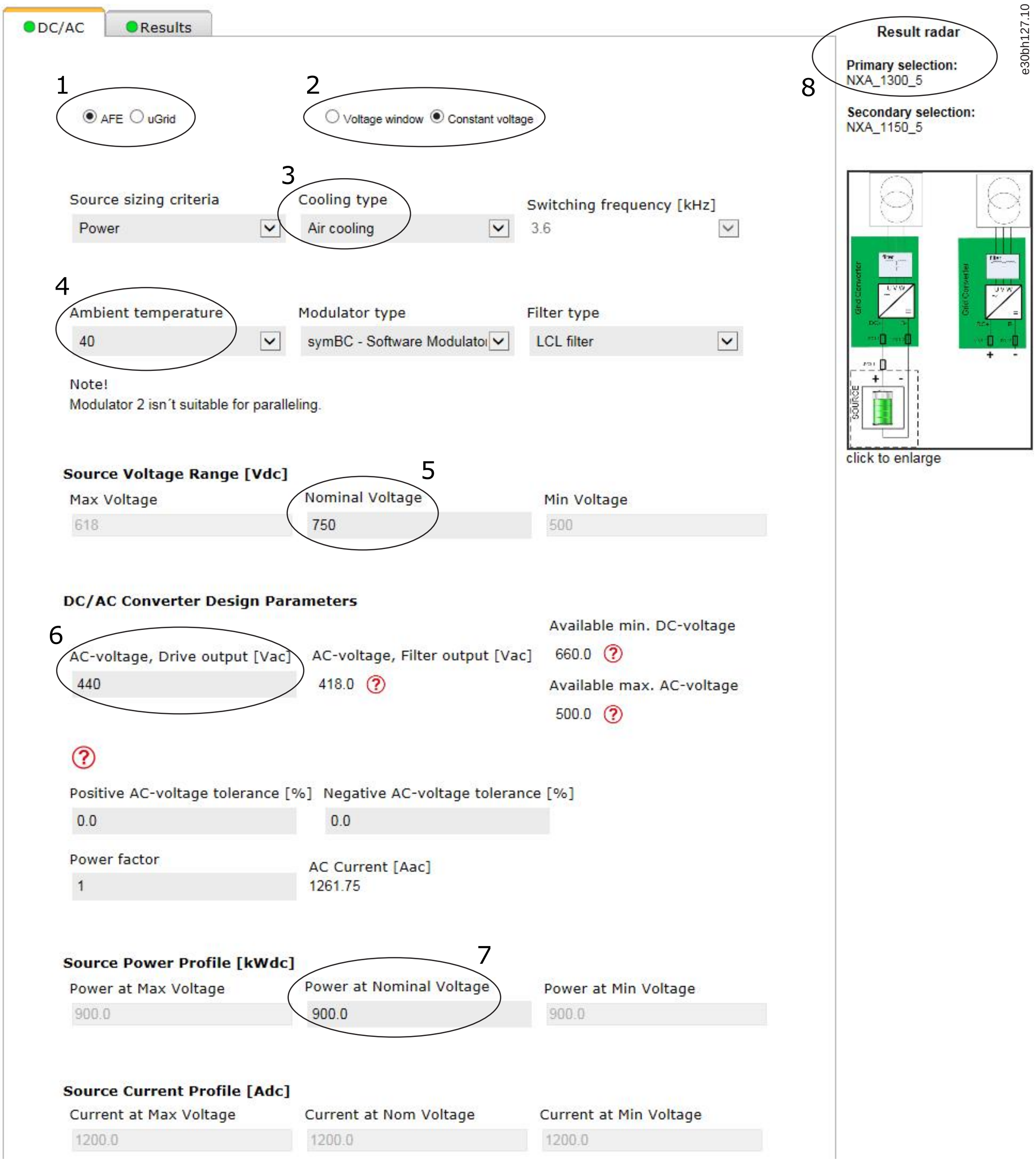
[1] *For more current ratings, see the user manual for the AFE.*

[2] *If a short circuit occurs on the AC grid supplied by the grid converter, the grid converter detects the short circuits and injects reactive current to burn the fuses nearest to the fault.*

7.3.2 Selection Instructions

The AFE and Grid converter selection can be done easily with the VACON® Select Web Tool. See 7.1 VACON® Select Web Tool. To do the selection, use the information in the technical datasheet.

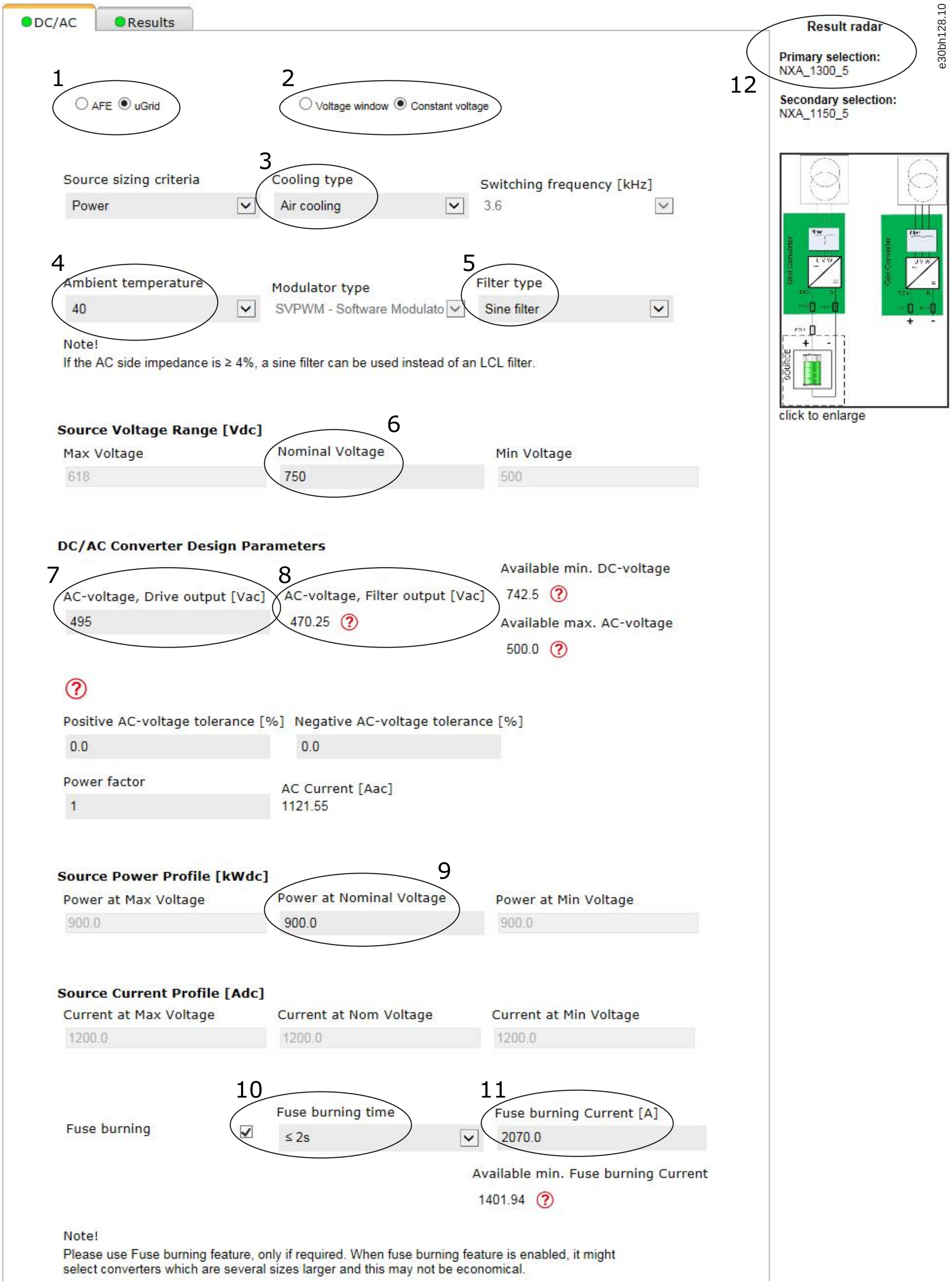
AFE Selection



1 Select AFE.	**2** Select Constant voltage.
3 Select Cooling type: Air cooling.	**4** Set the maximum Ambient temperature: 40˚C.
5 Set the required DC-link voltage, Nominal voltage: 750 V.	**6** Set the required minimum AC supply voltage, Drive output: 440 V.
7 Set the required Power at nominal voltage: 900.0 kVA.	**8** The Result radar shows the selected AFE.

Illustration 15: Design Example 2: AFE Selection

Grid Converter Selection



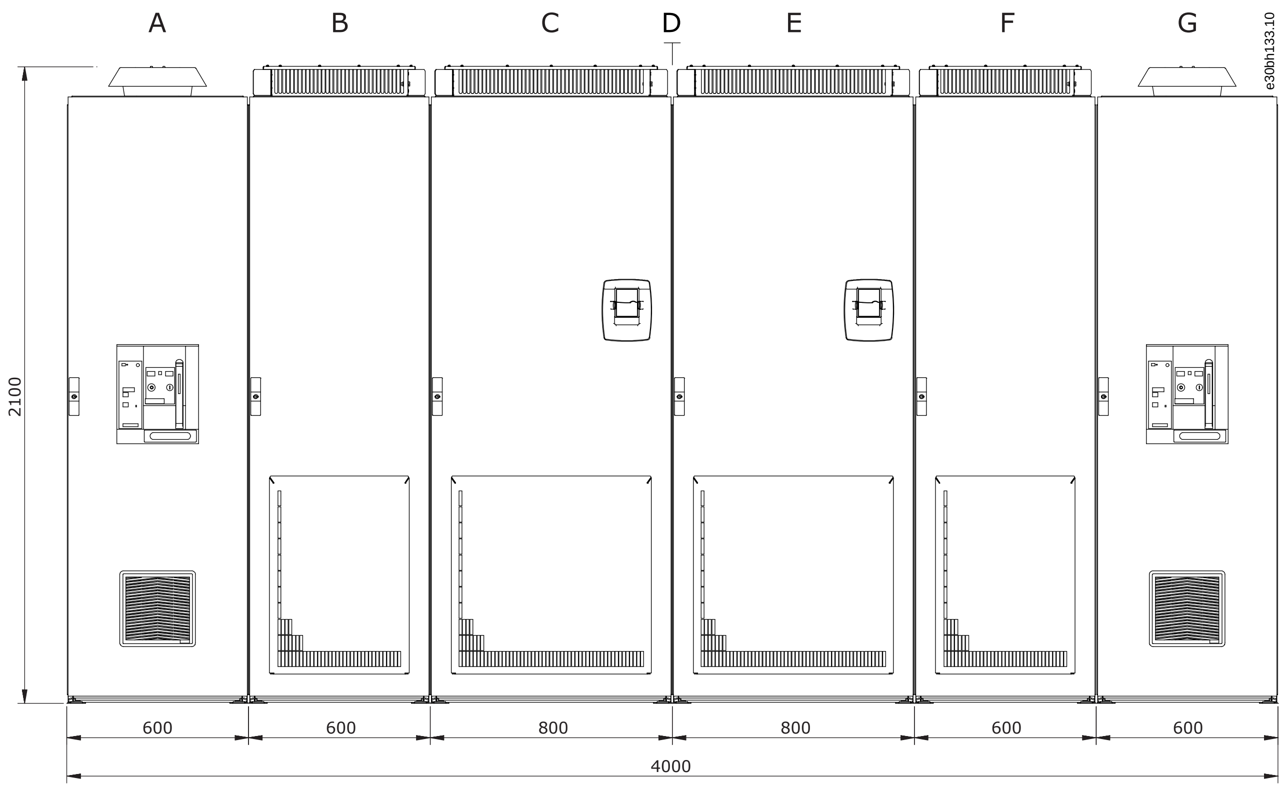
1 Select uGRID.	**2** Select Constant voltage.

3 Select Cooling type: Air cooling.	**4** Set the maximum Ambient temperature: 40˚C.
5 Set the Filter type: Sine filter.	**6** Set the required DC-link voltage, Nominal voltage: 750 V.
7 Set the required minimum AC supply voltage to the sine-wave filter, Drive output: 495 V.	**8** Check that the required minimum AC supply voltage to the isolation transformer primary winding is correct.
9 Set the required Power at nominal voltage: 900.0 kVA.	**10** Select Fuse burning, and set the Fuse burning time: ≤ 2 s.
11 Set the required maximum Fuse burning current (Is): 2070.0 A.	**12** The Result radar shows the selected Grid Converter.

Illustration 16: Design Example 2: Grid Converter Selection

7.3.3 Drawing of The Selected Arrangement

The illustration shows an example of the dimensions and components of the selected VACON® NXC arrangement. The dimensions are in mm.



A Input section with supply breaker	**B** Input filter section with LCL filter
C Active front end	**D** Cabinet transport split
E Grid converter	**F** Output filter section with LCL or sine-wave filter
G Output section with output breaker	

Illustration 17: Example of the Selected VACON® NXC Arrangement, NXA_1300_5

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