SINAMICS S120 Cabinet Modules
Application Shaft Generator Drive
For energy-efficient and reliable marine solutions

siemens.com/sinamics-s120-cabinet-modules
Shaft generators – the efficient alternative to diesel generators

Shaft generators are used as an alternative to diesel generators as the ship’s onboard supply. The generator is either directly mounted on the main propulsion shaft of the ship (rotor with a high number of poles) or is connected to the shaft through a gearbox (rotor with a low number of poles). As a consequence, it is possible to shut down the conventional onboard diesel generators and instead supply the vessel with power from the main engine. When compared to diesel generators, the main engine has a significantly lower specific fuel consumption (g/kWh).

In addition to the technological lead, aspects such as total cost of ownership and high operational reliability are some of the most important properties of a cost-effectively operated system.

The operating costs are significantly reduced as a result of the better specific fuel consumption of the main engine. Being able to shut down the diesel generators extends the service and maintenance intervals, which in turn further reduces the operating costs.

The vibration and noise emitted from shaft generators are significantly lower than those from diesel generators. The lower emissions and operating costs are complemented by the high operational reliability. In the case of shaft generator drive systems, which have a booster function (power take in-operation), when required, it is possible to drive the main propulsion shaft. This can be used to either increase the ship’s speed, or if the main diesel engine is down, to guarantee that the vessel can be maneuvered and to implement “take home operation”.

The perfect frequency converter solution for shaft generators – energy efficient and reliable.
Frequency converter for energy recovery in the marine operation

In the system to feed energy from the shaft generator into the onboard ship’s supply, frequency converters ensure the electrical decoupling between the onboard supply and the generator. On the other hand, for booster operation, the shaft generator is fed from the onboard supply and operates as motor. In marine operation, the frequency converter technology must be able to master special challenges. As a result of the different speeds of the vessel or in heavy seas, the speed of the main propulsion shaft fluctuates. However, the onboard supply must be fed with a constant voltage and frequency.

Perfectly harmonized

The SINAMICS S120 Cabinet Modules Shaft Generator Drive Application is the perfect frequency converter solution for shaft generators, precisely tailored to address this application. It is a voltage-source DC link converter with pulse-width modulation, employing IGBTs (Insulated Gate Bipolar Transistor) in-line with the latest state-of-the-art technology. For a standard power range from 1.5 MVA to 2 MVA, which can be expanded up to 4 MVA, it has a system voltage of 690 V AC. An isolating transformer is used to adapt the voltage to the onboard line voltage. In addition to shaft generator operation (power take off) as standard, as a result of its topology, the frequency converter is also suitable for booster operation (power take in). Depending on the selected shaft generator solution, it forms a system for operating separately-excited synchronous machines or induction machines without encoder with a high associated degree of availability.

It can operate in standalone operation as well as in parallel operation with other shaft generators or onboard diesel generators. The frequency converter SINAMICS S120 Cabinet Modules Shaft Generator Drive Application has a patented algorithm, which when required, can ensure selective tripping of the protective elements at the fault location, which in turn reliably limits the current. In this case, the converter system feeds a short-circuit current with the required magnitude and duration into the onboard supply. The scalable overload capability for the short-circuit current reduces costs. The capacitor machine can be eliminated, therefore reducing the amount of space required and the associated maintenance costs.
Innovative technology in an optimized design for higher availability and reliability

Standard options:
Using a wide range of options, standard products can be flexibly adapted to address customer requirements. The standard version of the SINAMICS S120 Cabinet Modules Shaft Generator Drive Application is implemented in compliance with the requirements of marine classification GL. Other marine classifications and additional electrical and mechanical features can be chosen as standard options, which can be selected and ordered using the appropriate option code.

Modular excitation concept
When using a separately-excited synchronous machine, the excitation winding is fed directly from the DC link through a DC/DC IGBT controller. This clearly highlights the state-of-the-art technology of the excitation equipment employing IGBTs when compared to classic excitation controllers using thyristors. The excitation system supplied from the DC link ensures a higher degree of availability. In the case of a short-circuit, the machine excitation can be controlled independently of the onboard supply. An innovative, well thought-out and graduated protection concept guarantees all protection functions of the converter system without requiring fuses on the line side.

Effective protection
The system has comprehensive and effective monitoring and protective functions for all of the important system components. In addition to the usual overvoltage and overcurrent monitoring functions, the temperatures of all important components, such as semiconductors, heat sinks, reactors and electronics, machine and transformer are monitored. Using plausibility checks, a clear distinction can be made between a line short circuit (which must be supplied) and an internal short circuit (where the system must be shut down).

Clean power for the onboard supply
SINAMICS S120 Cabinet Modules Shaft Generator Drive Application ensures clean power for the onboard supply. The total harmonic distortion factor (THD) of the generated voltage at the supply point fulfills the requirements of all classification societies. As a result of the electrical isolation provided by the isolating transformer, reactions to the onboard supply as result of DC quantities as well as interference currents are effectively prevented. EMC filters are optionally available to comply with increased EMC requirements, such as installation in the general distribution zone.
Design optimized for marine applications

The mechanical design of the SINAMICS S120 Cabinet Modules Shaft Generator Drive Application is predestined to address marine applications. A rugged cabinet system that has proven itself in shipbuilding is used. Further, the equipment footprint has been optimized to address the limited space available on board a ship. The equipment can be installed in the control room as well as in the engine room. It can be easily installed in low rooms and spaces that are just 2.5 m high. Depending on the space available, the cabinet system can also be lined up as well as installed back-to-back. Another positive feature is the connection-friendly design: In spite of the extremely compact design, the connection spaces for the generator and line cables are easy to access and ensure convenient, straightforward and fast connection.

Integrated in the automation environment

The frequency converter can be seamlessly integrated into the process control system of the ship. The control cabinet is prepared for installing an automation unit (PLC) to communicate with the higher-level onboard power supply management.

Highest-quality

The shaft generator system has been developed in-line with the specifications of a standard product, and has been subject to a type test. All functions have been exhaustively verified in a system test. A model system specifically designed for this purpose in a 1:20 scale has been built, which allows onboard line supply states occurring in reality to be simulated. The result of these comprehensive tests: maximum reliability with maximum efficiency.

Optimum service

A global service network is also in place to ensure the high-availability of SINAMICS S120 Cabinet Modules Shaft Generator Drive Application. This service network is available and ready to support customers around the clock. Another advantage is the fact that the system components are based on standard SINAMICS components, therefore guaranteeing long term availability of spare parts around the world. This is complemented by a service-friendly design: As a result of the modular design, individual components, such as control modules, sensor modules, power blocks, fans, etc., can be quickly and simply replaced. Test modes ensure fast and straightforward commissioning and diagnostics as well as optimum service on board.
Technical data

<table>
<thead>
<tr>
<th></th>
<th>1.5 MVA ASM 6SL3710-8LG42-0AW0</th>
<th>2.0 MVA ASM 6SL3710-8LG42-4AW0</th>
<th>1.5 MVA FESM 6SL3710-8LG42-0AW1</th>
<th>2.0 MVA FESM 6SL3710-8LG42-4AW1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated apparent power in kVA</td>
<td>1680</td>
<td>2090</td>
<td>1680</td>
<td>2090</td>
</tr>
<tr>
<td>Onboard line voltage</td>
<td>3 AC 460 V / 60 Hz (3 AC 400 V / 50 Hz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated active power PTO in kW</td>
<td>1344</td>
<td>1672</td>
<td>1344</td>
<td>1672</td>
</tr>
<tr>
<td>Rated active power PTI in kW</td>
<td>1792</td>
<td>2220</td>
<td>1749</td>
<td>2167</td>
</tr>
<tr>
<td>Rated current 1) in A</td>
<td>2121</td>
<td>2636</td>
<td>2121</td>
<td>2636</td>
</tr>
<tr>
<td>Short-time overload current 1) in A</td>
<td>5322</td>
<td>6595</td>
<td>5322</td>
<td>6595</td>
</tr>
<tr>
<td>Line power factor PTO/PTI cosφ</td>
<td>0.8 / 0.98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency in %</td>
<td>96</td>
<td>96.3</td>
<td>95.9</td>
<td>96.2</td>
</tr>
<tr>
<td>THDu in %</td>
<td>&lt; 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overload capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current short-time overload factor in %</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current short-time overload capability in s</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power overload capability in %</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power overload capability in s</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load duty cycle duration in s</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Converted data, line</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated apparent power in kVA</td>
<td>1707</td>
<td>2121</td>
<td>1707</td>
<td>2121</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>3 AC 690 V / 60 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated current in A</td>
<td>1428</td>
<td>1775</td>
<td>1428</td>
<td>1775</td>
</tr>
<tr>
<td>Short-time overload current in A</td>
<td>3584</td>
<td>4441</td>
<td>3584</td>
<td>4441</td>
</tr>
<tr>
<td>Converter data, machine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated active power in kW</td>
<td>1453</td>
<td>1805</td>
<td>1496</td>
<td>1858</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>3 AC 690 V / 60 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated current in A</td>
<td>1382</td>
<td>1716</td>
<td>1277</td>
<td>1586</td>
</tr>
<tr>
<td>Maximum current in A</td>
<td>2045</td>
<td>2533</td>
<td>1792</td>
<td>2220</td>
</tr>
<tr>
<td>Achievable booster power in kW</td>
<td>1792</td>
<td>2220</td>
<td>1749</td>
<td>2167</td>
</tr>
<tr>
<td>W x H x D (standard) mm</td>
<td>5800 x 2400 x 600</td>
<td>6200 x 2400 x 600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP 43</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight kg</td>
<td>4250</td>
<td>4510</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling air requirement m³/s</td>
<td>6.8</td>
<td>7.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound pressure level LpA in dB</td>
<td>78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient temperature °C</td>
<td>0...+45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line supply type</td>
<td>IT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) the specified currents refer to 3 AC 460 V / 60 Hz
Options

A16 SINAMICS shaft generator automation
With option A16, an S7 CPU 317-2 DP can be supplied for a SINAMICS S120 Shaft Generator Drive. The option includes the S7 CPU, the interface preparation and the operating panel. The systems-side engineering is not included in the scope of delivery.

A17 Interface Preparation
The customer interface for the signals on the system side to the automation are optionally provided in the cabinet in the form of terminal strips.

A18 Teleservice adapter
Teleservice adapters allow users to remotely establish a connection with a system, e.g. for in-depth remote diagnostics when service is required. With option A18, all internal connections are prepared, so that only one connection has to be established with a remote messaging system.

S02 Grid droop
The grid droop control is a software function requiring a license, which releases specific functions in the standard SINAMICS S120 software for Shaft Generator Drive. This enables an onboard supply system-specific control for energy recovery into the onboard supply system. When supplied with option S02, the license is saved on the CompactFlash card. The STARTER commissioning tool is used to activate the function. Using option S02, a differentiation is made between the specific function for the shaft generator drive and other functions.

M66 Marine version
Corresponding to the requirements of the marine classification societies:
• Lloyds Register
• American Bureau of Shipping
• Germanischer Lloyd
• Bureau Veritas
• Det Norske Veritas
• Chinese Classification Society
This option includes a reinforced mechanical cabinet design, handrails below the operator panel and mechanical locking of the cabinet doors. The cabinet is equipped with anti-condensation heating (option L55). A welding frame can be ordered with option M74 to mount the converter to the ship’s hull. Note: If the converter is used for a safety-relevant drive on the ship, then in addition, an individual certification is required (see option E11 to E71).

M71 Roof 200 mm
SINAMICS S120 Cabinet Modules Shaft Generator Drive Application with a low-profile canopy (200 mm) is suitable for installation in rooms < 2.50 m high. Using this option, heat in the converter cabinet can be dissipated from the room. On the system side, a ventilation duct with a fan is required to provide the required volumetric air flow. As a consequence, a climate control system can either be dimensioned smaller or even completely eliminated.

Notice: The roof sections are painted in RAL 7035 as standard. If a special color is requested for the cabinet (option Y09), the roof section is also painted in this color. Notice: In order to dissipate the heat from the cabinet, the systems-side fan must be dimensioned approx. 20 % larger than the total air flow of all of the cabinets. The ventilation duct must also be dimensioned for 20 % more than the total volumetric air flow for all of the cabinets.

M54 IP54 degree of protection Shaft Generator Drive
The cabinet design in an IP54 degree of protection is supplied with plastic ventilation grilles and a filter element at the air entry, which ensures an IP54 degree of protection. The filters must be maintained according to the local environmental conditions. For the roofs, the degree of protection can be implemented with two versions (M71, M54), whereby the cabinet height changes. The standard roof changes the cabinet height by 400 mm and at the air discharge it also has a ventilation grille with the matching filter element. Option M71 “Roof 200 mm” changes the cabinet height by 200 mm, and does not contain any ventilation grille. The air discharge is directly connected with a discharge duct.

Notice: The roof sections are colored RAL 7035 as standard. If a special color is requested for the cabinet (option Y09), the roof section is also painted in this color. The molded plastic parts (e.g. ventilation grilles) are colored RAL 7035 and cannot be painted.

M73 Back-to-back installation
Where space is restricted, cabinets can be installed back-to-back. This means that the cabinet length is approximately reduced by half, the depth is 1200 mm.

Notice: For installation and service, the cabinets must be able to be accessed from both sides. Special installation and connection instructions apply for this type of installation.

M74 Welding frame for mounting to the ship’s structure
A 10 mm thick welded frame with 4 x M12 bolts is available as option to mount the SINAMICS cabinet units to the ship structure. The cabinet units are mounted using these bolts.

Notice: Welded frames having different widths are supplied for the cabinet units. When welding, it is absolutely necessary to correctly observe the cabinet sequence.

E11, E21, E31, E51, E61, E71 Individual certification
E11 individual certificate from Germanische Lloyd (GL)
E21 individual certificate from Lloyds Register (LR)
E31 individual certificate from Bureau Veritas (BV)
E51 individual certificate from Det Norske Veritas (DNV)
E61 from the American Bureau of Shipping (ABS)
E71 individual certificate from the Chinese Classification Society (CCS)
Note: A combination of several individual certificates is possible. The cabinet has been designed in compliance with the mechanical and electrical specifications of the marine classification societies.

F75 Function testing with test field motor under no-load conditions.
In addition to the general visual inspection and component checks, the option includes a function test of the shaft generator using a test field motor under no-load conditions.

F77 Insulation test
The insulation test option includes a high-voltage test and measurement of the insulation resistance corresponding to the specifications of the marine classification societies.

Y09 Special cabinet paint finish
As standard, the cabinets are painted in RAL 7035. The special color must be specified in plain text when ordering. All RAL colors can be selected, which are available as powder paint.

Notice: If roofs are supplied with the converter cabinet units, then they have the same color as the cabinets. Molded plastic parts, for example ventilation grilles, are only available in RAL 7035 and cannot be painted.

A combination of several options is possible. The combination of option A16 and A17 is not possible.
The information in this brochure only provides a general description and performance features. For a specific application, this information will not always be applicable in the form described here. This information can also change due to ongoing product development. The required performance features are only binding if they have been expressly agreed upon in the form of a written contract.

All product designations could be trademarks or product names of Siemens AG or other companies, which, if used by third parties, could infringe the rights of their owners.