Shore-to-ship power Solutions
ACS6080 SFC & PCS100 Static Frequency Conversion Platforms
Roberto Bernacchi, Global Product Manager
Agenda

Static Frequency Converters for Shore-to-ship power application
ACS6080 SFC
PCS100 SFC
RFC vs SFC Case Study
Summary
## Static frequency converters for Shore-to-Ship Power

### Applications and segments overview

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>RORO/Ferry</th>
<th>Container</th>
<th>Cruise</th>
<th>LNG / Tanker FSU / FPSO</th>
<th>Shipyards / Navy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>11 kV or low voltage</td>
<td>6.6 kV</td>
<td>6.6 &amp; 11 kV</td>
<td>6.6 kV</td>
<td>6.6 kV, 11 kV or low voltage</td>
</tr>
<tr>
<td>Max Power consumption</td>
<td>6.5 MVA</td>
<td>7.5 MVA</td>
<td>16/20 MVA</td>
<td>Approx. 10 MVA</td>
<td>Case by Case</td>
</tr>
<tr>
<td>Frequency</td>
<td>60 &amp; 50 Hz</td>
<td>60 mainly</td>
<td>60 mainly</td>
<td>60 Hz</td>
<td>50 &amp; 60 Hz</td>
</tr>
<tr>
<td>Plugs/cables (per connection)</td>
<td>1</td>
<td>2</td>
<td>4+1</td>
<td>2/3</td>
<td>Case by case</td>
</tr>
<tr>
<td>Transformer</td>
<td>onboard</td>
<td>onshore</td>
<td>onshore</td>
<td>onshore</td>
<td>Case by case</td>
</tr>
<tr>
<td>Layout</td>
<td>Not critical</td>
<td>critical</td>
<td>critical</td>
<td>critical</td>
<td>Not critical</td>
</tr>
<tr>
<td>Load profile</td>
<td>Partially controlled</td>
<td>Partially controlled</td>
<td>Flat profile</td>
<td>Not controlled</td>
<td>Case by case</td>
</tr>
<tr>
<td>Protect selectivity</td>
<td>critical</td>
<td>Not critical (if P=7.5 MVA)</td>
<td>critical</td>
<td>Case by case</td>
<td>Case by case</td>
</tr>
<tr>
<td>Cable management system</td>
<td>mid cost</td>
<td>low cost</td>
<td>high cost</td>
<td>Mid cost</td>
<td>Case by case</td>
</tr>
</tbody>
</table>
Static Frequency Converter for Shore-to-Ship Power

A complete portfolio

PCS100 SFC

ACS6080 SFC

0.1 – 2 MVA / unit

5 – 24 MVA / unit

Higher power ratings can be achieved by paralleling units
## Static Frequency Converter for Shore-to-Ship Power

### Power converter portfolio

<table>
<thead>
<tr>
<th>Frequency converter</th>
<th>Rated power</th>
<th>Value proposition</th>
<th>Application details</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCS100 SFC</td>
<td>0.1 MVA up to 4MVA</td>
<td>Lowest Opex</td>
<td>Market segments</td>
</tr>
<tr>
<td></td>
<td>– LV IGBT technology</td>
<td>• highest efficiency</td>
<td>• Green port</td>
</tr>
<tr>
<td></td>
<td>– Forced air cooling</td>
<td>• highest availability</td>
<td>• Cruise</td>
</tr>
<tr>
<td></td>
<td>– 0.1 – 2 MVA *</td>
<td>• lowest maintenance costs</td>
<td>• Container</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lowest Capex</td>
<td>• RORO ferry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Smallest weight and footprint</td>
<td>• Shipyards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Scalable solution</td>
<td>• FRSU/FSU</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lowest project execution &amp; operation risk</td>
<td>• Naval ports</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Expert application know how available</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Simulation models available</td>
<td></td>
</tr>
<tr>
<td>ACS6080 SFC</td>
<td>5MVA up to 24 MVA</td>
<td>ABB global footprint</td>
<td>Standard Features:</td>
</tr>
<tr>
<td></td>
<td>– MV IGCT technology</td>
<td>• Global Service organization</td>
<td>• 50 or 60 Hz grid control</td>
</tr>
<tr>
<td></td>
<td>– Closed loop liquid cooling</td>
<td>• Global service support</td>
<td>• Load side transformer pre-magnetization</td>
</tr>
<tr>
<td></td>
<td>– 5-24 MVA *</td>
<td>Benefits</td>
<td>• Synchronization and blackstart</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Most economic solution (Opex and Capex) to make</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>frequency fit</td>
<td></td>
</tr>
</tbody>
</table>

* Higher power levels can be obtained by paralleling units
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Static Frequency Converters for Shore-to-ship power application

ACS6080 SFC
PCS100 SFC
RFC vs SFC Case Study
Summary
ACS6080 SFC

At a glance

**Highlights**

- Voltage source inverter, 3-level neutral point clamped topology
- Voltage range: 2.3-3.3kV
- Power range: up to 24 MVA
- Output frequency range: 50/60 Hz
- Parallelability and scalability
- Based on ABB’s well proven IGCT semiconductor platform
- Line Supply Unit (LSU) for two-quadrant operation with a constant power factor of 0.95
- Active Rectifier Unit (ARU) for four-quadrant operation and reduced harmonics, adjustable power factor
ACS6080 SFC
Industrial converter for demanding applications

<table>
<thead>
<tr>
<th>Industries</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement, Mining and Minerals</td>
<td>Mine hoists, conveyors, crushers and mills</td>
</tr>
<tr>
<td>Chemical, oil and gas</td>
<td>Pumps, compressors, extruders, mixers and blowers</td>
</tr>
<tr>
<td>Marine</td>
<td>Main propulsion, thrusters (pumps and compressors)</td>
</tr>
<tr>
<td>Metals</td>
<td>Rolling mills, coilers</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>Fans, pumps, refiners and chippers</td>
</tr>
<tr>
<td>Power generation</td>
<td>Fans and pumps</td>
</tr>
<tr>
<td>Water</td>
<td>Pumps</td>
</tr>
<tr>
<td><strong>Special applications</strong></td>
<td><strong>Shore-to-ship power</strong></td>
</tr>
<tr>
<td></td>
<td>Static Frequency Conversion / Grid Intertie</td>
</tr>
<tr>
<td></td>
<td>Test stands</td>
</tr>
<tr>
<td></td>
<td>Wind tunnels</td>
</tr>
</tbody>
</table>
Benefits with modular design

All ACS6080 drives are configured of a combination of standardized modules. The modules can be arranged according to the required output power and application specific needs. Benefits:

- Optimal adaptation of converter rating according to customer requirements
- Customer specific engineering can be taken into account with the flexible Control, Terminal and Interface units
- Each configuration consists of well-proven industrial components
- Compact, standardized design reduces space requirements
- Reduced installation and commissioning time

ACS6080
Base Module

Pre-defined interfaces for power, cooling and control connections
ACS6080 SFC

Product overview

**Terminal and Control Unit**
Contains the power terminals and the control swing frame.

**Inverter Unit (INU)**
Self-commutated, 6-pulse, 3-level voltage source inverter with IGCT technology to invert the voltage from DC to AC.

**Capacitor Bank Unit**
DC capacitors for smoothing the intermediate DC voltage.

**Water Cooling Unit**
Supplies deionized water for cooling the main power components.

**Active Rectifier Unit (ARU)**
Self-commutated, 6-pulse, 3-level voltage source inverter with IGCT technology to rectify the line voltage from AC to DC.
ACS6080 SFC
The right choice for high performance applications

Modularity and flexibility
- Built to order - every drive is tailored to fulfill your needs
- 2 or 4 quadrant, single or multi motor, wide range of customer-specific options in a very compact design

Performance and usability
- Part of the ABB drives all-compatible portfolio
- Smooth integration and easier operation throughout your entire installation
- Advanced process control

Highest level of safety
- Arc resistant design with fast arc elimination as standard
- Integrated DC grounding switch
- Electromechanically interlocked doors
- Certified functional safety

Reliability and availability
- ABB Ability™ condition monitoring for SFC to monitor your power converter condition every time, every where.
- Low parts count and fuseless design - ABB IGCT technology confirmed to be the best choice for high power applications
## ACS6080 SFC

Model ratings & dimensions

<table>
<thead>
<tr>
<th>MODEL</th>
<th>NOMINAL RATING (c)</th>
<th>INTERFACE</th>
<th>HEAT LOSS</th>
<th>DIMENSION</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>CONFIGURATION NAME</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double-A</td>
<td>Double-ACS6109_L12_2a05</td>
<td>7.5</td>
<td>135%</td>
<td>162%</td>
<td>DIODE (12p)</td>
</tr>
<tr>
<td>Double-A</td>
<td>Double-ACS6107_A06_2a05</td>
<td>7.5</td>
<td>126%</td>
<td>160%</td>
<td>ACTIVE (6p)</td>
</tr>
<tr>
<td>Double-B</td>
<td>Double-ACS6114_L12_2a9</td>
<td>14</td>
<td>127%</td>
<td>135%</td>
<td>DIODE (12p)</td>
</tr>
<tr>
<td>Triple-A</td>
<td>Triple-ACS6209_L24_3a7</td>
<td>18</td>
<td>141%</td>
<td>141%</td>
<td>DIODE (24p)</td>
</tr>
<tr>
<td>Triple-A</td>
<td>Triple-ACS6209_A12_2a7</td>
<td>18</td>
<td>157%</td>
<td>157%</td>
<td>ACTIVE (2*6p)</td>
</tr>
<tr>
<td>Triple-B</td>
<td>Triple-ACS6309_A18_3a9</td>
<td>27</td>
<td>134%</td>
<td>134%</td>
<td>ACTIVE (3*6p)</td>
</tr>
</tbody>
</table>
Benefits and features

**Tailor-made solutions**
- Modular and expandable configuration.
- The modules can be arranged according to the required output power.
- Very compact and standardized design for reduced footprint.
- Flexible layout can be straight in line or fitted into the installation room with U, L or back-to-back setups.

**Highest level of personal safety**
- Arc resistant design (certified by 3rd party) with fast arc elimination.
- Integrated DC grounding switch.
- Electromechanically interlocked doors to all MV compartments.
- Certified functional safety features (E-off, E-stop, Safe Stop 1, STO, POUS).

**High reliability and availability**
- Each configuration consists of very well-proven components and simple power circuit.
- Low part count.
- Fuseless design.
- Self healing capacitors.
- Redundant configurations.
- ABB Ability and cloud connection for remote condition monitoring and remote assistance.

**Increase productivity**
- Part of ABB drives All-compatible family.
- Smoother integration and easier operation throughout your entire installation.
- Best-in-class control in terms of dynamic performance and power quality.
ACS6080 SFC

HMI Interface

**Same control interface**
- Easy navigation and monitoring
- Harmonized parameters and common shared functions
- Built-in USB connection to the PC tool

**Universal connectivity**
- Many fieldbus options
- Standard customer interface

**Free entry level PC tool**
- Quick and harmonized access to drive settings
- Flexible monitoring capabilities
- Diagnostics support with one mouse click
- Additional settings in Pro version

**Technical and commercial documentation**
- Full set of standard document for HW and SW
- Project specific document for SFC application
Highest safety for your people and equipment

Arc resistant design with fast arc elimination as standard offering

Description

Electric arcs represent a hazard source for people and equipment

ACS6080 offers the highest possible level of safety by detecting the arc and eliminating before it even occurs. Every ACS6080 drive comes with an arc proof design as a standard and is certified according to IAC (internal arc classification).

Optionally, ACS6080 can be equipped with ABB’s Arc Guard System™ for even superior protection function.

No compromises
Certified functional safety features
For a safe and reliable system integration into your process

The ACS6080 is equipped with safety integrity level 3 (SIL3) and performance level e (PL e) and provides the following safety functions:

- Emergency off - stop category 0 according to IEC 60204-1
- Emergency stop - stop category 1 according to IEC 60204-1
- Safe torque-off (STO) - according to IEC 61800-5-2
Door interlocking system

Integrated DC grounding switch and door interlock

The grounding switch is a safety switch to ground the DC bus of the drive. When the SFC is grounded the door safety switches of the medium voltage units are released and the doors can be opened.

It is electromechanically interlocked with a discharge monitoring circuit that prevents the switch from closing when the DC-link capacitors are still charged.

Grounding the SFC is only possible after main power supply is disconnected and the DC link has been discharged.
Reliable components
- ABB drive technologies (IGCT semiconductors, multilevel-fuseless topology) provide low parts count, increasing reliability and availability

Easy access
- The ACS6080 allows easy front access to the drive’s components

Redundant cooling
- The cooling equipment is available with redundant pumps which increases availability
ACS6080 SFC

Worldwide service and support

- Supervision of installation and commissioning
- Training
- Remote diagnostics
- Customized maintenance contracts
- Local support
- 24 x 365 support line
- Spare parts and logistics network
- Worldwide service network
ABB Ability™ for ACS6080 SFC

Highlights

### ABB Ability™ Remote Assistance for Drives

- Remote connectivity
- Expert support upon request

### ABB Ability™ Condition Monitoring for Drives

- Remote or Local connectivity
- Condition Monitoring Portal

**Rapid solution in case of problems**

Should a fault be detected, ABB specialist provides rapid support by using ACS6080 SFC data which is stored remotely.

**Alerts and information, for customer to react**

ABB Ability Condition Monitoring is a service that delivers you accurate, real-time information about SFC condition and events to ensure your equipment is available, reliable and maintainable.
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Static Frequency Converters for Shore-to-ship power application

ACS6080 SFC

PCS100 SFC

RFC vs SFC Case Study

Summary
PCS100 SFC – product

The solution

- The ABB PCS100 SFC is a clean, efficient way to provide the frequency and voltage required
- Complete low voltage product range from 125 kVA to multi MVA
- Modular power electronic architecture
- Parallel capable
- Synchronizing and load limiting functions
PCS100 SFC – product

Modular construction 125 kVA to 2 MVA

- Housed in 800mm cabinets
- 125 kVA power modules
- Minimum spares required
- Fast replacement
# PCS100 SFC – product

## Ratings

<table>
<thead>
<tr>
<th>Model</th>
<th>Current Rating (A)</th>
<th>Load kVA @ 480V</th>
<th>Converter/Connection Cabinet</th>
<th>Transformer Cabinet</th>
<th>Number of module pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40°C</td>
<td></td>
<td>Dimensions</td>
<td>Weight (Kg)</td>
<td>Dimensions</td>
</tr>
<tr>
<td>SFC-0125</td>
<td>150</td>
<td>125</td>
<td>2154 x 809 x 804</td>
<td>860</td>
<td>Included in converter cabinet</td>
</tr>
<tr>
<td>SFC-0250</td>
<td>300</td>
<td>250</td>
<td>2154 x 809 x 804</td>
<td>801</td>
<td>2154 x 809 x 804</td>
</tr>
<tr>
<td>SFC-0375</td>
<td>450</td>
<td>375</td>
<td>2154 x 809 x 804</td>
<td>761</td>
<td>2154 x 809 x 804</td>
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<tr>
<td>SFC-0500</td>
<td>600</td>
<td>500</td>
<td>2304 x 1609 x 804</td>
<td>1503</td>
<td>2304 x 1209 x 804</td>
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<tr>
<td>SFC-0625</td>
<td>750</td>
<td>500</td>
<td>2304 x 2009 x 804</td>
<td>1772</td>
<td>2304 x 1209 x 804</td>
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<tr>
<td>SFC-0750</td>
<td>900</td>
<td>750</td>
<td>2304 x 2409 x 804</td>
<td>1932</td>
<td>2200 x 2250 x 1600</td>
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<td>SFC-0875</td>
<td>1050</td>
<td>875</td>
<td>2304 x 2809 x 804</td>
<td>2308</td>
<td>2200 x 2250 x 1600</td>
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<tr>
<td>SFC-1000</td>
<td>1200</td>
<td>1000</td>
<td>2304 x 3209 x 804</td>
<td>2586</td>
<td>2200 x 2250 x 1600</td>
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<tr>
<td>SFC-1125</td>
<td>1350</td>
<td>1125</td>
<td>2304 x 3209 x 804</td>
<td>2746</td>
<td>2200 x 2250 x 1600</td>
</tr>
<tr>
<td>SFC-1250</td>
<td>1500</td>
<td>1250</td>
<td>2304 x 4409 x 804</td>
<td>3407</td>
<td>2350 x 2300 x 1600</td>
</tr>
<tr>
<td>SFC-1375</td>
<td>1850</td>
<td>1375</td>
<td>2304 x 4909 x 804</td>
<td>3700</td>
<td>2350 x 2300 x 1600</td>
</tr>
<tr>
<td>SFC-1500</td>
<td>1900</td>
<td>1500</td>
<td>2304 x 4909 x 804</td>
<td>3880</td>
<td>2350 x 2300 x 1600</td>
</tr>
<tr>
<td>SFC-1625</td>
<td>1950</td>
<td>1625</td>
<td>2304 x 5209 x 804</td>
<td>4248</td>
<td>2350 x 2300 x 1600</td>
</tr>
<tr>
<td>SFC-1750</td>
<td>2100</td>
<td>1750</td>
<td>2304 x 5609 x 804</td>
<td>4550</td>
<td>2350 x 2300 x 1600</td>
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<tr>
<td>SFC-2000</td>
<td>2400</td>
<td>2000</td>
<td>2304 x 6099 x 804</td>
<td>5102</td>
<td>2350 x 2300 x 1600</td>
</tr>
</tbody>
</table>

All specs are subject to change without prior notice.

- Parallel load sharing allows operation of multiple PCS100 SFC’s up to 10MVA
- Dimensions are for side-by-side configuration. Back to back configuration dimensions will vary
- Weights are for LV transformers. For MV, transformers add 25% approx
- IP23 + 100mm depth

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**PCS100 SFC – How it works**

**Power module redundancy**

<table>
<thead>
<tr>
<th>Traditional FC</th>
<th>Modular FC without redundancy</th>
<th>PCS100 SFC advanced redundancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available power</td>
<td>0 kVA / 0 %</td>
<td>0 kVA / 0 % (fault with one module stops the whole system)</td>
</tr>
<tr>
<td>MTTR</td>
<td>many hours</td>
<td>30 min</td>
</tr>
<tr>
<td>Available power</td>
<td>1875 kVA / 93.7 %</td>
<td></td>
</tr>
<tr>
<td>MTTR</td>
<td>30 min or continue operation until scheduled maintenance</td>
<td></td>
</tr>
</tbody>
</table>
The PCS10 SFC includes a built-in synchronizer. The synchronizer is used to automatically synchronize its output to a live AC bus before starting.

Synchronization procedure as follows:

- SFC is given a start command
  - SFC measures its output, as it is live it synchronizes the internal control loops to this voltage, frequency, and phase.
- SFC starts running in parallel with the generator.
- Generator can be unloaded and SFC used to supply the switchboard.
Parallel systems

Typical multi MVA system example
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RFC vs SFC Case Study
Summary
SFC vs RFC – Case study

6 MVA RFC – Typical system

- Air insulated/SF6 MV feeder switchgear
- Feeder transformer: dry type transformer (20 kV / 6 …15 kV)
  • Note: Feeder transformer may not be necessary for 15 kV
- Motor: 6 …11 kV brushless excited 10-pole synchronous machine
- Generator: 6 …11 kV brushless excited 12-pole synchronous machine
- Air insulated/SF6 MV load switchgear
SFC vs RFC – Case study

6 MVA RFC – Required space for installation

- Motor (6MVA):
  • Length: 4 m x Width: 1.8 m x Height: 3 … 4.5 m
  • Weight: 23.4 tons
- Generator (6MVA):
  • Length: 4 m x Width: 1.8 m x Height: 3 … 4.5 m
  • Weight: 27.3 tons
- System space req. including RFC, Control, Switchgear excluding transformer:
  • 9(+3) m x 1.5(+2.0) m x 4.5(+1) m → 211 m³
- Overall system weight including RFC, control, switchgear excluding transformers: Approx. 56 tons
SFC vs RFC – Case study

6 MVA RFC – Electrical characteristics

- Control system:
  - Sequences (start/stop/fault); motor/generator & switchgear supervision and voltage control (AVR), 2x excitation supervision and control
- Motor excitation system:
  - AC or DC brushless static (thyristor controlled appr. 50 kW) excitation system with crowbar protection circuitry.
- Generator excitation system:
  - AC or DC brushless excitation (thyristor controlled appr. 50 kW) excitation system with protection crowbar circuitry.
- Load side harmonics (voltage): < 5%
- MTBF: One transformer, two static excitation converters, motor, generator: ~4.4 years
SFC vs RFC – Case study

10 MVA SFC – Typical system

- Air insulated/SF6 MV feeder switchgear
- Feeder transformer: 12 pulse dry type transformer (xx kV/2x~1.7 kV)
- Converter: 3-level NPC MV converter with diode rectifier (at feeder side) and IGCT inverter at load side
- Load side transformer: 2 x 6 pulse dry type transformer (~3 kV/xx kV)
- Air insulated/SF6 MV load switchgear
SFC vs RFC – Case study

10 MVA SFC – Required space for installation

- Converter (10MVA):
  - Length: 9 m x Width: 1.2 m x Height: 2.2 m
  - Weight: 7.5 tons

- System space req. including SFC, control, switchgear, excluding transformers:
  - 9 (+3) m x 1.2(+1.2) m x 2.5 m = 72 m³

- System weight including SFC, control, switchgear excluding transformer: Approx. 10 tons
SFC vs RFC – Case study

10 MVA SFC – Electrical characteristics

- Control:
  - Converter control and protection integrated in SFC

- Power factor feeder side: ~0.95
- Power factor load side: variable, 0.8 … 1.0

- Feeder side harmonics (current): according to IEC61000-2-4

- Load side harmonics (voltage): according to IEC/ISO/IEEE 80005-1
# SFC vs RFC – Case study

## Case study - Comparison table

<table>
<thead>
<tr>
<th>Item</th>
<th>RFC-6 MVA</th>
<th>SFC-10 MVA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feeder and feeder protection components:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeder transformer</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Feeder aux. transformer</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Feeder main switchgear</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Feeder aux. Excitation switchgear</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Frequency conversion system:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>9m</td>
<td>9m</td>
</tr>
<tr>
<td>Width</td>
<td>1.5m</td>
<td>1.2m</td>
</tr>
<tr>
<td>Height</td>
<td>4.5m</td>
<td>2.2m</td>
</tr>
<tr>
<td>Weight RFC,SFC</td>
<td>56 tons</td>
<td>10 tons</td>
</tr>
<tr>
<td>Volume requirement excluding transformer</td>
<td>211m³</td>
<td>72 m³</td>
</tr>
<tr>
<td>Load side (V) harmonics</td>
<td>&lt;5%</td>
<td>&lt;2%</td>
</tr>
<tr>
<td>MTBF (estimated)</td>
<td>~4.4 years</td>
<td>~5.7 years</td>
</tr>
<tr>
<td>Load side (V) harmonics</td>
<td>~95%</td>
<td>~96.5%</td>
</tr>
<tr>
<td><strong>Production time (typical):</strong></td>
<td>10 months</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td>SFC</td>
<td>RFC</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Noise and vibration</td>
<td>Low, mainly cooling system (fans-air cooled, pumps-water cooled)</td>
<td>High, especially for large machines</td>
</tr>
<tr>
<td>Frequency regulation</td>
<td>Precise, electronically controlled</td>
<td>Can vary depending on the input frequency</td>
</tr>
</tbody>
</table>
| Serviceability/Maintenance | Low MTTR due to modular construction  
                         | Standard yearly maintenance plan (1/2 days)                        | Breakdowns can be time consuming (bearing replacement)  
                         |                                                                       | Critical parts wearing                                                |
| Efficiency              | High  
                         | PCS100 ~95%  
                         | ACS6080 ~98%                                                      | Lower than SFC especially at light/partial loads                  |
| Overload capability      | PCS100 → 200% x 2 s  
                         | → 150% x 30 s  
                         | ACS6080 → Depending on the model.                                 | Good overload capability                                            |
| Technology, as perceived by end users | New technology → concerns on operation & maintenance | Old, proven technology → high reliability                           |
Agenda

Static Frequency Converters for Shore-to-ship power application
ACS6080 SFC
PCS100 SFC
SFC vs RFC
Success stories
Summary
### Shore-to-ship power – Rotterdam, The Netherlands
One of the world’s largest S2SP installations

### Customer needs
Complete electrical infrastructure to simultaneously power several vessels while berthed in the port of Hoek van Holland

- Customer
  Stena Line B.V., a subsidiary of Stena AB, one of the world’s largest ferry companies
- Year of commissioning
  2012

The entire installation, both onshore and onboard the ships, was accomplished within a year and was activated at the Stena Line ferry terminal at the port of Rotterdam in June 2012

### ABB response
- Turnkey shore-to-ship power installation including design, engineering, project management, installation and commissioning
- Complete substation and automation package based on PCS 6080 static frequency converters rated at 6 MVA

### Customer benefits
- Mitigation of negative impact of ferry operations on the local community and the environment
- Reduction of fleet’s fuel consumption
- Greenhouse gas emissions reduced by 98%
- Less noise and vibrations
ACS6080 - SFC
Knutsen FSO project

**Customer needs**

- Martin Linge O&G offshore facility (Norway) uses a floating, storage, and offloading unit (FSO) supplied by Knutsen NYK Offshore Tankers AS
- The Martin Linge field, including the FSO needs to be powered with electricity from shore through the world’s longest high voltage AC subsea cable. (approx. 180 km length)

**ABB response**

- ACS6080 SFC in double configuration performing 50 to 60 Hz frequency conversion at 6,6 kV
- Marine / off-shore certified system
- Island mode operation and bumpless switch between grid-to-island and vice versa

**Customer benefits**

- Martin Linge FSO represents an environmentally friendly installation with regards to CO2 emissions.
- Operating in parallel with diesel generator sets including active and reactive load management to optimize power consumption
## Shore-to-ship power – Gothenburg, Sweden

First 50/60 Hz shore connection in Sweden

<table>
<thead>
<tr>
<th>Customer needs</th>
<th>ABB response</th>
<th>Customer benefits</th>
</tr>
</thead>
</table>
| Shoreside power supply to a vast number of Stena Line vessels while at berth | - Turnkey 11kV Grid Integration, including Safe+ GIS switchgear 6 bays 50Hz, 4 bays 60Hz, and 2 transformers type Resibloc  
- Two static frequency converters 1250kVA  
- PLC system type AC500 | - Dependable project execution from design to start-up, and state-of-the-art equipment  
- Reliable shoreside power supply to ferries  
- Reduced emissions, low-frequency noise and vibrations  
- Better environment for passengers, crew, dockworkers and local residents |

- Customer  
  Processkontroll Elektriska AB Stenungsund  
- Year of commissioning  
  2012
## Shore-to-ship power – Fincantieri, Italy

**Standard containerized solution for shipyards**

### Customer needs
- Shore power supply for Castellamare shipyard for newly built vessels
- Outdoor solution with minimized civil works
- Short delivery time of 15 weeks

### ABB response
- Standard containerized solution, air-cooled, including frequency converter, isolation transformer, LV switchgear
- One static frequency converter PCS100, 1000kVA, rack-mounted

### Customer benefits
- Scalable solution suitable for all shipyards
- Lower OPEX costs than 60 Hz diesel genset
- Improved efficiency at partial loads
- High reliability owing to converter redundancy

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Customer
- Fincantieri
- Year of commissioning 2014

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Agenda

Static Frequency Converters for Shore-to-ship power application
ACS6080 SFC
PCS100 SFC
SFC vs RFC
Success stories
Summary
Summary

SFC dimensioning: Ask the right questions

1. Voltage and frequency
   - Grid side (U1, f1)
   - Ship side (U2, f2)

2. Power [MVA]
   - Nominal & Peak
   - Ship load profile, Single Line Diagram
   - Direct online motors
   - Transformer inrush
   - Overload (protection & selectivity)

3. Installation
   - Indoor / Outdoor

4. Environmental data
   - Minimum / maximum temperatures
   - Pollution levels
Summary

ACS6080 - PCS100 SFC Static Frequency Converter

ABB’s SFCs are the ideal solution for providing a different frequency and voltage.

ACS6080 - PCS100 SFC design provides the followings benefits:

- Energy savings compared to dynamic converters.
- High reliability static conversion.
- Rugged ratings and short circuit protection.
- Versatile configurations.
- High efficiency even at partial load
  \( \sim 98.0 \% \text{ (ACS6080 SFC)} \quad \sim 95.0 \% \text{ (PCS100 SFC)} \)

Advanced System Integration support

- Pre-engineered packages for fast lead time
- Customized solution for demanding requirements

ABB can deliver these benefits worldwide with performance and support you can trust.