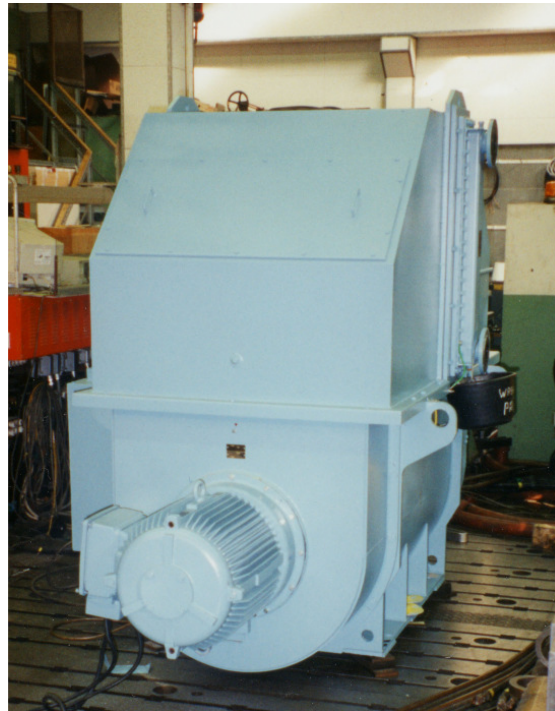


Combined Shaft Alternator / Motor

Technical Specification



Take-Home-Drive

Motor operation: 1500 kW, 1200 rpm
Generator operation: 1500 kW, 1200 rpm

Combined Shaft Alternator / Motor

1. System Configuration

- The shaft alternator / motor is designed for mains supply and as auxiliary propulsion drive. A booster-drive mode is not considered.
- It can be operated in motor mode as additional redundant propeller. Due to the necessary constant speed the operation is suitable for vessels with controlled pitch propeller. Parallel operation in shaft alternator mode is restricted to load shifting.
- For unrestricted parallel operation with diesel generators and / or for variable speed and use with fixed pitch propeller we can offer our shaft alternator / motor system with frequency converter.

2. System Description

The shaft alternator / motor is connected to the propeller shaft via clutch and PTO/PTI reduction gear (not SAM supply). In the shaft line between the main diesel engine and the reduction gear a clutch shall be mounted for independent operation of the shaft motor and the main engine.

2.1 Shaft Alternator Operation

In alternator mode the shaft alternator supplies the power required by the mains with a frequency depending on the main engine speed. Its automatic voltage regulator (AVR) operates in the same way as a normal diesel alternator when it keeps the mains voltage constant by means of its AVR.

Parallel operation with the diesel alternator sets is limited to load shifting between diesel alternators and shaft alternator.

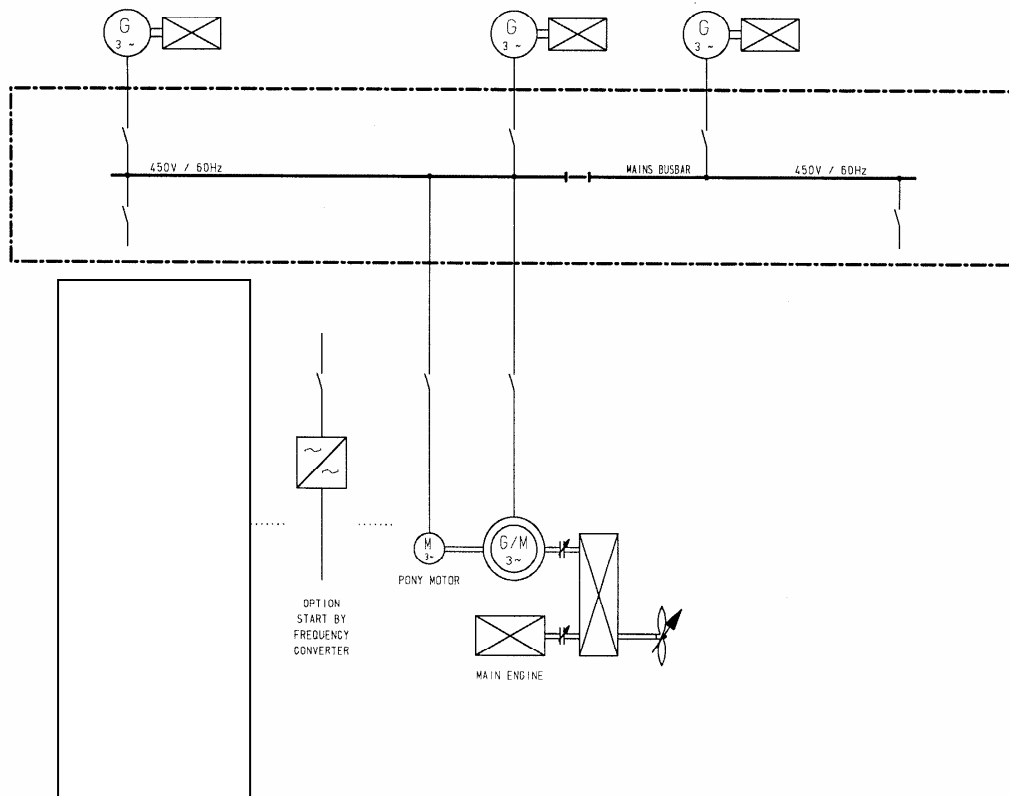
2.2 Motor Operation

In motor mode the machine operates as a synchronous motor which is supplied by the diesel alternator sets. The automatic voltage regulator (AVR) keeps the power factor constant (cos phi regulator). The propeller is driven by the motor via clutch and reduction gear. For the use as auxiliary drive the main diesel engine is disconnected from the propeller by a clutch.

In order to avoid the high inrush current of the synchronous motor the shaft alternator / motor is equipped with a start up motor. This pony motor is an asynchronous squirrel-cage motor without own bearings and shaft, its squirrel-cage rotor is mounted at shaft end of the shaft alternator / motor. Depending on the size of the supplying diesel alternator sets the pony motor is started directly, via star/delta starter or via frequency converter. The unit is synchronized to the mains by a synchronization unit.

After switching off the pony motor and engaging the clutch the machine operates as propulsion motor.

Combined Shaft Alternator / Motor



2.3 Rules

Classification Society: e.g. LRoS
 Ambient temperature: 45 °C

2.4 Output Data of the System

Rated voltage: 450V
 Rated frequency: 60Hz

Generator

Rated active power : 1.500kW
 Power factor at rated power: $\cos \varphi = 0,8$
 Rated apparent power: 1.875 kVA
 Speed: 1.200 rpm

Motor

Rated active power : 1.500kW
 Power factor at rated power: $\cos \varphi = 1.0$
 Rated apparent power: 1.500 kVA
 Speed: 1.200 rpm

Combined Shaft Alternator / Motor

3. Option: Propeller Pitch/Power Management for Motor Operation

For control of the propeller pitch a concept is used, which was especially designed for electric propulsion. The electric propulsion motor is considered as a subordinated consumer, the output being automatically reduced in accordance with the consumption of other consumers if this exceeds the output of the supplying alternator sets. In order to assure at any time a stable operation of the power station, the pitch of the cp-propeller will be automatically reduced if:

- the apparent current of the diesel alternators reaches the nominal value,
- the active power of the auxiliary diesel engines exceeds the nominal value,
- the speed of the diesel alternator sets decreases below the admissible value.

Furthermore the reverse power, which has to be absorbed by the mains and the auxiliary diesel engines in case of reversing manoeuvre, will be automatically reduced if the mains frequency is more than 5% above set value.

The data necessary for the superior control system to assure a stable operation of the power station have to be delivered by the power management system (not included in the scope of supply of SAM Electronics for this alternator/motor concept).

4. Description of Components and Services

4.1 Three-phase Synchronous Shaft Alternator/Motor

for constant speed, self excited, self regulated, self ventilated, brushless, with damping windings.

according to the following main technical data:

Power – Generator Mode:	1.500kW / 1.875 kVA
Power – Motor Mode:	1.500 kW
Voltage:	450 V
Frequency:	60 Hz
Speed:	1200 rpm
Enclosure:	IP23 with shaft mounted fan and double tube freshwater cooler for water inlet 36 °C.
Design:	IM B3 according to IEC34 with asynchronous motor for start up flanged at the non drive end
Bearings:	plain bearings
Terminal box:	enclosed IP23
Cable inlets:	cable glands
Insulation class:	F with special protection against moisture, oil and tropical ambient
Temperature rise:	class F
Space heater:	230V

Combined Shaft Alternator / Motor

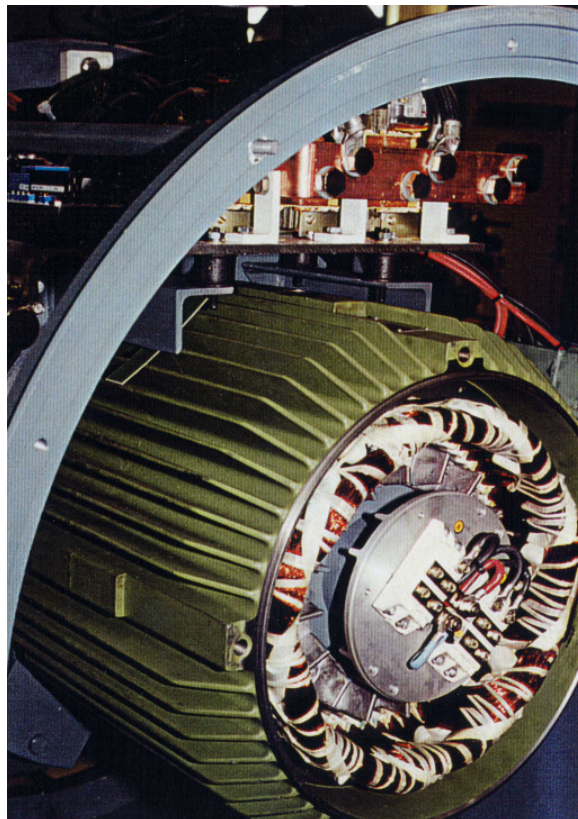
Direction of rotation:	right or left
Voltage characteristic:	voltage = constant
Parallel operation:	only for load shifting from/to diesel alternators
Monitoring:	stator windings: per phase 2 resistance thermometers PT 100 (1 active, 1 spare), cooling air: 2 resistance thermometers PT100, cooler: 1 water leakage sensor. Bearings: pt100
Space heater:	230 V
Voltage regulator (AVR):	built in separate box at the machine in alternator operation: for short time parallel operation with load dependent voltage droop in motor operation: constant power factor $\cos \phi$
Rated value setter:	located at the AVR
Drawing:	similar to M3 – 720-5 enclosed

Combined Shaft Alternator / Motor

4.2 Start up Motor

as asynchronous motor with squirrel-cage rotor to start up the synchronous machine, rated for 3 consecutive starts, with stator flanged at the end shield and rotor mounted at the shaft end of the shaft alternator/motor.

Output:	approx. 80 kW, designed to start up the non excited shaft alternator/motor with disengaged clutch. The final power output will be calculated after having in hand the correct data of the counter-torque and the moment of inertia of the clutch.
Enclosure:	IP55
Monitoring:	stator winding: per phase 2 thermistor sensors
Space heater:	230V



Combined Shaft Alternator / Motor

4.3 Auxiliary Panel including Start up Equipment for Motor Operation

For operation of the motor / alternator we include in our scope of supply an auxiliary panel which contains all necessary relays, contactors and interlocking functions for start up and a safe operation in both alternator and motor mode. We enclosed for the start up of the pony motor a frequency converter although this is not necessary. The starting current of the pony motor for direct starting is approximately 850 A at a rated current of the diesel generators of 2085 A.

Dimensions: Length:	1.200 mm
Depth:	900 mm
Height:	2.500 mm

4.4 Converter Panel



Combined Shaft Alternator / Motor

4.5 Spare parts

one set of bearings, one voltage regulator and one set of consumable electronic parts.

4.6 Commissioning

The commissioning will be carried out by qualified personnel from SAM Electronics or any other authorised company on behalf of SAM Electronics.

Place of commissioning

All works will be carried out on board the vessel.

Time of commissioning

The commissioning is based on normal working days (Monday through Saturday) with 7 normal working hours and a maximum of 3 hours overtime per day, starting from 7:00 o'clock in the morning until 6:00 o'clock in the afternoon. Our staff will need approximately three (3) days for the first switch cabinet on each ship and about two (2) days for each following unit.

For each trip abroad our staff will need one (1) day for preparation and one (1) day for finishing works after the trip.

Accommodation and transportation

Appropriate transportation and accommodation for SAM's staff to/at the place of commissioning will be booked by SAM Electronics. The transportation from the hotel to the harbour and back will be conducted by SAM Electronics. Any other necessary transportation of staff or equipment will be provided by any other party (customer, shipyard, etc.) as soon as possible and totally free of charge for SAM Electronics.

Tools and measuring equipment

Normal tools and measuring equipment will be provided by SAM Electronics.

Necessary assistance

Any assistance necessary to carry out the commissioning has to be provided as soon as possible by any other party (customer, shipyard, etc.) totally free of charge for SAM Electronics.

Combined Shaft Alternator / Motor

Required conditions for commissioning

- The switch cabinets have to be completely installed on board the vessel
- All cabling works have to be finished and tested
- An uninterrupted reliable and appropriate power supply has to be provided for the whole time of the commissioning
- The relevant pumps, pipes and tanks have to be ready for working
- It must be possible to start and stop the relevant pumps at any time for the commissioning by our staff.
- Access to all other units connected to the switch cabinets with frequency inverters, drive motors and pumps must be possible and has to be permitted to our staff.
- It must be possible for our staff to work full days (at least 10 hours per day with adequate breaks).

Interruptions / delay

Any interruptions of the commissioning not caused by our staff will lead to additional costs which will have to be invoiced to our customer, regardless who might be responsible.

Not included:

Cables and Cable glands

Any cables necessary to connect the frequency inverter with the existing installation on board of the vessels and to the drive motors (such as screened cables to connect the driving motor to the frequency inverter) are not supplied by SAM Electronics. No cable glands will be provided for the switch cabinets with frequency inverters. The connection boxes of the drive motors will be delivered with necessary amount and size of cable glands for marine type cables (MGH or MGCH).

Mounting, cabling and connection works

Mounting cabling and connection works are not included and have to be completely finished before SAM Electronics will begin with commissioning.

Changes within the existing installation

Any changes - necessary or not - within the provided installation on board the vessel will not be carried out by SAM Electronics. All interfaces as specified in this document have to be provided.

Combined Shaft Alternator / Motor

4.7 Approvals and Test Field Trials in the Factory

As far as important components and subsystems are concerned, the representatives of our contractors as well as of the ship owners will be informed and invited in due time to attend the approvals and test field trials in our factory. A time schedule will be submitted in due time.

The program of test field trials follows common practice and is based on the requirements of the manufacturer as well as of the classification society.

4.8 Delivery Documentation

Descriptions of the complete system, subsystems and the component -containing explanation of the main functions - will be submitted 6-fold in English language. The manuals contain complete set of circuit diagrams, terminal lists, instruction how to check main functions of the system, and spare parts list.