easYgen-3400/3500 Marine

‘Functioning as Load Share Module ‘

Optional Supplementary Information

General Information

The following alert boxes can be used in this publication:

“DANGER” indicates a hazardous situation which, if not avoided, will result in death or serious injury.

“WARNING” indicates a hazardous situation which, if not avoided, could result in death or serious injury.

“CAUTION”, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

“NOTICE” is used to address practices not related to personal injury.

“IMPORTANT” is used to address practices not related to personal injury.

Personnel

WARNING!
Hazards due to insufficiently qualified personnel!

If unqualified personnel perform work on or with the control unit hazards may arise which can cause serious injury and substantial damage to property.

- **Therefore, all work must only be carried out by appropriately qualified personnel.**

For further Product Support Options, Product Service Options, Returning Equipment for Repair, and/or Engineering Services please download application note #37573.

Publication

⚠WARNING

Read this entire application note and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions.
Failure to follow instructions can cause personal injury and/or property damage!

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment.
Any such unauthorized modifications: constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and invalidate product certifications or listings.

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Requirements

Device	Part Number
easYgen-3400/3500 Marine	8440-2044, 8440-2045, 8440-2046, 8440-2047
RP-3000 Remote Panel	8446-1046

This application note supports also the DNV Type Approval certificate A-12292 and A-13410.
For a more detailed description, please refer to easYgen-3400/3500 Marine Technical Manual 37531.

1. Introduction

This information is designed to help the commissioner to set up a load sharing system. This application note covers the basic functions, which are required. The load share functionality is a subset of features in the easYgen. This application note consists of two sections:

- The first section explains how the easYgen-3400/3500 Marine can be installed and configured for use as a load share module (LS module) whereby the easYgen does not start and stop the drive.
- The second section describes ('The Segment Handling') how to switch the single LS modules into different segments. This is required in applications where the tie-breaker can isolate the generators from each other.

Additional functions are usable (see the manual), but these functions are not a part of this application note.

This application note handles different types of passing setpoints to the speed control of the engine:

1. 0/4 to 20 mA signal, for example MAN SaCoS$_{one}$
2. Raise / Lower commands
3. PWM signal, for example CAT ADEM

1. Functional Description - Load Share Module

In this application the easYgen measures the generator voltage, current and frequency. It calculates active and reactive power. The unit guides the speed control to regulate the frequency and the generator load isochronously in relation to the other generators. Optionally the easYgen can guide the AVR of the genset to regulate the voltage and the generator reactive load isochronously. The load share information is exchanged via CAN bus with other easYgens acting as load share modules or as genset controls. The easYgen sends the speed setpoint as 0/4 to 20 mA signal or PWM signal or Raise/Lower commands to the speed control.

The LS module is an isochronous running speed (and voltage) control with an incorporated load share error signal. It is recommended to configure the speed control with 2 to 3 % Droop characteristic for a smoother and more secure load sharing system. If Raise/Lower commands are used, the droop must be adjusted in the speed control. The same applies for the AVR connection.

The easYgen is usually active and sends a setpoint to the speed control. During engine start the LS module watches generator frequency and voltage and begins to guide the frequency (and voltage), when configurable start values for frequency (and voltage) are passed.

The module is informed about the GCB condition directly via discrete input [DI 08] (terminal 74) and discrete input [DI 11] (terminal 77). With a closed GCB and a deactivated unloading generator signal, the unit automatically ramps the generator up to a load related to the other generator(s).

If the Unloading Generator signal is active discrete input [DI 03] (terminal 69), and the GCB is closed, the unit automatically ramps the generator down to 0 kW. While the unload command is active, the LS module energizes the relay [R 07] (terminal 51) 'Generator is Unloaded', if the generator load falls under a configurable level.

The LS module provides in this basic configuration following monitoring functions:

- LS module self-test is OK Relay [R 01] (terminal 41/42)
- Alarm: Missing member on the CAN load share bus (the unit switches internally to droop) Relay [R 02] (terminal 43/46)
- Alarm: Load Share Monitoring Relay [R 03] (terminal 44/46)
- Alarm: GCB feedback monitoring (the unit switches internally to droop) Relay [R 04] (terminal 45/46)
- Tie-breaker feedback is OK (if not, the unit switches internally to droop) Relay [R 08] (terminal 53/54)

The GCB feedback provides two digital inputs. The LS module always holds the last correct feedback of the GCB. Additionally a GCB feedback monitor checks both feedback wires for energized / de-energized state (wire break).

In cases where a Tie-breaker feedback is connected (see chapter 'The Segment Handling'), two feedback wires are provided. In the failure case, the 'Tie-breaker feedback OK' signal would fail.

The LS module switches its own isochronous speed (and voltage) control into droop mode, when:

- Missing member alarm is active
- GCB feedback mismatch alarm is active
- Tie-breaker feedback mismatch alarm is active (when Tie-breaker connected)
- The discrete input [DI 04] (terminal 71) 'LSM speed control with droop' is active.

This is signaled via the relay [R 04] (terminal 45) 'Speed control with Droop'.

The alarm 'GCB feedback mismatch' is latched and must be acknowledged by the PMS system through discrete input [DI 01] (terminal 67). The relay [R 12] (terminal 59) signals 'Common Alarm'. The alarms can be receipt also by communication interfaces:

- RS-485 (Modbus RTU protocol)
- RS-232 (Modbus RTU protocol or ToolKit)
- CAN bus 1 (CANopen protocol)
- CAN bus 2 for RP-3000 Remote Panel

The LS module handles 2 frequency setpoint sources. Source 1 is the rated frequency, and source 2 is a frequency setpoint, which can be increased and decreased through discrete input [DI 05] (terminal 71) 'f/P raise' and discrete input [DI 06] (terminal 72) 'f/P lower'. To enable source 2, the discrete input [DI 02] (terminal 68) 'Setpoint raise / lower' must be energized.

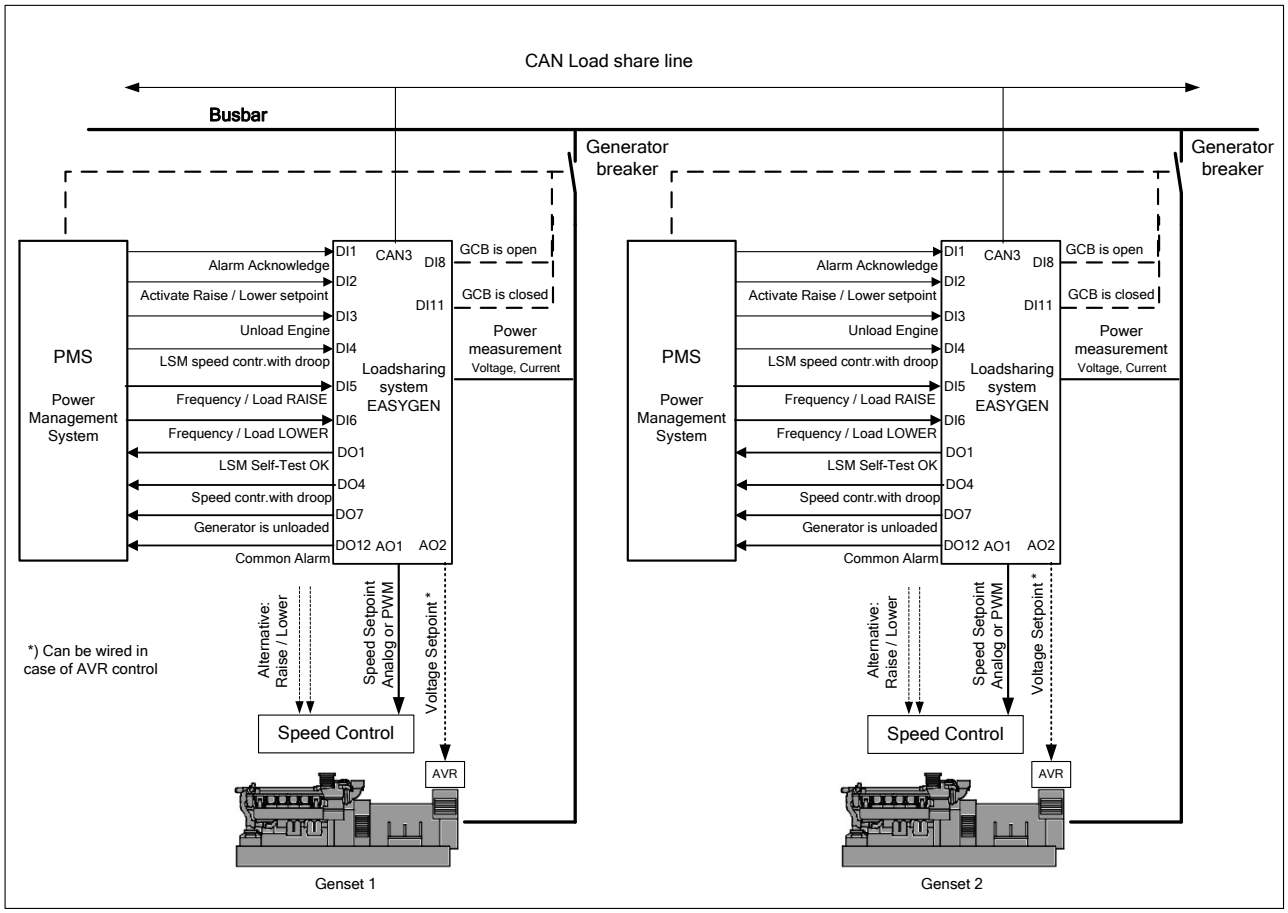
Note: As long the source 2 is not active, the setpoint 2 is initialized with the real frequency value.

Note: In this application the easYgen switches the operation mode automatically between STOP and AUTOMATIC through recognized generator frequency. Actually the AUTOMATIC mode can always be activated, but the STOP mode is the only mode which allows a firmware update.

1.1 PMS System Requirement

- To remotely change speed or load, the LS module provides raise and lower inputs. The raise and lower inputs become active with the discrete input [DI 02] (terminal 68) ‘Setpoint Raise / Lower’.
- During unloading, the PMS system can monitor the relay [R 07] (terminal 51) ‘Generator is Unloaded’ and open the breaker, when this relay is energized.
- The PMS system generally monitors the relay [R 01] (terminal 41) output ‘Load Share Module self-test ok’. If the relay trips, the speed (and voltage) regulation cannot be executed anymore.
- The LS module provides monitoring functions, which have to be acknowledged by the PMS system. The Reset Command must be executed with two rising edge signals on [DI 01] (terminal 67) or by interface command. (please refer to the manual)
- The single alarms are signaled by relay outputs or can be recognized via communication interface. Generally the event logger of the easYgen stores the failures with date and time stamp.

1.2 System Block Diagram



1.3 Operation Modes

Put the Generator in operation

1. The engine is started and the speed control ramps up the engine to nominal speed.
2. The LS module guides the frequency (and voltage) isochronously after reaching the appropriate start levels.
3. The first GCB is closed by a dead busbar closure through the PMS system. The LS module still monitors frequency (and voltage)
4. Each of the other GCBs is closed by an external synchronizer, which changes the speed setpoint via raise/lower inputs at the LS module.
5. If the GCB is closed and at least one other GCB is closed, the LS module ramps up the generator load.

Put the Generator out of operation

1. The unload generator signal is given by the PMS system.
2. The LS module unloads the generator.
3. During an activated unloading command, the LS module signals ‘Generator Unloaded’, when the generator load is under the configured level.
4. The PMS opens the GCB.
5. The LS module still guides the frequency (and voltage) due cool down run
6. The engine will be stopped.

Manual Change of Frequency

1. GCB open: When the engine is running, the frequency setpoint can be changed manually via raise/lower inputs at the LS module.
2. GCB closed, no other generator on busbar: The frequency setpoint can be changed manually via raise/lower inputs at the LS module.
3. GCB closed, other generator on busbar: The frequency setpoint can be changed manually via raise/lower inputs at the LS module. This has final control of the generator load of all generators. With a raise command, the particular generator will increase the load. With a lower command, the particular generator will decrease load.

Note: The load share monitoring is still active and will issue an alarm, if the load unbalance is too large.

1.4 Failure Scenarios

The LS module does not function

→ The LS module fails and trips the relay output ‘Load Share Module self-test ok’.

The LS module signals alarm

→ If any other alarm occurs in the LS module the relay output ‘Common Alarm’ is energized.

This relay output is caused by

→ Alarm: Missing member on the CAN load share bus.The missing member alarm is issued, if the configured number of members on the CAN bus is not recognized anymore.

→ Alarm: Load Share Monitoring. The Load Share Monitoring alarm is issued, if the configured unbalanced load tolerance is succeeded.

- Alarm: GCB feedback monitoring. The GCB feedback mismatch alarm is issued, if the GCB condition cannot be recognized anymore.
- Alarm: Tie-breaker feedback monitoring. The Tie-breaker feedback alarm is is issued, if the TB condition cannot be recognized anymore. The alarm is only possible, if a tie-breaker feedback connection exists. The alarm will be driven through the discrete input [DI 12].

1.4.1 Running in Droop mode (Philosophy)

To provide the best load share security for the genset system in any possible failure constellations, the easYgens acting as follows:

1. A missing member alarm will lead to a “Droop mode” in all easYgens independent on the segments.
2. A GCB feedback breaker alarm will lead to a “Droop mode” in all easYgens independent on the segments.
3. A Tie-breaker feedback alarm will lead to a “Droop mode” in all easYgens independent on the segments.
4. A device, manually switched to Droop mode (DI4) causes the other devices as well to switch to Droop mode independent on the segments.

Being in droop mode the CAN communication remains active between the recognized devices independent on the segments. But the load share relevant messages are ignored by all members and the droop share takes place.

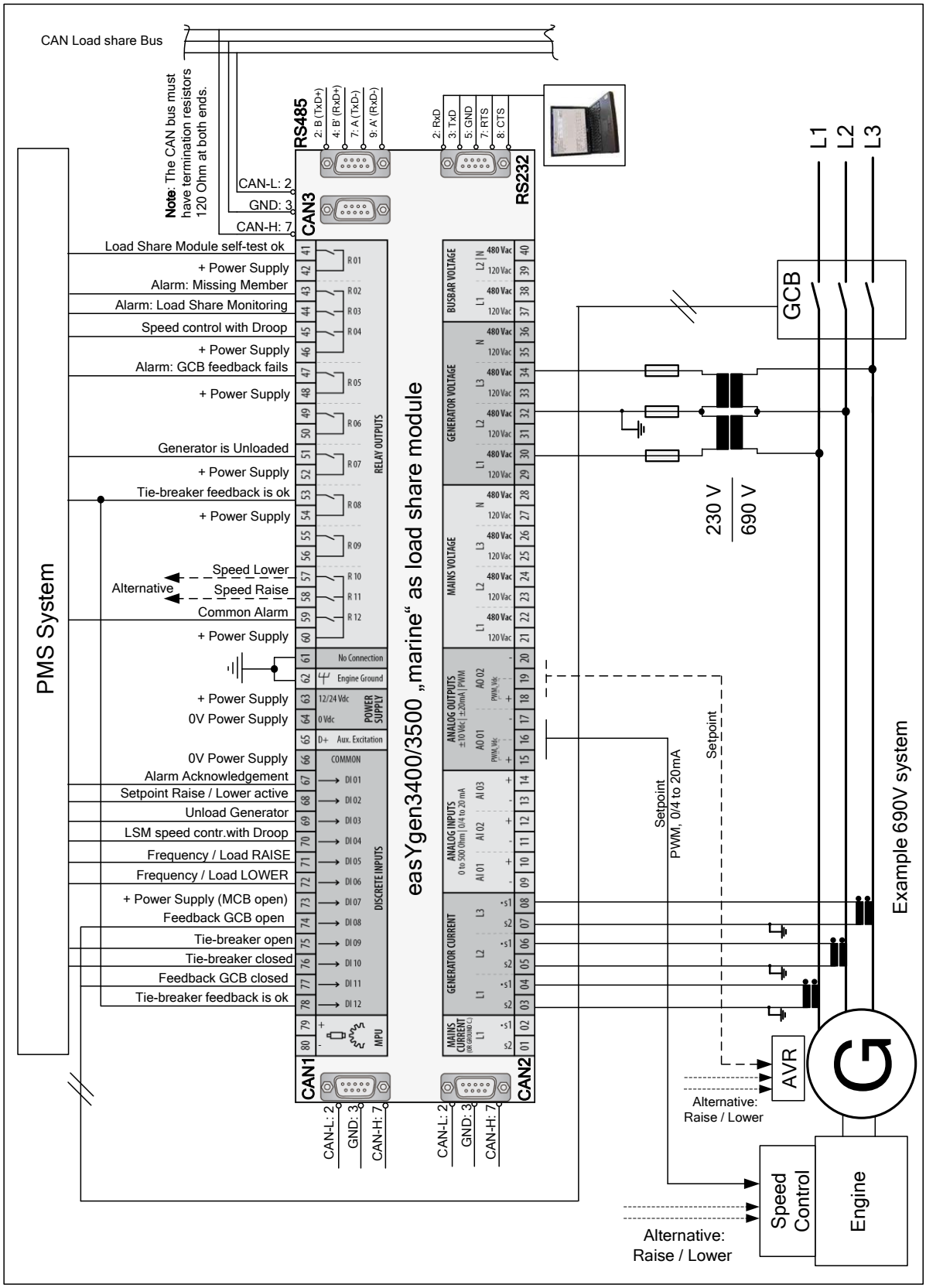
1.4.2 Failure Modes in an Open Bus-tie Configuration

The following table shall give an overview what are the consequences for the whole system in different failure modes, if an Open Bus-tie configuration separates the gensets.

Failure	Description of the System Response	Detection Method	Comment
→ An easYgen is faulty or powered down.	All easYgen devices switch to Droop mode.	All easYgens issue the alarm "Missing member". The relay 1 (self-test ok) of the according easYgen is tripped.	See chapter 1.4.1
→ The CAN load share communication bus is broken or short-circuited.	All easYgen devices switch to Droop mode.	All easYgens issue the alarm "Missing member". Observe the CAN communication status window on HMI.	See chapter 1.4.1
→ Broken current signal (Generator CT)	**The faulty segment with the broken CT:** The load sharing in this segment is unbalanced due to the wrong power measurement of the affected easYgen device. **The healthy segment:** No impact on the segment.	As long the power deviation between the single phases exceeds the threshold of the unbalanced load monitor, the according easYgen recognizes an "Unbalanced load" and trips an alarm.	1. The healthy segment will be not switched into droop. 2. The devices of the healthy segment ignore the load share messages from the faulty segment.
→ Failure of the setpoint signal from the easYgen to the speed governor	**The faulty segment with the broken setpoint signal:** The affected engine will shut down. **The healthy segment:** No impact on the segment.	The according engine will go into "Reverse power" and will trip.	The healthy segment will be not switched into droop.
→ Failure of the voltage signal from the generator (Generator PT)	**The faulty segment with the broken voltage signal:** The load sharing in this segment is unbalanced due to the wrong power measurement of the affected easYgen device. **The healthy segment:** No impact on the segment.	- As long the power deviation between the single phases exceeds the threshold of the unbalanced load monitor, the easYgen recognizes an "Unbalanced load" and trips an alarm. - As long the voltage deviation between the single phases exceeds the threshold of the asymmetry voltage monitor, the easYgen recognizes an "Voltage asymmetry" and trips an alarm.	1. The healthy segment will be not switched into droop. 2. The devices of the healthy segment ignore the load share messages from the faulty segment.
→ GCB feedback error	All easYgen devices switch to Droop mode.	The according easYgen trips the alarm "GCB feedback monitoring".	See chapter 1.4.1
→ Tie-breaker feedback error	All easYgen devices switch to Droop mode.	The according easYgen trips the alarm "TB mismatch".	See chapter 1.4.1

1.5 Installation Example

→ Based on wset-file 5418-3928-3930_LS-Module



1.6 Configuration (Generator #)

A detailed explanation of the configuration can be found in the easYgen-3400/3500 Marine manual. The configuration in this application note only covers the minimum requirements for running the easYgen as a load share module. Relative to the different types of speed controls, three main basic configuration files are introduced:

Setpoint Speed Control	Basic Configuration	Example
0/4 to 20 mA	5418-3928-3930_LS-Module_Analog.wset	MAN $SaCo_{Sone}$
PWM	5418-3928-3930_LS-Module_PWM.wset	Caterpillar ADEM
Raise / Lower	5418-3928-3930_LS-Module_RL.wset	MAN $SaCo_{Sone}$

1. Connect a PC, running ToolKit, to the LS module. After successful connection, enter your password.
2. Navigate ‘Settings/Load Settings File to Device’ and browse for the wset-file 5418-3928-3930_LS-Module. Follow the instructions and load this configuration file into the LS module. This is now the base for all other settings, listed in this chapter.
3. Select the page PARAMETER as a starting point for navigate through the settings. Click the right blue button at the top to start your individual setting.

Recommendation: First perform a complete setup for one LS-Module. Test this setting by starting the engine and checking the measured values. Check the setpoint signal to the speed control (and AVR). After this you can ‘load settings from device to file’ and bring that settings to the other LS-Modules.

Navigate to the following parameters and check:

ToolKit Page	ID	Parameter	Default	Checked	New Value
→ System management	1702	Device number	1		
→ Configure interfaces → Configure CAN interface 3	8952	Node-ID CAN bus 3	1		
→ Configure measurement	1750	System rated frequency	60 Hz		
	1601	Engine rated speed	900 rpm		
	1766	Generator rated voltage	690 V		
	1752	Gen. rated active power [kW]	1000		
	1758	Gen. rated reactive power [kvar]	500		
	1754	Generator rated current	837		
	1858	1Ph2W voltage measuring	Phase-phase		
	1859	1Ph2W phase rotation	CW		
	1851	Generator voltage measuring	3Ph 3W		
	1801	Gen. PT primary rated voltage	690 V		
	1800	Gen. PT secondary rated volt.	230 V		
	1806	Gen. CT primary rated current	1200 A		
→ Configure controller → Configure load share	5530	Active power load share level	50 %		
	5630	React. Power load share factor (if reactive load share is enabled)	50 %		
	1723	Segment number	1		
	5568	Mode ext. load share gateway (if load share gateway is connected)	0		
	12929	Segment no. 2 act.	(always False)		
	12928	Segment no. 3 act.	(always False)		
	12927	Segment no. 4 act.	(always False)		
→ Configure controller → Configure frequency control → 4 to 20mA; PWM setpoint	5510	Proportional gain	0.50		
	5511	Integral gain	1.00		
	5512	Derivative ratio	0.01		
→ Configure controller → Configure frequency control → Raise / Lower setpoint → (3-Position Controller)	5550	Deadband	0.1Hz		
	5551	Time pulse minimum	0.05s		
	5552	Gain factor	5.0		
	5553	Expand deadband factor	1.0		
	5554	Delay expand deadband	2.0s		
→ Configure controller → Configure frequency control → 4 to 20mA; PWM setpoint; → Raise / Lower setpoint	5500	Int. freq. control setpoint 1	60.00 Hz		
	5516	Start frequency control level	57.00 Hz		
	5517	Start frequency control delay	3 s		
	5504	Frequency control droop	2.0 %		
	5508	Freq. control initial state	50 %		
Configure controller Configure load control	5522	Load control setpoint ramp	3.00 %/s		
→ Configure controller → Configure voltage control (if reactive load share is enabled)	5610	Proportional gain	0.50		
	5611	Integral gain	1.00		
	5612	Derivative ratio	0.01		
	5600	Int. voltage control setpoint 1	690 V		
	5616	Start value	70 %		
	5617	Start delay	3 s		
	5604	Voltage control droop	5.0 %		
	5608	Voltage control initial state	50 %		
→ Configure controller	5622	React. pwr. ctrl setpoint ramp	3.00 %/s		

ToolKit Page	ID	Parameter	Default	Checked	New Value
→ Configure load control (if reactive load share is enabled)					
→ Configure analog outputs → Analog output 1 → 4 to 20mA setpoint	5201	Selected hardware type	4 – 20mA		
	5208	User defined min. output value	0.00 %		
	5209	User defined max. output value	100.00 %		
→ Configure analog outputs → Analog output 1 → PWM setpoint	5201	Selected hardware type	User defined		
	5208	User defined min. output value	65.00 %		
	5209	User defined max. output value	85.00 %		
	5202	PWM signal	On		
	5210	PWM output level	10V		
→ Configure analog outputs → Analog output 2 (AVR connection)	5215	Selected hardware type	0 to 20 mA		
	5222	User defined min. output value	0.00 %		
	5223	User defined max. output value	100.00 %		
→ Configure monitoring → Generator Operating V/f	5800	Upper voltage limit	110 %		
	5801	Lower voltage limit	90 %		
	5802	Upper frequency limit	105.0 %		
	5803	Lower frequency limit	95.0 %		
→ Configure monitoring → Engine mismatch → Generator unloading mismatch	3125	Unload limit	10.0 %		
	3123	Delay	300 s		
	3121	Alarm class	A		
	3122	Self acknowledge	Yes		
→ Configure monitoring → Load sharing mismatch	4841	Limit Active Power Load Share	30.0 %		
	5104	Delay	10.00 s		
	5106	Monitoring	Off		
	4842	Limit Reactive Power Load Share	30.0 %		
	5110	Delay	10.00 s		
→ Configure monitoring → Flexible limits 1-2	4205	Limit	410 (410 = 4.1 % of rated kW)		
→ Configure monitoring → Multi-unit settings	4063	Number of gens communicating	2		
	4061	Alarm class	B		
	4062	Self acknowledge	Yes		

1.7 Commissioning Guide

In order to adjust the LS module for optimum performance, it is important that the base engine is adjusted correctly. If the engine is not set up according to the frequency controller (speed governor) procedure, then it is not possible to achieve good isochronous load sharing and frequency stability. Bear in mind that the speed control runs with a PID controller. The upper LS module only runs as an isochronous PID controller at a minimum of 5 times slower; otherwise control behavior could become erratic and cause poor control behavior.

Engine

1. First test the engine without the LS module. Disconnect the LS module speed biasing output to the speed control or switch the frequency controller in the LS module off (parameter 5507). As long the frequency controller of the LS module is switched off, you can adjust the initial state of the analog value (or PWM signal) going to the speed control.
2. Make sure that the fuel rack and engine actuator outputs are adjusted according to engine manufacturer specification.
3. Run engine at different loads, up to full load and adjust applicable parameters according to manufacturer procedure. Perform this test for each engine in both droop and isochronous operation. Check that the droop curve for each engine is the same. Same percentage load related to the engine size shall behave with the same decrease of frequency.
4. Perform single engine load steps, and adjust, if needed, PID speed control settings for optimal performance. When this step is finished, the engine should be able to pass single-engine load tests according the required certification. If the single-engine test is successful, do not make any further changes to the speed governor PID settings.

LS Module

1. Configure the LS module base settings. Follow the section ‘Configuration’ in this note. This includes ‘constant’ settings, such as generator rated load, engine rated speed, CT and PT ratio. These settings need to be set once, and will be set the same in all 4 LS module modules (assuming that generator rated output is the same, and same type of PTs and CTs is used). Take care that each module gets its own device ID number and CAN node ID.
2. Confirm that wiring to and from the LS module is correct. Check that the load share CAN bus connection is working. You can switch in ToolKit to the page ‘States easYgen’, where you should see all connected LS modules. Before the LS module is reconnected to the speed control, run the single engine with load and check the measured values of the LS module. This is viewable on the STATUS MENU Generator page of ToolKit. Care about the power signing, negative power means reverse power.
3. Reconnect the speed bias output to the speed control or enable the frequency controller in the LS module.
4. With the LS module disconnected, disable the frequency controller (parameter 5507) in the LS module to figure out the right initial state setting to run 60 Hz.
5. Adjust the analog value range (or PWM range) of the LS module so, that with 3% Droop of the speed control at maximum load 60 Hz can be reached. This has to be done at all engines. Usually the same range settings should be taken.
6. Release the LS module (parameter 5507) and perform the required single-engine test, and confirm that the engine can still pass the test.
7. If the single-engine test cannot be passed, repeat the test with the LS module deactivated. If this test works properly, decrease the gain of the LS module (parameter 5510) of the speed control. Repeat the test with activated LS module again. In the end you should find a gain in the easYgen which does not disturb the single engine loading and load shedding. If the LS module does not influence the test negatively, you can increase the gain in small steps to get better performance for load sharing afterwards. But again you have to double-check to make sure the test can be passed. Use the gain value found at this engine as a starting point for the next engine. Do not continue with load sharing if the steps above have not been completed.

Multiple Engines

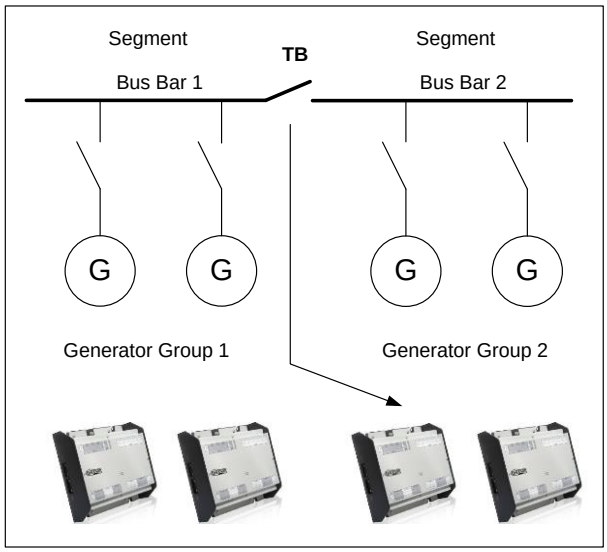
1. With default LS module settings, load DG 1 with 50% of rated load, synchronize DG 2, and check if the loading of DG 2 follows the desired ramp rate (parameter 5522). The loading should not be faster than the allowed ramp rate. If you get too much overshoot, you have several possibilities to improve this behavior:
   - Reduce proportional gain of the LS module (parameter 5510)
   - Reduce integral gain of the LS module (parameter 5511)
   - Reduce the load share error signal in relation to the overall frequency/load share PID error. This is done with active power load share level (parameter 5530 power/frequency weight factor). A larger value represents a smaller load share error signal influence.
   - Do not change the derivative ratio (parameter 5512) because the LS module acts only as a PI controller.
2. Ensure that the transition from loading DG2 to load sharing of DG 1 and DG 2 is smooth, with an overshoot as small as possible, and recovery time (time to stabilize) as short as possible. A helpful instrument for analysis here is the trending functionality of ToolKit.
3. Unload DG 2, and open DG 2 GCB. Repeat step 8 with different initial load on DG 1 and confirm that overshoot and recovery time is acceptable.
4. With DG 1 and DG 2 sharing load, increase and decrease the total load of the bus to check isochronous load sharing. Start with small load changes, and increase load steps if performance is OK. Adjust LS module PID and power/frequency weight factor, if necessary. Power/frequency weight factor should be set to the same value in all LS modules. LS module PID setting of all modules are typically set to the same values.
5. Confirm that var sharing is acceptable. Optimize voltage regulator settings if necessary.
6. Repeat steps 8, 9, 10 for DG 1 and DG 3.
7. Repeat steps 8, 9, 10 for DG 1 and DG 4.
8. Repeat steps 8, 9, 10 by ramping DG 1 into still running DG 2 and DG 3. If LS module settings were changed during this step, confirm that DG 1 to other DGs load sharing is still correct.
9. Repeat steps 8, 9, 10 by ramping DG 1 into still running DG 2, DG 3 and DG 4. If LS module settings were changed during this step, confirm that DG 1 to other DGs load sharing is still correct.
10. Confirm that loading a new generator is acceptable, confirm that load sharing is acceptable and bus frequency remains within required limits during load steps.
11. Perform multiple engine load tests according the required certification.

Failure Test Program

1. Load share bus:
   - Run all engines with load and disconnect the CAN 3 connection on one of the LS modules. All LS modules should energize the relay [R 02] ‘Alarm Missing Member’ and the relay [R 12] ‘Common alarm’. Decrease and increase load on the system. Engines should carry out correct load sharing. Speed / frequency deviates according the droop characteristic.
   - Make a short connection on the CAN bus 3. The same behavior shall occur.
2. Run all engine with load, and power down one of the LS modules. This LS module de-energizes the LS-Module self-test relay
3. [R 01]. All other controls go in droop (missing member).
4. Disconnect the setpoint signal (PWM signal) from the LS module to the speed control. The according speed control issues the broken wire alarm and the PMS system switches all other LS modules to droop characteristic.
5. Create an unbalanced load by influencing the power of a single engine. The LS module energizes the relay [R 03] ‘Alarm load share monitoring’ and the relay [R 12] ‘Common alarm’. The PMS system must read this alarm and switch all engines to droop, if no explanation has been found (manually load control).
6. Run one engine with an open GCB and activate the unloading command at an LS Module. Nothing should happen, the frequency remains stable.

2. easYgen-3400/3500 Marine: The Segment Handling

Application: System with 2 busbars and 1 tie-breaker



Approach

- The TB controls all easYgen of group 2 over LogicsManager (parameter 12929) 'Segment no.2 act.'
- The easYgens of group 1 are not involved

1-Wire Feedback Connection

- One wire coming from the tie-breaker is used.

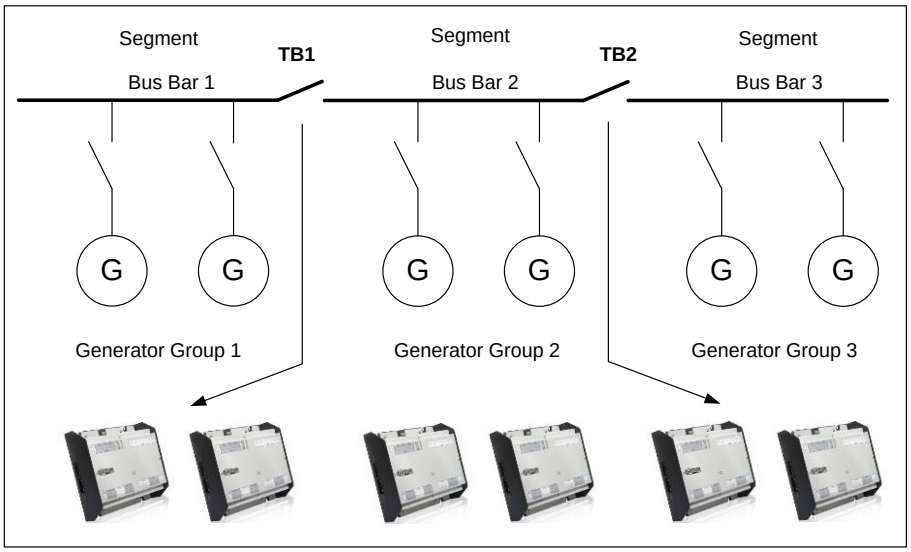
	easYgen Group 1	easYgen Group 2
System Condition	**Configured As Base Segment No.1**	**Configured As Base Segment No.1**
TB closed	Group 1 = segment 1	DI 'TB closed' = 1 Group 1 remains on 1
TB open	Group 1 = segment 1	DI 'TB closed' = 0 → LM Segment 2 active Group 2 = segment 2

2-Wire Feedback Connection

- The tie-breaker feedback is executed with 2 wires. They have opposite signals to detect wire-break, which can be monitored. This feature is often used in marine class certifications.

	easYgen Group 1	easYgen Group 2
System Condition	**Configured As Base Segment No.1**	**Configured As Base Segment No.1**
TB closed	Group 1 = segment 1	DI 'TB closed' = 1 DI 'TB open' = 0 Group 1 remains on 1
TB open	Group 1 = segment 1	DI 'TB closed' = 0 DI 'TB open' = 1 → LM Segment 2 active Group 2 = segment 2

Application: System with 3 busbars and 2 tie-breakers



Approach

- The TB1 controls all easYgen of group 1 over LogicsManager (parameter 12929) ‘Segment no.2 act.’
- The TB2 controls all easYgen of group 3 over LogicsManager (parameter 12929) ‘Segment no.2 act.’
- The easYgens of group 2 are not involved

1-Wire Feedback Connection

- One wire coming from the tie-breaker is used.

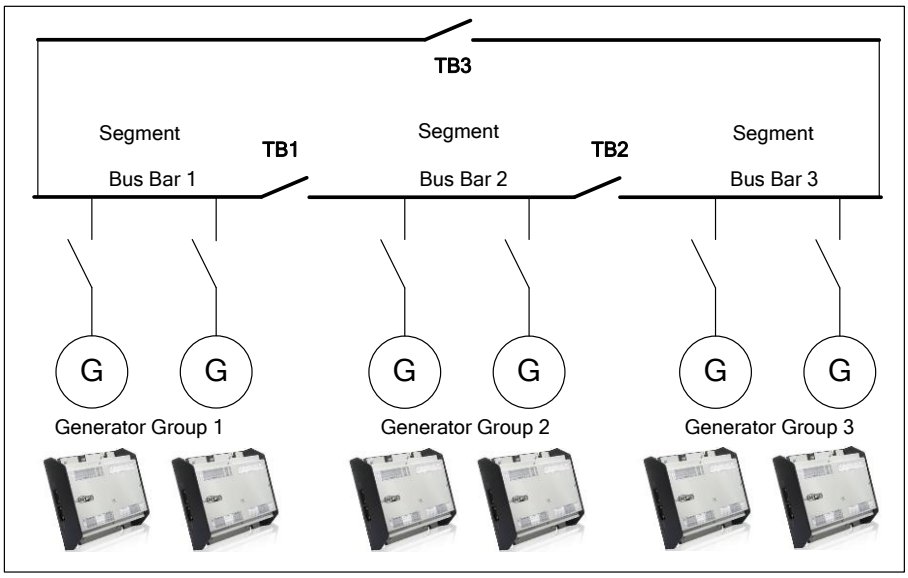
	easYgen Group 1	easYgen Group 2	easYgen Group 3
System Condition	**Configured As Base Segment No.1**	**Configured As Base Segment No.2**	**Configured As Base Segment No.3**
TB1 closed TB2 closed	DI ‘TB1 closed’ = 1 → LM Segment 2 active Group 1 = segment 2	 Group 2 = segment 2	DI ‘TB2 closed’ = 1 → LM Segment 2 active Group 3 = segment 2
TB1 closed TB2 open	DI ‘TB1 closed’ = 1 → LM Segment 2 active Group 1 = segment 2	 Group 2 = segment 2	DI ‘TB2 closed’ = 0 Group 3 = segment 3
TB1 open TB2 closed	DI ‘TB1 closed’ = 0 Group 1 remains on 1	 Group 2 = segment 2	DI ‘TB2 closed’ = 1 → LM Segment 2 active Group 3 = segment 2
TB1 open TB2 open	DI ‘TB1 closed’ = 0 Group 1 remains on 1	 Group 2 = segment 2	DI ‘TB2 closed’ = 0 Group 3 remains on 3

2-Wire Feedback Connection

→ The tie-breaker feedback is executed with 2 wires. They have opposite signals to detect wire-break, which can be monitored. This feature is often used in marine class certifications.

	easYgen Group 1	easYgen Group 2	easYgen Group 3
System Condition	**Configured As Base Segment No.1**	**Configured As Base Segment No.2**	**Configured As Base Segment No.3**
TB1 closed TB2 closed	DI ‘TB1 closed’ = 1 DI ‘TB1 open’ = 0 → LM Segment 2 active Group 1 = segment 2	Group 2 = segment 2	DI ‘TB2 closed’ = 1 DI ‘TB2 open’ = 0 → LM Segment 2 active Group 3 = segment 2
TB1 closed TB2 open	DI ‘TB1 closed’ = 1 DI ‘TB1 open’ = 0 → LM Segment 2 active Group 1 = segment 2	Group 2 = segment 2	DI ‘TB2 closed’ = 0 DI ‘TB2 open’ = 1 Group 3 = segment 3
TB1 open TB2 closed	DI ‘TB1 closed’ = 0 DI ‘TB1 open’ = 1 Group 1 remains on 1	Group 2 = segment 2	DI ‘TB2 closed’ = 1 DI ‘TB2 open’ = 0 → LM Segment 2 active Group 3 = segment 2
TB1 open TB2 open	DI ‘TB1 closed’ = 0 DI ‘TB1 open’ = 1 Group 1 remains on 1	Group 2 = segment 2	DI ‘TB2 closed’ = 0 DI ‘TB2 open’ = 1 Group 3 remains on 3

Application: System with 3 busbars and 3 tie-breakers



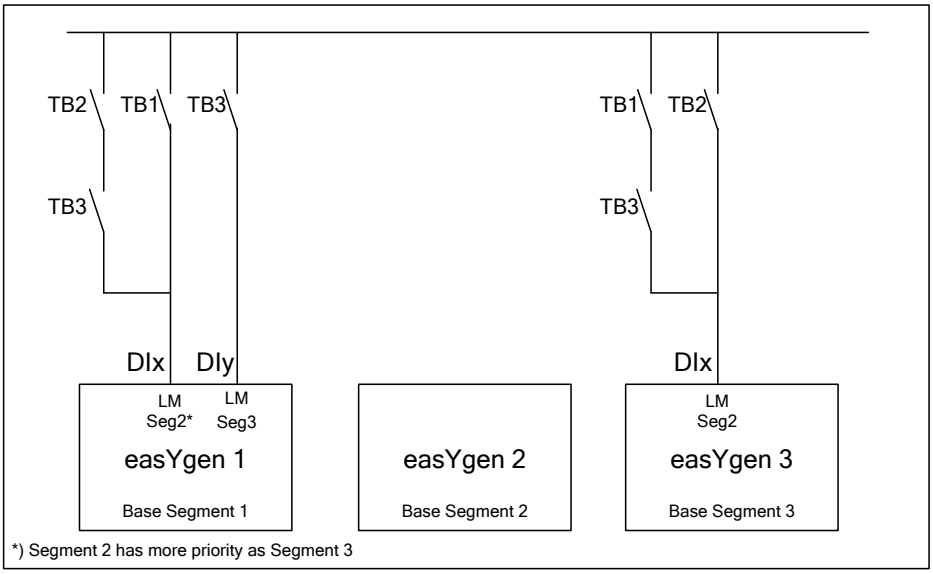
Logic Table

Tie-Breaker Condition			Segment		
TB1	**TB2**	**TB3**	**easYgen Group 1**	**easYgen Group 2**	**easYgen Group 3**
0	0	0	1 (Base segment)	2 (Base segment)	3 (Base segment)
0	0	1	LM3	2	3
0	1	0	1	2	LM2
0	1	1	LM2	2	LM2
1	0	0	LM2	2	3
1	0	1	LM2	2	LM2
1	1	0	LM2	2	LM2
1	1	1	LM2	2	LM2

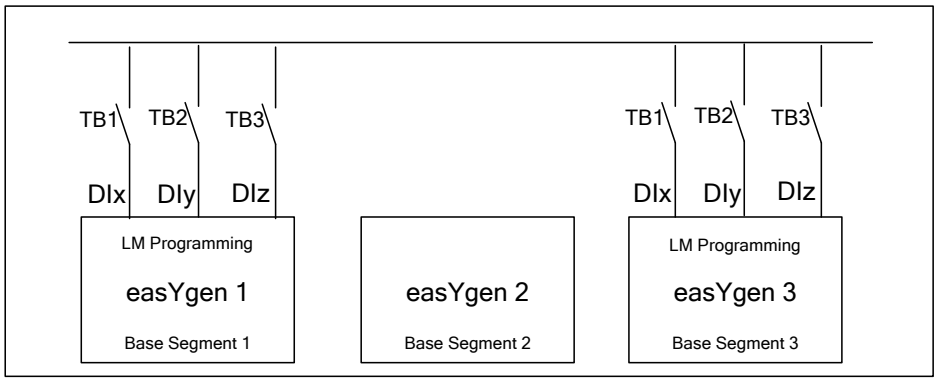
1-Wire Feedback Connection

- One wire coming from the tie-breaker is used.

Approach 1 (External Logic)



Approach 2 (Internal Logic)



Two-Wire Feedback Connection

- The tie-breaker feedbacks are executed with 2 wires. This is theoretically possible to do with the easYgen but this requires further digital inputs. In such cases contact Woodward for DI expansion boards.

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