Option K27
Run-up Synchronization

Brief Manual
easYgen-3200

WARNING

Read this entire manual 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.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

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: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

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Important definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation that, if not avoided, could result in damage to equipment.

NOTE

Provides other helpful information that does not fall under the warning or caution categories.

Revision History

Rev.	Date	Editor	Changes
NEW	09-09-01	TE	Release
A	10-03-22	TE	Additional monitoring operating range failure check Reworked transition modes "Interchange" and "Closed transition" Updated figure “Run-up synchronization procedure”
B	10-06-15	TE	Minor corrections

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Chapter 1.
Introduction

The easYgen-3200 Option K27 includes two new functions:

- **Run-up Synchronization**

The generators are paralleled together by closing their circuit breakers during the engine start sequence. Then after a certain speed is achieved the voltage regulators are enabled and the generators will produce voltage. The run-up synchronization method is used to get several synchronous generators onto load in a very short time. This time is determined by the engine start time and the AVR on-excitation. Another application is the excitation of power transformers. In some cases the in-rush current of a transformer may be more than one generator can supply when closing the live generator to the dead transformer. Using this run-up synchronization method allows the generator and transformer to build up voltage gradually through the start without the large in-rush.

- **Generator Group breaker control (GGB control)**

The GGB control logic will open and close a generator group breaker. The breaker is located between the generator busbar and the load. The GGB is needed, if either a run-up synchronization is required or the load is too high for one single generator. For applications with multiple generator sets, this feature measures the amount of generation capacity there is on the generator bus. When enough generators are paralleled together, then the GGB can be closed.

Both features can be used independently.

Chapter 2.
Run-up Synchronization

General

When run-up synchronization is enabled the easYgen evaluates a reply of a Generator Group Breaker (GGB), controlled by the easYgen or by external breaker logic. When using this feature a magnetic pickup is required. If the run-up synchronization is enabled, following terminals are fixed:

- Terminal 47/48, relay 5, switches the excitation on
- Terminal 77, discrete input 11, initiates the run-up synchronization
- Terminal 75, discrete input 09, gives the reply of the GGB

The run-up synchronization can be applied in different applications. The following figures show some examples:

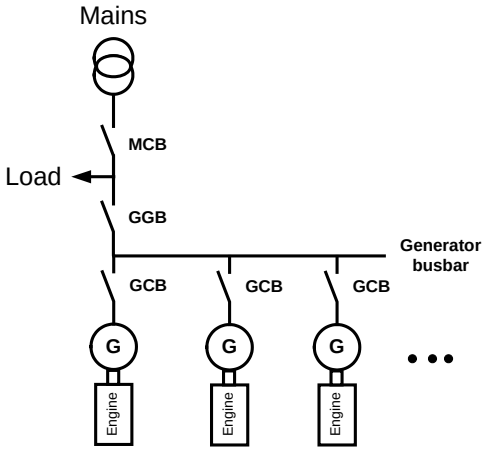

Figure 2-1: Several generators with a large load on busbar

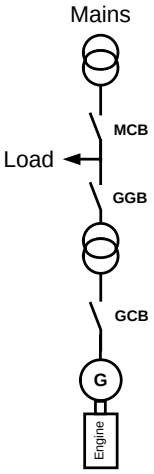

Figure 2-2: Single generator with power transformer

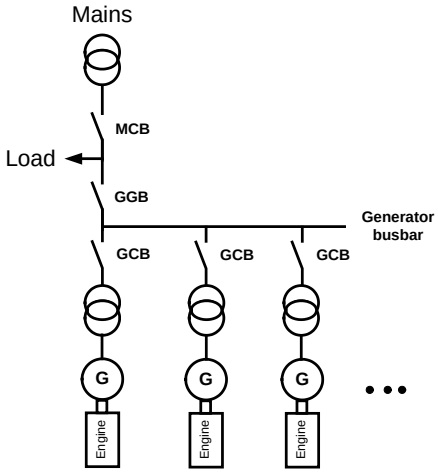

Figure 2-3: Several generators with block transformers

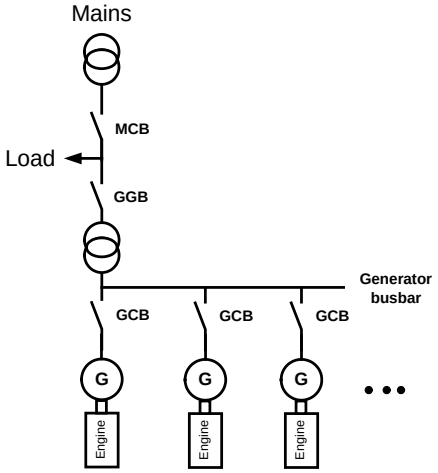

Figure 2-4: Several generators with common transformer

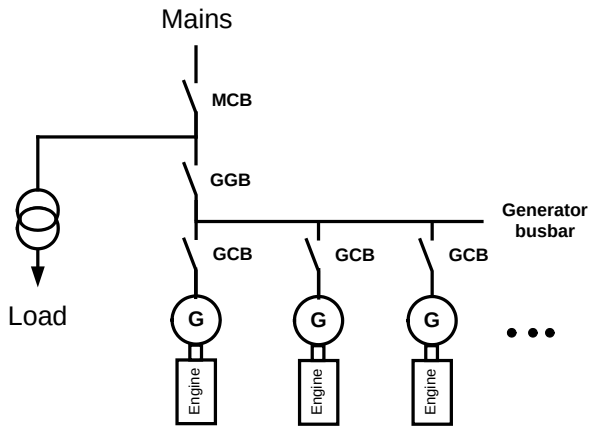

Figure 2-5: Between GGB and load resides a power transformer

MCB: Mains Circuit Breaker
GGB: Generator Group Breaker
GCB: Generator Circuit Breaker

Run-up Synchronization Configuration

Located in the HMI or Toolkit under Parameter > Configure Application > Configure Engine

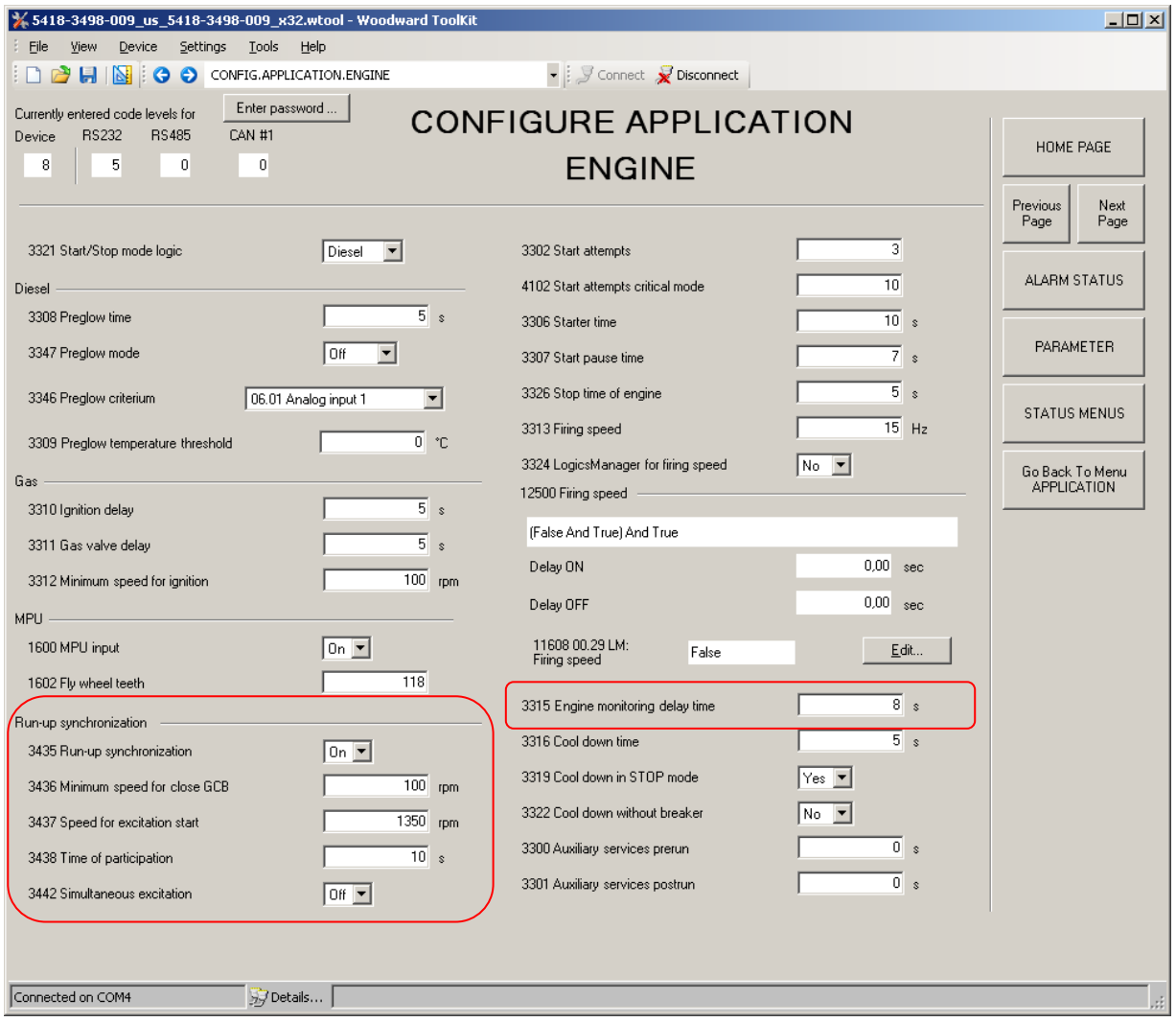

Figure 2-6: Configure run-up synchronization in Toolkit

ID	Parameter	CL	Setting range	Default	Description
3425	**Run-up synchronization**		On/Off	Off	**On:** The run-up synchronization is enabled and the dedicated terminals are occupied with the required functions. **Off:** The run-up synchronization is disabled and the dedicated terminals are free for other purposes.
3436	**Minimum speed for close GCB**		0 to4000 rpm	350 rpm	This configuration determines at what speed the GCB shall be closed. If the speed is configured on 0 the GCB will be closed before the engine starter begins to turn.
3437	**Speed for excitation start**		0 to 4000 rpm	1350 rpm	This configuration determines at what speed the excitation shall be switched on. This limit must be above the minimum speed for close GCB.
3438	**Time of participation**		1 to 180 sec	7 sec	This is the time allowed for the engine to start successfully. If the engine has not reached the correct speeds in this time, its breaker will be opened and it will not be included in the Run-Up Synchronization.

ID	Parameter	CL	Setting range	Default	Description
3442	**Simultaneous excitation**		On/Off	Off	**On:** The excitation is activated at all run-up members at the same time. All units start their excitation after the time of participation simultaneously. **Off:** The excitation is not activated at all members at the same time. It purely depends on the own speed.
3315	**Engine monitoring delay time**		1 to 99 sec	8 sec	The engine monitoring delay time has a function in the run-up synchronization mode: First it controls at each normal start, when the suppressed monitors (like under voltage, under frequency, oil pressure) shall be activated. Secondly it controls after issue the excitation, when the under voltage, under frequency monitoring and the controllers shall be switched on.

Table 2-1: Parameters – run-up synchronization

The run-up synchronization can be used in following breaker modes:

- Breaker Mode GCB
- Breaker Mode GCB/MCB
  - Parallel
  - Interchange
  - Closed Transition
  - Open Transition

Assumptions for using at the run-up synchronization:

- The run-up synchronization is enabled AND
- The MPU input is enabled
- The operating mode **AUTOMATIC** is active AND
- The DI “Run-up synchronization” is energized AND
- An engine start command is active AND
- The unit recognizes a generator dead busbar situation AND
- No shutdown alarm is present.

Run-up Synchronization – Interrupt condition:

- The run-up synchronization is disabled OR
- The DI „Run-up synchronization“ is not energized OR
- A shutdown failure (C,D,E,F) is active OR
- An engine start command is not active OR
- The DI „Generator Group Breaker is closed” AND GGB control is configured.

Run-up Synchronization – Behavior of the biasing signals

During run-up synchronization the frequency controller, the voltage controller, and the load sharing are disabled. To avoid a reverse power condition shortly after activation of the excitation, the biasing signals of the easYgen will behave with a droop (static) curve.
The droop settings for the frequency *f* [ID5504] and voltage *v* [ID5604] are used for this calculation.

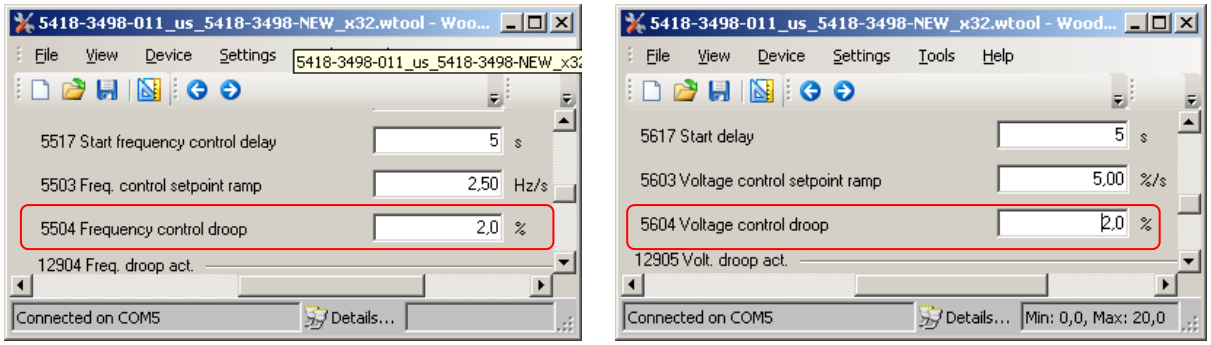

Figure 2-7: Behavior of the biasing signals

The initial state frequency decreases as active power increases according to this formula:
$Initial\ State\ Frequency\ Deviation = Initial\ State\ Frequency * Active\ Power\ [\%] * Droop\ f\ [\%]$

The initial state voltage decreases as reactive power increases according to this formula:
$Initial\ State\ Voltage\ Deviation = Initial\ State\ Voltage * Reactive\ Power\ [\%] * Droop\ v\ [\%]$

The frequency and voltage biasing is switched on, when the excitation is activated and the following triggered “Monitoring delay time” [ID3315] has expired.

Chapter 3.
Generator Group Breaker Control (GGB Control)

General

The GGB control function supports the run-up synchronization feature. The function can also be used independently of a run-up synchronization i.e. to operate a GGB in case of large loads, which can't be served by one generator. If the GGB control is enabled, the following terminals are fixed:

- Terminal 57/60, relay 10, switches the Close Command GGB
- Terminal 58/60, relay 11, switches the Open Command GGB
- Terminal 75, discrete input 09, gives the reply of the GGB
- Optional: Terminal 76, discrete input 10, signals a dead Load Busbar. This is a discrete signal coming from a device that is measuring the voltage of the load bus. When this input is energized the Load Busbar is recognized as dead.

The GGB control works in following breaker modes:

- Breaker Mode GCB
- Breaker Mode GCB/MCB
  - Parallel
  - Interchange
  - Closed Transition
  - Open Transition

The GGB is generally opened, after all generator breakers (GCB) have opened on the generator busbar. The opening depends on the operating mode. The closing of the GGB is only performed while in the AUTOMATIC operating mode. The closing and opening signals are pulsing commands.

Two GGB control modes exist:

Mode A: The GGB is closed after GCBs.

First, all desired generators will be started, their GCB will be closed, and then, if enough generator power is available, the GGB will be closed (see figures 1-1 to 1-4 on page 6).

Mode B: The GGB is closed before GCBs.

If the GGB control mode is used in conjunction with a run-up synchronization. The GGB is closed first and then the GCBs are closed. This mode is used, if a power transformer has to be energized, avoiding inrush current. (see figure 1-5 on page 7).

GGB Control Configurations

GGB Application

Located in the HMI or Toolkit under Parameter > Configure Application > Configure GGB

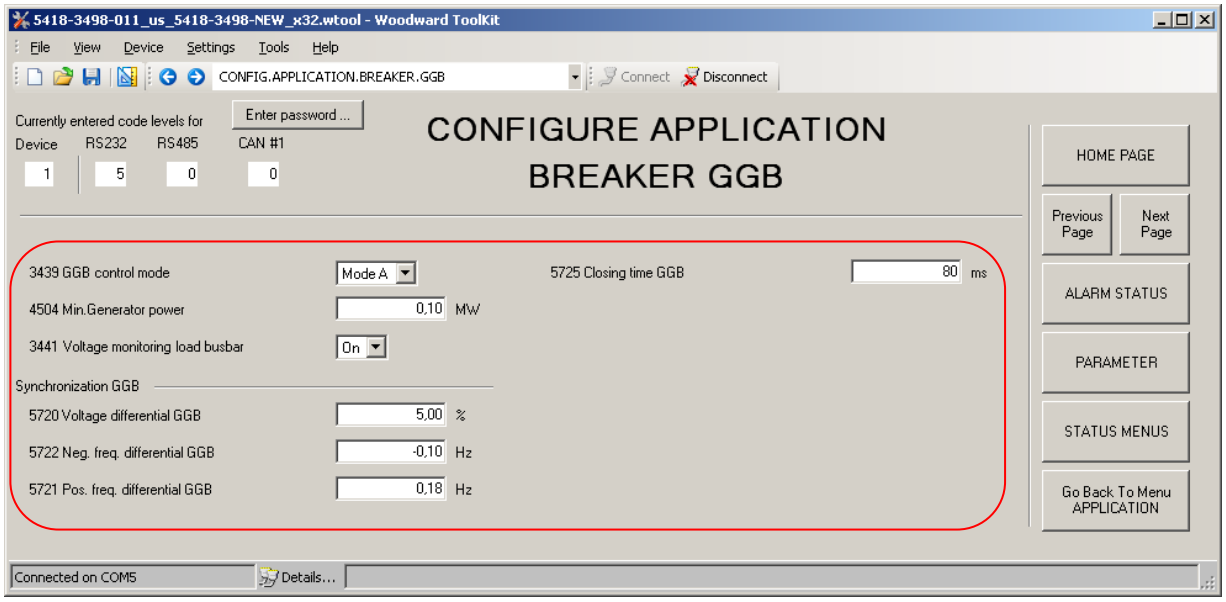

Figure 3-1: Configure GGB application in Toolkit

ID	Parameter	CL	Setting range	Default	Description
3439	**GGB control mode**		Mode A/Mode B/Off	Off	**Off:** The GGB control is disabled and the dedicated terminals are free for other purposes. The run-up synchronization can be used, but group breaker control must be handled by an external means. **Mode A:** The GGB control is enabled. The GGB will be closed, if enough rated generator power is available on the busbar. **Mode B:** When run-up synchronization is enabled the GGB will be closed before any GCB's are closed.
4504	**Min. generator power (Mode A)**		0 to 99.00 MW	0.10 MW	This configuration is valid for the mode A. When this amount of generator rated power is reached on the generator busbar the GGB will be closed.
3441	**Voltage monitoring load busbar**		On/Off	On	**Off:** The external load busbar voltage monitoring is disabled and the terminal 76 (input 10) is free for other purposes. **On:** The external load busbar voltage monitoring is enabled and the terminal 76 (input 10) expects a dead load busbar signal issued by an external three phase voltage relay.
5720	**Voltage differential GGB**		0.5 to 20.00 %	5.00 %	This is the maximum permissible voltage differential for closing the generator group breaker when synchronizing. If the difference between generator busbar and mains voltage does not exceed the value configured here and the mains voltage is within the operating voltage window, the "Command: GGB close" may be issued.
5721	**Pos. freq. differential GGB**		0.02 to 0.49 Hz	0.18 Hz	This is the maximum permissible positive differential frequency between generator busbar and mains voltage. If the differential frequency is larger, the GGB close command is not issued. Positive differential frequency means the frequency of the genera-tor is higher than the mains.
5722	**Neg. freq. differential GGB**		-0.49 to 0.00 Hz	0.10 Hz	This is the maximum permissible negative differential frequency between generator busbar and mains voltage. If the differential frequency is larger, the GGB close command is not issued.

ID	Parameter	CL	Setting range	Default	Description
5725	**Closing time GGB**		40…300 ms	80 ms	The inherent closing time of the GGB corresponds to the anticipation time of the GGB close command. This value is typically found in the manufacturers data sheet for the circuit breaker.

Table 3-1: Parameters – GGB application

NOTE

In applications with mains (a utility or shore power connection) the use of an additional voltage relay for detecting a dead load busbar is strongly recommended.

GGB Monitoring

Located in the control display menu or Toolkit under Parameter > Configure Monitoring > Configure Breaker

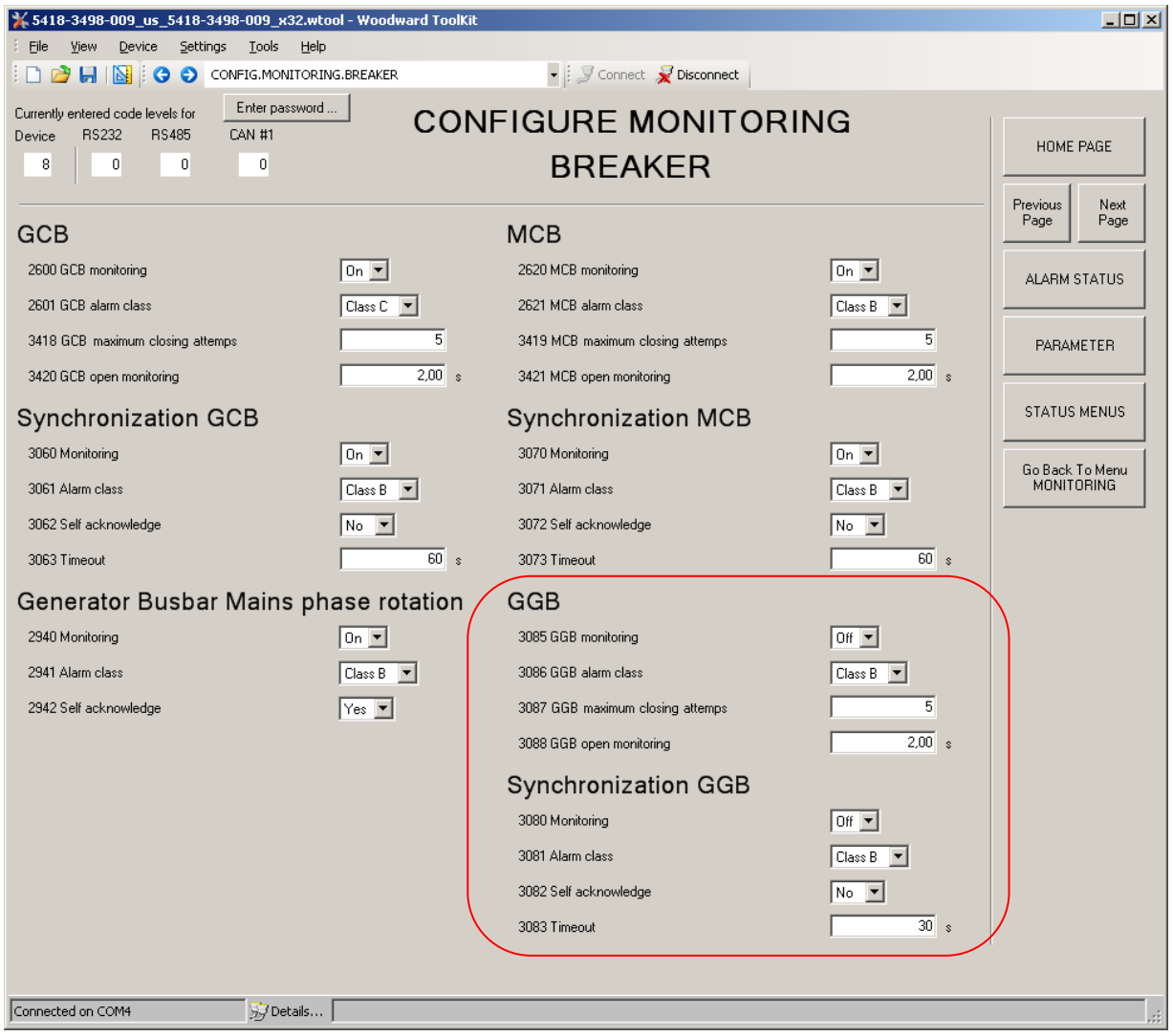

Figure 3-2: Configure GGB monitoring in Toolkit

GGB Monitoring

The circuit breaker monitoring contains two alarms: A breaker reclose alarm and a breaker open alarm.
Breaker Reclose Alarm: If the control initiates a close of the breaker and the breaker fails to close after the configured number of attempts the CB alarm will be initiated.
When this protective function is triggered, the display indicates "**GGB fail to close**".
Breaker Open Alarm: If the control is attempting to open the circuit breaker and it fails to see that the CB is open within the configured time in seconds after issuing the breaker open command then the monitoring CB alarm will be initiated. When this protective function is triggered, the display indicates "**GGB fail to open**".

ID	Parameter	CL	Setting range	Default	Description
3085	**GGB monitoring**		On/Off	On	**On:** The GGB breaker monitoring for close and opening is enabled. **Off:** The GGB breaker monitoring for close and opening is disabled.
3086	**GGB alarm class**		Class A/Class B	Class B	The Alarm Class for the GGB breaker alarms can be set to either a Class A or Class B alarm. Both alarms will be present on the display screen, the class B alarm will also activate the common alarm relay, where the class A alarm will not.

ID	Parameter	CL	Setting range	Default	Description
3087	**GGB maximum closing attempts**		1 tot 10	5	The maximum number of breaker closing attempts is configured in this parameter. When the GGB breaker reaches the configured number of attempts, a GGB failure alarm is issued. The counter for the closure attempts will be reset as soon as the "Reply GGB" is de-energized for at least 5 seconds to signal a closed GGB.
3088	**GGB open monitoring**		0.1 to 5.0 sec	2.00 sec	When the control issues an open command for the GBB, this timer is started as the control waits for the reply signal to be returned telling the control the breaker is open. If the reply is not received before this timer is finished an alarm is issues. The alarm configured in parameter [ID3086] is issued.

Table 3-2: Parameters – GGB monitoring

Monitoring GGB Synchronization

ID	Parameter	CL	Setting range	Default	Description
3080	**Monitoring**		On/Off	On	**On:** The GGB synchronization timeout monitoring is enabled. **Off:** The GGB synchronization timeout monitoring is disabled.
3081	**Alarm class**		Class A to Class F	Class B	Each limit may be assigned an independent alarm class that specifies what action should be taken when the limit is surpassed.
3082	**Self acknowledge**		Yes/No	No	**Yes:** The control automatically clears the alarm if the fault condition is no longer detected. **No:** The control does not automatically reset the alarm when the fault condition is no longer detected. The alarm must be acknowledged and reset by manually pressing the appropriate buttons or by activating the LogicsManager output "External acknowledgement" (via a discrete input or via an interface).
3083	**Timeout**		3 to 999 sec	30 sec	If it was not possible to synchronize the GGB within the time configured here, an alarm will be issued. The alarm text is shown as “GGB syn. Timeout”.

Table 3-3: Parameters – Monitoring GGB synchronization

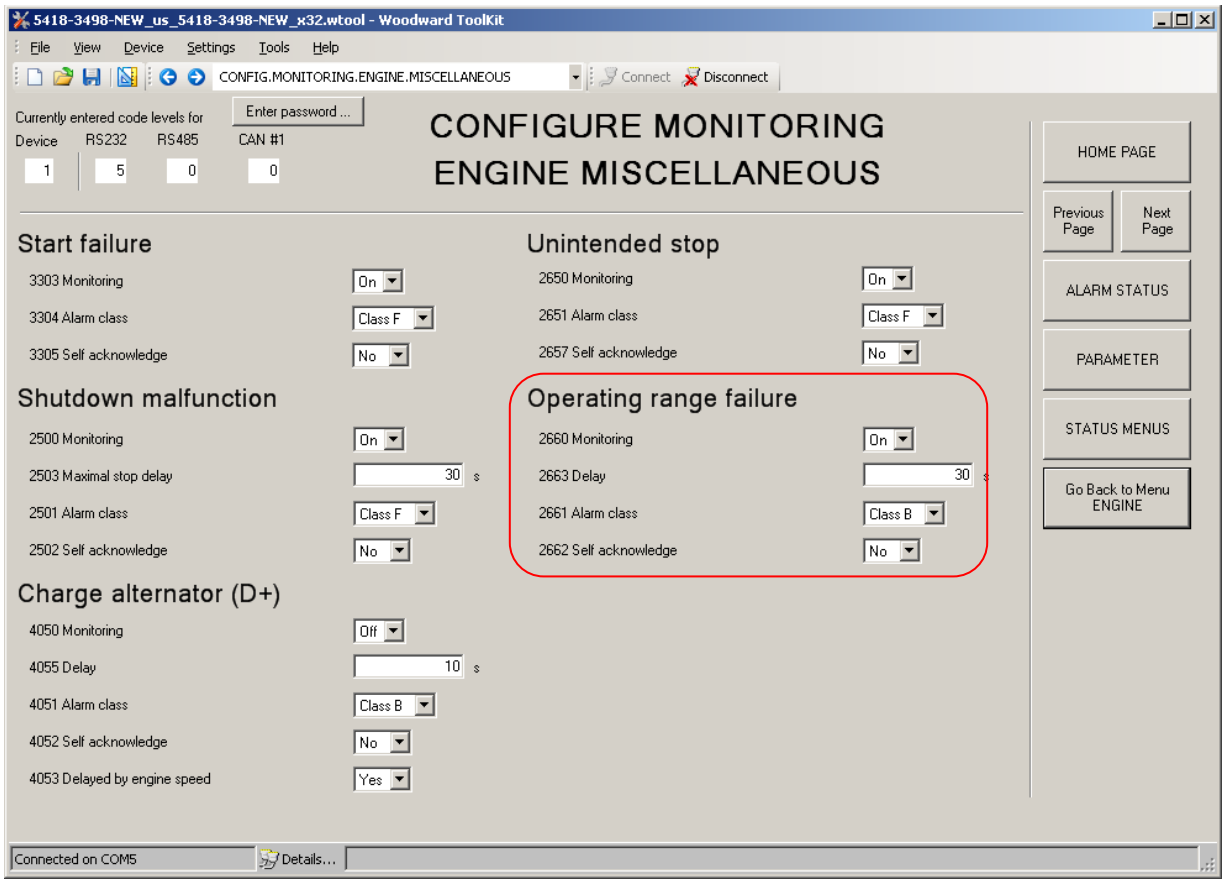

Figure 3-3: Configure operating range failure in Toolkit

Monitoring Operating range failure

The Monitoring “Operating range failure” issues an alarm if one of the following conditions is fulfilled:

- Check 1: The easYgen tries to close the GCB, but the generator is not within its operating range
- Check 2: The easYgen tries to synchronize the GCB, but the busbar or the generator is not within the generator operating range
- Check 3: The easYgen tries to close the GCB to the dead busbar, but the busbar voltage is NOT below the dead busbar detection limit
- Check 4: The run-up synchronization is active and the busbar is not coming in operating range
- Check 5: Close of GGB:
    - The GGB shall be synchronized in “Interchange or closed transition mode” and the minimum generator power is not matched
    - The GGB shall be closed on a dead busbar and the minimum generator power is not matched

If this protective function is triggered, the display indicates "**Operat. range failed**" and the logical command variable "06.31" will be enabled.

ID	Parameter	CL	Setting range	Default	Description
2660	**Monitoring**		On/Off	On	**On:** Monitoring of the operating range is carried out according to the following parameters. **Off:** Monitoring is disabled.
2663	**Delay**		1 to 999 sec	30 sec	If one of the above mentioned conditions for an operating range failure is fulfilled, an alarm will be issued. If the respective condition is not fulfilled anymore before the delay time expires, the delay time will be reset.
2661	**Alarm class**		Class A to Class F	Class B	Each limit may be assigned an independent alarm class that specifies what action should be taken when the limit is surpassed.

ID	Parameter	CL	Setting range	Default	Description
2662	**Self acknowl-edge**		Yes/No	No	**Yes:** The control automatically clears the alarm if the fault condition is no longer detected. **No:** The control does not automatically reset the alarm when the fault condition is no longer detected. The alarm must be acknowledged and reset by manually pressing the appropriate buttons or by activating the LogicsManager output "External acknowledgement" (via a discrete input or via an interface).

Table 3-4: Parameters – Monitoring operating range failure

Chapter 4.
Procedures of the Run-up Synchronization

Application Mode “GCB/MCB”

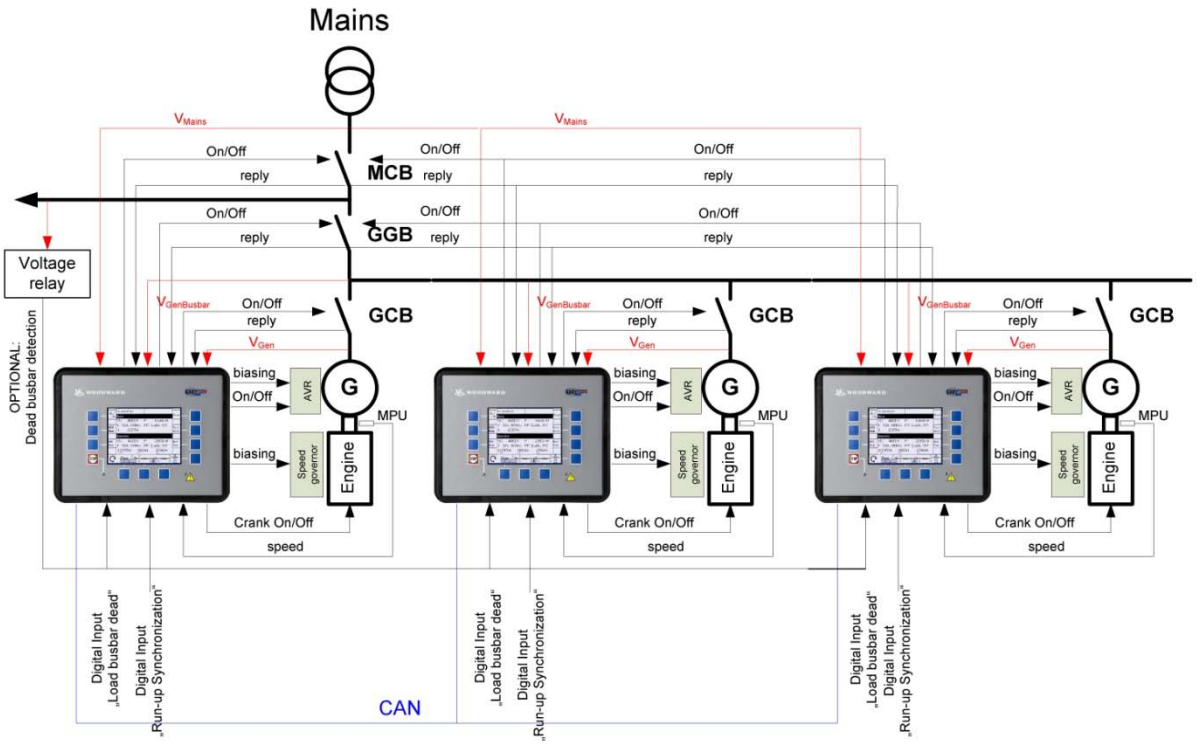

Figure 4-1: Gensets in a mains application

Run-up Synchronization		
Parameter-ID	**Meaning**	**Setting**
3435	Run-up synchronization	On/Off
3436	The minimum speed for close GCB	0…4000 rpm
3437	Speed for excitation start	0…4000 rpm
3438	Time of participation	0…180 sec
3442	Simultaneous excitation	On/Off

Table 4-1: Parameter overview (application mode GCB/MCB) – run-up synchronization

GGB Control		
Parameter-ID	**Meaning**	**Setting**
3439	GGB control mode	Off/Mode A/Mode B
4504	Min. generator power (Mode A)	0...99.00 MW
3441	Voltage monitoring load busbar	On/Off

Table 4-2: Parameter overview (application mode GCB/MCB) – GCB control

Run-up Synchronization with GGB control Mode A

Initial conditions for a run-up synchronization are:

- GGB open
- Engines are stopped
- Run-up Synchronization is selected via digital input (Digital input 11)

The "Minimum speed for close GCB" [ID3435] is 0 rpm:
All units commanded to start will close their GCB. After verifying the GCB is closed each unit will start the engine and wait until the speed for excitation is reached.
If the speed for excitation is reached within the "Time of participation" [ID3438], the unit closes its digital output to excite the generator. If the speed for excitation is not reached, the unit will interrupt the run-up synchronization procedure and open its generator breaker. It will then close the excitation relay to excite the generator and perform a normal synchronization to the bus.

The "Minimum speed for close GCB" [ID3435] is greater than 0 rpm:
All units commanded to start will begin to start their engine. Upon reaching the "Minimum speed" each unit will close its GCB and waits until the speed for excitation is reached.
If the minimum speed and the speed for excitation are reached within the "Time of participation" [ID3438], each unit switches on its excitation. If the speed for excitation is not reached, the unit will interrupt the run-up synchronization and open its generator breaker. It will then close the excitation relay to excite the generator and perform a normal synchronization to the bus.

The "Simultaneous excitation" [ID3442] is enabled:
If the simultaneous excitation is enabled, all participating units that are running greater than the speed for excitation, will communicate with each other to enable the excitation at the same time.

After switching on the excitation, each unit waits for the "Engine monitoring delay time" [ID3315]. If the generator comes into the "Operating range" [ID5800…ID5803] for voltage and frequency the unit is considered ready for load. If the generator does not come into the operating range, the run-up synchronization of this unit will be interrupted.
The next step in this sequence depends on the configured transition mode.

Transition Mode "Parallel" - Emergency run is not active (Mains voltage is present and stable)
Providing that the MCB has not been opened externally, the GGB is synchronized and the generators will run parallel with the mains.
When the start command is removed the generator will be unloaded and when the last GCB is opened the GGB will be tripped as well.

Transition Mode "Parallel" - Emergency run is active (mains voltage is not available)
The MCB is opened after successful start and the GGB will be closed once enough rated generator power is available on generator busbar this is determined by the Min Gen Power parameter [ID4505].
When the start command is removed the MCB will be synchronized back, the generators will be unloaded and with the opening of the last GCB the GGB will be tripped as well.

Transition Mode "Interchange" - Emergency run is not active
Providing that the MCB has not been opened externally, the GGB is synchronized once enough rated generator power is available on generator busbar this is determined by the Min Gen Power parameter [ID4505]. After closing the GGB the generators will run parallel with the mains. Once the mains is unloaded the MCB will be opened.
When the start command is removed the MCB will be synchronized back, the generators will be unloaded and with the opening of the last GCB the GGB will be tripped as well.

Transition Mode "Interchange" - Emergency run is active
The MCB is opened after a successful start and the GGB will be closed once enough rated generator power is available on the generator busbar this is determined by the Min Gen Power parameter [ID4505].
When the mains returns and the mains settling time is complete the MCB will be synchronized back, the generators will be unloaded and with the opening of the last GCB the GGB will be tripped as well.

Transition Mode "Closed transition" - Emergency run is not active
Providing that the MCB has not been opened externally, the GGB is synchronized once enough rated generator power is available on generator busbar this is determined by the Min Gen Power parameter [ID4505]. With closed GGB the MCB will be opened.
When the start command is removed the MCB will be synchronized back, the GCBs will be opened and the GGB will be tripped as well.

Transition Mode "Closed transition" - Emergency run is active
The MCB is opened and the GGB will be closed once enough rated generator power is available on generator busbar this is determined by the Min Gen Power parameter [ID4505].
When the mains returns and the mains settling time is complete the MCB will be synchronized back, the GCBs will be opened and the GGB will be tripped as well.

Transition Mode "Open transition" - Emergency run is not active
If enough rated generator power is available on the generator busbar, the MCB will be opened, the transition time "MCB to GCB" counts down and the GGB will be closed on the dead load busbar.
When the start command is removed the GGB will be tripped with the last GCB then the MCB will be closed after the transition time "GGB -> MCB" [ID3400].

Transition Mode "Open transition" - Emergency run is active
The MCB is opened and the GGB will be closed once enough rated generator power is available on the generator busbar.
When the mains returns and the mains settling time is complete the GCBs and the GGB are tripped. After the transfer time "GGB ->MCB" [ID3400] the MCB will be closed.

Run-up Synchronization with GGB control Mode B

Initial conditions for a run-up synchronization are:

- MCB is opened, when the start command occurs
- GGB open
- Engines are stopped
- Run-up Synchronization is released (Digital input 11). The Enable MCB logic manager condition [ID12923] must be false.

The "Minimum speed for close GCB" [ID3435] is 0 rpm:
The GGB will be closed first. Then all units close their GCB. After verifying the GCB is closed each unit will start the engine and wait until the speed for excitation is reached.
If the speed for excitation is reached within the "Time of participation" [ID3438], the unit closes its digital output to excite the generator. If the speed for excitation is not reached, the unit will interrupt the run-up synchronization procedure and open its generator breaker. It will then close the excitation relay to excite the generator and perform a normal synchronization to the bus.

The "Minimum speed for close GCB" [ID3435] is greater than 0 rpm:
The GGB will be closed first. Then all units begin to start their engine. Apon reaching the "Minimum speed" each unit will close its their GCB and waits until the speed for excitation is reached.
If the minimum speed and the speed for excitation are reached within the "Time of participation" [ID3438], each unit switches on its excitation. If the speed for excitation is not reached, the unit will interrupt the run-up synchronization and open its generator breaker. It will then close the excitation relay to excite the generator and perform a normal synchronization to the bus.

The "Simultaneous excitation" [ID3442] is enabled:
If the simultaneous excitation is enabled, all participating units that are running greater than the speed for excitation, will communicate with each other to enable the excitation to the same time.

After switching on the excitation, each unit waits for the "Engine monitoring delay time" [ID3315].
If the generator comes into the "Operating range" [ID5800…ID5803] for voltage and frequency the unit is considered ready for load. If the generator does not come into the operating range, the run-up synchronization of this unit will be interrupted.
The next step in this sequence depends on the configured transition mode.

Transition Mode "Parallel" - Emergency run is not active
Providing that the MCB has not been opened externally, the run-up synchronization is blocked and the engines will not be started.
To start the run-up synchronization the MCB must be opened and the signal "Enable MCB" must be deactivated before the start command is issued.
When the start command is removed and the signal is activated "Enable MCB" the MCB is synchronized back. Then the generators will be unloaded and with the opening of the last GCB the GGB will be tripped as well.

Transition Mode "Parallel" - Emergency run is active
In case of an emergency run the easYgen will open the MCB, before the run-up synchronization begins. The GGB will be closed when enough generator kW capacity has closed to the bus bar.
When the mains returns and the mains settling time is complete the MCB will be synchronized back. Then after unloading and the opening of the GCBs the GGB will be tripped as well.

Transition Mode "Interchange" - Emergency run is not active
Providing that the MCB has not been opened externally, the run-up synchronization is blocked and the engines will not be started.
To start the run-up synchronization the MCB must be opened and the signal "Enable MCB" must be deactivated before the start command is issued.
When the start command is removed and the signal "Enable MCB" is activated the MCB will be synchronized back. Then the generators will be unloaded and with the opening of the last GCB the GGB will be tripped as well.

Transition Mode "Interchange" - Emergency run is active
In case of an emergency run the easYgen will open the MCB, before the run-up synchronization begins. The GGB will be closed when enough generator kW capacity has closed to the bus bar.
When the mains returns and the mains settling time is complete the MCB will be synchronized back, the generators will be unloaded and with the opening of the last GCB the GGB will be tripped as well.

Transition Mode “Closed transition” - Emergency run is not active
Providing that the MCB has not been opened externally, the run-up synchronization is blocked and the engines will not be started.
To start the run-up synchronization the MCB must be opened and the signal “Enable MCB” must be deactivated before the start command is issued.

When the start command is removed and the signal is activated “Enable MCB” the MCB will be synchronized back. Then the GCBs will be opened and the GGB will be tripped as well.

Transition Mode “Closed transition” - Emergency run is active
In case of an emergency run the easYgen will open the MCB, before the run-up synchronization begins. The GGB will be closed when enough generator kW capacity has closed to the bus bar.
When the mains returns and the mains settling time is complete the MCB will be synchronized back, the GCBs will be opened and the GGB will be tripped as well.

Transition Mode “Open transition” - Emergency run is not active
The MCB will be opened, before the run-up synchronization begins. The GGB will be closed when enough generator kW capacity has closed to the bus bar.
When the start command is removed the GGB will be tripped with the last GCB then the MCB will be closed after the transition time “GGB -> MCB” [ID3400].

Transition Mode “Open transition” - Emergency run is active
The MCB will be opened, before the run-up synchronization begins. The GGB will be closed when enough generator kW capacity has closed to the bus bar.
When the mains returns and the mains settling time is complete the GCBs and the GGB are tripped. After the transfer time “GGB ->MCB” [ID3400] the MCB will be closed.

Run-up Synchronization and GGB Control - Handling the MCB

Application Mode	Transmission Mode	GGB Breaker Mode	No Emergency run	Emergency Run
GCB/MCB	• **Parallel**	Mode A	The MCB will not be opened.	The MCB will be opened after successful start.
		Mode B	The MCB will not be opened.	The MCB will be opened before start the engines.
	• **Closed Transition** • **Interchange**	Mode A	The MCB will be opened after synchronization the GGB.	The MCB will be opened after the GGB is closed.
		Mode B	The MCB will be opened after synchronization the GGB.	The MCB will be opened before the GGB will be closed.
	• **Open Transition**	Mode A	The MCB will be opened before close the GGB.	The MCB will be opened before close the GGB.
		Mode B	The MCB will be opened before start the engines.	The MCB will be opened before start the engines.
GCB	-	Mode A	The MCB is not operated	-
		Mode B	The MCB is not operated	-

Table 4-3: Overview – handling the MCB

Application Mode “GCB”

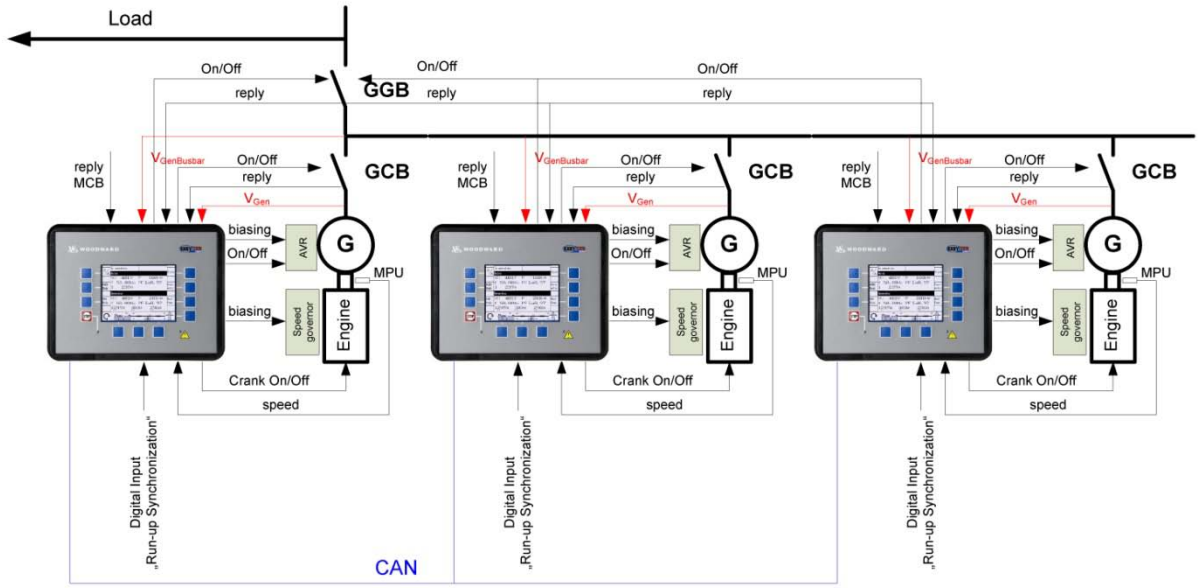

Figure 4-2: Gensets in an isolated application

Run-up Synchronization		
Parameter-ID	**Meaning**	**Setting**
3435	Run-up synchronization	On/Off
3436	The minimum speed for close GCB	0…4000 rpm
3437	Speed for excitation start	0…4000 rpm
3438	Time of participation	0…180 sec
3442	Simultaneous excitation	On/Off

Table 4-4: Parameter overview (application mode GCB) – run-up synchronization

GGB Control		
Parameter-ID	**Meaning**	**Setting**
3439	GGB control mode	Off/Mode A/Mode B
4504	Min. generator power (Mode A)	0...99.00 MW
3441	Voltage monitoring load busbar	On/Off

Table 4-5: Parameter overview (application mode GCB) – GCB control

Run-up Synchronization with GGB control Mode A

Initial conditions for a run-up synchronization are:

- GGB open
- Engines are stopped
- Run-up Synchronization is selected via digital input (Digital input 11)

The run-up synchronization is executed according the application mode “GCB/MCB” and GGB control mode A.
The explanation of the procedure continues here with the finished run-up synchronization.

The reply MCB is closed (mains parallel application)

If the MCB is not opened from external, the GGB is synchronized independent on the rated generator power available on generator busbar. The easYgen keeps the parallel-run to mains.
With removing the start command the generator will be unloaded and with opening the last GCB the GGB will be tripped as well.

The reply MCB is open (isolated application)

The GGB will be closed on the dead load busbar, if enough rated generator power is available on generator bus-bar.
With removing the start command the GCB will be opened and with opening the last GCB the GGB will be tripped as well.

Run-up Synchronization with GGB control Mode B

The precondition for a run-up synchronization is:

- MCB open
- GGB open
- Engines are stopped
- Run-up Synchronization is released (Digital input 11)

The run-up synchronization is executed according the application mode “GCB/MCB” with GGB control mode B.
The explanation of the procedure continues here with the finished run-up synchronization.

The reply MCB is closed (mains parallel application)

If the MCB was not opened from external, the run-up synchronization is blocked and the engines don’t start.
If the MCB is opened from external, the run-up synchronization functions according to the GGB control mode B.
With removing the start command the generator will be unloaded and with opening the last GCB the GGB will be tripped as well.

The reply MCB is open (isolated application)

The GGB will be closed on the dead load busbar according to the already explained run-up synchronization with GGB control mode B.
With removing the start command the generator will be unloaded and with opening the last GCB the GGB will be tripped as well.

Appendix A.
Logic Charter Run-up Synchronization

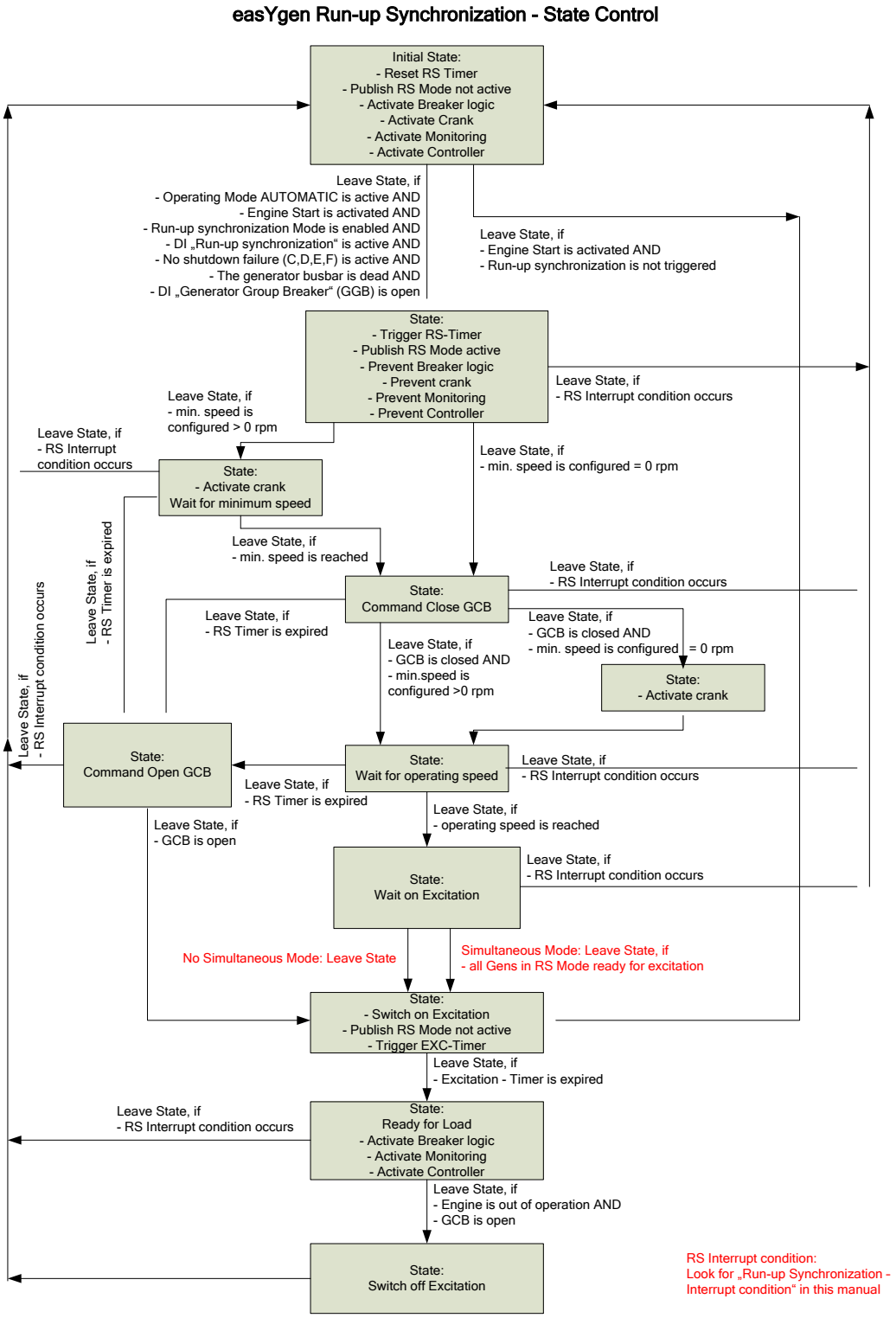

Figure 4-3: The state machine for the run-up synchronization procedure

Appendix B.
Logic Charter GCB Control

easYgen GGB Breaker Handling - State Control
Mode A

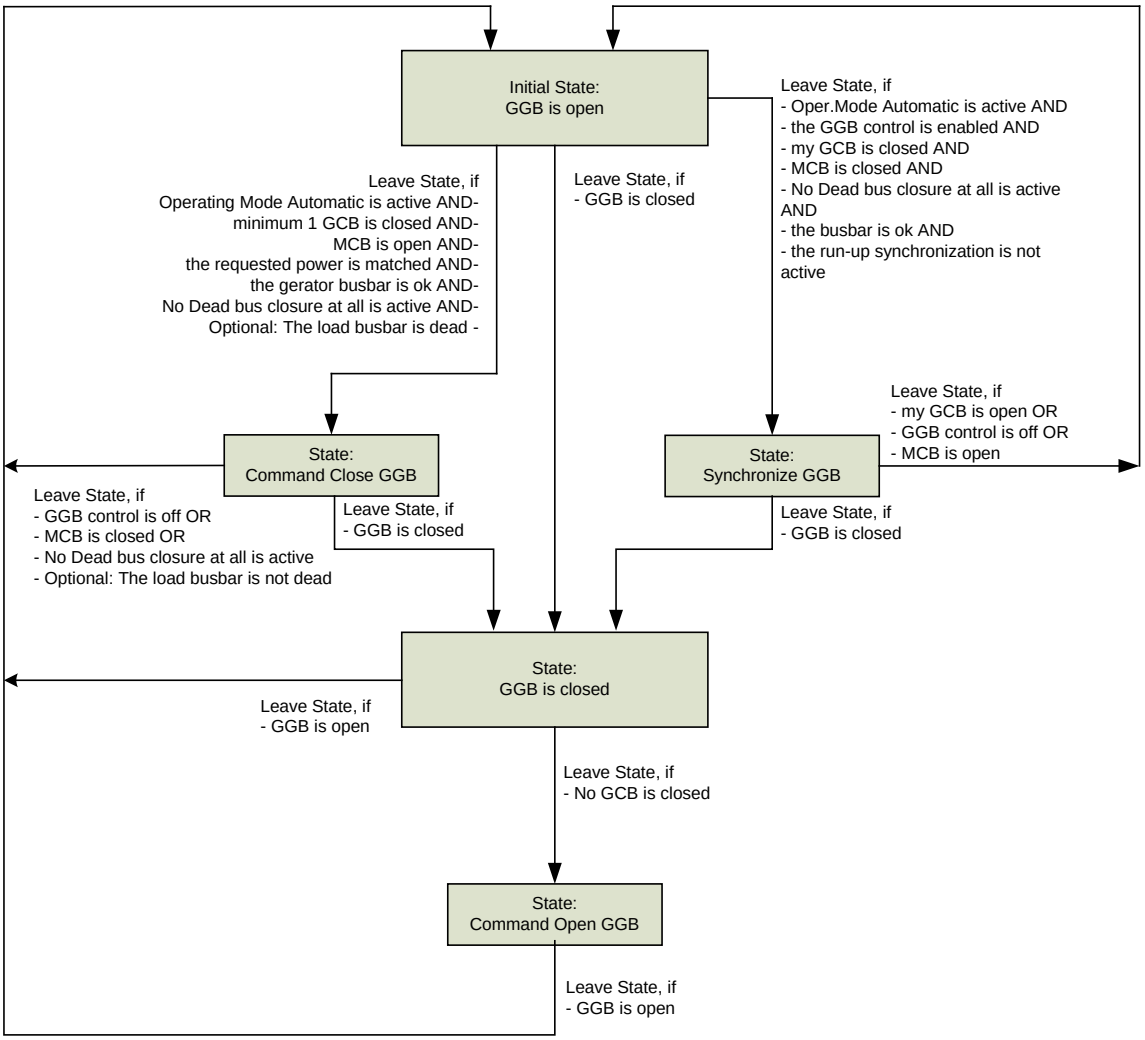

Figure 4-4: The state machine for the GGB control mode A

The GGB breaker handling in Mode A can be used without run-up synchronization. In some applications there is a requirement it could be required to have a normal start procedure and then, when enough generator rated power on busbar is reached the GGB shall be closed.

easYgen GGB Breaker Handling - State Control
Mode B

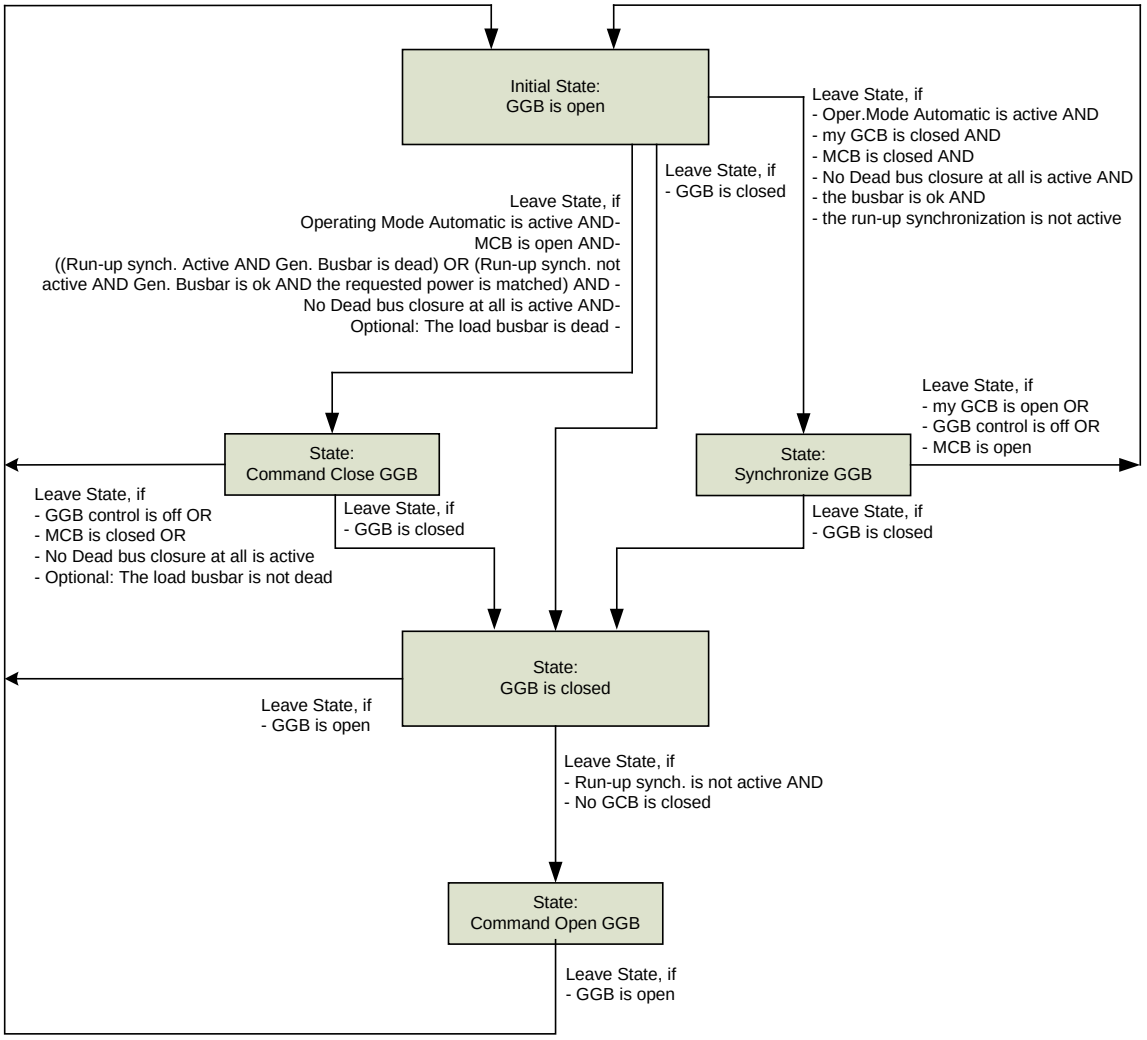

Figure 4-5: The state machine for the GGB control mode B

The GGB breaker handling in Mode B can only be used in conjunction with the run-up synchronization function in the easYgen.

Appendix C.
Wiring Diagram easYgen-3200 Package P1

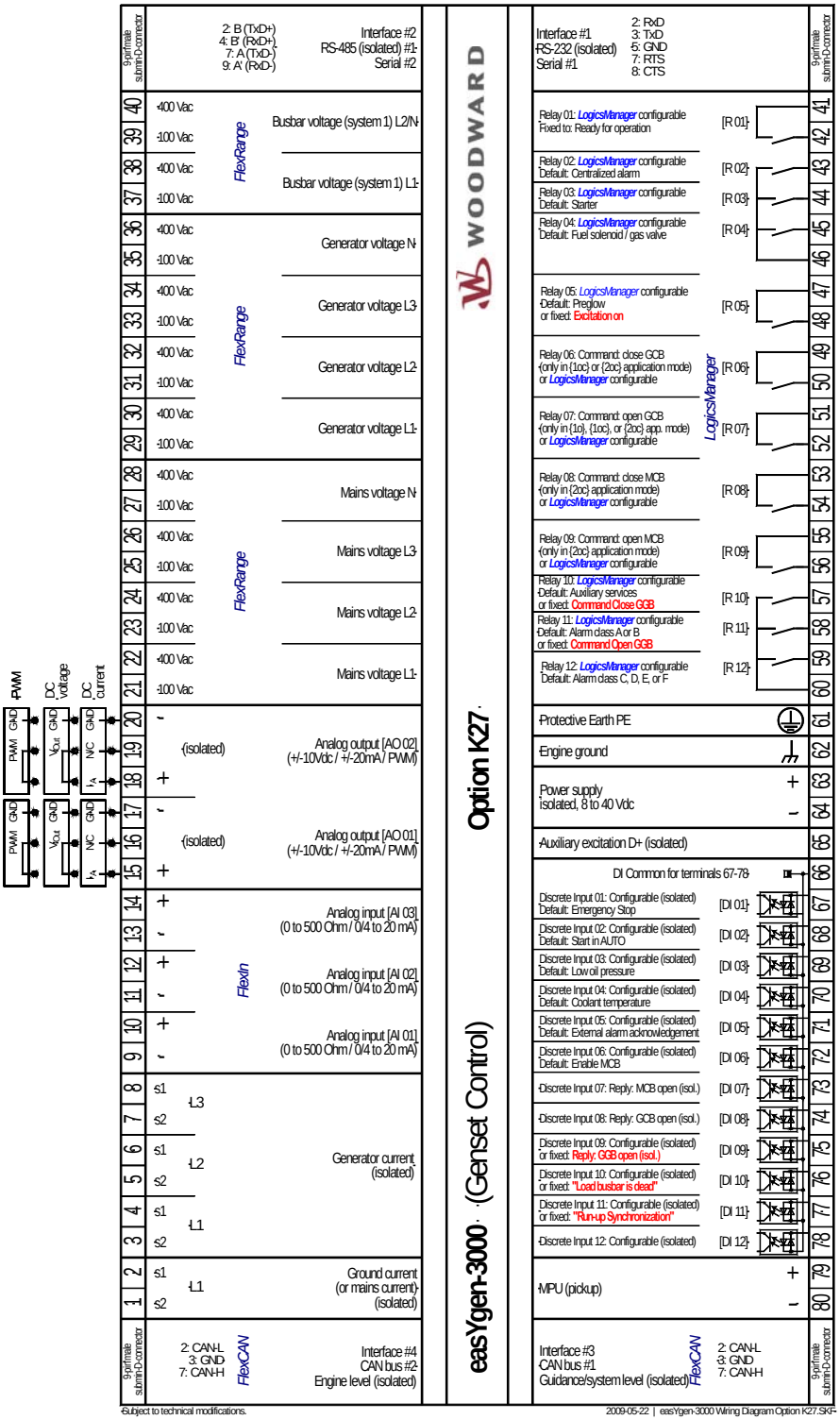

Figure 4-6: Wiring diagram

Appendix D.
Checklist Commissioning the Run-up Synchronization

1. Choose the right Application Mode according to your application. Note that the feedback digital input of the MCB is always used and must be set accordingly. For an isolated only application the feedback of the MCB must be always set(1=MCB is open) and the "Enable MCB LogicsManager [ID12] must be set false.
2. For the case of the application mode set to GCB/MCB the desired transition mode needs to be set.
3. Verfiy all breaker feedbacks are working correctly.
4. For the case of a GCB/MCB application mode it is recommended to use the optional voltage relay digital input. Verify the operation of this voltage relay input. (Dead load busbar shall energize the input.)
5. Be sure that your Emergency-Stop Button works
6. Before trying any run-up synchronization function, check each unit with a normal start by de-energizing the digital input "Run-up synchronization"
7. Do a single start (without run-up synchronization) for each engine to check:
    a. Starter
    b. Solenoid valve
    c. MPU input (speed)
    d. Generator voltage measurement
    e. Optional voltage relay input
    f. Busbar voltage measurement
    g. Mains voltage measurement
    h. Generator Breaker control
    i. Generator Group Breaker control
    j. Mains Breaker control.
8. Check the synchronization of GCB, GGB and MCB at each unit individually.
9. Check the frequency, voltage, active power and power factor control
10. Check the Load share function with all units
11. Check the CAN communication between the easYgens. Verify that each unit has its one Device identifier and its own node ID. (Usually ID 1, 2, 3,… and Node identifier 1, 2, 3,….) The sequencing window gives you an overview.
12. Before you begin with the run-up synchronization be sure, that the physical connection to mains is really open. Later on, if the easYgen shall open the MCB check this also
13. Before you do the first attempt with the run-up synchronization read this manual and especially the chapter describing your application.
14. Run-up Sync: Determine, if you would like a GCB closed before issue the crank command [ID3437 is set to 0] or after the engine crank shaft is definitely turning. [ID3437 > 0]
15. Run-up Sync: Determine, if you would like simultaneous excitation [ID3442 = On] or not. Simultaneous excitation sequence can take a little bit longer but can avoid reverse power on the engines, if they happen to start at different rates.
16. Run-up Sync: Determine the Time of Participation [ID3438], that decides, when a unit is not starting correctly and should stop the run-up sync function and continue with a normal start.

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