



MASTER 2.0



COMPLETE POWER PLANT CONTROLLER WITH MAINS PARALLELING

Part Number:
A54 Z0 9 0020

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NOTE

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

Motors, turbines and any other type of generator must be equipped with protections (overspeed, high temperature, low pressure...) depending on the power plant.

Any changes of the normal use of the equipment can cause human and material damage.

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**INFORMATION**

You can download the most up-to-date version of this documentation and different other documentations relating to CRE technology products on our Web site <http://www.cretechnology.com>.

Technical documentation history

Date	Version	Comments
November 2008	A	Derived from MASTER 2.0 documentation. Starting point.
February 2009	B	Added menu references. Global revision by all the team
April 2009	C	Update and revision.
February 2010	D	Ethernet connexion update. Wiring diagram update. SD Card modification. Breaker modification.
Mars 2016	E	 Complete rewrite of the documentation. Only MASTER 2.0 specific information is described in this document. See also GENSYS 2.0 range documentation for global information on the product.

You can download the most up-to-date version of this documentation and different other documentations relating to CRE products on our Web site: <http://www.cretechnology.com>.

Documentations available on CRE technology Web site:

- A53 Z0 9 0020 x-EN is the GENSYS 2.0 technical documentation. This documentation is generally used for product integration.
- A53 Z0 9 0031 x-EN is the translation help tool to download a CUSTOM language file.
- A53 Z0 9 0020 x-EN is the Complete variable list with labels, units and limits in English, in PDF format. This documentation is generally used as reference during the integration phase.
- A53 Z0 9 0030 x- is the Complete variable list with labels, units and limits in all languages, in EXCEL WORKBOOK format. This documentation is generally used as reference during the installation phase. It is generally called "EXCEL FILE".

NOTE



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1 OVERVIEW



NOTE

*This documentation is a specific documentation on MASTER 2.0. It means that **only specific difference between GENSYS 2.0 and MASTER 2.0 are described here**. For a complete description of the product such as mechanical dimension, HMI, Ethernet configuration, Modbus, PLC, CANopen, broadcast data on CAN bus inter-unit ... please refer to GENSYS 2.0 global range technical documentation.*

MASTER 2.0 is a power plant controller for generating sets paralleled with one or several mains. It can manage from 1 to 31 generating sets with a maximum power of 31MW.

This product includes all necessary functions:

- Power plant management with several mains
- Three phase mains failure
- Electrical protection for power plants and mains
- Manual and automatic paralleling with mains (frequency, phase, voltage)
- Change over mode
- kW power management with several modes:
 - No break change over with load transfer
 - Permanent paralleling in base load
 - Permanent paralleling in peak shaving
- Power factor control when paralleling with mains.

To summarize, MASTER 2.0 is identical in terms of functions to a GENSYS 2.0 that would be configured as a single generating set paralleled with the Mains.

2 DESCRIPTION

2.1 FRONT PANEL



FIGURE 1 - FRONT PANEL

2.1.1 CONTROL PANEL LED

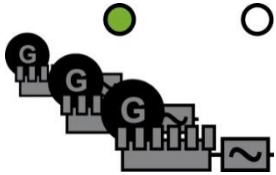
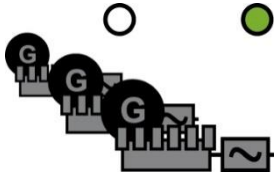



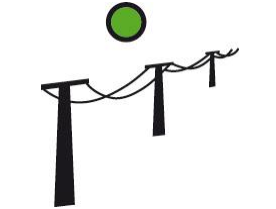
LED		Function
Plant		Green LED lit when plant is running.
Bus		Green LED lit when plant voltage is present.
Bus bar breaker		Green LED lit when generator breaker is closed.
Utility		Green LED lit when utility is power on.
Mains breaker		Green LED lit when mains breaker is closed.
Mains voltage		Green LED lit when voltage is present on Mains voltage inputs.

TABLE 1 - CONTROL PANEL LED



2.2 REAR PANEL - CONNECTORS

2.2.1 OVERVIEW

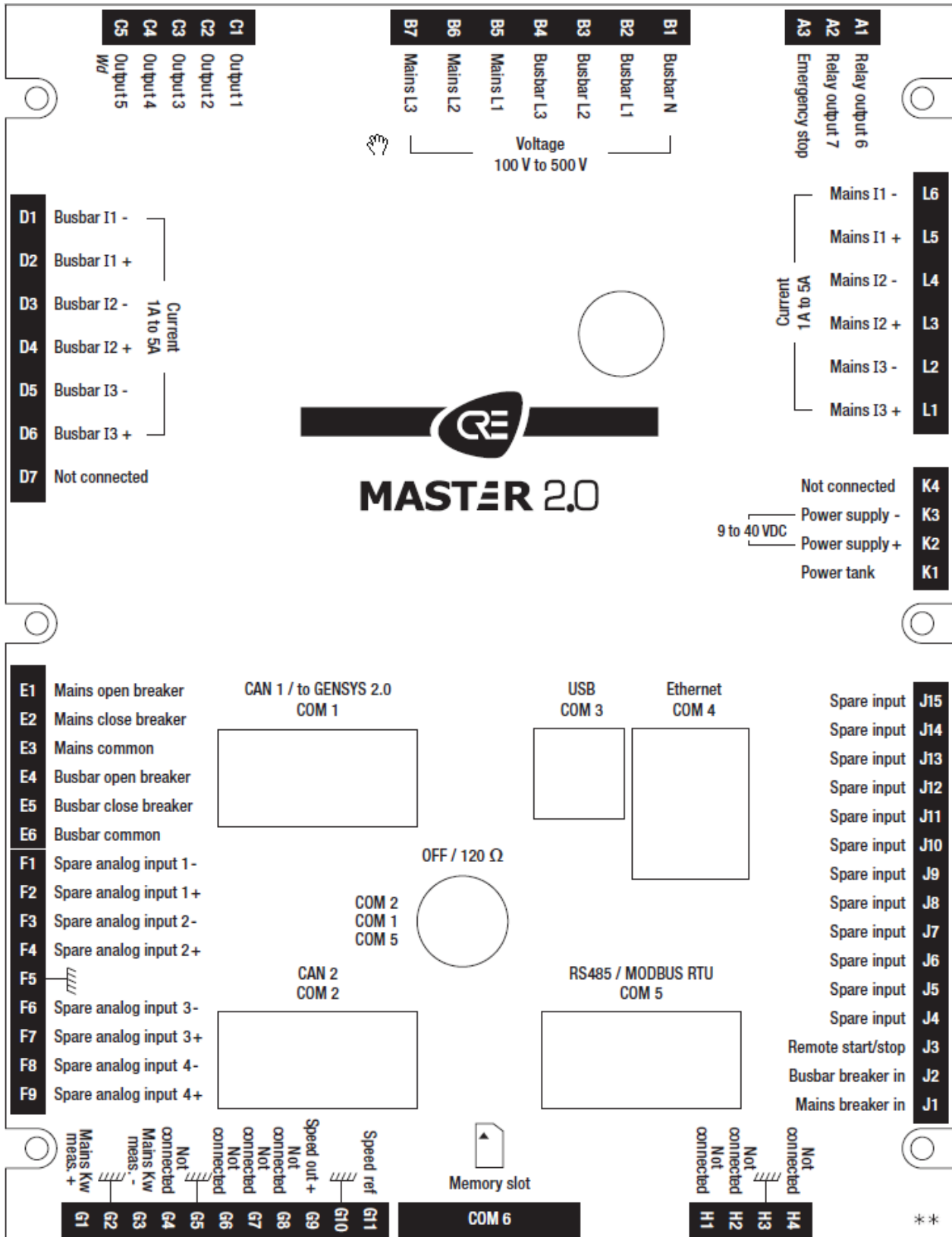


FIGURE 2 - REAR PANEL



2.2.2 INPUTS/OUTPUTS

Terminal	Description	Terminal capacity (mm ² / AWG)	Comment
A1	Relay Output 6	2.5 / 12	Supplied via emergency stop input at battery positive voltage. Can be used as configurable relay output, 5A max.
A2	Relay Output 7	2.5 / 12	
A3	Emergency stop	2.5 / 12	To battery positive, normally closed; direct supply to output relay 6 and 7.
B1	Bus bar N	2.5 / 12	Not necessarily connected.
B2	Bus bar L1	2.5 / 12	Power plant true RMS voltage measurement. 100 to 480 V _{AC} line to line. Frequency: 50 or 60Hz nominal, measurement from 35 to 75Hz. These lines must be protected externally with 100mA/600V _{AC} fuses. 1VA (Phase/Neutral).
B3	Bus bar L2	2.5 / 12	
B4	Bus bar L3	2.5 / 12	
B5	Mains L1	2.5 / 12	Mains true RMS voltage measurement. 100 to 480V _{AC} line to line. Frequency: 50 or 60Hz nominal, measurement from 35 to 75Hz. These lines must be protected externally with 100mA/600V _{AC} fuses. 1VA (Phase/Neutral).
B6	Mains L2	2.5 / 12	
B7	Mains L3	2.5 / 12	
C1 to C5	Output 1 to 5	2.5 / 12	<p>Transistor output powered by the supply voltage (<350mA per output). Over current protected. Reactive load.</p> <p>Each output can be configured with a predefined function or programmed with custom equations.</p> <p>C5 can also be used as a watchdog output (by default).</p>
D1	Bus bar I1-	2.5 / 12	<p>Bus bar true RMS current measurement 0 to 5A. Maximum rating: 15A during 10s.</p> <p>1VA consumption.</p> <p>External current transformers are normally used.</p> <p>Maximum ratio is 3250 (meaning 3250:1 or 16250:5).</p>
D2	Bus bar I1+	2.5 / 12	
D3	Bus bar I2-	2.5 / 12	
D4	Bus bar I2+	2.5 / 12	
D5	Bus bar I3-	2.5 / 12	
D6	Bus bar I3+	2.5 / 12	
D7	Not connected	N/A	
E1	Mains open breaker	2.5 / 12	Two configurable relays with one terminal in



Terminal	Description	Terminal capacity (mm ² / AWG)	Comment
E2	Mains close breaker	2.5 / 12	common. Factory setting uses one relay for closing and one for opening the MAINS breaker.
E3	Mains common	2.5 / 12	Isolated contact. 240V _{AC} /5A.
E4	Bus bar open breaker	2.5 / 12	Two configurable relays with one terminal in common.
E5	Bus bar close breaker	2.5 / 12	Factory setting uses one relay for closing and one for opening the busbar set's breaker.
E6	Bus bar common	2.5 / 12	Isolated contact. 240V _{AC} /5A.
F1	Spare analog input 1-	2.5 / 12 (shielded)	0 to 10kΩ resistive sensors with programmable gain.
F2	Spare analog input 1+	2.5 / 12 (shielded)	
F3	Spare analog input 2-	2.5 / 12 (shielded)	0 to 10kΩ resistive sensors with programmable gain.
F4	Spare analog input 2+	2.5 / 12 (shielded)	
F5	Shield	2.5 / 12	Must be used to protect shielded signals.
F6	Not connected	2.5 / 12 (shielded)	Not used
F7	Not connected	2.5 / 12 (shielded)	
F8	Not connected	2.5 / 12 (shielded)	
F9	Not connected +	2.5 / 12 (shielded)	
G1	±20mA (Input +)	2.5 / 12 (shielded)	±20mA (50Ω input). Can be used as: <ul style="list-style-type: none"> • mains power input measurement • power plant input measurement • spare 0...20mA input (see chapter 6.2.1)
G2	Shield	2.5 / 12	
G3	±20mA (Input -)	2.5 / 12 (shielded)	

Terminal	Description	Terminal capacity (mm ² / AWG)	Comment
G4	Not connected	2.5 / 12 (shielded)	Not used
G5	Shield	2.5 / 12	
G6	Not connected	2.5 / 12 (shielded)	
G7	Not connected	2.5 / 12	Not used
G8	Not connected	2.5 / 12	
G9	Speed out +	2.5 / 12	Analogue output to control the power plant (frequency/phase synchronization and active power)
G10	Shield	2.5 / 12	
G11	Speed ref	2.5 / 12	
H1	Not connected	2.5 / 12	Not used
H2	Not connected	2.5 / 12	
H3	Shield	2.5 / 12	
H4	Not connected	2.5 / 12	
J1	Mains breaker in	2.5 / 12	Digital input with 10kΩ pull-up dedicated to Mains breaker feedback. Accepts NO or NC contact to 0V. Not isolated.
J2	Bus bar breaker in	2.5 / 12	Digital input with 10kΩ pull-up dedicated to bus bar breaker feedback. Accepts NO or NC contact to 0V. Not isolated.
J3	Remote start/stop	2.5 / 12	Digital input with 10kΩ pull-up dedicated to remote start/stop request in Auto mode. Accepts NO or NC contact to 0V. Not isolated.
J4 to J15	Spare input 1 to 10	2.5 / 12	Digital input with 10kΩ pull-up. 12 inputs can be configured with a specific function or programmed with PLC equations. Accepts NO or NC contact to 0V. Not isolated.

Terminal	Description	Terminal capacity (mm ² / AWG)	Comment
K1	Power Tank	2.5 / 12	Only used for 12V power supply backup during crank time. An external capacitor can be connected between terminal K1 (+) and K3 (-) for better tolerance to power drops. A 47.000µF capacitor can help accept a 200ms power drop depending on inputs/outputs states.
K2	Power supply +	2.5 / 12	9 to 40V, 10W consumption. Protected against polarity inversion.
K3	Power supply -	2.5 / 12	"Power supply -" must be wired from the speed governor via 4 mm ² wires. See "state of the art" rules wiring diagram. External 5A / 40V _{DC} fuse recommended.
K4	Not connected	2.5 / 12	Not used
L1	Mains I3+	2.5 / 12	Mains true RMS current measurement. 1 to 5A. Maximum rating: 15A during 10s. 1VA consumption. External current transformer is normally used. Maximum ratio is 3250 (meaning 3250:1 or 16250:5).
L2	Mains I3-	2.5 / 12	
L3	Mains I2+	2.5 / 12	
L4	Mains I2-	2.5 / 12	
L5 ⁽¹⁾	Mains I1+	2.5 / 12	
L6 ⁽¹⁾	Mains I1-	2.5 / 12	
COM1 ⁽²⁾	CAN1 - Inter-unit	Male DB9 (shielded)	Isolated CAN bus (125kb/s factory setting). Proprietary protocol to communicate with other GENSYS 2.0/MASTER 2.0 units.
COM2 ⁽²⁾	CAN2 - CANopen	Male DB9 (shielded)	Isolated CAN bus (125kb/s factory setting) Used to communicate with Remote I/O

Terminal	Description	Terminal capacity (mm ² / AWG)	Comment
COM3	USB	USB Type B High Quality	<p>GENSYS 2.0 with firmware v2.00 (or later) : This port is replaced by Ethernet communication.</p> <p><i>GENSYS 2.0 with firmware v1.xx :</i> Isolated type B standard USB connector. Use a standard USB A to B cable to connect with PC. Used for configuration, parameters, file downloading and uploading. Uses TCP/IP protocol to communicate with modem emulation. Not to be used while engine is running.</p>
COM4	Ethernet	RJ45 CAT5	<p>Standard RJ45 ETHERNET connector. Use a 100Ω cable. Isolated. Uses TCP/IP protocol to communicate with external world.</p>
COM5	RS485 MODBUS RTU	Male DB9 (shielded)	Modbus RTU slave device. 2 wires. Isolated.
COM6	Memory card	SD	Memory card used for extensions.

TABLE 2 - INPUTS/OUTPUTS DESCRIPTION

Notes:

1. Can be used as ground fault in case of kW measure by analogue input
2. Communication ports COM1 and COM2 may be used in different combinations with protocols CANopen, and proprietary inter-GENSYS.



3 OPERATING MODE

There are 4 main operating modes to allow you to control your generator. The first 3 are standard modes. These operating modes are:

- Automatic mode.
- Test mode.
- Assisted manual mode (also called semi-automatic mode).
- 100% manual mode. This mode must be user enabled by setting parameter [E1621] to 0.

The MASTER 2.0 works in the same way as would a GENSYS 2.0 configured to manage a generating set paralleled with the Mains. However some differences of behaviour exist in assisted manual mode.

In assisted manual mode, when pressing twice on STOP button, the power plant will not stop immediately.

4 START SEQUENCE

4.1 OVERVIEW

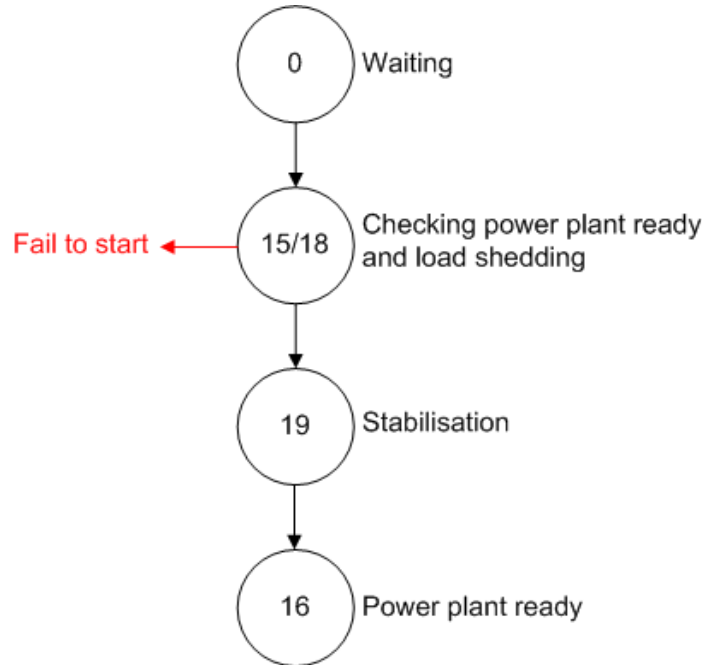


FIGURE 3 - START SEQUENCE

To be considered as operational before triggering a fail to start fault, the power plant must meet **ALL** the following conditions:

- Minimum number of generators ready according to parameter E4000
- Minimum voltage on bus bar according to parameter E1028 – Undervoltage protection
- Minimum power available according to parameters E4001/E4002/E4003/E4004/E4005. Minimum power available is the sum of E4001 to E4005 (see below for more details)

The power plant can be forced to be operational using variable E2515 (external power plant ready signal). This variable can be set by digital input or PLC equation.

These parameters can be configured in menu “Configuration/Busbar threshold control”.

Variable number	Default value	Description
E4000	0	Minimum number of generators required to considered the power plant ready
E4001	0	Minimum power available in kW – Threshold n°1
E4002	0	Minimum power available in kW – Threshold n°2
E4003	0	Minimum power available in kW – Threshold n°3
E4004	0	Minimum power available in kW – Threshold n°4
E4005	0	Minimum power available in kW – Threshold n°5

TABLE 3 - START SEQUENCE PARAMETERS



Example n°1:

On a power plant with one MASTER 2.0 and 3 GENSYS 2.0 of 300kW with a minimum number of required generators set to 2 (E4000 = 2), power plant will be considered as ready when 2 GENSYS 2.0 will be working in load sharing mode.

Example n°2:

On a power plant with one MASTER 2.0 and 3 GENSYS 2.0 of 300kW with two different thresholds set to respectively 300kW and 400kW (E4001=300 and E4002=400), power plant will be considered as ready when 3 GENSYS 2.0 will be in load sharing (E4001 and E4002 are totalling 700 kW, which requires 3 engines of 300kW each).

Note: The fail to start timer [E2526] must be long enough to take care of the different timing of all GENSYS 2.0 start (preglow, prelubrication, stabilisation, warm-up, synchronization)

When considered as operational, MASTER 2.0 units stay in voltage/speed stabilization mode according to the stabilization time [E1140].

**WARNING**

If the stabilization timer is longer than the automatic unload timer set in GENSYS 2.0, as no load is connected on power plant, only one GENSYS 2.0 will be kept on busbar.

4.2 LOAD SHEDDING

If the start conditions mentioned previously are not met after the fail to start timer, MASTER 2.0 may trigger load shedding signals according to the configured thresholds. If minimum power threshold n°1 [E4001] is set to 0, the load shedding will be not operational.

Up to 5 load shedding signals can be configured. For each load, a load shedding close breaker output and a load shedding breaker feedback input must be set.

A delay set by the parameter [E4048] is added between each load shedding output signal. As soon as the load is under the threshold, the power plant is considered as operational.

Threshold	Close breaker order	Breaker input feedback	Alarm ⁽¹⁾
E4001	E5000	E5005	E5087
E4002	E5001	E5006	E5088
E4003	E5002	E5007	E5089
E4004	E5003	E5008	E5090
E4005	E5004	E5009	E5091

TABLE 4 - LOAD SHEDDING PARAMETERS

(1) If the control of load shedding information is set as alarm (E4224=3), an alarm appears when a load is shed i.e. when the associated breaker feedback is not activated while its load shedding signal has been issued.

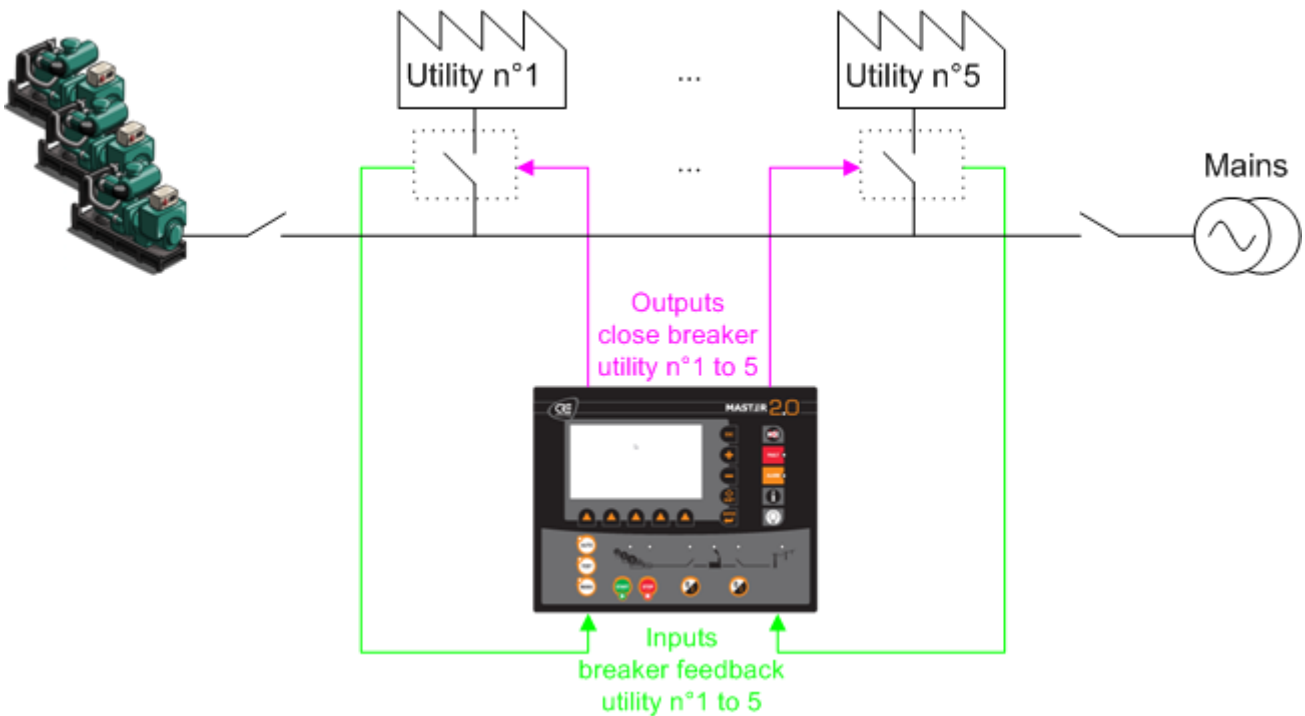


FIGURE 4 - LOAD SHEDDING

Once the power plant is operational, load shedding is still working. It means that:

- If a generator synchronizes to the power plant, shed loads may be un-shed.
- If a generator stops for any reason, some loads may be shed.



5 TYPICAL APPLICATIONS

5.1 POWER PLANT WITH ONE MAINS

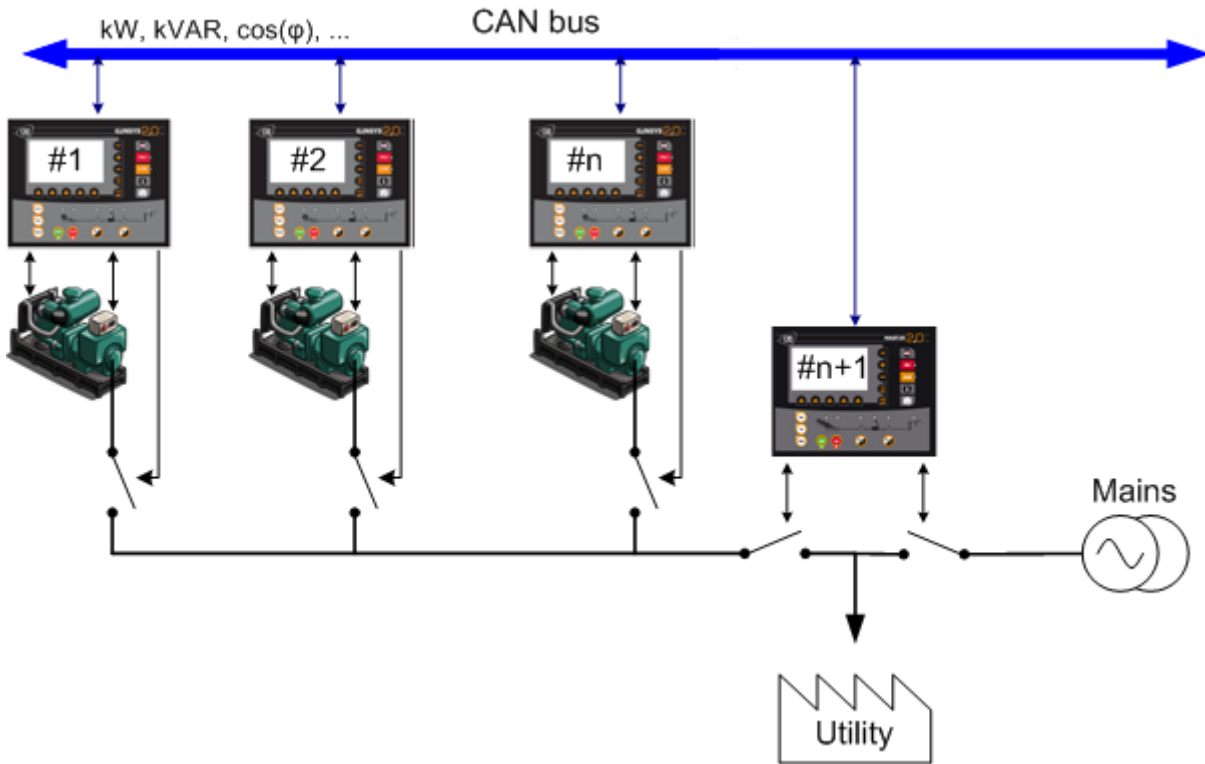


FIGURE 5 - POWER PLANT PARALLELING WITH MAINS

With the above example and depending on your settings, MASTER 2.0 will:

- Start/stop generators on remote start, in manual mode by pressing START button, or in case of Mains failure.
- Open/close mains breaker and power plant breaker.
- Synchronize to the Mains, load and unload power plant, kW and $\cos(\varphi)$ management of the power plant when paralleled with the Mains.

Note:

In change over mode, MASTER 2.0 will never control speed and voltage except in manual mode. In case of 100% manual, MASTER 2.0 will work in droop mode. According to your application, you could set speed droop and voltage droop to 0 in order to avoid frequency and voltage drop.

5.2 POWER PLANT PARALLELED WITH SEVERAL MAINS

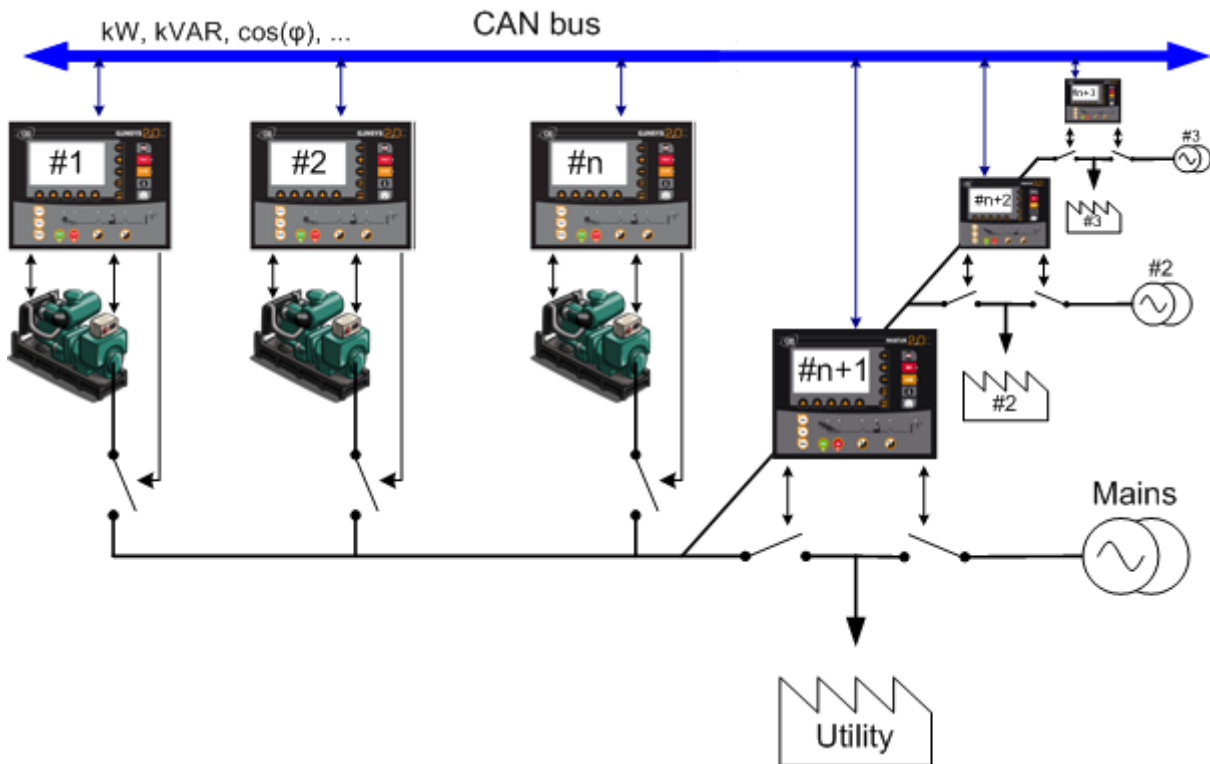


FIGURE 6 - POWER PLANT PARALLELING WITH SEVERAL MAINS

The multi-Mains function is an extension of the mode described above. Each Mains system is managed independently by a dedicated MASTER 2.0 unit. Depending on events and configuration, one MASTER 2.0 at a time will take control of the power plant.

CAN bus communication between MASTER 2.0 units will select which unit should take control of the power plant. Control from a MASTER 2.0 unit is required in case of:

- Power plant synchronization to the Mains.
- Load/unload ramp.
- Power plant paralleled with the Mains.

Selection rules are as follows:

- A MASTER 2.0 configured in AMF (E1148=0 or 3) mode does not participate in the election and triggers a standard sequence without worrying about the other MASTER 2.0 units since they control neither the frequency nor the voltage of the generating sets.
- When a sequence is initiated, it must be completed before a new election of a MASTER 2.0 is started.
- A MASTER 2.0 working in no break change over mode (E1148=1) has priority over a MASTER 2.0 configured in permanent (E1148=2) mode.
- In case of same mode priority, the highest number assigned to MASTER 2.0 (E1179) has priority over the others.

In manual mode (100% manual or assisted manual mode with power plant breaker open), MASTER 2.0 could control the voltage / frequency without election. However as soon as another MASTER 2.0 has been elected it could not control anymore the voltage/frequency in manual mode.

6 INSTALLING AND COMMISSIONING A MASTER 2.0 APPLICATION

6.1 WIRING DIAGRAM

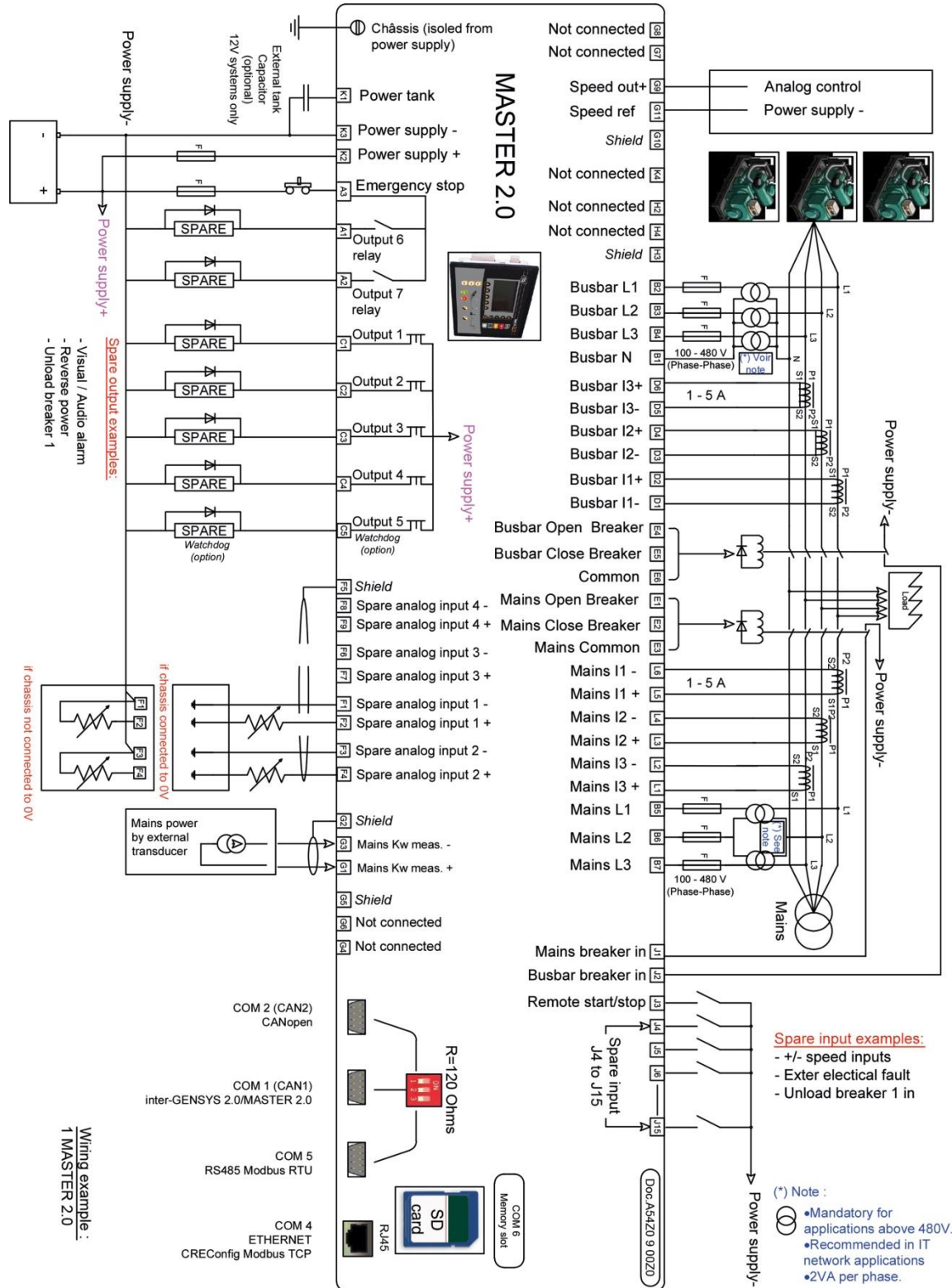


FIGURE 7 - WIRING DIAGRAM



6.2 COMMISSIONING

6.2.1 MAJOR PARAMETERS

The table below described the MASTER 2.0 major parameters.

Variable number	Description
1179	Module ID
1147	Count of GENSYS 2.0
4006	Count of MASTER 2.0
1464	Mains measure type 0 - Measure kW by analogue 4-20mA input 1 - Internal RMS measure
4037	Power plant measure type: 0 – Internal RMS measure 1 – Measure kW by analogue 4-20mA input 2 – Measure kW, kVAR, cosφ by CAN bus
4134	Control on power plant unavailable

TABLE 5 - MAJOR PARAMETERS

1/ Measure type by analog 4-20mA input

It's possible to select only one measure on this input either mains kW or power plant kW.

In case of mains kW measure is done by analogue input, mains current I1 input may be used as a ground fault current input.

If your application doesn't use analogue input as mains kW measurement input or as mains synchronization input, then it can be used as a spare 0...20mA analogue input. In this case, adjust the following parameters:

- E1464 = 1. Mains/Bus kW measurement through 1A/5A current inputs L1 to L6.
- E1461 = 1. G1-G3 input switched to 0...20mA input type.
- E1020 and E1021 to setup the calibration curve of your 0...20mA input.

Value E0035 will then indicate the value measured by the 0...20mA signal applied to G1-G3. You can now use the value of E0035 in custom equations to use it as a spare analogue input.

2/ Power plant unavailable

The power plant is considered as unavailable when at least one of the conditions described below is activated on all GENSYS 2.0.

- GENSYS 2.0 is in fault
- GENSYS 2.0 is in assisted manual mode with generator breaker open
- GENSYS 2.0 is in 100% manual mode

By default the control on power plant unavailable is set on hard shut down. You can change the action of an unavailable power plant with [E4134] parameter.

3/ Nominal powers and low/high limits

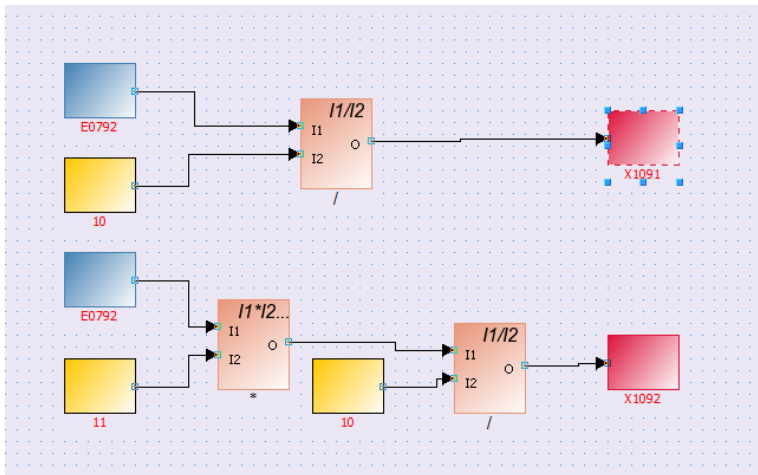
kW and kVAR nominal are computed via CAN bus by adding the nominal powers of the generators which have their generator breaker close. If the control of the speed and active power is done by analog output, kW and kVAR nominal are linked to [E1006] and [E1015] parameters.

Low and high limits are not calculated via CAN bus but are fixed by the parameters [E1091] and [E1092]. They must be set according to the low and high limits from the GENSYS 2.0.

It's possible to modify these parameters by equation in order to change it according to the generators really on bus bar.

To do so, writing by equation must be allow on [E1091] and [E1092] parameters then

- Either test the state of the each generator breaker in order to add or not the low/high limit value
- Either compute the low and high limit in percent of the sum of the nominal power of the generators on bus bar [E0792] (example below with low limit to 10% and high limit to 110%)



BLOC

@ Limit;

@ Low = 10% nominal ;

@ High = 110% nominal;

@ E0792 sum kW nominal;

@ X1091 GE low limit;

@ X1092 GE high limit;

TEST 1 NE 0 THEN

BLOC

X1091 := (E0792 / 10);

X1092 := ((E0792 * 11) / 10)

BEND

TEND

BEND

Note : This principle can be also apply on ramp up and ramp down timers

6.2.2 USEFUL VARIABLES

The table below described the useful variables to display during commissioning in particular in case of a power plant with many MASTER 2.0.

Variable number	Description
5010	Activated on a MASTER 2.0 when it requested to be elected
5011	ID of the MASTER 2.0 elected to control the power plant
5012	<u>Bit 1</u> : A start request has been received by at least one MASTER 2.0 <u>Bit 2</u> : At least one MASTER 2.0 controls the voltage/frequency
5046	On GENSYS 2.0, it's the speed or active power regulation from MASTER 2.0
5047	On GENSYS 2.0, it's the voltage or reactive power regulation from MASTER 2.0

TABLE 6 - USEFUL VARIABLES



7 I/O LINES

The specific input/output functions of the MASTER 2.0 are listed below. See GENSYS 2.0 technical documentation for additional common functions.

7.1 SPECIFIC DIGITAL INPUT FUNCTIONS.

Value	Function	Description
5000	Unload brk1 in	Order output to close generator breaker n°1 upon start-up if available nominal power < E4001
5001	Unload brk2 in	Order output to close generator breaker n°1 upon start-up if available nominal power < E4002
5002	Unload brk3 in	Order output to close generator breaker n°1 upon start-up if available nominal power < E4003
5003	Unload brk4 in	Order output to close generator breaker n°1 upon start-up if available nominal power < E4004
5004	Unload brk5 in	Order output to close generator breaker n°1 upon start-up if available nominal power < E4005

TABLE 7 - INPUT FUNCTIONS

7.2 SPECIFIC DIGITAL OUTPUT FUNCTIONS

Value	Function	Description
2950	Mains parallel	Activated when MASTER 2.0 is paralleled with the Mains (power plant and mains breaker close).
5000	Unload brker 1	Order output to close generator breaker n°1 upon start if nominal power < E4001
5001	Unload brker 2	Order output to close generator breaker n°1 upon start if nominal power < E4002
5002	Unload brker 3	Order output to close generator breaker n°1 upon start if nominal power < E4003
5003	Unload brker 4	Order output to close generator breaker n°1 upon start if nominal power < E4004
5004	Unload brker 5	Order output to close generator breaker n°1 upon start if nominal power < E4005

TABLE 8 - DIGITAL OUTPUTS FUNCTION

8 PROTECTIONS

Protections are triggered by different events (digital inputs and logic sequences). They take action to protect a process or power plant.

When enabled, they can trigger actions as listed here under.

Value	Action
0	Disable
1	Power plant electrical fault
2	Mains electrical fault
3	Alarm
4	Fault (soft shut down)
5	Security (Hard shut down)

TABLE 9 - POSSIBLE VALUE ON PROTECTION

8.1 DISABLE

Protection will have no effect.

8.2 POWER PLANT ELECTRICAL FAULT

This action triggers a “Generator electrical fault”. Protection will open the generating set’s breaker and try to re-synchronize again. Number of attempts can be configured.

8.3 MAINS ELECTRICAL FAULT

This action triggers a “Mains electrical fault”. Protection will open Mains breaker and will start power plant and take the load if the parameter [E1841] start on fault is set to 1 (“Configuration/Mains/Bus/mains electrical fault” menu).

The Mains back is validated by timer [E1085] (“Configuration/Timers/Mains” menu).

In change-over mode, the delay between the emergency open and the normal close signals is managed by timer [E1459] (“Configuration/Timers/Mains” menu).

In no break change-over mode, the load transfer time between the normal towards the emergency (and conversely) is defined by timers [E1151] load ramp and [E1152] unload ramp (“Configuration/Generator” menu).

8.4 ALARM

This action triggers an “Alarm”.

8.5 FAULT (SOFT SHUT DOWN)

This action triggers a “Soft shutdown”. Power plant breaker and generators breakers will open immediately allowing the generator to cool down off load for the duration of the cool down timer. The engine is then stopped.

8.6 SECURITY (HARD SHUTDOWN)

This action triggers a “Hard shutdown”. Power plant breaker and generators breakers will open immediately. Generators will stop after cooling down.

WARNING

It is recommended to hard-wire both the emergency stop signal and a MASTER 2.0 hard shut-down output signal to all products (GENSYS 2.0 and MASTER 2.0).

Otherwise an emergency stop or a MASTER 2.0 hard shutdown signal will not stop the generators:

- In case of CAN bus fault.
- In case of multi-MASTER 2.0, if another MASTER 2.0 requests a start of the power plant.



8.7 CAN BUS FAULT

8.7.1 DEFAULT MODE

By default in case of a CAN bus fault:

- MASTER 2.0 units will not be able to control the frequency/voltage on the power plant anymore.
- GENSYS 2.0 units that were already on production will keep on running and switch to droop mode.

As a consequence:

- if the power plant is paralleled with the Mains, the Mains will provide all power to the utility.
- if the power plant is alone on the utility, the power regulation between generators will be done in droop.



WARNING

According to the frequency and the voltage of the mains, the power plant can be in reverse kW or reverse kVAR.

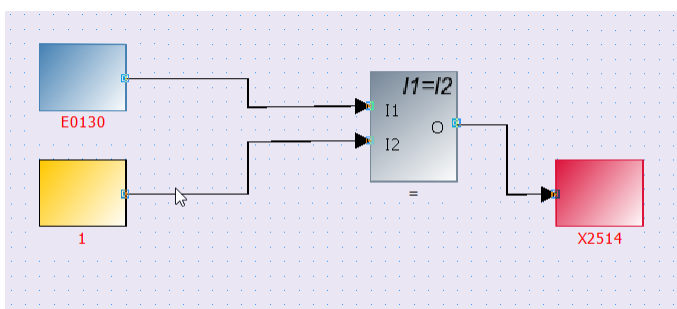
8.7.2 OTHER MODES

Different actions can be triggered on a CAN bus fault (E1259) as described in Table 9 . However, according to the application, GENSYS 2.0 must also be configured in consequence.

Examples:

If the CAN bus fault is configured as Security (Hard shut down) on MASTER 2.0, it must be the same on all GENSYS 2.0.

If the CAN bus fault is configured as Mains electrical fault on MASTER 2.0, all GENSYS 2.0 must be configured in alarm + droop mode. If the utility needs more power, additional GENSYS 2.0 should be requested to start through PLC equation (example below) or any other means (Modbus, digital input).



@ GENSYS2.0- Start on CAN bus fault;
 @ E0130 CAN bus fault;
 @ X2514 Virtual Start;

```
TEST 1 NE 0 THEN
BLOC
    X2514 := (E0130 EQ 1)
BEND
TEND
```

8.8 SPECIFIC POTENTIAL ALARMS/FAULTS LIST

Variable	Potential Alarm/Fault	Description	Alarm/Fault control
E0820	Unavailable	Indicates that the power plant is not available. GENSYS 2.0 units may be in manual mode or in fault. (See chapter 6.2.1 for more details)	E4134
E5030 to E5045 E5071 to E5086	Alarm mod. 01 to Alarm mod. 32	Indicates that group number 1 to 32 is in fault.	Alarm



9 ADDITIONAL FUNCTIONS

9.1 STATIC PARALLELING

9.1.1 OVERVIEW

Static paralleling of the MASTER 2.0 is much useful when your installation includes high voltage transformers. Starting generators which are paralleled together leads to a progressive magnetization without peaks (no transient short-circuit).

When using static paralleling on MASTER 2.0 (parameter E1177 = 1), static paralleling must also be configured on all GENSYS 2.0.

Note: As long as there is a voltage on the bus bar, the dynamic paralleling mode will be used even if static paralleling is configured. The static paralleling mode is only usable if all power generators are stopped and bus bars are dead.

9.1.2 LIMITATIONS

1. In manual mode (100% or assisted manual mode), to close immediately the power plant breaker the following sequence must be follow:
 - Start the power plant by pressing **START** button
 - Immediately after that, press the **Close power plant breaker** button

This working is useful when the user wants only to start the power plant without closing the power plant breaker.

2. Static paralleling is not usable with the start sequence check (minimum generators and minimum power available on bus). All the parameters related to the start sequence are set to 0.
3. In case of change over mode, the changeover timer is also set to 0
4. Under-voltage timer (E1065) and safety on timer (E1514) must take care of the start time of the power plant.

Example: If the power plant takes 10 seconds before sending excitation, the safety on timer must be set at least at 10s.

9.2 MASTER 2.0 WITHOUT POWER PLANT BREAKER

In order to answer to different topologies used around the world, function “MASTER 2.0 without power plant breaker” has been implemented starting from firmware v4.66.

In this configuration:

- MASTER 2.0 unit only controls a Mains breaker.
- MASTER 2.0 unit can only be used in **permanent** or **no break change over** modes.
- All other MASTER 2.0 functions are available.

Picture below describes the connection of such a power plant.

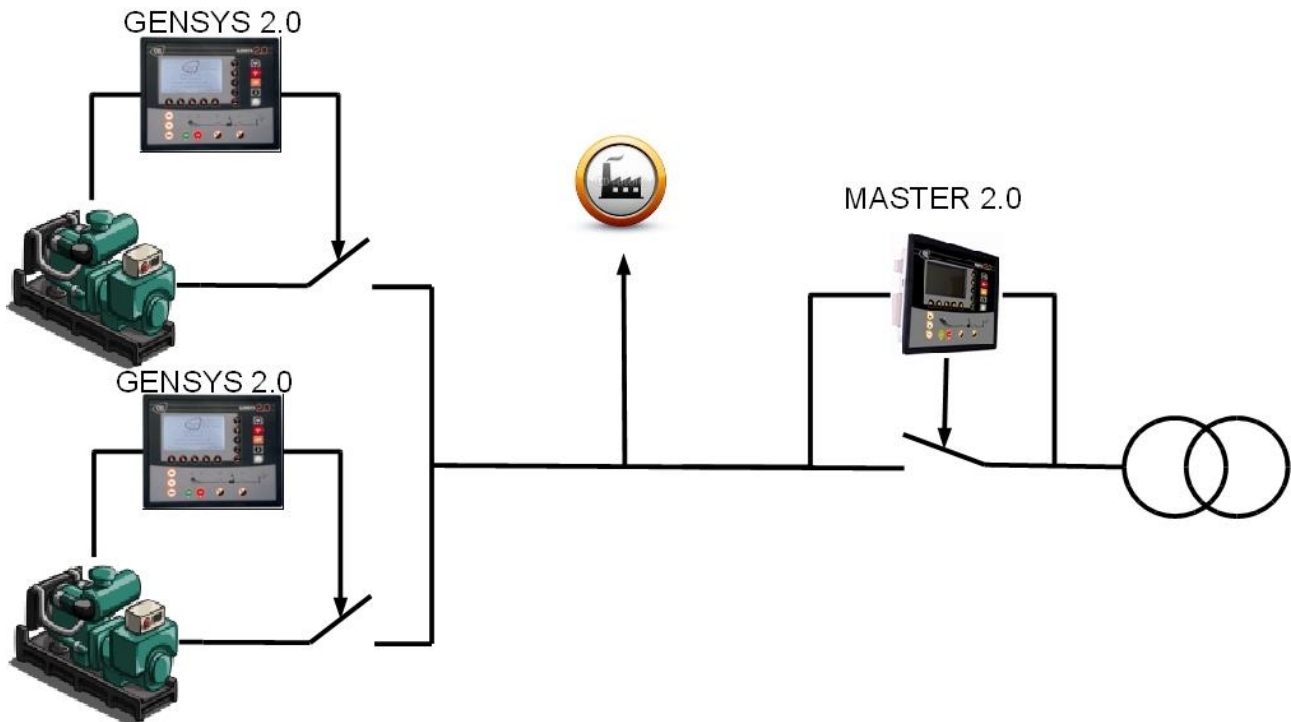


FIGURE 8 - POWER PLANT CONFIGURATION

Note: From GENSYS 2.0 point of view, nothing changes. The behaviour of GENSYS 2.0 module is identical if they are managed by a standard MASTER 2.0 or by a MASTER 2.0 setup without power plant breaker.

9.2.1 CONFIGURATION

1/ Software configuration

In order to configure the MASTER 2.0 for an application without power plant breaker, set parameter E4084 to 1. Internal configuration will be done automatically by the MASTER 2.0. This parameter is available in the "Power plant" configuration menu in level 2.

Table below lists some useful parameters.

Parameter [var.num]	Possible value	Comment
Nbr of Breaker [E4084]	2 (Default)	MASTER 2.0 is configured to control both Mains and bus breakers.
	1	MASTER 2.0 is configured to control only Mains breaker.
Mains parallel [E1148]	1	Permanent mode
	2	No break change over mode

TABLE 10- USEFUL PARAMETERS

Table below shows the restriction on some parameters as implied by this specific configuration.

Parameter [var.num]	Set value	Comment
Break Ma Fault [E1846]	1	Select the Mains breaker to open upon a "Mains electrical fault".
CT mains open [E4132]	0	Open Mains breaker immediately on Mains electrical fault.
Close gen ext. [E2336]	0	Inhibition of remote close generator button.
Open gen. ext. [E2337]	0	Inhibition of remote open generator button.
Min No. GE // [E4000]	1 or greater	This parameter has to be equal to 1 or greater in MASTER 2.0 without power plant breaker mode.
All protections, digital inputs or virtual inputs	x	"Power plant Electrical Fault" is forbidden.

TABLE 11- RESTRICTION PARAMETERS



WARNING

Protections, digital inputs and virtual inputs must not be set as "Power plant Electrical Fault". In case of wrong setting, the function is set by default to "Soft Shut Down".

2/ Specific wiring

As the MASTER 2.0 doesn't control power plant breaker:

- The power plant breaker feedback (J2) must be left unconnected.
- The power plant breaker command (E4/E5/E6) must be left unconnected.

All others connections depend on the application and MASTER 2.0 configuration.

3/ Specific Display

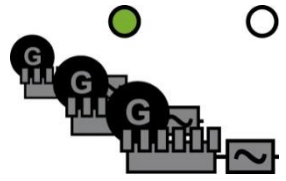
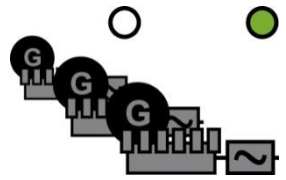



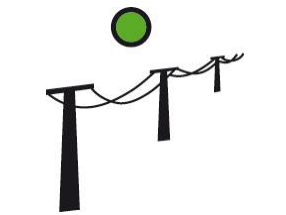
LED		Function
Plant		Green LED lit when plant is ready. Can be activated by digital input "power plant ready" or when power plant is considered as ready (E2057 equal 16).
Bus		Green LED lit when voltage is present on power plant side. It means that if mains voltage is present and mains breaker is closed, this led will be on.
Bus bar breaker		Always ON as there is no power plant breaker.
Utility		Green LED lit when utility is fed power by the Mains or by the power plant.
Mains breaker		Green LED lit when Mains breaker is closed.
Mains voltage		Green LED lit when voltage is present on Mains voltage inputs.

TABLE 12- DISPLAY- MASTER 2.0 WITHOUT POWER PLANT BREAKER

9.2.2 LIMITATIONS

- 1 When starting generators from GENSYS 2.0 (remote start, or in manual/test mode) and not from MASTER 2.0, GENSYS 2.0 will be in in load sharing mode without control from MASTER 2.0 even if mains is present and mains breaker is closed.
- 2 On a mains fault, if mains breaker doesn't opened:
 - in case of permanent mode GENSYS 2.0 will stay on bus bar
 - in case of no break change over mode GENSYS 2.0 will start and close their breaker

This working can be modified according to your application by using equations inside the MASTER 2.0 and with a specific wiring.

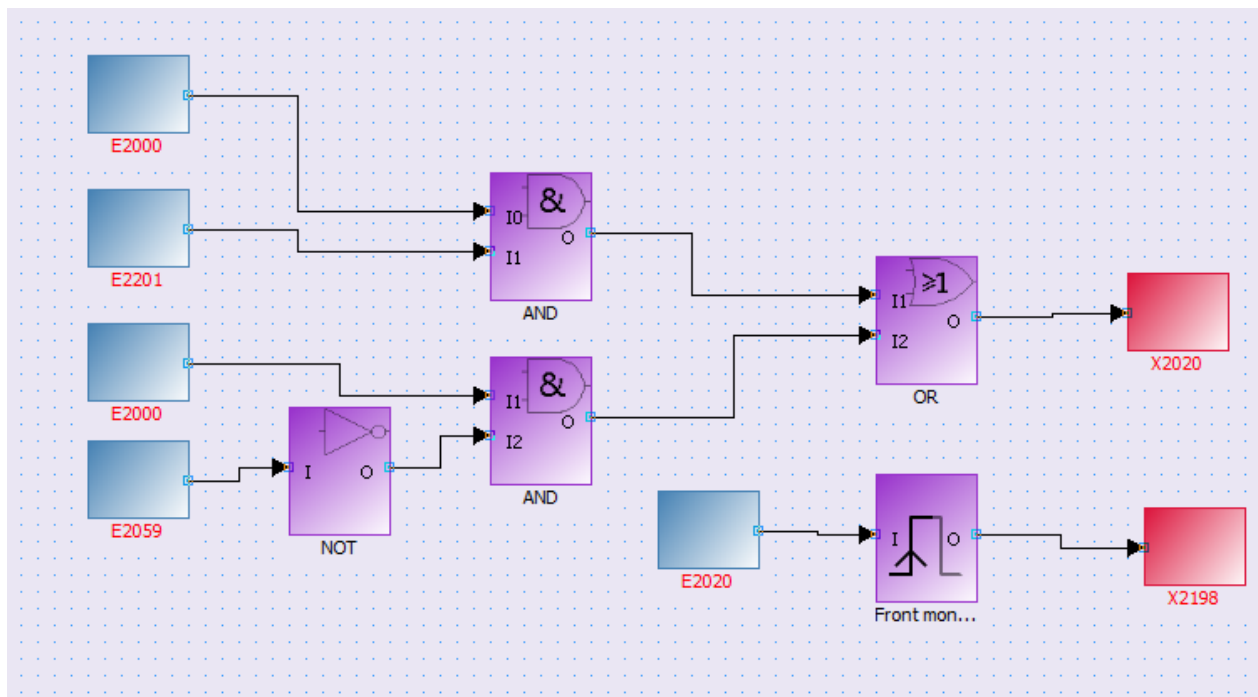
New working example:

Connect the digital output n°1 of the MASTER 2.0 set as “used by equation” on a digital input set as “Running with generator breaker open” [E2661] on all GENSYS 2.0.

Add the equations below inside the MASTER 2.0

These equations allows to:

- not close the generator breakers if
 - mains breaker is closed **and** a mains fault is present
 - ⇒ in AUTO mode on mains fault, the generators will start but could not closed their breaker
 - **OR** mains breaker is closed **and** MASTER 2.0 didn't ask to start the power plant
 - ⇒ GENSYS 2.0 could not close their breaker event in manual mode
- open the generator breakers by doing a stop request during 100ms
 - ⇒ on a mains breaker opening fault, the generators open their breaker and stay running



```
{INIT L1}
INIT 1
  BLOC
    X2440 := 0
  BEND
.
{EQUATIONS L1}
PROG 1
  BLOC
    @ Mono Breaker;
    @ E2000 Mains breaker feedback;
    @ E2201 Mains fault ;
    @ E2000 Mains breaker feedback ;
    @ E2059 Start request;
    @ E2020 Output C1;
    @ X2020 Output C1;
    @ X2198 Start inhibited;

    TEST 1 NE 0 THEN
      BLOC
        X2020 := ((E2000 AND E2201) OR (E2000 AND (!E2059)));
        X2198 := (E2440 LE 0) AND (E2020 GE 1);
        X2440 := E2020
      BEND
    TEND
  BEND
.
{END OF FILE}
```



9.3 MANAGEMENT BY ANALOG OUTPUT

9.3.1 OVERVIEW

The frequency/phase synchronization and active power management can be controlled by analog output of the MASTER 2.0. The MASTER 2.0 is compatible with GENSYS 2.0, UNIGEN units and older generation analog systems such as Woodward/Barber Colman units (ILS, Pow-R-con ...).

This configuration can be done in 2 different ways:

- With CAN bus connected (only for GENSYS 2.0)
- Without CAN bus connected

Advantage of connecting CAN bus is:

- Start/stop without external connection
- Voltage synchronization
- $\cos(\varphi)$ regulation when paralleled with the Mains
- Report of operating mode

In both cases, connection between MASTER 2.0 and GENSYS 2.0 must be done as described below.

MASTER 2.0	All GENSYS 2.0	Comment
Speed output+ (G9)	Parallel lines + (G6)	
Speed ref (G11)	Parallel lines – (G4)	Speed ref- G11 must also be connected to battery negative terminal (0V)

TABLE 13-ANALOG OUTPUT CONNECTION WITH GENSYS 2.0

9.3.2 ANALOG OUTPUT WITH CAN BUS CONNECTED (GENSYS 2.0)

The following picture describes how to connect modules with analogue output control.

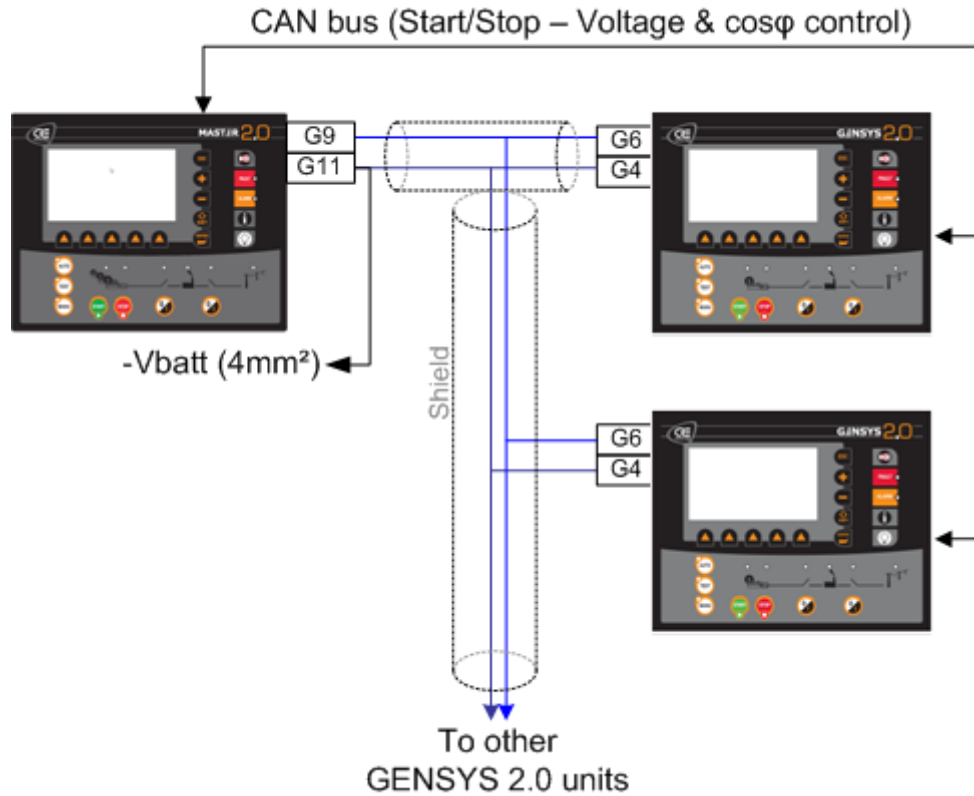


FIGURE 9 - ANALOG OUTPUT WITH CAN BUS CONNECTED

Table below describes the minimum parameters to be set on MASTER 2.0.

Parameter [var.num]	Set value	Comment
[E1158]	0 - Analog	Synchronization and power management by analog output
[E1618]	1	Configure MASTER 2.0 to synchronize with slow generators.
[E1075]	0%	Speed droop set to 0%
[E1006]		Set nominal kW and kVAR according to your power plant
[E1015]		
[E1076]	30.0	Must be adjusted to get 100% on parallel lines measure (E0156) on GENSYS 2.0 side when increasing MASTER 2.0 speed output at maximum value.
[E1077]	0.00	Must be adjusted to get 0% on parallel lines measure (E0156) on GENSYS 2.0 side

TABLE 14- MASTER 2.0 PARAMETERS -ANALOG OUTPUT WITH CAN BUS CONNECTED

Table below describes the minimum parameters to be set on all GENSYS 2.0.

Parameter [var.num]	Set value	Comment
[E1158]	0-Analog	Load sharing done by parallel lines
[E1476]	0	No kW load sharing integral and frequency centring
[E1504]	0	No kVAR load sharing integral and voltage centring

TABLE 15- GENSYS 2.0 PARAMETERS -ANALOG OUTPUT WITH CAN BUS CONNECTED



9.3.3 ANALOG OUTPUT WITHOUT CAN BUS CONNECTED (GENSYS 2.0)

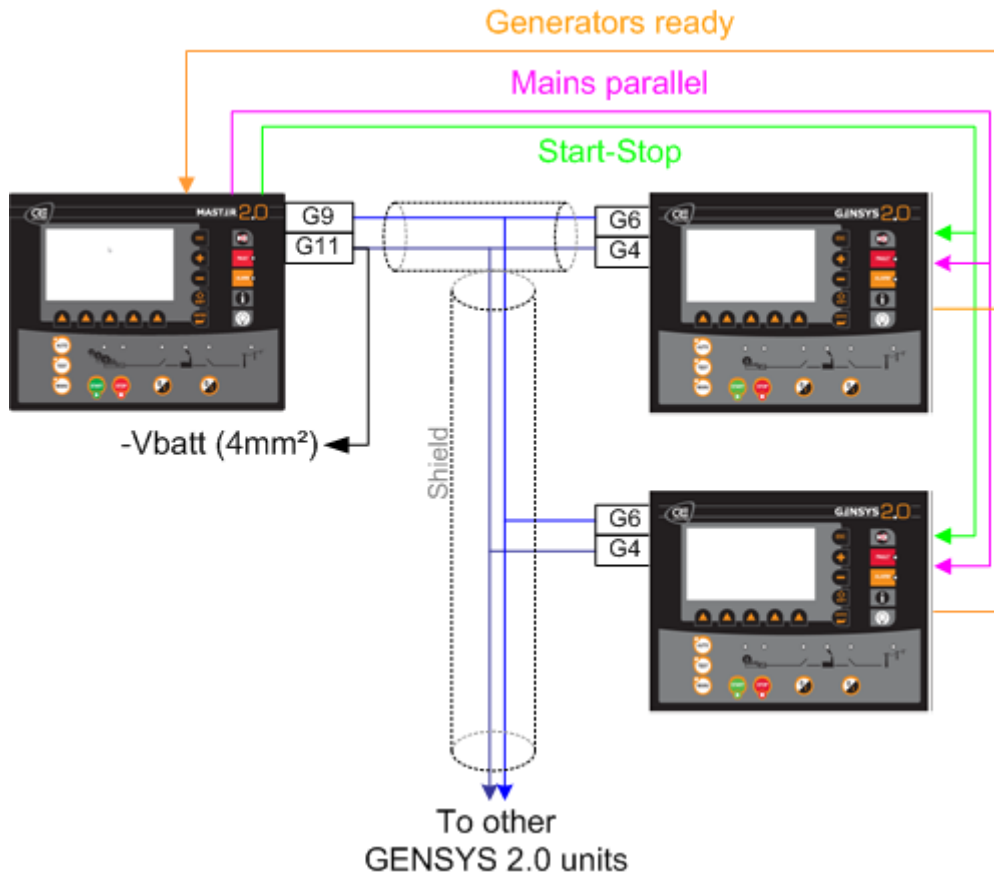


FIGURE 10 - ANALOG OUTPUT WITHOUT CAN BUS CONNECTED

With this configuration, the frequency/phase synchronization and active power management is done by the analog output.

There is no voltage synchronization. The reactive power management is done in droop on GENSYS 2.0. In case of mains paralleling, $\cos(\varphi)$ regulation will be done directly by GENSYS 2.0.

Specific connections must be done between MASTER 2.0 and GENSYS 2.0 to:

- Start/stop the power plant
- Indicate when power plant is ready.
- Indicate when the power plant is paralleled with mains

At the first start of the power plant, there will be no voltage on bus from the GENSYS 2.0 point of view. Before closing the generator breaker, arbitration will be done depending on GENSYS 2.0 number and internal timing. As a consequence, the power plant may take a longer time to be ready and fail to start timer should be increased accordingly.



Table below describes the minimum parameters to be set on MASTER 2.0.

Parameter [var.num]	Set value	Comment
[E1158]	0 - Analog	Synchronization and power management by analogue output
[E1618]	1	Configure MASTER 2.0 to synchronize with slow generators.
[E1075]	0%	Speed droop set to 0%
[E1006]		Set nominal kW and kVAR according to your power plant
[E1015]		
[E1076]	30.0	Must be adjusted to get 100% on parallel lines measure (E0156) on GENSYS 2.0 side when increasing MASTER 2.0 speed output at maximum value.
[E1077]	0.00	Must be adjusted to get 0% on parallel lines measure (E0156) on GENSYS 2.0 side
[E4136]	0 - Unused	No communication port used for CRE protocol
[E1259]	0 - Unused	CAN bus fault not configured
[E1633]	60.0s	Fail to start timer. May be increased in order to take GENSYS 2.0 arbitration time into account.
[E4037]	0-CT or 1-mA	Power plant power measure can be done by CT or by +/- 20mA signal, but not through CAN bus.

TABLE 16- MASTER 2.0 PARAMETERS -ANALOG OUTPUT WITHOUT CAN BUS CONNECTED

Here are some specific Input/Output connections of MASTER 2.0:

- Set a digital output as “Remote start” – E2019 (Equivalent to a fuel output for a GENSYS 2.0).
- Set a digital output as “Mains parallel” – E2950. This output will be activated when power plant is paralleled with the Mains. It will be used on GENSYS 2.0 side to switch to $\cos(\varphi)$ regulation mode when the associated input will be activated.
- Set a digital input as “power plant ready” – E2515 and connect it to a summary of generators ready feedback.

Another solution to indicate that the power plant is ready is to use equation with multiple digital inputs (one for each **generator ready** signal) all set as ‘Used by equations’. Each input being connected to a digital output of a GENSYS 2.0 set as “genset ready with breaker close” - E2883.

Then the power plant can be considered as operational according to your application.

For example as described in the equation below, the power plant is considered as operational when 2 or more generators are ready (E2440 is used to count the number of “generator ready” signals and is then compared to 2).

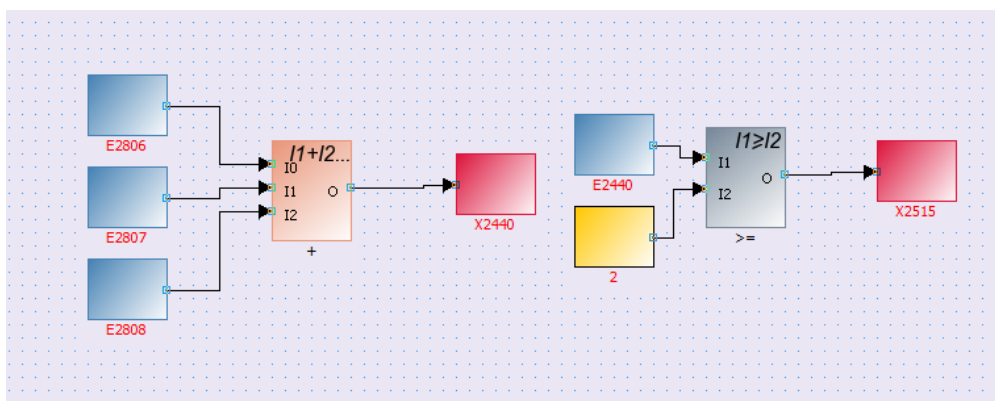


Table below describes the minimum parameters to be set on all GENSYS 2.0.

Parameter [var.num]	Set value	Comment
[E1158]	0-Analog	Load sharing done by parallel lines
[E1476]	0	No kW load sharing integral and frequency centring
[E1504]	0	No kVAR load sharing integral and voltage centring
[E1258]	0 - Unused	No load/unload management according to the load
[E4136]	0 - Unused	No communication port used for CRE protocol
[E1259]	0 - Unused	CAN bus fault not configured
[E1105]	2%	Voltage droop setting
[E1110]		cos(φ) setpoint used when power plant is paralleled with the Mains

TABLE 17- GENSYS 2.0 PARAMETERS -ANALOG OUTPUT WITHOUT CAN BUS CONNECTED

Here are some specific Input/Output connections of the GENSYS 2.0:

- Remote start input must be connected to “Remote start” output of the MASTER 2.0 described above.
- Configure a digital input as “Mains parallel” – E2949. When activated the GENSYS 2.0 will switch to cos(φ) regulation
- Configure a digital output as “GE on load” – E2883. This output will indicate to the MASTER 2.0 that this specific generator is ready for use with its own breaker closed.

9.3.4 ANALOG OUTPUT WITHOUT CAN BUS CONNECTED (MULTI-UNITS)

MASTER 2.0 can also use its analog output to manage a power plant made up of different generator control units linked by parallel lines. The principle is identical to a power plant made up of GENSY 2.0 managed by analog output without CAN bus as described above, *i.e.*:

- Manage frequency/phase and kW regulation by analog output
- No management of the voltage and no $\cos(\varphi)$ regulation. It means that generator units need to individually manage $\cos(\varphi)$ regulation when paralleled with the Mains.
- External connections needed to start/stop power plant, indication on **power plant ready** and **power plant paralleled with Mains** signals.

External connection and setup of the units must be adapted as described in the picture below. Note that synchronization and kW regulation is done on speed/load control inputs of the generator control units, contrary to GENSY 2.0 that are using parallel lines.

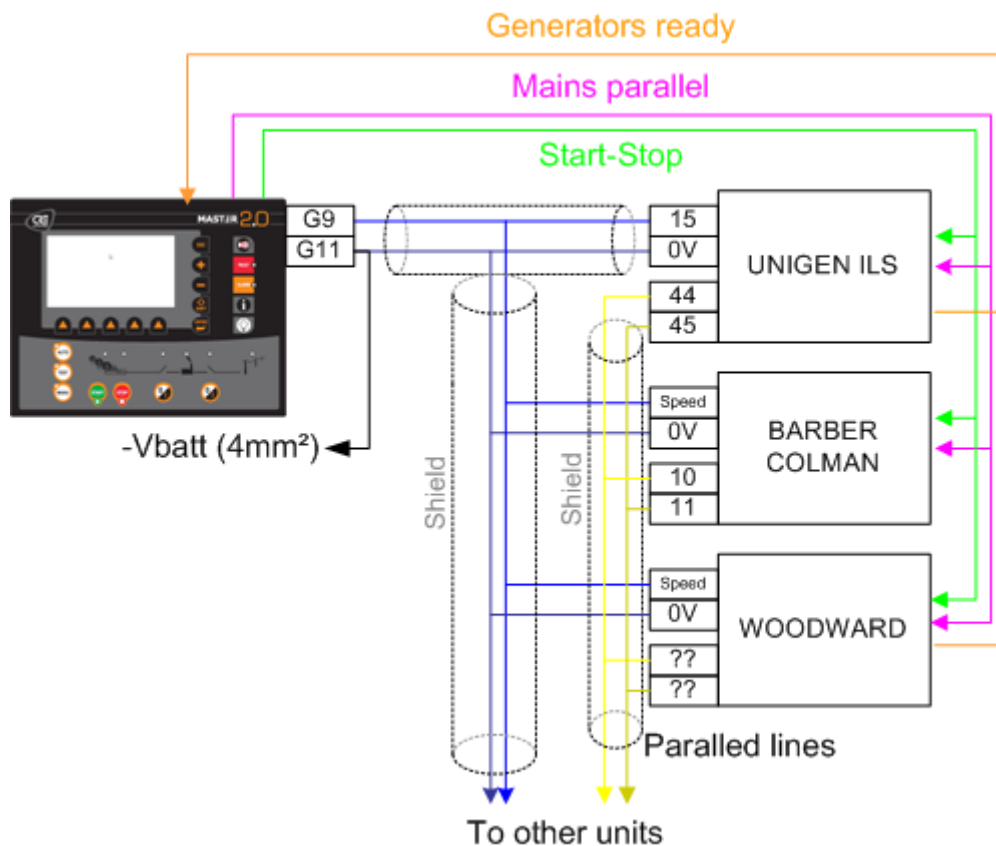


FIGURE 11 - ANALOG OUTPUT WITHOUT CAN BUS CONNECTED MULTI-UNITS

Note: In order to work properly, it is necessary that the speed/load control input of the different generator control units use the same voltage range. You may modify the speed output of the MASTER 2.0 with parameters [E2076] and [E2077] in order to adapt MASTER 2.0 to the configuration of the connected units.

10 REFERENCES

10.1 PRODUCT REFERENCE

Reference	Description
A54Z0	MASTER 2.0: Power plant controller with mains paralleling unit with integrated PLC
A54Z1	MASTER 2.0 CORE: Back-panel mounted power plant controller with mains paralleling unit with integrated PLC
A53C9	GENSYS 2.0 CORE MASTER MARINE: Back-panel mounted power plant controller with mains paralleling unit with integrated PLC for marine
A53Z0	GENSYS 2.0: all-in-one door-mounted generating set control and paralleling unit with integrated PLC.
A53Z1	GENSYS 2.0 CORE: all-in-one back-panel mounted generating set control and paralleling unit with integrated PLC.
A53Z2	GENSYS 2.0 LT: all-in-one generating set control and paralleling unit.
A53Z3	GENSYS 2.0 MARINE: all-in-one door-mounted generating set control and paralleling unit with integrated PLC and with marine functions.
A53Z4	GENSYS 2.0 CORE MARINE: all-in-one back-panel mounted generating set control and paralleling unit with integrated PLC and with marine functions.
A53Z5	GENSYS 2.0 LT MARINE: all-in-one generating set control and paralleling unit with marine functions.
A53Y0	RDM 2.0 : Remote display module for all-in-one generator control & paralleling unit for industrial product
A53Y3	RDM 2.0 MARINE : Remote display module for all-in-one generator control & paralleling unit for marine product
A53Y9	RDM 2.0 MASTER MARINE : Remote display module Power plant controller with mains paralleling unit for marine product

TABLE 18 - PRODUCT REFERENCE

Full reference follows this format: A53Z0-L00xx (xx value depends on factory installed options).

Standard product is A53Z0-L0001.

Contact your local dealer for complete reference.

10.2 OPTIONS

Each of the following options can be selected and is password activated: contact your dealer for procedure.

OPT2: Mains paralleling option for single generator paralleled with the mains.

Some of the main paralleling functions are:

- Power management (command mode, peak shaving...)
- Phase shift
- ROCOF

OPT5: Disable paralleling function (AMF). Disabling this option will also disable option 2 “Mains paralleling” described above.

OPT8: Transformer phase shift compensation (HV, Dyn11 ...)

Note:

On GENSYS 2.0 LT modules, option 2 is always linked to option 5. They are both factory enabled. Enabling/Removing option 5 will automatically enable/remove option 2.



Starting from firmware v5.00, paralleling options 2 and 5 are included into all modules as a factory setting.

A watchdog option is also available using logic output C5. This option must be specified when ordering your unit so that CRE Technology can produce it in the factory.

10.3 ACCESSORIES

CRE Technology provides a complete range of accessories to help you install and use your module. Some examples are given below. Please contact your local distributor to help you choose adequate equipment to fit your needs.

1/ Cables

For more information on cables see the specific technical documentation A53 W0 9 0002 – Paralleling unit harness information.



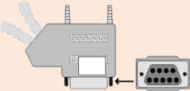





Reference	Overview	Description
A53W1		Crossover RJ45 Ethernet cable (3m)
A40W2		DB9 female connector with 120Ω terminal resistor/free wires.
A40W3		DB9 connector accepting double cable connection. To be used on multiple generators applications
A40W4		CAN/RS485 communication cable without connectors. Length on request.
A40W5		DB9 120Ω termination dongle
A40W8		CAN cable for 2 GENSYS 2.0 application (7m)
A53M0		CAN bus: Optic fiber convertor Multimode ST/ST
A53M1		Optic fiber ST/ST multimode 100 meters

TABLE 19 - CABLE REFERENCE



2/ *Other equipments*

Table below shows some of many other types of equipment available in the CRE Technology product range.

Reference	Description
A53X0	Manual GENSYS 2.0/MASTER 2.0 test bench.
A53X1	GENSYS 2.0 demonstration suitcase kit
A53X2	GENSYS 2.0 MARINE demonstration suitcase kit
A09Tx	GCR - digital Mains controller (ref A09T0 for 100V _{AC} , A09T1 for 230V _{AC} , and A09T2 for 400V _{AC}).
A24Zx	CPA – Converts three phase active power measurements into a +/-20mA signal. Exists for 100V _{AC} /5A, 230V _{AC} /5A, 400V _{AC} /5A, 100V _{AC} /1A, 230V _{AC} /1A and 400V _{AC} /1A measurements.
A61Y1⁽¹⁾	BSD 2.0 - remote management box (GPRS, email, SMS ...)
A25Z0	C2S - Auto Synchronizer and Safety Column to safely control the paralleling of two alternating power sources.

TABLE 20 - CRE TECHNOLOGY PRODUCT REFERENCE

(1) Not available for MASTER 2.0

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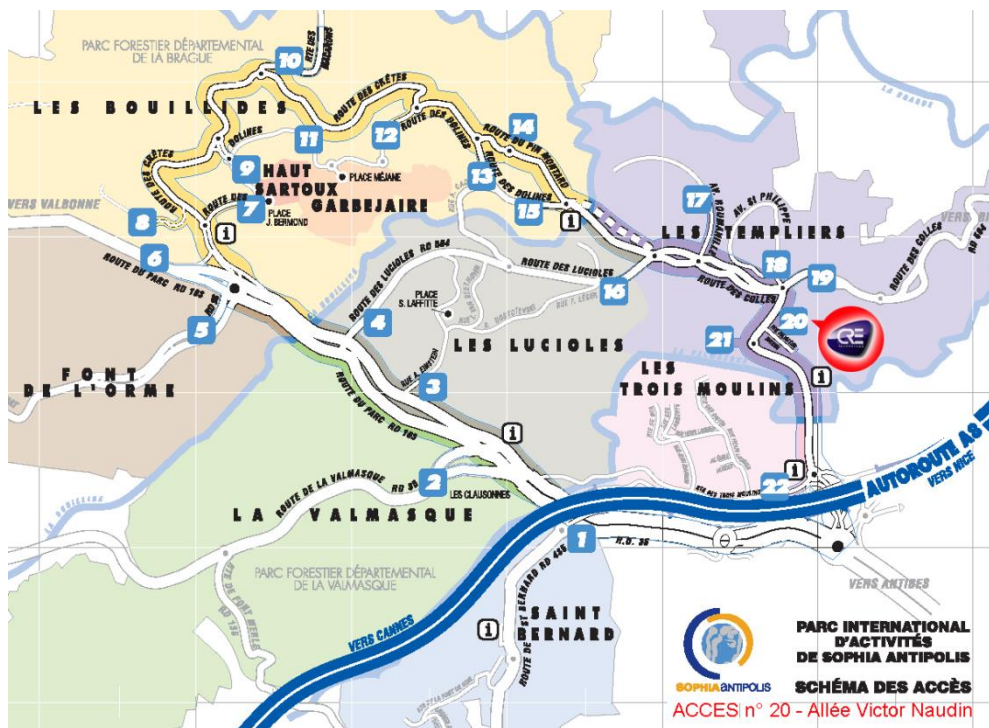


FIGURE 12 - ACCESS TO CRE TECHNOLOGY



Check our entire distributors list around the world on www.cretechnology.com, tab "DISTRIBUTORS"



FIGURE 13 - CRE TECHNOLOGY DISTRIBUTORS

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