UNIGEN
UNIGEN *PLUS*

Technical documentation

"Synchronization and load sharing module"

Part Number:
A51 Z0 9 0004 EN

CRE TECHNOLOGY

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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.

For further information, please contact your CRE technology distributor or the After-Sales Service Team.

All CRE Technology products are delivered with one year warranty, and if necessary we will be happy to come on site for product commissioning or troubleshooting. The company also provide specific trainings on our products and softwares.

Technical support: +33 (0)4 92 38 86 86 (office hours: 8.30AM-12AM / 2PM-6PM GMT+1).
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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

VERSION	DATE	MODIFICATION
A	May 2005	Initial document
B	March 2007	New PCB and Embedded software
C	November 2007	Administrative update
D	December 2008	Neutral in wiring diagram (three phase with neutral)
G	December 2009	MOBDUS modification
H	February 2010	Connection to EFC speed regulator
I	May 2010	Firmware v1.28 : • 500Hz PWM speed output (hardware option). • MODBUS read/write functions. • External speed potentiometer features. • External synchronization input features.
J	February 2011	Commissioning tips for small generating sets (below 200kW). Description of automatic load/unload feature (using CAN bus load sharing).
K	June 2012	Connection to Woodward EPG speed governor. Connection to CRE technology GCR module. Firmware v2.00: • Compatibility with CRE Config software. • Advanced settings for external speed potentiometer. • Optimized PID transitions. • User delay on SYNC_OK output.

Documentations available on CRE technology Web site:

A51 Z0 9 0004: UNIGEN/UNIGEN *PLUS* technical documentation.
A51 Z1 9 0015: TCP-IP connection under Windows XP.
A51 Z0 9 0246: TCP-IP connection under Windows 7.
A51 Z1 9 0103: Replacing a Barber Colman DYN2-94026 by a UNIGEN PLUS.
A51 Z2 9 0107: Replacing a Barber Colman DYN2-90300 by a UNIGEN.

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.

Contact your CRE technology distributor for course training.

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3 OVERVIEW

3.1 UNIGEN FRONT COVER

Each terminals of the industrial UNIGEN are also available on UNIGEN *PLUS*.

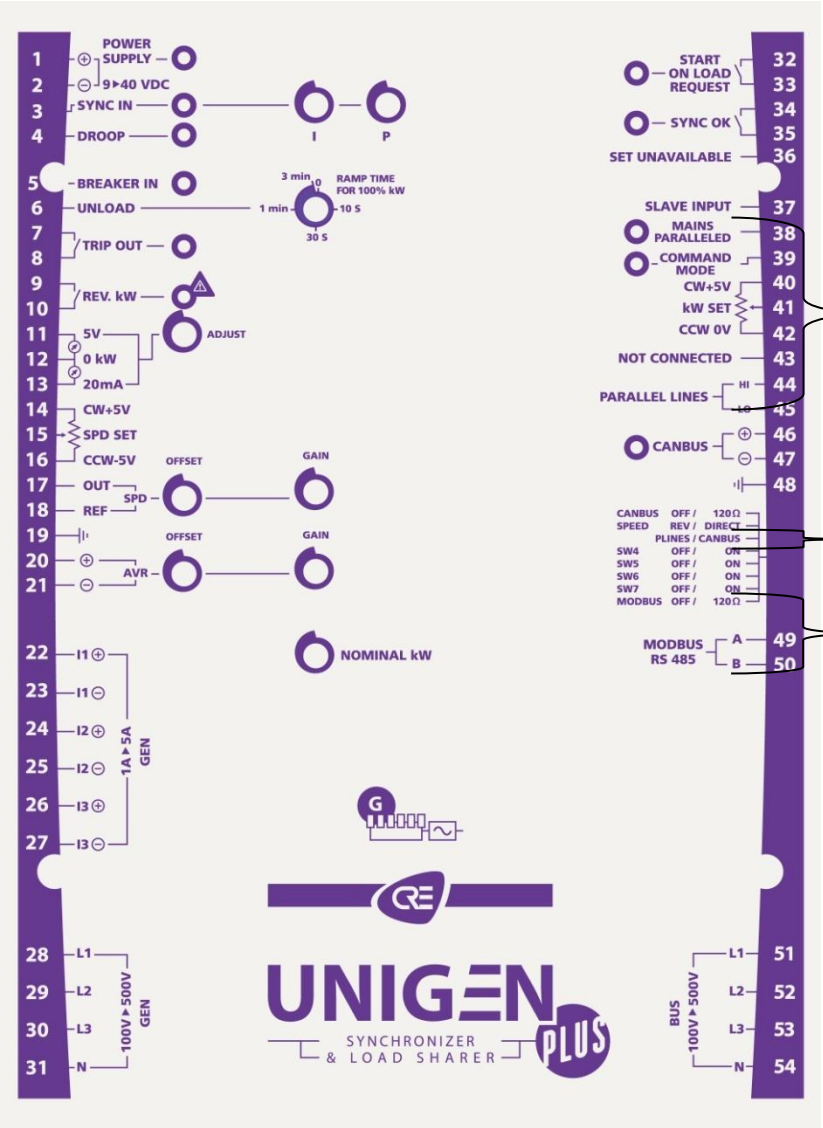


FIGURE 1: FRONT PANEL

Only for UNIGEN *PLUS*: this symbol is used in technical documentation to indicate UNIGEN *PLUS* special features.

3.2 GLOBAL FUNCTIONS

The main functions performed by the UNIGEN are followings :

- Automatic and Manual synchronization (See SW5 and SW6 configuration).
- Active load sharing in **isochronous**, **droop** mode or **Command** mode (UNIGEN *PLUS* only).
- Reactive load sharing in **isochronous** voltage, **droop** mode or **power factor fixed** (UNIGEN *PLUS* only).
- Compatibility with all speed governors (See SW2 configuration) and AVR on the market.
- Remote speed control by potentiometer (See SW7 configuration).
- Internal synch check relays, useful for auto and manual synchronization.
- Phase sequence protection.
- Load sharing with CAN plug and play (See SW1 configuration) or with paralleling lines (UNIGEN *PLUS* only, see SW3 configuration).
- Automatic load/unload.
- Reverse kW relays.
- 2 analogue outputs (0…5V and 0…20mA/4…20mA) for kW meter (See SW4 configuration).
- MODBUS RTU on serial port RS485 (UNIGEN *PLUS* only, see SW8 configuration).
- Command mode (UNIGEN *PLUS* only).
- Mains Paralleled (UNIGEN *PLUS* only).

3.3 CRE CONFIG SOFTWARE

Starting from firmware v2.00, UNIGEN modules *are* compatible with PC software *CRE Config*. This software gives you the ability to communicate with your module using RS232 serial communication. Serial COM port is placed under the front cover of UNIGEN modules.

UNIGEN modules can be installed without any computer, but you may want to use *CRE Config* software to set advanced parameters or display internal measurements such as generating set voltages, currents, active power and so on.

For more information, please refer to the following documentation available on CRE technology Web site:

- A70 Z1 9 0003: *CRE Config* user manual.
- A51 Z1 9 0015: TCP-IP connection under Windows XP.
- A51 Z0 9 0246: TCP-IP connection under Windows 7.

4 FEATURES

4.1 SYNCH CHECK RELAY

SYNC_OK output (terminals 34/35) permit the coupling of generators when all following conditions are correct:

- Voltage of generator and bus bar within a 15 - 130% window from nominal voltage (500V).
- Voltage difference between generator and bus bar, < 10%.
- Frequency of generator and bus bar within a 30 - 130% window from nominal frequency.
- Phase Angle difference between generator and bus bar. <+/- 10°.
- Frequency difference between generator and bus bar, < 0.01Hz.
- Phase sequence correct.

Switch SW5 allows or not to close the generator breaker even if ***SYNC_IN*** logical input is not active.

Switch SW6 allows or not to close the generator breaker on a dead bus bar.

Table below describes the behaviour of ***SYNC_OK*** relay depending on the actual setup of your module and according to voltage measurements on generator and bus bar sides.

Logical inputs		Configuration		Electrical conditions		Relay
BREAKER_IN	SYNC_IN	SW6 Dead Bus bar	SW5 Synchronization (manual/auto)	Dead bus (No voltage on bus)	Δϕ, ΔHz, ΔV + phase sequence	SYNCH_OK
Inactive (not connected)	Active (connected to $0V_{DC}$)	OFF	X	X	NOK	open
		X	X	NO	OK	**closed**
		ON	X	YES	NOK	**closed**
		ON	X	NO	NOK	open
	Inactive (not connected)	X	OFF	X	X	open
		OFF	ON	X	NOK	open
		X	ON	NO	OK	**closed**
		ON	ON	YES	NOK	**closed**
		ON	ON	NO	NOK	open

TABLE 1: SYNC_OK LOGIC TABLE

X = Do not care.

NOTE:

*Since firmware v1.28, **SYNC_IN** input is taken into account only if both generator and Mains/Bus frequencies are greater than a predefined percentage of nominal frequency. This percentage can be changed using parameter E01226. It is factory set to 0% to help you check AVR and speed output range during commissioning, but it may be useful to set it to a higher value (e.g. 80%) depending on your use of **SYNC_IN** input.*

Since firmware v2.00, SYNC_OK output can be delayed according to parameter E01227. In this case, SYNC_OK output is closed when all parameters described above are in the proper conditions during the delay set in parameter E01227. Otherwise SYNC_OK is kept open.

After power on sequence on dead bus conditions, a minimal delay must elapse before ***SYNC_OK*** relay is closed. This delay may be adjusted using parameter E01033 (Default value is 3.0s).

CAUTION :

One generator has to be started alone to close on the dead bus before starting the other generators.

The ***SYNC_OK*** green LED confirms the activation of the relay:

- LED ON = contact closed.
- LED OFF = contact open.

4.2 REVERSE KW RELAY

UNIGEN includes a reverse kW relay on terminals 9 & 10. This relay output closes when the kW of the generator is below -5% of the nominal kW during more than 20 seconds.

The ***REV._kW*** red LED confirms the activation of the relay:

- LED ON = contact closed.
- LED OFF = contact open.

4.3 KW INDICATOR

UNIGEN has two analogue outputs for kW indicator on terminals 11, 12 and 13. These outputs allow the display of active power (kW).

Outputs are between 0-5V_{DC}, 0-20mA or 4-20mA depending on SW4 configuration. A multi-turn potentiometer allows the calibration of the output to adapt it to your indicator.

4.4 REMOTE SPEED CONTROL INPUT

UNIGEN includes a remote speed control input on terminals 14, 15 and 16. This input is provided for connecting an external potentiometer (5kΩ). The mid-point of this potentiometer (5 turns for a 10 turns potentiometer) will generate a 0V signal to the cursor input and will not generate any speed deviation.

The potentiometer is taken into account depending on switch SW7:

- OFF position, potentiometer is always read by UNIGEN.
- ON position, potentiometer value is set to zero when generator breaker is closed (***BREAKER_IN*** logical input active). Potentiometer is normally read when generator breaker is open.

Maximal speed deviation depends on the speed output adjustments. When it is adjusted for the recommended range of +/- 3.00Hz, then the following rules apply:

- +5V applied on cursor input will increase the speed of + 3.00Hz.
- -5V applied on cursor input will decrease the speed of -3.00Hz.

This input can also be used as 0…5V_{DC} for a master PLC control. In this case the nominal speed must be adjusted when 2.5V_{DC} are applied on the cursor input.

NOTE:

Starting from firmware v2.00, parameter E01228 is associated to DIP-switch SW7 to determine the speed correction due to the external speed potentiometer while generator breaker is closed and SW7 is ON. Factory setting is set to 0 so that potentiometer correction is set to zero as described above. Depending on your specific application, you may want to set E01228 to 1. In this case, external speed potentiometer value will be memorised just before the generator breaker is closed.

4.5 PWM 500HZ (A51M141 MODULES ONLY)

UNIGEN *PLUS* offering PWM output feature are identified with a modification label (A51M141). This option must be specified when ordering parts from your dealer.

Connection to the speed regulator must be done as shown below:

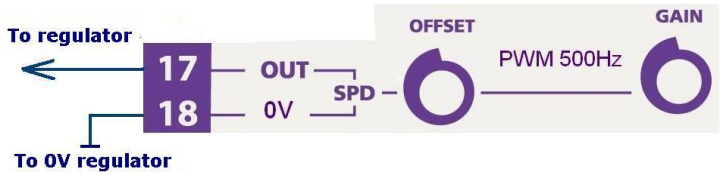


FIGURE 2: 500HZ PWM OUTPUT

The output is protected against short-circuit to 0V. The PWM adjustment is done with the OFFSET and GAIN potentiometers of the speed output. Picture below shows the behaviour of the potentiometers on the output signal.

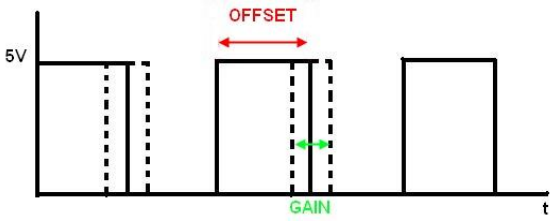


FIGURE 3: PWM OUTPUT SETTINGS

4.1 CAN BUS LOAD SHARING

When ***DROOP*** input (terminal 4) is open and DIP-switch SW3 (plines/canbus) is set to select CAN bus (ON position for UNIGEN *PLUS*), UNIGEN is in isochronous load sharing mode. The load setpoint will be calculated via the CAN connection.

Up to 8 UNIGEN modules can be connected via CAN bus.

The CAN bus needs terminal resistors at each end of the bus. Switch SW1 (CAN bus termination resistor OFF/120Ω) to ON position on the first and last UNIGEN modules connected to the physical CAN bus. SW1 should be switched OFF on all other UNIGEN modules.

4.1.1 PLUG'N'PLAY CAN PROTOCOL

As soon as several UNIGEN are connected together through CAN bus, they automatically choose a generator number different from each other. They are able to share the load without any settings. If one UNIGEN disappear from the CAN, it is no longer taken under account by the others, and they continue to share the load isochronously.

The rules of the Plug'n'play CAN protocol are described below:

- UNIGEN must receive information on the availability of the GE. (Input ***SET_UNAVAILABLE***). If this information is set to 0 then the UNIGEN will not participate to the negotiations.
- A generator is considered as slave when the ***SLAVE INPUT*** is connected to 0V.
- At least one UNIGEN must be configured as master (***SLAVE INPUT*** not selected).
- At power up, all UNIGEN connected to the CAN bus will be automatically attributed a set number (1, 2, 3...) according to the power supply sequence of the UNIGEN. If multiple units are powered ON at the same time, then serial number will be used to attribute a different group number to each unit.
- At power up, all UNIGEN are fully operational during 2 minutes (No stop negotiation), then the automatic load/unload mode starts.

Note:

Plug'n'play can be inhibited if you want each unit to keep the same generating set number whatever the status of other modules (powered ON or OFF). To do so, set parameter V01038 to 0 on all UNIGEN modules and select a different generating set number to each module using parameter V02192. Do not forget to save parameters in FLASH memory so the setup will be kept even if power supply is lost.

4.2 LOAD SHARING USING PARALLEL LINES (UNIGEN PLUS)

When ***DROOP*** input (terminal 4) is open and switch SW3 (plines/canbus) is on plines position (OFF), UNIGEN *PLUS* is set to isochronous load sharing mode, it compares its power with the level of the paralleling lines and generates an output signal to the speed governor to adjust its power.

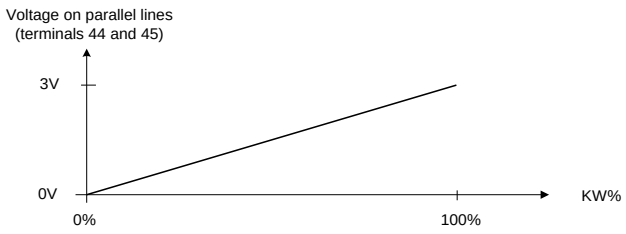


FIGURE 4: ISOCHRONOUS LOAD SHARING WITH PARALLEL LINES

Parallel lines are compatible with other analogue sharing lines products on the market. This can be useful to extend power plants with heterogeneous control units. Examples of such products are:

- GENSYS/GENSYS 2.0 product range from CRE technology.
- Barber Colman products (ex: DYN2-80109, Pow-R-Con…).
- Woodward 2301A controller.
- …

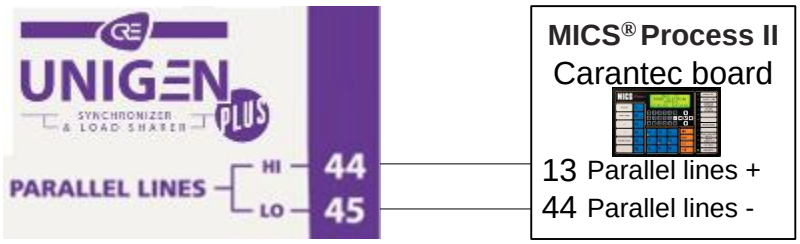


FIGURE 5: CONNECTING WITH CARANTEC BOARDS

4.1 DROOP LOAD SHARING

When ***DROOP*** (terminal 4) input is connected to 0 V_{DC}, UNIGEN is in Super droop mode. In this mode the load sharing is managed between 50.50Hz (0% load) and 50.00Hz (100% load).

For this specific droop, it is not needed to set precisely the engine speed, and any connections are required between each UNIGEN, even the 0V.

kW and kVAR load sharing are managed with droop.

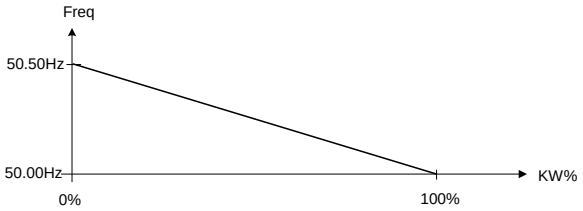


FIGURE 6: DROOP LOAD-SHARING

4.2 AUTOMATIC LOAD/UNLOAD REQUEST

The ***START_ON_LOAD_REQUEST*** relay output can be used to start and stop the slave generators depending on the power plant load. ***START_ON_LOAD_REQUEST*** green LED confirms the activation of the relay:

- LED ON = contact is closed.
- LED OFF = contact is open.

This feature can be used when UNIGEN modules are connected through CAN bus. If the power plant load goes below 20% of the nominal power during more than 2 minutes then a slave generator will be elected to stop.

If the power plant load goes above 70% of the nominal power of the power plant during at least 10 seconds then a slave generator will be elected to start.

If the load is between 20% and 70% of the nominal power then the actual number of generators on the bus bars will not change until either 20% or 70% threshold is reached.

NOTE:

Thresholds and timers described above can be changed using CRE Config software to tune up modules depending on your application.

Refer to Plug'n'Play CAN protocol chapter for more details concerning attribution of a generating set number to each UNIGEN module.

Figure below gives an example of power plant with three generating sets. Two of them (UNIGEN with ***SLAVE_INPUT*** connected to 0V) can request to start or stop their engine depending on the global load of the power plant.

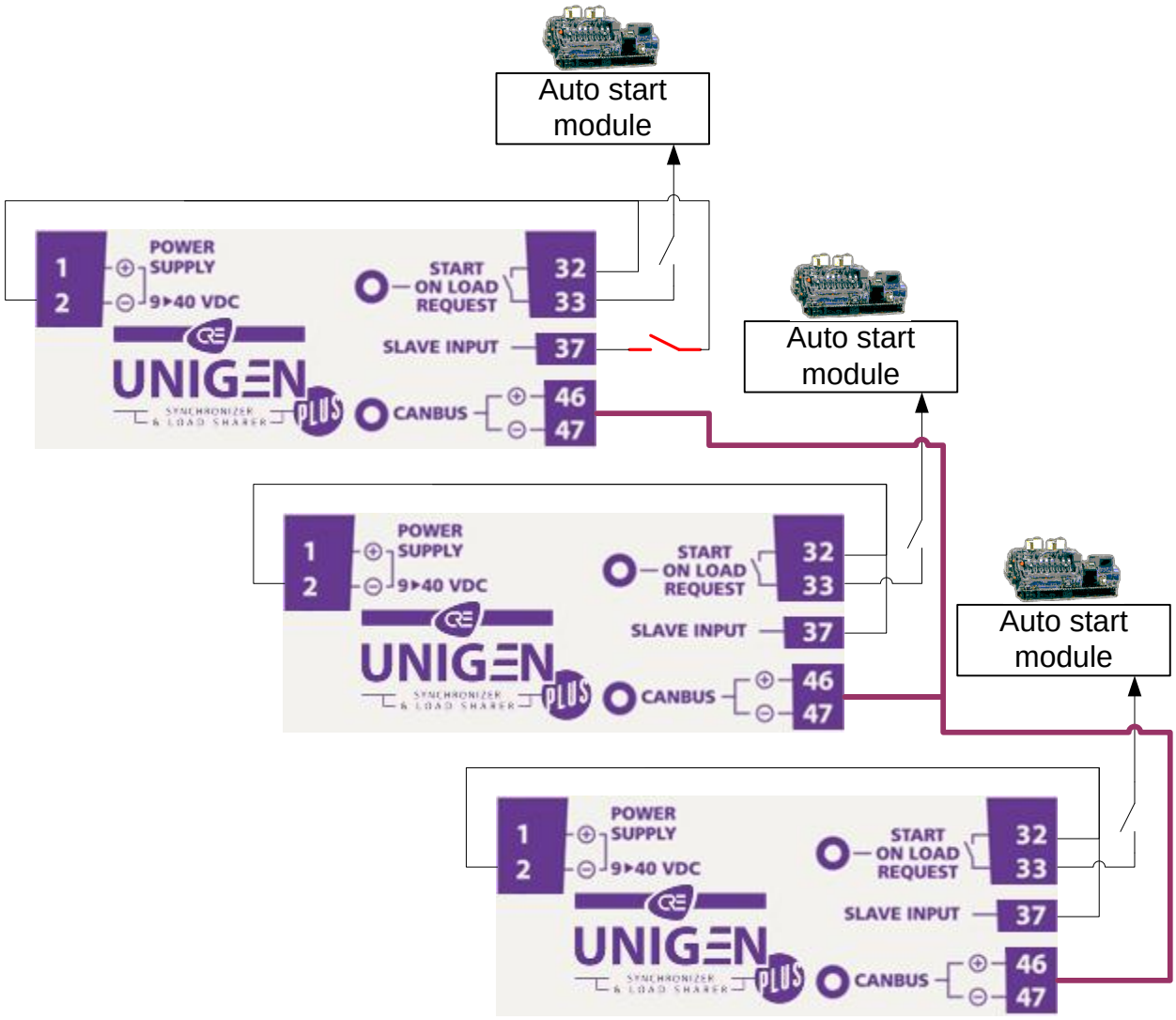


FIGURE 7: AUTOMATIC LOAD/UNLOAD EXAMPLE

SET_UNAVAILABLE input:

- If UNIGEN is stopped and its ***SET_UNAVAILABLE*** input is activated it will prevent any start upon load request by keeping ***START_ON_LOAD_REQUEST*** relay open and ***TRIP_OUT*** relay closed.

CAUTION:

If UNIGEN is running and on the bus bar, as soon as *SET_UNAVAILABLE* input is closed the *TRIP_OUT* relay is activated (closed) to open the breaker of the generator.

Load shedding inhibition:

- Don't connect the ***START_ON_LOAD_REQUEST*** relay: the load shedding will not have any influences.

- In droop mode the load shedding is inhibited.

START_ON_LOAD_REQUEST relay behaviour is described in the schematic below:

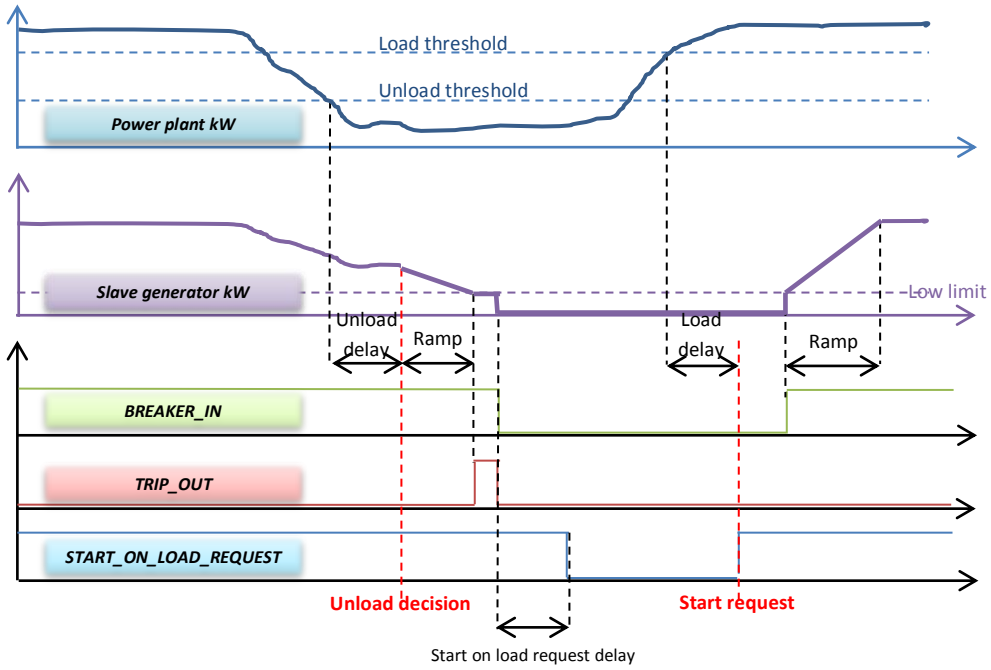


FIGURE 8: AUTOMATIC LOAD/UNLOAD PRINCIPLE

Note: at start up, START_ON_LOAD_REQUEST relay is closed. All generators are started because it is impossible to know the level of load before start.

4.3 LOAD RAMP MANAGEMENT

4.3.1 RAMPS

Ramp sequences:

- The first generator on the bus bars takes immediately the load with no ramp.
- The other generator load ramp stops when generators reach the load setpoint (average power plant load).
- The unload ramp stops when the power reach 5% of its nominal power.

Load and Unload ramp rates are using the same potentiometer. The single turn potentiometer named 'RAMP TIME' adjusts the ramp time from 0 seconds to 180 seconds. This setting is the time to transfer 100% of the nominal power.

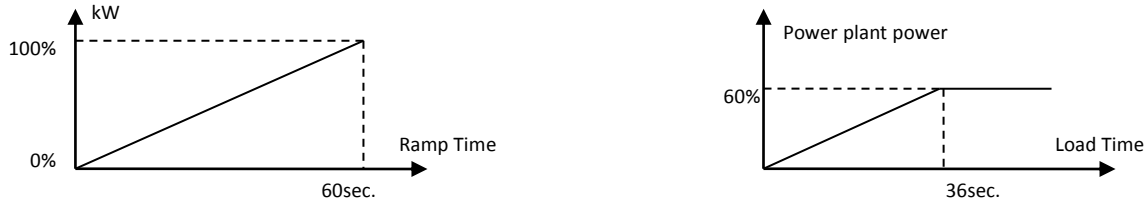


FIGURE 9: RAMP SEQUENCES

4.3.2 AUTOMATIC TRIP OUT

TRIP_OUT relay (terminals 7 and 8) is used to open the breaker once the unload ramp is finished. The relay is closed when the kW of the generator which is unloading reaches 5% of the nominal kW.

TRIP_OUT green LED is lit to confirms the activation of the relay:

- LED ON = contact closed.
- LED OFF = contact open.

4.3.3 MANUAL LOAD/UNLOAD REQUEST

The Load/Unload ramps are managed by the ***UNLOAD*** input (terminal 6):

- ***UNLOAD*** input disconnected = when the breaker closes, the load ramp starts immediately.
- ***UNLOAD*** input connected to 0V = the generator starts an unload ramp.

4.4 COMMAND MODE (UNIGEN PLUS)

When the following conditions are met:

1. ***DROOP*** input is opened (terminal 4 not connected).
2. ***COMMAND_MODE*** input is closed (terminal 39 connected to the $0V_{DC}$).
3. Generator breaker is closed (***BREAKER_IN***, terminal 5 connected to the $0V_{DC}$).

Then the UNIGEN Plus is in **COMMAND** mode. The kW set point is then fixed via the remote potentiometer of kW set point (terminals 40/41/42) and the power factor is fixed to 0.95 using parameter E11020. The low limit of the potentiometer is 5% and the high limit is 110% of nominal kW. Behaviour of kW set point (potentiometer) is described on schematic below:

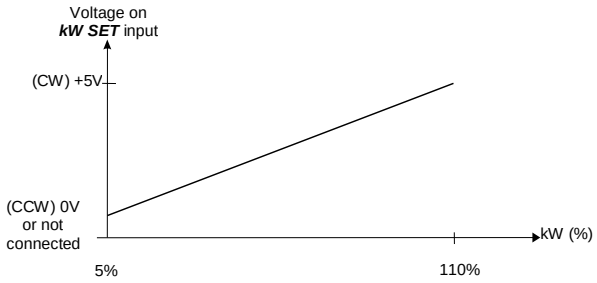


FIGURE 10: KW SET POINT VS POTENTIOMETER INPUT

COMMAND mode is described in the second schematic shown on MAINS PARALLELED chapter.

4.5 MAINS PARALLELED (UNIGEN PLUS)

When the following conditions are met:

1. ***DROOP*** input is opened (terminal 4 not connected).
2. ***COMMAND_MODE*** input is opened (terminal 39 not connected).
3. ***MAINS_PARALLELED*** input is closed (terminal 38 connected to the $0V_{DC}$).
4. Generator breaker is closed (terminal 5 connected to the $0V_{DC}$).

Then UNIGEN *PLUS* is in **MAINS PARALLELED** mode. The kW set point is then fixed by the paralleling lines (driven by a GCR module for example) and the power factor is fixed at 0.95 by the parameter E11020.

A 0V on the parallel lines (terminals 44/45) will make the generator take 0% of load while a 3V signal will make the generator take 100% of load as described on schematic below:

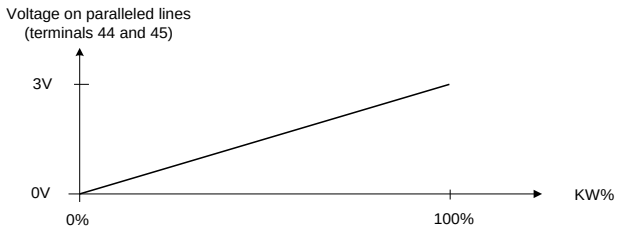


FIGURE 11: PARALLEL LINES VOLTAGE / POWER PLANT AVERAGE KW

COMMAND mode and MAINS PARALLELED active power behaviour are described in the schematic below:

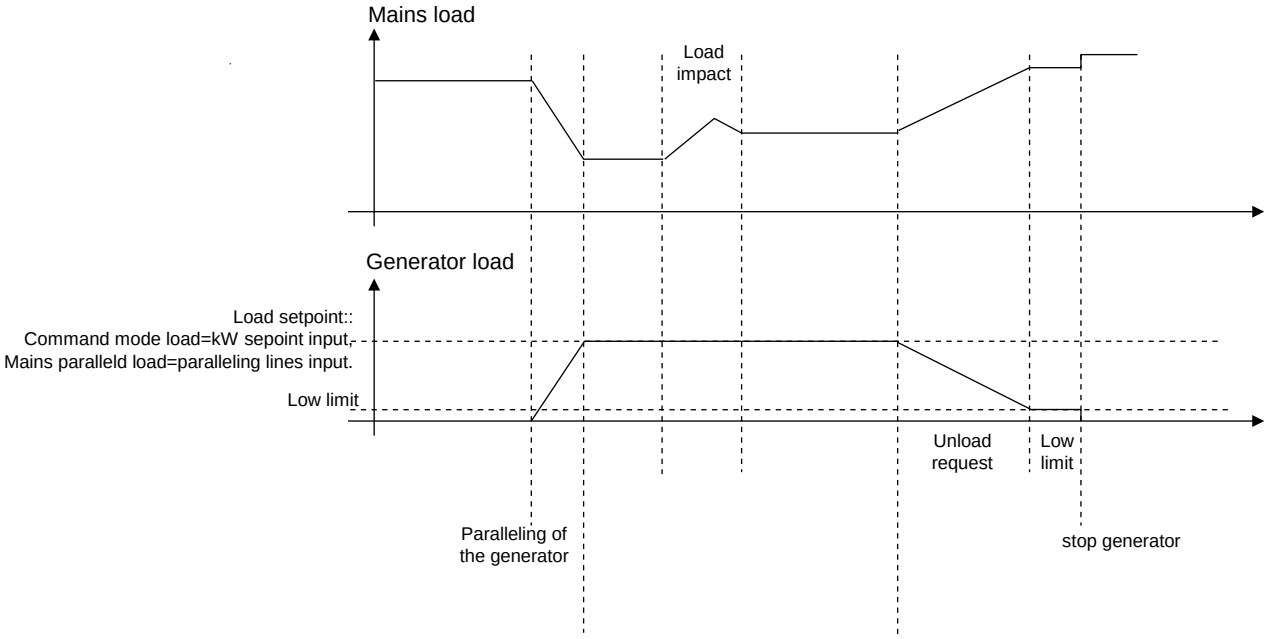


FIGURE 12: COMMAND MODE AND MAINS PARALLELED KW MANAGEMENT

Active power set point behaviour in different mode is described in the following table:

	UNLOAD	BREAKER IN	DROOP	MAINS PARALLELED	COMMAND MODE	SW3	Mode	kW/Speed management according to
				PLUS	PLUS	PLUS		
	X	open	X	X	X	X	Waiting	None
	open	closed	closed	X	X	X	Droop	Frequency
	closed	closed	open	X	X	X	Unload	Ramp time pot.
	open	closed	open	open	open	ON	Load sharing	CAN bus
PLUS	open	closed	open	open	open	OFF	Load sharing	Parallel lines
PLUS	open	closed	open	X	closed	X	Fixed kW	kW set point
PLUS	open	closed	open	closed	open	X	Paralleled with Mains	Parallel lines

TABLE 2: KW/SPEED MANAGEMENT

Close = connected to $0V_{DC}$.

Open = not connected.

PLUS = concerns UNIGEN PLUS only.

4.5.1 CONNECTING TO A GCR MODULE

Figure below shows the speed and parallel lines connections that can be done between UNIGEN PLUS and a GCR module from CRE technology in order to parallel a power plant with the Mains.

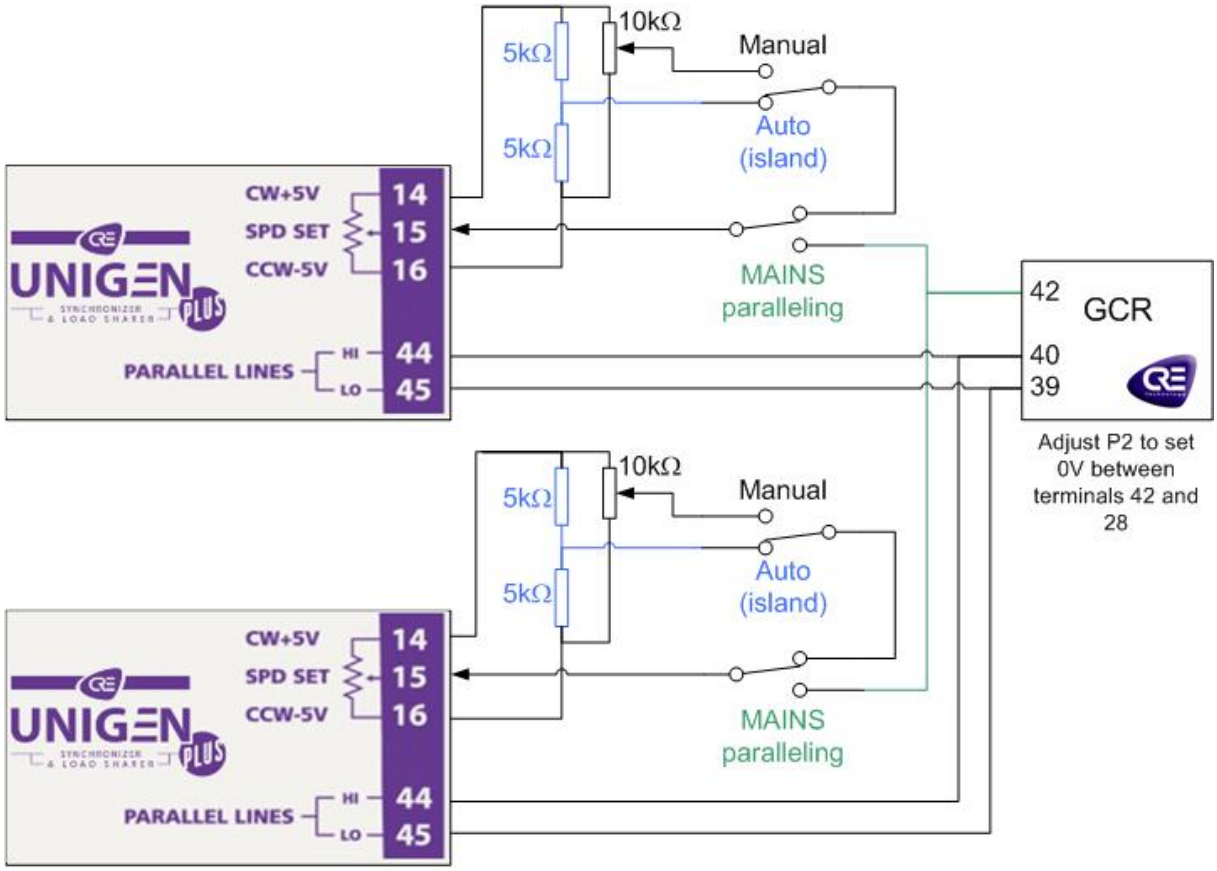


FIGURE 13: CONNECTION TO A CRE TECHNOLOGY GCR MODULE

4.6 MODBUS (UNIGEN PLUS)

All the logical and analogue input/output values and all the other parameters which appear in the UNIGEN *PLUS* menus can be read by the serial port RS485 terminals 49A and 50B (2 wires). UNIGEN *PLUS* behaves as a MODBUS slave device.

If your UNIGEN *PLUS* is located at one end of the RS485 network, then you should activate the internal 120Ω termination resistor by switching SW8 (Modbus OFF/120Ω) to ON position.

Support of MODBUS RTU by the UNIGEN *PLUS* is performed using the following parameters:

- Communication speed: 4800, 9600 and 19200 (default: 19200).
- Number of bits by character: 8.
- Number of parity bits: 0.
- Number of stop bits: 1.
- Supported function: 04 (analogue reading) and 03 (registers reading) and 06 (registers writing).
- The RTU address of the variables is the same than their number plus 1, converted in hexadecimal.

Example:

Variable E00110 (Mains breaker status) has RTU address 006Fh (Decimal 111). See file A51Z090030 for the whole list of existing registers.

MODBUS registers writing meets the following rules:

- Ex0xxx measures are “Read only”.
- Ex1xxx parameters are factory set to “Read only”. It is possible to switch them to “Read/write” using the embedded Web site. To do so it is necessary to connect to UNIGEN with a laptop in level 2 (distributor password). Go to ***Configuration/Modification by variable nb*** page, enter the parameter that you want to change, and then in the « Writing by modbus/PLC » box, choose « allow » and validate. Go to ***System/Flash all parameters*** and press « FLASH it » red button to save parameters (Otherwise changes are lost when UNIGEN is switched off).
- Variables Ex2xxx can be written using MODBUS without restriction.

Example:

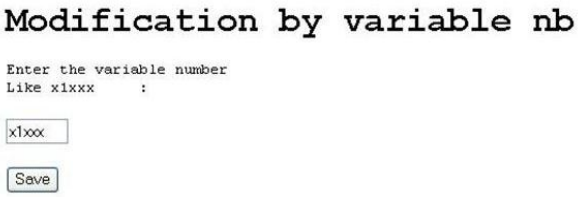
Table below is an example of a master that needs to read variable E00001, E00002 and E00003 from a UNIGEN *PLUS*. So the request will be a “read register” function starting at address 0001h and for 3 registers. Left columns represent the request from the master while right columns represent the corresponding answer from UNIGEN *PLUS*.

Field	Data (hex.)		Field	Data (hex.)	Description
Slave address	01		Slave address	01	
Function	04		Function	04	
Start address (MSB)	00		Number of data bytes	06	2 bytes per register
Start address (LSB)	01		1st data byte	*XX*	MSB of 1st register
Number of registers (MSB)	00		2nd data byte	*XX*	LSB of 1st register
Number of registers (LSB)	03		3rd data byte	*XX*	MSB of 2nd register
CRC16 (MSB)	E1		4th data byte	*XX*	LSB of 2nd register
CRC16 (LSB)	CB		5th data byte	*XX*	MSB of 3rd register
			6th data byte	*XX*	LSB of 3rd register
			CRC16 (MSB)	--	
			CRC16 (LSB)	--	

<u>Changing Modbus RTU slave address (Parameter E01215) and communication speed (Parameter E01216) of the UNIGEN *PLUS*:</u>

- *Connect using a computer (see A51Z1 9 0015A).*
- *Type the password 1*

- *Go to Configuration / Modification by variable Number*
- *Enter 1215 to set slave address (Parameter E01215) or 1216 to set communication speed (Parameter E*01216) and press ***Save*** button.



- *Enter desired value for the specific parameterand press* ***Save*** button.
- *Go to menu* ***System / Save all variables***
- *Click on "Flash it!" button.*
- *Disconnect UNIGEN, switch power off and then switch it on for new settings to take effect.*

5 SETTINGS

UNIGEN modules include the following adjustments for calibration and settings:

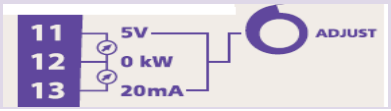
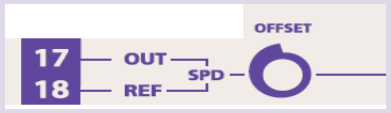
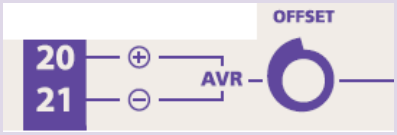
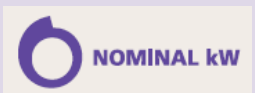
Potentiometers	Factory	Description
Synchronization adjustments 	6h  6h 	Single turn potentiometers. Proportional and Integral adjustments of the synchronization control loop. Adjust them using the following steps: • Turn ***P*** and ***I*** fully Counter Clockwise. • Turn ***P*** clockwise until the generator is unstable and then turn it back counter clockwise to stop the instability. • Repeat above step for I potentiometer.
Ramp time 	0s	Single turn potentiometer (0…180s). Adjusts the time taken by a 100% kW load/unload ramp.
kW monitor output adjustment 	None	Multi turn potentiometer (0…100%). Span adjustment for 0…5V_{DC} and 0…20mA/4…20mA output signals. ⇨ Also see SW4 configuration in table below.
Speed output adjustments  	None 6h 	Multi turn potentiometer (-10 to +10V_{DC}). Offset adjustment of the speed control output. ⇨ Also see dedicated commissioning chapter. Single turn potentiometer (0 to 10V_{DC}). Span adjustment of the speed control output. ⇨ Also see dedicated commissioning chapter.
AVR output adjustments  	None 6h 	Multi turn potentiometer (-10 to +10 V_{DC}). Offset adjustment of the voltage control output ⇨ Also see dedicated commissioning chapter. Single-turn potentiometer (0 to 10V_{DC}). Span adjustment of the voltage control output ⇨ Also see dedicated commissioning chapter.
Nominal kW 	None	Generator nominal kW. ⇨ See dedicated commissioning chapter to adjust this potentiometer correctly.

TABLE 3: POTENTIOMETERS

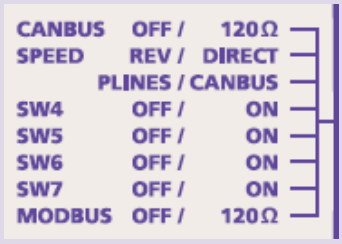
DIP switches	Description
	SW1: 120Ω CAN bus termination resistor. OFF: termination resistor is not connected. ON: termination resistor is connected. SW2: speed output slope sign. OFF: reverse speed regulation for GAC speed regulator. ON: direct speed regulation for other speed regulators. SW3: load sharing communication. OFF: kW load sharing set point comes from paralleling lines. ON: kW load sharing set point comes from CAN bus. UNIGEN *PLUS* only. SW4: kW monitor output signal. OFF: 0…5V_{DC} and 0…20mA output signals. ON: 4…20mA output signal. SW5: synchronization. OFF: ***SYNC_OK*** relay closes only when synchronisation conditions are OK and ***SYNC_IN*** input is active (connected to the 0V_{DC}). ON: ***SYNC_OK*** relay closes when synchronisation conditions are OK whatever the value of ***SYNC_IN*** input. ⇨ Also see SYNCH CHECK RELAY dedicated chapter. SW6: Dead bus bar authorization. OFF: ***SYNC_OK*** relay never closes on dead bus bar conditions. ON: ***SYNC_OK*** relay closes on dead bus bar conditions. ⇨ Also see SYNCH CHECK RELAY dedicated chapter. SW7: Speed potentiometer behaviour. OFF: external ***SPEED_SET*** potentiometer is always active. ON: external ***SPEED_SET*** potentiometer is not active when the generator breaker is closed. ⇨ Also see REMOTE SPEED CONTROL dedicated chapter. SW8: 120Ω RS485 termination resistor for Modbus RTU. OFF: termination resistor is not connected. ON: termination resistor is connected. UNIGEN *PLUS* only.

TABLE 4: DIP SWITCHES DESCRIPTION

6 DISPLAY

UNIGEN includes LED to have information feedback.

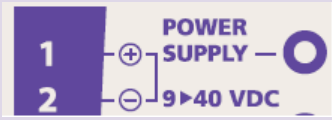
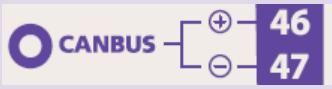
LED	Description
	This LED is ON when DC power supply (12 or 24V_{DC}) is connected.
	This LED is ON when synchronization is requested (***SYNC_IN*** input closed to the 0V_{DC}).
	This LED is ON when a droop is required (***DROOP*** input closed to the 0V_{DC}).
	This LED is ON when the generator breaker is closed (***BREAKER_IN*** input closed to the 0V_{DC}).
	This LED is ON when ***TRIP_OUT*** relay is closed.
	Red LED switched ON when ***REV_kW*** relay is closed.
	This LED is ON when ***START_ON_LOAD_REQUEST*** relay is closed.
	This LED is ON when ***SYNC_OK*** relay is closed.
	This LED is ON when the mains breaker is closed (***MAINS_PARALLELED*** input closed to the 0V_{DC}) UNIGEN *PLUS* only.
	This LED is ON when the fixed kW control is requested (***COMMAND_MODE*** input closed to the 0V_{DC}). UNIGEN *PLUS* only.
	This LED blinks when load sharing is done through CAN bus. This LED blinks according to the number of UNIGEN modules detected in the CAN bus.

TABLE 5: LED DESCRIPTION

7 TERMINALS

7.1 TERMINALS DESCRIPTION

Terminal	Name	Recommended wires (mm² / AWG)	Description
1 2	POWER SUPPLY + POWER SUPPLY-	2.5 / 13	9 to 40 V_{DC} power supply from, 10 W. Protected against reverse connection. Fuse: 5A / 40V_{DC}. Note: terminal 2 must be connected to the 0V terminal of the speed governor with a 4 mm² wire.
3	SYNC IN	1 / 17	Not isolated digital input, dry contact to 0V (10kΩ pull-up). This input activates automatic synchronization of the generator to the bus bar. See SW5 and SW6 configuration.
4	DROOP	1 / 17	Not isolated digital input, dry contact to 0V (10kΩ pull-up). This input forces kW and kVAR load sharing in DROOP mode.
5	BREAKER IN	1 / 17	Digital input. Connect to POWER SUPPLY+ when the generator breaker is closed. Use an auxiliary contact of the generator breaker.
6	UNLOAD	1 / 17	Not isolated digital input, dry contact to 0V (10kΩ pull-up). This input will unload the generator if BREAKER_IN is closed.
7 8	TRIP OUT	1 / 17	Dry contact: normally open. 250V_{AC}, 5A. This output controls the opening of generator breaker at the end of the unload ramp.
9 10	REV kW	1 / 17	Dry contact: normally open. 250V_{AC}, 5A. The relay is closed when generator is in reverse power conditions.

Terminal	Name	Recommended wires (mm^2 / AWG)	Description
11 12 13	+Power monitor (0…5V) -Power monitor (0V) +Power monitor (0…20mA)	1.5 / 16 0.25 / 23 0.25 / 23	0…5V_{DC} (Terminals 11/12) or 0…20mA (Terminals 13/12) analogue output proportional to the generator active power.
14 15 16	SPEED SET CW +5V SPEED SET cursor SPEED SET CCW -5V	0.25 / 23 *	5kΩ potentiometer input or +/-5V_{DC} between terminal 2 (-) and 15 (+). Use a shielded wire. Used as manual remote control of generator speed.
17 18	Generator OUT Generator REF (from speed governor)	0.25 / 23 *	+/-10 V_{DC} analogue output. Use a shielded wire. Engine speed control output compatible with most speed governors on the market. See dedicated commissioning chapter + SW2 configuration. A51M141 modules: 500Hz PWM output, 5V. See dedicated chapter.
19	Shield	0.25 / 23 *	Terminal used to connect the shield of the analogue signals.
20 21	AVR OUT (+) AVR OUT (-)	0.5 / 20 *	Isolated analogue output +/-10V_{DC}. This output controls alternator voltage. Offset and gain potentiometers, this output is compatible with all AVRs of the market.
22 23 24 25 26 27	Generator I1+ Generator I1- Generator I2+ Generator I2- Generator I3+ Generator I3-	2.5 / 13	AC current inputs from generator. 0 to 5A inputs (1VA). Withstands up to 15A during 10s. Nominal current input must be as close as possible to 5A to ensure maximum measurement accuracy.

Terminal	Name	Recommended wires (mm² / AWG)	Description
28 29 30 31	Generator L1 Generator L1 Generator L1 Generator neutral	1.5 / 16	AC voltage measurement inputs from generator. 100 to 500 V_{AC} (Line to line), 50/60Hz. Use 100 mA / 600 V_{AC} fuses. Note: neutral connection is optional.
32 33	START ON LOAD REQUEST	1.5 / 16	Dry contact: Normally open, 250 V_{AC}, 5A. Used for automatic load/unload of generators. See specific chapter and for more details.
34 35	SYNC OK	1.5 / 16	Dry contact: normally open, 250 V_{AC}, 5A. SYNC OK relay is closed when coupling the generator is considered as safe. See specific chapter and SW5/SW6 configuration for more details.
36	SET UNAVAILABLE	1 / 17	Not isolated digital input, dry contact to 0V (10kΩ pull-up). Connect "fault" signal from the generator.
37	SLAVE INPUT	1 / 17	Not isolated digital input, dry contact to 0V (10kΩ pull-up). Set this UNIGEN as slave for automatic load/unload feature.
38	MAINS PARALLELED	1 / 17	Not isolated digital input, dry contact to 0V (10kΩ pull-up). This input gives the position of mains breaker to the UNIGEN. Directly connect an auxiliary contact of the breaker.
39	Mode COMMAND	1 / 17	Not isolated digital input, dry contact to 0V (10kΩ pull-up). This input forces kW and kVAR load sharing in COMMAND mode (fixed kW setpoint).
40 41 42	kW SET CW +5V kW SET cursor kW SET CCW 0V	0.25 / 23 *	Analog input 5kΩ potentiometer or 0-5V_{DC} between 42 (-) and 41 (+). Use a shielded wire.
43	Not connected		

Terminal	Name	Recommended wires (mm² / AWG)	Description
44 (plus) 45	Parallel lines (+) Parallel lines (-)	2.5 / 13*	0…3V_{DC} load sharing signal between UNIGEN modules, or active power set point when used with GCR module. Used when SW3 is OFF. Compatible with Wheatstone bridge load sharing signals.
46 47	CANBUS+ CANBUS-	2.5 / 13*	Isolated input. Load sharing through CAN bus communication. Used when SW3 is ON for UNIGEN *PLUS*. See also SW1 configuration.
48	SHIELD	0.25 / 23 *	Terminal used to connect the shield of the analogue signals.
49 (plus) 50	MODBUS A MODBUS B	2.5 / 13 *	19200 bps RS485 Modbus RTU slave. Also see SW8 configuration.
51 52 53 54	Bus bar L1 Bus bar L2 Bus bar L3 Bus bar neutral	1.5 / 16	AC voltage measurement inputs from bus bar. 100 to 500 V_{AC} (Line to line), 50/60 Hz. Use 100 mA / 600 V_{AC} fuses. Note: neutral connection is optional.
COM1	RS232 to PC or modem	Female DB9	Connection via *CRE Config* software. Use a straight 9 wires cable.

TABLE 6: TERMINALS OF THE MODULE

(plus) Only available on UNIGEN *PLUS*.

Note:

- *Shielded cable is recommended for these connections. Use 2 or 3 Conductor Foil Shield with drain Wire.*
- *Cable sizes are for guidance only. Cable size should be increased for long cable runs, to overcome possible voltage drop and to increase noise immunity. Only for UNIGEN PLUS.*

7.2 WIRING DIAGRAM

Terminals of the industrial UNIGEN are all present on UNIGEN *PLUS*.

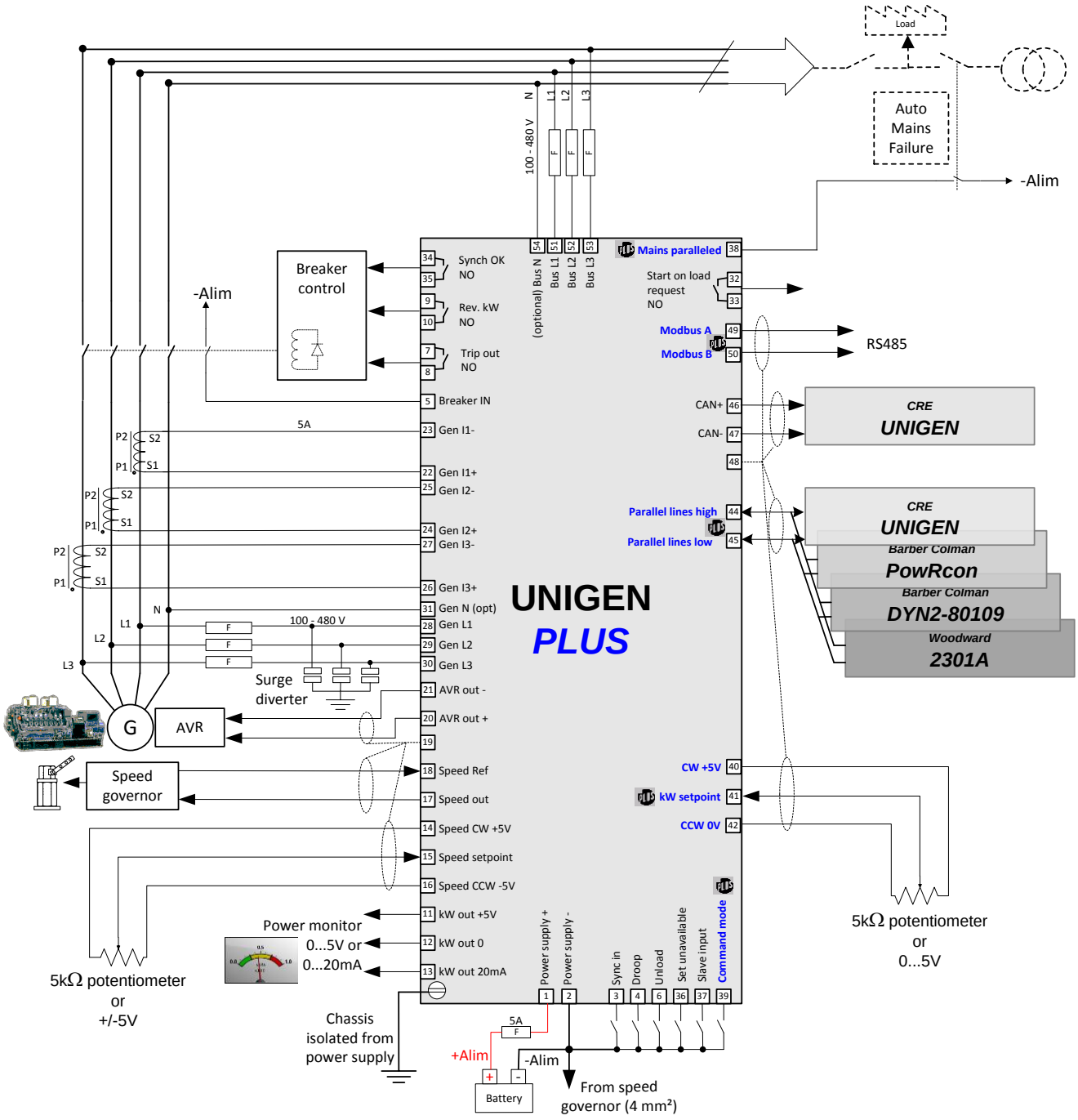


FIGURE 14: WIRING DIAGRAM

UNIGEN *PLUS* only

7.3 CONNECTION TO A CUMMINS EFC SPEED REGULATOR

Due to the big sensitivity of Cummins EFC speed input, wiring should be applied as shown below. This allows a higher voltage span on UNIGEN speed output.

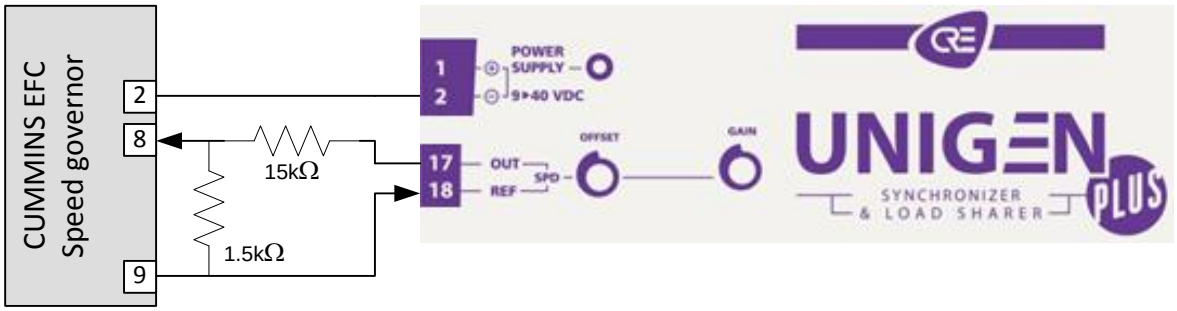


FIGURE 15: EFC CUMMINS CONNECTION

7.4 CONNECTION TO A WOODWARD EPG SPEED REGULATOR

Refer to dedicated commissioning chapter for potentiometers adjustment.

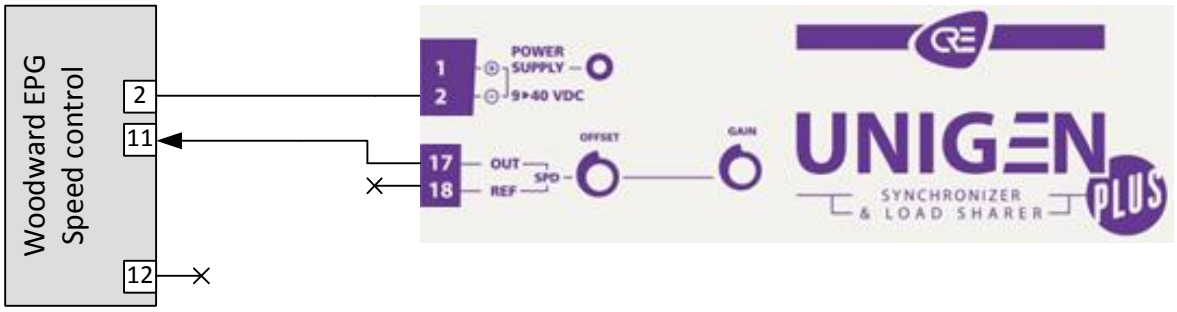


FIGURE 16: WOODWARD EPG CONNECTION

7.5 CONNECTION TO A LEROY SOMER VOLTAGE REGULATOR

Most Leroy Somer AVR modules feature an input for an external potentiometer for voltage control. Figure below shows the example of an R448 AVR connection.

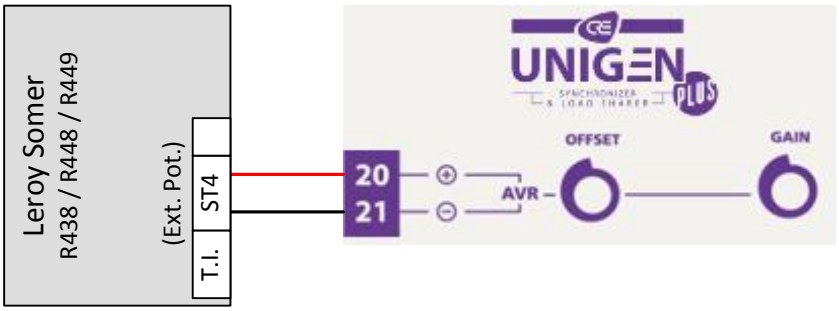


FIGURE 17: CONNECTION TO LEROY SOMER R448/R449 AVR

7.6 CONNECTION SPECIFICATIONS

- **Power supply:** 9 to 40V_{DC}, <1A with 12 V_{DC} and <500mA with 24V_{DC}.
- **AC voltage inputs:** 100 to 500V_{AC}, 100mA max. The neutral wire can be connected or not.
- **AC currents inputs:** 0 to 5A, 1VA. Each input is isolated from the other ones.
- Possible over-current: 15A during 10s.
- **Frequency measurement:** 45 to 70 Hz – 15 V_{AC} minimum between neutral and line.
- **Digital inputs:** Normally Open, to be connected to 0V (internal pull up of 10kΩ).
- **Relay outputs:** 5A, 230V_{AC} max.
- **Remote speed control input:** 5kΩ potentiometer or +/-5V_{DC}.
- **Remote kW control input for COMMAND mode:** potentiometer (5kΩ) or 0…+5V_{DC}.
- **kW monitor output (0…5V_{DC} or 0…20mA/4-20mA):** 300Ω maximum load on the 0…20mA or 4…20mA output. 1kΩ minimum load on the 0…+5V_{DC} output.
- **Speed bias output:** The frequency control is made by the adjustable 0…10V_{DC} output. Adjust using ***OFFSET*** and ***GAIN*** potentiometers.
- **Voltage bias output:** The voltage control is done via the AVR. The output is a +/-10V. Adjust using ***OFFSET*** and ***GAIN*** potentiometers.
- **Terminals:** with screws, 2.5 mm^2.

8 COMMISSIONING

8.1 CAUTION

8.1.1 GROUNDING:

The grounding of the chassis of UNIGEN must be done with the M5 screw. Use a 4mm² wire to connect to earth, this cable should be as short as possible.

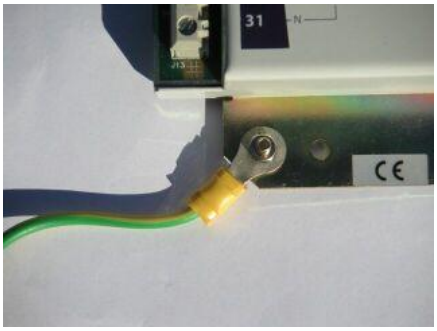


FIGURE 18: EARTH CONNECTION

8.1.2 WIRING RULES:

The cables with high voltage ($400V_{AC}$) and/or high current (5A) must be separated from the command cables. All the command and digital inputs / outputs can be in the same cable path.

If you have to cross the command/DC cables with the 400V/5A cables, it is recommended to cross with a right angle.

The grounding must be done in a proper way to avoid personal injuries and for a reduction of EMC.

8.1.3 VIBRATIONS:

In case of heavy vibrations, UNIGEN should be mounted using AV Mounts.

8.2 POWER PLANT START-UP/COMMISSIONING

Caution: before starting the generating sets, please read the following part.

This is a standard commissioning for a simple power plant. If you use only this procedure, it can't engage our responsibility.

Before commissioning (before going on site)

Check of schematics

How?

- Be sure you have the latest power plant schematics.

Why?

- To be sure the wires will be present on site (Can bus connector, shielded wires...).

What?

- 0 Volt wiring.
- Shields.
- Speed governor / UNIGEN Interface.
- Automatic Voltage Regulator / UNIGEN Interface (droop current transformer must be removed).
- CAN bus.
- Parallel lines.

During commissioning

Start in safe condition

How?

- Generator breaker output locked in open position.
- Disconnect the wires between UNIGEN (terminals 17/18) and the speed governor.
- Disconnect the wires between UNIGEN (terminals 20/21) and the AVR.
- Ask the technician who had wired the power plant to lock the generator breaker open.
- Battery negative of each UNIGEN power supply (terminal 2) must be connected to each other UNIGEN and to the 0V of the speed governor.
- Disconnect the wires of the relay 'SYNC OK' (terminals 34/35) of the UNIGEN.

Why?

- To be sure not to drive a false paralleling during the beginning of commissioning.

Switches configuration

How?

- Put switches in OFF/ON position before start the engine, see dedicated chapter "Settings" for more details.

Why?

- To configure several important functions of the UNIGEN.

Interface UNIGEN / Speed governor

Interface UNIGEN / Auto Voltage Regulator

How?

- Start the engine.
- Adjust the nominal speed and voltage, for example 50.00Hz & 400V_{AC}, on the speed/voltage regulator. If a trim pot is present on the AVR, adjust it to get +/-8% (see AVR manufacturer doc).
- Stop the engine.
- Remove the cover of the UNIGEN if necessary.
- Connect only the ***REF*** input (terminal 18) to the speed governor "speed ref output".

➢ Speed setting :

- Start the engine.
- Adjust Speed gain RV10 full CCW on the UNIGEN.
- Measure the voltage between Ref and remote voltage input on speed regulator side.
- Adjust UNIGEN output voltage (terminals 17/18) adjusting the offset RV9 to have the same voltage than measurement of previous point.
- Connect the control wire (terminal 17).
- Shunt terminals 15 and 16 together to get the maximal negative speed correction on ***SPEED_SET*** input.
- Adjust the speed gain RV10 to have 48.00Hz.
- Remove the shunt between terminals 15 and 16..
- Stop the generator.

➢ Voltage setting :

- Adjust AVR Offset RV11 & Gain RV12 full CCW on the UNIGEN.
- Connect AVR outputs (terminals 20/21) to AVR.
- Adjust voltage offset RV11 to have 400V_{AC}.
- Close ***SYNC_IN*** input (Terminal 3 to 0 volts).
- Adjust AVR Gain RV12 to reach 370V_{AC}

Check the control of the breaker on dead bus (depending on SW6 position)

- Be sure there is no critical load connected on bus bar.
- Close the breaker and verify that the breaker feedback input (terminal 5) is closed (***BREAKER_IN*** LED should light on).
- Open the breaker and verify that the breaker feedback input is opened (LED not lit).

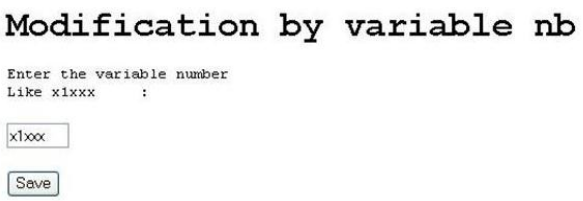
Adjustment of the nominal power

- For the Industrial UNIGEN:
  - Set the kW monitor output in 0-5V: switch SW4 to OFF position.
  - Put in full CW the multi turn potentiometer *ADJUST* RV7.
  - Close the circuit breaker of the generator. ***BREAKER_IN*** LED must light on.
  - Apply 100% of load on the generating set (with bench load for example).
  - Adjust ***NOMINAL_kW*** potentiometer RV13 to reach 7.45V_{DC} between terminals 11(+) and 12(-) of the UNIGEN.
  - Open the circuit breaker of the generator.
  - Set switch SW4 as desired depending on your application.

- UNIGEN *PLUS* (Generating set below 200kW):

  On GE with a nominal power below 200kW, adjustment of ***NOMINAL_kW*** potentiometer RV13 may be hard to find. To adjust this setting more easily it may be helpful to decrease UNIGEN *PLUS* internal CT ratios (Factory set to 1000). This can be done by lowering value of variables E11002, E11003 and E11004 (e.g. set them to 200):

  - Connect to UNIGEN *PLUS* internal Website using a computer (see document A51Z1 9 0015A).
  - Type in password "1".
  - Go to ***Configuration/Modification by variable nb*** page.



  - Enter the number of the variable to modify (at first "11002") and validate.
  - Enter the new desired value and press SAVE button.
  - Repeat these steps for variables E11003 and E11004.
  - Go to page ***System/save all variables***.
  - Click on "Flash it!".
  - Disconnect UNIGEN, switch power off and then switch it on again for new settings to take effect.
  - Finally, adjust the nominal power potentiometer as described below for engines above 200kW.

- UNIGEN *PLUS* (Generating set with nominal power between 200kW and 4000kW):
  - Switch SW3 to OFF position.
  - Paralleling lines are not connected on terminals 44 and 45.
  - Close the circuit breaker of the generator. ***BREAKER_IN*** LED must light on.
  - Apply 100% of load on the generating set (with bench load for example).
  - **Adjust *NOMINAL_kW*** potentiometer RV13 to obtain 3V on parallel lines (terminal 44 & 45).

  Open the circuit breaker of the generator.

Check wiring of current

- Put load.
- Measure the voltage between terminals 11 and 12.
- Shunt the phase 1 current directly of the secondary of the current transformer (CT).
- Measure the voltage between terminals 11 and 12. Check that this voltage decrease of 1/3 that before.
- Do the same test for phases 2 and 3 (don't forget to remove the shunt of each phase after test).
- Switch SW3 as desired depending on your application.

Check synchronization

- Close the breaker to have voltage on the bus bar (mains or other generator).
- Lock the engine breaker in open position.
- Start the engine to check the synchronization.
- Close ***SYNC_IN*** input (terminal 3 connected to $0V_{DC}$).
- Adjust ***P*** (RV15) & ***I*** (RV1) potentiometers of synchronization to reach a response time of 4 or 5 seconds to get the ***SYNC_OK*** signal (terminals 34/35) the relay closes.
- With a voltmeter check on both sides of the breaker if the voltage is <20VAC on each phases.
- With the voltmeter check also that there is 400VAC between phase 1 of the engine and phase 2 of the bus bar (crossed monitoring).
- In this test we don't close the breaker.
- If the test is OK, connect the wires of the relay ***SYNC_OK*** (terminals 34/35) of the UNIGEN.

Load sharing / kW regulation

- Regarding the application check the stability of kW and kVAR regulation.
- Open Breaker.
- Stop engines.

9 ENVIRONMENT

- **Operational temperature:** 0 to + 70°C.
- **Storage temperature:** -30 to +70°C.
- **Humidity:** 5 to 95%. The PCB is tropicalized to be used in humid climate areas. Protection IP20.
- **Size:** 275x200x26mm.
- **Mounting:** Can be placed in all positions.
- **Weight:** 1.5Kg.

9.1 CE DIRECTIVES

EMC Directive 89/336/EEC deals with electromagnetic emissions and immunity. This product is tested by applying the standards, in whole or in part, which are documented in technical construction file CEM 2004/108/EC, which replaces directive CEM (89/336/EEC) relative to electromagnetic emissions as from July 20th 2009. This product is developed to respect harmonized norms:

- EN 55099:2009
- EN 55099:2010
- EN 55088:2008
- 2006/95/EC (replaced directive 73/23/EEC since January 16th 2007).

Other standards:

- EN 61326-1: 2006 (Industrial location)
- EN 55011
- EN 61000-3-2
- EN 61000-3-3

10 DIMENSIONS

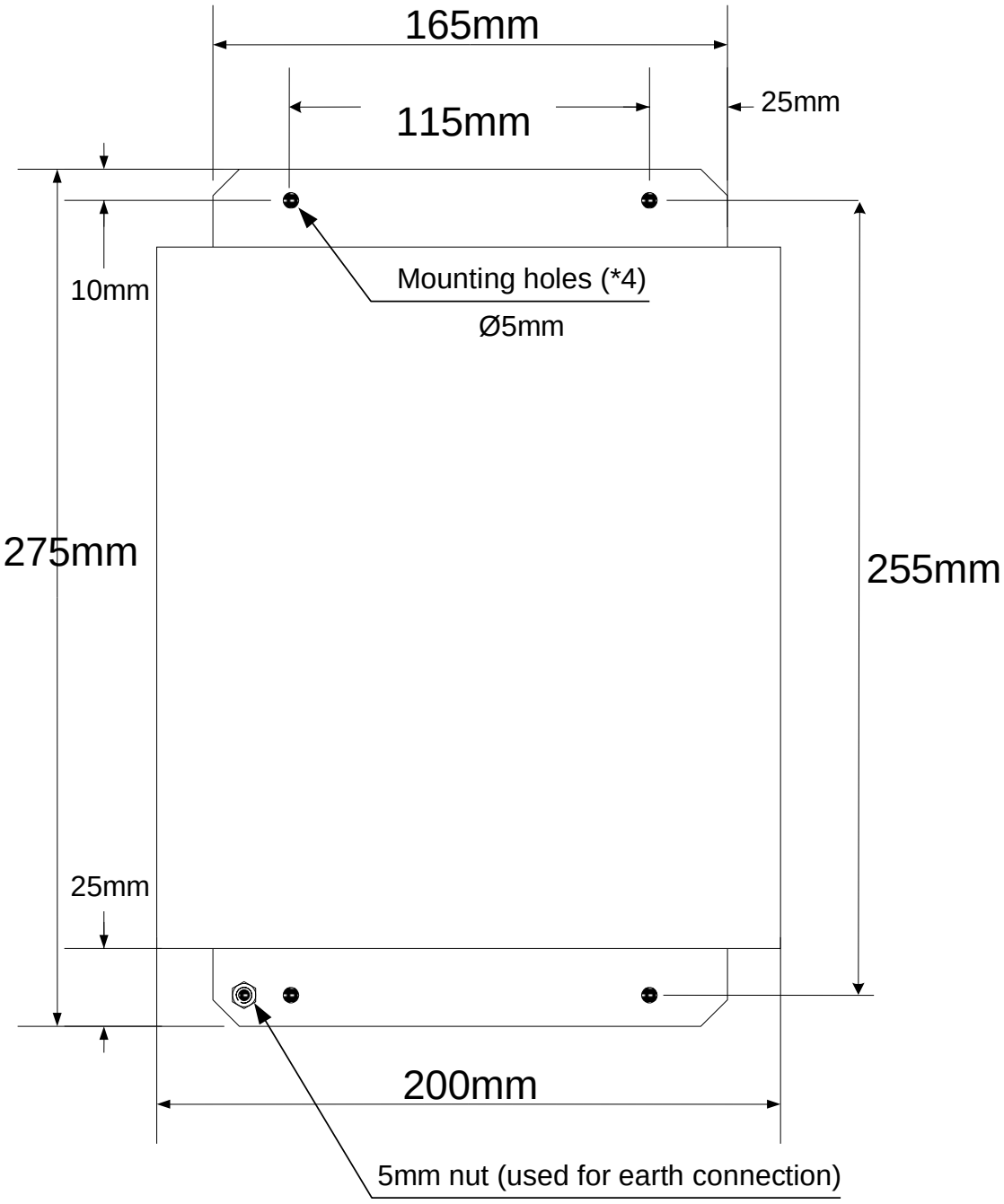


FIGURE 19: DIMENSIONS

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Email: support@cretechnology.com

SKYPE: support-cretechnology.com

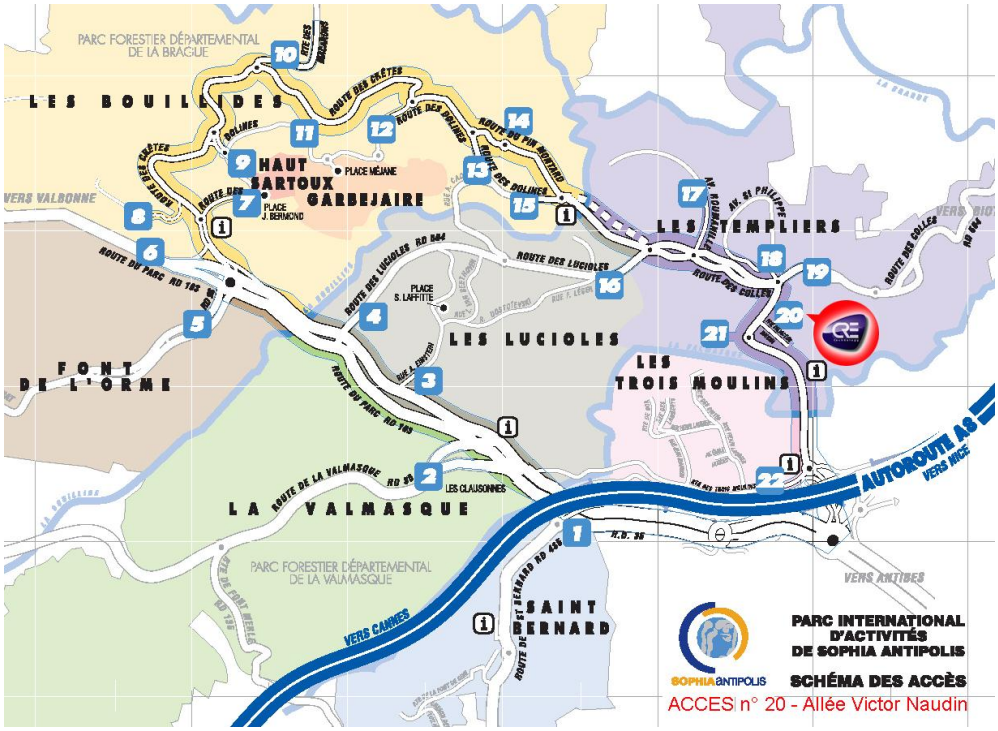

FIGURE 20 - ACCESS TO CRE TECHNOLOGY

Check our entire distributors list around the world on www.cretechnology.com tab “DISTRIBUTORS”

FIGURE 21 - CRE TECHNOLOGY DISTRIBUTORS