

MPS 5.0

November 2005



Synchronization and load sharing module Technical documentation



NOTE :

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage. Contact your CRE dealer for course training.

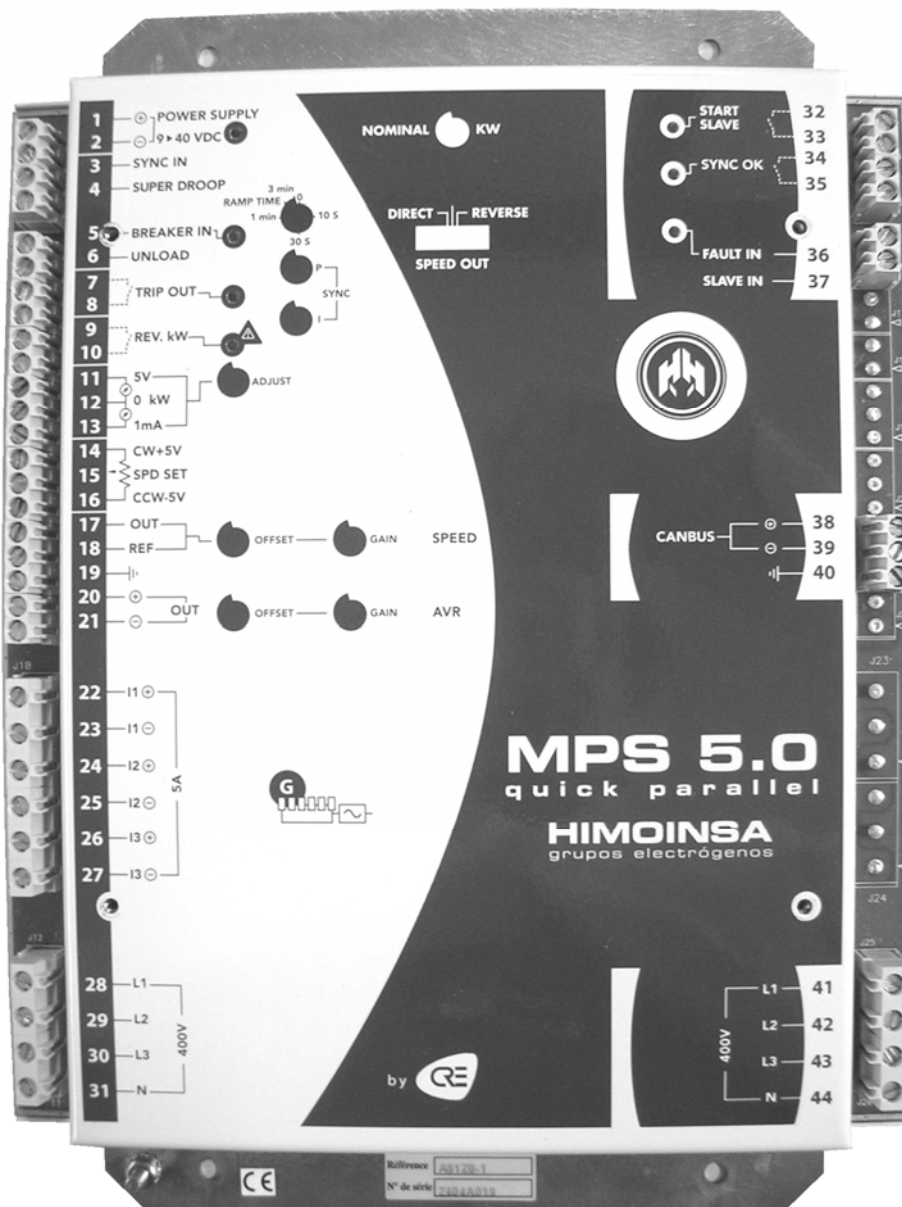
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1. Overview

1.1. Cover



1.2. Global function

- Automatic and Manual synchronization.
- Active load sharing in isochronous or super droop mode.
- Reactive load sharing in isochronous voltage or droop mode.
- Compatibility with all the speed governors and AVR on the market.
- Remote speed control by potentiometer.
- Internal synch check relays, useful for auto and manual synchronization.
- CAN plug and play.
- Automatic load/unload.
- Reverse Kw relays.
- 2 analogue outputs (0-5V or 0-1ma.) for Kw meter.

2. Features

2.1. Synch check relay

SYNC OK output (terminal 34 + 35) permit the coupling of generators when all following conditions are correct:

- Voltage of generator and bus bar within a 70 - 130% window from nominal voltage.
- 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

The relay is closed when the conditions are correct. This output is NOT dependant of the SYNC IN (terminal 3) input.

At start, on dead bus, there is a delay before closing the SYNC OK relay (E01033, default value 3.0s).



CAUTION : There is no dead bus management.
On dead bus the synch check relay is automatically closed.
One generator has to be started alone to close on the dead bus before starting the other generators.

2.2. Reverse kW relay

MPS 5.0 includes a reverse Kw relays, terminal 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 red LED is ON to confirm the activation of the relay:

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

2.3. KW indicator

MPS 5.0 includes one Kw output on terminals 11, 12 and 13.

Those outputs allows the display of the Kw with a 0-5VDC or 0-1ma. Instrument scaled in kW.

Multi-turn ADJUST potentiometers tune the output nominal kW to calibrate the instrument.

2.4. Remote speed control input

- MPS 5.0 includes a remote speed control input on terminals 14, 15 and 16.

Those 3 wires inputs (+5v, cursor, -5v) are design to accept 5 K/Ohms external potentiometers.

The mid point of those potentiometers (5 turns for a 10 turns potentiometer) will generate a 0V signal to the cursor input and will not generate any speed deviation.

The maximum speed deviation is +/- 3,00Hz:

- +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 0-5Vdc for a master PLC control. In this case the nominal speed have to be adjusted with 2.5 VDC applied on cursor input.

2.5. CAN load sharing

When SUPER DROOP (terminal 4) input is opened, MPS 5.0 is in isochronous mode. The load setpoint will be calculated via the CAN connection.

Until 8 MPS 5.0 can be connected via CAN bus.

2.5.1. Plug and play

As soon as several MPS 5.0 are connected together, they choose automatically a generator number different from each other.

They are able to share the load without any settings.

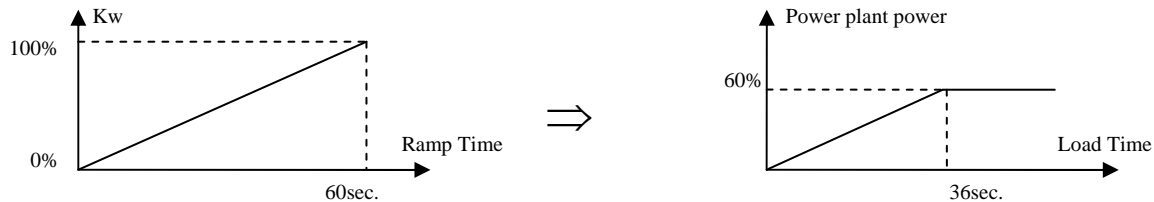
If one MPS 5.0 disappear from the CAN, it is no longer taken under account by the others, and they continue to share the load isochronously.

2.5.2. 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.



2.5.3. Automatic trip.out

TRIP OUT (terminal 7 & 8) is used to open the breakers once the unload ramp is finished.

The relay is closed when the kW of the generator which is unloading reach 5% of the nominal kW. The TRIP OUT green LED confirms the activation of the relay:

LED ON = contact close.

LED OFF = contact open.

2.5.4. Manual load/unload request

The Load /Unload ramps are managed by the UNLOAD inputs (terminal 6 for generator and terminal 37 for bus bar):

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

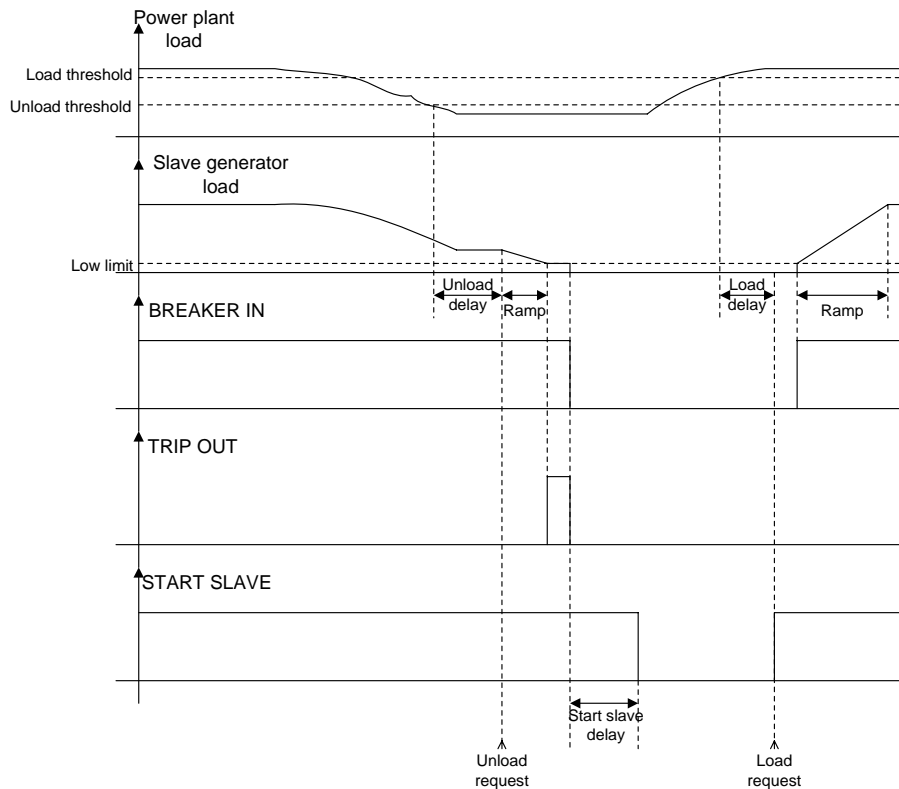
2.5.5. Automatic load/unload request

The START SLAVE relay output can be used to start and stop the slave generators depending on the load request.

A generator is slave when the SLAVE IN input is connected to 0V.

- If the power plant load goes below 20% of the nominal power during more than 2 minutes, stop negotiations begin to elect one of the slave generators to stop.
- If the power plant load goes above 70% of the nominal power of the power plant during 10 seconds, start negotiations begin to elect one of the slave generators to start.
- If the load is between 20 and 70% of the nominal power than the actual number of generators on the bus bars will not change until 20% or 80% threshold is reached.

START SLAVE relay behaviour is described in the schematic below.



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

2.6. SUPER DROOP load sharing

When SUPER DROOP (Terminal 4) input is connected to 0 VDC, MPS 5.0 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 MPS 5.0, even the 0V.

kW and kVAR load sharing are managed with droop.

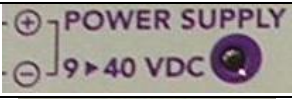
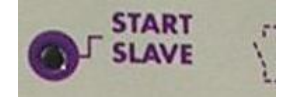
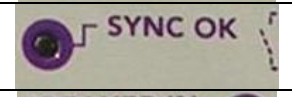
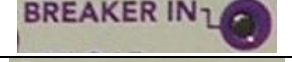
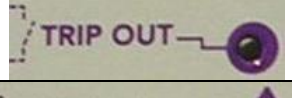
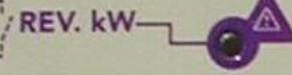
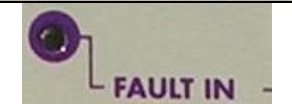
3. Settings

MPS 5.0 includes the following adjustments for calibration and settings:

Setting	Picture	Default value	Description
SPEED OUT		DIRECT	3 positions switch for speed output option : Direct for standard speed regulator. Reverse for GAC speed regulator.
NOMINAL KW		None	Have to be set during the commissioning. See chapter ???.
RAMP TIME		0s	Single turn potentiometer (0.0 - 180s). This setting adjusts the time for LOAD and UNLOAD ramps. 1 potentiometer for each generator.
SYNCHRO Proportional SYNCHRO Integral		6h  6h 	Single turn potentiometers. Proportional gain adjustment of synchronization. Single turn potentiometers. Integral adjustment of synchronization. Synchronization adjustment: <ul style="list-style-type: none"> • Turn P and I fully Counter Clockwise • Turn P potentiometer till the generator is unstable, Come back in CCW to stop the instability. • I potentiometer is adjusted with the same procedure.
ADJUST KW monitor		None	Multi turn potentiometer (0-100%). Output span adjustment Kw (0-5V or 0-1ma.).
OFFSET Speed control output		None	Multi turn potentiometer (-10 to +10 VDC). Adjustment of the Offset of the speed output. Used to adjust the nominal frequency of the generator (ex: 50,00Hz).
GAIN Speed control output		6h 	Single turn potentiometer (Span from 0 to 10VDC). Span adjustment of the speed control output. Used to adjust the maximum deviation asked by MPS 5.0 = +/-3 Hz
OFFSET Voltage control output		None	Multi turn potentiometer (-10 to +10 VDC). Offset adjustment of the voltage control output. Used to adjust the nominal voltage of the alternator (ie. 400 VAC)
GAIN Voltage control output		6h 	Single-turn potentiometer (Span from 0 to 10VDC). Span voltage control output. Used to adjust the maximum deviation: = +/- 8% of the nominal voltage.

4. Display

MPS 5.0 includes LED to have information feedback.

Led	Description
POWER SUPPLY 	Green LED. This LED is ON when DC power supply (12 or 24 VDC) is connected.
START SLAVE 	Green LED. This LED is ON when the relay LOAD SHEDDING is closed.
SYNC OK 	Green LED. This LED is ON when synchronous condition OK
BREAKER IN 	Green LED. This LED is ON when the breaker is closed.
TRIP OUT. 	Green LED. This LED is ON when the relay TRIP OUT is closed.
REV KW 	Red LED. This LED is ON when the relay REV Kw is closed.
FAULT IN 	Green LED. This LED is ON when the relay FAULT IN is closed.

5. Terminals

5.1. Terminals description

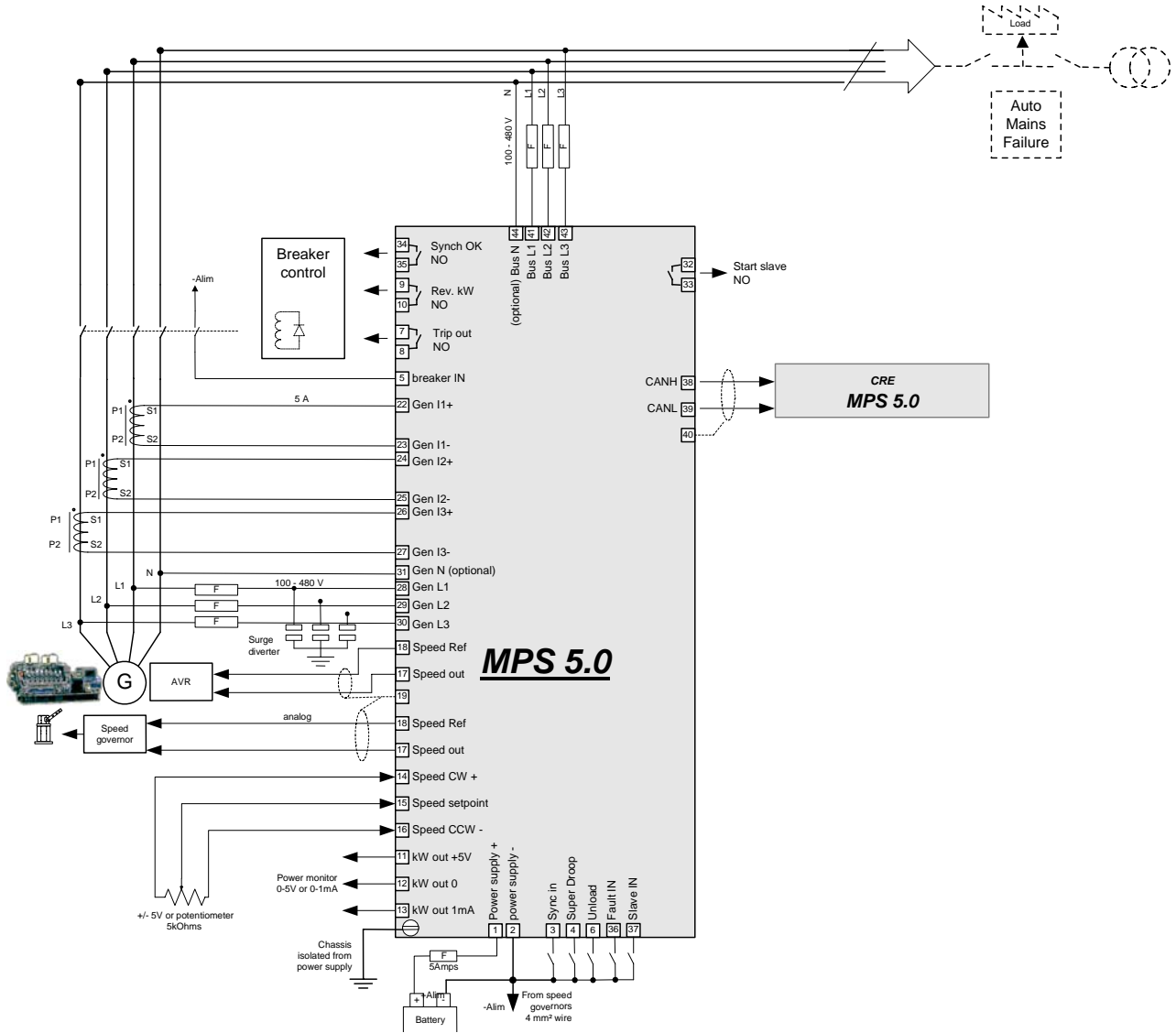
Terminal n°	Description	Wire (mm ² / AWG)	Commentaries
1	POWER SUPPLY +	2.5 / 14	DC Voltage from 9 to 40 VDC, 10 Watt. Twist protection. Note: Terminal 2 MUST be connected to both 0v of the speed governors with a 4 mm ² wire. Fuse: 5 Amps / 40 VDC.
2	POWER SUPPLY -	2.5 / 14	
3	SYNC IN	1 / 18	None isolated digital input, Dry contact to 0v (10 K/Ohm pull-up). This input activates the automatic synchronization If generator on the Bus bars -> synchronization of bus bar If bus bar on the bus bars -> synchronization of generator.
4	SUPER DROOP	1 / 18	None isolated digital input, Dry contact to 0v (10 K/Ohms pull-up). This input forces kW and kVAR load sharing in DROOP mode.
5	BREAKER IN	1 / 18	None isolated digital input, Dry contact to 0v (10 K/Ohms pull-up). This input gives the position of generator 1 breaker to the MPS 5.0. Use a direct Aux contact of the breaker.
6	UNLOAD	1 / 18	None isolated digital input, Dry contact to 0v (10 K/Ohms pull-up). This input generate an unload ramp of generator 1.
7	TRIP OUT	1 / 18	Dry contact; normally open. 250 VAC, 5A. This output controls the opening of generator 1 breaker at the end of the unload ramp.
8	TRIP OUT	1 / 18	
9	REV KW	1 / 18	Dry contact; normally open. 250 VAC, 5A. The relay is closed when generator 1 is in reverse.
10	REV KW	1 / 18	
11	KW monitor (0 – 5V) +	1.5 / 16	DC analogue output 0 – 5V (Terminals 11 and 12) Or 0 – 1mAmps (Terminals 12 and 13). This output (voltage and/or current) sends the actual value of generator 1, kW.
12	KW monitor (0V)	0.25 / 24	
13	KW monitor (0 – 1mA) +	0.25 / 24	
14	SPEED SET CW +5V	0.25 / 24	Analogue input 5 K/Ohms potentiometer or 0-5 VDC between 16 (-) and 15 (+). Use a shielded wire. This input allows a manual remote control of generator speed.
15	SPEED SET cursor	0.25 / 24 *	
16	SPEED SET CCW -5V	0.25 / 24 *	
17	Generator OUT speed control output	0.25 / 24 *	Analogue output +/-10 VDC. Use a shielded wire. This output controls the speed of generator 1 (offset and gain potentiometers) this output is compatible with all speed governors of the market.
18	Generator REF from speed governor speed control output	0.25 / 24 *	
19	Shield	0.25 / 24 *	Terminal to connect the shield of the analogue signals.
20	AVR OUT (+)	0.25 / 24 *	Isolated analogue output +/-10 VDC. This output controls alternator 1, voltage.(offset and gain potentiometers), this output is compatible with all AVRs of the market.
21	AVR OUT (-)	0.5 / 20 *	
22	Generator I1+	2.5 / 14	AC current inputs from generator 1. Current: from 0 to 5 A. Max current: 15 A during 10s. Load: 1 VA. The nominal current of the secondary of the current transformers must be as close as possible to 5Amps.
23	Generator I1-	2.5 / 14	
24	Generator I2 +	2.5 / 14	
25	Generator I2 -	2.5 / 14	

26	Generator I3 +	2.5 / 14	
27	Generator I3 -	2.5 / 14	
28	Generator L1	1.5 / 16	AC voltage input measurement generator. Line to line voltage from 100 to 500 VAC . Frequency: 50 or 60 Hz. Fuses: 100 ma. / 600 VAC. Note: If the neutral input is not connected, MPS 5.0 will generate an internal virtual neutral point.
29	Generator L2	1.5 / 16	
30	Generator L3	1.5 / 16	
31	Generator Neutral	1.5 / 16	
32	START SLAVE	1 / 18	Dry contact: Normally open, 250 V _{AC} , 5A. LOAD SHEDDING relay is closed when the load request exceeds 80% of the nominal power -> slave generator is to start. LOAD SHEDDING relay is opened when the load request is above 20% of the nominal -> Slave generator is to stop.
33	START SLAVE	1.5 / 16	
34	SYNC OK	1.5 / 16	Dry contact normally open, , 250 VAC, 5A. SYNC OK relay is closed when the coupling of the generators is safe: - Voltage difference within limits. - Phase difference within limits. - Frequency difference within limits.
35	SYNC OK	1.5 / 16	
36	FAULT IN	1 / 18	None isolated digital input, Dry contact to 0v (10 K/Ohms pull-up). This input gives the position of generator 2 breaker to the MPS 5.0. Use a direct Aux contact of the breaker.
37	SLAVE IN	1 / 18	Non isolated digital input, Dry contact to 0v (10 K/Ohms pull-up). This input generate an unload ramp of generator 2.
38	CANBUS+	*	
39	CANBUS-	*	
40	SHIELD	0.25 / 24 *	Terminal to connect the shield of the CAN signals.
41	Bus bar L1	1.5 / 16	AC voltage input measurement bus bar. Line to line voltage from 100 to 500 VAC. Frequency: 50 or 60 Hz. Fuses: 100 ma. / 600 VAC. Note: If the neutral input is not connected, MPS 5.0 will generate an internal virtual neutral point.
42	Bus bar L2	1.5 / 16	
43	Bus bar L3	1.5 / 16	
44	Bus bar Neutral	1.5 / 16	

Note: * Shielded cable is recommended for these connections. Use 2 or 3 Conductor Foil Shield with drain Wire.

Note: 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.

5.2. Wiring diagram

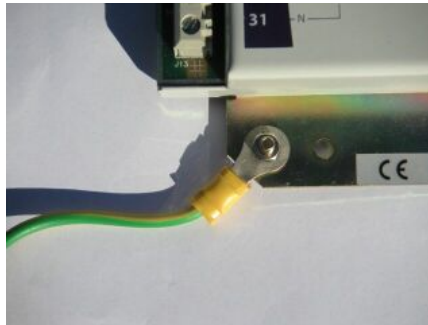


6. Commissioning

6.1. Caution

6.1.1. **Grounding:**

The grounding of the chassis of MPS 5.0 must be done with the M5 screw. Use a 4mm² wire to connect to earth, this cable should be as short as possible.



6.1.2. **Wiring rules:**

The cables with high voltage (400 VAC) and/or high current (5A) must be separated from the DC cables. All the command and digital inputs / outputs should 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.

6.1.3. **Vibrations:**

In case of heavy vibrations, the MPS 5.0 should be mounted using AV Mounts.

6.2. Power plant start-up

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

- Generator has to be in safe position (breaker output locked in open position, dead bus bar...).
- Remove the cover if necessary.
- Set the GAC switch (LEFT = Normal, RIGHT = GAC/reverse acting).
- Disconnect the cable SPEED OUT (17) and AVR outputs.
- Adjust the nominal speed and voltage, for example 50,00Hz & 400VAC, on the speed/voltage regulator. If a trim pot is present on the AVR, adjust it to get +/-8% (see AVR manufacturer doc).
- Speed setting :
 - o Adjust Speed gain RV2 CCW.
 - o Adjust potentiometer Speed Offset RV1 to get 0 VDC between speed OUT and the Aux input of the governor.
 - o Re-connect the SPEED OUT to the governor.
 - o Close the SYNC IN input (terminal 3 to 0Volt). MPS 5.0 is trying to synchronize on a dead bus (00.00Hz).
 - o Adjust the speed gain RV2 to have 48,00Hz.
 - o Open the SYNC IN input.
- Voltage setting :
 - o Adjust AVR Offset & Gain CCW.
 - o Connect AVR outputs to AVR.
 - o Adjust voltage offset RV9 to have 400VAC.
 - o Close SYNC IN input (Terminal 3 to 0volt).
 - o Adjust AVR Gain RV7 to reach 370VAC.
- Close breaker and verify that the breaker feedback is closed (the BREAKER IN led should lit).
- Apply 100% of load.
- Close SUPER DROOP input.
- Adjust NOMINAL KW potentiometer RV13 to reach 50.00Hz.
- Repeat all previous step for each generator.
- Synchronization test :
 - o Start 1generator, close its breaker.
 - o Lock another generator breaker in open position.
 - o Start another generator.
 - o Close SYNC IN input.
 - o Adjust the P & I potentiometer of synchronization to have a response time of 4 or 5 seconds to get the SYNC OK signal.
 - o With a voltmeter check on both sides of the breaker if the voltage is 0V.
 - o With the voltmeter check also that there is 400V between line 1 of 1st generator and line 2 of the bus bar (crossed monitoring) stop generators.
- Repeat synchronization test for each generator.

7. Environment

- **Operational temperature:** -20 to + 85°C.
- **Storage temperature:** -30 to +85°C.
- **Humidity:** 5 to 95%. The PCB is tropicalized to be used in humid climate areas. Protection IP20.
- **Altitude:** 2000m.
- **Size:** 275x200x26mm.
- **Mounting:** Can be placed in all positions.
- **Weight:** 1.5Kg.
- Directive CE:
 - Generic emission standard: EN 50081-2, EN 50082-2.
 - Generic immunity standard: EN 61000-6-2.
 - Low voltage directive: 73/23EEC.
- **Power supply:** 9 to 40 VDC, <1A with 12 VDC and <500mA with 24 VDC.
- **AC voltage inputs:** 100 to 500 VAC, 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 VAC minimum between neutral and line.
- **Digital inputs:** NO, to be connected to 0v (internal pull up of 10 K/Ohms).
- **Relay outputs:** 5A, 230 VAC max.
- **Remote speed control input:** potentiometer (5 K/Ohms) or 0-5 VDC.
- **Kw monitor output (0-5 V or 0-1ma.):** the maximum load impedance for the 0-1 ma. is 500 Ohms and the minimum load impedance for the 0-5 VDC is 1 K/Ohms.
- **Speed bias output:** The frequency control is made by the adjustable 0-10 VDC output. The adjustments are, Offset and Gain potentiometers.
- **Voltage bias output:** The voltage control is done via the AVR. The output is a +/-10V, output with Gain and Offset adjustments.
- **Terminals:** with screws, 2.5 mm².

8. Dimensions

