

## Genset Controller EMC-01

### Introduction

EMC-01 is a diesel generator controller designed for small Gensets (3.5KVA-12.5KVA) sold in the private market segment. The unit incorporates Manual and Auto-Start input initiated start and stop sequencing, monitors engine and alternator operating parameters and provides both engine and alternator protection in a single integrated package.

The Genset's operating parameters are shown in sequence on a four character seven segment LED display.

Separate LEDs indicate which parameter is currently being shown. Alarms and Warnings are indicated on the seven segment display using Error Codes which are printed on the front label. The unit provides monitoring of the engine and generator operating parameters and provides automatic shutdown of the set in the event of damaging conditions. In regards to engine protection the unit monitors oil pressure, fuel level and engine temperature to provide protection. For alternator protection, it monitors AC voltage, frequency and load and if any parameter goes beyond the safe operating limits the unit shuts down the Genset.

### Benefits

- Reduces system cost.
- Integrates engine gauges and AC metering into one unit.
- No need of external Current Transformer, as it has on-board CT (0-64A).
- Minimizes control panel wiring offering reduced material and labour costs.
- Reduces warranty costs by providing comprehensive engine and generator protection.

Physical Form



Figure 1: EMC-01- Front View

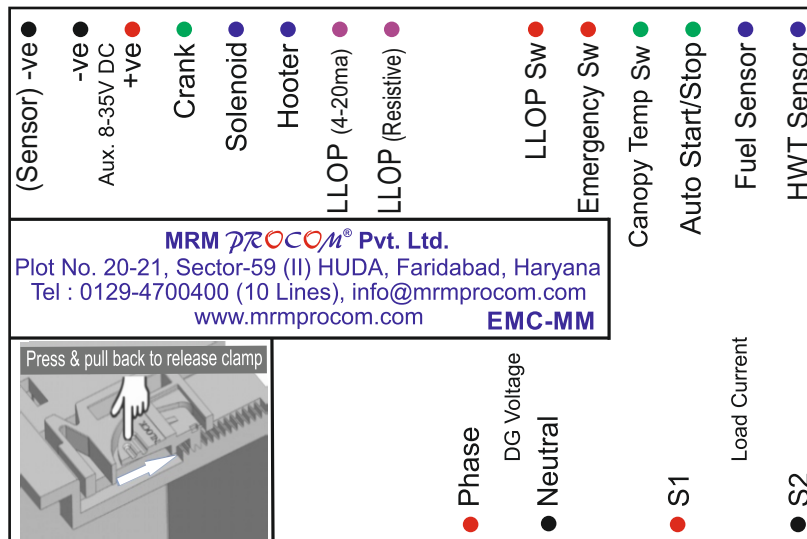


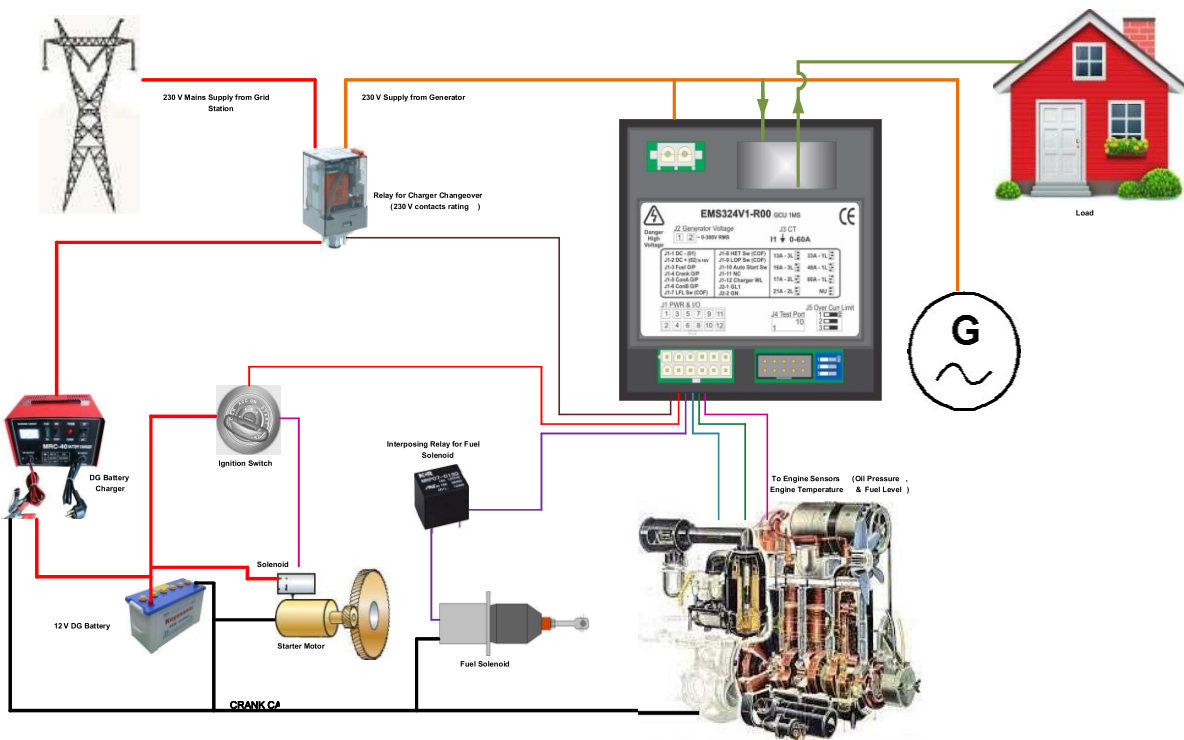
Figure 2: EMC-01 Rear View

System Diagram

Figure 4 and 5 shows the field view and system level diagram of EMC-01 & EMC-02.



Engine Monitoring



System Level Diagram

Functions System

| Functions | Description |
|-----------|-------------|
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|           |             |

Engine Monitoring

| Functions | Description |
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Alternator AC Monitoring

| Functions | Description |
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|           |             |

System LED Indications

| Functions | Description |
|-----------|-------------|
|           |             |
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|           |             |
|           |             |

Engine 7-Segment LED Displays

| Functions | Description |
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|           |             |

Alternator 7-Segment LED Displays

| Functions | Description |
|-----------|-------------|
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|           |             |
|           |             |

AC Inputs

| Functions | Description |
|-----------|-------------|
|           |             |
|           |             |

Analog Inputs

| Functions | Description |
|-----------|-------------|
|           |             |

Digital Inputs

| Functions | Description |
|-----------|-------------|
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Digital Inputs

| Functions | Description |
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Digital Outputs

| Functions | Description |
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Operations



Start

The unit supports three types of Starts ,  
 i.e., External / Key Switch Start : When the Key Switch is turned to ON position, the unit powers up, shows "Strt" on its LED Display and activates the Pre-Heat output for the configured time (only available in EMS733). The unit then activates the Fuel Control Output and keeps it activated for next 30 seconds. The unit jumps to Run Up state when

it sees Oil Pressure and/or AC Frequency otherwise it jumps to Ready state at the end of 30 seconds.

**Manual Start :** In response to the front panel push button the unit performs a fully sequenced engine start.

**Auto Start :** In response to a digital input the unit performs a fully sequenced engine start.

#### Run Up

Once the engine starts the unit goes in Run Up state and LED display shows "runP". It stays in this state for next 5 seconds and waits for the engine and alternator measurement to become stable. In this state it only checks two alarms; loss of frequency and very high frequency.

#### Warm Up

After Run up the unit goes to Warm Up state for next 6 seconds and LED display shows "UnuP". In this state the unit monitors all parameters and alarms.

#### Display Operation

Once the engine has started the unit then cycles through displaying the Volts, Amps, Hertz, Battery Volts, RPM and Engine Hours on its 4-Digit LED display and also turns ON respective LED.



FIGURE : AC VOLTAGE DISPLAY

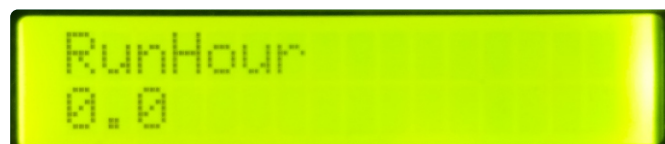


FIGURE : RUNHOUR





FIGURE : RMP DISPLAY



FIGURE : RMP DISPLAY

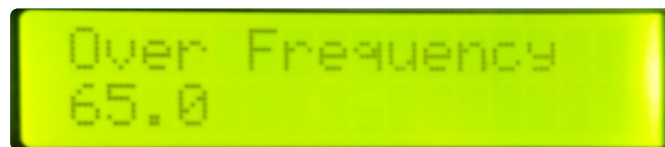


FIGURE : OVER FREQUENCY

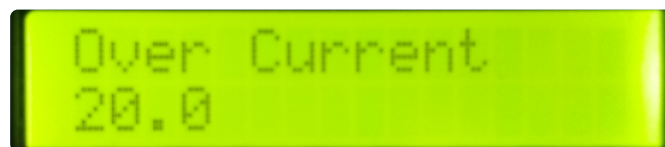


FIGURE : OVER CURRENT

If any of the alternator or engine measurements move outside operational limits the unit deactivates the Fuel Control Output to shut down the engine, if required and display the respective Error Code on the LED display.








### Speed Sensing

The unit obtains the speed information from the Generator AC output and shows the AC frequency and the Engine RPM on its 4-Digit LED display.

### AC Current Measurement

The unit measures AC current with the help of an on-board CT. Since the controller is designed to be used with 3.5KVA to 12.5KVA sets so a 64A/25mA CT is used to cover the whole range. But in order to get better accuracy, for small sets, multiple loops are required around the CT.

To set the divide ratio, based on the number of turns around the CT and to set the over-current limit, 3 DIP switches have been provided on the unit. Table 11 shows the required number of turns and position of DIP switches against DG size.

| Engine Size         | Over Current Limit (A) | Wire Size (mm <sup>2</sup> ) | Required Turns | J5 Position   |
|---------------------|------------------------|------------------------------|----------------|---|
| 3.5KVA at PF = 1    | 13                     | 1.5                          | 3              |   |
| 3.5KVA at PF = 0.8  | 16                     | 1.5                          | 3              |  |
| 5KVA at PF = 1      | 17                     | 2.5                          | 2              |  |
| 5KVA at PF = 0.8    | 21                     | 2.5                          | 2              |  |
| 7.5KVA at PF = 0.8  | 33                     | 4                            | 1              |  |
| 10KVA at PF = 0.8   | 48                     | 6                            | 1              |  |
| 12.5KVA at PF = 0.8 | 60                     | 10                           | 1              |  |
| NA                  | NA                     | NA                           | NA             |  |

## Shut Down

To shut down the engine, simply turn off the key switch or Press the the Manual Stop Button. The unit will deactivate the Fuel Control Output causing the engine to shut down. If the unit still sees Oil pressure and/or AC Frequency, 30 seconds after deactivating the fuel output, it will raise a Failed to Stop Alarm.

## Clearing Alarms

To clear an alarm message power cycle (reset) the unit by turning the key switch OFF and then ON again or press the Manual Stop button.

## Alarms and Warnings

In the event of abnormal operating conditions the unit will raise an Alarm or Warning, display respective Error Code on its LED display and shut the genset down, if required. The Error Codes are printed on the front label of the unit. The genset cannot be started if an alarm exists. To clear an error code press the Manual Stop button.

| Error Code | Description                   | Activation  |
|------------|-------------------------------|---|
| E 00       | Low Oil Pressure Alarm        | When closed to common for more than the configured time   |
| E 02       | Low Fuel Level Alarm          | When closed to common for more than the configured time   |
| E 04       | High Engine Temperature Alarm | When closed to common for more than the configured time   |
| E 11       | High Battery Voltage Warning  | Gets activated if battery voltage exceeds 16V for more than 3 seconds   |
| E 12       | Low Battery Voltage Warning   | Gets activated if battery voltage goes below 10V for more than 3 seconds  |
| E 13       | Battery Charging Warning      | Gets activated if battery voltage goes below the configured limit while engine is running for more than 3 seconds |
| E 18       | Over Frequency Alarm          | If Frequency exceeds the set limit for more than the configured time  |
| E 19       | Under Frequency Alarm         | When Frequency drops below the set limit for more than the configured time  |
| E 21       | High Genset Voltage Alarm     | AC voltage goes above the set limit for more than the configured time   |
| E 22       | Low Genset Voltage Alarm      | AC voltage goes below the set limit for more than the configured time   |

|      |                       |   |
|------|-----------------------|---|
| E 24 | Over Current Alarm    | If AC current goes above set limit for more than the configured time  |
| E 25 | Failed To Start Alarm | If one minute after pressing Manual Start button or activating Auto Start input the unit doesn't see oil pressure and AC frequency  |
| E 26 | Failed To Stop Alarm  | If the unit sees oil pressure or AC frequency, 30 seconds after deactivating the fuel solenoid  |
| E 28 | Oil Pressure Lockout  | If the unit sees oil pressure when the genset is not running it goes to oil pressure lockout state  |
| E 29 | Auto Start Lockout    | If the engine shuts down because of an alarm and Auto Start input is still active, the unit enters in Auto Start Lockout state. Upon deactivation of Auto start input the unit goes back into Ready state. In this state the unit can be restarted by pressing the Start button |
| E 30 | Tacho Lockout         | If the unit sees AC frequency when the genset is not running it goes to oil pressure lockout state  |

#### Inputs Electrical Specifications

| Input                          | Type    | Comment   |
|--------------------------------|---------|---|
| DC Input                       | Power   | Nominal 12VDC. Max 18VDC  |
| 0V Common                      | Power   | 0VDC, Common  |
| Low Oil Pressure Switch        | Digital | Suitable for switch C.O.F. senders. Current limited exciting voltage 10V at 10mA approx |
| Low Fuel Level Switch          | Digital | Suitable for switch C.O.F. senders. Current limited exciting voltage 10V at 10mA approx |
| High Engine Temperature Switch | Digital | Suitable for switch C.O.F. senders. Current limited exciting voltage 10V at 10mA approx |
| Auto Start                     | Digital | Close to 0VDC to activate. Current limited exciting voltage 10V at 10mA approx          |

|                 |            |                                      |
|-----------------|------------|--------------------------------------|
| Battery Voltage | Internal   | High Impedance                       |
| GL1             | AC Voltage | Generator Phase 1 Volts. Max 300VRMS |
| GN              | AC Voltage | Generator Neutral. Max 300VRMS       |
| I1              | AC Amperes | Phase 1 Amps. Max 64A                |

### Outputs Electrical Specifications

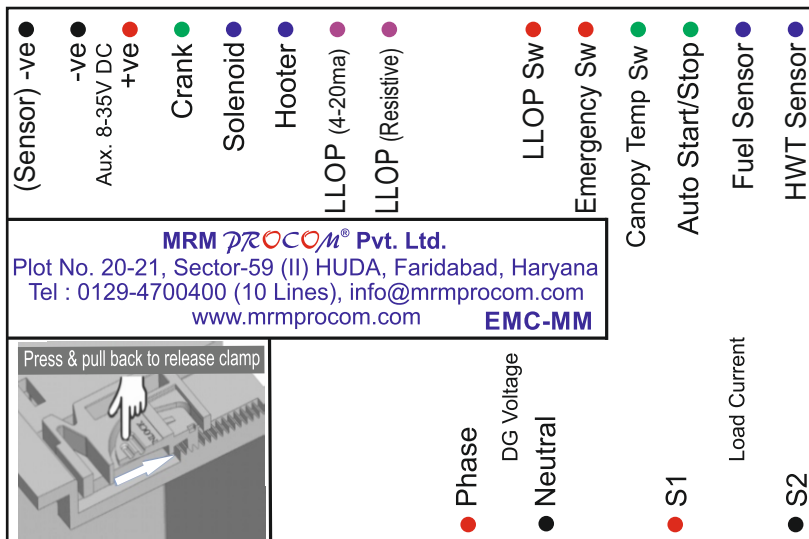
| Output        | Type       | Comment   |
|---------------|------------|---|
| Fuel Solenoid | Open Drain | 300mA Open Drain protected coil drive. Max 18VDC<br>This output is used to maintain the fuel solenoid activated for running duty. |
| Crank         | Open Drain | 300mA Open Drain protected coil drive. Max 18VDC<br>This output is used to control the starter motor to start the engine.         |
| Con A         | Open Drain | 300mA Open Drain protected coil drive. Max 18VDC<br>This output is used to maintain the fuel solenoid activated for running duty. |
| Con B         | Open Drain | 300mA Open Drain protected coil drive. Max 18VDC<br>This output is used to maintain the fuel solenoid activated for running duty. |
| Charger WL    | Current    | 200mA burst mode pulsed current controlled output. Used to provide the battery charging alternator with excitation current.       |

## Unit General Specifications

| Feature               | Specifications  |
|-----------------------|---|
| Overall Dimensions    | 96 x 96 mm (Bezel) x 28 mm behind bezel   |
| IP Rating             | IP51 front, IP20 rear   |
| Supply Voltage        | 8 V to 18V DC   |
| Operating Temperature | -20 to +70C   |
| Storage Temperatur    | -20 to +70C   |
| Relative Humidity     | 95% non condensing  |
| Supply Current        | 40mA (Average)  |
| AC Voltage Rang       | L-N Max 300VRMS.  |
| AC Frequency Range    | 40 - 70Hz   |
| CT current rang       | 0 - 60A   |
| Overall Accuracy      | Class 1   |
| Digital Output Rating | Open Drain Relay Coil Driver. 300mA, 18VDC max.   |
| Input Referenc        | 0V Common   |
| Displayed Speed Range | 0 - 1500 RPM  |
| Engine Hours          | 0 - 99999.9 Hours   |
| Engine Sensors Typ    | Switch: Close to common on f <del>a</del> ul  |
| Terminations          | Molex Mini Fit JNR  |
| Testing               | Automotive Tests: ISO7637-2 & ISO16750-2 (12V Cat IV)<br>Environmental Tests: IEC68 Part2<br>EMC Compliance: EN50081-1, EN50081-2, IEC6100-4-3<br>Electrical Safety AS 3100 and AS 3260 |

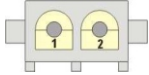



## Installation and Wiring

Connect the wires as per the labelling done in back sticker:





- The unit is a complex electronic device and caution should be taken to ensure correct wiring before power is applied.
- The unit is fitted with a 10 way Molex Minifit or equivalent socket connector for which mating plugs can be selected from Amp PE or TPK range.
- The unit is also fitted with a 2 way Mate-N-Lok or equivalent socket connector for which mating plug can be selected from Molex or Tyco range.







| Connector                        |            | Description  |
|----------------------------------|------------|--|
| <b>J1: PWR &amp; I/O</b><br><br> | <b>Pin</b> | <b>Connection</b>  |
|                                  | 1          | Common -ve<br>Must be made directly with Battery -ve for lowest electrical noise. It must not have currents other than the controller currents flowing and must be exclusively for the controller. |
|                                  | 2          | Battery +ve<br>Must be made directly with Battery +ve for best performance. Do not make this connection with the positive terminal of the Starter Motor.   |

|  |   |   |
|--|---|---|
|  | 3   | Fuel Output (Low Side Relay Driver)                                       |
|  | 4   | Crank Output (Low Side Relay Driver)                                      |
|  | 5   | Contactor A (Low Side Relay Driver) <i>For EMS324 Pre-Heat For EMS733</i> |
|  | 6   | Contactor B (Low Side Relay Driver)                                       |
|  | 7   | Low Fuel Level Switch (Close on Fault)                                    |
|  | 8   | High Engine Temperature Switch (Close on Fault)                           |
|  | 9   | Low Oil Pressure (Close on Fault)   |
|  | 10  | Auto Start Input (Close to 0V to activate)                                |
|  | 11  | Not Connected   |
|  | 12  | Battery Charging Alternator Excitation (WL Point)                         |
| <b>J2: Genset Voltage</b><br> | <b>Pin</b>  | <b>Connection</b>   |
|  | 1   | Genset AC Phase 1 (0-300V RMS)  |
|  | 2   | Genset AC Neutral   |
| <b>J3: AC Current</b><br>     | Genset Phase 1 Current  |   |
| <b>J4: Test Port</b><br>      | Test Port<br><br><b>NB: Connect Only manufacturer approved equipment to this port</b> |   |
| <b>J5: DIP Switches</b><br>   | To set appropriate overload current limit   |   |

**Connectors Details**

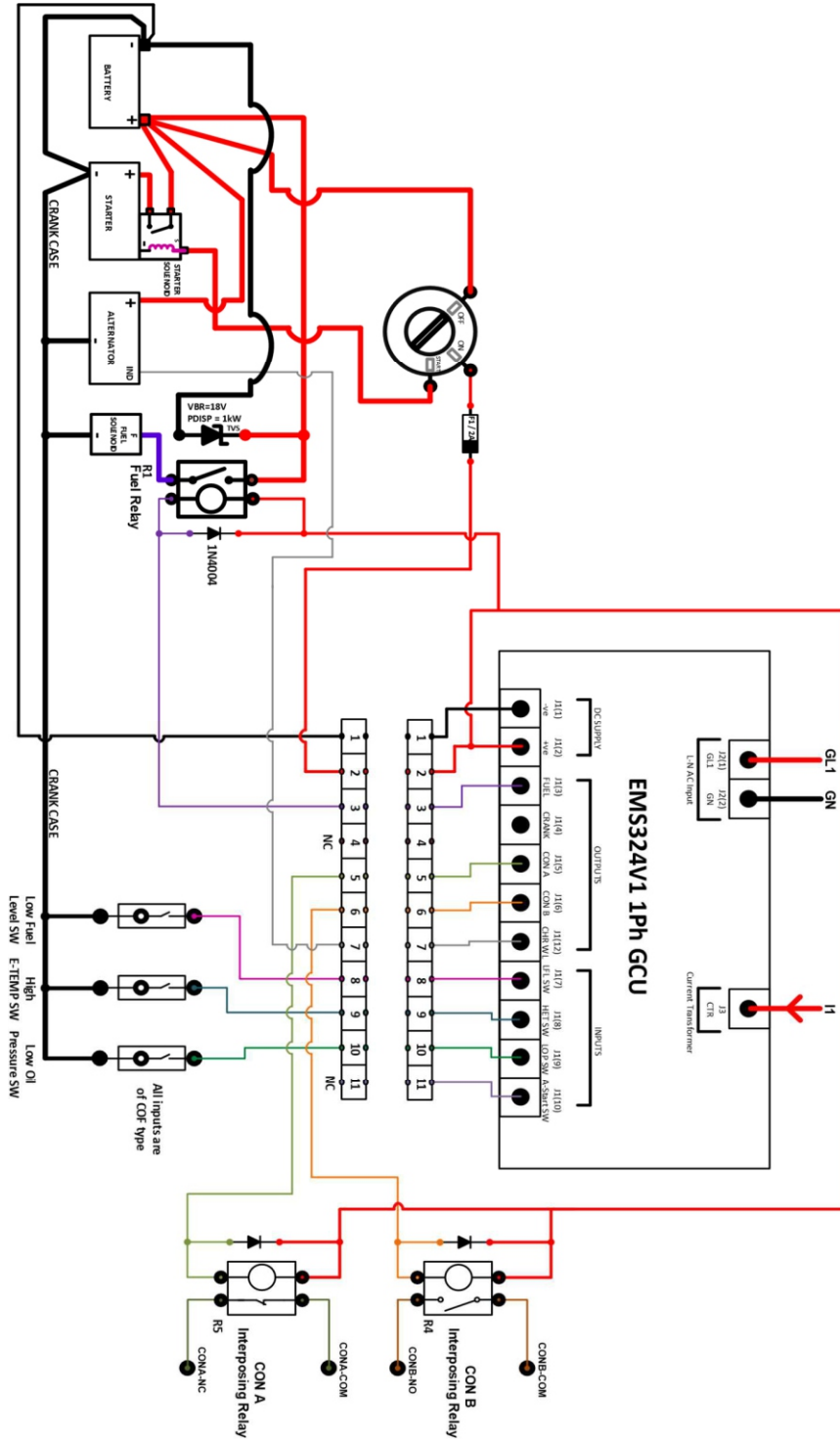
| Engine Size        | Over Current Limit (A) | Wire Size (mm <sup>2</sup> ) | Required Turns | J5 Position   |
|--------------------|------------------------|------------------------------|----------------|---|
| 3.5KVA at PF = 1   | 13                     | 1.5                          | 3              |  |
| 3.5KVA at PF = 0.8 | 16                     | 1.5                          | 3              |  |

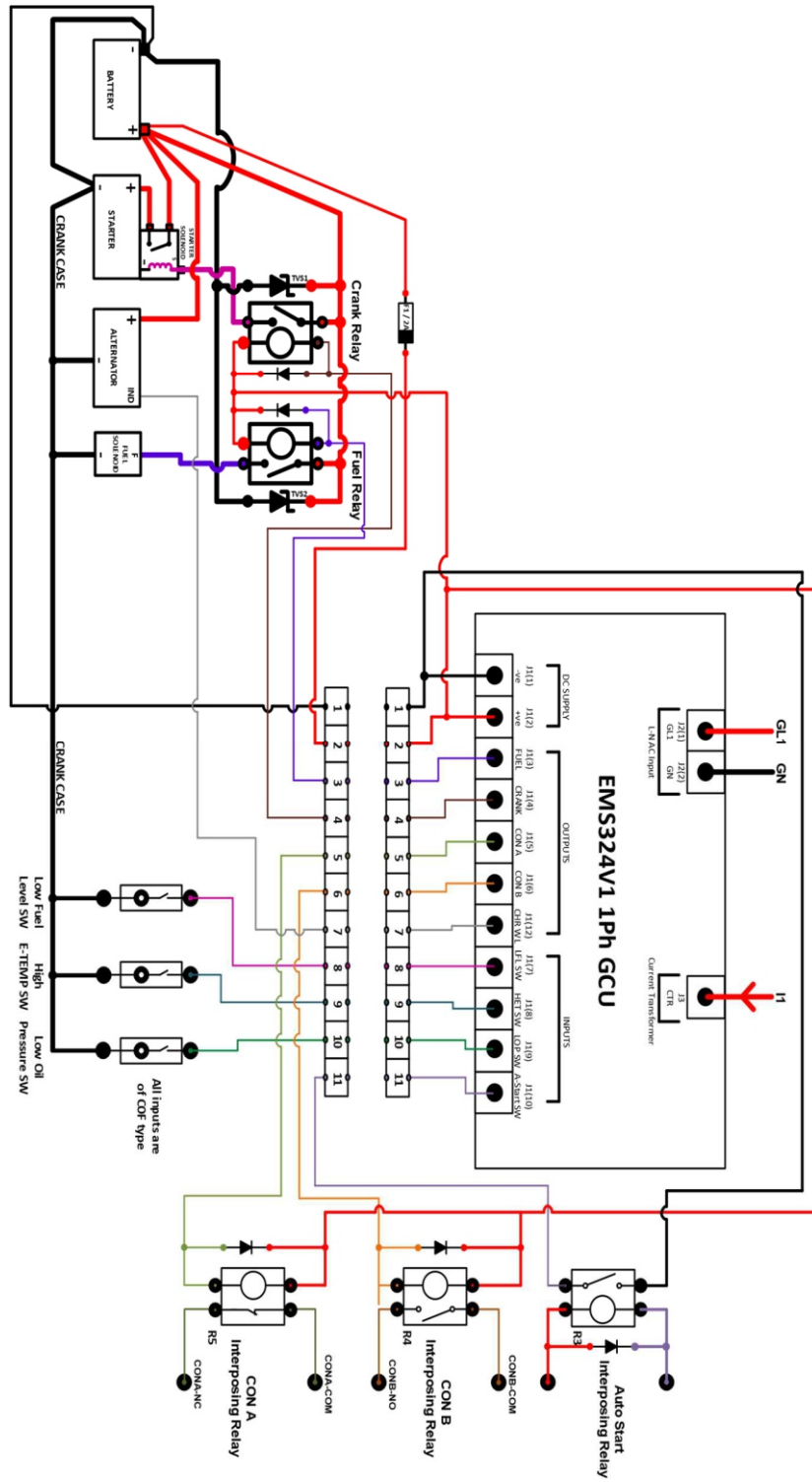


|                    |    |     |    |   |
|--------------------|----|-----|----|---|
| 5KVA at PF =       | 17 | 2.5 | 2  |  |
| 5KVA at PF = 0.    | 21 | 2.5 | 2  |  |
| 7.5KVA at PF = 0.  | 33 | 4   | 1  |  |
| 10KVA at PF = 0.   | 48 | 6   | 1  |  |
| 12.5KVA at PF = 0. | 60 | 10  | 1  |  |
| NA                 | NA | NA  | NA |  |

**Required Loops around CT and Position of DIP Switches**

Recommended Wiring Diagram





#### Notes

- All outputs are rated at 300mA maximum.
- All relays must be used and installed in the DG panel.
- Fuse (F1) must be used and installed near the power source, i.e., DG battery.
- Keep DG battery voltage (12V) in mind and use appropriate relay (coil voltage needs to be looked at).
- The majority of wiring, excluding CT, is low current for which 0.75mm<sup>2</sup> wire is

sufficient. For CT wire sizes refer Table 17.

#### Trouble shooting

##### Safety Considerations

- Stop the Genset and disconnect the battery charger before disconnecting the battery.
- Disconnect battery charger from AC source before disconnecting battery cables.
- Always disconnect battery positive terminal first and reconnect it at last.

##### WARNING:

Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, pilot lights and sparks can ignite battery gas. Do not smoke near battery. Discharge static charge from body, before touching batteries, by touching a grounded metal surface.

#### Troubleshooting Procedure

Below tables are a guide to help the user to analyse problems with the genset. Engine Does Not Start

#### Engine Does Not Start

| Possible Cause          | Corrective Action   |
|-------------------------|---|
| No Power supply to unit | Poor battery connections. Clean the terminals and tighten all connections (including Key switch terminals). |
| Fuse Blown              | Connect BAT +ve directly with unit's DC +ve. If it powers up that means the Fuse needs to be replaced.      |

|                     |   |
|---------------------|---|
| Fuel Output         | Turn the Key Switch at ON position and check whether the Fuel Output is properly driving the external relay ot.no |
| External Fuel Relay | Connect the Fuel relay coil directly across battery to verify that it is still operational.                       |
| Low Fuel            | Check the Fuel tank and fill it up if fuel level is very low.   |
| Fuel Solenoid       | Verify that the Fuel solenoid is till in working condition.   |

### Error Codes

| Error Code | Corrective Action   |
|------------|---|
| E 00       | Alarm to indicate low oil pressure. Check Oil level, filters and also verify that Oil switch is still in working condition.   |
| E 02       | Low Fuel Level Alarm. Check Fuel level, fill up the tank if it is low and check the condition of the switch.  |
| E 04       | High Engine Temperature indication. Allow engine to cool down before proceeding with any checks. Then check water/coolant level and replenish if low. Look for leakage points, check fan belt and repair if necessary. Also verify the condition of switch. |
| E 11       | High Battery Voltage Warning. Battery voltage is approaching to a level that can damage the controller. Check float voltage from charger and lower it down if it is very high.  |
| E 12       | Low Battery Voltage Warning. Clean the terminals and tighten all the connections. Replace the battery or battery charger, if necessary.   |
| E 18       | Over Frequency Alarm. Frequency has exceeded 53Hz for more than 3 seconds.  |
| E 19       | Under Frequency Alarm. Frequency has gone below 48.5Hz for more than 3 seconds. Check fuel supply, intake air supply and load.  |
| E 20       | Loss of Frequency Alarm. Unit cannot see AC signal from alternator. Check AC input connections.   |
| E 21       | High Genset Voltage Alarm. Genset voltage has exceeded 253V for more than 3 seconds.  |

|      |   |
|------|---|
| E 22 | Low Genset Voltage Alarm. Genset voltage has gone below 207V for more than 3 seconds.   |
| E 24 | Over Current Alarm. Current has exceeded the limit.   |
| E 26 | Failed To Stop Alarm. It means even 30 seconds after deactivating Fuel Solenoid output the unit is still seeing Oil Pressure or AC frequency. Stop the engine by disconnecting the fuel supply and then check external relay and fuel solenoid. |

**Possible Causes for Alarms and Corrective Actions**