



**Power
Generation**

Technical Training Participant's Guide

PowerStart0500



PowerStart0500 Module
Table Of contents

Introduction.....	3
Overview.....	5
How to operate me.....	7
PS0500 control features.....	25
Mounting Guidelines.....	28
Control outputs/inputs.....	29
Control systems.....	34
Setup Trims and adjustments.....	40
Meter Calibrations.....	44
Wiring diagram.....	51
Environmental capability.....	52
Faultcode list.....	53
Troubleshooting.....	54

Introduction

Welcome! Welcome to the *training module* for the *PowerStart 0500*. This module was written by the Cummins Sales and Service India Limited-Electronic Cell department for your use and reference. We suggest you read through the entire Introduction to become familiar with the module's structure. Then, just follow along in the module during your training session.

Module Purpose

The purpose of the *Power Start 0500 training* module is to help you to understand the *Power Start 0500* which is going to be used on Low Horse Power (LHP) genset. With this information, you will be better prepared to meet your customers' varying needs.

Module Audience

This module was written for dealer service technicians who have previous experience with or knowledge of electrical engine, and generator basics.

Module Structure

This module contains lessons on related topics. Each lesson follows a carefully designed training format, including a warm up, presentation, and activity (or exercise).

Module Assessment

After completing all the lessons in the module, you will complete a *module assessment*. The module assessment lets us evaluate the level of knowledge you have on the topic after completing the module.

Module Comment Form

You will also complete a *module comment form*. This form gives you the chance to comment on the usefulness and effectiveness of the training module and make suggestions for improvements. We will use the results from the module assessment and module comment form to help us determine if there is a need to modify the module.

Overview

The PS0500 controller is a microprocessor-based generator set monitoring, metering, and control system. The control provides a simple operator interface to the Genset and engine parameters, remote start / stop control and generator set protective functions. The control does not have in-built speed governing and voltage regulation features. It does not support magnetic pickup connectivity.

The PS0500 series controllers are designed for use on engines from 10 to 100 KW range, it means it is genset controller without AVR controller in the range of 12.5KVA to 125KVA for non-paralleling applications. The control can also be configured for various frequency (50 Hz / 60 Hz operation), voltage configuration up to 600 Vrms L-L. The control is designed for mounting on the generator set.

The control also has a 16X2 LCD module with seven indicator LEDs and six tactile feel pushbuttons, which can be used for navigation.

Tactile Push Buttons

- Manual
- Auto
- Start
- Stop
- Reset
- Ok

16 X 2 Alphanumeric display

Genset status LEDs



Module assessment :

- 1) What is operating range of engine KVA rating for PS0500?
- 2) What are the functions of PS0500 controller?
- 3) Will PS0500 support voltage regulation?
- 4) What is maximum line to line RMS voltage reading configured in PS0500?
- 5) Can we get MPU support for PS000?
- 6) Can we start engine remotely by PS0500?
- 7) Will PS0500 support paralleling operation?
- 8) How many push buttons are uses in PS0500?
- 9) How many indicator LEDs are use in PS0500?

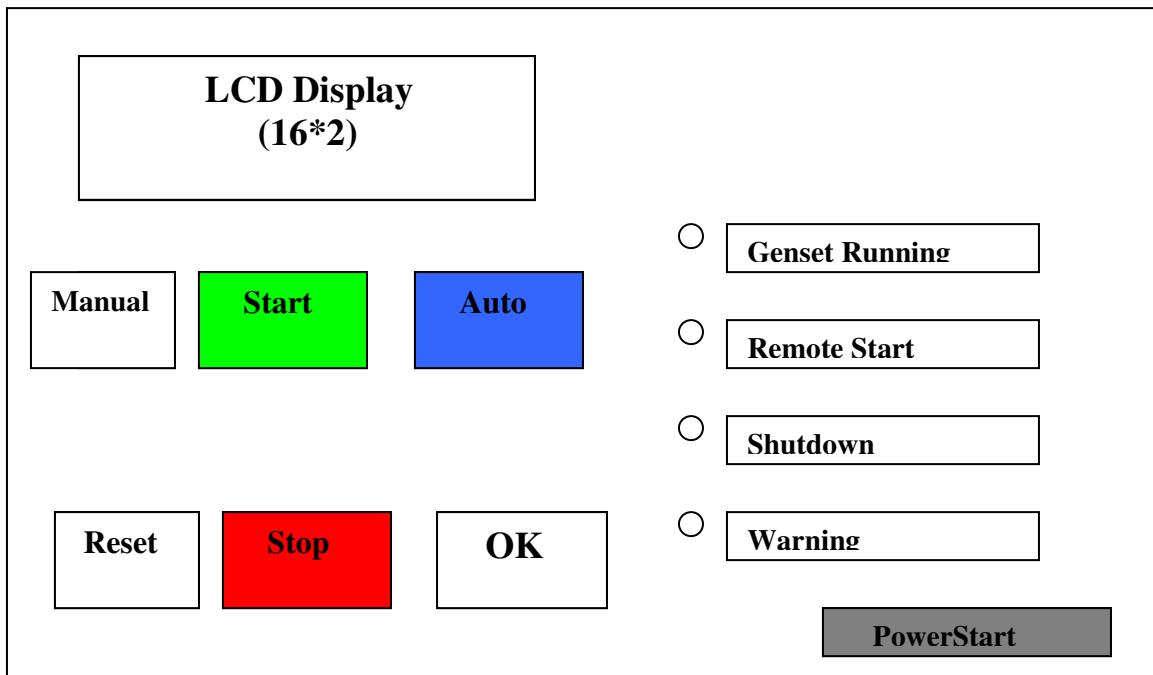
How to operate PS0500

The reason to include this module, is to make everyone aware of the product and its operations.

One who will go through this will be very well educated about PS0500, its operations, applications.

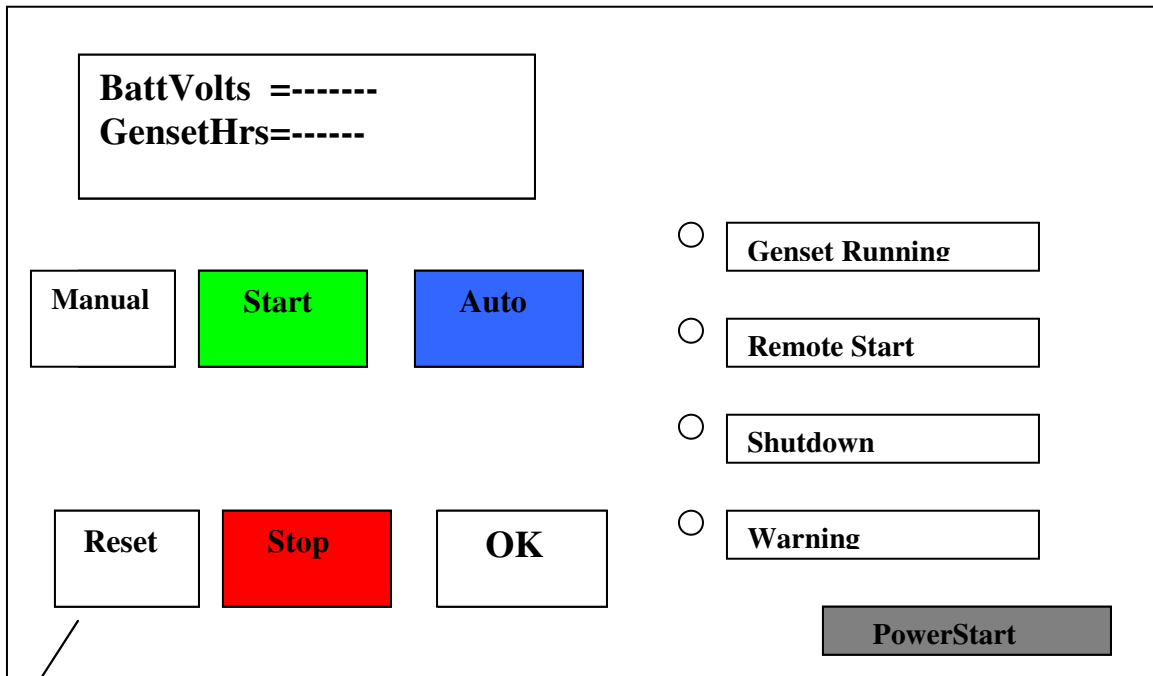
This is basic block diagram for PS0500, which will be referred throughout this module for your reference.

PS0500



Lets first know how to start PS0500 after connecting it to 12V battery supply.

PS0500



Press this button

Once you press this push buttons all LED's will glow for 1 second. And LED above STOP button will start bblinking continuously. While as on display show message shown as in above picture.

The display of PS0500 has three display mode-

- 1) Monitor
- 2) Set Up
- 3) Calibration

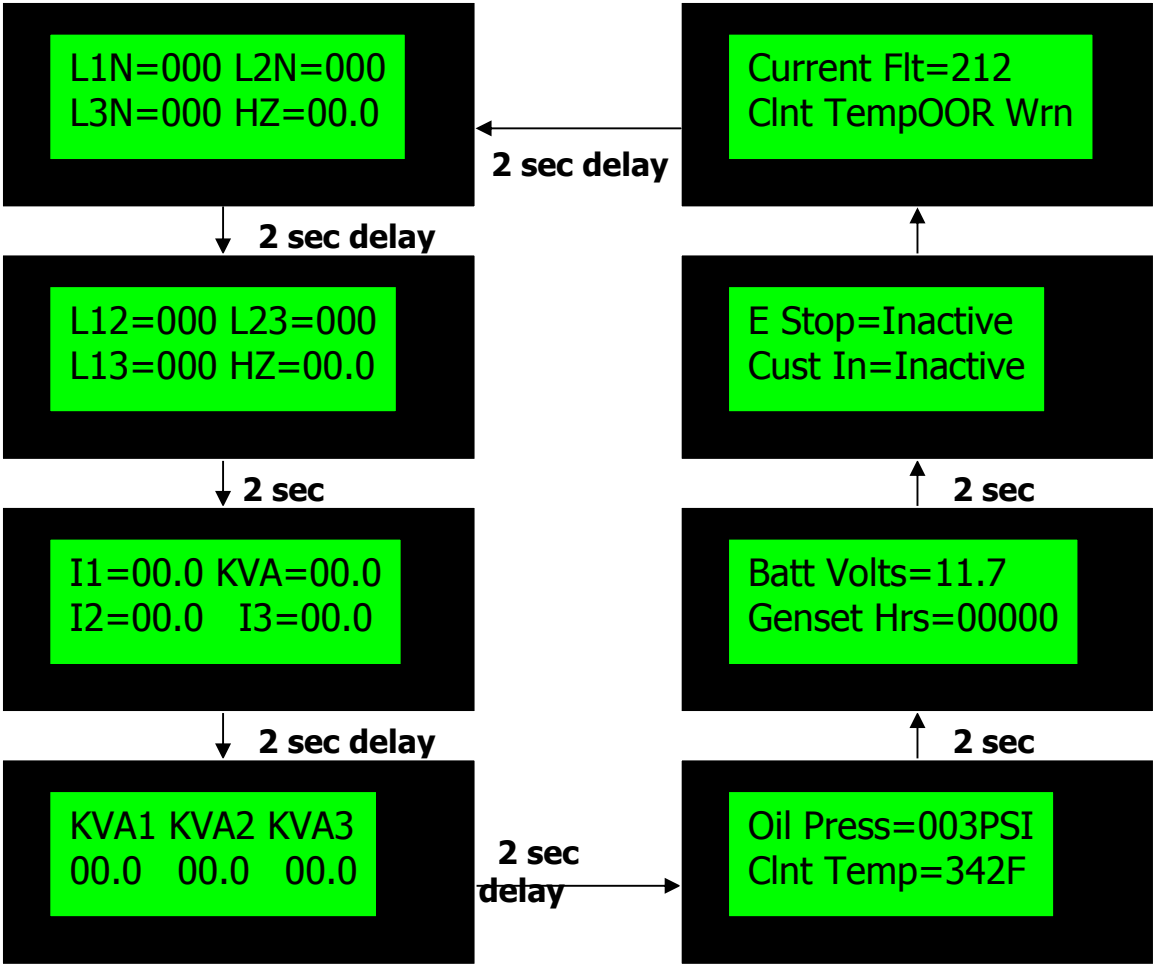
Monitor mode allows user to monitor the Genset parameters

Monitor mode has 2 modes of operations

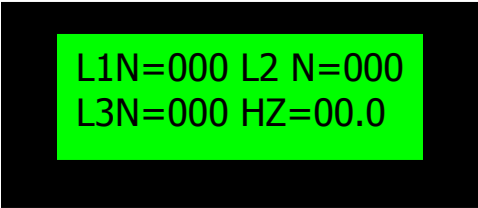
Scroll - The display will scroll the screen one by one

Scroll Stop – User can monitor a desired screen continuously

In scroll mode one will observe following screens,the screens will scroll in the time span of 2 sec.



Following is the explanation for all above screens.



Table

L1N	Line1 to Neutral Voltage
L2N	Line2 to Neutral Voltage
L3N	Line3 to Neutral Voltage
HZ	Frequency

L12=000 L23=000
L13=000 HZ=00.0

Table

L12	Line 1 to Line 2 Voltage
L23	Line 2 to Line 3 Voltage
L13	Line 1 to Line 3 Voltage
HZ	Frequency

I1=0.0 KVA=00.0
I2=00.0 I3=00.0

I1	Line 1 current
KVA	Total power
I2	Line 2 current
I3	Line 3 current

KVA1	KVA2	KVA3
00.0	00.0	00.0

Table

KVA1	Line1 Power
KVA2	Line2 Power
KVA3	Line3 Power

Oil Press=003PSI
Clt Temp=342F

Table

Oil Press	Oil Pressure
Clt Temp	Coolant Temperature

Batt Volts=11.7
Genset Hrs=00000

Table

Batt Volts	Battery Voltage
Genset Hrs	Genset Hours

E Stop=Inactive
Cust In=Inactive

NOTE: E Stop and Cust In shows the status of the input that whether it is active or inactive

Table

E Stop	Emergency Stop
Cust In	Customer Input

Current Flt=212
Clnt Temp OOR Wrn

NOTE: It displays the type of the warning for the fault condition

Table

Current Flt		Current Fault
Clnt Temp OOR	Wrn	Coolant Temperature Out Of Range Warning

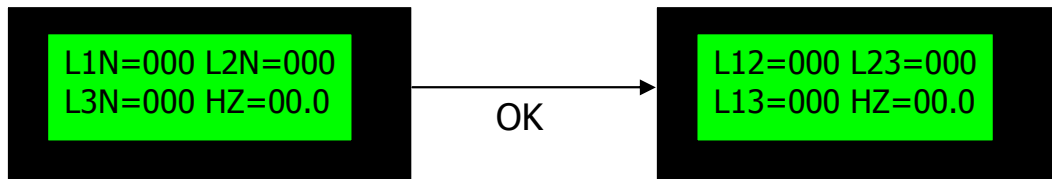
How to **enter** the Scroll Stop Monitor mode ?

L1N=000 L2N=000
L3N=000 HZ=00.0



Press **Ok** button to stop the scrolling and enter scroll stop to monitor the parameters on specific screen continuously

How to **exit** from the Scroll Stop Monitor mode ?

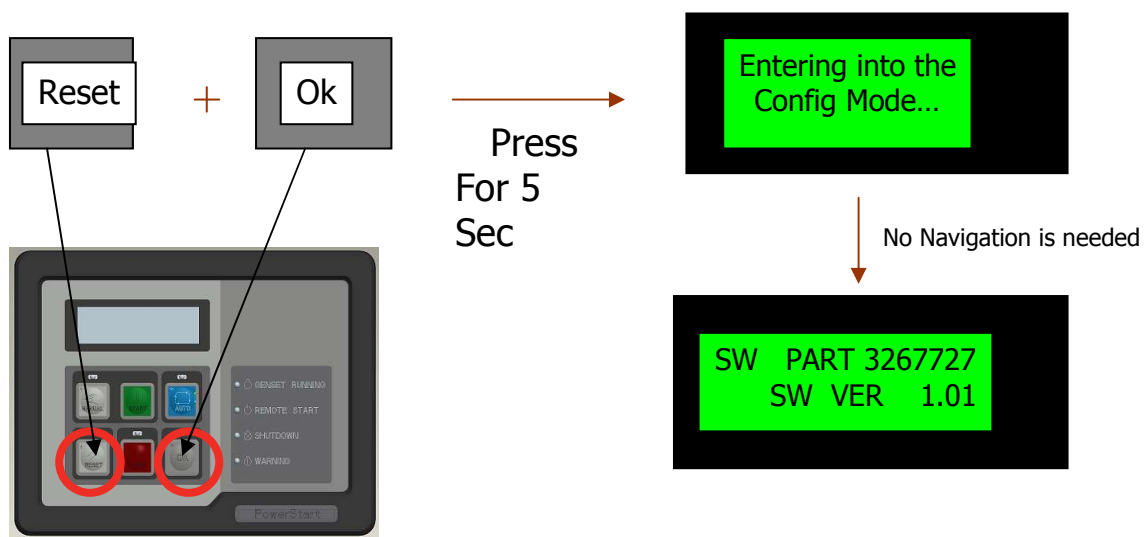


Press **Ok** button on front panel



To enter into SETUP mode-

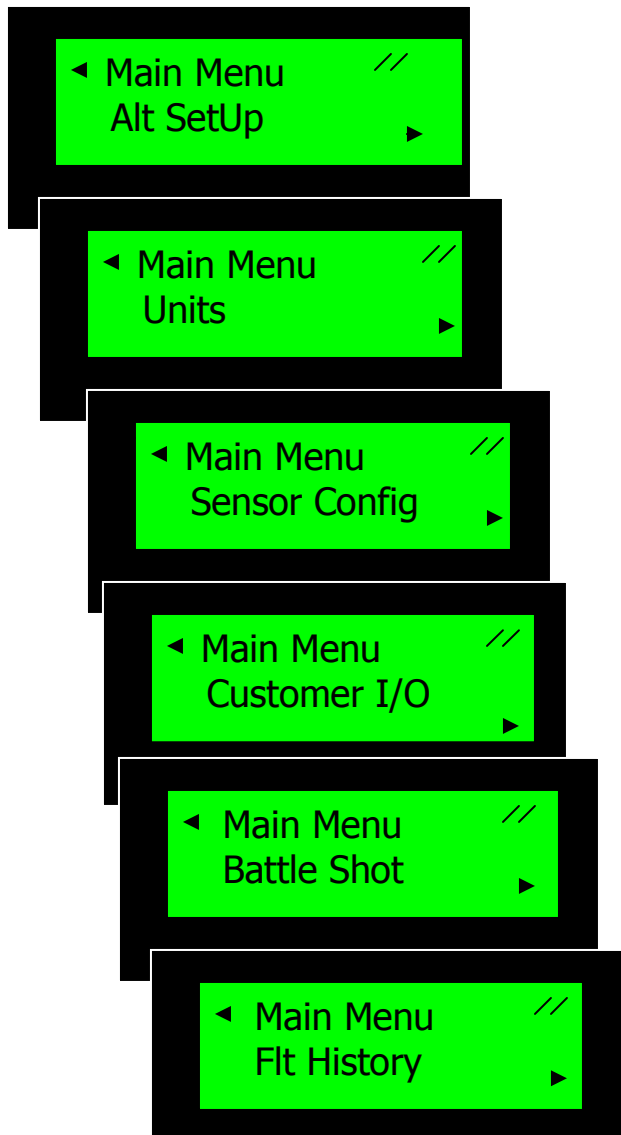
After going to stop mode only we can enter in to Setup mode.

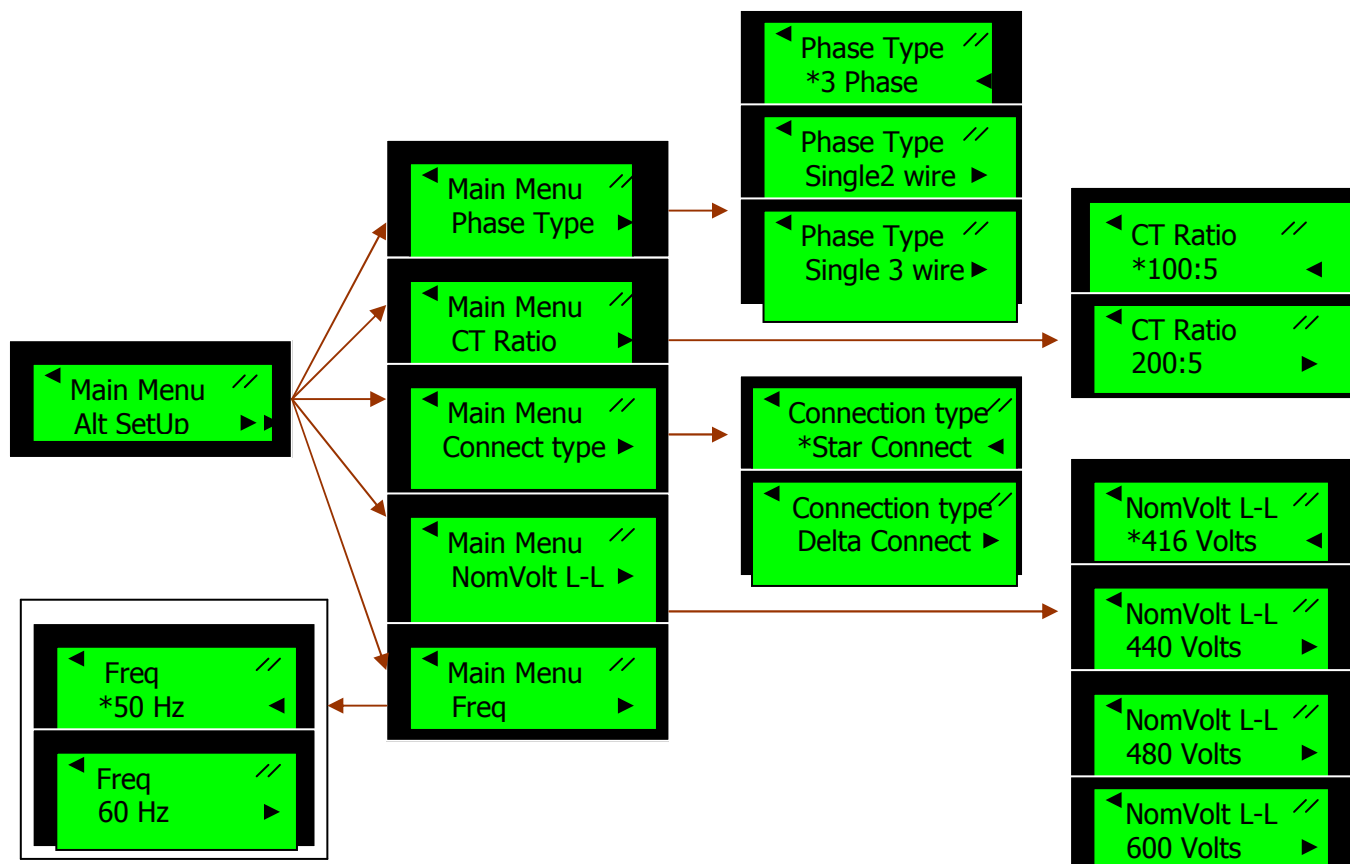


One need to understand key to operate-

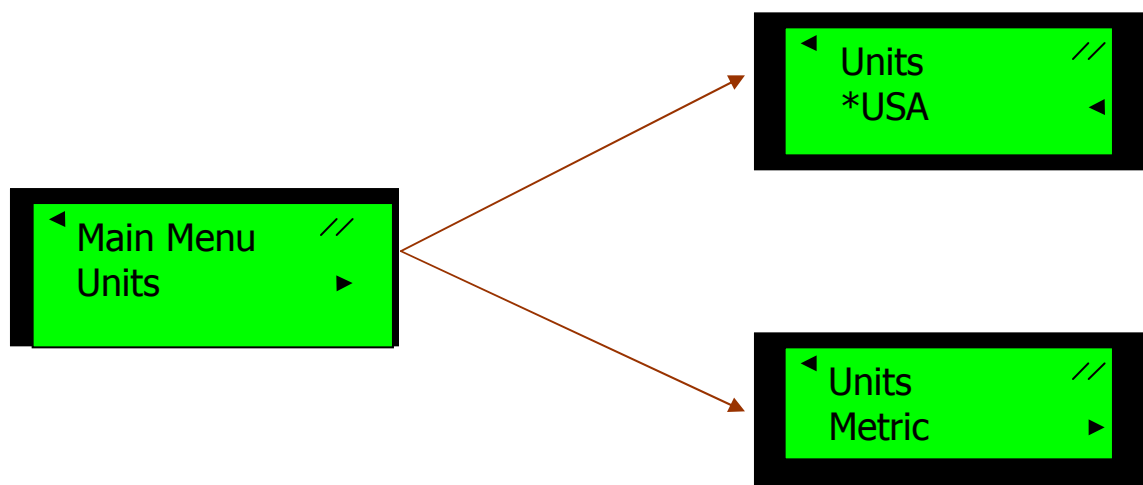
Keys	Properties
→	Will go to the next value
←	Will go to the Previous value
//	Will go down
*	It shows the default value. when we select the particular value it will comes to that value

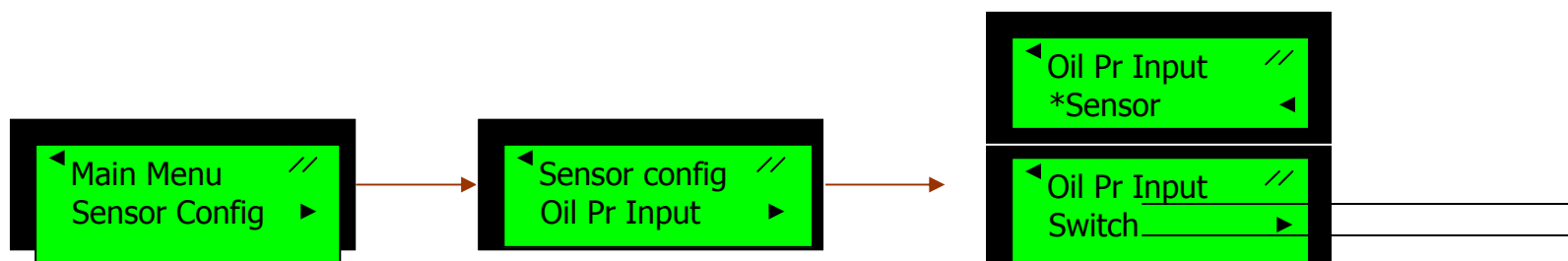
Following are the screens of the display when you will enter setup mode. Use above explain keys to go through and to change the value. Jus look down for more clear understanding.



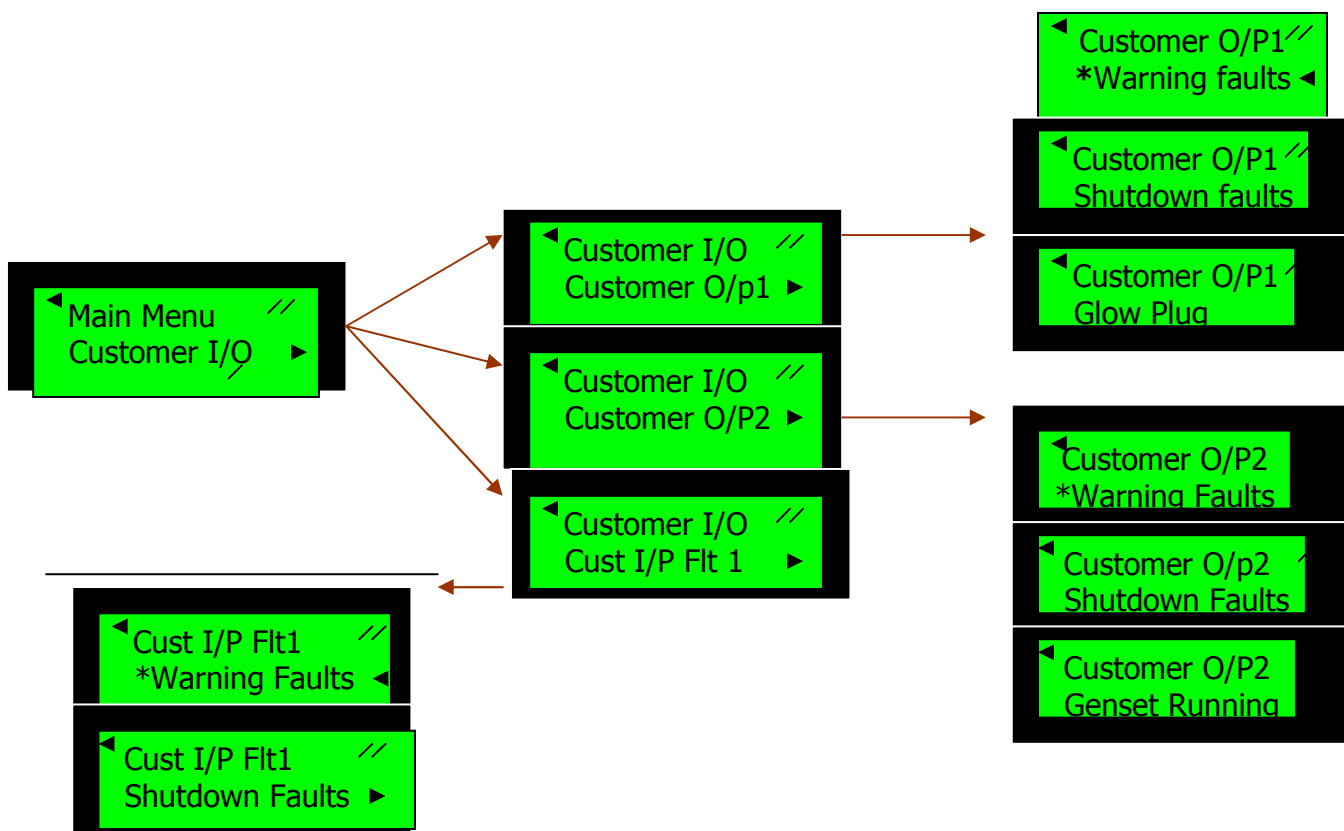


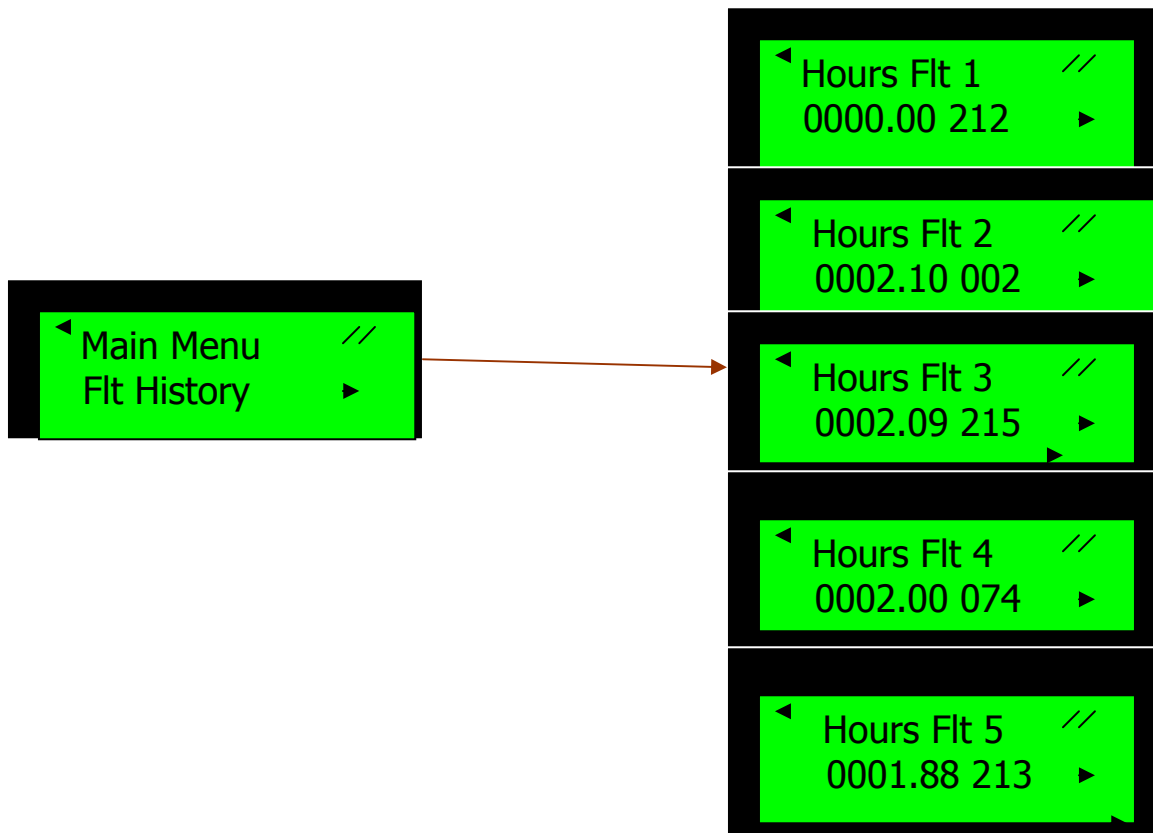
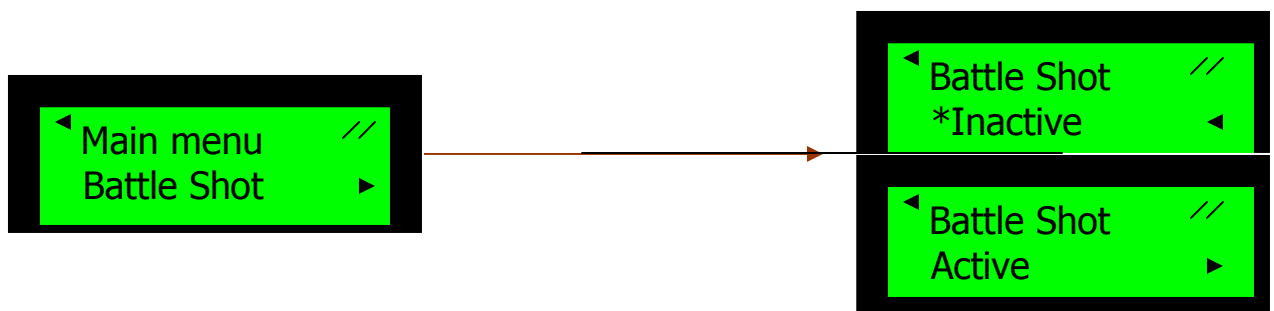
Setup screen



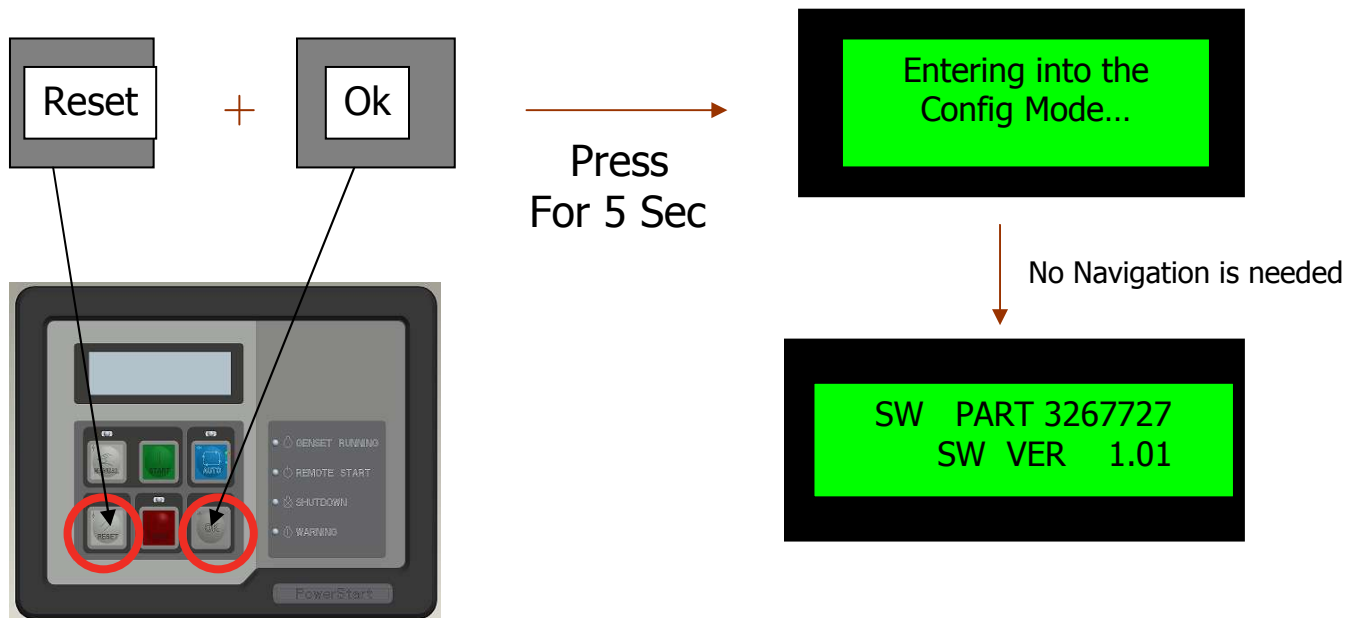


Setup screen





To enter into CALIBRATION MODE-



Meter calibration screens

Keys

Action

will increase the voltage value

will decrease the voltage value

will calibrate next value

will calibrate previous value

Voltage Screen

▪ L1N	L2N	L3N
234	235	234

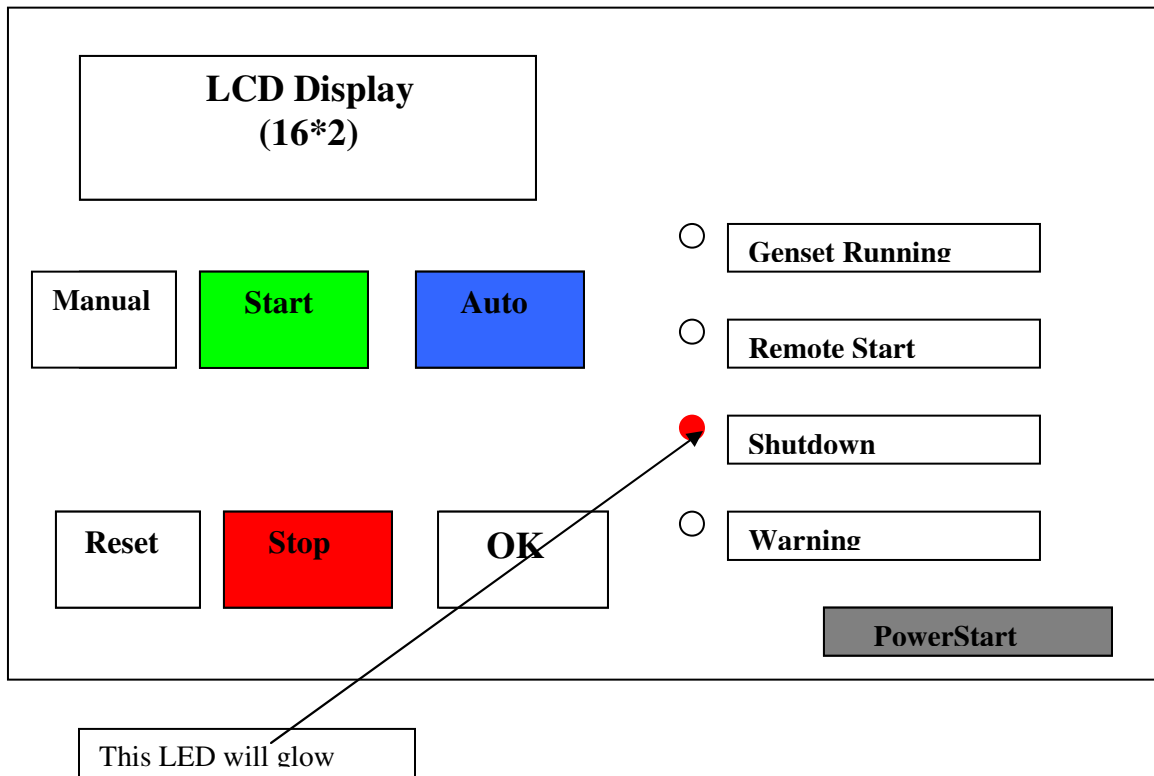
Current Screen

I1	I2	I3
025	024	024

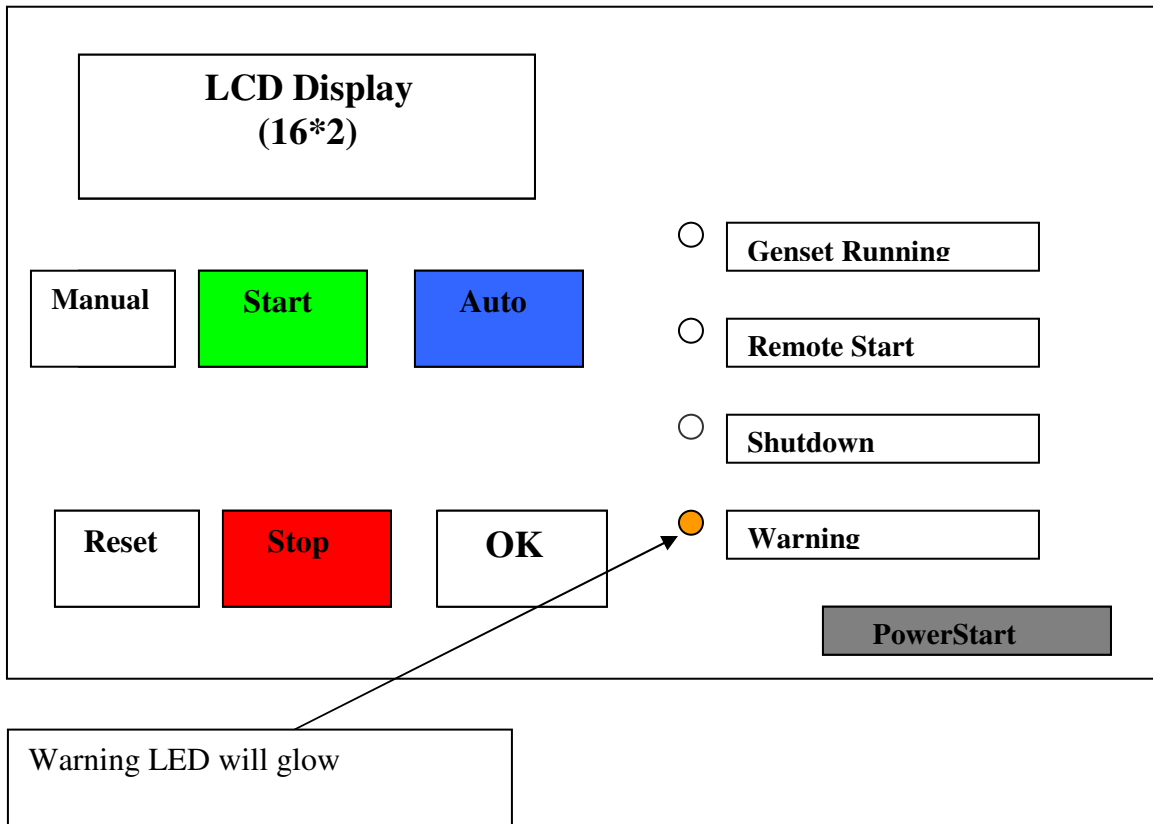
- Initially dot is set to default value(set to L1N). If we press the → the next values
- When the dot is on L3N and [→ (button)] is pressed, then current screen will be loaded
- When the dot is on I1 and [← (button)] is pressed, then voltage screen will be loaded

This will guide you for calibrations of voltages and currents.

For any shutdown shutdown LED will glow.



For any warning ,warning LED will glow-



Assessment module-

One need to use PS500 once.It is mandatory for all participants to practice on PS0500 to get to introduced to system.

PS0500 Control Features

- Operates on 12 VDC
The operating voltage for PS0500 is 12VDC.
- Low power sleep mode
- Phase voltage and current sensing. Current sensing with an external 0 - 5 amp current transformers.

- Engine starter and fuel shutoff relay driver - capable of driving 1A load. There are no on-board relays present. External relays are required to be wired for starter and fuel shutoff. Relay K7 drives starter while as relay K8 drives Fuel shutoff valve. E-stop on canopy is connected through this relay supply connections. As you push E-stop on canopy relay supply will disconnect and engine will stop immediately. These connections for relay driver are coming from J16 connector pin no's 3 and 4 respectively. Pole connection P1 and P2 are connected to starter positive. While as output for both the relays are connected to pull and hold of Fuel shut off coil respectively.

- Generator set monitoring - Display status of critical engine parameters like battery voltage , coolant temperature , lube oil pressure , engine run hours, All parameters are scrolling on the display one by one. One can observe that parameter by seeing in to the display continuously. To watch single parameter one has to press OK push button on the screen while screen is scrolling. Screen will stop at that particular parameter and one can see required and wanted parameter. One has to push OK button on PS0500 to start scrolling of display again.

- Generator set monitoring - Display status of critical electrical parameters like line to line voltage , line to neutral voltage , current for three phase , operating frequency, KVA ratings for three phases.

- Genset protection – Engine and Alternator protection features
 - Low lube oil pressure warning /shutdown
 - High coolant temp warning /shutdown
 - Low/high/ weak battery voltage warning
 - Fail to start warning
 - High / low AC voltage shutdown
 - Under / over frequency shutdown
 - Loss of AC sense shutdown

All the above said protection can be seen on display as well as in InPower. All the necessary adjustments can be done through InPower on case of any of above cases. PS0500 has InPower compatibility.

It can be connected to InPower same as that of one connects for PCC1301. One must have registered dongle (P/N=0326-6648-04), InPower V6.0 (0326-6957-02), communication cable of PCC1301 (P/N=0338-5490), laptop.

- Customer Input - One discrete customer input, active GND. Customer Output – One Low Side driver output for driving external relay.

Module Assessment

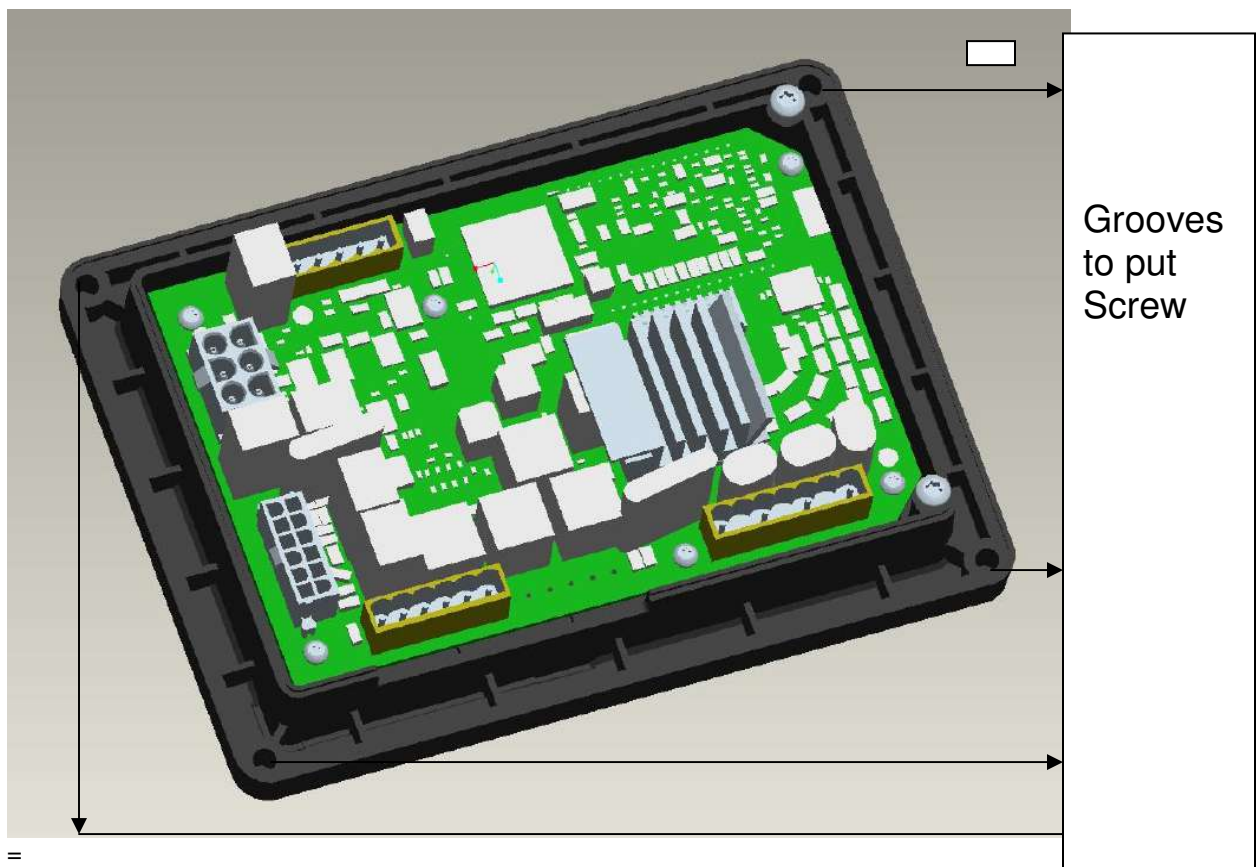
- 1) What is CT ratio?
- 2) What is maximum load current capacity for relay driver?
- 3) Which relay drives fuel shut off valve?
- 4) What is operating voltage for PS0500?
- 5) What is driven by relay K7?
- 6) Which push is use to stop scrolling of display?
- 7) Which are the parameters observe in display?
- 8) Which engine protection is provided in PS0500?
- 9) Is there any protection given for battery voltage?
- 10) Do we have under frequency protection provided in PS0500?

Mounting Guidelines

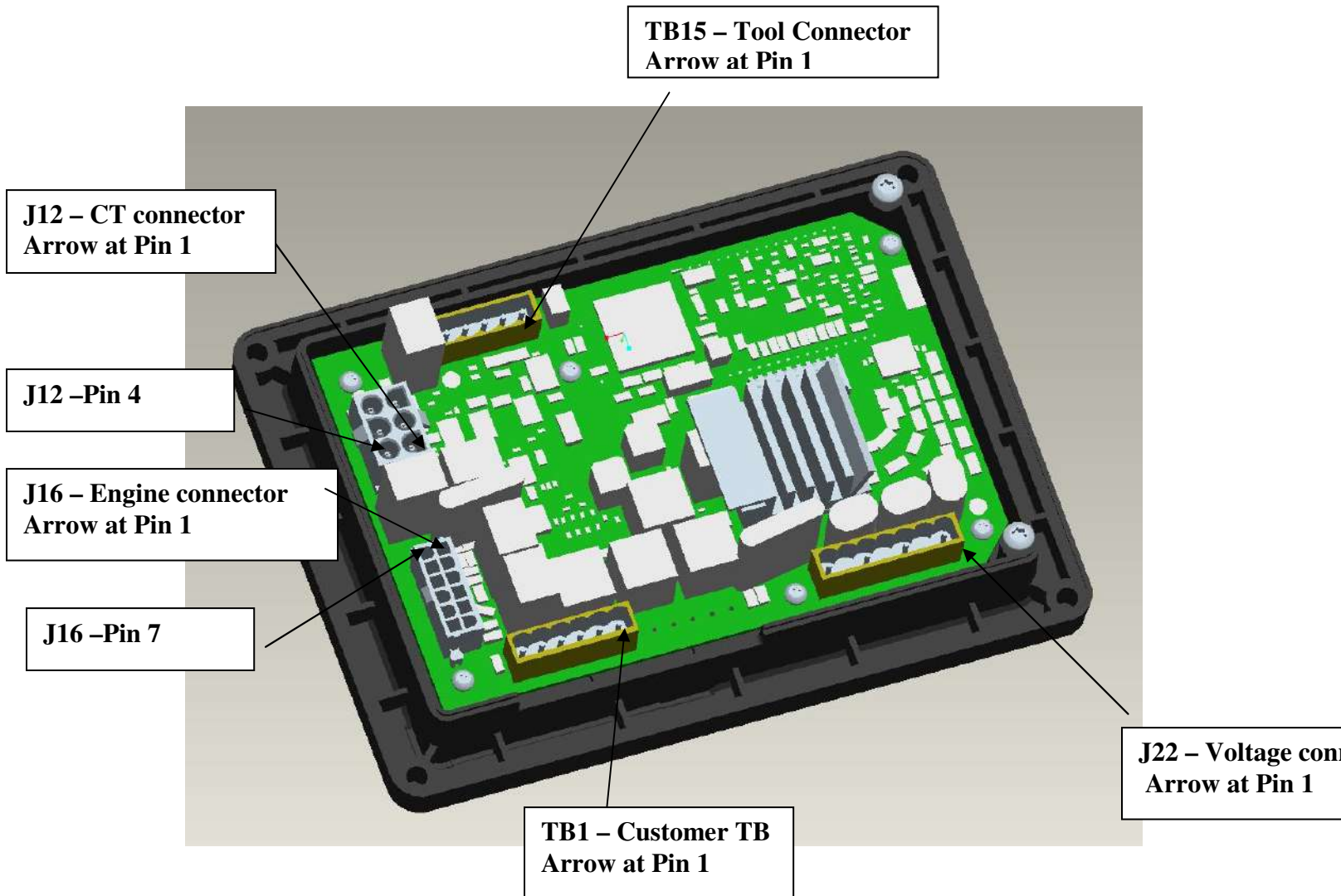
The control is suitable for non-engine mounting. As such should not be directly mounted on the engine.

The control may be mounted on a suitable frame on top of the alternator, or on a frame supported from the genset base rail or on a stand alone mounting frame suitably isolated from the vibration of the genset. Appropriate vibration isolators should be used to make sure that the control is not subjected to vibration levels beyond the specifications.

To avoid occurrences of the control board being exposed to conditions beyond their specifications, care should be taken not to mount them close to the engine exhaust pipes. Also mounting them in a manner that would expose them to direct sunlight, rain/snow should be avoided.



Control outputs and Inputs



Engine Connector

The engine connector (J16) is a 12 pin connector-plug (12 MINI M-N-L). A possible supplier is Molex; their part number is 39299123. The Cummins part number for this connector is 0323-2589. The PCB outline drawing shows where the connector is located as above. Each signal is described as below –

Connector Pin	Signal Name
J16-1	NC
J16-2	NC

J16-3	Oil pressure sensor
J16-4	Starter disc input
J16-5	Sensor Common
J16-6	BAT +
J16-7	Coolant temperature sensor
J16-8	Battery charging alternator (WL)
J16-9	Starter Relay Driver (Low Side)
J16-10	Fuel shutoff relay Driver (Low Side)
J16-11	BAT-
J16-12	Chassis GND

CT Connector

The CT connector is a 6- pin MATE-N-LOCK connector. The possible manufacturer is Tyco, and the supplier part number for the part is 643749-1. The Cummins part number for this connector is 0323-2154. Connector details are as follows –

Connector pin	Signal
J12-1	CT1_input
J12-2	CT2_input
J12-3	CT3_input
J12-4	CT1_COM
J12-5	CT2_COM
J12-6	CT3_COM

Voltage Connector

The voltage connection is via a 4 pin header with alternate spaces between the pins. The possible supplier is Tyco with the supplier part number as 282828-4. The Cummins part number for the same is 0323-2225-03.

Connector pin	Signal
J22-1	Gen_V1
J22-2	Gen_V2
J22-3	Gen_V3
J22-4	Gen_N

Customer Connection TB

The customer connection TB2 is a 6 pin terminal block. The possible supplier is Magnum: The terminal pins details are as shown below-

Terminal pins	Signal
TB2-1	Remote start Switch Input
TB2-2	Customer Output Relay Driver (Low Side)
TB2-3	Glow Plug Output Relay Driver (Low Side)
TB2-4	Remote E-Stop
TB2-5	Customer Input

TB2-6	NC
-------	----

Returns for all the above connections are required to be connected externally.

All the inputs are active GND. Remote E-Stop switch should have two independent potential free contacts. One NC contact for cutting out the Battery supply to the Fuel Solenoid and another NC contact to connect controller's E-Stop input to GND to indicate to the control when the E-Stop is pushed in active state.



Battery Positive is not provided on the Customer terminal block (TB2). External provision needs to be made in the harness to provide the B+ signal for convenience of wiring up external relays and may be used as relay supply (high side) for FSO, Starter, Customer Output and Glow plug Relays via a 1 Amp Fuse.

PC Tool Connector

The PC tool connector is a dedicated 5 pin connector header block. The possible supplier is Tyco, with the supplier part numbers are 796643-5. The Cummins part number for the same is 0323-2191-04.

Terminal pins	Signal
TB15-1	GND
TB15-2	NC
TB15-3	RS485 DATA A
TB15-4	RS485 DATA B
TB15-5	TOOL_WAKEUP

Connector Part Numbers

Quantity	Name	Description	Manufacturer	Manufacturer's part number	Cummins part no	Remarks
1	J22	Alt Voltage Connector	TYCO	282828-4	0323-2225-03	All these connectors are PCB mounted connectors
1	J12	CT Connector	TYCO	643749-1	0323-2154	
1	J16	Engine Connector	MOLEX	39299123	0323-2589	
1	TB2	Customer TB	MAGNUM	EM257506VC	0323-1677-05	
1	TB15	Tool Connector	TYCO	796643-5	0323-2191-04	
Quantity	Name	Description	Manufacturer	Manufacturer's part number	Cummins part no	Remarks

1	J22	Alt Voltage Connector	TYCO	282809-4	0323-2226-03	All these connectors are used in the harness
1	J12	CT Connector	TYCO	1-480704-0	0323-1932	
		Crimp Terminals		350551-1	0323-1200	
1	J16	Engine Connector	MOLEX	39012120	0323-2602	
		Crimp terminals		39000038	0323-2603	
1	TB2	Customer TB	MAGNUM	EM256506H	0323-1678-05	
1	TB15	Tool Connector	TYCO	Communication cable Kit 0541-1199 is used for the tool interface		

Wiring Information

- For connecting Battery supply, use two twisted pair wires minimum 1 sq mm cable size (16 Gauge).
- The On board drivers are low side drivers capable of driving 1AMP. External relays with an appropriate contact rating should be used in the FSO, Glow Plug, Customer Output and Starter solenoid circuits. Also make sure to use appropriate wire size based on the current drawn by the solenoids.
- For connecting current transformers use three twisted pair wires minimum 1 sq mm (16 Gage).
- For All other connections use minimum 0.8 Sq mm (18 Gauge) wires.

Module assessment

- 1) What is function for TB1?
- 2) How many pins are in engine connector?
- 3) Which pin has received battery negative on engine connector?
- 4) Which is pin on engine connector for sensor common signal?
- 5) What is Cummins P/N for J-16 connector?
- 6) What is Cummins P/N for J-12 connector?
- 7) On what pin no, voltage neutral signal goes on voltage connector?
- 8) What is Cummins P/N for voltage connector?
- 9) How to protect controller?
- 10) What is Cummins P/N for tool connector?

Control System

Engine Sensors

Coolant Temperature Sensor

The PS0500 control can be programmed to use one of the following temperature sensors.

Internal P/N.	Man / Man P/N	Resistive Temp Range	Threading
0193-0529-01	AirPax / 5024-0250	-40 to +230 F	3/8 "NPTF
0193-0529-02	AirPax / 5024-0274	-40 to +230 F	M14 X 1.5 with "O" Ring

Coolant Temperature Sensor Connector

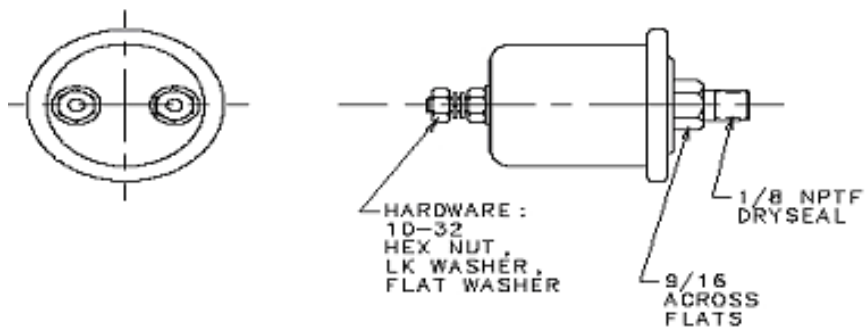
Internal P/N.	Man	Man P/N	Comments
0323-1755	Packard	121621893	Plastic shell with seal
0323-1818	Delphi	12124075	Socket Connector

Temperature sensor

Lube Oil Pressure Sensor

The PS0500 control can be programmed to use the following pressure sensors. While using the single wire sensor the Sensor return wire from harness needs to be grounded to Engine body.

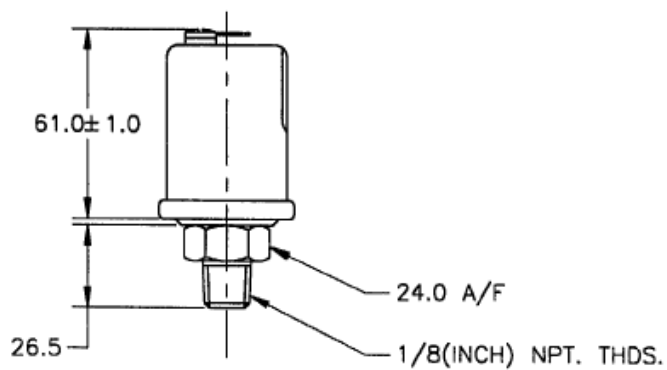
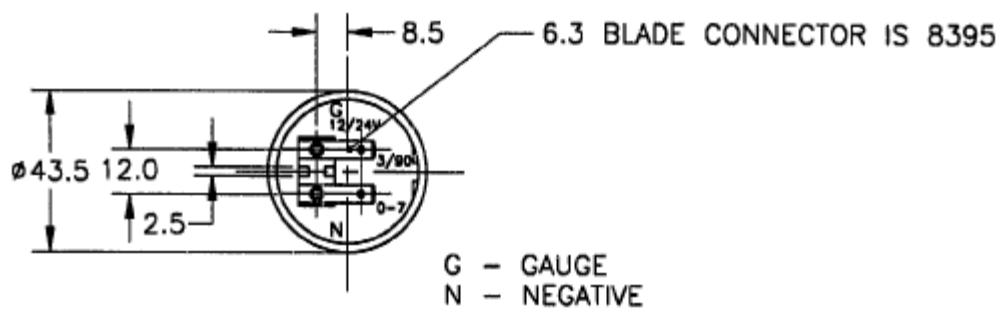
Internal P/N.	Man/ Man P/N	Sensor Type	Range / Unit	Nominal Resistance / Voltage
0193-0430-01(Dual wire)	F.W. Murphy ES2P-100	Standard Resistive Sender	0-100 PSIG	240 – 33 Ohms
0193-0244 (Single Wire)	-	Standard Resistive Sender	0-100 PSIG	240 – 33 Ohms
3814118	Pricol	Resistive Sender	0-5 Kg/Cm2	0 – 134 Ohms
0309-0641-XX	-	Switch	-	-



TABULATION						
DASH NO.	SENDER	MFR. NO.	PRESSURE RANGE	OHMS RANGE	CALIBRATION	
					P. S. I.	OHMS
193-0430-01	SINGLE	ES2P-100	0-100 PSI	240-33	0 50 100	225-257 82-114 51-21

*NOTE: ALL CALIBRATION DIMENSIONS ARE REF ONLY

Pressure sensor



PRESSURE-kg/Cm ²	RESISTANCE-OHMS
1	36 ± 4
3	88 ± 5
5	134 ± 6
7	-

Part Number - 3814118

Lube Oil Pressure Switch

The Part number for Lube Oil Pressure Switch is 0309-0641-XX. XX - depends on the trip pressure point. Select proper lube oil pressure switch.

If an oil pressure switch is used, the active state (active high or active low) of the switch must be configured using a PC based service tool. A software trim allows selection of the active state of the switch. The trim parameter for this is,

Lube Oil Pressure Switch Polarity = Active High, Active Low.

While using the switch the Display will only show the status of oil pressure as "OK" or "Not OK". The input is active low i.e. when the pressure is healthy the input is low.

Engine Control

Remote Start Mode

The control accepts a ground signal from remote devices to automatically start the generator set and immediately accelerate to rated speed and voltage. The control can incorporate a time delay start and stop in AUTO mode. The ground signal needs to be removed to stop the set in normal condition.

Emergency Stop

The Emergency Stop will be active when the ground signal is removed. This means a normally closed emergency stop switch needs to be wired between TB2-4 to Battery ground. Activation of the emergency will stop the generator set immediately to shut down. The generator set is prevented from running or cranking with the switch latched to open position. Remote E-Stop switch should have two independent potential free contacts. One NC contact for cutting out the Battery supply to the Fuel Solenoid and another NC contact to connect controller's E-Stop input to GND to indicate to the control when the E-Stop is pushed in active state.

Sleep Mode

When the mode select switch is in the STOP or AUTO position, the control will go into a low-power-consumption mode until the Reset button on the panel is operated or Remote start is received. The control will also wake-up after receiving a Remote start command if the control goes to sleep mode during Auto mode. If any warning or shutdown fault is active then control will enter the sleep mode.

- The "Sleep in AUTO" mode can be enabled or disabled from service tool.
- The "Sleep in AUTO" is defaulted as Disable.

Engine Starting

The control system supports automatic engine starting. It requires an external suitable contact rating relay for the starter motor and fuel shutoff. Primary and backup start disconnects are achieved by one of two methods.

Battery charging alternator feedback

Main alternator output frequency.

Cycle Cranking

Configurable for number of starting cycles (1 to 7) and duration of crank and rest periods. Control includes starter protection algorithms to prevent the operator from specifying a starting sequence that might be damaging.

Glow Plug Control

The control supports programmable glow plug control. This feature can be disabled when not required. The trim parameter for this is Glow Plug = Enable/Disable. If Glow Plug is disabled then the output can be configured as common warning or common shutdown.

Time Delay Start and Stop (Cool down)

The control can be configured for time delay of 0-300 seconds prior to starting after receiving a remote start signal, and for time delay of 0-600 seconds prior to shut down after receiving signal to stop in Auto modes. Default for start time delay is 0 while stop time delay period is 120 second.

Engine Speed Sensing

The PS0500 control derives the engine speed from the alternator output frequency. Starter disconnect is derived from the battery charging alternator or alternator frequency.

Battle Short Mode

The PS0500 control can be programmed to work in battle short mode by setting the battle short trim to enable by manufacturing tool or PC based service tool only.

Genset Protective Functions

On operation of a protective function the control will indicate a fault by lighting the respective LED on the control. The warning or shutdown LED will glow, fault code and short description will be displayed on the display. The nature of the fault and time of occurrence will be logged. The service manual and PC based service tool provide service keys and procedures based on the service codes provided.

The control provides the following system protective functions:

- **Configurable Alarm and Status Inputs** – The PS0500 control will accept one alarm input to indicate customer-specified conditions. The input is programmable for warning or shutdown. The fault condition on this input will be annunciated as “Cust I/P Flt”
- **Emergency Stop** - Annunciated whenever the emergency stop signal is received from an external switch.

Engine Protection

- **Over Speed Shutdown** – Engine Over Speed default setting is 115% (configurable with a PC based service tool) of the rated engine speed nominal. Control includes time delays to prevent nuisance shutdown signals.

- **Low Lube Oil Pressure Warning/Shutdown** - Level is preset (configurable with a PC based service tool) to match the capabilities of the engine used. Control includes time delays to prevent nuisance warning/shutdown signals.
- **High Engine Temperature Warning/Shutdown** - Level is preset (configurable with PC based service tool) to match the capabilities of the engine used. Control includes time delays to prevent nuisance warning/shutdown signals.
- **Low Battery Voltage Warning** - Indicates battery charging system failure by continuously monitoring battery voltage. Control includes time delays to prevent nuisance warning signals.
- **High Battery Voltage Warning** - Indicates battery charging system is of higher level by continuously monitoring battery voltage. Control includes time delays to prevent nuisance warning signals.
- **Weak Battery Voltage Warning** - Control system will test the battery bank each time the generator set is signaled to start, and indicate a warning if the generator set battery indicates impending failure. Control includes time delays to prevent nuisance warning signals.
- **Fail to Start Shutdown.** Control has completed the programmed cranking cycle but generator does not start. After predefined crank attempts the control will declare the Fail to Start shutdown fault.
- **Cranking Lockout** - The control will not allow the starter to attempt to engage or to crank the engine when the genset is running.
- **Sensor Failure Indication** – Out of range high / low diagnostic logic is provided. Control will detect analog sensor or interconnecting wiring failures.

Alternator Protection

- **High / Low AC Voltage Shutdown** – The control will announce the faults when ever the voltage is higher than 110% of the rated voltage for 5 seconds continuously or voltage is higher than 130% of the rated voltage (Instantaneous). Threshold for Low AC voltage fault is 85% of the rated voltage for 5 seconds continuous.
- **Under/Over Frequency** - Under frequency fault is announced if the frequency is less than the normal frequency by 6Hz for 10 seconds continuous. Over frequency fault is announced if the frequency is more than the normal frequency by 6Hz for 10 seconds continuous.
- **Loss Of Sensing AC Voltage Shutdown** – Loss of sensing AC voltage detects the loss of voltage sensing or senses the loss of zero crosses. This fault will also be the primary way to detect short circuit conditions.

Module assessment:

- 1) What is P/N for temperature sensor?
- 2) What is resistive temperature range for temperature sensor?
- 3) What is connector p/n for temperature manufacture by Packard?
- 4) Is pressure sensor use is three wires?
- 5) What is resistance range for pressure sensor?

Setup, Trims and Adjustments

Setup

While applying a PS0500 control to a new application, the following parameters should be ensured to have appropriate values. The table below lists the default values of the various parameters. Some of these parameters can be adjusted using the operator panel but the others require use of InPower.

It is intended that there will be only one software part number (0327-7727) for the PS0500 control.

Parameters like nominal voltage, frequency, CT Ratio etc need to have appropriate values at the manufacturing time based on the application requirements. This may be accomplished by InPower

The default values are intended to be suitable for major volume application. As of now it is known to be S and B series Gensets and sub 12 kW Gensets manufactured in India.

Group	Parameter Name	InPower Adjustability	Operator Panel Adjustability	Possible Values		Default value	Units
Adjustment				Lower	Higher		
Setup – Genset	Nominal Voltage (L-L)	Y	Y	190	600	416	V AC
	Nominal Frequency	Y	Y	50 or 60		50	Hz
	Connection type	Y	Y	Delta or WYE		WYE	-
	Phase type	Y	Y	Single Phase 2 wire, Single Phase 3 wire or Three Phase		Three	-
	CT ratio	Y	Y	50 to 300		100	Amp
	Oil Pressure Input Type	Y	Y	Switch	Sender	Sender	N/A
	Oil Pressure Sensor Type	Y	Y	Onan	CIL	Onan	N/A
	Cycle Crank Attempts	Y	N	1	7	3	Attempts
	Cycle Crank time	Y	N	3	30	5	Sec
	Cycle Crank Rest time	Y	N	0	60	5	Sec
	Battle Short Enable	Y	N	Enable or Disable		Disable	NA
	Start Time Delay	Y	N	0	300	0	Sec
	Stop Time Delay	Y	N	0	600	120	Sec
	Sleep In AUTO Mode	Y	N	Enable	Disable	Disable	N/A
	Speed/Hz gain Select	Y	N	20,30 and 60		30	N/A
Setup - Configurable I/O							

Group	Parameter Name	InPower Adjustability	Operator Panel Adjustability	Possible Values		Default value	Units
	Customer Input Active State Select	Y	N	Active open or Active closed		Active closed	N/A
Alternator Protection Adjust	Customer Input Fault Select Trim	Y	Y	Warning or Shutdown,		Shutdown	N/A
	Customer output #1 Function	Y	Y	Common warning, Common Shutdown or Glow-Plug		Common Warning	N/A
	Customer output #2 Function	Y	Y	Common warning, Common Shutdown or Genset Running		Common Shutdown	N/A
	High AC Voltage Threshold	Y	N	105	125	110 %	%
Protection – Engine	High AC Voltage Delay	Y	N	1	10	5	Sec
	Low AC Voltage Threshold	Y	N	50	95	90%	%
	Low AC Voltage Delay	Y	N	2	20	5	Sec
	Under Frequency Threshold	Y	N	2	10	6	Hz
	Under Frequency Delay	Y	N	500	2000	1000	½ cycles
	Over Frequency Shutdown Threshold	Y	N	2	10	6	Hz
	Over Frequency Delay	Y	N	100	2000	1000	1/2 cycles
	Low Oil Pressure Shutdown Threshold	Y	N	10	100	29	Psig
	Low Oil Pressure Shutdown Delay	Y	N	2	15	5	Sec
	Low Oil Pressure Warning Threshold	Y	N	10	100	36	Psig
	Low Oil Pressure Warning Delay	Y	N	2	15	5	Sec
	High Coolant Temperature Shutdown Threshold	Y	N	180	300	209	deg f
	High Coolant Temperature Shutdown Delay	Y	N	2	10	5	Sec
	High Coolant Temperature Warning Threshold	Y	N	150	290	203	deg f
	High Coolant Temperature Warning Delay	Y	N	2	10	5	Sec
	Low Battery Voltage Threshold for 12 V battery	Y	N	11	13	11	VDC
	Low Battery Delay for 12 V battery	Y	N	2	60	30	Sec

Group	Parameter Name	InPower Adjustability	Operator Panel Adjustability	Possible Values		Default value	Units
	High Battery Voltage Threshold for 12 V battery	Y	N	14	17	16	VDC
	High Battery Delay for 12 V battery	Y	N	2	60	30	Sec
	Weak Battery Voltage Threshold for 12 V battery	Y	N	6	10	8	VDC
	Weak Battery Delay for 12 V battery	Y	N	1	5	3	Sec

Install a PC based service tool onto desktop or laptop.

To install a PC based service tool follow in the installation instructions for the tool.

Creating and saving calibrations in the control via Capture File

Saving calibrations in the control –

Once trim or parameters has been changed, save trims in the control, disconnect the PC based service tool and do a power down reset of the control. Repower the control, reconnect with the service tool and take a Capture file.

Restoring Calibration -

To reconfigure a control with the content of a Capture File, connect to the controller with the service tool, connect to the desired Capture File and drag the content of the Capture File to the control and save trims.

Module assessment

- 1) Which parameters need to have appropriate values at the time of manufacturing?
- 2) Which engine families will support PS0500?
- 3) What is range for nominal voltages (L-L)?
- 4) How many cycle crank attempts can be set in PS0500?
- 5) What is start time delay provided?
- 6) What is default value for stop time delay?
- 7) What is range of High AC voltage threshold?
- 8) What is default value for under frequency threshold?
- 9) What is Low oil pressure shutdown threshold default value?
- 10) What is default value for High coolant temperature threshold?
- 11) What are default value for high coolant temperature warning threshold and delay?
- 12) What is weak battery voltage threshold default value?
- 13) What are default value for low battery & high battery voltage threshold?

Meter Calibration

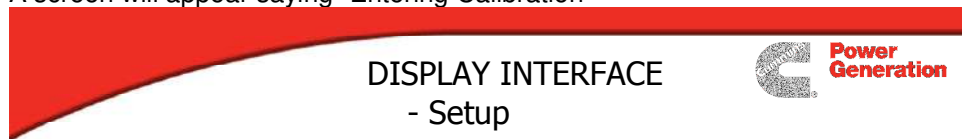
PS0500 can be calibrating from DISPLAY and InPower as well.

Procedure to calibrate display:

The display of the PS0500 control may need to be calibrated.
The meter calibration is done when the genset is running.

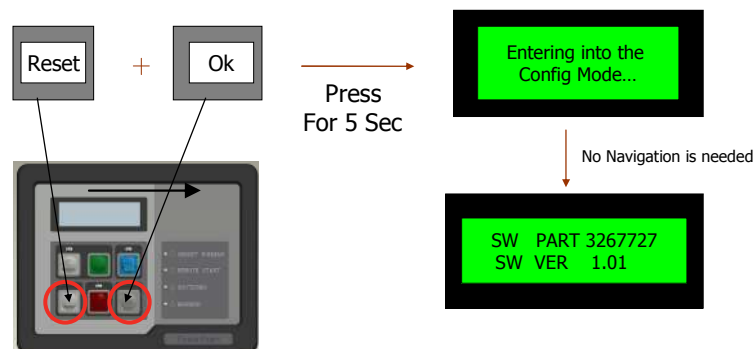
The display must be calibrated as per the procedure below -

1. To enter meter calibration, press "Reset" while holding down "OK" for 5 seconds.
2. A screen will appear saying "Entering Calibration"



To enter into the Set up mode :

➤ After going to the stop mode only we can enter the Setup mode



- 3.
4. Some of the pushbuttons on the operator panel are used for navigation as indicated by an arrow on the pushbutton.

Keys	Function	
→	Will go to the next value	
←	Will go to the Previous value	
//	Will go down	
*	It shows the default value. when we select the particular value it will comes to that value	

5. When in meter calibration, the voltage screen will be displayed first as below.

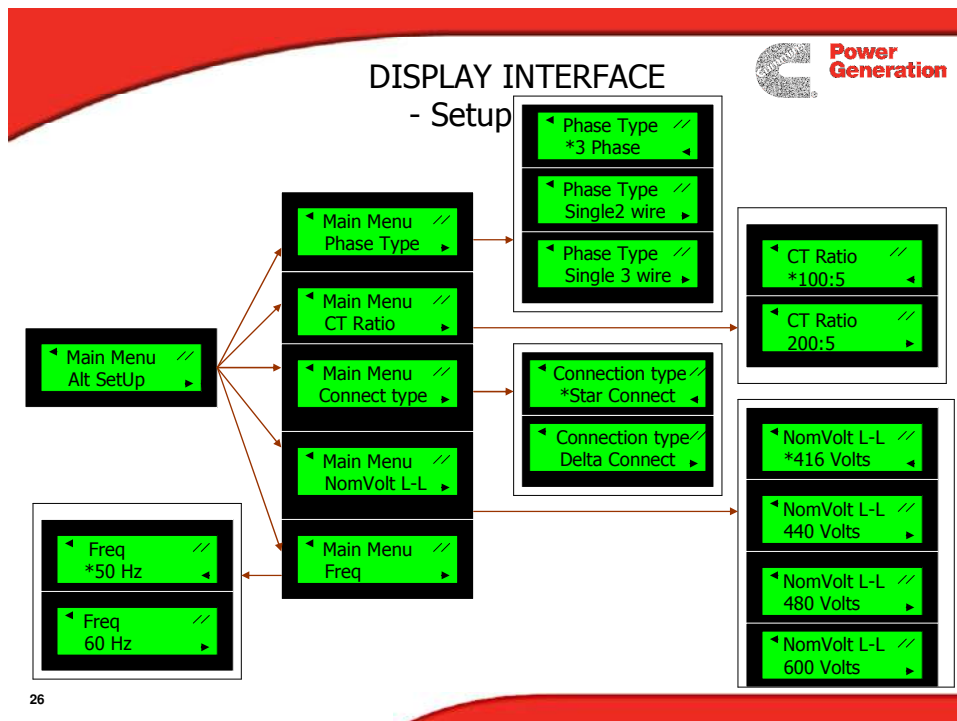
		L	1	N			L	2	N			L	3	N	
		2	3	4			2	3	6			2	3	7	

6. Increase/Decrease the L1-N voltage by pressing the ↑/ ↓ till the desired value is achieved.
7. Press → (OK) to OK this setting and move to L2-N voltage.
8. Increase/Decrease the L2-N voltage by pressing the ↑/ ↓ till the desired value is achieved.
9. Press → (OK) to OK this setting and move to L3-N voltage.
10. Increase/Decrease the L3-N voltage by pressing the ↑/ ↓ till the desired value is achieved.
11. Press → (OK). The screen will change to Current Calibration as below

		I	1				I	2				I	3		
		0	2	8			0	2	9			0	2	7	

12. Press → (OK) to move to I1 current.
13. Repeat the same for I2 and I3 calibration.
14. Press → (OK) to exit the Meter calibration. This will also save the adjusted values of the voltage and current in the control.

This is display interface setup .Anyone can calibrate using this guide.



Procedure to calibrate from InPower:

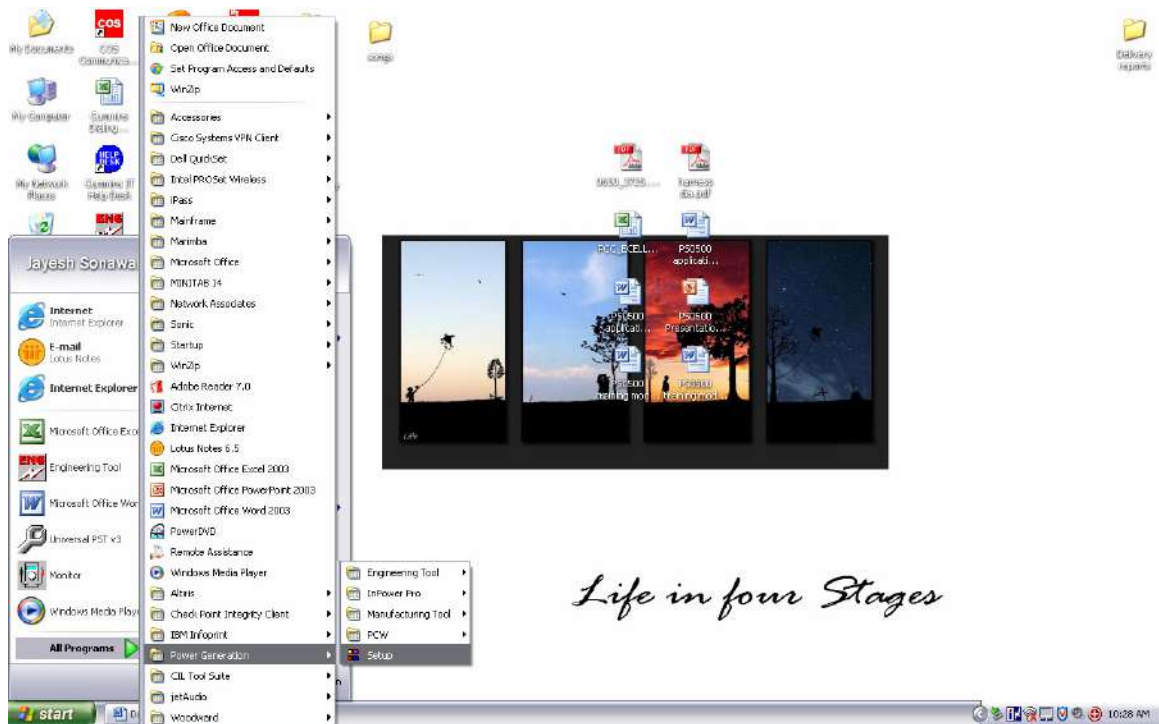
One need to have latest INCAL cd for successful and appropriate calibration, communication cable for PCC1301 (P/N=0338-5490), Laptop loaded with InPower V6.0.Adapter (0324-0021), Dongle (0998-0077-04).

Before going for calibration one need to check site setup for PS0500.

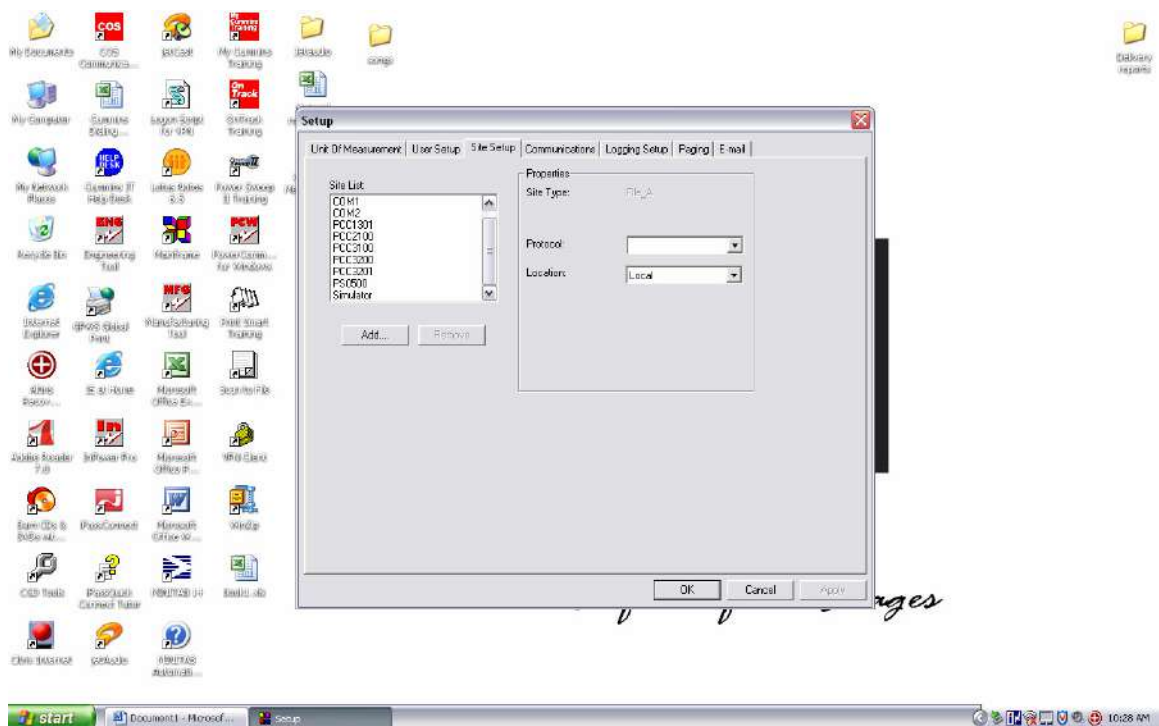
Go to START command for windows



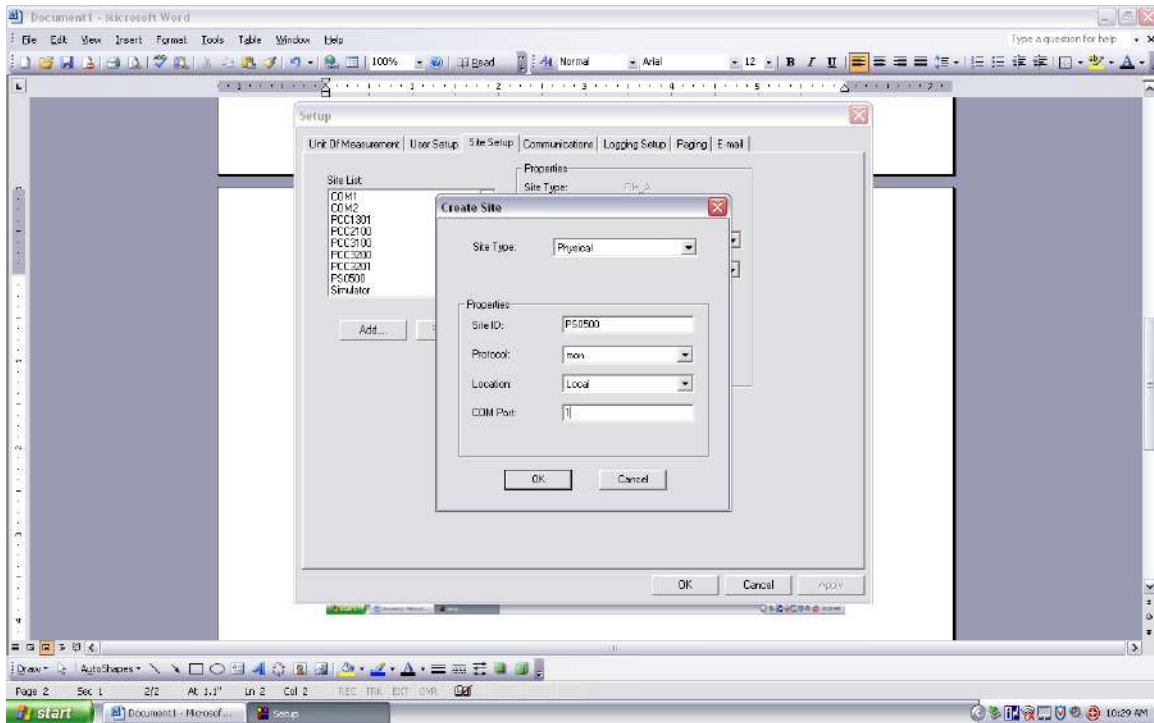
ALL PROGRAMMS
Open Power Generation folder

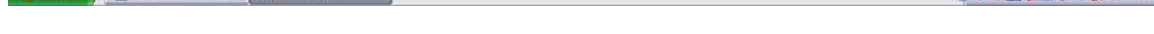


Open SETUP
Go to SITE SETUP



Click on ADD
SITE TYPE: PHYSICAL
Site ID: PS0500
Protocol: mon
COM Port: Respective to each computer.
Click on OK.

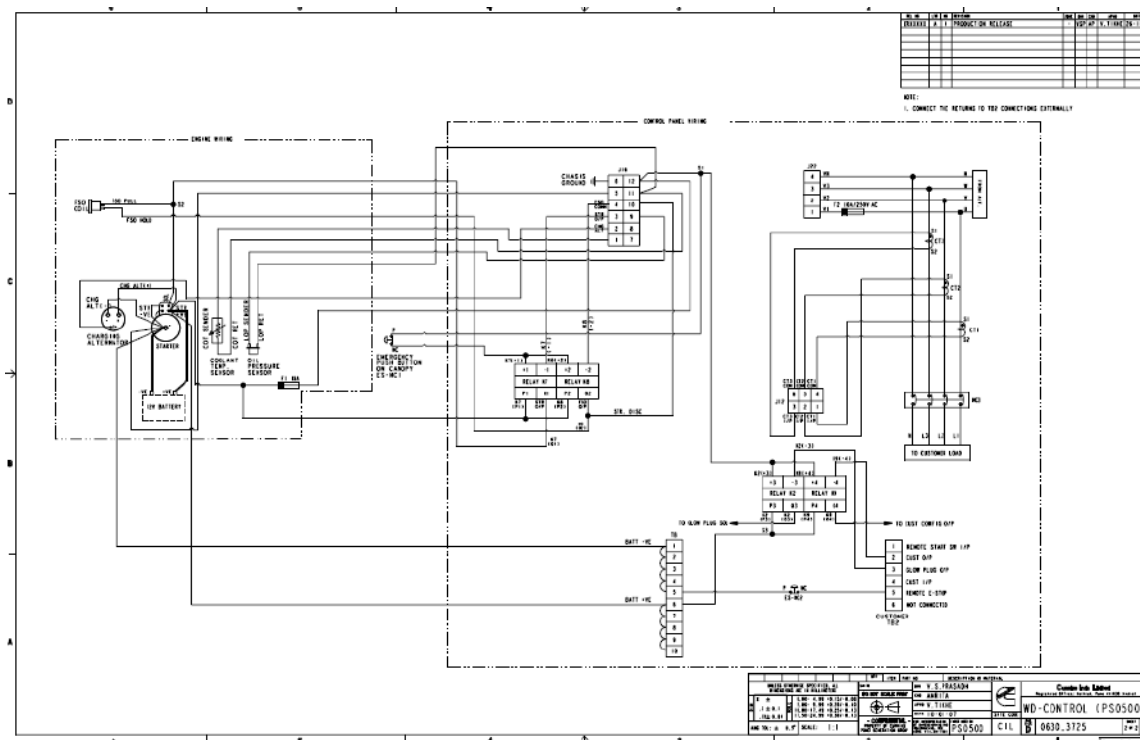
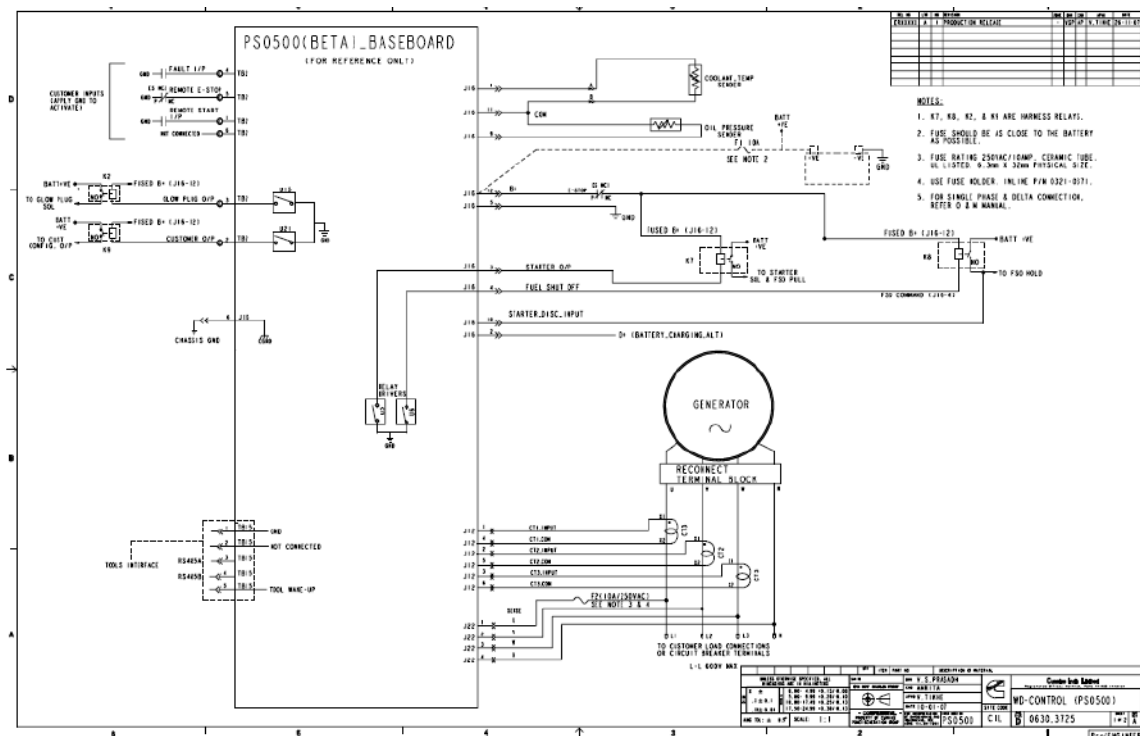




Module assessment:

- 1) Can we calibrate controller from display?
- 2) Which are two push buttons use to enter in meter calibration?
- 3) Write down the procedure for meter calibration of voltage.
- 4) Write down procedure for site setup in InPower.

Wiring Diagram



Environmental Capability

The control board is designed to withstand vibration levels of 50 mm / sec in 20 to 100 Hz range and of 3.3 G in the range of 100 -2000 Hz.

The base control is designed for proper operation without recalibration in ambient temperatures from –20 Deg C to +70 Deg C, and for storage from –30 Deg C to +70 Deg C. Control will operate with humidity up to 95%, non-condensing, and at altitude up to 13,000 feet (5000 meters).

The control board has conformal coating. The high voltage part of the circuit board is covered with protective cover.

The front panel of the control has an overlay to protect from the effects of dust, moisture, oil, and exhaust fumes.

The control system is specifically designed and tested for resistance to RFI / EMI and the effects of vibration to provide a long reliable life when mounted on a generator set. The control includes transient voltage surge suppression to provide compliance to referenced standards

Fuse Details

A fast acting ceramic fuse with a rating of ten amperes shall be placed inline with the Sense U (J13-4) voltage sensing lead.

A fast acting Auto type fuse with a rating of five amperes shall be placed inline with the B+ supply for the control.

A fast acting Auto type fuse with a suitable rating shall be placed inline with the Pull and Hold supply of the Fuel Shut off valve.

Fault Code List

Fault Description	Fault Code
Shutdown Faults	
Common Shutdown	157
High Coolant Temp. Shutdown	151
Low Oil Pressure Shutdown	415
High AC Voltage Shutdown	1446
Low AC Voltage Shutdown	1447
Over Frequency Shutdown	1448
Under Frequency Shutdown	1449
Loss of AC Voltage Sensing Shutdown	2335
Engine Overspeed Shutdown	234
Emergency Shutdown	1434
Fail To Start Shutdown	359
Fail To Stop Shutdown	2677
Configurable Fault Input#2 Shutdown	1312
Shutdown After Battle Short	1123
Fault Description	Fault Code
Warning Faults	
Common Warning	156
High Coolant Temp. Warning	146
Low Coolant Temp. Warning	1435
Coolant Temp. OOR Warning	144
Low Battery Voltage Warning	441
High Battery Voltage Warning	442
Low Oil Pressure Warning	143
Oil Pressure OOR Warning	141
Battle Short Mode Active Warning	1131
Battery Charging Failure Warning	2678
Fail to Shutdown Warning	1416
Weak Battery Voltage Warning	1442

Troubleshooting

GENERAL

The PS0500 control continuously monitors engine sensors for abnormal conditions, such as low oil pressure and high coolant temperature. If any of these conditions occur, the control will light a yellow warning lamp or a red shutdown lamp and display a message on the LCD display.

PC BASED SERVICE TOOL

The PC based service tool can be used in troubleshooting to perform tests, verify control inputs and outputs, and test protective functions.

When used improperly, a PC based service tool can cause symptoms like warnings and shutdowns that appear to be a defective base board. When these problems occur, always verify that a self-test or fault simulation (override) have not been left enabled with the tool. If you do not have a PC based service tool, or the enabled fault simulation(s) can not be found using the tool, disconnect battery power to disable the test or override condition.

Make sure that parameter adjustments and time delays, related to the fault condition, have been appropriately set for the application. It may be necessary to write the initial capture file to the device or update the calibration file. Updating a calibration file requires a Pro version of many of PC based service tools. Confirm that the installed calibration part number matches the serial plate information.

CAUTION using the wrong capture file can result in equipment damage. Do not swap Base boards from another genset model and only use the calibration file shown on the nameplate.

SAFETY CONSIDERATIONS

WARNING Contacting high voltage components can cause electrocution, resulting in severe personal injury or death. Keep the output box covers in place during troubleshooting.

WARNING Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.

Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (-) cable first and reconnect last.

CAUTION Disconnect battery charger from AC source before disconnecting battery cables.

READING FAULT CODES

The fault code and message can be viewed on the display. After the fault is acknowledged and corrected, the recorded fault will be deleted from the control panel memory, but will remain in a data log to maintain a fault code history. A PC based service tool is required to view this data log.

TROUBLESHOOTING PROCEDURE

The following tables are a guide to help you evaluate problems with the generator set. You can save time if you read through the manual ahead of time and understand the system.

Voltage/Continuity Testing

Voltage and continuity tests are required in the following tables. In some cases, it is necessary to

remove a plug to complete the test. Where required, the corrective action will mention when it is necessary to remove a plug for testing. In other cases, the plug cannot be removed for testing. When plug removal is not mentioned, testing must be performed by inserting a narrow meter probe into the back of the plug.

TABLE 20-1. ENGINE DOES NOT CRANK IN MANUAL MODE (NO FAULT MESSAGE)	
Reason: This indicates that the control has not received or recognized a manual start signal.	
Effect: Engine will not start.	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. No power supplied to control. Poor battery cable connections. Clean the battery cable terminals and tighten all connections. Fuse Blown	Check wakeup conditions Poor battery cable connections. Clean the battery cable terminals and tighten all connections. Remove connector P16 and check for B+ at P16-6 and GND at P16-11. If B+ or ground missing, isolate to harness and TB BAT terminal mounted on engine block. If B+ and ground check OK, cycle power to base board by reconnecting P16 and retry operation.
2. Base board not properly calibrated or corrupt calibration.	Confirm that the installed calibration part number matches the serial plate information. Re-enter calibration file if necessary.
3. The Emergency Stop switch or wiring is defective.	With Emergency Stop push button not activated (switch closed), remove configurable leads from TB2-4 and B- and check for continuity between these two leads. If circuit is open, isolate to Emergency Stop switch and wiring. If there is continuity, go to next step.
5. Oil Pressure switch or wiring is defective	Remove P16 connection and check wiring between P16-3 and P16-5 to the switch. Verify control is configured for the type of switch installed. Verify proper operation of the switch
6. Oil Pressure sender, setup on wiring is defective.	Remove P16 connection and check wiring between P16-3, P16-5 to the sender. Verify control is configured for the type of sender. Verify operation of the sender

TABLE 20-2. ENGINE DOES NOT CRANK IN REMOTE MODE (NO FAULT MESSAGE)	
Reason: This indicates that the PS0500 control has not received or recognized a remote start signal.	
Effect: Engine will not start in remote mode, but starts in manual mode.	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. The remote start switch or configurable wiring is faulty.	Reset the control. Attempt to start, and check for ground at TB2-1. If ground level is not present, isolate to the remote switch or configurable wiring. Repair as necessary. If ground level is present then the control is bad. Replace the control

TABLE 20-3. WARNING AND SHUTDOWN CODES	
FAULT CODE	CORRECTIVE ACTION
151 HIGH COOLANT TEMP Lamp: Shutdown	Indicates engine has overheated (coolant temperature has risen above the shutdown trip point). Allow engine to cool down completely before proceeding with the following checks: a. Check coolant level and replenish if low. Look for possible

	<p>coolant leakage points and repair if necessary.</p> <ol style="list-style-type: none"> Check for obstructions to cooling airflow and correct as necessary. Check fan belt and repair or tighten if necessary. Check blower fan and circulation pumps on remote radiator installations. Reset control and restart after locating and correcting problem.
415 LOW OIL PRESSURE Lamp: Shutdown	Indicates engine oil pressure has dropped below the shutdown trip point. Check oil level, lines and filters. If oil system is OK but oil level is low, replenish. Reset control and restart. If oil switch is used, check switch performance.
1446 HIGH AC VOLTAGE Lamp: Shutdown	Indicates that one or more of the phase voltages has exceeded 130% of nominal for 0 second, or has exceeded high ac voltage threshold of nominal for time delay seconds.
1447 LOW AC VOLTAGE Lamp: Shutdown	Indicates that one or more of the phase voltages has dropped below low ac voltage threshold for time delay seconds.
1448 OVER FREQUENCY Lamp: Shutdown	Indicates frequency is 10% above base frequency for approximately 10 seconds.
1449 UNDER FREQUENCY Lamp: Shutdown	Indicates that engine speed has dropped below 90% of nominal for approximately 10 seconds. Check fuel supply, intake air supply and load.
234 OVERSPEED Lamp: Shutdown	<p>Indicates engine has exceeded normal operating speed. The default thresholds are 1725 RPM (50 Hz) or 2075 RPM (60 Hz).</p> <p>Possible causes are single step large block load removal or flammable vapors drawn into the intake air passage. Reset control and restart after locating and correcting problem.</p>
1434 EMERGENCY STOP Lamp: Shutdown	<p>Indicates remote Emergency Stop. To reset the remote Emergency Stop button:</p> <ol style="list-style-type: none"> Open (disable) remote emergency stop button. Press the OFF button. Select the desired operating mode (manual or remote).
359 FAIL TO START Lamp: Shutdown	<p>Indicates possible fuel system or air induction problem. (Engine cranks but fails to start)</p> <ol style="list-style-type: none"> Check for empty fuel tank, fuel leaks, or plugged fuel lines and correct as required. Check for dirty fuel filter and replace if necessary. Check for dirty or plugged air filter and replace if necessary. Reset the control and restart after correcting the problem.
2677 FAIL TO STOP Lamp: Shutdown	Genset continues to run after receiving shutdown command from the controller.
1312 CONFIGURABLE INPUT #2 Lamp: Shutdown	<p>The nature of the fault is an optional configurable selection. Example inputs: Low Fuel Day Tank, Water In Fuel, Ground Fault, etc.</p> <p>Each of the fault functions can be programmed (using service tool or operator panel), as follows:</p> <ul style="list-style-type: none"> Warning or Shutdown (Default: Warning) (See fault code 1312 for Warning)
1123 SHUTDOWN AFTER BS	A shutdown fault occurred while the Battle Short mode was enabled. Check fault history for faults that may have been bypassed.

Lamp: Shutdown	
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146 HIGH COOL TEMP. Lamp: Warning	Indicates engine is operating near cooling system capacity. Increase in load or higher ambient temperature may cause High Coolant Temp (151) shutdown. Review code 151 correction list for other possible causes.
1435 LOW COOLANT TEMP Lamp: Warning Set is not operating. Warning occurs when engine coolant temperature is 70F (21C) or lower. NOTE: In applications where the ambient temperature falls below 40F (4C), Low Coolant Temp may be indicated even though the coolant heaters are operating.	Indicates engine coolant heater is not operating or is not circulating coolant. Check for the following conditions: <ol style="list-style-type: none"> Coolant heater not connected to power supply. Check for blown fuse or disconnected heater cord and correct as required. Check for low coolant level and replenish if required. Look for possible coolant leakage points and repair as required. Open heater element. Check current draw of heater. Coolant temperature must be below 70F (default setting) for one minute to activate warning and be above 70F for five minutes before the warning can be cleared.
1312 CONFIGURABLE INPUT Lamp: Warning	The nature of the fault is an optional configurable selection. Example inputs: Low Fuel Day Tank, Water In Fuel, Ground Fault, etc. Each of the fault functions can be programmed (using service tool), as follows: <ul style="list-style-type: none"> Warning or Shutdown (Default: Warning) (See fault code 1312 for Shutdown)
144 COOL SENSOR OOR Lamp: Warning	Indicates that the control has sensed that the engine coolant temperature sensor output is out of range (high or low). Check sender/connectors/wires. This fault will only occur if water temperature sensor is equipped on the genset.
441 LOW BATTERY Lamp: Warning	Indicates battery voltage supply to the control is approaching a low level at which unpredictable operation will occur. <ol style="list-style-type: none"> Discharged or defective battery. Check the battery charger fuse. Recharge or replace the battery. Poor battery cable connections. Clean the battery cable terminals and tighten all connections. Check battery wiring/calibration. Check engine DC alternator. Replace engine DC alternator if normal battery charging voltage is not obtained. Check battery charge voltage float level if applicable (raise float level).
442 HIGH BATTERY Lamp: Warning	Indicates battery voltage supply to the control is approaching a high level at which damage to the control can occur. Check float level on battery charger if applicable (lower float level). Check battery wiring/calibration.
141 OIL PRESS SENSOR OOR	Indicates that the control has sensed that the engine oil pressure sensor output is out of range (high or low). Check sender/connectors/wires. This warning will only occur if genset is

Lamp: Warning	equipped with an oil pressure sender.
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1131 BATTLE SHORT ACTIVE Lamp: Warning	Indicates that the control is in Battle Short mode - used to bypass several fault shutdowns for genset operation during emergencies.
2678 CHARGER FAILURE Lamp: Warning	Indicates the battery charging alternator has not reached an acceptable voltage range within the selected period (default = 120 seconds). Refer to engine service manual if this fault occurs. If not failed, check wiring.
220 FAIL TO SHUTDOWN Lamp: Warning	Genset continues to run after receiving shutdown command from the controller. Battle Short feature enabled - used to bypass several critical fault shutdowns for genset operation during emergencies.
1442 WEAK BATTERY Lamp: Warning	Indicates that during cranking, the battery voltage is at or below the weak battery warning trip point for a time greater than or equal to the weak battery set time. See code 441 for corrective action.

CODE 151/146 - HIGH OR PRE-HIGH COOLANT TEMPERATURE (SHUTDOWN/SHUTDOWN) Reason: Engine coolant temperature has exceeded the warning threshold for pre-high/high coolant temperature. Effect: Calibration-dependent. No action is taken by the Control for code 146 . Engine will shut down for code 151 .	
1. Fault simulation was enabled with a PC based service tool.	1. With a PC based service tool, verify that the fault simulation is not enabled for the coolant sensor. If you do not have a PC based service tool, remove battery power from the control to disable fault simulation overrides.
2. Engine or sensor circuitry problem.	Check the sensor accuracy with a thermocouple or similar temperature probe. <ul style="list-style-type: none"> • If the coolant temperature reading is accurate, the engine may be overheating. Refer to the engine service manual. • If the coolant temperature reading is not accurate, go to next step.
3. The sensor could be bad.	Disconnect the sensor and connect a coolant temperature sensor simulator to the harness. If the control responds to the simulator, replace the sensor. If control does not respond, go to next step.
4. The harness or Base board could be bad.	4. Measure the resistance of the coolant sensor and reconnect harness to sensor. Remove connector P16 from Base board and check resistance between pins P16-7 (H20) and P16-5 (H20 COM). <ul style="list-style-type: none"> • If resistance is not the same, harness is bad. • If resistance is the same, Base board is bad.

CODE 2/215 - LOW OIL OR PRE-LOW PRESSURE (WARNING/SHUTDOWN) Reason: Engine oil pressure has dropped below the warning/shutdown threshold for low/high oil pressure. Effect: Calibration-dependent. No action is taken by the Control for code 215 . Engine will shut down for code 2 .	
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POSSIBLE CAUSE	CORRECTIVE ACTION
1. Fault simulation was enabled with a PC based service tool.	With a PC based service tool, verify that the fault simulation is not enabled for the oil pressure sensor. If you do not have a PC based service tool, remove battery power from

	the control to disable fault simulation overrides.
2. Low oil level. Clogged lines or filters.	Check oil level, lines and filters. If oil system is OK but oil level is low, replenish.
3. Sensor or oil pump could be bad. Or the generator set may be shutting down on another fault.	<p>Disconnect the oil pressure sensor leads, and connect an oil pressure sensor simulator to the harness.</p> <p>a. If the control responds to the simulator, reconnect the sensor, disconnect the + signal wire at the fuel solenoid, and crank the engine. Check the oil pressure reading on the digital display.</p> <ul style="list-style-type: none"> If the display shows an acceptable oil pressure, the problem may not be in the oil or oil sensing system. The genset may be shutting down on another fault (out of fuel, intermittent connector). Restart the genset and monitor the display panel for other faults. If the display does not show an acceptable oil pressure, replace the sensor. If the Control still doesn't display an oil pressure while cranking, the oil pump may be bad. Refer to the engine service manual. <p>b. If the control does not respond to the simulator, go to next step.</p>
4. Harness or Base board could be bad.	<p>If the control does not respond to the simulator, the Base board or the harness is bad.</p> <p>Check the resistance in P16-3 and P16-5 (Sensor COMM). If the resistance signal (100 to 33 Ohm) does not get to P16, isolate to the harness. If the resistance does go to P16, the Base board is bad.</p>
5. Low Oil Pressure fault set points could be incorrect.	Verify set points against the normal operating pressures of the engine. Refer to engine manual.

CODE 1446 - HIGH AC VOLTAGE (SHUTDOWN)

Reason: One or more of the phase voltages has exceeded 130% of nominal for 1 second, or has exceeded the High AC Voltage Threshold for the High AC Voltage Delay seconds.

Effect: Engine will shut down.

POSSIBLE CAUSE	CORRECTIVE ACTION
1. Fault simulation was enabled with a PC based service tool.	1. With a PC based service tool, verify that the related fault simulation is not enabled. If you do not have a PC based service tool, remove battery power from the control to disable fault simulation overrides.
2. Single step large block load removal.	2. Clear fault and restart genset.
3. Fault threshold is not set correctly with InPower.	3. Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.
4. AVR or generator is bad.	4. Refer to Generator AVR Board Isolation Procedure in Alternator manual to determine if the AVR board is causing the high AC voltage shutdown fault.
5. Voltage sense connections/set up could be incorrect.	See Section 17 for proper corrective actions.

CODE 1447 - LOW AC VOLTAGE (SHUTDOWN)

Reason: One or more of the phase voltages has dropped below the Low AC Voltage Threshold for Low AC Voltage Delay seconds.

Effect: Engine will shut down.

POSSIBLE CAUSE	CORRECTIVE ACTION
1. Fault simulation was	1. With a PC based service tool, verify that the related fault simulation is

enabled with a PC based service tool.	not enabled. If you do not have a PC based service tool, remove battery power from the control to disable fault simulation overrides.
2. Fault threshold is not set correctly with A PC based service tool.	2. Reset the threshold to the lowest allowable setting. Determine the required operating range before adjusting the threshold.
3. Overload.	3. Check the load and correct any overload. Check operation by disconnecting load and restarting generator set.
4. Improper connections have been made at the generator output terminals.	4. Reconnect according to the appropriate reconnection diagram. See Section 17.
5. Voltage sense or setup wiring connection could be incorrect.	5. Check that Voltage senses inputs P22-1 to 4 are connected to the correct voltage sensing point at alternator.
6. The rotating rectifier assembly (diodes CR1 through CR6) is faulty.	6. Check each diode. See genset service manual
7. Loose connector or Base board is bad.	8. Repair connections (P22) or replace the Base board if necessary.
8. AVR or Alternator is bad.	4. Refer to Alternator / AVR Board Isolation Procedure in Alternator manual to determine if the AVR board is causing the Low AC voltage shutdown fault.
9. Voltage sense connections/setup could be incorrect	See section 17 for proper connections

CODE 1448 - OVER FREQUENCY (SHUTDOWN)

Reason: Generator AC output frequency is high.

Effect: Generator set will shut down.

POSSIBLE CAUSE	CORRECTIVE ACTION
1. Fault threshold is not set correctly with PC based service tool.	2. Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.
2. Fuel or air delivery problem.	3. Refer to the engine service manual.
3. Loose connector or Base board is bad.	4. Repair connections (P22 – 1 to 4) or replace the Base board if necessary.

CODE 1449 - UNDER FREQUENCY (SHUTDOWN)

Reason: Generator AC output frequency is low.

Effect: Generator set will shut down.

POSSIBLE CAUSE	CORRECTIVE ACTION
1. Fault threshold is not set correctly with PC based service tool.	2. Reset the threshold to the lowest allowable setting. Determine the required operating range before adjusting the threshold.
2. Overload.	3. Check the load and correct any overload. Check operation by disconnecting load and restarting generator set.
3. Fuel or air delivery problem.	4. Refer to the engine service manual.
4. Governor fault.	5. Check fuel shutoff solenoid adjustment (refer to Section 8).
5. Loose connector or	6. Repair connections (P22 – 1 to 4) or replace the Base board if

Base board is bad.	necessary.
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CODE 234 - OVERSPEED (SHUTDOWN)	
Reason: Engine speed signal indicates an engine speed greater than shutdown threshold.	
Effect: Engine will shut down.	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. Cold engine (no coolant heaters)	1. Overspeed can occur when starting a very cold engine. Clear fault and restart genset.
2. Single step large block load removal.	2. Clear fault and restart genset.
3. Fault simulation was enabled with a PC based service tool.	3. With PC based service tool, verify that the fault simulation is not enabled for the coolant sensor. If you do not have PC based service tool, remove battery power from the control to disable fault simulation overrides.
4. Fault threshold is not set correctly with PC based service tool.	4. Reset the threshold to the highest allowable setting. Determine the required operating range before adjusting the threshold.
5. Monitor the engine rpm using InPower.	5. If the RPM is not correct, refer to fault code 1448 for corrective action.
6. Governor fault.	6a. Check fuel shutoff solenoid adjustment (refer to Section 8). 6b. Replace defective injection pump unit.
7. Mechanical Fuel system setup could be incorrect.	Verify fuel stop settings for the application.

CODE 359 - FAIL TO START (SHUTDOWN)	
MECHANICAL GOVERNED ENGINE	
Reason: This indicates that the engine failed to start after expiration of last crank time.	
Effect: Engine will not start.	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. Restricted fuel supply due to: a. Fuel level below pickup tube in tank. b. Closed shutoff valve in supply line. c. Fuel injectors clogged. d. Air in fuel system.	1a. Add fuel if low. Prime the fuel system. 1b. Open any closed shutoff valve in the fuel line supplying the engine. 1c. Refer to engine service manual. 1d. Bleed air from fuel system. Refer to engine service manual.
2. Glow plugs are not heating due to: a. Glow plug(s) is bad. b. Base board is bad.	The Base board determines at what temperature and duration of time that the glow plugs will be energized. Using sensed coolant temperature, the glow plugs are energized at 77F (25C) and colder. The glow plugs are energized for up to 15 seconds when the coolant temperature is -5F (-20.5C) or colder. Time duration (15-0 seconds) is linear between -5F and 77F.

c. Glow Plug Relay is bad.	<p><i>With coolant temperature colder than 77F (25C):</i></p> <p>2a. Each glow plug should be warm to the touch if the engine has just been cranking. First clean and tighten the terminal of any cold glow plug and then replace it if necessary.</p> <p>2b. Attempt to start and check for if K2 energises. TB2-3 should be at GND potential. If the TB2-3 is at GND and K2 relay is not working check relay coil.</p> <ul style="list-style-type: none"> • If TB2-3 is not at GND potential replace the Base Board. • If B+ is present, check for open circuit between glow plug relay contact and glow plugs.
<p>3. Fuel solenoid on the injection pump not energized due to:</p> <p>a. Fuse may be open.</p> <p>b. Fuel solenoid is bad.</p> <p>c. Base board/K8 Fuel Relay is bad.</p>	<p>Isolate to fuse, K8 relay, fuel solenoid or Base board.</p> <p>3a. Remove fuse (if installed) and check continuity. If open, replace the fuse with one of the same type and amp rating. If fuse reopens, check wiring continuity of fuel solenoid circuit/test fuel solenoid.</p> <p>Binding in the solenoid linkage can prevent activation of the hold coil circuitry in the solenoid. Make sure solenoid shaft moves completely in and out freely. (Applies to solenoids with both Pull and Hold coils.)</p> <p>3b. Attempt to start and check for B+ at the fuel solenoid coil.</p> <ul style="list-style-type: none"> • If B+ is present, fuel solenoid is bad. • If B+ is not present, go to step c. <p>3c. Check wiring continuity/test K8 relay or fuel pilot: Remove lead from K8-COM (fuel pilot). Attempt to start and check for GND at lead COM.</p> <ul style="list-style-type: none"> • If there is no GND, check for open circuit between K8-COM and Base card. • If GND is present, reconnect lead COM to relay. Remove lead from N/O connection. Attempt to start and check for B+ at terminal N/O connection. • If B+ is present, check for open circuit between N/O connection and fuel solenoid (+). • If B+ is not present, check for relay contacts.
5. The engine fuel system is worn or malfunctioning or has lost prime (fuel lift pump, injection pump, injectors, timing).	4. Service according to the engine service manual.
6. The engine is worn or malfunctioning mechanically.	5. Service according to the engine service manual.
CODE 1312 - CONFIGURABLE INPUT (SHUTDOWN) Reason: The nature of the fault is an optional configurable selection. Effect: Shutdown.	
POSSIBLE CAUSE	CORRECTIVE ACTION
If there is no actual fault, the problem may be an external wiring problem.	<p>Disconnect the signal lead from TB2 and reset the control. Check the following two points.</p> <ul style="list-style-type: none"> • CUST_IN#2 – TB2-5 <p>If the message drops out, the external wiring has a short circuit. Grounding of the input activates fault.</p>

CODE 146 - HIGH COOLANT TEMP (WARNING)	
Reason:	
Effect:	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. Refer to code 151.	1. Refer to code 151.
CODE 1435 - LOW COOLANT TEMPERATURE (WARNING)	
Reason: Engine coolant temperature has dropped below the warning threshold for low coolant temperature.	
Effect: No action is taken by the control. Engine may not start due to slow cranking speed.	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. Fault simulation was enabled with PC based service.	1. With PC based service tool, verify that the fault simulation is not enabled for the coolant sensor. If you do not have a based service tool, remove battery power from the control to disable fault simulation overrides.
2. Fault threshold is not set correctly with A PC based service tool.	2. Reset the threshold to the lowest allowable setting. Determine the required operating range before adjusting the threshold.
3. The engine coolant heater could be bad. (Radiant heat should be felt with hand held close to outlet hose.)	3. Coolant heater not operating due to: <ul style="list-style-type: none"> • Coolant heater not connected to power. Check for blown fuse, or disconnected heater cord and correct as required. • Low coolant level. Look for possible coolant leakage points and repair as required. • Defective heater element/thermostat. With coolant heater removed from engine and power disconnected, flush with cold tap water for two minutes to close internal heater thermostat (opens at 100°F and closes at 80°F). Check resistance across input power leads: <ul style="list-style-type: none"> a. Open - replace coolant heater. b. Closed - coolant heater OK (coil resistance of 10 to 60 ohms)
4. The sensor connections could be bad.	4. Inspect the sensor and engine harness connector pins. Repair or replace as necessary.
5. The sensor could be bad.	5. Disconnect the sensor, and plug in a resistive sensor simulator to isolate the fault. If the control responds to the simulator, replace the sensor. If control does not respond, harness or Base board are bad.
6. The harness or Base board could be bad.	6. Measure the resistance of the coolant temperature sensor and reconnect harness to sensor. Remove connector P16 from Base board and check resistance between pins P16-7 (H20) and P16-5 (Sensor Common). <ul style="list-style-type: none"> • If resistance is not the same, harness is bad. • If resistance is the same, Base board is bad.
CODE 1312 - CONFIGURABLE INPUT (WARNING)	
Reason: The nature of the fault is an optional configurable selection.	
Effect: Warning.	
POSSIBLE CAUSE	CORRECTIVE ACTION
If there is no actual fault, the problem may be an external wiring problem.	Disconnect the signal lead from TB1 and reset the control. Check the following pins. <ul style="list-style-type: none"> • CUST_IN2 – TB2-5 If the message drops out, the external wiring has a short circuit. Grounding of the input activates fault.

CODE 144 - COOLANT SENSOR OOR (HIGH/LOW) (WARNING)

Reason: This indicates that the coolant temperature sensor signal is out of range - shorted high or low.

Effect: No engine protection for coolant temperature during genset operation. Possible white smoke.

POSSIBLE CAUSE	CORRECTIVE ACTION
1. The sensor connections could be bad.	2. Inspect the sensor and engine harness connector pins. Repair or replace as necessary.
2. The sensor could be bad.	3. Disconnect the sensor, and plug in a resistive sensor simulator to isolate the fault. If the control responds to the simulator, replace the sensor. If control does not respond, go to next step.
3. The harness or Base board could be bad.	4a. Remove connector P16 from Base board and disconnect sensor. Check pins P16-7 (H20) and P16-5 (Sensor common) for short circuit as follows: <ul style="list-style-type: none"> • Check for a short circuit to the engine block ground (more than 200k ohms OK). • Check for a short circuit from pin to pin (more than 200k ohms OK). Repair or replace as necessary. 4b. Measure the resistance of the coolant sensor and reconnect harness to sensor. Remove connector P16 from Base board and check resistance between pins P16-7 (H20) and P16-5 (Sensor Common). <ul style="list-style-type: none"> • If resistance is not the same, harness is bad. • If resistance is the same, Base board is bad.

CODE 441 - LOW BATTERY (WARNING)

Reason: Low voltage has been detected for battery.

Effect: The control's voltage supply approaching level at which unpredictable operation may occur.

POSSIBLE CAUSE	CORRECTIVE ACTION
1. Weak or discharged battery.	1. Recharge or replace the battery. Specific gravity for a fully charged battery is approximately 1.260 at 80F (27C).
2. Low electrolyte level in battery.	2. Replenish electrolyte and recharge battery.
3. Battery connections loose or dirty.	3. Clean and tighten or replace the battery cable connectors and cables at the battery and the set.
4. Insufficient battery charging voltage.	4. Adjust charge rate of AC powered battery charging circuit, according to manufactures instructions.
5. Engine DC alternator could be bad.	5. Replace engine DC alternator if normal battery charging voltage (12 to 14 VDC) is not obtained.
6. If the batteries are OK, the problem may be the harness or the Base board.	6. Remove connector P16 from Base board and check battery voltage at P16-6 (B+) to P16-11 (GND). <ul style="list-style-type: none"> • If the voltage at P16 is not the same as the battery voltage, the harness is bad. • If the voltage at P16 is OK, the Base board is bad.
7. Fault threshold could be bad.	7. Check fault threshold against requirement of the application.

CODE 442 - HIGH BATTERY VOLTAGE (WARNING) Reason: High voltage has been detected for battery. Effect: Control damage will occur.	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. Excessive battery charging voltage.	1. Adjust charge rate of AC powered battery charging circuit according to manufacturers instructions.
2. Engine DC alternator could be bad.	2. Replace engine DC alternator if normal battery charging voltage (12 to 14 VDC) is not obtained.
3. Fault threshold could be bad.	3. Check fault threshold against requirement of the application.
CODE 143 - LOW OIL PRESSURE (WARNING) Reason: Effect:	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. Refer to code 415.	1. Refer to code 415.
CODE 141 - OIL PRESSURE SENSOR OOR (HIGH/LOW) (WARNING) Reason: This indicates that the engine oil pressure sensor signal is out of range - shorted high or low. Effect: No engine protection for oil pressure during genset operation.	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. The sensor connections could be bad.	2. Inspect the sensor and engine harness connector pins. Repair or replace as necessary.
2. The sensor could be bad.	3. Disconnect the oil pressure sensor leads, and connect an oil pressure sensor simulator to the harness. “OIL PRESSURE SENSOR OOR” warning is displayed after the fault condition is sensed for 10 seconds. If the control responds to the simulator, replace the sensor. If control does not respond, go to next step.
3. The harness could be bad.	4. Remove connector P7 from Base board and connector from sensor. Check P16-3 and P16-5 as follows: <ul style="list-style-type: none"> • Check for a short circuit from pin to pin (more than 200k ohms OK). • Check for an open circuit (10 ohms or less OK). Repair or replace as necessary.
4. The Base board could be bad.	5. With all connectors attached, check pressure signal (.500 to .033 VDC) at P16-3 and P16-5 (Sensor Common). If in range, replace Base board.
CODE 1442 - WEAK BATTERY (WARNING) Reason: Effect:	
POSSIBLE CAUSE	CORRECTIVE ACTION
1. Refer to code 441	1. Refer to code 441.