


OGSC400

Auto Start Generator Set Controller

OPERATOR'S MANUAL

Marine Generators | Marine Diesel Engines | Land-Based Generators

NORTHERN LIGHTS




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NORTHERN LIGHTS

OPERATORS MANUAL
for GSC400
Auto Start Generator Set Controller

Please Read Manual Before Installing Unit

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GSC400 Specifications

VDC Rating	12/24 VDC		
DC Power Cons.	25 mA @ 12 VDC		
Operating Temp	-40°C to +85°C (-40°F to +185°F)		
LCD Operating Temp***	-20°C to +60°C (-4°F to +140°F)		
Function Selection Range	Function	Selection	Range
	Speed Sensing	Generator pickup Magnetic pickup	0-300vac, 0-3600rpm 0-300vac, 0-3600rpm
	Voltage Sensing	Single phase Three phase Delta, Wye	Max 700vac, +/- 1% Max 700vac, +/- 1% Max 700vac, +/- 1%
	Current Sensing*	Enable/Disable	Max 5A, =+/- 1%
	Frequency Sensing	Enable/Disable	1 - 100 HZ
	Engine Temp	GND=Fail, Open=Fail	10-265°F, 10-265°F
	Oil Pressure	GND=Fail, Open=Fail	0-90 PSI, 0-90 Kpa
	Oil Level	GND=Fail, Open=Fail	0-90%
	Fuel Level	GND=Fail, Open=Fail	0-100%
	Engine Logic	Delay to start Pre-heat Crank Rest Time Mid Heat Crank Attempts False Start Post Heat Warm-up Cooldown Crank Oil Pressure Crank Disconnect	0 - 60 seconds 0 - 60 seconds 3 - 60 seconds 1 - 60 seconds 0 - 60 seconds 1 - 60 tries Enable, Disable 0 - 60 seconds 0 - 600 seconds 0 - 600 seconds 0 - 90 KPa 100 - 2000 RPM
	Analog Input	Input 2, 5-7 (High Z) Input 3-4 (Low Z)	Gnd=Fail, Open=Fail 7mA Max
	Digital Input	Input A-D (Sw to Bat) Input E-H (Sw to Gnd)	Bat=Fail, 7mA Max Gnd=Fail, 7mA Max
	Digital Output	Output A-H Extra Relay	300 mA Max 40A Max
	Exerciser	Enable, Disable	10 - 240 Minutes
	Battery Recharge	Enable, Disable	10 - 240 Minutes
	Password	4-Digit	0-9
LCD Display	128 x 64 Graphic Display, Backlit, 60° Viewing Angle, LCD Operating Temperature -30°C to +60°C (-22°F to +140°F)		
LED Display	Red, Green, Yellow LED representation, Daytime Visible, 60° Viewing Angle		
Programming	Manual, Software, Field Upgradable		
J1939 Interface	Low emission capable		
Relays**	Replaceable 40A relays for Crank, Fuel, Extra Output. 12 or 24 VDC Coil		
Dimensions	W x H x D, 139 x 113 x 65 mm (5.47 x 4.45 x 2.56 in.)		
Weight	0.45 Kg (1.0 lb)		
* Use of Industry Standard CT Required ** 40A output at room temperature ***The LCD display will exhibit color and response time changes at high and low temeratures respectively but will not be damaged as long as within Operating temp.			

1. GSC400 CONTROLLER SERIES

The GSC400 is designed for use on generator sets with either mechanical or electronic (J1939) engines. It can monitor analog data from senders on the engine and generator such as oil pressure, coolant temperature, current, voltage, and engine speed and generator frequency. The GSC400 can also gather engine parameters from the engine ECM via J1939 and use them to control the engine or for display purposes.

An RS232 interface is provided that allows communication with the Northern Lights GSC400 PC Interface to change settings display information on the PC. An RS435 port is provided for Modbus communications (slave only) for remote annunciation or communications.

In addition to the monitoring features, the GSC400 controller can be used to automatically start/stop a generator system as well as provide protective warning or shutdowns.

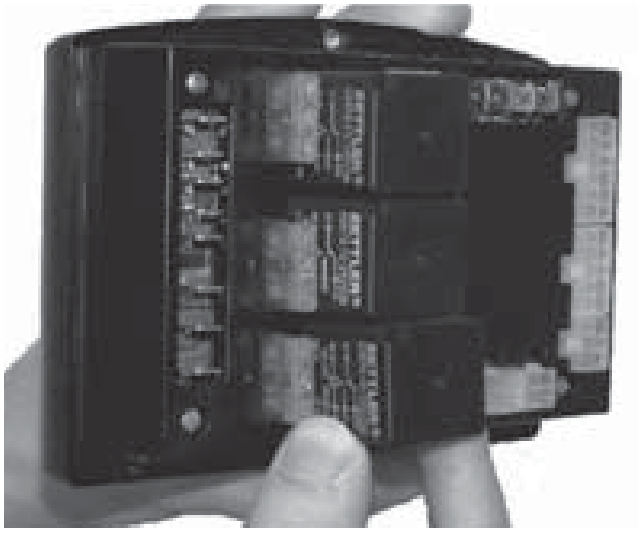
GSC400 Front View

1.1 USING THIS MANUAL

This manual is divided into three sections:

1. Hardware installation
2. Basic operation / configuration
3. Advanced configuration

GSC400 Back View



2. RECEIVING, HANDLING & STORAGE

Receiving:

Every effort is made to ensure that your GSC400 gen-set controller arrives at its destination undamaged and ready for installation. The packaging is designed to protect the GSC400 internal components as well as the enclosure. Care should be taken to protect the equipment from impact at all times. Do not remove the protective packaging until the equipment is at the installation site and ready to be installed.

When the GSC400 reaches its destination, the customer should inspect the shipping box and controller for any signs of damage that may have occurred during transportation. Any damage should be reported to a Northern Lights representative after a thorough inspection has been completed.

A shipping label affixed to the shipping box includes a variety of product and shipping information, such as items and Customer numbers. Make certain that this information matches your order information.

Each GSC400 controller is packaged in its own box. Do not discard the packing material until the controller is ready for installation.

Handling:

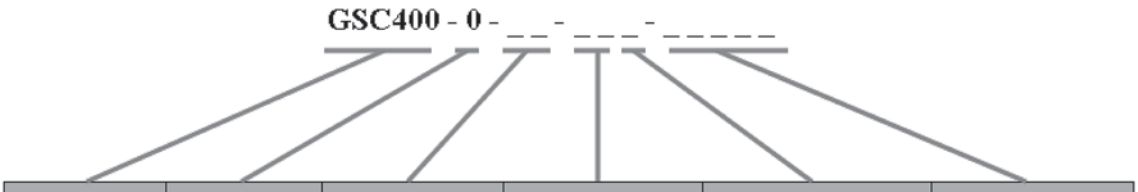
As previously mentioned, each GSC400 gen-set controller is packaged in its own individual box. Protect the equipment from impact at all times and do not carelessly stack. Once the controller is at the installation site and ready to be installed, the packaging material may be removed.

Storage:

Although well packaged, this equipment is not suitable for outdoor storage. If the GSC400 is to be stored indoors for any period of time, it should be stored with its protective packaging in place. Protect the controller at all times from excessive moisture, dirty conditions, corrosive conditions, and other contaminants. It is strongly recommended that the package-protected equipment be stored in a climate-controlled environment of -20 to 65°C (-4 to 149°F), with a relative humidity of 80% or less. Do not stack other equipment on top of the stored controllers.

3. GSC400 PRODUCT NUMBER IDENTIFICATION

The GSC400 series product numbering scheme (i.e. serial number) provides various information (including options selection by the customer) about the unit. A serial number has the format given in Figure 1.



Position 1-6	Position 8	Position 10-11	Position 13-14	Position 15	Position 17 to 21
Series	Place Value	DC Voltage	Labeling	Revision	Identifier
Controller Series: GSC400	Set to 0.	12=12VDC 24=24VDC	LS=Standard LX=Customized	A letter is placed in this position to indicate the hardware revision level. No letter indicates revision A.	Uniquely indentifies the particular unit.

Figure 1 - GSC400 Product numbering scheme

4 GSC400 SERIES INSTALLATION AND WIRING

4.1 SAFETY INFORMATION

Generator systems contain circuits of high voltages. Not powering down equipment can cause damage to equipment, injury, or death. The following symbols will be used in this document to classify information:

Caution: This is used to indicate something that you should take special notice of but that is not normally a threat to safety.

Danger: This is used to indicate a potential for injury or death.

Danger - High Voltage: This is similar to Danger above but relates specifically to conditions where high voltage is encountered.

The following general safety precautions should be heeded:

1. The GSC400 may carry high Voltage/Current which can cause serious injury or death. Extreme caution must be exercised when connections are being installed to or from the controller. All wiring connections must be de-energized before any installations are performed. Wiring of the GSC400 should be performed by qualified electricians only.

2. AC power may carry high Voltage/Current which can cause serious injury or death. De-energize all AC power sources before any connections are performed.

3. NEVER energize AC power with AC current sensing connector unplugged. An energized, unplugged connector could result in severe injury or death. Never unplug an energized connector.

4.2 MOUNTING LOCATION

The GSC400 gen-set controller must be properly mounted for safe operation. Caution must be taken at the installation site to make sure the site is free from excessive moisture, fluctuating temperatures, dust, corrosive materials etc. The controller should be safely mounted in a secure lusing the 3 mounting screws provided. Figure 2 for the mounting locations.

Caution: Mounting screws must be installed at the recommended torque of 10 inch pounds

Figure 2 - GSC400 Mounting Locations

4.2.1 GSC400 MOUNTING DIMENSIONS

Figure 3 gives the precise dimensions of the mounting hardware.

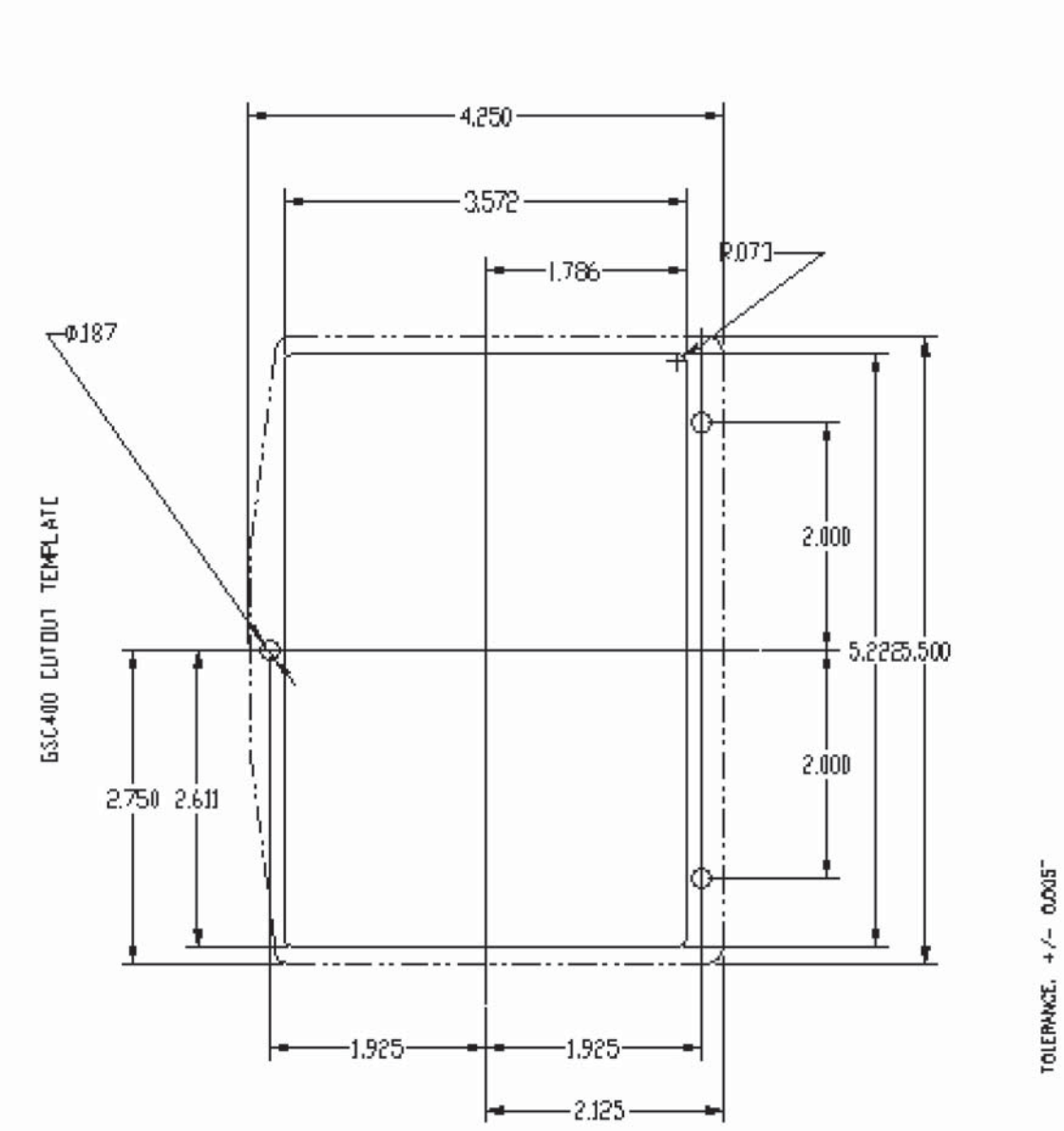


Figure 3 - Dimensions of Mounting Holes

4.3 GSC400 12/24VDC SYSTEM OPERATION

The GSC400 controller can be placed in either 12V or 24V electrical systems.

4.3.1 UL RATING

The GSC400 is UL listed to UL508. For conditions of acceptability refer to UL file number: E250327 or contact Northern Lights.

4.3.2 40A RELAYS

The GSC400 controller is designed to operate in either 12 or 24 VDC system voltages. When operating in 12VDC systems the fuel, crank and extra relays need to be the proper 12VDC relay type. When operating in 24VDC systems these relays need to be the proper 24VDC relay type. Contact DynaGen if relays are required.

UL Listed relays for 12 or 24VDC system operation are as follows:

- Northern Lights P/N 22-42047 for 12VDC operation
- Northern Lights P/N 22-40085 for 24VDC operation

CAUTION: The above relays must be installed in the GSC400 for it to meet UL.

4.3.3 RELAY FUSES

CAUTION needs to be taken when connecting relay outputs to an inductive load. Due to the inductive nature of certain loads (starters, pull coils), initial current draw may be higher than stated in the load specs which could damage the onboard relays.

Output relays are protected by onboard 40A fuse protection. Smaller amperage fuses from many automotive stores may be used in place of the higher current 40A. If installing lower amperage fuse protection, be certain that the current draw on each relay does not exceed the fuse current limit.

An approved 40A fuse is:

- LITTLEFUSE – 257040 (32VDC, 40A, Auto fast Action)

4.4 GSC400 TERMINALS

The type and part number for each of the terminal connections are given in Table 1 . Figure 4 shows the location of all terminals on the controller and the numbering of all circuits. Table 2 gives the part numbers of the various starter-kit harnesses you can order from DynaGen. Only commonly used circuits on each connector are populated (i.e. connected with a wire on the harness).

Table 2 lists the minimum wire size, maximum current capacity, name, and function of each circuit. The wire gages given in the table are the minimum recommended only.

Table 1: GSC400 Terminal Information (Manufacturer & Part Number)

Terminal Name	GSC400 Terminal Type*	Mating Connector Type (for wiring harness)**
Digital Input	Molex 39-28-1123	Molex 39-01-2120
Digital Outputs	Molex 39-28-1103	Molex 39-01-2100

TABLE 1 (CONT'D) AND FIGURE 4

Terminal Name	GSC400 Terminal Type*	Mating Connector Type (for wiring harness)**
AC Current	Molex 39-28-1063	Molex 39-01-2060
RS485 (Modbus)	Molex 39-28-1063	Molex 39-01-2060
CAN (J1939)	Molex 39-28-1043	Molex 39-01-2040
Analog Inputs	Molex 39-28-1083	Molex 39-01-2080
RS232	AMP 87337-5	Major League Electronics TSHS-1-05-D-16-A-C (2 x 5pin double header, 0.1" spacing)
Quick Connects (Spade Terminals)	Keystone 4901 (0.25" wide)	Standard 0.25" wide female quick connect

* These are the terminals located on the GSC400 that the wiring harness mates to.
**The Molex connectors require the following contacts: Molex 39-00-0039. The hand crimp tool required to crimp the contacts to the wire is Molex 0638190900. The extraction tool part number is Molex 011030044 which allows you to remove contacts from the Moles connector without damaging the contact. The extraction tool is available from Northern Lights,(Part Number: ACC0087)

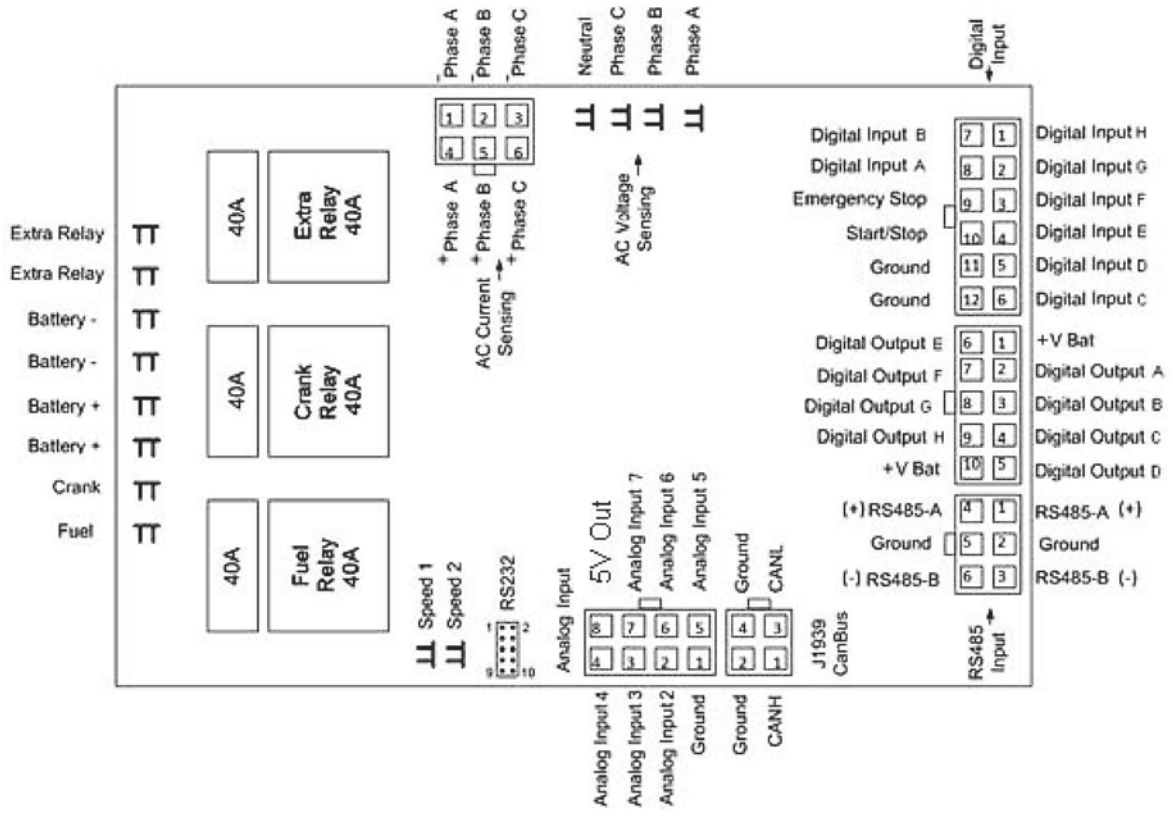


Figure 4 - GSC400 terminals as seen from the rear.

TABLE 2

Table 2 - GSC400 Terminal Details					
Quick Fit Terminalls	Terminal	Wire Size (AWG)	Current Max*	Functions	
	Crank	12	40A	Crank Output Terminal	
	Battery +	12	40A	Positive Battery Terminal	
	Battery -	12	40A	Negative Battery Terminal	
	Fuel	12	40A	Fuel Output Terminal	
	Extra Relay	12	40A	Extra Relay Output Terminal	
	Speed 1	18	100mA	Speed Signal Conection	
	Speed 2	18	100mA	Speed Signal Conection	
	* Total controller current output (max 60A)				
Analog Inputs	Terminal Detail	Terminal Location	Wire size (AWG)	Current Max	Function
	Ground	1	18	7mA	Ground
	Input 2 - High	2	18	7mA	Configurable (Low Resistance, Gain of 1)
	Input 3 - Low	3	18	7mA	Configurable (Low Resistance, Gain of 3)
	Input 4 - Low	4	18	7mA	Configurable (Low Resistance, Gain of 3)
	Input 5 - High	5	18	7mA	Configurable (High Resistance, Gain of 3)
	Input 6 - High	6	18	7mA	Configurable (High Resistance, Gain of 1)
	Input 7 - High	7	18	7mA	Configurable (High Resistance, Gain of 3)
	Ground	8	18	7mA	Ground
Digital Inputs	Terminal Detail	Terminal Location	Wire size (AWG)	Current Max	Function
	Input H - GND	1	18	7mA	Configurable[1]
	Input G - GND	2	18	7mA	Configurable[1]
	Input F - GND	3	18	7mA	Configurable[1]
	Input E- GND	4	18	7mA	Configurable[1]
	Input D - BAT	5	18	7mA	Configurable[2]
	Input C - BAT	6	18	7mA	Configurable[2]
	Input B - BAT	7	18	7mA	Configurable[2]
	Input A - BAT	8	18	7mA	Configurable[2]
	Emer. Stop	9	18	7mA	Allows Manual Emergency Stop (Open=Active)
	Start/Stop	10	18	7mA	Allows Manual Start/Stop of Engine (Active = Start, Inactive = Stop)
	Ground	11	18	7mA	Ground
	Ground	12	18	7mA	Ground
	[1] Ground input to generate active high.		[2] Tie input to battery + to generate active high.		

TABLE 2

Digital Outputs *	Terminal Detail	Terminal Location	Wire size (AWG)	Current Max	Function
	+ BAT	1	18	1.5A	Positive Battery Voltage
	Output A	2	18	200mA	Configurable *
	Output B	3	18	200mA	Configurable *
	Output C	4	18	200mA	Configurable *
	Output D	5	18	200mA	Configurable *
	Output E	6	18	200mA	Configurable *
	Output F	7	18	200mA	Configurable *
	Output G	8	18	200mA	Configurable *
	Output H	9	18	200mA	Configurable *
	+ BAT	10	18	200mA	Positive Battery Voltage
	* See Advanced Setup Menu Chart under Digital Output Setup (page 49) for possible selections. **These are sinking outputs (i.e. switched to ground)**				
RS485 (Modbus)	Terminal Detail	Terminal Location	Wire size (AWG)	Current Max	Function
	RS485-A	1	18	7mA	RS485 Connection
	Ground	2	18	7mA	Ground Terminal Connection
	RS485-B	3	18	7mA	RS485 Connection
	RS485-A	4	18	7mA	RS485 Connection
	Ground	5	18	7mA	Ground Terminal Connection
	RS485-B	6	18	7mA	RS485 Connection
AC Voltage Sensing	Terminal	Wire Size (AWG)	Current Max	Function	
	Phase A	18	7mA	Monitor Generated AC Voltage	
	Phase B	18	7mA	Monitor Generated AC Voltage	
	Phase C	18	7mA	Monitor Generated AC Voltage	
	Neutral	18	7mA	AC Voltage Neutral Connection	
AC Current Sensing	Terminal Detail	Terminal Location	Wire size (AWG)	Current Max	Function
	Phase A	1	18	5A	Phase A current sensing CT-
	Phase B	2	18	5A	Phase B current sensing CT-
	Phase C	3	18	5A	Phase C current sensing CT-
	Phase A	4	18	5A	Phase A current sensing CT+
	Phase B	5	18	5A	Phase B current sensing CT+
	Phase C	6	18	5A	Phase C current sensing CT+
	 It is extremely important to connect each phase to the appropriate terminal location. Never mix phase inputs. Always match terminal details to the matching terminal location.				
CAN (J1969)	Terminal Detail	Terminal Location	Wire size (AWG)	Current Max	Function
	CANH	1	18	7mA	CANH Connection
	Ground	2	18	7mA	Ground Terminal Connection
	CANL	3	18	7mA	CANL Connection
	Ground	4	18	7mA	Ground Terminal Connection

4.5 SYSTEM WIRING DIAGRAM

A typical system wiring diagram is given in Figure 5 below.

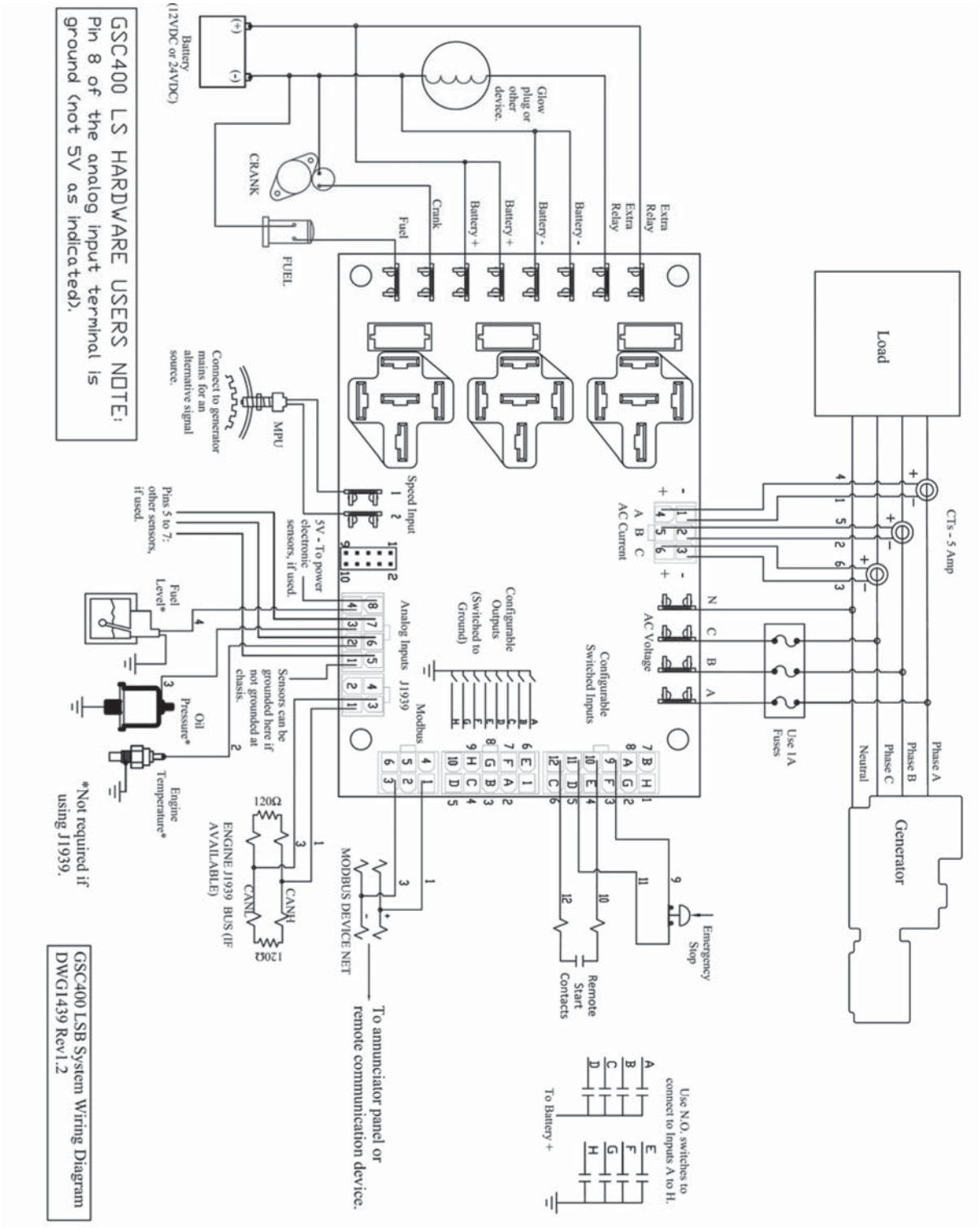


Figure 5 – General GSC400 System Wiring Diagram

4.5.1 CAN WIRING NOTE (J1939)

The CAN communication bus's CANL and CANH lines must be terminated with 120Ohm resistors on either end of the bus. If you are not connecting to an existing bus you must do this. If you are connecting to an existing bus check that it has the proper terminating resistors.

To check for proper resistance disconnect the CAN bus harness from the GSC400 and measure across the CANH and CANL pins on the harness connector. It should be 60 Ohms (two 120 Ohms in parallel). If you measure 120Ohms then only one resistor has been installed.

4.5.2 CURRENT TRANSFORMER (CT) WIRING NOTE

The current transformers (CTs) negative leads must be terminated individually into the GSC400 AC Current connector. **Do not tie the negative leads together to a common neutral or ground.** The negative lead of the CT is usually black**.**

5 GSC400 OPERATION AND BASIC USER CONFIGURATION

5.1 POWER-UP

The very first time the controller is powered up the unit will go through an initialization where all the configurable settings are set to factory default values. This will happen only on the first power-up. Once the initialization is finished, the controller will display the firmware and hardware version on the screen and flash the indicator lamps on the side of the controller (this will also occur during all subsequent power-ups).

The controller will then enter the Off state. Pressing the Auto button will cause the controller to enter the Auto state. From this state, the user can manually put the controller into Run mode (i.e. start the generator) or the controller itself will be able to start the generator automatically if required (e.g. remote start capability on low battery if enabled).

The controller has the ability to remember whether it was in the off or auto state the last time it was powered up and will reenter that state when it is repowered.

Note that the emergency stop pin on the digital input connector must be tied to the ground pin on the same connector or to either of the battery negative quick connects. If this is not done, the emergency stop feature will be active on power-up which will prevent the controller from leaving the off state and will also sound the audible alarm.

5.2 REMOTE START CONTACTS / EMERGENCY STOP

The GSC400 has a dedicated remote start contact located on the digital input connector. See Figure 4 on page 6 for the location of the remote start contact. A grounded signal on the contact when the controller is in AUTO Mode (see below for more information on the AUTO Mode) will cause the controller to start. Removing the ground will cause the controller to go back into AUTO Mode.

It is also possible to set one of the programmable digital inputs as a remote start contact. This feature works the same way as the dedicated remote start (active = start). See Table 12 on page 34 for more information on the digital input features.

The GSC400 also has a dedicated emergency stop input that when open will stop the generator immediately and the controller will enter the OFF Mode (see below for more information on the OFF Mode) and remain in the OFF Mode until the emergency stop input is grounded. While the emergency stop input is active the GSC400 will sound an audible alarm and display “Emergency Stop” on the LCD display. See Figure 4 on page 6 for the location of the emergency stop input.

5.3 CONTROLLER STATES

The GSC400 incorporates 3 primary modes of operation:

1. OFF Mode
2. AUTO Mode
3. RUN Mode

5.3 CONTROLLER STATES (CONTINUED)

1. OFF Mode – When the GSC400 is set to the Off Mode, starting will be disabled. No automatic controls will be initiated. The Off Mode may be initiated when no generator controls are required or when the controller configuratiorequires adjustment.

All of the failures and most of the warnings are disabled when the controller is in the Off Mode. The controller will beep every few seconds to alert the user that the unit is in the Off Mode and cannot automatically start. To silence this alarm, press the off button as instructed on the screen.

In Off Mode you may simultaneously press the Up and Down arrow keys to perform a lamp test.

2. AUTO Mode - When the GSC400 is set to the Auto Mode, automatic starting will be enabled. Possible triggers include start/stop, battery recharge and exerciser features (all of which are controllable form the menu system). If the engine is started, failures will be automatically detected allowing for dafe engine operation.

While in Auto Mode, the controller will display engine temperature, battery voltage, fuel level and engine hours.

3. RUN Mode – The controller starts the engine/generator and enters the RUN Mode automatically on certain triggers (low battery voltage or to exercise the generator) or the user can manually start the engine/generator by pressing the Run button when the controller is in the AUTO Mode. Another option is to use the remote start contacts located on the digital input connector. The controller will automatically shut the engine/generator down and re-enter the auto mode if it initiated an engine/generator start. When the controller is in the OFF Mode both automatic and manual starting is disabled.

When the controller is in the RUN Mode, generator parameters will be displayed on the screen to allow the user to monitor the engine status. These include engine speed, generator voltage and current, and engine temperature as well as others. The parameters are displayed in groups and the screen scrolls between the various groups. The Page Roll Display menu option controls how long each parameter group is displayed on the screen before moving on to the next group. See Table 5 on page 15 for more information.

5.3.1 LOCKING THE GSC400 SCREEN WHILE IN THE RUN MODE

When in the RUN Mode the GSC400 LCD screen can be locked to display a particular parameter group. To do this press the up or down keys to scroll to the parameter group you wish to view and then press the ENTER key to lock the screen. You will see a lock symbol displayed on the right hand side of the display just under the date and time.

To unlock the screen press “Enter” again which causes the lock symbol to disappear and the screen will start to scroll though the parameter groups again. The screen will automatically unlock after 10 minutes.

5.4 CONTROLLER SLEEP

The controller has a low power Sleep Mode that it can enter when in the OFF or AUTO states. In this state the LCD screen backlighting is turned off. The time it takes to enter Sleep Mode is configurable in the menu. It is recommended that the Sleep Delay is set as short as possible to prolong the life of the backlighting and to reduce battery consumption.

The backlight display will illuminate automatically upon button activation. A button press will only cause the controller to exit the Sleep Mode. The button must be pressed again to perform its normal function.

5.5 GSC400 MENU SYSTEM OPERATION

The GSC400 incorporates a menu system to allow the end user to adjust basic settings such as the time of day. The menu system will also allow technicians and OEMs to adjust advanced settings (this feature is password protected).

With the controller in the Off Mode, the menu system may be selected simply by pressing the Enter button.

In the off state press “ENTER” to access the GSC400 Menu System. This is called the Basic Menu. The following buttons perform the menu navigation:

1. Scroll up using the up button 

2. Scroll down using the down button 

3. Enter menus by pressing the enter button. 

Each menu has a “Back” selection. Scroll up to the Back selection and press the Enter button to go back to the previous menu. When in the basic menu you can go back to the Off state by pressing the OFF key.

5.6 BASIC MENU

When you press the Enter button in the Off state you will enter the basic menu which includes the Clock Setup, Basic Setup, Advanced Setup, and Failure History submenus.

1. Clock Setup
2. Basic Setup
3. Advanced Setup
4. Failure History

Table 3: Basic Menu Layout		
Basic Menu:	Clock Setup	Year, Month, Date, day, Hour, Minute, 12/24
	Basic Setup	Contrast Adj, Page Roll Delay, State Roll Dly, Sleep Delay, Maintenance, Not In Auto, Off Mode Start
	Events History	

5.6.1 CLOCK SETUP

The Clock Setup menu will allow you to set the clock. The clock is important if you are planning to use the event log (records all failures and warnings and when they occurred) or the exerciser feature (starts the generator for a settable period).

Table 4- Clock Setup Menu	
Menu	Selection and Range
Year	2000-2099
Month	January - December
Date	01 - 31
Day	Monday - Sunday
Hour	00-23
Minute	00-59
12/24	12 Hours, 24 Hours

The GSC400 internal clock information can remain “in memory” for approximately 2 weeks when no DC power is supplied to the controller. Two week memory storage is available in a completely charged controller clock. DC power is required to be supplied continually to the GSC400 for approximately 1 hour to allow a complete clock charge. Customers may need to set the clock if improper time is displayed.

5.6.2 BASIC SETUP

The Basic Setup menu will allow the user to customize the basic features of the GSC400 to their preference.

The Contrast Adjustment allows the user to adjust the contrast of the LCD.

The Page Roll Delay controls how long each group of parameters are displayed in the RUN state (i.e. when the engine/generator is running) before displaying the next set of parameters.

The second line of the GSC400 LCD screen is usually dedicated to displaying warnings, and events. The State Roll Delay determines how long the warning or event message is displayed before moving on to the next message. Setting the State Roll Delay to a larger value may cause some warning or event messages to not be displayed if the event or warning is of a short duration.

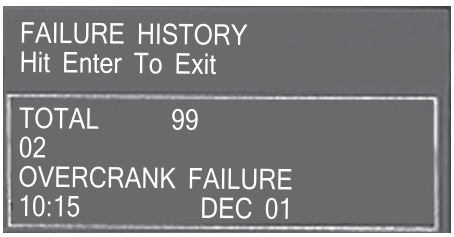
The Sleep Delay determines how long to wait with no buttons presses before turning off the LCD backlighting. The Sleep Delay also controls the automatic exit from the menu system. First the controller exits to the basic menu after the first sleep delay, exits to the Off state after the second sleep delay, and finally goes into sleep mode after the third sleep delay. The sleep delay does not work in the Run Mode or during cranking.

Table 5 – Basic Setup Menu

Menu	SELECTION AND RANGE
Contrast Adjust	5-95 %
Page Roll Delay	1-10 s
State Roll Delay	1-10 (1 is shortest delay, 10 is longest)
Sleep Delay	10-600s. Shorter is ideal to extend the backlighting life.
Maintenance	Read only. Displays the amount of hours until next service if this feature is enabled. If service is overdue the hours become negative.

5.6.3 EVENT HISTORY

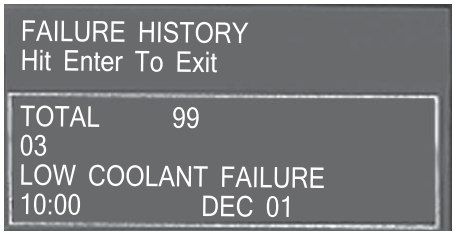
The GSC400 incorporates an event status history logging system. When engine failures or events occur, the failure condition information is documented into the GSC400 Event History Log.



Referring to Table 3 on page 14, the history log is the last entry in the basic menu. The basic menu is entered by pressing the ENTER button when in the OFF Mode.

A total of the most recent 100 event/failure conditions will be recorded within the log. Event/failure conditions may be viewed simply by scrolling up or down throughout the menu. In addition to the event/failure condition information, the associated date and time of the event/failure will be displayed.

Simply scroll through the Failure History Log by pressing the  or  buttons located on the GSC400.



5.7 GSC400 LED STATUS INDICATOR

Some industry standard failures, warnings, and events on the GSC400 are indicated by a series of LEDs on the left side of the controller.

Specific LED indicators will be illuminated depending upon the condition of the controller. The benefit of the GSC400 LED indicators is that it allows a quick check of the controller's condition.

The GSC400 displays multi color LED's for specific condition representation.

Red
- Represents Failure Conditions

Yellow
- Represents Warning Conditions

Green
- Represents Normal/Active Conditions

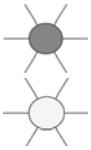
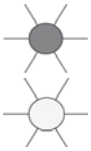
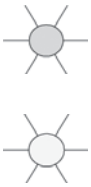
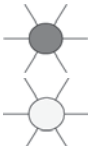
An LED test may be performed by the user for illumination of all controller LED's. The LED test may be performed by simultaneously pressing the UP key and the DOWN key on the GSC400.

TABLE 6 – GSC400 LAMP INDICATION MEANINGS

Table 6 – GSC400 Lamp Indication Meanings

LED Description	LED color	LED Status	Indication
Over Crank	Red	Solid Red	A solid red illuminated LED represents an Over Crank condition on the final crank attempt. This is a Failure.
	Yellow	Solid Yellow	A solid yellow illuminated LED represents an Over Crank Warning condition when there are crank attempts still remaining.
High Engine Temp	Red	Solid Red	A solid red illuminated LED represents a High engine Temp Failure condition
	Yellow	Solid Yellow	A solid yellow illuminated LED represents a High engine Temp Warning Condition
Low Oil Press	Red	Solid Red	A solid red illuminated LED represents a Low Oil Pressure Failure condition.
	Yellow	Solid Yellow	A solid yellow illuminated LED represents a Low Oil Pressure Warning condition.

TABLE 6 – GSC400 LAMP INDICATION MEANINGS (CONT'D)

Table 6: WaveNet Lamp Indication Meanings (cont'd)			
LED Description	LED color	LED Status	Indication
Over Speed	 Red Yellow	Solid Red Solid Yellow	A solid red illuminated LED represents an Over Speed Failure condition. A solid yellow illuminated LED represents an Over Speed Warning condition.
Low Fuel	 Red Yellow	Solid Red Solid Yellow	A solid red illuminated LED represents a Low Fuel Level Failure condition. A solid yellow illuminated LED represents an Low Fuel Level Warning condition.
Battery Status	 Green Yellow	Solid Green Flashing Green Solid Yellow	A solid green illuminated LED represents a normal battery condition. Controller in Auto mode - Waiting to start A solid yellow illuminated LED represents a Low Battery condition.
Not In Auto	 Red	Solid Red	A solid red illuminated LED represents a Not in Auto condition.
Low Coolant	 Red Yellow	Solid Red Solid Yellow	A solid red illuminated LED represents a Low Coolant failure condition. A solid yellow illuminated LED represents a Low Coolant Warning condition.
Pre-Heat	 Green	Solid Green	A solid green illuminated LED represents an active Pre-Heat condition
EPS Supplying Load	 Green	Solid Green	A solid green illuminated LED represents an active load condition supplied from the Emergency Power System.
Failure	 Red	Solid Red	A solid red illuminated LED represents a general Failure condition.

5.8 WARNINGS AND FAILURES

The GSC400 incorporates many types of warnings and failures. Some are only active in the RUN mode while others are also active in AUTO and/or OFF modes. Warnings and Failures can be triggered from a Digital Input, Analog Input, AC Voltage or Current sensing, Speed Signal Input, as well as others. The Advanced Setup section of this manual will give more information of the specific warning and failures for each type of input.

When a warning occurs, the second line (the area under the time and date display) of the LCD is used to display the warning text. Also, after the warning is displayed, instructions are displayed showing the user how to silence the warning. When in the AUTO or RUN states the instructions are to press the Auto key and when in the OFF state press the Off key.

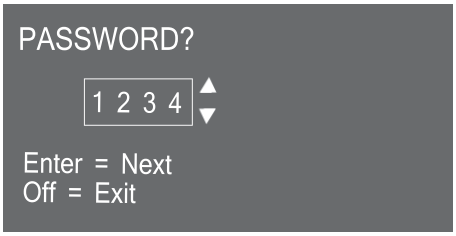
When a failure occurs (although most failures only occur in the RUN state, the Low Fuel Level and Low Coolant Level failures occur in any state including OFF and AUTO) the controller exits the RUN state and goes to the FAILURE state – turning off the Fuel output and other outputs on or off depending on the advanced settings – and displays the failure message. The alarm will turn on continuously. The Auto button can be pressed to silence the alarm. Once the alarm is silenced it can be reset by pressing the Auto key and then the Off key. This returns the controller to the OFF state.

The failure is recorded in the event log accessible from the Basic menu.

6 ADVANCED SETUP

The GSC400 incorporates an Advanced Setup menu. Menu adjustments include input, output and other advanced settings. The possible advanced menu selections are covered in this section. Only OEMs or advanced and knowledgeable users should change these parameters.

Before entering the Advanced menu a password is required to be entered. The password will consist of a four digit number. Each number needs to be selected using the up or down arrows on the GSC400.



Simply choose the correct password number for each selected position by scrolling to the proper number followed by the Enter button. The default password is 0 0 0 0. The password may be changed anytime. See Password Setup section.

The Advanced Setup menu on the GSC400 is shown to the right.

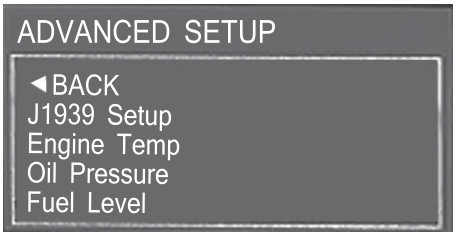


TABLE 7: ADVANCED MENU LAYOUT SUMMARY

Table 7: Advanced Menu Layout Summary		
Menu Layout		Description
Advanced Menu (Password Protected)	J1969	The J1969 setup contains general settings for J1939 such as shutdown on loss of messages. To set whether to read a value fron a local sender/switch ot the J1939 bus please see below.
	High Engine Temp	**Analog Inputs:** These control all aspects of the specific analog input listed in the left column such as whether it is a switch, sender, or obtained from J1939. You can also set the input to which you want it to connect. The warnings and failures as well as open and shorted sender detection shutdowns are also configurable.
	Oil Pressure	
	Fuel Level	
	Oil Level	
	Fuel in Basin	
	Low Engine Temp	
	Speed Sensing	The speed sensing source (magnetic pickup, generator voltage, NMEA2000), under and over speed warnings and failures.
	AC Frequency	The crank disconnect frequency and the over/under frequency warning/failures.
	AC Voltage	The AC voltage sensing/display is contained here as well as the over and under voltage warnings and failures.
	AC Current	The CT ratio (X:5), AC current sensing and display enable are contained in this menu.
	Engine Logic	All the basic start and shutdown logic are contained in this menu.
	Outputs Setup	This menu allows you to assign a feature/action to one of eight digital outputs. For example you can turn on a digital output when an under-speed failure occurs.
	Exerciser Set	Generators require periodic operation as part of their scheduled maintenance. This menu allows settings to control how often the engine/generator is started and for how long.
	Inputs Setup	This menu allows you to assign features/warnings to one of eight digital inputs. For example low oil pressure.
	Battery Setup	This menu controls the settings for the battery under and over voltage warnings and failures. It also allows the user to set at what battery voltage to start the generator and how long the generator is to remain running.
	Set Password	The advanced menu requires a password for access. The user can change the password here. The default password is 0000.
	Set Maintain	This menu controls the service notification feature for regular maintenance. The user can enable/disable the feature and set the service interval. A technician can reset the service interval here. On reset the service counts down to the next service.
	Set Modbus	This sets the modbus slave address and baud rate.
	Common Faults	The user can select a group of failures, warnings, and events that when triggered will cause a digital output to turn on. The user also needs to select this feature in the digital outputs menu for one of the outputs.
	Set Dummy Load	This contains the logic to turn on and off a digital output to place an additional load on a generator. The user can select the switch-on and switch-off current thresholds.

TABLE 8: SUBMENUS OF THE ADVANCED MENU

Table 8: Submenus of the Advanced Menu		
J1939 Setup	Manufacturer:	John Deere, Volvo / DDC
	Loss of ECM:	Enable, Disable
	Display Group 1:	Enable, Disable
	Display Group 2:	Enable, Disable
High Engine Temperature	Input Pin:	Disable, Analog 2-7
	Signal Source:	J1939, Switch input, Sender 1, 2, or 3
	Bypass Delay:	0-60 Seconds GND = Fail, Open = Fail
	Switch Setting:	Disable, Warning, Shutdown
	Shorted Sender:	Disable, Warning, Shutdown Fahrenheit,
	Open Sender:	Celsius
	Units:	10-265°F, 10-265°C
	Warning Level:	10-265°F, 10-265°C
	Failure Level:	
Oil Pressure	Input Pin:	Reserve, Analog 2-7
	Signal Source:	J1939, Switch input, Sender 1, 2 or 3
	Bypass Delay:	0-60 Seconds
	Switch Setting:	GND = Fail, Open = Fail
	Shorted Sender:	Disable, Warning, Shutdown
	Open Sender:	Disable, Warning, Shutdown
	Units:	PSI, KPa
	Warning Level	0-90 PSI, 0-90 KPa
	Failure Level:	0-90 PSI, 0-90 KPa
Fuel Level	Input Pin:	Reserve, Analog 2-7
	Signal Source:	Switch input, Sender
	Bypass Delay:	0-60 Seconds
	Switch Setting:	GND = Warning, OPEN = Warning, GND = Fail,
	Shorted Sender:	Open = Fail Disable, Warning, Shutdown
	Open Sender:	Disable, Warning, Shutdown
	Units:	Percentage
	Warning Level:	0-90%
	Failure Level:	0-90%
	0% Fuel Level:	0-1000 Ohms (data sheet or measured value)
	25% Fuel Level:	0-1000 Ohms (data sheet or measured value)
	50% Fuel Level:	0-1000 Ohms (data sheet or measured value)
	75% Fuel Level:	0-1000 Ohms (data sheet or measured value)
	100% Fuel Level:	0-1000 Ohms (data sheet or measured value)
Oil Level	Input Pin:	Reserve, Analog 2-7
	Signal Source:	J1939, Switch input, Sender
	Bypass Delay:	0-60 Seconds
	Switch Setting:	GND = Fail, Open = Fail
	Shorted Sender:	Disable, Warning, Shutdown
	Open Sender:	Disable, Warning, Shutdown
	Units:	Percentage
	Warning Level:	0-100%
	Failure Level:	0-100%

TABLE 8: SUBMENUS OF THE ADVANCED MENU (CONT'D)

Fuel In Basin	Input Pin:	Reserve, Analog 2-7
	Signal Source:	J1939, Switch input, Sender
	Bypass Delay:	10-60 Seconds
	Switch Setting:	GND = Fail, Open = Fail
	Shorted Sender:	Disable, Warning, Shutdown
	Open Sender:	Disable, Warning, Shutdown
	Units:	Percentage
	Warning Level:	0-90%
	Failure Level:	0-90%
Low Engine Temperature	Input Pin:	Reserve, Analog 2-7
	Signal Source: r	J1939, Switch input, Sender
	Bypass Delay:	10-60 Seconds
	Switch Setting:	GND = Fail, Open = Fail
	Shorted Sender:	Disable, Warning, Shutdown
	Open Sender:	Disable, Warning, Shutdown
	Units:	Fahrenheit, Celsius
	Warning Level:	10-265°F, 10-265°C
Speed Sensing	Signal Source:	J1939, Mag pickup, Gen output
	Rated Freq:	10-9990 Hz
	Rated RPM:	200-4000 RPM
	Over RPM Warn:	100-5000 RPM
	Over RPM Fail:	100-5000 RPM
	Under RPM Warn:	100-5000 RPM
	Under RPM Fail:	100-5000 RPM
AC Frequency	DisconnectFreq:	1-100 Hz
	Over Freq Warn:	1-100 Hz
	Over Freq Fail:	1-100 Hz
	UnderFreq Warn:	1-100 Hz
	UnderFreq Fail:	1-100 Hz
AC Voltage	Voltage Source:	Disable, Enable
	Voltage Display:	Line-Line, Line-Neutral, Both
	Voltage Group:	1-Single, 2-Three, 3-Hi Wye, 4-Three phase
	Group 1 Setting:	3 Wire Single, 2 Wire Single
	Group 4 Setting:	Four Wire Delta, Three Phase
	Over Volt Warn 1:	0-700 VAC
	Over Volt Fail 1:	0-700 VAC
	Under Volt Warn 1:	0-700 VAC
	Under Volt Fail 1:	0-700 VAC
	Over Volt Warn 2:	0-700 VAC
	Over Volt Fail 2:	0-700 VAC
	Under Volt Warn 2:	0-700 VAC
	Under Volt Fail 2:	0-700 VAC
	Over Volt Warn 3:	0-700 VAC
	Over Volt Fail 3:	0-700 VAC
	Under Volt Warn 3:	0-700 VAC
	Under Volt Fail 3:	0-700 VAC
	Over Volt Warn 4:	0-700 VAC
	Over Volt Fail 4:	0-700 VAC
	Under Volt Warn 4:	0-700 VAC
	Under Volt Fail 4:	0-700 VAC

TABLE 8: SUBMENUS OF THE ADVANCED MENU (CONT'D)

AC Current	Current source:	Disable, Enable
	Turns Ratio:	5-5000A:5A
	Over Current Warn 1:	0-6500 A
	Over Current Fail 1:	0-6500 A
	Over Current Warn 2:	0-6500 A
	Over Current Fail 2:	0-6500 A
	Over Current Warn 3:	0-6500 A
	Over Current Fail 3:	0-6500 A
	Over Current Warn 4:	0-6500 A
	Over Current Fail 4:	0-6500 A
	Hi Wye Current:	100%, 50%
	Cur Warn Latch:	Disable, Enable
Engine Logic	Delay to Start:	0-60 seconds
	Glowplug Time:	0-60 seconds
	Crank Time:	3-60 seconds
	MidHeat Time:	0-60 seconds
	Crank Rest Time:	1-60 seconds
	Crank Attempts:	1-60
	Fuel Crank Rest:	Disable, Enable
	False Restart:	Disable, Enable
	Post-Heat Time:	0-60 seconds
	ETS On Duration:	0-30 seconds
	Warm-up Time:	0-600 seconds
	RPM Disconnect:	100-2000 RPM
	Cool Down Delay:	0-600 seconds
	Crank Oil pres:	0-90 Psi
Digital Output Setup All selections apply to each individual output.	Extra Relay: Output A: Output B: Output C: Output D: Output E: Output F: Output G: Output H:	Disable, Warm-Up, ETS, Glowplug, Cooldown, Over Crank , High Temp Fail , High Temp warn, Low Oil Fail , Low Oil Warning, Under RPM Fail, Under RPM Warn, Over RPM Fail Over RPM Warn, Low Fuel Fail Low Fuel Warn, Battery Fail, Battery Warn, Low Coolant Fail, Low Coolant warn, Not in Auto, Failure, Crank Rest, Engine Running, Crank On, Exerciser Alarm, Recharge Alarm, Under Volt Warn, Over volt warn, Over Amp Warn, Fuel in Basin, Volt Regulator, Low Temp Warn. Back Light, Auxiliary Warn, Maintenance, System Ready, Common Output 1, Common Output 2, Dummy Loads, High Fuel Warn, Current Latch, Config Warn 1, Config Warn 2, Config Fail 1, Config Fail 2.
Exerciser Setup	Exerciser Enable:	Disable, enable
	Run Duration:	10-240 minutes
	Pre-Alarm Delay:	1-20 minutes
	Repeat Freq.:	1-672 hours
	Start Hour:	0-23
	Start Date:	1-31

TABLE 8: SUBMENUS OF THE ADVANCED MENU (CONT'D)

Digital Input Setup	Input A (Bat): Input B (Bat): Input C (Bat): Input D (Bat): Input E (Gnd): Input F (Gnd): Input G (Gnd): Input H (Gnd):	Disable, Low Air Pres Low Hyd Pres, Low Oil Pres, EPS Supply Load Alarm Silence, Low Coolant, Volt Select 1, Volt Select 2, Idle Mode, Start/Stop, Auxiliary Fail, Auxiliary Warn, Charger Fault1, Charger Fault2, High Fuel Warn, Config Warn 1, Config Warn 2, Config Fail 1, Config Fail 2 (located at bottom of menu) Global Trig, Crank Trig, Run Trig, Crank+Run Trig,
Battery Setup	Low Auto Charge: Charge Pre-Alarm: Charge Duration: Recharge Level: Low Warn Level: Low Fail Level: High Warn Level: High Fail Level: Low Vol InCrank:	Disable, Enable 1-60 minutes 10-240 minutes 7-24 volts 7-24 volts 7-24 volts 12-32 volts 12-32 volts 4 – 18 volts
Set Password	Password No. 1: Password No. 2: Password No. 3: Password No. 4:	0-9 0-9 0-9 0-9
Set Maintain	Reset Counter: Enable Counter: Count Interval:	No, Yes Disable, Enable 10 to 1000 Hours in 10 hour increments.
Ser Modbus	Device Address: Baud Rate:	1 - 247 9600, 19200, 38400, 57600
Common Faults	Failure Table 1 Warning Table 1 Events Table 1 Failure Table 2 Warning Table 2 Events Table 2	**Failures:** Disable, Over Crank, Locked Rotor, HighEngineTemp, LowOil Pressure, Over Speed, Low Fuel Level, Oil Level, Low Coolant, Low Air Pres, Low Hydraulic, Auxiliary Fail, Low Battery, High Battery, UnderSpeed, Under Voltage, Over Voltage, Over Current, Loss of ECM, EPS Load Fail, Config Fail 1, Config Fail 2 **Warnings**: Disable, HighEngineTemp, LowOil Pressure, Over Speed, Low Fuel Level, Oil Level, Fuel In Basin, Auxiliary Warn, Charger Fault, Low Battery, High Battery, Under Speed, Under Voltage, Over Voltage, Over Current, LowEngine Temp, High Fuel Level, Config Warn 1, Config Warn 2 **Events:** Disalbe, EPS Load On, Idle Running, Service Needed, Not In Auto, LoBatt InCrank
Set Dummy Load	Load Check: Bypass Delay: Load On Point: Load Off Point:	Disable, Enable 10 – 120s 0 – 500A 0 – 500A

6.1 ANALOG INPUTS

The GSC400 has support for the following analog input types:

1. High Engine Temperature
2. Oil Pressure
3. Fuel Level (Note: must only be connected to analog inputs #3 or #4.)
4. Oil Level
5. Fuel In Basin
6. Low Engine Temperature

For each of the analog input types, you can select the pin (2 to 7) for the type of analog sender that is connected to it. See Figure 4 on page 6 for the pin locations of the analog input connector. If you are not using one of the inputs indicated then select Disabled. Also, you must select a pin even if you are using J1939 instead of a physical sensor. Two different analog types cannot share the same pin with the exception of the Low Engine Temperature and High Engine Temperature. This feature allows the user to use one sender to measure both low engine temperature and high engine temperature.

In addition, you must select the **Input Type**, such as sender, J1939, or switch (see the section below for more information on senders). If using the switch setting you must determine if the switch is of the normally open or normally closed type. If it is normally open then you would select the “Switch Closed = Failure” otherwise you would select the “Switch Open = Failure”.

A **Bypass Time** can be selected for each input. After crank success, the bypass period will start, and during this period the controller will not enable the warning or failure checks for this input. After the bypass period, if there are any warnings or failures they will be triggered. The controller will display a message and sound the alarm in the case of a warning or will shut down and sound the alarm in the case of a failure.

Each of the sender types support **Warnings** and/or **Failures**. In the case of high engine temperature, if the data from the sender (or J1939) exceeds the value set, then the controller will give a warning or failure. For the other analog input types, the data from the source must drop below the warning and/or failure setting. Warnings and failure thresholds are only supported when using senders or J1939.

The Low Oil Level and Fuel In Basin warnings are global meaning they are always active even in the OFF state. These warnings ignore the Bypass Time.

If you have the **Input Type** as a sender then you also need to set the **Open Sender Detection** or **Shorted Sender Detection** to Warning, Failure, or Disable. The Open Sender Detection will trigger if the analog input voltage rises above 4.76V. The Shorted Sender Detection will trigger if the voltage drops below 0.122V.

6.1.1 GSC400 SENDER SUPPORT

In the **Signal Source** submenu in each of the six analog input menus there is a selection of three preloaded sender tables from which to choose in addition to the “J1939 Input” and “Switch Input” choices. The sender tables that are preloaded into the controller are given in Table 9 on page 25 . The PC Interface Sender Utility name for versions 1.8.1 and above are shown for reference and to provide more information to allow the user to determine which sender to use. Refer to the PC Interface manual.

TABLE 9: DEFAULT SENDER TABLES

Table 9 - Default Sender Tables				
		Position 1	Position 2	Position 3
High Engine Temperature / Low Engine Temperature	Front Panel Menu Name	Datcom 1	VDO 2	Murphey 1
	Sender Utility Name	Datcon 330F 491 Ohm	VDO 266F 488 Ohm	Murphey 368F 4880 Ohm
	Resistance Type	Low	Low	Low
	Supported Analog Input Pins	3,4	3,4	3,4
Oil Pressure	Front Panel Menu Name	Datcom 1	VDO 2	Murphey 1
	Sender Utility Name	Datcom 99 PSI 241 Ohm	VDO 99 PSI 136 Ohm	Murphey 99 PSI 237 Ohm
	Resistance Type	Low	Low	Low
	Supported Analog Input Pins	3,4	3,4	3,4

The six analog input pins are divided into two groups: those that support low resistance senders and those that support high resistance senders. Low resistance senders have a maximum resistance of less or equal to 500 Ohms. High resistance senders have a maximum resistance of greater than 500 Ohms (usually they are a few kOhm).

Note that the senders listed in Table 9 cannot be used on all outputs (for the reasons given in the previous paragraph). Table 9 also lists what sender tables may be loaded on each input. If your sender is not supported or you wish to use a sender on an unsupported input then you have to use the sender table configuration utility built into the PC Interface that allows you to create new sender tables or to modify supported ones for the input you desire. Refer to the PC Interface manual for more information.

6.2 SPEED SENSING

The speed sensing menu allows you to select the source to use for determining the rotational speed of the engine. There are three options to choose from:

1. **J1939 Input** – If the engine/generator comes equipped with an engine control module (ECM) that supports the J1939 protocol then the GSC400 can obtain the engine speed from the ECM.

2. **Magnetic Pickup** – If the engine/generator is equipped with a magnetic pickup sensor then the sensor can be connected to the SPEED 1 and SPEED 2 spade terminals on the GSC400.

3. Generator Output – The GSC400 can also determine the engine speed indirectly from the generator frequency. The voltage source of the generator must be connected to the SPEED 1 and SPEED 2 terminals.

Over-speed warnings and failures as well as under-speed warnings and failures can be set from the menu in terms of RPM.

6.2.1 RATED SPEED

For the magnetic pickup and generator output options you must select the rated frequency and rated speed. The GSC400 uses these values together to calculate the engine speed from the magnetic input or generator frequencies.

The **rated speed** is the speed at which the engine runs at when producing power. For example some generators run at 1800RPM when producing power at 60Hz while others run at 3600RPM.

The **rated frequency** is the frequency of the generator output or magnetic pickup when the engine is running at the rated speed. For a magnetic input the rated frequency is determined by the number of teeth on the flywheel and is calculated by:

Rated frequency = (Number of teeth x Rated Speed) / 60

6.3 GENERATOR (AC VOLTAGE / CURRENT / FREQUENCY) SETUP

The AC Frequency, AC Voltage, and AC Current menus allow the measurement and display of the AC voltage, current, and frequency from the generator.

6.3.1 AC FREQUENCY

In the AC Frequency menu, warnings and failures can be triggered for frequencies under and/or over settable thresholds. The **DisconnectFreq** setting is used by the GSC400 controller as a backup to the speed input. If the speed input is not detected, the controller checks the **DisconnectFreq** settings. If the measured frequency is greater than this setting then the engine will be considered running.

6.3.2 AC VOLTAGE

The user can enter under voltage, over voltage, and over current settings for four different voltage configurations. This allows the GSC400 to be used on multiple generator types without having to configure each GSC400 or it allows a single generator to support multiple voltage configurations without having to go into the menu system. Each voltage group supports a different generator configuration:

1. Voltage Group 1 – Single Phase (two or three wire)
2. Voltage Group 2 – Three Phase (Delta or Hi Wye)
3. Voltage Group 3 – Three Phase Hi Wye (Hi Wye centre tapped)
4. Voltage Group 4 – Three Phase (three or four wire delta)

Voltage Group 1 has an option (**the Group 1 Setting** under the AC Voltage menu) for two wire (Hot and Neutral) or three wire (A, B, Neutral) single phase. If two wire single phase is selected the GSC400 display is fixed to L-N.

Voltage Group 2 can be used for 3 wire delta and non-center-tapped Hi Wye configurations.

Voltage Group 3 is normally used for center tapped Hi Wye applications where the voltage displayed on the controller is double the actual measured voltage. Voltage Group 3 is also useful in non-center-tapped Hi Wye and 4-wire Delta applications where the user wishes to measure a voltage greater than 600VAC – the maximum voltage the GSC400 supports. In this case the user can use a 2:1 potential transformer (PT) to step down the voltage to the GSC400 and still have the GSC400 display the correct voltage.

6.3.2 AC VOLTAGE (CONT'D)

Voltage Group 4 has an option (the **Group 4 Setting** submenu under the AC Voltage menu) for four wire delta or three phases (default). The two different configurations are shown in Figure 6. The three wire delta requires three voltage transformers to create the neutral reference.

The GSC400 controller requires a neutral reference. All voltages are measured line to neutral and then converted in the GSC400 for display as line to line if required unless Voltage Group 1 is selected with the two wire option in which case only Line to Neutral is displayed.

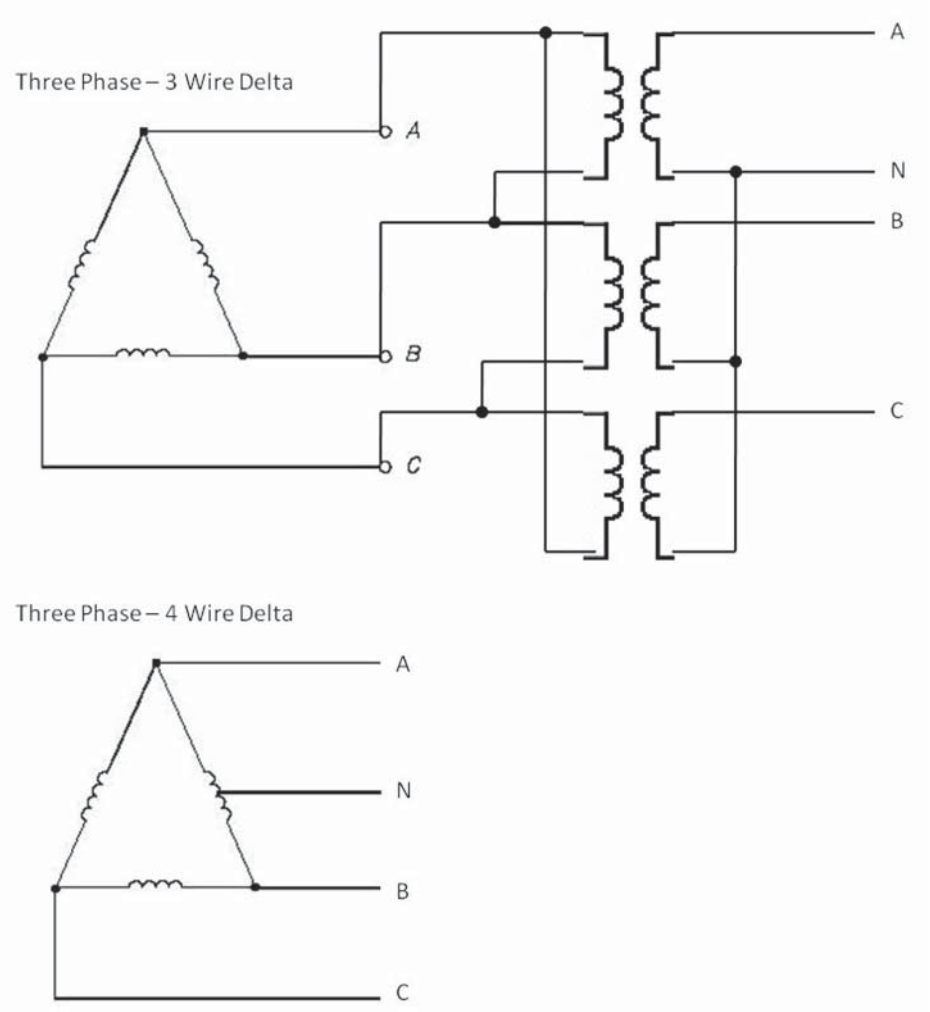


Figure 6 – Three-wire versus four wire delta generator configurations

6.3.2.1 VOLTAGE SELECT INPUTS

It is possible to automatically choose between each configuration by setting one or two of the digital inputs to **Volt Select 1** and **Volt Select 2**. This allows the GSC400 to automatically re-configure its voltage display as well as warning/shutdown trip points relating to AC voltages and currents. This is useful for mobile gen-sets where voltage selections can be selected via a CAM switch.

Warning: The Voltage Select Inputs override the **Voltage Group** submenu parameter in the AC Voltage menu.

Table 10: Voltage Select Inputs

	Voltage Configuration	Digital Imputs	
		Volt Select 1	Volt Select 2
Voltage Group 1 (Single Phase)	1 phase, 3-wire (2-wire option also selectable)	Open Circuit	Open Circuit
Voltage Group 2	3 Phase, 4-wire Wye	ACTIVE *	Open Circuit
Voltage Group 3	3 Phase, 4-wire (2x display voltage option also selectable)	Open Circuit	ACTIVE *
Voltage Group 4	3 Phase, 4-wire Wye (4-wire, Delta option also selectable)	ACTIVE *	ACTIVE *

* If Digital Input Pin A, B, C or D is used, then ACTIVE is defined as a switched to +BAT connection. If Digital Input Pin E, F, G or H is used then ACTIVE is defined as a switched to GND connection.

Note: If only a single AC Group Sel funtion is selected, then the remaining unassigned AC Group Sel is equivalent to an “Open Circuit” in the above table.

6.3.3 AC CURRENT

The GSC400 controller is designed to measure AC current from the generator with the use of current transformers (CTs). The maximum current on the AC current terminals of the GSC400 is limited to 5A.

The “**Turns Ratio**” sub menu is used to setup the CT ratio. All numbers in this menu are in terms of 5A. For example select 1000 means 1000:5A which, in turn, means the GSC400 displays 1000A on the screen when the current measured on the GSC400 AC Current terminals is 5A.

The GSC400 current terminals can handle a maximum of 5A. Larger currents can damage the GSC400.

The AC Current menu is also used to setup the over current warnings and shutdowns. These are grouped in terms of the voltage group 1 to 4. The current warning and failure depends on the voltage group selected in the Voltage Group submenu of the AC Voltage menu.

The **Hi Wye Current** parameter (second to last entry in the AC Current menu) is used to double the current reading (50% selection). If this is not desired then the 100% selection should be selected. Some generators have two wires for each phase, and as such, the current transformer (which is placed on one lead) will see only 50% of the current from each phase.

6.3.3 AC CURRENT (CONT'D)

The **Cur Warn Latch** option (last entry in the AC Current menu) is used to latch on a special digital output (see Current Latch in Table 11 on page 33) that turns on when the current exceeds the Current Warning Threshold and can only be turned off by the user from the front panel. On a current latch condition the LCD displays "Over Current Latched." and "<Up Arrow> + <Down Arrow> for Unlatch".

The current transformers (CTs) negative leads must be terminated individually into the GSC400 AC Current connector. **Do not tie the negative leads together to a common neutral.** See the system wiring diagram (Figure 5 on page 9) for more details.

6.3.4 AC CURRENT AND VOLTAGE CALIBRATION

Each GSC400 undergoes an advanced two point calibration at the factory and typically does not required calibration except in the following instances:

1. Current Transformers (CT) are used that have poor tolerances.
2. The uncommon occurrence where the AC signal from the generator is distorted with a high total harmonic distortion (THD).

Northern Lights has a software utility that can perform a basic calibration of the current and voltage.

6.4 ENGINE LOGIC

The Engine Logic menu contains the settings that control the starting and stopping of the engine. All parameters in bold below are located in the engine logic menu unless otherwise noted.

The **Crank Disconnect** setting determines the speed that must be attained before the crank output is turned off and the engine is considered to be running.

The **Crank Oil Pressure** parameter is used to determine when to check for the **Locked Rotor** condition. If the oil pressure is lower than the Crank Oil Pressure the GSC400 will check the engine speed for a locked rotor condition (see section 6.5.1.1 on Locked Rotor).

6.4.1 STARTUP SEQUENCE

All parameters in bold below are located in the engine logic menu unless otherwise noted.

When performing an automatic or manual start, the controller will wait for the **Delay To Start** duration and then turn on the glow plug output for the **Preheat** duration.

After the preheat time, the crank output is turned on for the duration specified by the **Crank Time**. The fuel output is also turned on. If the engine speed does not go above the **Crank Disconnect Setting** before the crank time then the crank output is turned off and the controller waits a period specified by the **Crank Rest Time**. The locked rotor condition is also checked while cranking (see 6.4.1.1 Locked Rotor below). The fuel output is also turned off unless the "**Fuel On During Crank Reset**" is enabled.

6.4.1 STARTUP SEQUENCE (CONT'D)

THE LCD WILL TURN OFF DURING THE FIRST 2 SECONDS OF CRANKING TO LIMIT THE VOLTAGE DIP DURING CRANKING.

If the **Midheat** Time is greater than zero, the glow plug output remains on during cranking but not during crank rest. The glow plug output turns off if a crank failure occurs, once crank success is reached (unless the PostHeat is set to a value greater than 0s), or if the Midheat time expires.

After the crank rest delay expires, the controller turns on the fuel and crank outputs and attempts to start the engine/generator again. This is repeated until the number of tries equals the **Crank Attempts**. If the controller cannot start the engine/generator after the set number of crank attempts, the failure state is entered and an **over crank failure** is displayed on the screen.

If the generator starts successfully and the "**Restart on False Start**" submenu is set to Enabled then the engine speed is monitored for 10 seconds. If the engine speed goes below the crank disconnect speed the controller attempts to restart the engine/generator. At the same time, if the **Warm-up** sub menu is set to a value greater than zero, an output is turned on (one of the digital outputs must be set to "Warm Up"). This is used to disengage any load or potential loads until the gen-set is warmed up. Once the Warm-up time has expired the output is turned off.

Once the controller enters the Running state and if the **PostHeat** time is greater than 0, the glow plug output is turned on for the duration of the PostHeat time.

6.4.1.1 LOCKED ROTOR

The GSC400 has a safety feature where a locked rotor condition will be detected. This applies to generators only. To disable this feature set the **Crank Oil Pressure** in the engine logic menu to 0.

During cranking the locked rotor condition is checked if the oil pressure is above the **Crank Oil Pressure** parameter (engine logic menu). The engine speed and AC frequency are checked and if both are 0 the crank time is shortened to 3s (including the time passed in cranking). If the engine/generator has not reached the crank disconnect speed at the end of the 3s the GSC400 will stop cranking and go into a Locked Rotor Failure.

6.4.2 SHUTDOWN SEQUENCE

When the stop button is pressed while the engine/generator is running and if the **Cool-Down** submenu is set to a value greater than 0 seconds the generator will go into Cool Down mode where an output is turned on (one of the digital outputs must be set to Cool Down). Once the Cool Down time is expired, the fuel relay is turned off and the controller enters the OFF state. If the **ETS On Duration** is set to a value greater than 0 seconds an output will be turned on for the time set (one of the digital outputs must be set to "Energize-to-Stop") by the ETS On Duration submenu.

6.5 DIGITAL OUTPUT SETUP

There are eight 200mA digital outputs and one 40A digital output (extra relay), all of which are configurable. Each feature (listed in Table 11 below) is permitted to be set to only one digital output.

Table 11: Digital Output Selections

Name	Description
Warm-Up	This sets up the output to be controlled by the Warm-up feature. See **Section 6.4.1** for more details. The Warm-up time is set in the engine logic menu. This is an active low output (i.e. the output remains off during warm-up and turns on after warm-up is finished). The output always remains off when the controller is not in the RUN mode.
Energize to Stop	This allows the Energize to Stop feature to control an output. The time duration is set in the engine logic menu. See **section 6.4.2** for more details.
Preheat	This allows the Preheat, Midheat, and Postheat features in the engine logic menu to control the output. The Preheat (glow plug) time is set in the engine logic menu. See **section 6.4.1** for more details.
Cool-Down	This allows the Cool Down feature to control the output. The Cool Down duration is set in the engine logic menu. See **section 6.4.2** for more details.
Over Crank	This turns on the digital output when the Over Crank Failure is activated. See **section 6.4.1** for more details. The number of crank attempts is set in the engine logic menu.
High Temp Failure	This turns on the digital output if the High Engine Temperature Failure is activated. See **section 6.1** for more details.
High Temp Warning	This turns on the digital output if the High Engine Temperature Warning is activated. See **section 6.1** for more details.
Low Oil Failure	This turns on the digital output if the Low Oil Pressure Failure is active. See **section 6.1** or **section 6.7** for more details.
Low Oil Warning	This turns on the digital output if the Low Oil Pressure Warning is activated. See **section 6.1** for more details
Under Speed Failure	This turns on the digital output if the Under Speed Failure is activated. See **section 6.2** for more details
Under Speed Warning	This turns on the digital output if the Under Speed Warning is activated. See **section 6.2** for more details.
Over Speed Failure	This turns on the digital output if the Over Speed Failure is activated. See **section 6.2** for more details.
Over Speed Warning	This turns on the digital output if the Over Speed Warning is activated. See **section 6.2** for more details..
Low Fuel Failure	This turns on the digital output if the Low Fuel Failure is activated. See **section 6.1** for more details.
Low Fuel Warning	This turns on the digital output if the Low Fuel Warning is activated. See **section 6.1** for more details.
Battery Failure	This turns on the digital output if the Low or High Battery Failure is activated. See **section 6.8** for more details.
Battery Warning	This turns on the digital output if the Low or High Battery Warning is activated. See **section 6.8** for more details.

6.5 DIGITAL OUTPUT SETUP (CONT'D)

Name	Description
Low Coolant Failure	This turns on the digital output if the Low Coolant Failure is activated. This is controlled by the Low Coolant Digital Input described in Table 12 in **section 6.7**.
Low Coolant Warning	This turns on the digital output if the Low Coolant Warning is activated. See **section 5.2** for more details.
Not In Auto	This turns on the digital output when the controller is not in the Auto state. **Section 5.3** describes the various states of the controller.
General Failure	This turns on the digital output when any failure is active.
Crank Rest	This turns on the digital output when the controller is in the crank rest state after a crank attempt. The crank rest duration is set in the engine logic menu. See **section 6.4.1** for more details.
Engine Running	This turns on the digital output when the controller enters the run state (crank success). The run state is described in **section 5.3**.
Engine Cranking	This turns on the digital output when the crank output is on. See **section 6.4.1** for more details.
Exerciser Alarm	This turns on the digital output when the engine/generator starts on an exerciser event (**section 6.6**).
Battery Recharge Alarm	This turns on the digital output when the engine/generator starts on a low battery event (**section 6.1**).
Under Voltage Warning	This turns on the digital output when the AC Under Voltage Warning is activated.
Over Voltage Warning	This turns on the digital output when the AC Over Voltage Warning is activated.
Over Current Warning	This turns on the digital output when the AC Over Current Warning is activated.
Fuel in Basin Warning	This turns on the digital output if the Low Fuel In Basin Warning (**section 6.1**) is activated.
Voltage Regulator	This allows the digital output to be controlled by the idle feature. The idle feature also requires a digital input to be set to Idle Mode (see **section 6.7**). See section 5.7 on page 16 for more information on the Idle Mode feature.
Low Temp Warning	This turns on the digital output if the Low Engine Temperature Warning (**section 6.2**) is activated.
Backlight	This turns off the digital output if the LCD backlighting turns off. The controller enters the sleep mode (**section 5.4**) when this occurs.
Auxiliary Warning	This turns on the output if the Auxiliary Warning Digital Input (see **Table 12 in section 6.7**) is active.
Maintenance Timer	This turns on the output if maintenance is required to be performed on the engine/generator. See **section 6.10**.
System Ready	This turns on the output if the controller is in the auto state with no warnings (some warnings are ignored for this feature such as low and high battery voltage).
Common Fault Output 1	This turns on the output if the Common Fault 1 feature is active. See **section 6.12** for more details.

6.5 DIGITAL OUTPUT SETUP (CONT'D)

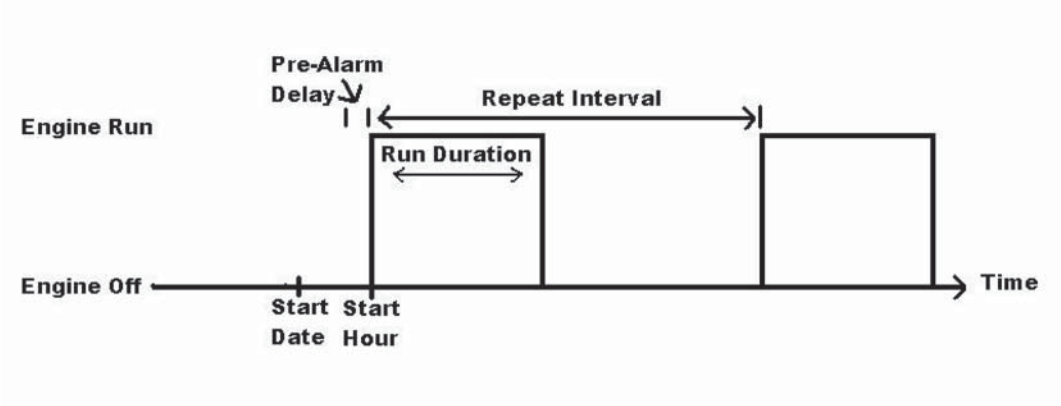
Name	Description
Common Fault Output 2	This turns on the output if the Common Fault 2 feature is active. See **section 6.12** for more details.
Dummy Load	This allows the digital output to be controlled by the Dummy Load feature. See **section 6.13** for more details.
High Fuel Level Warning	This turns on the output if the High Fuel Level Warning digital input in Table 12 on page 34 is active.
Current Latch	This turns on the output if the Cur Warn Latch in the AC Current menu (see Table 10 on page 28) is set to Enable and the High Current Warning is active. The output can only be turned off by the user. See section 6.3.2 on page 36 for more information.
Config Warn 1	This turns on the output if the Config Warn 1 digital input (Table 12 on page 34) is active.
Config Warn 2	This turns on the output if the Config Warn 2 digital input (Table 12 on page 34) is active.
Config Fail 1	This turns on the output if the Config Fail 1 digital input (Table 12 on page 34) is active.
Config Fail 2	This turns on the output if the Config Fail 2 digital input (Table 12 on page 34) is active.

6.6 EXERCISER SETUP

The GSC400 can be set to automatically start the engine/generator at regular intervals if left in the AUTO state. This is controlled by the Exerciser Setup menu. The **Exerciser Enable** should be set to Enabled if this feature is desired.

The GSC400 will display a message and sound the buzzer for a set amount of time (**Pre-Alarm Delay**) to alert nearby personnel that the generator is about to start. The engine/generator will run for a set period of time (**Run Duration**) and then shut down.

The **Start Date** and **Start Hour** determine the date (0 to 31) and time when the engine/generator will first start. After the first exerciser start, the engine/generator will start up on regular intervals given by the **Repeat Freq** which is measured in hours.



The exerciser feature depends on the GSC400 internal clock. Make sure the clock is set to the proper time and date.

GSC400 internal clock information can remain "in memory" for approximately 2 weeks when no DC power is supplied to the controller. Two week memory storage is available in a completely charged controller clock. DC power is required to be supplied continually to the GSC400 for approximately 1 hour to allow a complete clock charge.

6.7 DIGITAL INPUT SETUP

There are eight digital inputs. Each input can be selected to any of the features given in Table 14 below.

Table 12 – Digital Input Selections

Name	Description
Low Air Pressure	This input generates a Low Air Pressure failure when active.
Low Hydrolic Pressure	This input generates a Low Hydraulic Pressure failure when active.
Low Oil Pressure	This input generates a “Low Oil Pressure” failure when active.
EPS Supplying Load	IIf the generator is starting up but is not running (i.e. the controller is not in the RUN Mode) and if the input is active, the GSC400 will cancel the start sequence and enter the failure state on an EPS load failure. After crank success, if the input is active, the “EPS Supplying Load” lamp on the GSC400 front face will turn on.
Alarm Silence	This input silences the buzzer on the GSC400 unit when active.
Low Coolant	This input generates a Low Coolant Level failure when active..
Volt Select 1	These inputs allow the user to change the supported generator configuration without having to go into the controller menu. See s**ection 6.4.2.1** for more details.
Volt Select 2	
Idle Mode	This input, when active, allows the generator to run at a lower speed without triggering under-voltage, under-frequency, or under-speed warnings or failures. “Idle Running” is displayed on the GSC400 display when this input is active. The idle mode can also turn on a digital output (see the Voltage Regulator digital output feature in **Table 11 on page 31**). This output is used to turn off the generator voltage regulator when idle mode is entered.
Start / Stop	When the digital input is active the generator is started if in the Auto mode. If the digital input becomes inactive this places the controller back into the Auto mode (shuts down the generator). This performs the same function as the remote start contacts.
Auxiliary Failure	An Auxiliary Failure is generated when the input is active. This can occur in the Off, Auto, Cranking, and Running states.
Auxiliary Warning	An Auxiliary Warning is generated when the input is active. This can occur in the Off, Auto, Cranking, and Running states.
Charger 1 Fault	A Charger 1 Fault warning is generated when the input is active.
Charger 2 Fault	A Charger 2 Fault warning is generated when the input is active.
High Fuel Level Warning	A “High Fuel Level Warning” is generated when the input is active.
Config Warn 1	These inputs when active generate a warning/failure and a configurable text message is displayed to the screen when the input is active. The text message can only be configured from the PC Interface. The length of the message is limited to 15 characters. The user can control the states in which these features are enabled. The selections are: 1. Global –Everywhere 2. Crank – From start of delay-to-start to the end of cranking 3. Run – RUN Mode only 4. Crank+Run – Combination of 2 and 3 above. These settings are located at the bottom of the menu for each input.
Config Warn 2	
Config Fail 1	
Config Fail 2	

6.8 BATTERY SETUP

The Battery menu allows the user to set the low and high battery **warning** and **failure** levels. In addition, the engine/generator can be made to automatically start when in the AUTO state if the voltage drops below the **Recharge Level**. The **Charge Enable** parameter must be set to Enable as well.

The controller will display Low Voltage During Cranking on the screen if during cranking the voltage drops below the **Low Vol InCrank** setting.

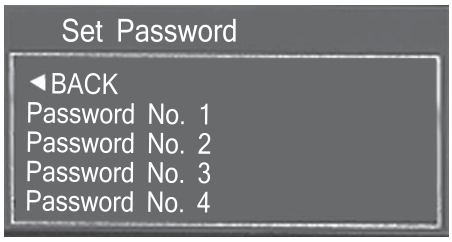
Note: When the engine/generator is running, the battery voltage will equal the alternator charging voltage. The actual open-circuit battery voltage may be lower than displayed.

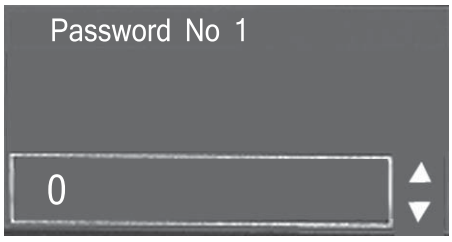
6.9 PASSWORD SETUP

The GSC400 allows a password to be entered to protect the advanced setup menu from any unauthorized changes. A four digit password may be selected. This password will be needed to perform any changes to the advanced setup. If the password is entered incorrectly, three chances will be allowed before the GSC400 returns back to the main menu.

To set password:

- Select Password No.1
  Enter the desired number 0-9
- Select Password No.2
  Enter the desired number 0-9
- Select Password No.3
  Enter the desired number 0-9
- Select Password No.4
  Enter the desired number 0-9





Remember to write down the password for future reference. The default password is all zeros.

6.10 SET MAINTAIN

This menu controls the service feature that is used to alert the user that the generator requires maintenance and can be enabled or disabled from this menu. If enabled, the **count interval** menu allows the user to set the number of hours until next service. The number of hours to next service is displayed in the Basic Setup menu under Maintenance (see Table 5 on page 15).

Once the count interval reaches 0 hours it displays a service message to the display and continues to count down (displays negative hours in the Maintenance submenu) until it is reset by the technician. The **reset counter** submenu is used by the technician to reset the counter after service is performed. The service feature does not count down to the next service until it is reset in this menu.

6.11 SET MODBUS

The GSC400 acts as a slave on a Modbus RS-485 network to remotely transmit warning, failure, and event indications. The device address and baud rate can be set from this menu.

See Appendix A: Modbus Map for more communication interface details.

6.12 COMMON FAULTS

Common Fault 1 and Common Fault 2 menus contain tables of all the events, warnings, and failures available in the GSC400 controller and allows the user to select those to generate a trigger when active. The trigger can be used to turn on a digital output, store the status of the trigger (active / inactive) to the Modbus Common Fault registers, or both. Both the common fault 1 and common fault 2 menus generate their own independent trigger and use separate modbus registers and digital outputs.

A digital output must be set to **Common Fault Output 1** if using the Common Fault 1 menu or **Common Fault Output 2** if using the Common Fault Output 2 menu to allow the trigger to turn on the digital output (see section 6.5 Digital Output Setup).

Using the PC Interface, the user can also mask the event, warning, and failure tables for each of the common faults. For example the user can set the Common Fault 1 modbus register to respond to events, warnings, and failures and set the Common Fault 1 digital output to respond to failures only. This configuration is not available in the front panel menu system; the PC Interface must be used.

6.13 SET DUMMY LOAD

The dummy load feature allows the user to turn on an output if the AC current is below a settable threshold (**Load On Point**). This is useful for applications where the generator must have a minimal load to prevent damage to the generator.

Upon crank success (RUN Mode entered), if enabled, the feature waits for a configurable bypass time, then starts to monitor the AC current. If the AC current remains above the Load On Point for 6.5 seconds then the dummy load digital output is turned on. If the AC current rises and remains above a settable threshold (**Load Off Point**) for 1.5s, the dummy load digital output is turned off.

A digital output must be set to dummy load to use this feature.

7 RECOMMENDED MAINTENANCE

The actions in Table 13 should be performed routinely.

WARNING: When performing any GSC400 or Engine maintenance be certain controller is in OFF Mode, is isolated from all possible sources of power, and the Crank wire is removed from the Controller.

Table 13: Recommended Maintenance	
PROCEDURE	ACTION
Making the controller safe for inspection and maintenance.	Disconnect all possible power sources before controller inspection.
Inspect controller mounting location for possible safety issues.	Inspect mounting location for any safety or fire issues. Inspect for dirt, wiring damage and mechanical damages.
Inspect controller for loose fasteners, terminals and wiring connections.	Check all hardware including controller wiring, terminals etc. for any looseness due to vibrations etc.
Clean area around controller.	Periodically inspect and remove any debris/dirt from within or near the controller.
Check for any overheating due to loose connections.	Check for any discoloration, melting or blistering of any wiring or connections
Perform regular testing of controller	Perform regular testing of the controller to check for proper operation.

8 DEFAULT CONFIGURATION SETTINGS

GSC400's are factory programmed and shipped with default settings loaded into the controller.

Table 14 – GSC400 Default Settings		
FUNCTION	DEFAULT SETTINGS	
J1939	Manufacturer Display Group 1 Display Group 2	Northern Lights Disable Disable
High Engine Temp	Input Pin Signal Source Bypass Delay Switch Setting Shorted Sender Open Sender Units Warning Level Failure Level	Input Pin 2 Switch 30 seconds SW Closed=Fail Warning Warning Fahrenheit 200^{O}F 220^{O}F

TABLE 14 (CONT'D)

FUNCTION	DEFAULT SETTINGS	
Oil Pressure	Input Pin	Disable
	Signal Source	Switch
	Bypass Delay	30 seconds
	Switch Setting	SW Closed=Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	PSI
	Warning Level	20 PSI
	Failure Level	15 PSI
Fuel Level	Input Pin	Disabled
	Signal Source	Switch
	Bypass Delay	30 seconds
	Switch Setting	SW Closed=Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	Percentage
	Warning Level	25%
	Failure Level	5%
Oil Level	Input Pin	Disable
	Signal Source	Switch
	Bypass Delay	10 seconds
	Switch Setting	SW Closed=Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	Percentage
	Warning Level	10%
	Failure Level	5%
Fuel In Basin	Input Pin	Disable
	Signal Source	Switch
	Bypass Delay	11 seconds
	Switch Setting	SW Closed=Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	Percentage
	Warning Level	2%
	Failure Level	5%
Low Engine Temperature	Input Pin	Disable
	Signal Source	Switch
	Bypass Delay	10 seconds
	Switch Setting	SW Closed=Fail
	Shorted Sender	Disable
	Open Sender	Disable
	Units	Fahrenheit
	Warning Level	10^{O}F
Spd Sensing	Signal Source	Generator Output
	Rated Freq	60 Hz
	Rated RPM	1800 RPM
	Over Speed Warn	1950 RPM

TABLE 14 (CONT'D)

FUNCTION	DEFAULT SETTINGS	
Spd Sensing (Cont'd)	Over Speed Fail	2050 RPM
	Under Speed Warn	1650 RPM
	Under Speed Fail	1550 RPM
A/C Frequency	Frequency Disconnect	22 Hz
	Over Freq Warn	70 Hz
	Over Freq Fail	75 Hz
	Under Freq Warn	50 Hz
	Under Freq Fail	45 Hz
A/C Voltage	Voltage Sourse	Enable
	Voltage Display	Line-Natural
	Voltage Group	Group #1 (Single)
	Over Volt Warn 1	250 VAC
	Over Volt Fail 1	260 VAC
	Under Volt Warn 1	230 VAC
	Under Volt Fail 1	220 VAC
	Over Volt Warn 2	220 VAC
	Over Volt Fail 2	230 VAC
	Under Volt Warn 2	195 VAC
	Under Volt Fail 2	185 VAC
	Over Volt Warn 3	500 VAC
	Over Volt Fail 3	520 VAC
	Under Volt Warn 3	460 VAC
	Under Volt Fail 3	440 VAC
	Over Volt Warn 4	630 VAC
	Over Volt Fail 4	650 VAC
	Under Volt Warn 4	570 VAC
	Under Volt Fail 4	550 VAC
A/C Current	Current Source	Enable
	Turns Ratio	100A - 5A
	Over Current Warn 1	90 A
	Over Current Fail 1	100 A
	Over Current Warn 2	80 A
	Over Current Fail 2	90 A
	Over Current Warn 3	20 A
	Over Current Fail 3	25 A
	Over Current Warn 4	15 A
	Over Current Fail 4	20 A
Engine Logic	Delay to Start	0 seconds
	Pre-Heat Time	0 seconds
	Crank Time	15 seconds
	MidHeat time	0 seconds
	Crank Rest Time	15 second
	Crank Attempts	3
	Fuel Crank Rest	Enable
	False Restart	Enable
	Post-Heat Time	0 seconds
	ETS On Duration	0 seconds
	Warm-up Time	600 seconds

TABLE 14 (CONT'D)

FUNCTION	DEFAULT SETTINGS	
Engine Logic	Crank Disconnect	650 RPM
	Cool Down Delay	0 seconds
	Crank Oil Pressure	10 PSI
Digital Output Setup	Extra Relay	Disable
	Output 1	Disable
All selections apply to each individual output.	Output 2	Disable
	Output 3	Disable
	Output 4	Disable
	Output 5	Disable
	Output 6	Disable
	Output 7	Disable
	Output 8	Disable
Exerciser Setup	Exerciser Enable	Disable
	Run Duration	30 minutes
	Pre-Alarm Delay	5 minutes
	Repeat Frequency	336 hours (14 days)
	Start Hour	12
	Start Date	8
Digital Input Setup	Input 1 (Bat)	Disable
	Input 2 (Bat)	Disable
All selections apply to each individual input	Input 3 (Bat)	Disable
	Input 4 (Bat)	Disable
	Input 5 (Gnd)	Disable
	Input 6 (Gnd)	Disable
	Input 7 (Gnd)	Disable
	Input 8 (Gnd)	Disable
Battery Setup	Low Auto Charge	Disable
	Charge Pre-Alarm	1 minute
	Charge Duration	91 minutes
	Reharge Level	10.4 Volts
	Low Warn Level	11.2 Volts
	Low Fail Level	7 Volts
	High Warn Level	15 Volts
	High Fail Level	16 Volts
	Low Vot InCrank	8
Set Password	Password No. 1	0
	Password No. 2	0
	Password No. 3	0
	Password No. 4	0

APPENDIX A: MODBUS MAP

Table 15 - Modbus Register Map				
Register	Name	Read/ Write	Type	Description
40001	Highest Severity Event	RO	WORD	bit 16=Alarm State, bit 15-14=Severity, Bits 13-10=Reserved, Bits 9-1=Event #
40002	Prev Highest Severity Event	RO	WORD	bit 16=Alarm State, bit 15-14=Severity, Bits 13-1=Event #
40003	Event Number 1-3	RO	WORD	The **Highest Severity Event** is the most recent active event with the highest severity. If an event with equal or higher severity is active it becomes the highest severity event and the current highest severity event becomes the **Previous Highest Severity Event**. There are 5 bits per event; the most significant bit in the register is not used (**see Table 16 - Event Stack Components**). Each event number corresponds to a specific status (e.g. oil pressure status). Events 21 - 99 are not presently used and are reserved. RO indicates Read Only.
40004	Event Number 4-6	RO	WORD	
40005	Event Number 7-9	RO	WORD	
40006	Event Number 10-12	RO	WORD	
40007	Event Number 13-15	RO	WORD	
40008	Event Number 16-18	RO	WORD	
40009	Event Number 19-21	RO	WORD	
40010	Event Number 22-24	RO	WORD	
40011	Event Number 25-27	RO	WORD	
40012	Event Number 28-30	RO	WORD	
40013	Event Number 31-33	RO	WORD	
40014	Event Number 34-36	RO	WORD	
40015	Event Number 37-39	RO	WORD	
40016	Event Number 40-42	RO	WORD	
40017	Event Number 43-45	RO	WORD	
40018	Event Number 46-48	RO	WORD	
40019	Event Number 49-51	RO	WORD	
40020	Event Number 52-54	RO	WORD	
40021	Event Number 55-57	RO	WORD	
40022	Event Number 58-60	RO	WORD	
40023	Event Number 61-63	RO	WORD	
40024	Event Number 64-66	RO	WORD	
40025	Event Number 67-69	RO	WORD	
40026	Event Number 70-72	RO	WORD	
40027	Event Number 73-75	RO	WORD	
40028	Event Number 76-78	RO	WORD	
40029	Event Number 81-84	RO	WORD	
40030	Event Number 85-87	RO	WORD	
40031	Event Number 88-90	RO	WORD	
40032	Event Number 91-93	RO	WORD	
40033	Event Number 94-96	RO	WORD	
40034	Event Number 97-99	RO	WORD	
40034-42002	Reserved			
49999	Reserved	RO	WORD	

TABLE 16 – EVENT STACK COMPONENTS

Table 16 – Event Stack Components					
Event Number	Name	Register No.	Bits Assigned	Severity	Audible Alarm
1	System Ready	40003	4-0	0	No
2	Overcrank	40003	9-5	3	Yes
3	High Engine Temperature Warning	40003	14-10	1	Yes
3	High Engine Temperature Shutdown	40003	14-10	3	Yes
4	Low Oil Pressure Warning	40004	4-0	1	Yes
4	Low OIl Pressure Shutdown	40004	4-0	3	Yes
5	Overspeed	40004	9-5	3	Yes
6	Emergency Stop	40004	14-10	3	Yes
7	Low Coolant Level	40005	4-0	3	Yes
8	Low Coolant Temperature	40005	9-5	1	Yes
9	Low Fuel Level in Tank	40005	14-10	1	Yes
10	Low Fuel Pressure	40006	4-0	1	Yes
11	Emergency Power Supply Load	40006	9-5	1	No
12	Generator Running	40006	14-10	0	No
13	Generator Not In Auto Mode	40007	4-0	3	Yes
14	Battery Charger Fault	40007	9-5	3	Yes
15	Battery Voltage Low	40007	14-10	1	No
16	Battery Voltage high	40008	4-0	1	No
17	Low Battery Voltage During Cranking	40008	9-5	1	No
18	Locked Rotor	40008	14-10	3	Yes
19	Common Fault #1	40009	4-0	See Note 4 below	Yes
20	Common Fault #2	40009	9-5	See Note 4 below	Yes
21	Reserved	40009	14-10	---	---
22	Reserved	10010	4-0	0-3	Yes/No
23	Reserved	10010	9-5	0-3	Yes/No
24	Reserved	10010	14-10	0-3	Yes/No

All the above events are read only. Each event contains 5bits, b4, b4, b3, b2, b0, where b0 is the least significant bit. These bits are defined as follows:
1. b0 -- Event Status. Indicates if a warning/failure is occurring. *Where*: 0 = Not Active, 1 = Active
2. b2 - b1 -- Event Severity. See the Severity column above.
Where: 0 = Take No Action, 1 = Warning/Acknowledge, 2 = Action Required, 3 = Take Immediate Action (most severe)
3. b3 -- Alarm Action. This is a recommendation only and can be ignored. *Where*: 0 = No Audible Alarm, 1 = Sound Audible Alarm
4. b4 = Enable. If enabled the feature status will be updated over modbus. *Where*: 0 = Disabled, 1 = Enabled

The following notes apply:
1. Warnings and Failures of the same quantity (e.g. Oil Pressure) share the same event; the GSC400 updates the severity to reflect a warning or failure.
2. When the event status (b0) is inactive the event severity (b2-b1) is always cleared. The alarm action and enable/disable bits remain the same.
3. When b4 is set, the event status will always be cleared. The other bits are do-not-care.
4. Common Fault events are given a severity of 1 with the exception of Not In Auto which is given a severity of 3; warnings are given a severity of 2, and failures are given a severity of 3. The largest severity number is stored if more than one event, warning, and/or failure is active at one time.

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