OPERATOR'S MANUAL

Centrilift

GCS VORTEX

GCS Vortex

ESP Motor Controller Operator's Manual

BAKER HUGHES

Centrilift

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Display screens and examples contained in this manual require that the GCS VORTEX system contain the listed versions of firmware. Please contact Centrilift for a system firmware update if necessary.

System Firmware Revisions required: Graphic Display Unit: 6.0 or higher
System Control Unit: 8.0 or higher

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INTRODUCTION

This manual contains general information regarding the GRAPHIC CONTROL SYSTEM (GCS) operating system, as well as specific installation, setup and operating instructions for the GCS VORTEX Motor Controller.

GENERAL DESCRIPTION

The GCS VORTEX is a stand-alone motor protection relay and programmable controller. Use of the latest microprocessor and display technology allows for an intuitive, human interface that delivers ease of set up, operation and diagnostics. Electronic miniaturization also reduces the number of components and the size of circuit boards required thus enhancing the reliability and versatility of the controller. The VORTEX GCS, combined with appropriate sensors, is configurable for use in many types of programmable motor control applications. The VORTEX GCS, as a module of the Graphic Control System (GCS) family of control products, also provides a high speed telemetry interface port (CITIBus^{TM}) that permits and simplifies control system expansion and customization. The GCS display unit is common to all modules of the GCS family providing the operator with a familiar interface for a variety of control and measurement products.

The GCS VORTEX motor controller is safety certified by the Canadian Standards Association (CSA) under the classification of CSA/NRTL Industrial Control Equipment - Motor Controllers, Class 3211- 86 and 3211-06. The NRTL approval rating indicates that it has a valid recognized Underwriters Laboratory (UL) equivalent approval.

The GCS VORTEX controller can communicate via wire-less or wire-line serial mode to a host computer for implementation of Supervisory Control and Data Acquisition (SCADA) systems. Support for Modbus RTU protocol is included as a standard feature.

Input /Output expansion modules can be added to the system, to provide a single point of control and monitoring for a wide range of sensor types.

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GCS VORTEX

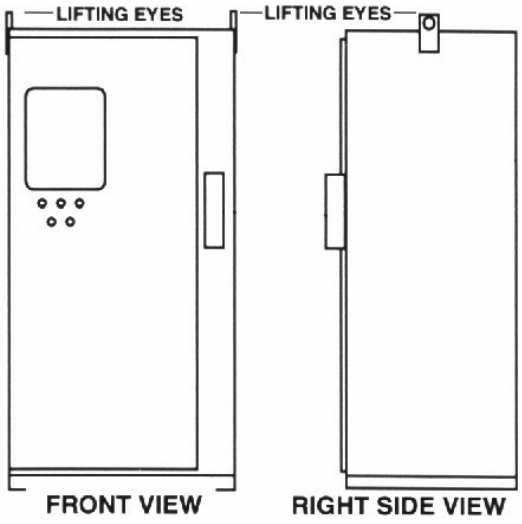
FEATURES/FUNCTIONS	BENEFITS
Connectivity, Telemetry ready	Allows networking or remote operation
Downloadable Configuration	Ease of multiple controller setup
Control system expandability: I/O modules, downhole sensors	Flexibility in system design & commissioning
GCS operator interface identical for all GCS products	Maintenance and operations personnel need to learn interface only once
Surface mount electronics technology	Smaller circuit boards, with fewer connections lead to higher reliability
Field upgradeable software	Controller does not have to be removed from location to modify or upgrade software
Datalogger outputs spreadsheet compatible recorded data data files	Allows monitoring and analysis of using familiar PC software tools.
Electronic Chart recorder built-in	Allows paper-less recording of motor current
Redundant backup of data and operating parameters	Reduces chance of data and protection loss due to failure.
Date / Time stamp of event and shutdown history	Helps identify problems or trends
Diagnostic / alarm windows pop up automatically	Automatic display of problems without operator security clearance
Programmable I/O	I/O can be programmed to function independently of controller operation, similar to an independent PLC
Compatible with entire GCS product line	Interfacing to and configuring other Centrilift products is made easier.
Enclosures comply to industrial standards NEMA 3, IP54, NEMA 1, IP33	Reliable operation in any environment

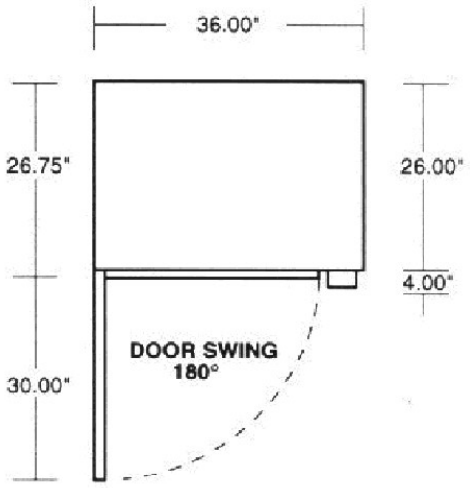
SAFETY & INSTALLATION

SAFETY RECOMMENDATION

The controller should be installed, adjusted and serviced by qualified electrical maintenance personnel. Improper installation or operation of the controller may cause injury to personnel or equipment. This device must be installed and grounded in accordance with local and national electrical codes. Potentially lethal voltages exist within the cabinet. Extreme care must be taken to insure all power sources are disconnected before starting installation, maintenance or repair jobs.

SHIPPING AND STORAGE





Top View: Actual measurements vary with model number

If the GCS VORTEX controller is supplied as part of a motor starter control panel, that cabinet should be securely fastened to any vehicle used to transport it. Use tie down ropes or straps to immobilize the cabinet during shipping and prevent shipping damage. To prevent damage during storage or transportation, the unit must not be stored or shipped in corrosive atmospheres. Centrilift's switchboard cabinets are specially designed for safe handling using a spreader bar placed through the lifting lugs at the top of the unit. Lift capacity should be checked prior to moving the unit into place. Check switchboard specifications for size and weight of specific unit being installed.

INITIAL CHECKS

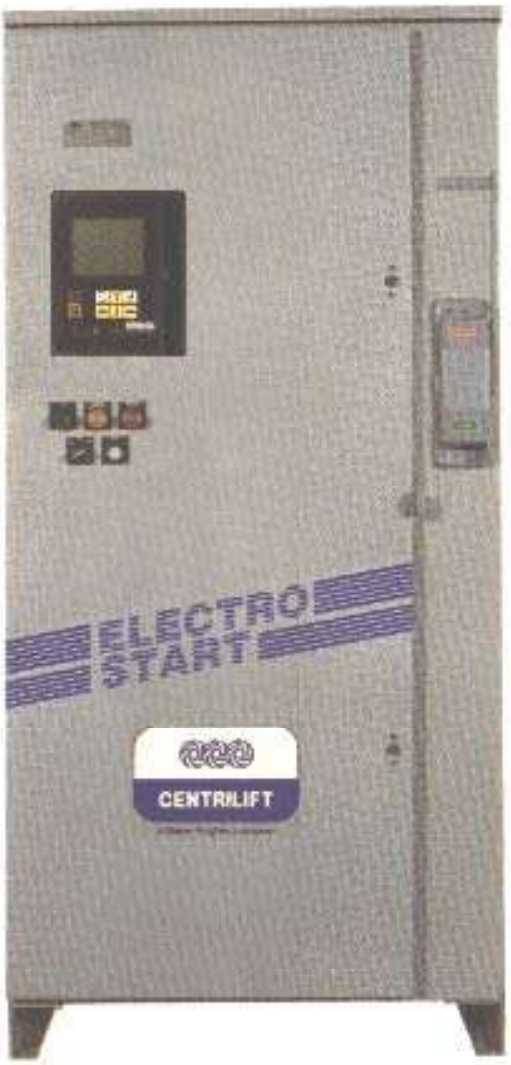
Before installing the controller, check the unit for the following:

* Physical damage to the controller or cabinet.
* Remove all packing materials, tape, padding, foam or restraints.
* Correct application. The controller nameplate data, transformers, and load must be compatible.
* Internal connections. Insure that all cables, components, and connectors are securely in place.

INSTALLATION OF CONTROL PANEL

Centrilift's General Purpose enclosure (NEMA 1, IP33) is suitable for most factory or control room installations, however, care should be taken in choosing the location. A minimum of 36 in. (1 m) clearance in front of the enclosure is recommended for servicing, which is also adequate for cooling air flow. Areas with oil vapors or mists, excessive moisture, or with fumes or vapors that are corrosive or flammable should be avoided.

The Weatherproof enclosure (NEMA 3, IP54) is suitable for outdoor installations in non-hazardous locations. Never install the controller close to heat generating sources such as transformers or other controllers.



POWER WIRING

Refer to specifications provided with the switchboard for recommended conduit entry locations. To find the recommended power cable size, first obtain the controller fuse size from the switchboard documentation, then use the cable manufacturer's data tables to find the recommended cable sizes based on amperage required, 40° C ambient temperature, and minimum cable temperature rating of 75°. Power wiring must be sized to meet local and national electrical codes, based on maximum ambient temperatures. Connect input power cable to terminals of the input disconnect switch. Output power cable is connected from the output terminals to the step up transformer when utilized or the input terminals of the electric motor.

CUSTOMER INTERFACE WIRING

Interface control inputs and outputs wire to the termination block plugged into the VORTEX GCS, or to a terminal strip, if one is installed, to the back panel of the switchboard. AC control wiring should be a minimum of 14 AWG, and run in conduit separate from DC control wiring. Analog inputs (Analog 1and 2) should be connected with a shielded, twisted pair cable, minimum 20 AWG.

ONBOARD DIGITAL INPUTS

The GCS VORTEX provides two status/digital inputs defined as 120VAC, "open to alarm" accessed via the termination block plugged into the VORTEX GCS, or to a terminal strip, if installed, to the back panel of the switchboard. The inputs are labeled SPARE for digital input #1 and PRESSURE for digital input # 2

ONBOARD ANALOG INPUTS

The GCS VORTEX provides two analog inputs rated for 0-10VDC available on the termination block plugged into the VORTEX GCS, or to a terminal strip, if installed, to the back panel of the switchboard. The terminal strip is labeled as Analog Input 1, Analog Input 2, and Analog Common Ground.

GCS BASICS

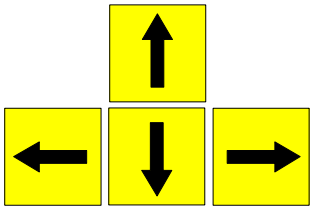
GRAPHICS DISPLAY OVERVIEW

This portion of the GCS operators' manual describes the basic principles of the Graphic Control operating System. It also describes the operation of the keypad, the LCD display screen and all available parameters. To locate information pertaining to any specific parameter, use the index at the end of this manual to locate a keyword, then view the information on the page(s) indicated. The GCS VORTEX controller utilizes a liquid crystal display (LCD) panel as its primary operator interface. Using this display, the operator can view and/or modify all setpoints contained in the controller. Whenever the GCS VORTEX is first powered up, the LCD display will show the MAIN MENU screen, similar to the illustration at left.

The interface has several keypad switches whose functions are defined as follows:

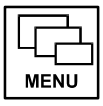
The green START key is pressed to manually start the motor.

The red STOP key manually stops the motor and is also used to clear or reset a "lockout" condition

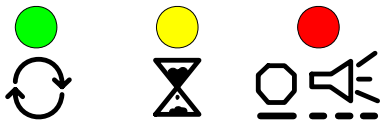


The arrow keys are used to move the cursor on the screen or to increment & decrement numbers when calibrating or editing a setpoint.

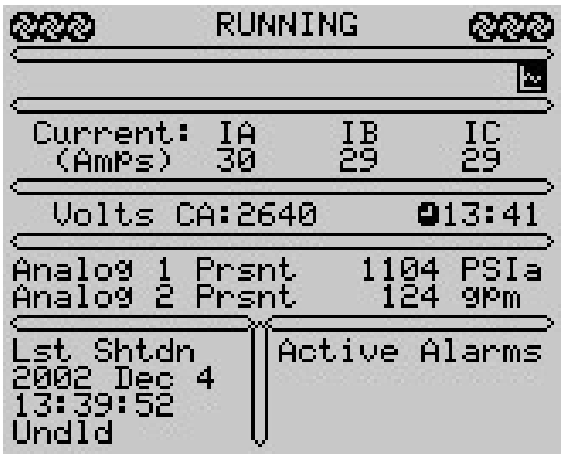
The ENTER key is used to select highlighted menu items or to program or finalize a setpoint or value entry.



The MENU key is used as a backup or cancel key, or to abort any adjustment in progress. Press MENU repeatedly to access the MAIN MENU screen.

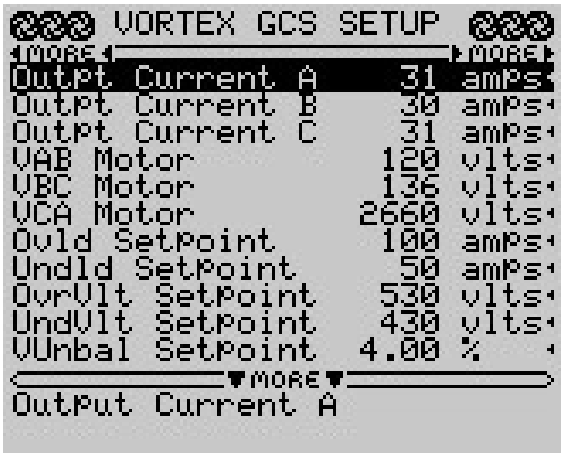


The green, amber and red panel LEDs indicate the present status of the motor. Green indicates the system is running. Green with flashing Amber indicates the controller is currently timing an active alarm for a shutdown. Amber denotes the system is stopped but all alarms are clear and it is timing down for an automatic restart. RED indicates the system is shutdown and that automatic restarts are disabled, and/or active alarms exist so that the controller will not restart by itself.



DISPLAYING A MENU, READING OR SETPOINT

The operator interacts with the GCS VORTEX by pressing the keypad switches below the LCD display screen. Use the arrow keys to move the highlighting pointer to the desired menu item and then press the ENTER button to select that item. (Although the highlighting pointer changes in appearance depending on the information displayed on the screen, it is always implemented in "reverse color" compared to other text on screen.) As an example, to display the current operational status of the motor, use the arrow keys to move the highlight to the center "STATUS" position as shown on the previous page and press the ENTER key. The GCS will display the status screen and show running status information similar to the screen shown at left. To return to the previous menu, press the MENU key and the display will change back to the MAIN MENU screen



GCS DISPLAY CONVENTIONS

All GCS menus and screens use common symbols to convey information. For example, when a menu screen contains more information than can fit onto one page of display, the graphic ▾MORE▾ will appear at the bottom of the screen to indicate that using the arrow keys to move the cursor to the bottom of the page will cause the screen text to scroll upward until the bottom line of the menu is displayed. Several menu screens can also be linked together by the left and right arrow keys. This is indicated by the ◂MORE◂ and ▸MORE▸ graphics appearing on the left and right ends of the bar at the top of the screen. When a parameter can be modified, the small arrow pointer ◀ appears at the right edge of the parameter's line. All of the parameters on the example screen shown at left can be edited.

◀ This pointer at the end of the line indicates that parameter can be edited.

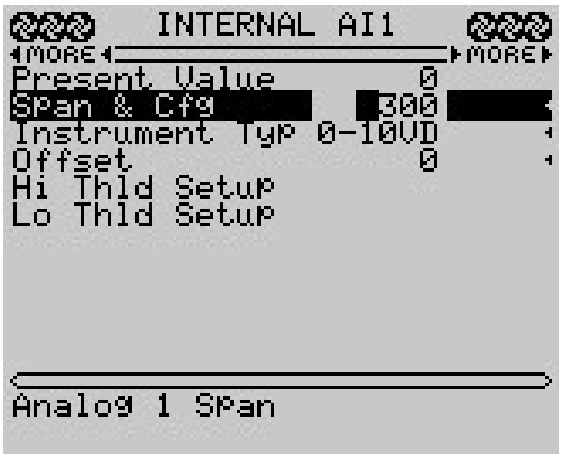
◂MORE◂ Indicates that additional menus can be accessed by pressing the "left" arrow key.

▸MORE▸ Additional menus can be accessed by pressing the "right" arrow key.

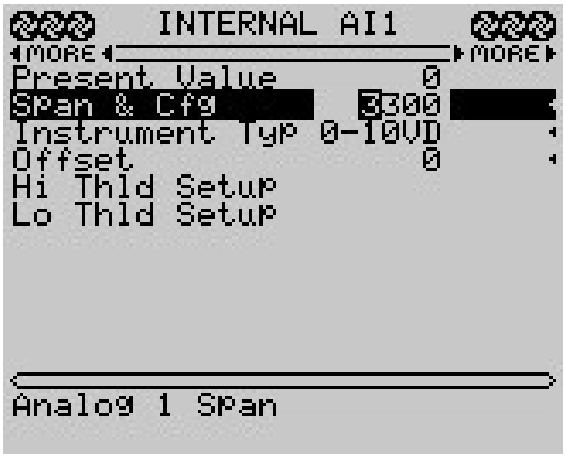
▼MORE▼ ▲MORE▲ More information or additional menu items can be reached by pressing the up or down arrow key and moving the cursor to the bottom or top of the screen.

EDITING A READING OR SETPOINT

Any parameter within the GCS VORTEX that can be edited or changed will display a small arrowhead on the right side of the cursor bar. To edit any of these parameters, use the arrow keys and the ENTER key to cause the desired point to be highlighted by the cursor. When there, press the ENTER key to activate the edit mode for that point. The present value of that parameter will appear in "reverse color" as in the illustration at left. Now, pressing the UP/DOWN arrow keys will now cause that value to increase or decrease. When the reading reaches the desired value, release the arrow key, then press and release the ENTER key to save the newly modified setting. If the user wishes to abort any modifications, simply press the MENU key instead of the ENTER key to cancel the changes.

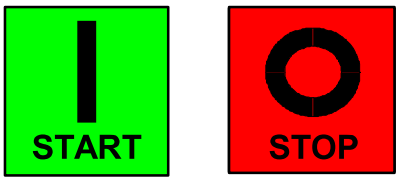


If a large number change is required, the user can use the LEFT/RIGHT arrow keys to shift the cursor to the appropriate digit location and then use the UP/DOWN arrow keys to change that digit. As an example, the illustrations at left show the steps taken to change the Analog Input #1 Maximum Span setpoint from 300 to 3300.



Note, if the controller does not allow the user to "edit" any reading even though the edit arrowhead is displayed, it is possible that system security has been enabled and the user must first enter a valid password. In this case, the lower portion of the screen will also display the message * ACCESS DENIED *. Read the SYSTEM SECURITY section to learn about working with security levels. “Read-only” parameters or menu selections do not display the small triangular graphic symbol at the right side of the display line.
The screen at left shows Present Value as “read-only”, three editable parameters and two menu selections.

BASIC OPERATION

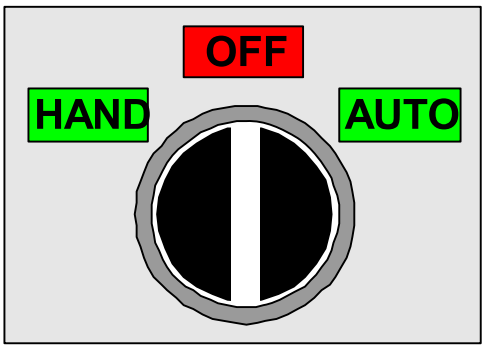


START / STOP DISPLAY UNIT SWITCHES

The VORTEX GCS's display unit keypad provides a discrete push-button switch for START and STOP. To start a motor manually, press the START button. To shutdown a running motor, or to clear a lockout condition, press the STOP button on the display unit.

HAND/AUTO MODE SELECTION

The HAND or AUTO operational mode is determined by the status of the Internal Auto Restarts (Int Auto Rstrt) parameter that is found on the STARTS screen of the GCS VORTEX SETUP menu group. When this parameter is set to "YES", the AUTO mode is selected, and the controller will automatically start the motor after the restart time delay has expired providing there are no active alarms. The motor can be started at any time by pressing the start button unless the Wait For Restart Timer (Wait Fr Rstrt T) setpoint is enabled. In this case, the motor will not start until the restart time delay has expired. In no case will a start be allowed if any alarms are active and do not have an associated start bypass time delay. If a shutdown has occurred that causes a lockout condition, the lockout must be cleared before the controller will allow another start attempt. A lockout condition can be cleared by pressing the STOP button switch on the display keypad. When the Internal Auto Restarts (Int Auto Rstrt) parameter is set to "NO", the HAND mode of operation is selected. When the HAND mode is selected, the motor can only be started manually by pressing the start button.

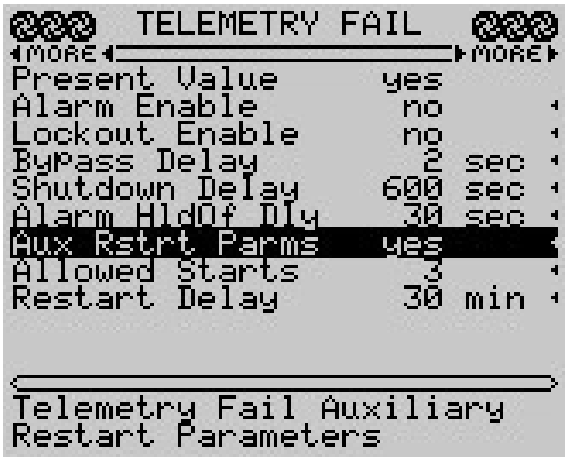


HAND/OFF/AUTO AND START PANEL MOUNTED SWITCHES

The controller's mode of operation can also be determined by the status of optional, externally mounted HAND/OFF/AUTO (HOA) mode and START switches. A running motor can be shutdown or a lockout condition can be cleared manually by changing the position of the HOA switch to the OFF position and then back to the desired mode of operation, HAND or AUTO. If external, panel mounted switches are used, be sure to enable them by setting the External HOA parameter to "YES". This parameter is found as a sub-menu of the SCADA & SECURITY & SYSTEM menu selection.

AUXILIARY RESTART PARAMETERS

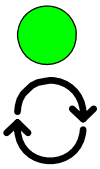
When the GCS controller has been configured to restart automatically, it normally uses two global parameters;



Maximum Allowed Restarts and Restart Time Delay, to determine how many starts are allowed and how long to wait before attempting the start. However, under some circumstances it can be desirable to configure those restart parameters differently based upon what the cause of the shutdown was. Every shutdown alarm in the GCS controller has an associated set of restart parameters connected with it. When these are enabled, and the controller shuts down because of that specific condition, it will use those parameters to control the restart attempt. If those parameters are not enabled, but automatic restarts are allowed, the controller will use the global restart time delay and allowed start attempts.

GREEN, AMBER AND RED DISPLAY LEDS

The GCS VORTEX display unit has red, amber and green LEDs (Light Emitting Diodes) built into it. These lights function slightly differently than any external, optional panel lights do and are not affected by the selection of External Light Mode. These lights can be used in combinations so that the combined states indicate the following.

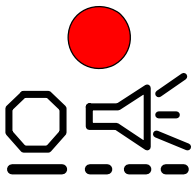


Green light on steady: The motor is running with no pending shutdowns or alarms.

Green light on with amber flashing: The motor is running, but an alarm is active and its associated time delay is counting down to expire. If the alarm persists past the associated time delay, the motor will shutdown.

Amber light on alone: The motor is stopped, but there are no active alarms and the motor will automatically restart when the restart time delay has expired. If the parameter, "Wait for Restart Timer" is disabled, the motor can be started at any time by pressing the START button.

Red light on steady: The motor is stopped because of a manual or operator stop or a central computer shutdown command.



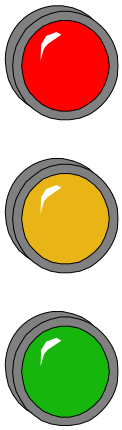
Red light on flashing: The motor is stopped because of one of the enabled alarms has occurred. Restart will not occur without operator intervention.

Red light on flashing with Amber: The motor is stopped because of one of the enabled alarms has occurred. Restart will occur when restart time delay has expired.

RED, AMBER AND GREEN PANEL LIGHTS

If the Red, Amber and Green lights are installed on the enclosure and wired to the corresponding digital output terminals, the system unit of the GCS VORTEX will operate the lights in the following modes. The operator can choose these modes of operation from the Ext. Light Md menu in the SYSTEM menu screen. In all modes, the GREEN light indicates the motor is running.

EXTERNAL LIGHT MODE: VORTEX

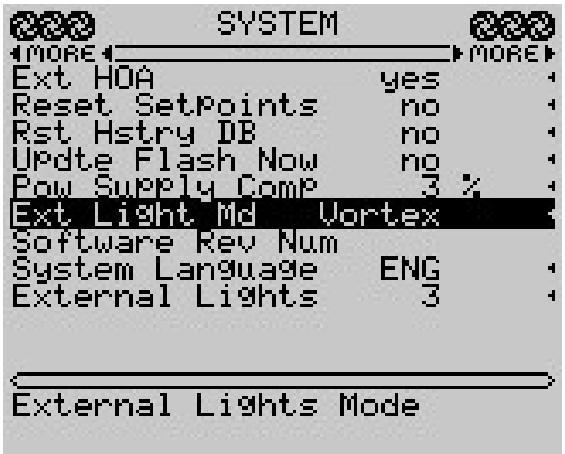


The red light indicates that the motor is stopped and that no automatic restart will occur. This may be because:

1: An alarm is still active, or
2: The last shutdown caused a lockout condition, or
3: The Hand/Off/Auto switch is in the OFF or Hand position, or
4: The controller has received a valid shutdown command from a central computer .

The amber light indicates that the motor is stopped, but all alarms are clear and the controller is counting down the Restart Time Delay. When this delay has expired the GCS VORTEX will automatically restart.

The green panel light indicates that the motor is running.



EXTERNAL LIGHT MODE: KRATOS

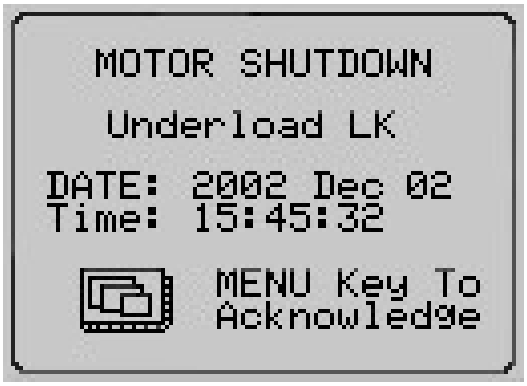
In this mode, the red and amber lights operate in the same way as a Kratos or Centrigard™ Controller. The red light indicates an Overload shutdown has occurred and an Amber light indicates all other shutdowns.

EXTERNAL LIGHT MODE: ICS Em

In this mode, the panel lamps operate in the same way as an ICS variable speed drive. The RED light indicates an OVERLOAD shutdown, an AMBER light indicates an UNDERLOAD shutdown. If the shutdown is caused by any other reason, no panel lights will be illuminated.

CONNECTING EXTERNAL PANEL LIGHTS

The three digital outputs corresponding to the RED, AMBER and GREEN lights are located on the GCS VORTEX terminal strip and are labeled RED, AMBER and CONTACTOR. All three outputs are “dry contact”, Normally Open (N.O.) relay contacts rated for use at up to 10 Amps @ 250 Volts. Refer to the appendix section at the end of this manual for a schematic diagram illustrating the connections to the terminal strip.



EXTERNAL LIGHTS

All three digital outputs (relays) internal to the GCS VORTEX can be reassigned as general purpose outputs if the panel lamp function is not required. In this case, the parameter External Lights can be set to indicate how many of the outputs are used in the External Light Mode explained above. The possible settings are 3, 1 or none. If set to 3, all three relays are used in the External Light Mode. If set to 1, only the GREEN lights' relay is used and the other two relays are available for general purpose outputs. If set to none, all three relays are available for general purpose outputs. These general purpose outputs can be utilized via the User Programmable Logic Functions discussed in that manual section.

ALARM AND SHUTDOWN INDICATION

The GCS VORTEX always enunciates live alarm and shutdown information on the STATUS screen of the display unit. The controller will also display an alarm alert screen after any shutdown occurs. This "pop-up" alert screen, similar to the illustration at left, is displayed on top of all other screens and shows the time and cause of the motor shutdown. Press the MENU key to acknowledge and clear this screen and return to the previously display screen.

LOCKOUT CONDITION

Any of the protective shutdown alarms can be configured to cause a lockout condition. This is indicated by "LK" or "LKout" displayed after the cause of shutdown as illustrated at left. If such a lockout condition has occurred, no starts of any kind, manual or automatic will be allowed until the lockout has been cleared. A lockout can be cleared by pressing the STOP keypad switch on the Display unit or changing the position of the HAND/OFF/AUTO Mode switch, if installed, to OFF and back to HAND or AUTO.

SYSTEM SECURITY

The GCS VORTEX has the capability of administering security protection to guard against unauthorized setpoint editing. The security is initiated by entering a code number or password into the Level 1 and/or 2 setpoint. If a password code number is entered into either security level setpoint, then an operator must enter the same password into the User Password variable before any changes to setpoints or readings will be allowed. Without any security level achieved, the operator may view most display screens but will be unable to edit or change them. Level one of security will grant access to the most commonly used or changed

setpoints, such as modifying alarm thresholds of protection setpoints. Level 2 security grants access to most of the other setpoints. The controller is shipped from the factory with all security protection disabled, so if an operator is unable to change setpoints in the field, a security code will have been entered in the field by local personnel. In this case, the lower portion of the screen will also display the message * ACCESS DENIED *.These local personnel should then be contacted to learn the security code required. The SECURITY input screen can found under the SCADA & SYSTEM & SECURITY section of the main display screen. The user password is found under the GCS VORTEX setup screen.

SYSTEM TIME CLOCK

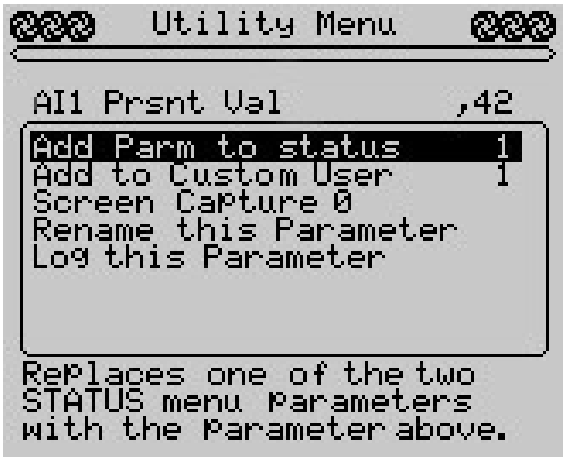
The GCS VORTEX uses a battery backed real time clock circuit for time keeping functions. All events and shutdowns recorded are time stamped with the date and time of occurrence. A battery is supplied with the system that will keep the clock up to date in the event of a power failure or shutdown. The system clock can be set to the current date and time by entering the desired data into the SET TIME menu screen found as a sub-menu of the SCADA & SECURITY & SYSTEM menu.

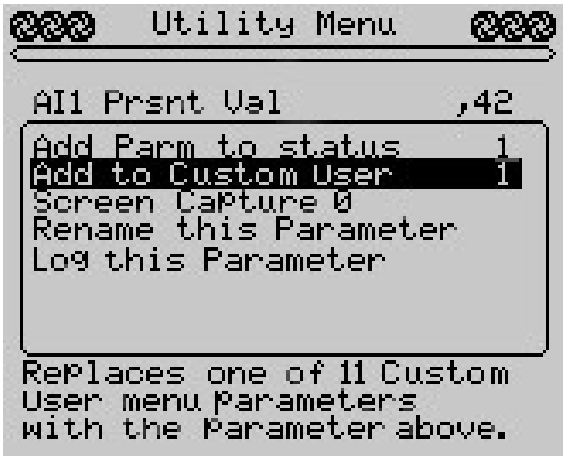
CITIBUS DIAGNOSTICS / CONTRAST ADJUST

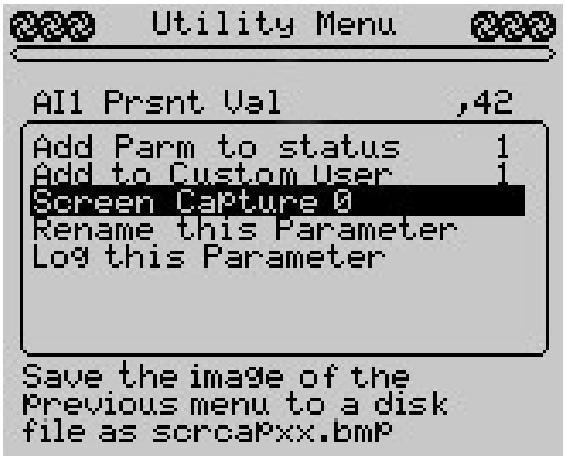
The CITIBus diagnostics information is displayed as the upper half of this screen. CITIBus is the trademark name of the hardware/software connection and communication between modules connected together in a GCS system. This information can be used to diagnose problems if they arise. The GCS display unit uses a temperature sensing circuit to automatically adjust the contrast of the LCD display screen. If manual adjustment of the contrast level becomes necessary, use this screen. To activate this adjustment screen, press both the LEFT and RIGHT arrow keys simultaneously, hold for a half a second, then release both keys. A screen similar to the one at left will be displayed. At this point, use the UP and DOWN arrow keys to adjust the contrast higher or lower as required.

SOFTWARE REVS

This screen also displays the software revision levels loaded into this unit. As illustrated, the GCS unit displays the labels for the Power Conversion Module even though it is not applicable (N/A). Contact Centrilift personnel for software upgrades if required.







SYSTEM DIAGNOSTICS / CONTRAST ADJUST

When the LEFT or RIGHT arrow keys are pressed while in the first contrast adjust screen, a second screen of information will be displayed. This screen displays the System Diagnostics which shows the number and type of resets recorded by the microprocessor controlling the units as well as the presently measured temperature of the display unit. The HST column represents the system controller host (In this case, Hst is a Vortex GCS), while the Dsp column represents the graphic display unit. Contrast adjustments can be made in this screen also. Once adjustments are complete, press the ENTER or MENU key to return to the GCS menu system.

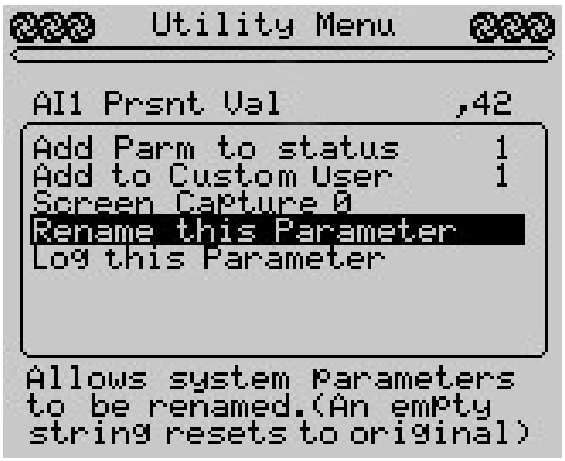
Utility Menu

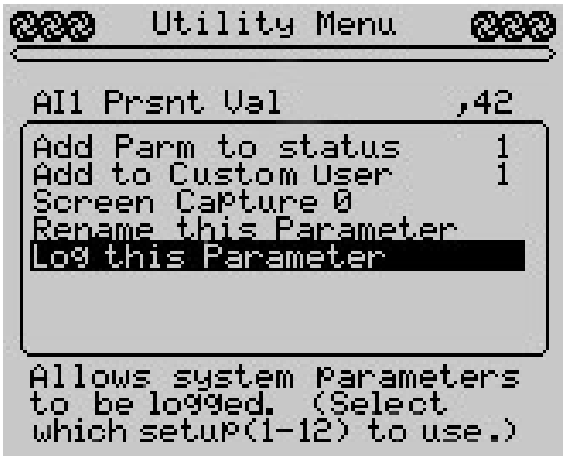
The Utility Menu is activated by depressing the UP and DOWN arrows keys at the same time. A menu screen similar to the one at left will appear.

Add Parm to status This function allows the user to replace one or both of the analog parameters on the STATUS screen. The factory default setting is for the STATUS screen to display the present value of On Board Analog inputs 1 and 2. To replace these parameters, first use the arrow keys to move the cursor to highlight the parameter that will be moved. Next, activate the Utility menu by depressing the UP and DOWN arrow keys at the same time. Then, move the cursor to highlight “Add Parm to status” and press ENTER. The cursor will highlight the number one at the right side of the screen. Press the UP or DOWN arrow key to select between status line 1 or 2. Press ENTER again to replace the selected status line with the new selection.

Add to Custom User This function allows the user to place up to 11 parameters unto the Custom User Screen. First, use the cursors keys to highlight the desired parameter. Next, activate the Utility Menu by pressing the UP and DOWN arrows at the same time. Move the cursor bar to highlight the “Add to Custom User” line, and press ENTER. Use the UP or DOWN arrow keys to select which line (1 to 11) of the Custom User screen this parameter will be placed on. Lastly, press the ENTER key again to execute the function. In the illustration, the present value of Analog Input 1 will be placed on line one of the Custom User Screen. Note that the parameter can also be renamed to a more descriptive label.

Screen Capture The Screen Capture function is used to store a copy of the presently displayed screen onto the PCMCIA memory card. A valid memory card must be installed to use this function. Use the cursor keys to





display the desired screen and activate the Utility Menu. Move the cursor to the “Screen Capture” menu line and press ENTER. The number “0” will change to reflect the file name created. All of the files are of a two color bitmap variety with automatically assigned filenames of scrcap01.bmp through scrcap99.bmp The capture function will automatically increment the number in the file name when it encounters an existing file.

Rename This Parameter This function allows the user to rename any valid data point. For example, Analog input #1 could be renamed to Tank Level. Up to 15 characters can be used in the descriptor. The first step is to use the cursor keys to highlight the parameter that will be renamed. Next, activate the Utility Menu, highlight the “Rename this Parameter” line and press ENTER. The screen will change to one resembling the one at left below. Use the arrow keys to move the cursor to the desired letter and press ENTER. Repeat this procedure until all the desired letters are selected, then move the cursor to the SAVE area on the screen. Press ENTER and the new name will be preserved while the screen reverts back to the original menu. If the name must be reset to default values, erase all of the custom characters in the string and save it as an “empty” string. The parameters’ name will revert to the default value.

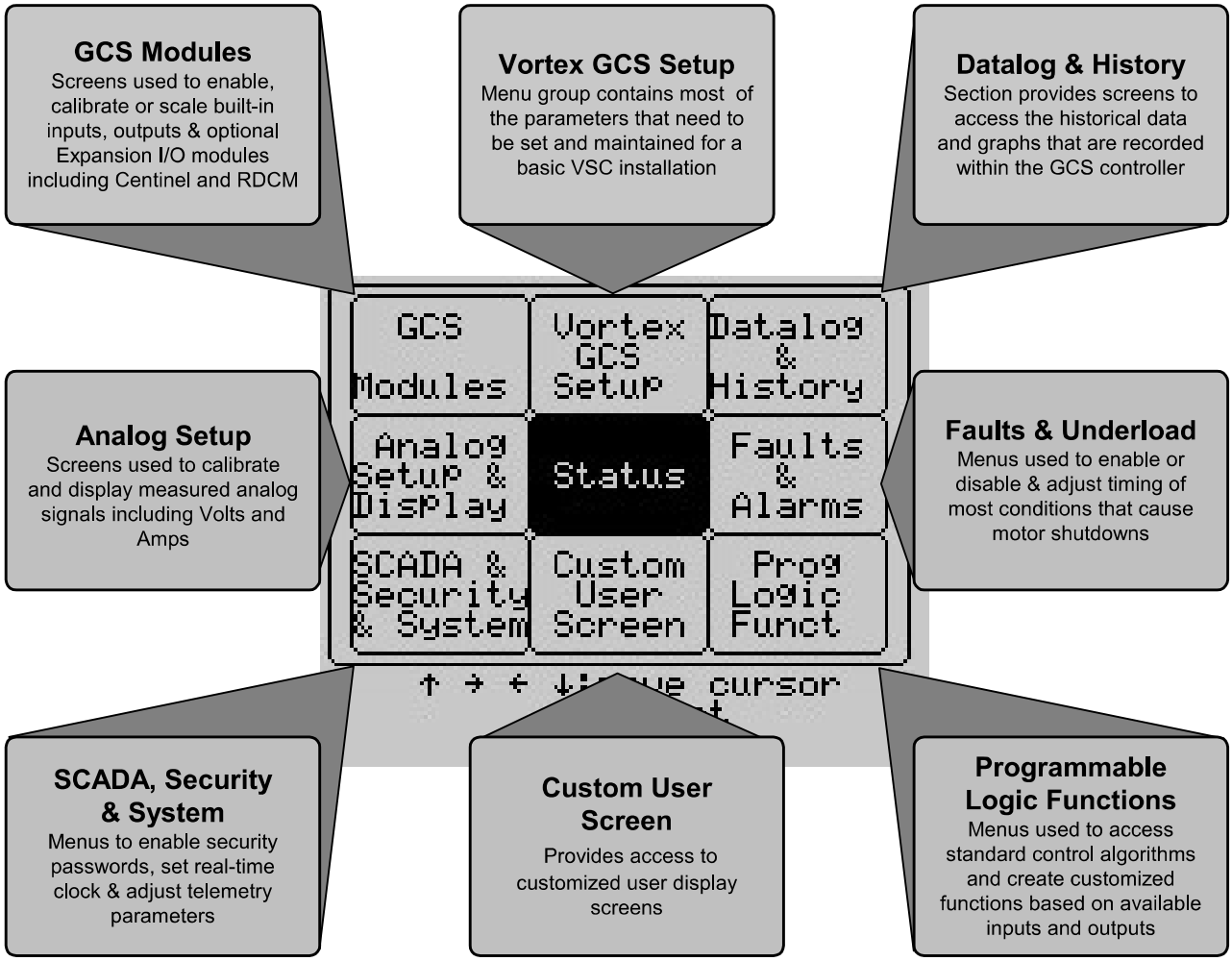
As shown in the illustration at left, the cursor is currently resting on the lower case “L” character and the newly created string will be “Tank Level”. The backslash character, “ \ ” , after the “l” indicates where the next letter or character will be placed.

Log This Parameter This function can be used to add any database point to the list of points being logged or recorded to the PC Memory card on the display unit. To use this feature, first move the cursor to highlight the desired parameter, then press the UP & DOWN arrow keys together to activate this Utility menu. Then select this menu item and press ENTER. The cursor at this line will change to display the number 1. This number indicates which of the twelve possible datalog slots this parameter will be configured into. If slot number 1 is already allocated, select another slot. Once that is selected, press ENTER and the screen will revert to the original location. The highlighted data point will be added to the list of logged points with a sample interval time of 1 second and a dead band value of 1. If those parameters are not acceptable, change them by using the DATALOG Setup menu discussed later in this manual.

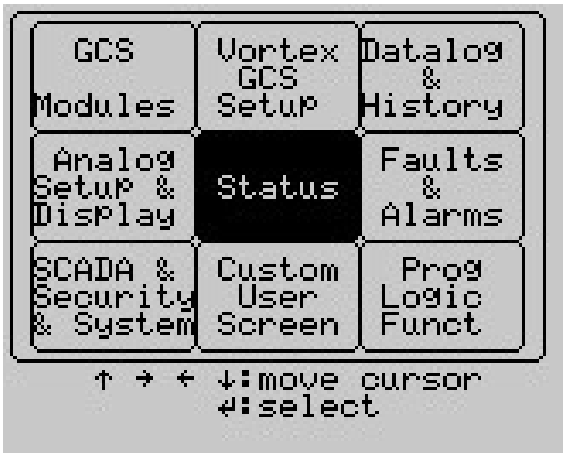
THE GCS MENUS

The following section will list and provide explanations of all the menus and parameters that are available to the user. The order in which the parameters are listed is based on starting with the MAIN MENU screen of the display, as shown below, proceeding to the STATUS screen, then, clockwise from GCS VORTEX SETUP, around the perimeter. Some of the display screens are longer than will fit unto the 11 lines of text available on one screen. For clarity within this manual, most of those screens will be illustrated to show all of the parameters available. To locate information pertaining to any specific parameter, use the index at the end of this manual to locate a keyword, and then view the information on the page(s) indicated.

OVERVIEW OF GCS VORTEX MENU STRUCTURE

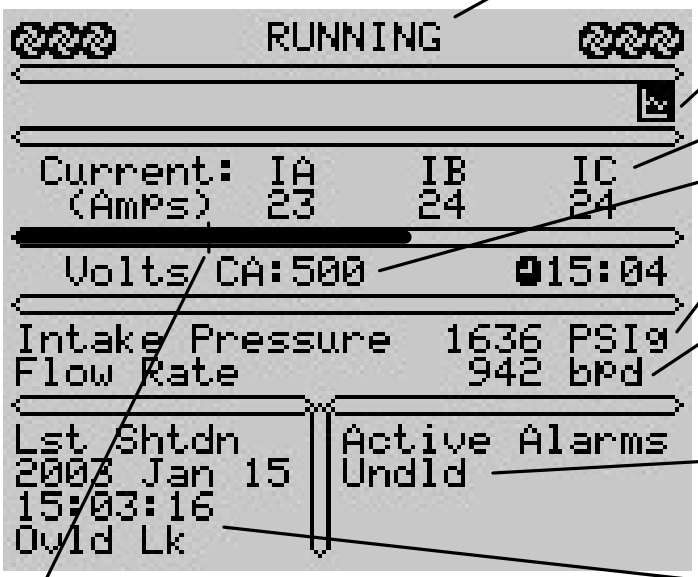


STATUS SCREEN



The status screen is the primary operator's display. From here, the operator can view most of the parameters needed when determining the run status of the motor. Two user selected parameters can be placed upon the status screen, in place of the renamed, default parameters "Intake Pressure" and "Flow Rate" shown below. Refer to the UTILITY menu section for more information.

As illustrated below, the screen contains the following information:



The motor is currently running

This icon indicates the AmpChart can be accessed by pressing the ENTER key. If the unit is locked-out, the padlock, , also appears here

The output currents are 23, 24 & 24 amps, output voltage is 500 VAC

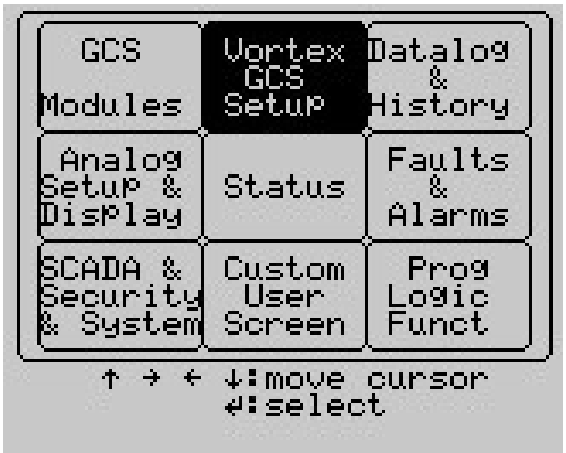
Analog Input #1 measures pump intake (bottom hole) pressure
Analog Input #2 measures barrels per day of fluid produced

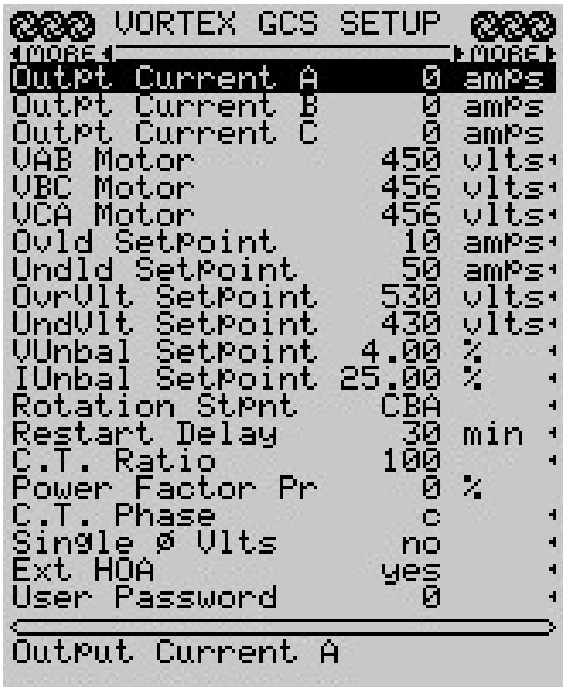
The controller is detecting an Underload alarm condition and is waiting for the time delay to expire before it shuts down the motor

The most recent shutdown was caused by an Overload Lockout condition on January 15,2003 at 3:03:16 PM local time

When the motor is running, this bar graph illustrates the amount of current relative to the overload setpoint. The tick represents the underload setpoint.

GCS VORTEX SETUP





When the cursor is moved to the top center position of the Main Menu screen, and the ENTER key is pressed, the first of two GCS VORTEX SETUP screens is displayed. These screens gather together most of the parameters needed to start-up and run the GCS VORTEX motor controller. To display another screen, press the left or right arrow key. To edit any parameter, use the arrow keys to move the cursor bar over any menu item as shown below at left and press the ENTER key. The GCS will enter the “edit” mode and allow changes to the value of that parameter. The two screens available within this group are GCS VORTEX SETUP, and STARTS. Each is reviewed in the following.

GCS VORTEX SETUP

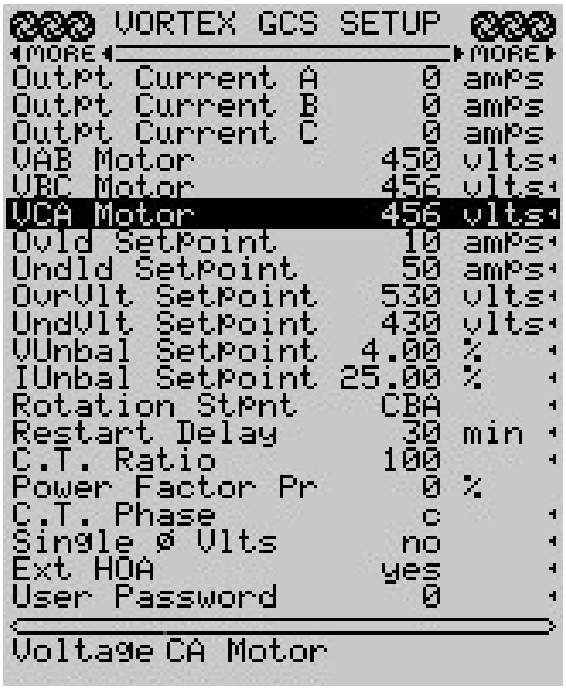
Outpt Current A Output Current Phase A displays the present value of the current being drawn on phase A of the motor. If the motor is currently shut off, this parameter will read zero. If the motor is running, the operator can edit the value of current displayed in this and the phase B and C parameter locations. If any one of the currents is scaled higher or lower, care must be taken not to exceed the Current Unbalance shutdown setpoint or risk shutting down the motor.

Outpt Current B Output Current Phase B displays the present value of the current being drawn on phase B of the motor. If the motor is currently shut off, this parameter will read zero.

Outpt Current C Output Current Phase C displays the present value of the current being drawn on phase C of the motor. If the motor is currently shut off, this parameter will read zero.

VAB Motor Voltage Phase AB Motor displays the present, scaled value of the phase to phase line voltage available across phases A and B . The operator can scale this voltage as well as VBC and VCA via these parameter displays. Take care to disable Voltage Unbalance whilst scaling voltages to prevent an unwanted Unbalance shutdown. If only one voltage monitoring potential transformer is installed, this parameter will read zero and the parameter Single Phase Volts should be set to “YES”.

VBC Motor Voltage Phase BC Motor displays the present, scaled value of the phase to phase line voltage available across phases B and C. If only one voltage monitoring potential transformer is installed, this



parameter will read zero and the parameter Single Phase Volts should be set to “YES”.

VCA Motor Voltage Phase CA Motor displays the present, scaled value of the phase to phase line voltage available across phases C and A. The operator can scale this voltage as well as VBC and VAB via these parameter displays. Take care to disable Voltage Unbalance whilst scaling voltages to prevent an unwanted Unbalance shutdown. If only one voltage monitoring potential transformer is installed, only this parameter will display a valid reading.

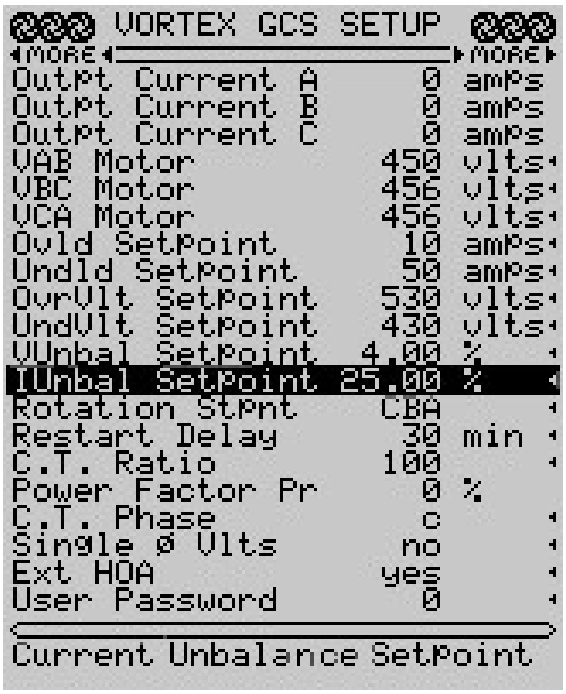
Ovld Setpoint Overload Setpoint represents the amount of current the motor is permitted to draw before the controller begins to process a shutdown. This value is typically 100 to 120% of the motor’s nameplate current rating. A time delay may also be set to permit the condition to exist for that period of time before shutting down. Refer to the Overload Alarm Setup Screen for more information regarding time delays.

Undld Setpoint Underload Setpoint is the minimum value of motor current that is permitted before the controller begins to process a shutdown. This value is typically set at 15 to 20% below average nominal motor current at normal load conditions. A time delay may also be used to delay the shutdown during short lived transient alarm conditions. Refer to the Underload Alarm Setup Screen for more information regarding other associated settings or variables

OvrVlt Setpoint Over Voltage Setpoint is the maximum value of supply voltage the controller permits before processing an Over Voltage alarm shutdown. This value is typically set at 10 to 15% above motor nameplate voltage rating. A time delay may also be used to delay the shutdown during short lived transient alarm conditions. Refer to the Over Voltage Alarm Setup Screen for more information regarding other associated settings or variables.

UndVlt Setpoint Under Voltage Setpoint is the minimum value of supply voltage the controller permits before processing an Under Voltage alarm shutdown. This value is typically set at 10 to 15% below motor nameplate voltage rating. A time delay may also be used to delay the shutdown during short lived transient alarm conditions. Refer to the Under Voltage Alarm Setup Screen for more information regarding other associated settings or variables.

VUnbal Setpoint Voltage Unbalance Setpoint is the maximum percentage value of supply Voltage Unbalance the controller permits before processing an Voltage Unbalance alarm shutdown. The unbalance is



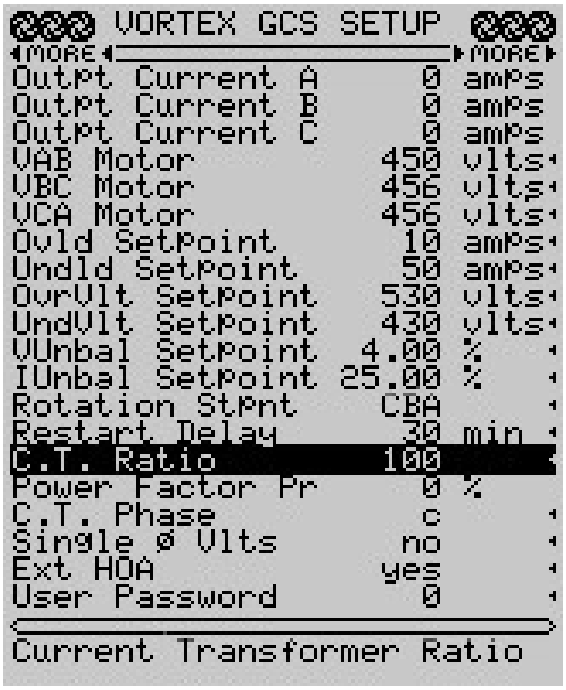
calculated as the maximum deviation of any one phase voltage from the average value of all three phases combined. This value is typically set at 4 to 10% deviation. A time delay may also be used to delay the shutdown during short lived transient alarm conditions. Refer to the Voltage Unbalance Alarm Setup Screen for more information regarding other associated settings or variables.

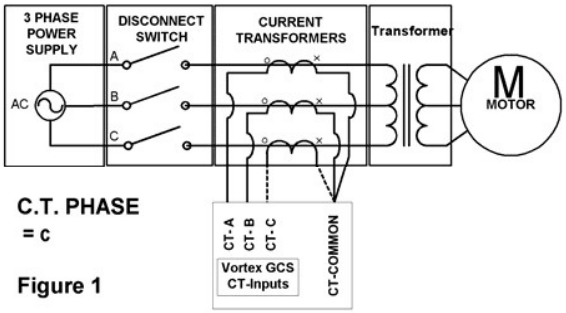
IUnbal Setpoint Current Unbalance Setpoint is the maximum percentage value of motor current unbalance the controller permits before processing a Current Unbalance alarm shutdown. The unbalance is calculated as the maximum deviation of any one phase current from the average value of all three phases combined. This value is typically set at 20 to 25% deviation. A time delay may also be used to delay the shutdown during short lived transient alarm conditions. Refer to the Current Unbalance Alarm Setup Screen for more information regarding other associated settings or variables.

Rotation Setpoint Rotation Setpoint is used to detect a change in the phase rotation of the incoming power supply. When first installed, the service man will manually determine the correct motor connection needed to turn the pump and motor in the proper direction necessary for efficient operation. The rotation setpoint in the GCS VORTEX is then set to the opposite of this previously determined proper rotation. In this way, if the phase rotation of the incoming power changes, the GCS VORTEX will detect the change and prevent further restart attempts. Refer to the Rotation Alarm Setup Screen to determine current incoming rotation and to enable or disable this shutdown.

Restart Delay Restart Delay controls the length of time the GCS VORTEX will wait before attempting to restart the motor when automatic restarts have been enabled. Automatic restarts are allowed when the parameter Internal Auto Restarts (Int Auto Rstrt) is set to “YES” or the optionally installed HOA (Hand-Off-Auto) mode switch is enabled and set to the AUTO position. When these conditions are met, the AUTO mode is selected, and the controller will automatically start the motor after the restart time delay has expired providing there are no active alarms. The motor can be started at any time by pressing the start button unless the Wait For Restart Timer (Wait Fr Rstrt T) setpoint is enabled. In this case, the motor will not start until the restart time delay has expired. In no case will a start be allowed if any alarms are active and they do not have an associated start bypass time delay.

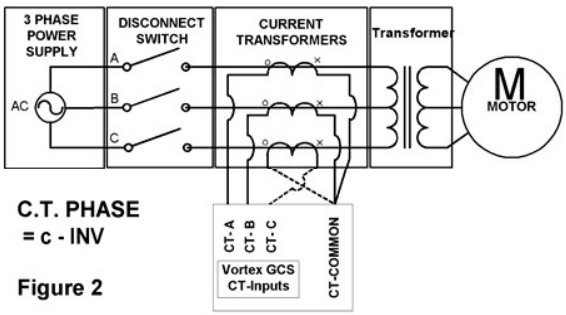
C.T. RATIO Current Transformer Ratio is the parameter that informs the GCS VORTEX of the step





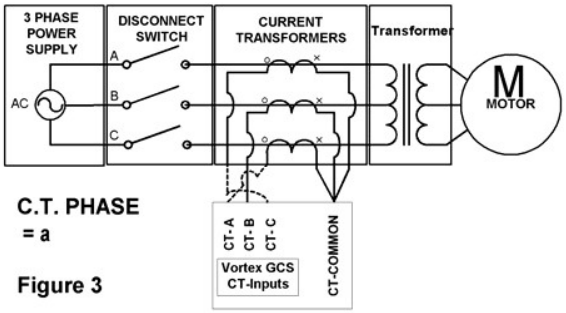
C.T. PHASE
= c

Figure 1



C.T. PHASE
= c - INV

Figure 2



C.T. PHASE
= a

Figure 3

down ratio used in the current measuring transformers. In typical applications it is not practical to measure the motor current directly since the amperage and voltages involved are dangerously high. Using a current transformer allows the amperage to be transformed down to lower and safer value. The C.T. provided (or selected) should have a primary winding capacity that matches or exceeds the load application and a secondary winding output of 1 amp AC RMS at full scale primary winding (input) current. The value set in this parameter is the primary winding current capacity. Standard C.T.s are available in 100, 300 and 500 amp primary ranges. This parameter defaults to 100, which sets the ratio at 100 to 1. In other words, when 100 amps of primary current flow through the C.T., 1 amp will flow from the secondary winding.

Power Factor This parameter displays the operating efficiency of the electrical motor. Power Factor within the GCS VORTEX is determined by the displacement method. The displacement angle is defined as the phase angle difference between the voltage and current on the same phase power lead. The power factor is then calculated from the following formula:

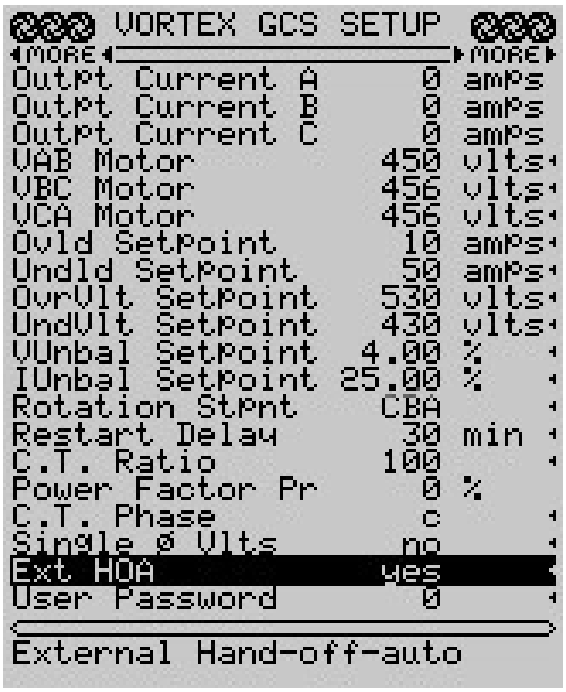
%Power Factor = Cosine (displacement angle) x 100

The voltage phase used for this calculation is always the one connected to Phase CA, and current input C. However those signals are not always connected to the correct inputs. Use the next parameter to configure the Vortex to use a different input phase.

C.T. Phase The C.T. Phase parameter allows the user to specify which phase and polarity of current is connected to the Phase-C current transformer input. If, for any reason, phase C current is not present on the CT-C input, the user can set this parameter to specify which phase is actually connected. This way, the VORTEX can be configured to accurately calculate power factor without physically exchanging current transformer lead connections. The power factor of a fully loaded ESP motor should range between 80% and 90%. With the motor running, change this setpoint and monitor the Power Factor reading until the value is within that range.

Figure 1 shows the normal connections
Figure 2 shows the C phase current is inverted
Figure 3 shows the non-inverted A phase current applied to C phase input.

This setpoint has six possible settings to accommodate current transformers connected to any one of three phases with either inverted or non-inverted phase relationships. The possible settings are: A, A-INV, B, B-INV, C, and C-INV.



Single ø Vlts This parameter, Single Phase Voltage determines whether the GCS VORTEX will try to measure voltages for power phases AB and BC. This measurement is available when the optional voltage monitoring transformer is installed and connected across power phases A and B. If the controller will be operated without this optional transformer, this setpoint should be set to “YES”. This will automatically disable the Voltage Unbalance and Rotation alarms, and will force the GCS VORTEX to use the CA phase voltage only for Over Voltage and Under Voltage alarm calculations.

Ext HOA The External HAND-OFF-AUTO (HOA) setpoint indicates to the GCS VORTEX whether an externally mounted HAND-OFF-AUTO mode switch has been installed and connected. When this parameter is set to “NO”, the controller uses the status of the Internal Auto Restarts (Int Auto Rstrt) variable to control the operating mode, AUTO or HAND and the keypad STOP button to cause a manual shutdown. When the optional mode switch is connected to the AUTO and HAND terminal strip connectors, this parameter can be set to “YES” and the HOA switch controls the operating mode. When the external HOA is enabled, the display units’ keypad switches are still active and either one can be used to shutdown the motor. An external START push button switch can also be installed and connected to the GCS VORTEX terminal strip to provide an alternative method of starting the motor.

Password The Password variable is used by the operator to gain security permission to edit setpoints and variables. This parameter must match the value programmed into the Level 1 or 2 Password variables in the Security menu. If a value has been entered into either password setpoint, its value will be displayed as “xxxxx” to prevent unauthorized access. If the operator cannot enter a value that matches either password value, they will not be able to modify any setpoints.

STARTS

The STARTS menu is accessed from the GCS VORTEX Setup screen by pressing the right or left arrow key until the screen shown at left is displayed.

Int Auto Rstrt This parameter, Internal Automatic Restart, controls whether the controller will automatically restart the motor after it has shutdown but not locked out. This parameter is used in the absence of an externally mounted HAND-OFF-AUTO (HOA) switch and is over-ridden by the position of the HOA switch when one is installed and enabled.

Strts Counter Starts Counter displays the number of times that the controller has automatically restarted the motor. This counter is used in conjunction with the following Maximum Allowed Starts and Starts Counter Reset Delay set points to limit and control the number of times the controller will restart the motor before assuming a lockout condition and preventing additional start attempts. A lockout condition can be cleared by pressing the STOP keypad switch or moving the HOA switch to OFF and back to AUTO or HAND.

Total Strts Total Starts records the number of times that the motor has been started since the last reset setpoints command.

Max Alowd Strts Maximum Allowed Starts controls the number of automatic restarts that will be attempted by the controller before generating a lockout. If the controller attempts this many restarts and the motor does not run for a minimum of the time set in the following Starts Counter Reset Delay parameter, the GCS VORTEX will then assume a lockout condition and prevent further restart attempts until the lockout is cleared. A lockout condition can be cleared by pressing the STOP keypad switch or moving the HOA switch to OFF and back to AUTO or HAND. This time delay is used for all restart attempts unless the Auxiliary Restart Parameters are enabled for that specific cause of shutdown.

Strts Cntr Rst Starts Counter Reset delay controls the length of time, in minutes, that the motor must run before the controller resets the automatic starts counter and again allows the full number of restart attempts to occur. When this time delay has expired and Starts Counter is reset to zero, the controller can again attempt as many automatic restarts as allowed by the Max Alowd Strts parameter. For example, if the motor has been started and has shutdown before the factory default delay of 60 minutes have elapsed, the controller will record 1 automatic start. If the motor is started again and shuts down again before 60 minutes of running time, the controller will then show 2 automatic start attempts. If this situation is repeated once again, the controller will record the third automatic start attempt and generate a lockout condition. This "lockout" condition will prevent any subsequent start attempts until the lockout has been cleared. This time delay is also used to reset the following Progressive Restart Time parameter.

Prog Rstrt Tm Progressive Restart Time Delay provides a method of automatically increasing the amount of restart time delay that the controller waits before restarting the motor. When this parameter is set to a non-zero value, the specified number of minutes will be added to the restart time delay whenever the

controller is attempting an automatic restart. In this situation, the controller will use the standard restart time delay for the first restart period and then add the progressive restart time delay to the second and subsequent restart attempts. To prevent an ever increasing restart time delay, the amount of progressive restart time added will revert to zero when the motor runtime has exceeded the previously discussed Starts Counter Reset delay.

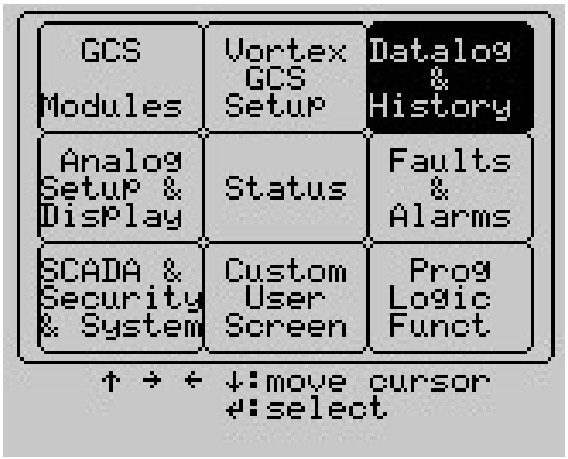
Restart Delay Restart Delay sets the amount of time in minutes the controller will wait after a shutdown, before attempting an automatic restart of the motor. If necessary, the motor can be started immediately by pressing the start keypad button or the panel mounted start switch if the panel is equipped with one. In all cases, the controller will attempt to restart the pump only if there are no active alarms and the Wait for Restart Time Delay setpoint is disabled. Restart delay can be automatically increased by the Progressive Restart Time delay set point previously discussed. If the Auxiliary Restart Parameters are enabled for the cause of the last shutdown, the controller will use those specific settings for restart time delay and number of starts.

Tm Til Rstrt Time until Restart displays the number of minutes and seconds left before the controller will attempt to restart the motor. If this set point reads zero and the motor is not running, there could be active alarms, or restarting is prevented because the keypad STOP button was pressed, the external HOA mode switch is in HAND or OFF position, a telemetry shutdown control command is active or Int Auto Rstrt is set to “NO”.

Stagrd Strt Tm Staggered Start Time provides a means of delaying the restart time of this motor following a power failure. After a power failure, all controllers will wait for a time delay equal to the Restart Delay plus this staggered start time delay. Offsetting individual restart times this way can help to prevent voltage sag on the power system caused when many motors start at once.

Wait Fr Rstrt T Wait for Restart Time Delay forces the controller to wait until the restart time delay expires before allowing any type of restart, either manual or automatic. To restart immediately in case of emergency, change this set point to “NO”, start the motor, and then set it back to “YES”. The controller will never attempt to restart the motor if there are any active, un-bypassed, alarms.

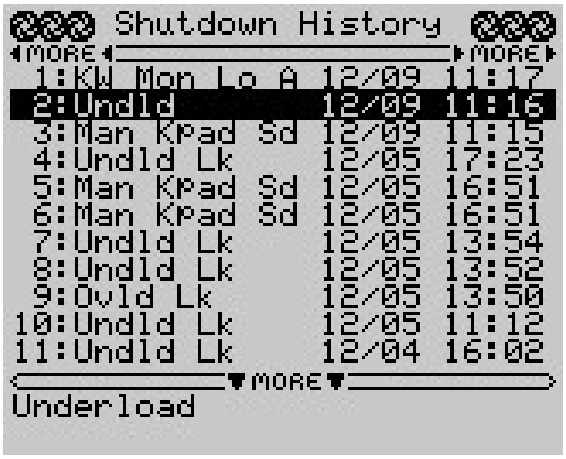
Rstrt on Ovld Restart on Overload programs the Overload Auxiliary Restart Parameters (ARPs) to allow the controller one automatic motor restart attempt after an Overload shutdown. All Auxiliary Restart Parameters



are accessible from each individual fault and alarm setup screen. Refer to the Overload fault and alarm sections of this manual for further details.

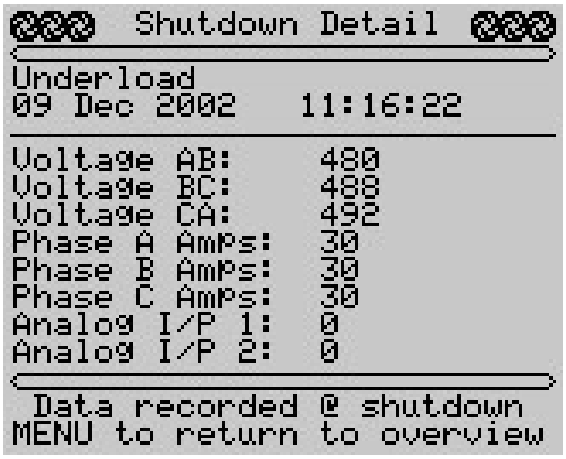
DATALOG & HISTORY

The DATALOG and HISTORY group of screens provides access to the recorded history stored within the VORTEX GCS. This group of screens includes the SHUTDOWN HISTORY, EVENT RECORDS, RUN HISTORY, and PC CARD DATA LOGGING AND GRAPHING. Also included in this section are screens accessing PC Card file/directory functions and a user entered site name and notes area.



SHUTDOWN HISTORY

Shutdown History displays the cause, time and date of the last ninety nine shutdowns. The screen holds eleven records at once. To view any other shutdown histories, press the down arrow key to move the cursor to the bottom of the screen and beyond, scrolling through all available records. The names of the causes of shutdown are often abbreviated, so if an explanation is required, the area at the bottom of the screen displays an expanded version of the cause.



SHUTDOWN DETAIL

The Shutdown Detail screen is displayed when the ENTER key is pressed while the cursor highlights a shutdown history record. This record contains the value of the three current and voltage readings and the two analog input readings at the time this corresponding shutdown occurred. This data can be useful for diagnosing troublesome applications.

EVENT RECORDS

The EVENT RECORDS screen displays the 254 most recent events that have occurred since the controller has been installed and powered up. When the event buffer has been filled, the controller will begin to overwrite the oldest records with the newest event information. Each numbered entry in the list of events is followed by a three letter abbreviation indicating the type of event, which is in turn followed by the data base point description that caused or was affected by the event. At the bottom of the screen, three lines of information are displayed that show: the type of event (non-abbreviated), the time and date of occurrence and, in the case of a setpoint change, the before and after values of that setpoint. Use the UP / DOWN arrow keys to move the cursor up and down to highlight different events and view their information at the bottom of the screen. To quickly move the cursor from one end of the list to the other end of the list, press the ENTER key.

RUN HISTORY

The RUN HISTORY screen displays counters and timers that record various operating information about the installation. To access RUN HISTORY press the right arrow key from the EVENT RECORDS screen.

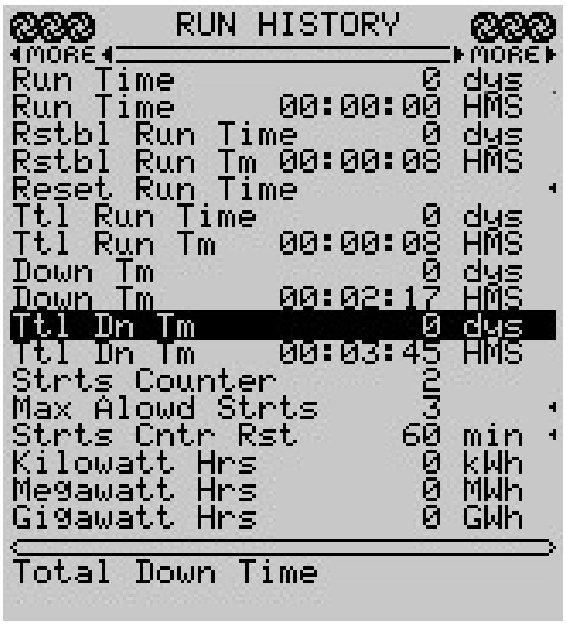
Run Time (days) This timer records the total number of 24 hour days that the motor has run since the last time it was started up.

Run Time This timer records the hours, minutes, & seconds (HMS) that the motor has run since the last start. When this timer reaches 24 hours, it will start again from zero, and Run Time (days) will be incremented by one day.

Rstbl Run Time (days) This user Resettable Run Timer records the number of 24 hour days that the motor has run since the last user reset.

Rstbl Run Tm This user Resettable Run Timer records the number of hours, minutes, & seconds (HMS) the motor has run since the last user reset. When this timer reaches 24 hours, it will revert to zero and the Rstbl Run Time (days) timer will be incremented by one day.

Reset Run Time Use this display point to reset the Rstbl Run Time counters back to zero. Move the cursor until it highlights this point, then press the ENTER key. The two resettable counters will reset to zero, and, if the motor is running, immediately begin to accumulate run time.



Ttl Run Time Total Run Time (days) records the total number of days the motor has run since it was first installed and commissioned.

Ttl Run Time This timer records the hours, minutes, & seconds (HMS) that the motor has run since it was first installed and commissioned. When this timer reaches 24 hours, it will start again from zero, and Ttl Run Time (days) will be incremented by one day.

Down Tm Down Time (days) records the total number of days that the motor has been off since the last time it was shut down.

Down Tm Down Time counter records the hours, minutes, & seconds (HMS) that the motor has been off since the last time it was shutdown. When this timer reaches 24 hours, it will start again from zero, and Down Tm (days) will be incremented by one day.

Ttl Dn Tm Total Down Time (days) records and accumulates the total number of days that the motor has been shut off since it was first commissioned and started.

Ttl Dn Tm The Total Down Time counter records and accumulates the hours, minutes, & seconds (HMS) that the motor has been off since it was first commissioned and started. When this timer reaches 24 hours, it will start again from zero, and Ttl Dn Tm (days) will be incremented by one day.

Strts Cntr Starts Counter displays the number of automatic restarts that have occurred, during which the motor did not run long enough to expire the Starts Counter Reset delay. If this starts counter reaches the value that is programmed into the Max Alowd Strts, the controller will enter a lockout state and will not allow further restart attempts until the lockout is cleared. This parameter is also accessible in the GCS VORTEX SETUP menu group and is duplicated here for operator convenience only.

Max Alowd Strts The maximum allowed starts parameter controls how many automatic restart attempts will be allowed before the controller lockouts out and prevents any further starts.

Strts Cntr Rst Starts Counter Reset delay controls the length of time, in minutes, that the motor must run before the automatic Starts Counter is reset to zero. When this time delay has expired and Starts Counter is reset to zero, the controller can again attempt as many automatic restarts as allowed by the Max Alowd Strts parameter. This set point is also accessible in the GCS

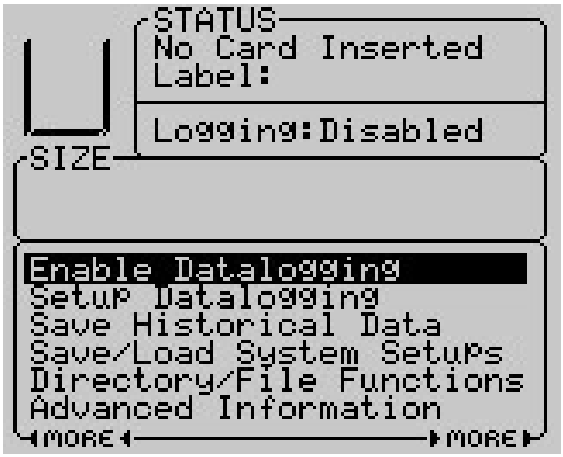
VORTEX SETUP menu group and is duplicated here for operator convenience only.

Kilowatt Hrs The Kilowatt Hours meter records and accumulates the amount of electrical power consumed by the motor. When Kilowatt Hours reaches 1000, it will revert to zero and Megawatt Hours will be incremented by one.

Megawatt Hrs The Megawatt Hours meter records and accumulates the number of megawatt/hours of electrical power consumed by the motor. When Megawatt Hours reaches 1000, it will revert to zero and Gigawatt Hours will be incremented by one.

Gigawatt Hrs The Gigawatt Hours meter records and accumulates the number of gigawatt hours of electrical power consumed by the motor. When Gigawatt Hours reaches 10,000, it will revert to zero.

PC CARD DATALOGGING

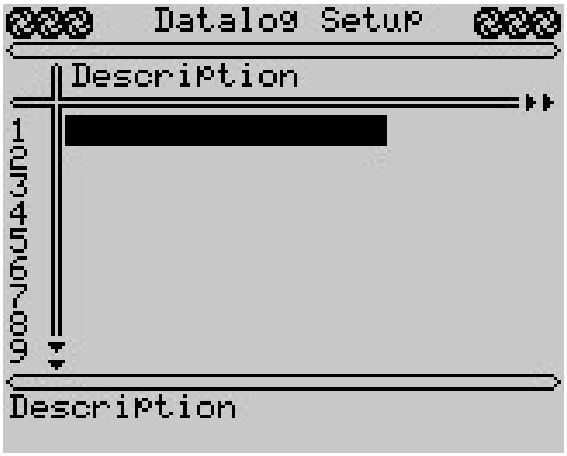


This screen provides access to the data logging functions provided with the GCS controller. The data recorded is stored onto a non-volatile memory card inserted into the provided socket on the GCS display unit. The PC memory cards are formatted and structured with a DOS file format. When plugged into the PC card slot of a personal computer, the card should appear as a disk drive and the logged data will appear as a normal "DOS" type of file upon that card. To use, view or manipulate the logged data, the user can open the file using MS Excel, MS Word or any other PC software that can import a "comma separated variable" or "CSV" file type. As can be seen in the next graphic below, the STATUS and SIZE portions of the screen are filled with appropriate information when a valid memory card is inserted.

Enable / Disable Datalogging Use this menu item to start or stop the data logging function. Move the cursor over this item and press the ENTER key to toggle between Enable and Disable. If this item is toggled to Enable Datalogging, the GCS controller will commence logging the data as configured within the next menu item, Setup Datalogging. Read the next section for instructions on configuring the data logging setup.

Setup Datalogging Move the cursor to this location and press ENTER. The GCS controller will then display a screen as illustrated below. This screen is used to configure the datalogging options. After the setup is completed, the configuration is stored within non-volatile memory and is retained even in the event of a power failure. In such a case, the user need not re-enter the setup, because the GCS will re-configure itself using this

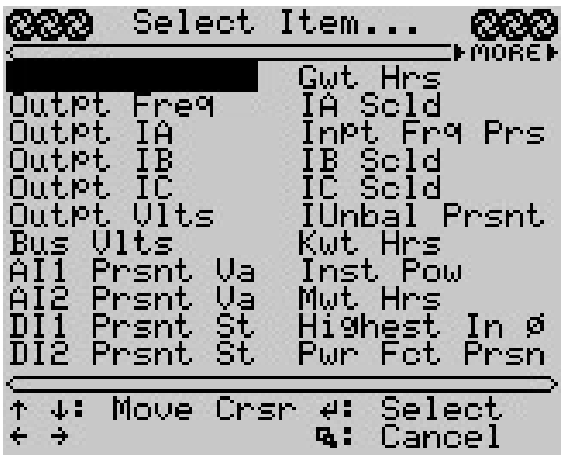
stored configuration. Note that the logging function must be disabled before access to the datalogging setup screen is allowed.



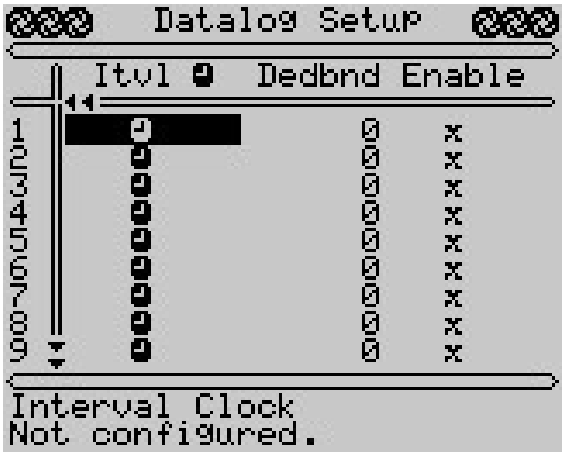
DATALOG SETUP

This screen provides the user with the ability to configure the type and frequency of data to be logged. Up to twelve data variables can be logged at intervals between 1 second and up to 99 hours, 59 minutes and 59 seconds. Each of the twelve logged data variables requires the user to enter a point identification (PID), a start time, dead band and a logging time interval. Once the datalog setup is complete, press the MENU key to exit.

Description Move the cursor to highlight one of the rows (1 through 12) in this column and press ENTER. At that point, a "Select Item…" screen will appear. Use the arrow keys to move the highlight cursor to the item to be logged and press ENTER. The selected data point is then added to the Description field for datalogging. Adjust the remaining variables, interval, dead band and Enable for that point to complete the setup.



Description (Select Item) This illustration shows the first screen of the selection list. Move the cursor to the right to display additional, selectable items. Note that if the desired item is not on this list, the Utility Menu provides an alternative method to select points for data logging. If any parameter currently selected for datalogging needs to be removed, first place the cursor on that position, press ENTER to open this screen, select the blank line at the top of the first screen and press ENTER again. That will cause the datalog entry for that line to be reset to inactive.



Itvl (Interval Time) Move the cursor to the Interval Time column and press ENTER to set the time delay between logged samples. This setpoint controls how often a data value is recorded for this data log point. The shortest interval possible is 1 second while the maximum time interval is 99 hours, 59 minutes and 59 seconds.

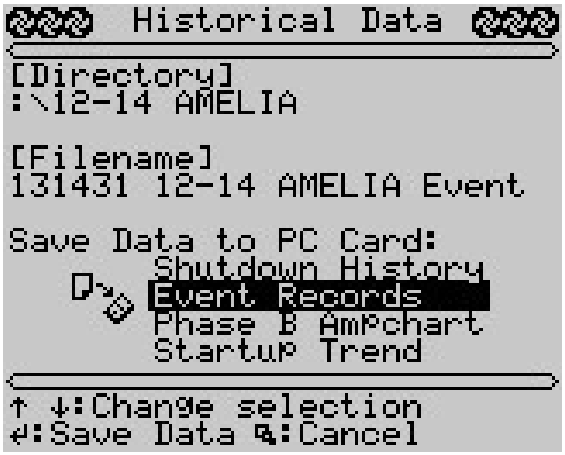
Dedbnd The dead band setting is used to help limit the total amount of data logged into the file. If the value of the point being monitored doesn't change by an amount greater than this parameter, no new data is added to the datalog file. This can be very useful when debugging troublesome installations as only the data that exceeds this setting will be recorded.

Enable This point controls whether the VORTEX controller will record (log) the data associated with the

description field. If this point displays a check mark, ✓, the data will be recorded, if it displays an X, the data will not be logged. Move the cursor to this variable and press ENTER. Next press the UP or DOWN arrow keys to toggle the value between enabled and disabled.

SAVE HISTORICAL DATA

This group of functions allows the user to copy the internal history databases to the PC memory card. Most PCMCIA card slot enabled computers can read this card and the data contained therein. All the following data files are written to the PC card in a comma separated variable (*.csv) format. The data will be written to a PC card "Windows/DOS" type file named according to the following conventions:
The file name will begin with the day of the month (1 thru 31) and the current hour and minute. If a site name has been entered, it is appended to the file name and lastly the file type identifier is added. In the example shown at left, the file name of the Event Records will be 131431 12-14 Amelia Event.CSV. In this case, because a site name has been entered, all the historical files will be written to a sub-directory on the PC Card named 12-14 Amelia. When no site name is supplied, the files are stored in the root directory of the PC Card.

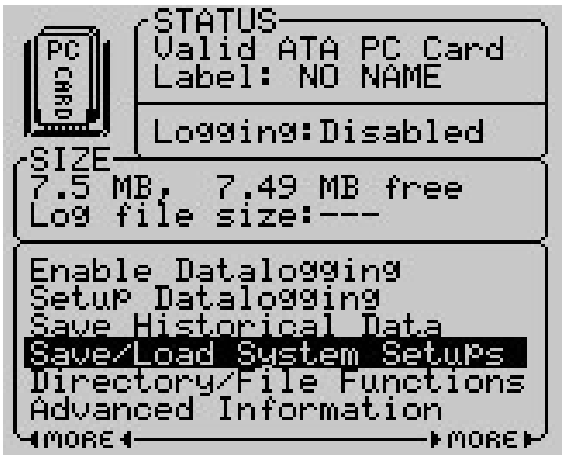


Shutdown History This function will copy the internal shutdown history database from the GCS VORTEX to the PC card.

Event History This function will copy the internal Event History database from the GCS VORTEX to the PC card.

Phase B Ampchart This function will copy the internal Phase B Ampchart data from the GCS VORTEX to the PC card.

Startup Trend This command will copy the data recorded the last time the motor was started to the PC card. This data is comprised of two seconds of voltage and current readings measured at 600 samples per second.



SAVE/LOAD SYSTEM SETUPS

The configuration of the Vortex can be recorded to the PC Memory card. This configuration can be used to archive the settings, or used to recreate these settings on another controller. Move the cursor to this location and press ENTER to access the screen shown below.

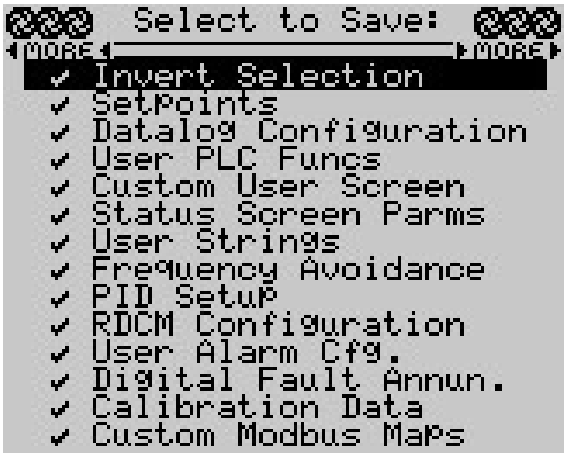
Save Setup to PC Card To save all of the settings in a GCS controller, move the cursor to this location and press enter. The screen displayed next will show the site name.

NOTE: As indicated in this illustration, reloading setpoints is not allowed while the motor is running. To upload setpoints, stop the motor first.

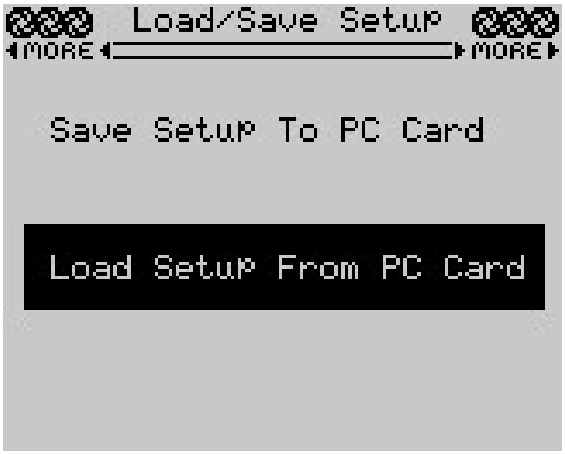
SAVE SETUP

This screen is displayed as a confirmation after the user has selected “SAVE SETUP TO PC CARD” from the previous menu. If all of the setpoints are to be saved, simply press the ENTER key at this screen and the unit will begin saving the setpoints to the PC card. While this function is in progress, the screen will show various progress indicators. Once the save is complete, the screen will revert to the main DATALOG menu.

From this menu, the user can press the RIGHT or LEFT arrow keys to access another screen that allows them to specify which of the internal setpoints will be saved. A screen similar to the next one will be displayed.



Save Setup (Select to Save) This screen allows the user to select which type of setpoints will be saved to the PC Card. If left untouched, all the setpoints will be saved. To prevent any category from being saved to the PC Card, use the arrow keys to move the cursor to that line and press ENTER. The check mark at the beginning of the line will change to an X, indicating that category will not be saved. To quickly select or deselect all the categories, toggle the All Sections menu item.
When all desired sections have been selected, press the RIGHT or LEFT arrow again to return the cursor to the "Save Setup To PC Card" menu and press ENTER.

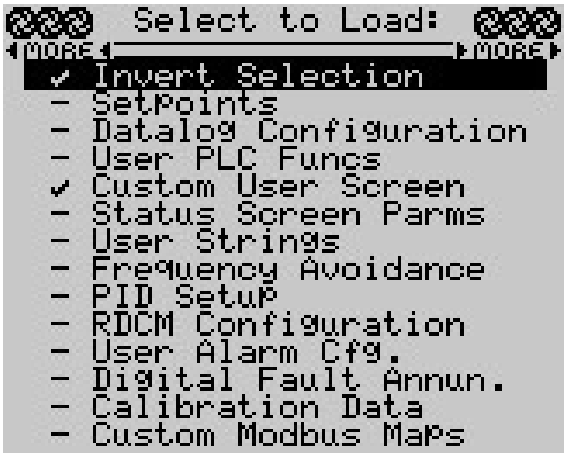


LOAD SETUP FROM PC CARD
This function is used to restore a previously saved setup or configuration from the PC Card. First save a valid setup by using the Save Setup function previously explained. With a valid saved setup on a PC Card insert it into a GCS controller, move the cursor to this position and press ENTER to proceed to the next screen shown below.

LOAD SETUP FROM PC CARD (SELECT FILE)
This screen is used to navigate the PC Card's directory structure to select a specific setup file to load. In the illustration, the cursor is highlighting the file called "181741 12-14 AMELIA setup". Press ENTER to select this file and proceed to the next screen shown below.

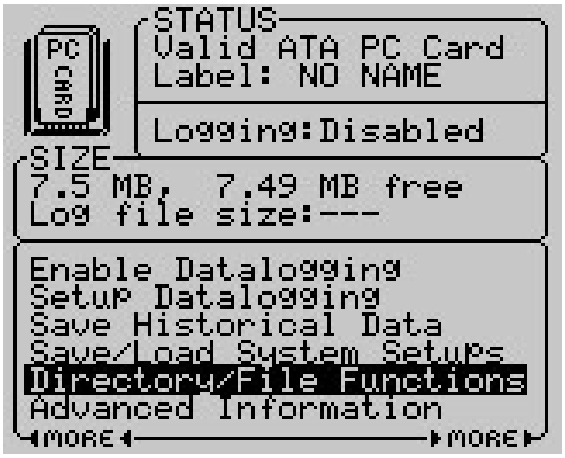
Load Setup from PC Card The GCS controller is ready to load the selected setup from the PC Card. If the complete setup is to be reloaded, press ENTER to proceed with the load. Progress indicators will show the steps taken. Once the load is complete, the screen will revert to the main DATALOG menu.

If only specific sections of the file will be loaded, press the LEFT or RIGHT arrow keys to access the section selection screen shown next.



Load Setup (Select info to Load) Use this screen to select from the available sections of the saved setup file. Move the cursor with the arrow keys to highlight an available section and press ENTER to check it. The example shown at left has only one available section, Datalog Configuration, and it is selected for loading.

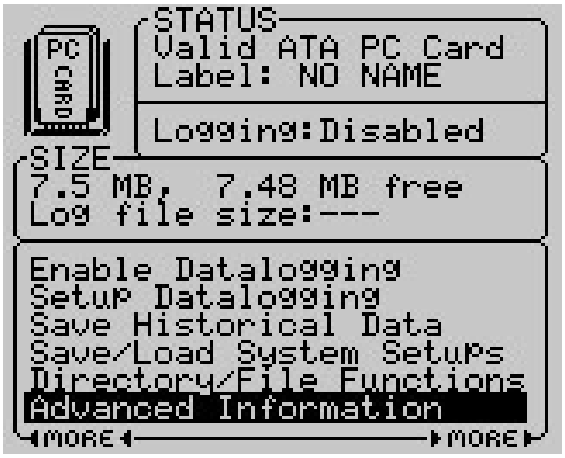
When all desired sections have been selected, press the RIGHT or LEFT arrow again to return the cursor to the “Load Setup From PC Card” menu and press ENTER.



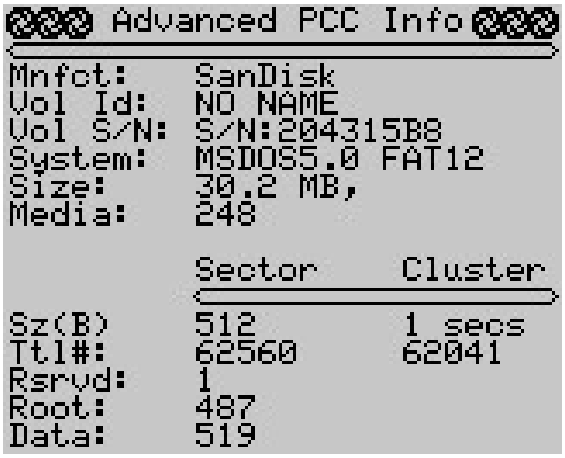
DIRECTORY / FILE FUNCTIONS
This menu item provides access to a basic directory and file manager. Press the ENTER key to display a screen similar to the next illustration.

When the Directory / File Functions menu item is selected, a screen similar to the one at left will display. It shows the cursor highlighting the sub-directory called 12-14 AMELIA. Press the ENTER key to view the contents of that directory. The file/directory creation time, date and size are displayed at the bottom of the screen.

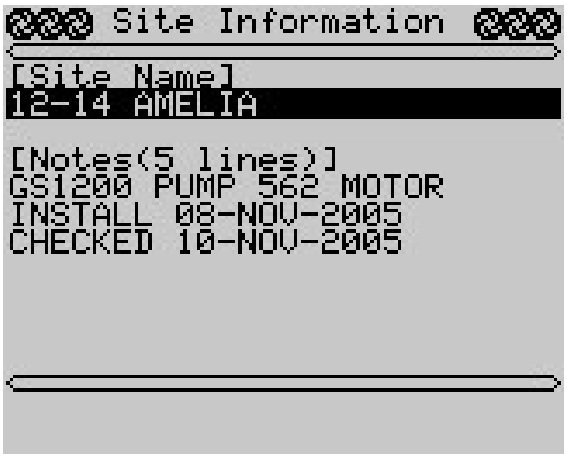
When the cursor is highlighting a file, press the RIGHT arrow key to delete it. To confirm the delete file command, press ENTER again at the prompt or press the MENU key to cancel.



ADVANCED INFORMATION
This menu item provides access to a screen displaying technical information regarding the inserted PC Card. An example screen is shown below.



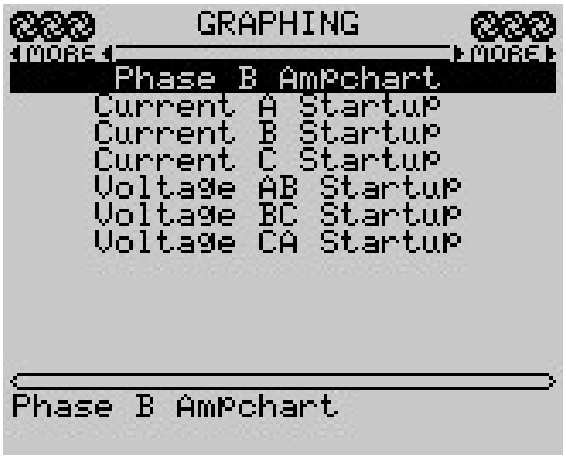
This is an example of the type of information available regarding the file system structure of the PC Card.



SITE INFORMATION

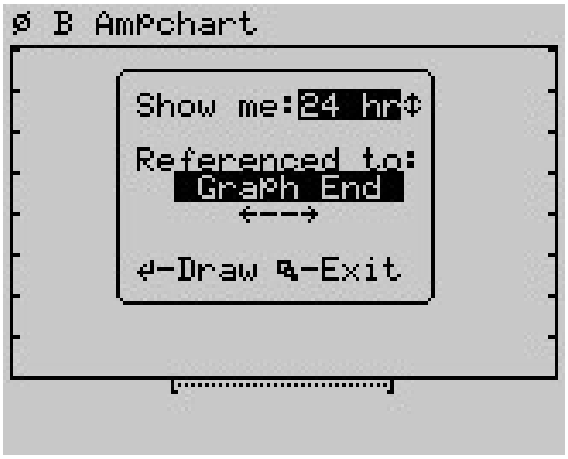
This screen is used to enter a descriptive site name and optional notes for this GCS controller. The factory default is for these entries to be blank or empty. If a site name is entered, it is used to create a sub-directory of the same name on a PC Card disk inserted into the display unit. Any historical or saved data will be stored into that sub-directory. Move the highlight cursor to one of these items and press ENTER to access the screen for data entry. The Notes section contains five lines capable of holding 20 characters each.

Information describing how to use the data entry screen can be found in the UTILITY MENU section of this manual.



GRAPHING

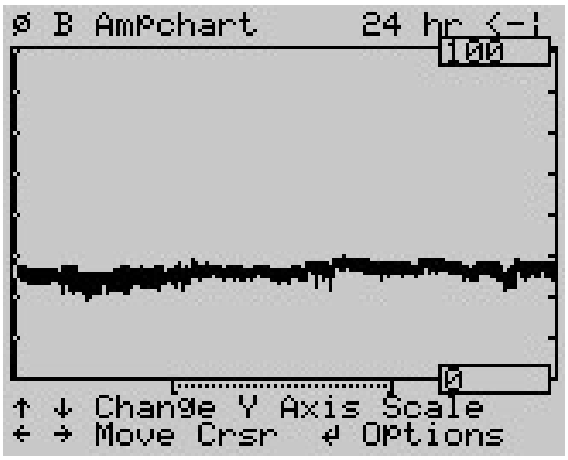
The GRAPHING group of screens gathers together all available graphing functions. To access the graphing functions screen, press the right arrow key from within the PC CARD DATALOG screen.



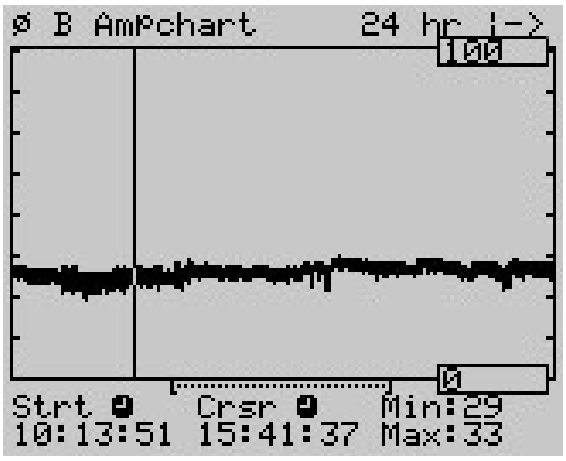
Phase B Amp Chart This time versus current graphing function serves the same function as the standard circular amp chart recorder commonly found in motor control applications. The GCS VORTEX samples the motor current on phase b of the output to the transformer / motor at a rate of 600 times per second and calculates an RMS value every 100ms. This “RMS” data is accumulated over a four minute period and the maximum, minimum and average values are calculated and recorded for use in this graph. The controller records data at this rate whenever the motor is running. When a full seven days of data have been captured, the amp chart function will begin to overwrite the oldest data with newly acquired values. In this way, the controller will always retain the data from the most recent seven day run period. This data is also available to be downloaded to a portable computer or PC card for analysis and graphing in common application programs such as MS Excel or MS Access and Lotus 123. If a valid PC memory card is inserted in the slot, the GCS VORTEX will copy the contents of the amp chart to the PC card every Sunday at midnight. This function can be used to accumulate long term amp chart data without operator intervention.

Ø B AMPCHART

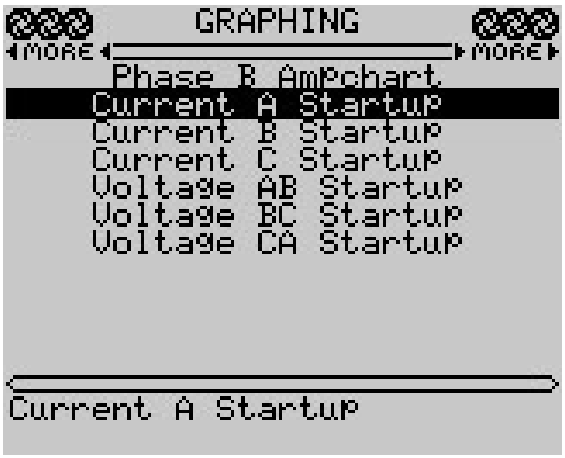
This graph screen displays the recorded ampchart data described in the previous section. Use the UP/DOWN arrow keys to select the graph duration of 12, 24, 48 hours or 1 week. Use the LEFT/RIGHT arrow keys to select the graph's starting location reference. The Referenced To: Graph Start selection causes the graph's left side axis to be set to the beginning of the data and extend forward in time for the amount set by the UP/DOWN arrow keys. The Graph End selection sets the graph's right hand axis to the present time/date. The Referenced to Cursor selection creates a graph centered on the present cursor line position extending forward and backward in time for the duration selected in the Show me: selection. Once these options are set, press the ENTER key to display the graph. The next illustration below shows a 24-hour ampchart, referenced to the beginning of the data on December 13, 2002 at 10:13:51



After the ENTER key is pressed, the Vortex will draw the graph and show the new key options at the bottom of the screen as shown below at left. Whenever the graph is being displayed, pressing the UP/DOWN arrows will change the Y axis scale up or down. Pressing the LEFT/RIGHT arrows will move the cursor left or right on the screen. To display the Options (duration and reference) screen again, press the ENTER key. To display the time date and current Minimum/Maximum values, press the LEFT or RIGHT arrow key. The graph screen will change to display the start time of the graph, the time of the present cursor position and the minimum and maximum recorded values at the cursor position. While the graph is being displayed, the Strt Time displayed represents the time/date at the left-hand axis, while the Crsr Time shows the time/date of the current cursor position. Both of these date displays will alternate between time and date at approximately one cycle per second.



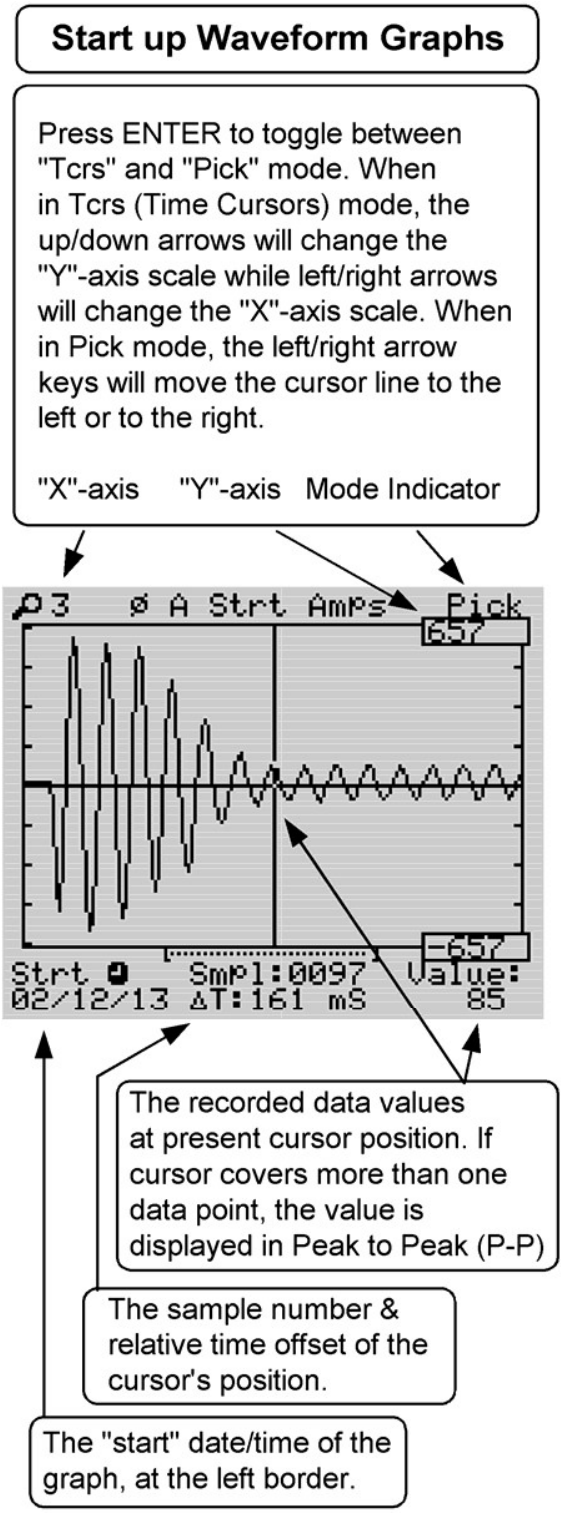
If desired, the data collected to create this graph can be transferred to a PC memory card inserted into the card slot on the graphic display unit. The command to copy the data to this card can be issued from the menu selections: DATALOG & HISTORY / DATALOG / SAVE HISTORICAL DATA / PHASE B AMPCHART



Current A Startup This menu selection will display a graph illustrating the current drawn on motor phase A during the most recent start up. The graph consists of two seconds of data recorded at 600 samples per second. Additional graphs are available for all three phases of voltage as well as phases B & C of motor current. The illustration on the next page provides a brief explanation of the graph.

Current B Startup
Current C Startup
Voltage AB Startup
Voltage BC Startup
Voltage CA Startup

All of these menu choices will display a graph similar to the one on the next page that will display the data pertinent to that phase of current or voltage.



Ø A START AMPS

This graph displays the phase A current draw recorded by the GCS VORTEX at startup time. This data is recorded at 600 samples per second for two seconds after the start attempt. It can be useful to diagnose a hard starting pump or other load based problems.

Ø B START AMPS

This graph is similar to Ø A START AMPS except that it displays current drawn on phase B.

Ø C START AMPS

This graph is similar to Ø A START AMPS except that it displays current drawn on phase C.

VOLTS AB START

This graph displays the phase AB voltage value recorded by the VORTEX at startup time. This data is recorded at 600 samples per second for two seconds after the start attempt. It can be useful to diagnose weak or overtaxed power supplies or other utility supply problems.

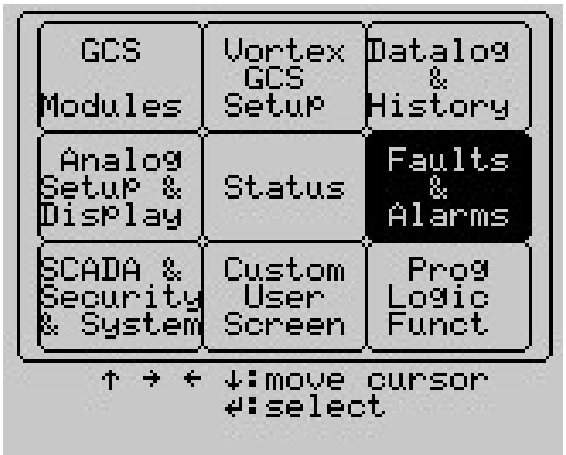
VOLTS BC START

This graph is similar to VOLTS AB START except that it displays voltage measured on phase BC.

VOLTS CA START

This graph is similar to VOLTS AB START except that it displays voltage measured on phase CA.

FAULTS & ALARMS



The FAULTS & Alarms group of screens provides access to the motor protection features within the VORTEX GCS. This menu group includes a set-up screen for each of the alarm conditions providing the user with complete control over the response of the motor controller to these occurrences. The first screen viewed after pressing ENTER at this Main Menu selection will usually be OVERLOAD.

OVERLOAD

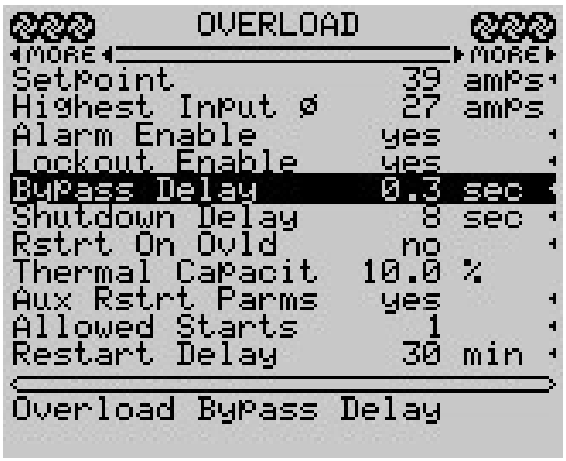
This screen contains the parameters concerning overload protection into one group. Overload alarms protect the motor from the heating effects of excessive current draw.

Setpoint The overload setpoint determines the maximum output current that can be delivered to the motor without engaging the overload routine and subsequently causing a motor shutdown. The controller uses the highest of the three phase currents to calculate the magnitude of overload. The typical setting for the overload setpoint is 0 to 20% higher than nameplate full load current, or motor nameplate current multiplied by the transformer ratio (voltage out/voltage in), when a transformer is connected between the controller and motor. Both the overload setpoint, and overload shutdown time delay should be set as low as practical for the application.

Highest Input ø This parameter displays the highest current drawn by either of the three phase leads. The overload condition is calculated upon this highest single phase of motor current. This point is not adjustable.

Alarm Enable This setpoint controls whether the controller will shutdown the motor because of an overload condition or will ignore it. Typical setting is “YES”, overload protection is enabled.

Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor due to overload. If this point is enabled and the motor is shutdown due to overload, the controller will “lockout” and prevent any further restart attempts until the condition is cleared. Typical setting is



"YES", overload shutdowns will lockout automatic restarts.

Bypass Delay Sets the number of tenths of a second that the GCS controller will ignore an overload alarm condition that is present at start-up, or occurs during this bypass period.

Shutdown Delay Sets the number of seconds that the controller will ignore an overload alarm condition that exists while the motor is running, but only after the Overload Bypass Delay timer has expired. The shutdown delay is normally the time delay in seconds before the controller shuts the motor off when the current draw exceeds the overload setpoint. In the case of Overload, this time delay is further shortened by a mathematical function that simulates motor heating effects and is established by the constant I^2T. Simply stated, the greater the overload current is, the shorter the time delay will be. In a typical submersible installation the overload time might be set for 8 seconds when the current exceeds the setpoint (100% current). Since the 100% setpoint of current represents 1 times the overload current, the I^2t constant would be $(1)^2 * 8 =$ 8 and the time delay before shutdown would then be expressed as:

I^2T CONSTANT / (MULTIPLE OF OVERLOAD CURRENT)^2 =

$8 / (1.0)^2$ = 8.0 / 1.0 = 8 seconds.

If the overload current was to reach 200%, or 2 times the overload setpoint, the time delay to shutdown would be $8/(2.0)^2 = 8/4$ or 2 seconds.
The overload time is typically set between two and eight seconds for a submersible motor and 30 to 45 seconds for conventional motors.

Rstrt on Ovld Restart on Overload programs the Overload Auxiliary Restart Parameters (ARPs) to allow the controller one automatic motor restart attempt after an Overload shutdown. All Auxiliary Restart Parameters are accessible from each individual fault and alarm setup screen. However, in the case of Overload, when Rstrt on Ovld is set to yes, the ARP for Overload is activated and the restarts set to one. The Overload Auxiliary restart time delay is not affected. The illustration at left depicts the ARP settings when this parameter is active.

Thermal Capacity This parameter displays the results of the overload calculation performed by the Vortex controller on the last start attempt. It represents the amount of thermal heating produced in the motor in percentage with respect to the total allowed heating. The total allowed capacity is determined when the user

inputs the Overload threshold and Shutdown Delay. Generally speaking, when the motor has failed to start due to an overload condition, this capacity value will exceed 100%. When the capacity remains less than 100%, the motor should be capable of starting. This reading can be used as an easy way to compare the ease with which a pump starts, especially when deployed in a well with scaling or asphaltine deposition characteristics. In these circumstances, as the scaling or deposits become thicker, the pump becomes more difficult to start. Monitoring the change in this reading over the lifetime of the pump can help to predict when acid or diluent treatments are needed.

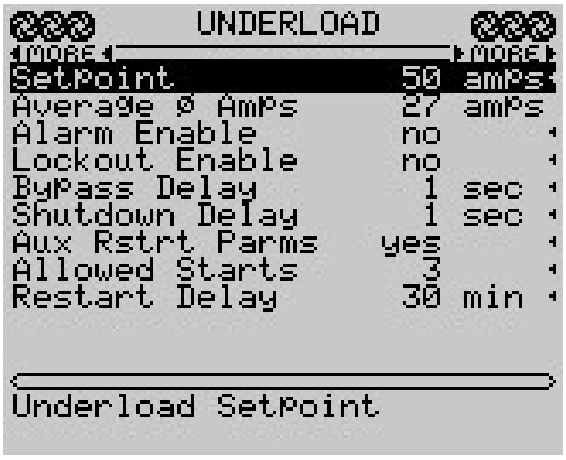
Aux Rstrt Parms Auxiliary Restart Parameters, when set to “YES”, forces the VORTEX controller to use the restart parameters listed below when it shuts down due to an Overload alarm. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to Overload and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to Overload and the Aux Rstrt Parms has been set to “YES”.

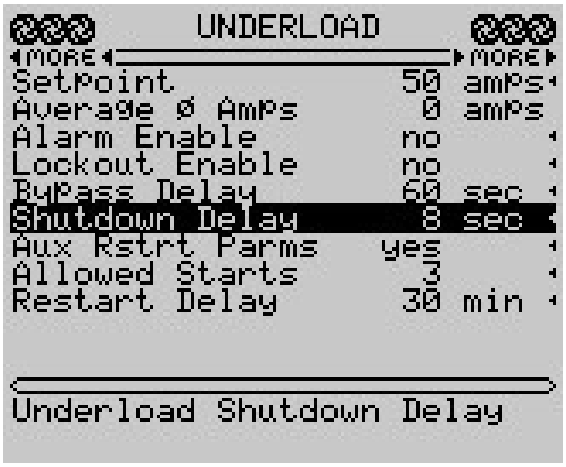
UNDERLOAD

This screen contains the parameters concerning underload protection into one group. Underload alarms protect the motor from insufficient current draw. In submersible pump applications, underload usually indicates loss of cooling due to low volumes of fluid flowing past the motor. Since an underload condition always exists before the motor is started, it is treated as a special alarm case. With any other alarm, if the Bypass Delay is zero, the GCS VORTEX will not attempt to start the motor while the alarm is active. However, in the case of underload, the VORTEX will still try to start the motor, even if the Bypass Delay is set to zero.



Setpoint The setpoint parameter must be set to the value of average motor current below which the controller will shutdown the motor. Typical setting is 15 to 20% below nominal load current.

Average ø Amps This parameter displays the average current drawn by all three phases. The underload alarm condition is calculated upon this average motor current.



This point is not adjustable and displays zero if the motor is not running or there are no 0-1 Amp AC signals available at the controller inputs.

Alarm Enable This setpoint controls whether the controller will shutdown the motor because of an underload condition or will ignore it. Typical setting is "YES", underload protection enabled.

Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor. If this point is enabled and the motor is shutdown due to underload, the controller will "lockout" and prevent any further restart attempts until the condition is cleared. Typical setting is "NO", do not lockout upon shutdown.

Bypass Delay Sets the number of seconds that the controller will ignore an underload alarm condition that is present at start-up, or occurs during this bypass period. Typical setting is 60 seconds.

Shutdown Delay Sets the number of seconds that the controller will ignore an underload alarm condition that exists while the motor is running, but only after the Underload Bypass Delay timer has expired. Typical setting is 8 seconds.

Aux Rstrt Parms Auxiliary Restart Parameters, when set to "YES", forces the VORTEX controller to use the restart parameters listed below when it shuts down due to an Underload alarm. If this parameter is set to "NO", the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to Underload and the Aux Rstrt Parms has been set to "YES".

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to Underload and the Aux Rstrt Parms has been set to "YES".

KILOWATT MONITOR

This screen provides access to the parameters controlling the power consumption alarm. The real power (Watts) used by the motor is often a more reliable indication of whether the motor is normally loaded or not. In the case of an ESP, when the motor is oversized for the pump, the actual current used may not change appreciably when the load is reduced since the drop in

efficiency (power factor) compensates for the loss of load. Use this shutdown to detect and protect against this condition and the associated motor overheating.

Inst Power This parameter displays the instantaneous power being consumed by the motor.

Lo Threshold This parameter sets the threshold under which the motor is deemed to be under-loaded and the controller will start to time down for a shutdown.

Lo Alarm Enable This setpoint controls whether the controller will shutdown the motor because of a low power consumption condition or will ignore it.

Lo Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor. If this point is enabled and the motor is shutdown due to low power consumption, the controller will "lockout" and prevent any further restart attempts until the condition is cleared. Typical setting is "NO", do not lockout upon shutdown.

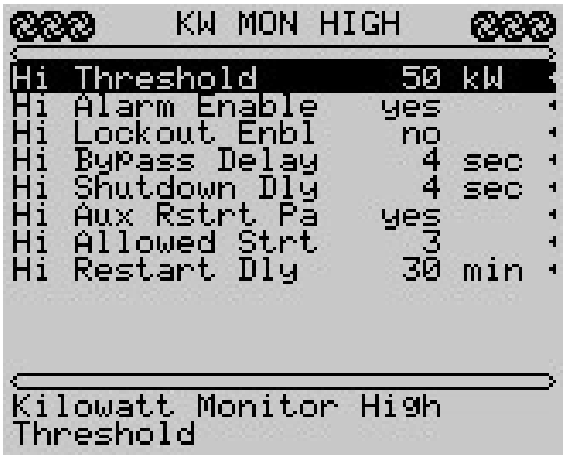
Lo Bypass Delay Sets the number of seconds that the controller will ignore a low power consumption alarm condition that is present at start-up, or occurs during this bypass period. Default setting is 4 seconds.

Lo Shutdown Delay Sets the number of seconds that the controller will ignore a low power consumption alarm condition that exists while the motor is running, but only after the Lo Bypass Delay timer has expired. Default setting is 4 seconds.

Lo Aux Rstrt Parms Lo Auxiliary Restart Parameters, when set to "YES", forces the VORTEX controller to use the restart parameters listed below when it shuts down due to a low power consumption alarm. If this parameter is set to "NO", the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to low power consumption and the Aux Rstrt Parms has been set to "YES".

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to low power consumption and the Aux Rstrt Parms has been set to "YES".



KILOWATT MONITOR HIGH

This screen accesses the parameters concerned with the high power consumption alarm. This condition usually detected and acted upon by the Overload alarm, will cause motor heating if it is not shutdown. Use this protective alarm as secondary protection in conjunction with Overload.

Hi Threshold This parameter sets the threshold over which the motor is deemed to be over-loaded and the controller will start to time down for a shutdown.

Hi Alarm Enable This setpoint controls whether the controller will shutdown the motor because of a High power consumption condition or will ignore it.

Hi Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor. If this point is enabled and the motor is shutdown due to High power consumption, the controller will "lockout" and prevent any further restart attempts until the condition is cleared. Typical setting is "NO", do not lockout upon shutdown.

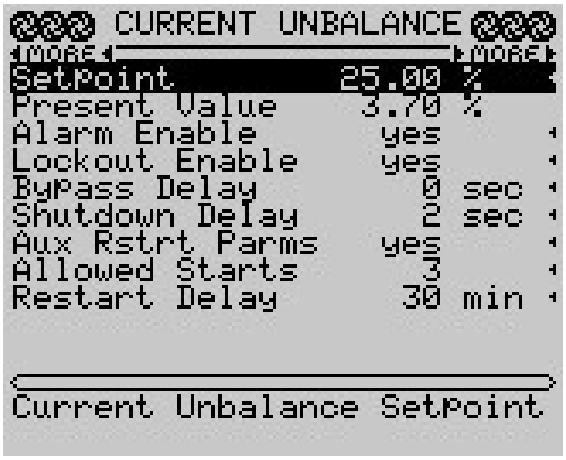
Hi Bypass Delay Sets the number of seconds that the controller will ignore a high power consumption alarm condition that is present at start-up, or occurs during this bypass period. Default setting is 4 seconds.

Hi Shutdown Delay Sets the number of seconds that the controller will ignore a high power consumption alarm condition that exists while the motor is running, but only after the Hi Bypass Delay timer has expired. Default setting is 4 seconds.

Hi Aux Rstrt Parms Hi Auxiliary Restart Parameters, when set to "YES", forces the VORTEX controller to use the restart parameters listed below when it shuts down due to a high power consumption alarm. If this parameter is set to "NO", the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to high power consumption and the Aux Rstrt Parms has been set to "YES".

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to high power consumption and the Aux Rstrt Parms has been set to "YES".



CURRENT UNBALANCE

This screen contains the parameters concerning Current Unbalance protection into one group. Current Unbalance alarms protect the motor from the heating effects of unbalanced currents.

Setpoint The Current Unbalance setpoint parameter must be set to the percentage value of motor current unbalance above which the controller will shutdown the motor. Typical setting is 25%

Present Value This parameter displays the present percentage value of current unbalance. This percentage is defined as the maximum deviation of any one phase current from the average value of all three phases. The current unbalance alarm condition is calculated upon this percentage of deviation. This point is not user adjustable.

Alarm Enable This setpoint controls whether the controller will shutdown the motor because of a current unbalance condition or will ignore it. Typical setting is “YES”, current unbalance protection enabled.

Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor due to current unbalance. If this point is enabled under those conditions the controller will “lockout” and prevent any further restart attempts until the condition is cleared. Typical setting is “YES”, lockout automatic restarts upon shutdown.

Bypass Delay Sets the number of seconds that the GCS controller will ignore a current unbalance alarm condition that is present at start-up, or occurs during this bypass period. Typical setting is 0 seconds or no bypass delay.

Shutdown Delay Sets the number of seconds that the controller will ignore a current unbalance alarm condition that exists while the motor is running, but only after the Current Unbalance Bypass Delay timer has expired. Typical setting is 2 seconds.

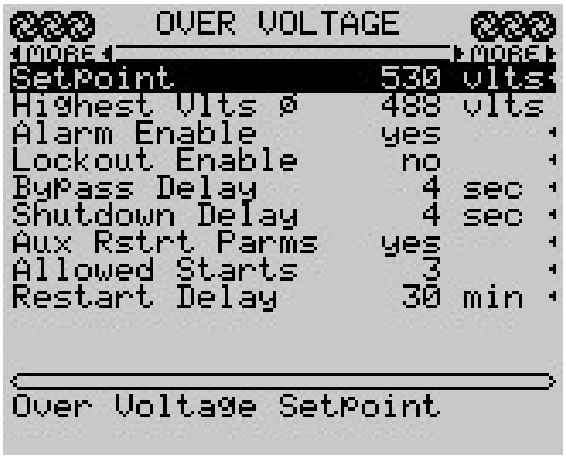
Aux Rstrt Parms Auxiliary Restart Parameters, when set to “YES”, forces the VORTEX controller to use the restart parameters listed below when it shuts down due to a Current Unbalance alarm. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller

has shutdown due to Current Unbalance and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to Current Unbalance and the Aux Rstrt Parms has been set to “YES”.

OVER VOLTAGE



This screen contains the parameters concerning Over Voltage protection into one group. Over Voltage alarms protect the motor from the heating effects of larger currents that will ensue from a higher voltage.

Setpoint The Over Voltage setpoint parameter must be set to the value of input voltage above which the controller will shutdown the motor. Typical setting is 10% above motor nameplate rating.

Highest Vlts ø This parameter displays the highest of the incoming voltage phases. The Over Voltage alarm condition is calculated upon this value. This point is not user adjustable.

Alarm Enable This setpoint controls whether the controller will shutdown the motor because of an Over Voltage condition or will ignore it. Typical setting is “YES”, Over Voltage protection enabled.

Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor due to Over Voltage. If this point is enabled and the motor is shutdown due to Over Voltage, the controller will “lockout” and prevent any further restart attempts until the condition is cleared. Typical setting is “NO”, so not lockout automatic restarts upon shutdown.

Bypass Delay Sets the number of seconds that the GCS controller will ignore an Over Voltage alarm condition that is present at start-up, or that occurs during this bypass period. Typical setting is 4 seconds.

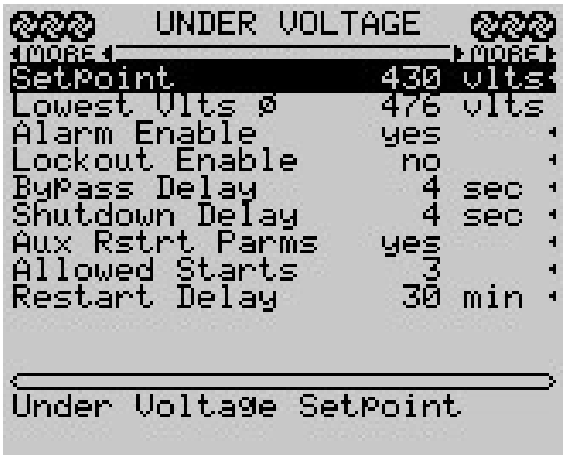
Shutdown Delay Sets the number of seconds that the controller will ignore an Over Voltage alarm condition that exists while the motor is running, but only after the Over Voltage Bypass Delay timer has expired. Typical setting is 2 seconds.

Aux Rstrt Parms Auxiliary Restart Parameters, when set to “YES”, forces the VORTEX controller to use the restart parameters listed below when it shuts down due to an Over Voltage alarm. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart

parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to Over Voltage and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to Over Voltage and the Aux Rstrt Parms has been set to “YES”.



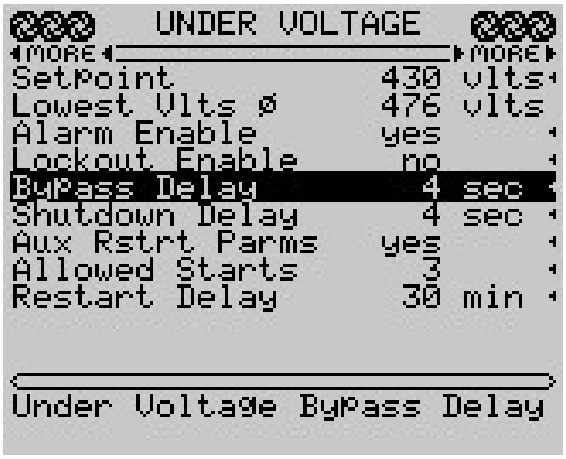
UNDERVOLTAGE

This screen contains the parameters concerning under voltage protection into one group. Under voltage alarms protect the motor from the heating effects that occur when the motor current rises in response to low input voltage.

Setpoint The Under Voltage setpoint parameter must be set to the value of input voltage below which the controller will shutdown the motor. Typical setting is 10% below motor nameplate voltage rating.

Lowest Vlts ø This parameter displays value of the lowest phase voltage of all three input phases. The under voltage alarm condition is calculated upon this lowest value. If the GCS VORTEX controller is being operated without the optional second voltage monitoring transformer, the controller will use the value of phase CA voltage only in determining under voltage. This point is not user adjustable.

Alarm Enable This setpoint controls whether the controller will shutdown the motor because of an under voltage condition or will ignore it. Typical setting is “YES”, under voltage protection enabled.



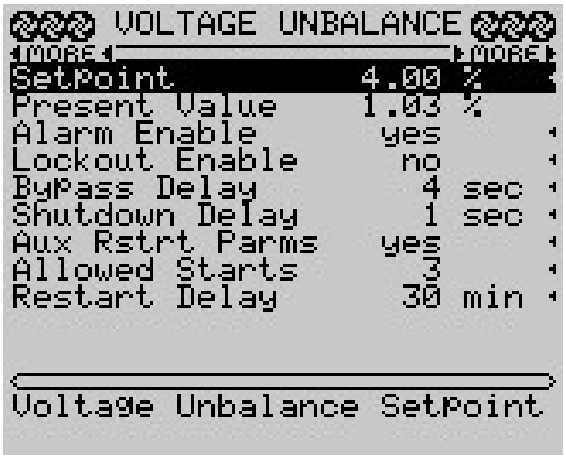
Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor due to under voltage. If this point is enabled and the motor is shutdown due to under voltage, the controller will “lockout” and prevent any further restart attempts until the condition is cleared. Typical setting is “NO”, do not lockout automatic restarts upon shutdown.

Bypass Delay Sets the number of seconds that the GCS controller will ignore an Undervoltage alarm condition that is present at start-up, or occurs during this bypass period. Typical setting is 4 seconds.

Shutdown Delay Sets the number of seconds that the controller will ignore a under voltage alarm condition that

exists while the motor is running, but only after the Under Voltage Bypass Delay timer has expired. Typical setting is 4 seconds. The shutdown delay is normally the time delay in seconds before the controller shuts the motor off when the alarm condition exists. However, in the case of Undervoltage, this time delay is further shortened by a mathematical function that simulates motor heating effects and is established by the constant T/V^2. Simply stated, the lower the input voltage is, the shorter the time delay will be. In a typical submersible installation the under voltage time delay might be set for 4 seconds when the voltage falls below the setpoint (100% under voltage). Since the under voltage setpoint equals 1 times the undervoltage level, the T/V^2 constant would be $4/(1)^2 = 4$. The time delay before shutdown would then be : **(T / V^2CONSTANT) / (Multiple of Undervoltage Setpoint)^2** or **$4/1^2$** = 4 seconds. If the under voltage was to reach 200%, or 2 times the under voltage setpoint, the time delay to shutdown would be $4/(2.0)^2 = 4/4$ or 1.00 seconds. The under voltage time is typically set between two and eight seconds for a submersible motor, and 30 to 45 seconds for conventional motors.

Aux Rstrt Parms Auxiliary Restart Parameters, when set to “YES”, forces the VORTEX controller to use the restart parameters listed below when it shuts down due to an Undervoltage alarm. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

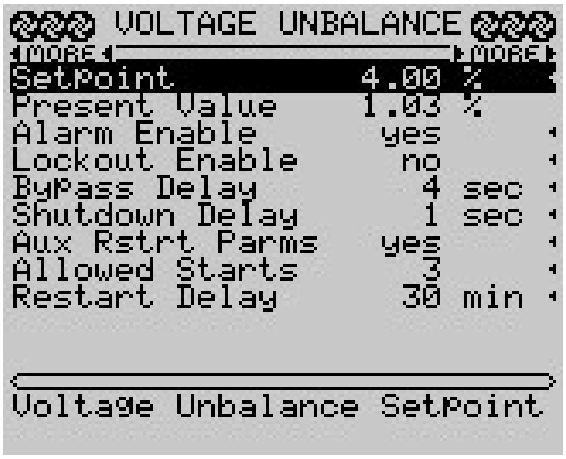


Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to Undervoltage and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to Undervoltage and the Aux Rstrt Parms has been set to “YES”.

VOLTAGE UNBALANCE

This screen contains the parameters concerning Voltage Unbalance protection into one group. The Voltage Unbalance alarm protects the motor from the heating effects of unbalanced phase voltages. This protection is only available when two 120VAC nominal output control voltage transformers connected to the phases AB and CA of the utility power supply are installed. The outputs of these transformers are connected to the 120VAC (Phase CA), 120VAC (Phase AB) and Neutral terminals of the VORTEX GCS.



Setpoint The Voltage Unbalance setpoint parameter must be set to the percentage value of motor voltage unbalance above which the controller will shutdown the motor. Typical setting is 4 to 10%

Present Value This parameter displays the present percentage value of Voltage Unbalance. This percentage is defined as the maximum deviation of any one phase voltage from the average value of all three phases. The Voltage Unbalance alarm condition is calculated upon this percentage of deviation. This point is not user adjustable.

Alarm Enable This setpoint controls whether the controller will shutdown the motor because of a Voltage Unbalance condition or will ignore it. Typical setting is “YES”, Voltage Unbalance protection enabled.

Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor due to Voltage Unbalance. If this point is enabled and the motor is shutdown due to Voltage Unbalance, the controller will “lockout” and prevent any further restart attempts until the condition is cleared. Typical setting is “NO”, do not lockout automatic restarts upon shutdown.

Bypass Delay Sets the number of seconds that the GCS controller will ignore a Voltage Unbalance alarm condition that is present at start-up, or occurs during this bypass period. Typical setting is 4 seconds.

Shutdown Delay Sets the number of seconds that the controller will ignore a Voltage Unbalance alarm condition that exists while the motor is running, but only after the Voltage Unbalance Bypass Delay timer has expired. Typical setting is 1 second.

Aux Rstrt Parms Auxiliary Restart Parameters, when set to “YES”, forces the VORTEX controller to use the restart parameters listed below when it shuts down due to a Voltage Unbalance alarm. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to Voltage Unbalance and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to Voltage Unbalance and the Aux Rstrt Parms has been set to “YES”.

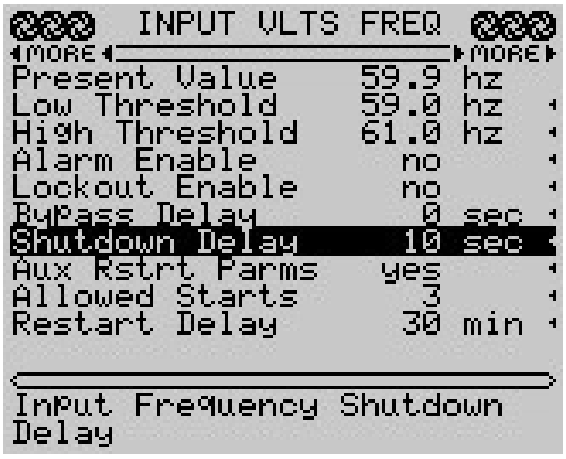
INPUT VOLTAGE FREQUENCY

The Input Voltage Frequency screen displays the setpoints pertaining to frequency deviation alarm protection. When operating ESP's from some power supplies, generator sets in particular, the frequency of the voltage available to the motor can vary quite widely. Since the rotational speed of the motor and horsepower are proportional to the power frequency, it could be necessary to shutdown the motor during severe deviations from normal.

Present Value This variable represents the currently measured frequency of the input voltage available at the VCA and Neutral terminals of the GCS VORTEX controller. This parameter is not editable.

Low Threshold This parameter represents the lowest allowable power frequency. Typical setting is 1 or 2 Hertz below the normal frequency.

High Threshold This parameter represents the highest allowable power frequency. Typical setting is 1or 2 Hertz above normal operating frequency.



Alarm Enable This setpoint controls whether the GCS VORTEX will shutdown the motor due to an Input Voltage Frequency alarm. If set to "YES", the shutdown delay processing will begin when the power frequency deviates outside of the limits represented by the high and low thresholds.

Lockout Enable This parameter determines if the controller will assume a lockout condition and prevent automatic restarts when a shutdown occurs due to a Input Voltage Frequency alarm. Typical setting is "NO".

Bypass Delay sets the number of seconds that the GCS controller will ignore an input voltage frequency alarm condition that is present at start-up, or occurs during this bypass period. Typical setting is 0 seconds which effectively prevents start attempts when an alarm exists.

Shutdown Delay sets the number of seconds that the controller will ignore an input voltage frequency alarm condition that exists while the motor is running, but only after the input voltage frequency Bypass Delay timer has expired. Typical setting is 10 seconds.

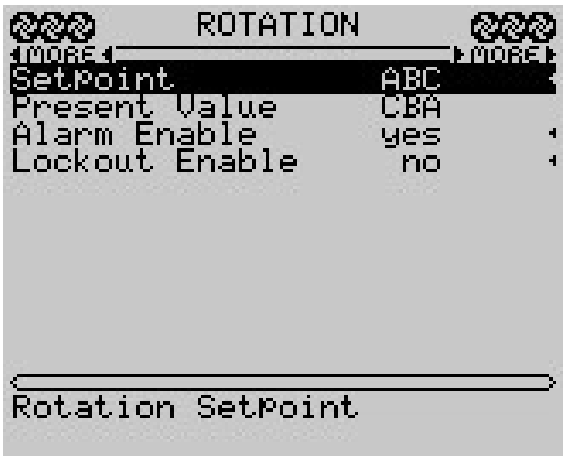
Aux Rstrt Parms Auxiliary Restart Parameters, when set to "YES", forces the VORTEX controller to use the restart parameters listed below when it shuts down due to an input voltage frequency alarm. If this parameter is set to "NO", the controller will use the global restart

parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to an input voltage frequency alarm and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to an input voltage frequency alarm and the Aux Rstrt Parms has been set to “YES”.

ROTATION



The Rotation screen displays the setpoints and variables pertaining to incoming voltage phase rotation alarms. A synchronous electric motor will rotate in the same direction as its poly-phase power supply. In ESP applications this rotation also determines the pump’s rotation. Since submersible pumps are typically most efficient in one specific direction, it is very important to first determine the correct rotation for the pump and subsequently guard against a change in this incoming phase rotation. Upon installation, the service technician installing the pump will determine correct rotation. This alarm point can then detect a change to that input rotation and prevent the motor from starting.

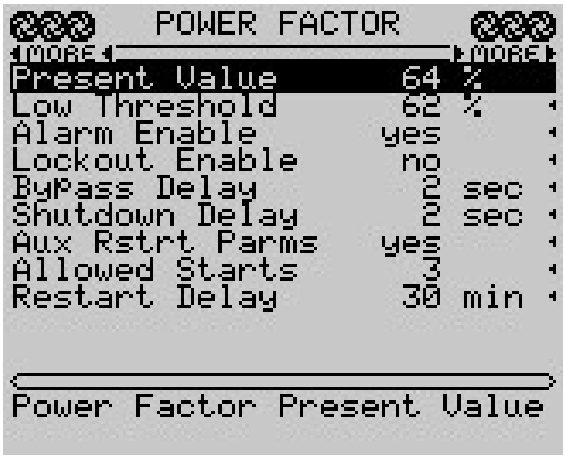
Setpoint The rotation setpoint represents the incoming voltage phase rotation that will cause an alarm. After the service technician determines the proper rotation for the pump, this parameter should be set to the opposite value that is displayed in the Present Value parameter. If the present value matches this setpoint and the alarm is enabled, the controller will shutdown the motor and prevent restarts.

Present Value This parameter represents the current incoming voltage phase rotation detected by the VORTEX GCS. As previously stated, the motor will be connected to provide proper rotational direction when it is supplied with this power. If for any reason the incoming phase rotation changes to the opposite value, the GCS VORTEX controller will shutdown the motor or prevent any restarts if already stopped.

Alarm Enable This variable controls whether the controller will detect and act upon a rotation alarm condition. Set it to “YES” to detect and Alarm, “NO” to ignore the condition. If only single-phase voltage inputs are available to the controller, this alarm should be left disabled.

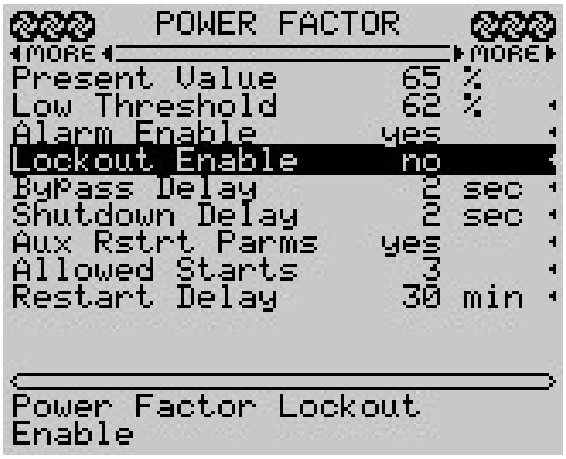
Lockout Enable Lockout Enable controls whether the controller will assume a lockout condition when a shutdown occurs because of a rotation alarm.

POWER FACTOR



This screen contains the parameters concerning Power Factor measurement into one group. Power Factor alarms can be used to protect a motor from the loss of its load. In submersible pump applications, a large decline in power factor usually indicates a broken pump shaft or low fluid levels above the pump. In either case, the loss of fluid flow, which is the primary motor coolant, will result in motor overheating and eventually damage. In the case of a fully loaded ESP motor, the motor current will typically fall dramatically during an underload condition. However, when an ESP motor is lightly loaded, the motor current may not change appreciably during underload. In this instance, a drop of power factor is a more reliable indication of loss of load.

Present Value This parameter represents the currently measured displacement power factor. This displacement power factor is calculated by measuring the phase angle difference between the current and voltage on the same phase. The phase of current that is used must be set in the GCS VORTEX SETUP menu under the heading of C.T. Phase.



Threshold This parameter sets the lowest allowable power factor. A fully loaded ESP motor will typically have a power factor of above 80%. A no load condition will typically be below 50%. A setting of 65% would represent a good compromise of alarm sensitivity.

Alarm Enable This setpoint controls whether the controller will shutdown the motor because of a low power factor condition or will ignore it.

Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor. If this point is enabled and the motor is shutdown due to Power Factor, the controller will “lockout” and prevent any further restart attempts until the condition is cleared. Typical setting is “NO”, do not lockout upon shutdown.

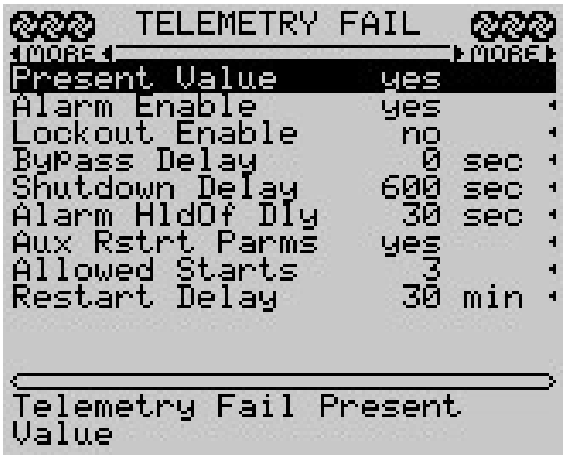
Bypass Delay Sets the number of seconds that the controller will ignore a Power Factor alarm condition that is present at start-up, or occurs during this bypass period. Since a motor exhibits a power factor of 0% when it is not running, a bypass delay must be entered to allow the motor to start. Typical setting is 2 to 60 seconds.

Shutdown Delay Sets the number of seconds that the controller will ignore a Power Factor alarm condition that exists while the motor is running, but only after the Power Factor Bypass Delay timer has expired. Typical setting is 2 to 8 seconds.

Aux Rstrt Parms Auxiliary Restart Parameters forces the VORTEX controller to use the restart parameters listed below when it shuts down due to a Power Factor alarm. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to Power Factor and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to Power Factor and the Aux Rstrt Parms has been set to “YES”.



TELEMETRY FAIL

This alarm screens allows access to the parameters associated with a Telemetry Failure alarm. This type of alarm can be useful when the GCS VORTEX controller is connected to telemetry or a SCADA system and the pump must not be allowed to operate during a communications failure. An example application of this protection could be to shutdown a water source well used to feed a process facility when the communication and control system in the facility fails.

Present Value This data variable displays the current status of the Telemetry Failure alarm. If this point reads “YES” and the alarm is enabled, the controller will shut down the motor after the associated time delays have expired. An alarm is considered to be present when the controller is not actively receiving or transmitting a message. Therefore, when enabled, the present value will change from “YES” to “NO” when it is actively communicating. The associated time delays discussed below allow the user to adjust the length of time before any action is taken due to this alarm.

Alarm Enable This setpoint controls whether this telemetry alarm will cause the controller to shutdown the motor when a communications alarm occurs.

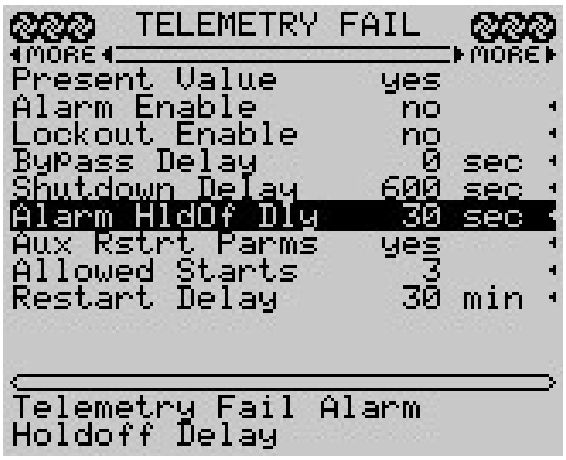
Lockout Enable This setpoint controls whether the controller will or will not attempt an automatic restart when the motor has been shutdown because of a telemetry alarm. If it is set to “YES” and a telemetry

alarm shutdown occurs, the controller will “lockout” and prevent any further start attempts.

Bypass Delay This setpoint represents the amount of time in seconds that the controller will ignore an existing telemetry alarm after a start.

Shutdown Delay This parameter represents the amount of time in seconds that the controller will allow a telemetry alarm to exist before shutting down the motor. This alarm time should be set to slightly longer than the total cycle time of the host SCADA computer. For example, if the SCADA host scans this particular controller every nine minutes, the alarm could be set to 600 seconds or 10 minutes. If the host SCADA system does not communicate with this controller within that time delay, its motor will be shutdown automatically.

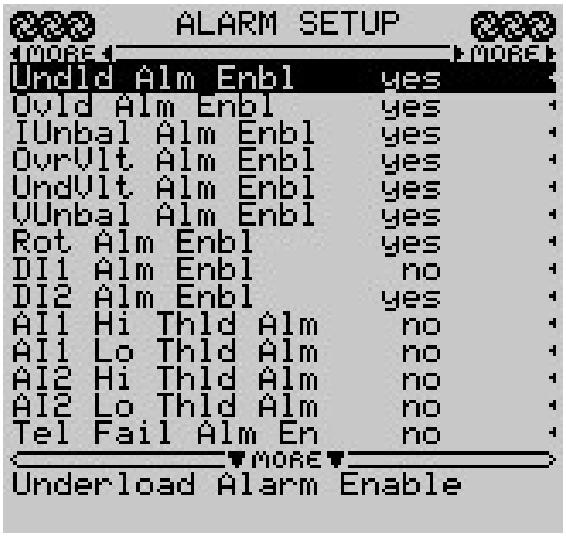
Alarm HldOff Dly The Alarm Hold Off Delay parameter controls whether the controller will allow the motor to be started even though the telemetry alarm exists. With the exception of Underload, all other controllable alarms within the VORTEX controller will allow a restart attempt if a non-zero Bypass time delay is set. In the case of telemetry alarms, it is usually not desirable to allow this start attempt if the alarm exists since the motor will likely be shutdown after the Bypass and Shutdown delays expire. Therefore, the Telemetry Fail alarm control chain contains this unique Hold Off delay. The controller must “hear” communications traffic for itself or for any RTU address or station on the telemetry system within this delay’s time period before it will attempt to start the motor. If valid communications messages exist, it is assumed that a telemetry system is in place and is functioning. Note that unlike the Bypass and Lockout time delays, this timer is re-triggered by any data traffic, not only messages destined for this unit.



Aux Rstrt Parms When set to “YES”, the Auxiliary Restart Parameters setpoint causes the VORTEX controller to use the restart parameters listed below when it shuts down due to a Telemetry Fail alarm. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to Telemetry Fail and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to Telemetry Fail and the Aux Rstrt Parms has been set to “YES”.



ALARM SETUP

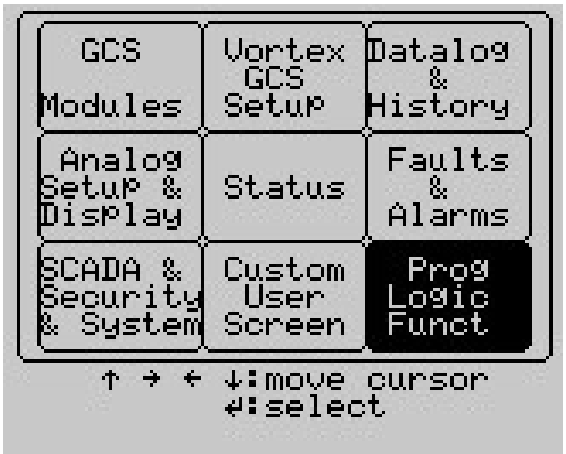
The alarm setup screen is provided as a convenience to the user where most of the alarm conditions that can be enabled or disabled are presented within one screen. The user can easily determine which alarms are enabled or not. Some of the alarm conditions listed are only available when the optional hardware sensors are installed. If these options are not installed, those alarms should be left disabled. This list only allows access to enable or disable the alarms. If further modification of the alarm thresholds and time delays are necessary, use the individual alarm setup screens.

These screens can be found under the FAULTS & ALARMS menus.

Undld Alm Enbl	Underload Alarm Enable
Ovld Alm Enbl	Overload Alarm Enable
IUnbal Alm Enbl	Amps Unbalance Alarm Enable
OvrVlt Alm Enbl	Overvoltage Alarm Enable
UndVlt Alm Enbl	Undervoltage Alarm Enable
Vunbal Alm Enbl	Voltage Unbalance Alarm Enable
Rot Alm Enbl	Rotation Alarm Enable
Tel Fail Alm En	Telemetry Failure Alarm Enable

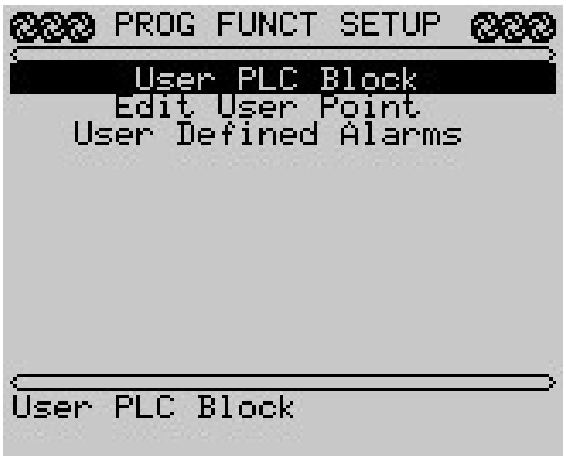
These Alarm configuration screens are found via the GCS MODULES / ONBOARD I/O menus

DI1 Alm Enbl	Digital Input 1 Alarm Enable
DI2 Alm Enbl	Digital Input 2 Alarm Enable
AI1 Hi Thld Alm	Analog Input 1 High Threshold Alarm Enable
AI1 Lo Thld Alm	Analog Input 1 Low Threshold Alarm Enable
AI2 Hi Thld Alm	Analog Input 2 High Threshold Alarm Enable
AI2 Lo Thld Alm	Analog Input 2 Low Threshold Alarm Enable



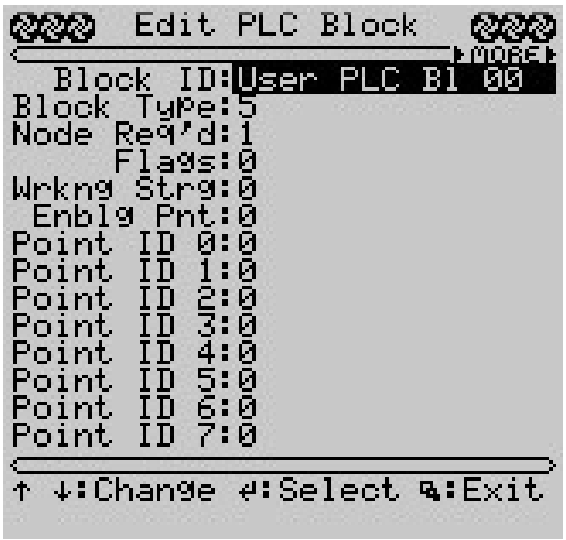
PROGRAMMABLE LOGIC FUNCTIONS

The programmable logic functions group of screens provides access to the custom programming functions of the VORTEX GCS. As features and functions become available, they will be distributed as software field upgrades, and will be access via these menus.



PROGRAMMABLE FUNCTION SETUP

User PLC Block The User PLC Block menu gives user access to the execution control block that drives the programmable logic function controller. Using the functions provided, the user can create custom, unique control algorithms that are not available within the standard controller. Please refer to the GCS Programmable Functions Application Guide for further information.



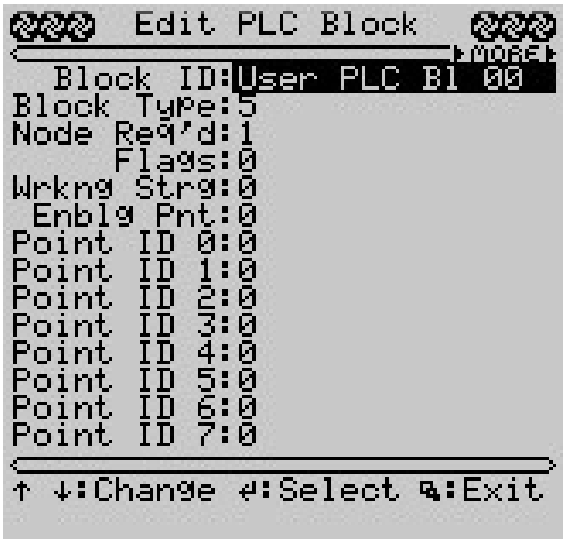
EDIT PLC BLOCK

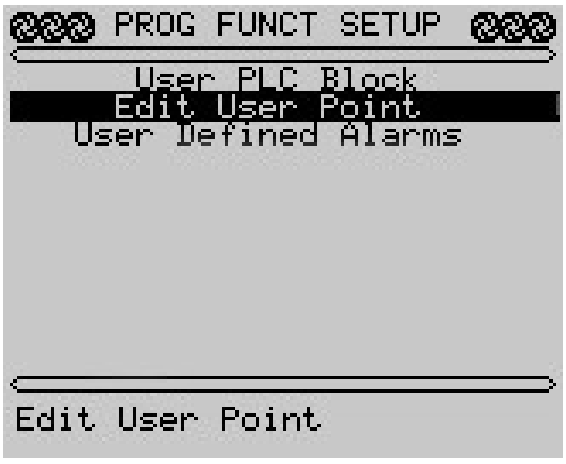
The Edit PLC Block screen allows the user to enter or edit any of the PLC Block variables. There are 48 User PLC Blocks available, numbered 1 through 48. When identified within a User PLC point, the blocks are identified by their database address number with block number one equaling address 99, block number two equaling address 98, and so on. The last PLC block available is block number 48, at address 52.

Block ID The Block ID variable indicates which PLC Block is presently shown on the screen. The illustration shows User PLC Block #01 displayed. Move the cursor to highlight this item and press the left/right arrow keys to show the last/next block

Block Type The User PLC block type determines what type of function this block will perform. Block Type 5 is general purpose

Node Req'd The Node Required variable is reserved for future use.





Flags The Flags variable controls execution of the PLC block. If the block is enabled and functioning it will be set to a two. Zero disabled execution of the PLC Block.

Wrkng Strg Working Storage is a variable used internally by the GCS controller.

Enblg Pnt Enabling Point is used to allow / disallow execution of a User PLC block that is configured as a user alarm control block. Enter the Point ID number of a stock, enabled alarm chain to activate this PLC block. When the named alarm chain is enabled, this User PLC block will also be enabled and processed.

Point ID 0 Point ID 0 holds the user database point number of the first point to execute. Valid entries are point ID 4095 through point ID 3840. The User PLC routine will execute any points listed before the point ID with a zero value. If valid point ID's exist in any subsequent point ID's, they will not be executed.

Point ID 1 Point ID 1 holds the user database point number of the second point to execute. Valid entries are point ID 4095 through point ID 3840.

Point ID 2 Point ID 2 holds the user database point number of the third point to execute. Valid entries are point ID 4095 through point ID 3840.

Point ID 3 Point ID 3 holds the user database point number of the fourth point to execute. Valid entries are point ID 4095 through point ID 3840.

Point ID 4 Point ID 4 holds the user database point number of the fifth point to execute. Valid entries are point ID 4095 through point ID 3840.

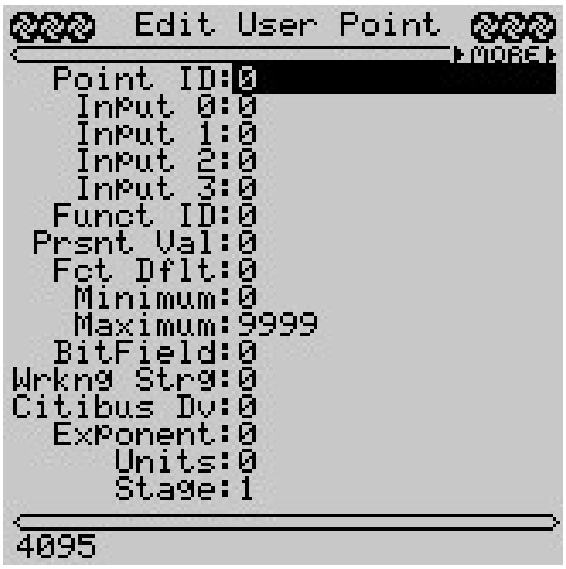
Point ID 5 Point ID 5 holds the user database point number of the sixth point to execute. Valid entries are point ID 4095 through point ID 3840.

Point ID 6 Point ID 6 holds the user database point number of the seventh point to execute. Valid entries are point ID 4095 through point ID 3840.

Point ID 7 Point ID 7 holds the user database point number of the eighth point to execute. Valid entries are point ID 4095 through point ID 3840.

EDIT USER POINT

The Edit User Point menu, in conjunction with the User PLC Block menus, provides access to the user database points used to perform calculations and logical functions.



Point ID The Point ID variable is used to identify which database point is being displayed or edited. Move the cursor to this location and press the left / right arrow keys to display the previous / next User database point. Press the ENTER key to be allowed to enter the actual point number of any User point. The GCS controller has 256 User Database points available. The number at the bottom of the screen, 4095 in this case, is the identifying address number for this point. To refer to this point, “Point ID 0” from within a User PLC routine, use the address 4095.

Input 0 This variable is used to indicate the first point ID that will be used by this User PLC function. This point can be set to the number of any of the available database points in the GCS controller and is not limited to the 256 user database point addresses. A complete list of addressable database points is available in the applications guide.

Input 1 This variable is used to indicate the second point ID that will be used by this User PLC function. This point can be set to the number of any of the available database points in the GCS controller and is not limited to the 256 user database point addresses.

Input 2 This variable is used to indicate the first point ID that will be used by this User PLC function. This point can be set to the number of any of the available database points in the GCS controller and is not limited to the 256 user database point addresses.

Input 3 This variable is used to indicate the first point ID that will be used by this User PLC function. This point can be set to the number of any of the available database points in the GCS controller and is not limited to the 256 user database point addresses.

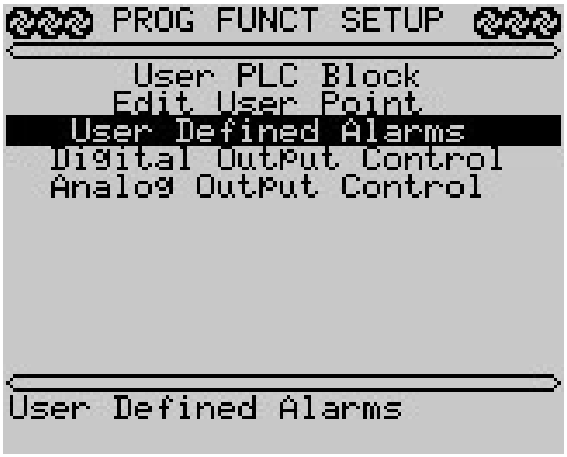
Funct ID The function ID variable holds the number identifier of the required function. These functions are listed in the GCS Programmable Functions Application Guide.

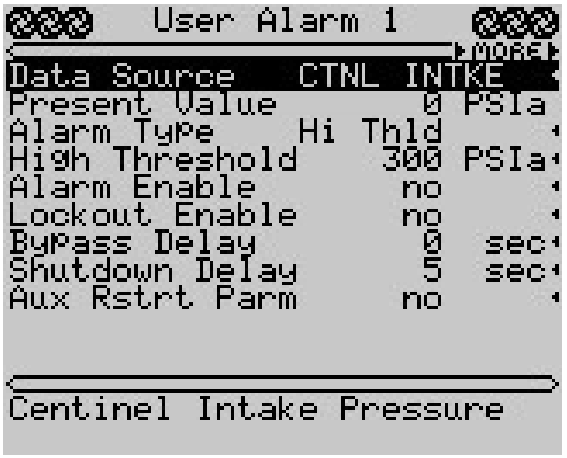
Prsnt Val The Present Value parameter contains the current numerical value of this point.

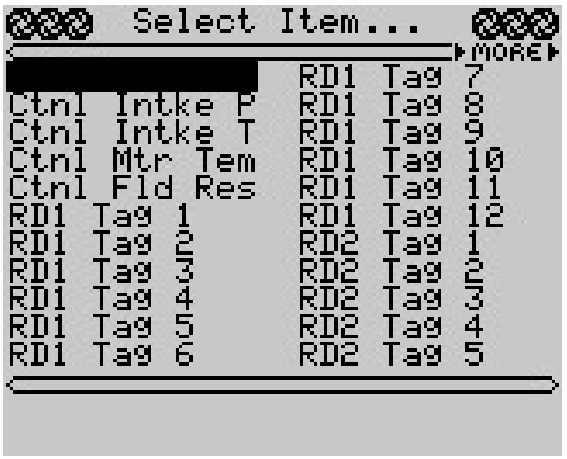
Fct Dflt The Factory default of the present value for this user database point is held in this variable.

Minimum The minimum value of this user database point.

Maximum The maximum value of this user database point.







Bitfield The bitfield variable contains a bit-coded value that classifies the database point according to the value contained. The GCS Programmable Functions Application Guide describes the available settings.

Wrkng Strg Working Storage is a variable used internally by the GCS controller.

CITIBus Dv Reserved / Not implemented at this time.

Exponent The exponent variable defines the location of the decimal point in the present value of this point. A "-1" means the value is divided by ten, "-2" means the value is divided by one hundred.

Units The units variable can be used to assign a label to the value represented by the point.

Stage Reserved / Not implemented at this time.

USER DEFINED ALARMS

The User Defined Alarms menu provides access to eight configurable alarms. Any number of these alarms can be activated and used to cause a motor shutdown if the defined conditions exist.

USER ALARM 1

This menu screen accesses all of the data controlling User Alarm 1. Eight identical, assignable alarm processing chains exist in the GCS controller. Only User Alarm 1 is explained in detail, since all eight alarms are configured in the same fashion as this one. Currently, the data source inputs include the Centinel down hole gauge and the Remote Data Communication Module (RDCM) unit's readings.

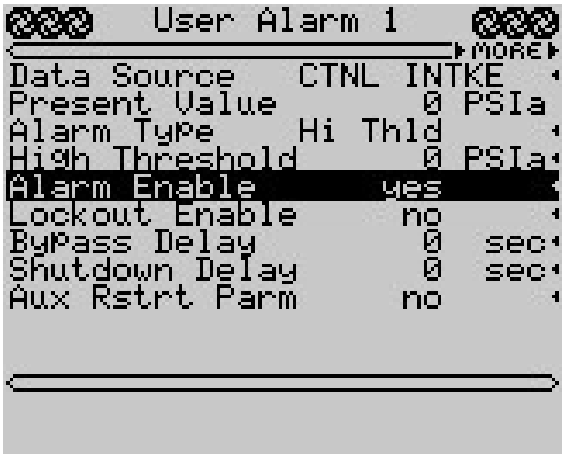
Data Source This parameter selects the source of the signal which will be used in the Alarm processing. The example shown has selected CTNL INTKE as the data source. This channel is defined as Centinel Intake Pressure, hence that label appears at the bottom of the screen. When selecting a source for the alarm input, an item select screen similar to the one at left will appear. User the arrow keys to move the cursor to the data point required and press ENTER.

Present Value The current value of the data source is displayed in this location.

Alarm Type The type of alarm is chosen in this parameter. If High Threshold is chosen, the GCS controller will consider the alarm condition active when

the present value exceeds the set threshold. When Low Threshold is chosen, the alarm will be active when the present value is less than the threshold parameter.

High Threshold This parameter holds the threshold value at which the alarm will become active. If a Low Threshold alarm is selected, this parameter label will read Low Threshold.



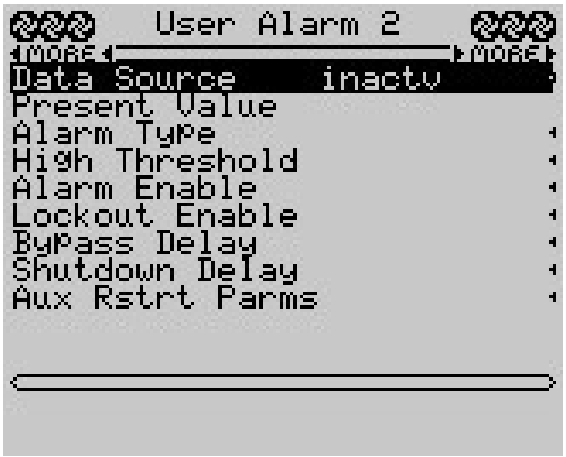
Alarm Enable This setpoint controls whether the controller will shutdown the motor because of a User Alarm condition or will ignore it.

Lockout Enable This parameter determines if the controller will enter a lockout condition when it has shutdown the motor. If this point is enabled and the motor is shutdown due to User Alarm 1, the controller will “lockout” and prevent any further restart attempts until the condition is cleared.

Bypass Delay Sets the number of seconds that the controller will ignore a User Alarm 1 condition that is present at start-up, or occurs during this bypass period.

Shutdown Delay Sets the number of seconds that the controller will ignore a User Alarm 1 condition that exists while the motor is running, but only after the User Alarm 1 Bypass Delay timer has expired.

Aux Rstrt Parms Auxiliary Restart Parameters forces the VORTEX controller to use the restart parameters listed below when it shuts down due to a User Alarm 1 condition. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.



Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to a User Alarm 1 condition and the Aux Rstrt Parms has been set to “YES”.

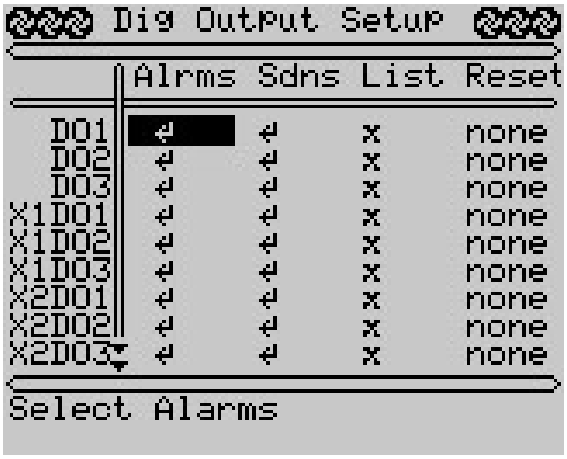
Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to a User Alarm 1 condition and the Aux Rstrt Parms has been set to “YES”.

USER ALARM 2 THROUGH 8

All eight User alarms are configured in the same method. The factory default setting is for all eight alarms to be disabled, or inactive as depicted on the graphic at left. Refer to the preceding section, User Alarm 1, for setup instructions. Note if a User Alarm must be deactivated, simply set the Data Source parameter to

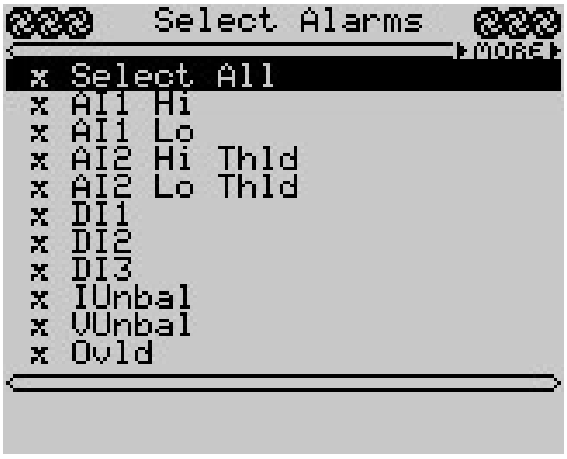
the “blank” selection. Once disabled, the Data Source parameter will read “inactv”.

DIGITAL OUTPUT CONTROL
The system control software in combination with the GDI5v20 and higher version of GDI software now allows the user to utilize available output relays to annunciate alarms or shutdowns. The relays can be connected to control systems or beacon lamps. Previously this function required a User PLC function, but can now be configured on site with no special tools or training.



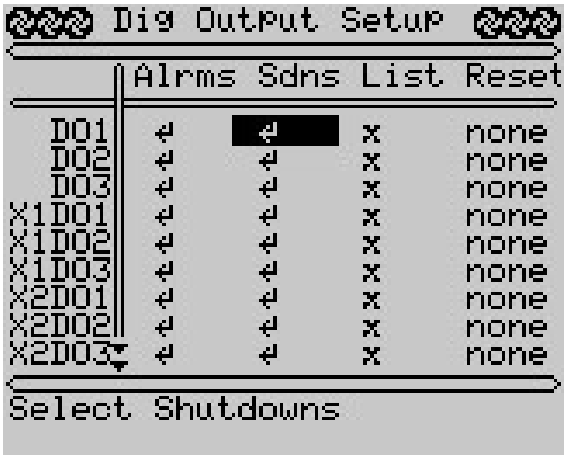
Digital Output Setup (Alarms)

This column provides a method to select and assign alarms to the digital output listed to the left of the cursor. In the illustration at left, Digital Output One (defaults to GREEN, run light) will be configured. Move the cursor to row containing the desired output and press ENTER to display the screen illustrated next.



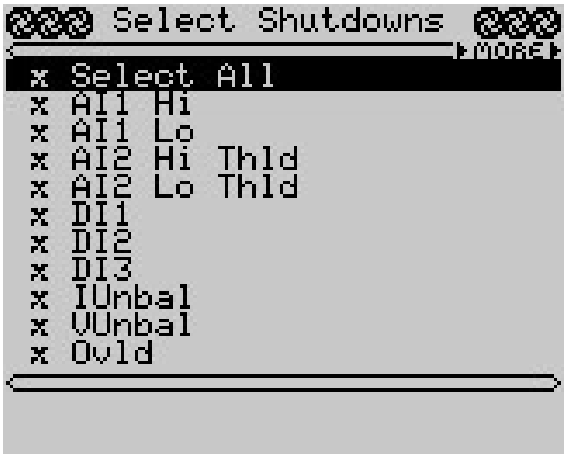
Select Alarms

This screen allows the user to select which alarms will cause the associated digital output to activate. If the cursor is highlighting the Select All item as shown at left and the ENTER key is pressed, all available alarms will cause the digital output to activate. In the case of alarms, the digital output will switch on and off when the alarm activates and deactivates. In other words, the digital output does not “latch” the alarm condition. If only individual alarms must be annunciated, move the cursor to highlight that specific alarm, then press ENTER. The “X” next to the alarm name will change to a check-mark. Once finished selecting alarms, press MENU to return to the previous screen.



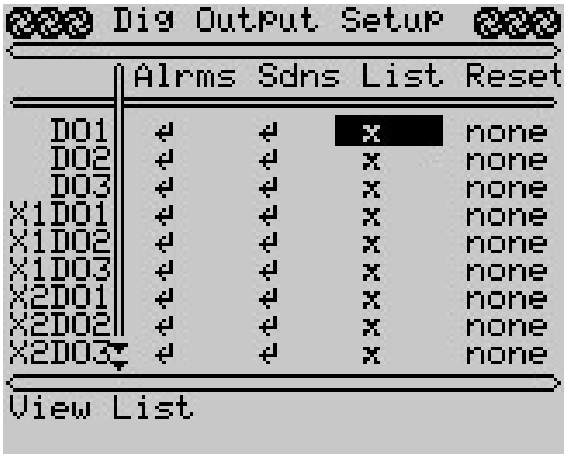
Digital Output Setup (Sdns = Shutdowns)

This menu item provides a way to assign shutdown events to a specific digital output. Both alarms and shutdowns or any combination thereof can be assigned any specific digital output.

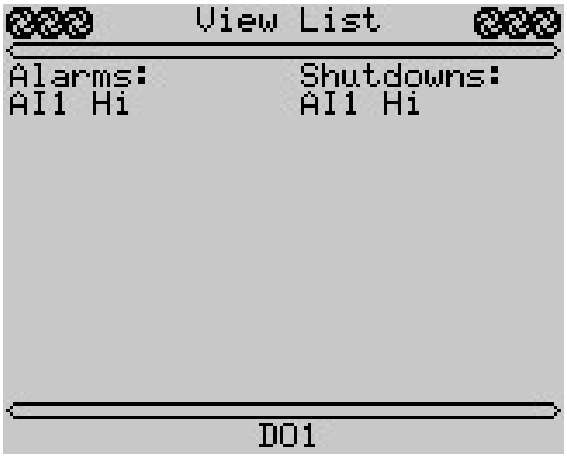


Select Shutdowns

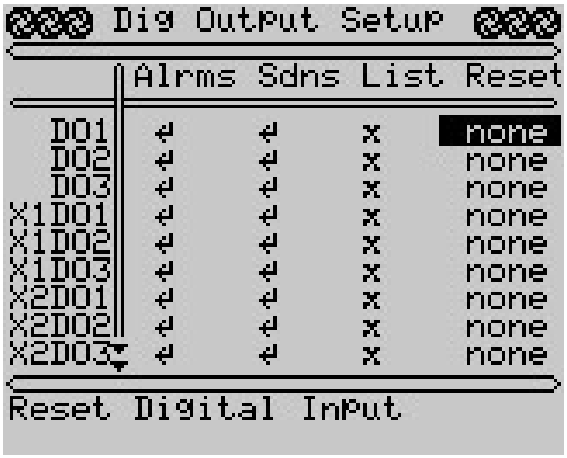
This screen allows the user to select which shutdowns will cause the associated digital output to activate. If the cursor is highlighting the Select All item as shown at left and the ENTER key is pressed, all available shutdowns will cause the digital output to activate. In the case of shutdowns, the digital output will switch on and latch in that state until the user resets it, or the motor is restarted If only individual shutdowns are to be annunciated, move the cursor to highlight that specific alarm, then press ENTER. The “X” next to the shutdown name will change to a check-mark. Once finished selecting shutdowns, press MENU to return to the previous screen.



Digital Output Setup (list)
This screen provides a list of all alarms and shutdowns associated with the particular digital output. This yields a simple method of checking the status of the configuration. Move the cursor to the row of the digital output in question and press the ENTER key. In the example illustration at left, the list shown will pertain to Digital Output #1. The example list generated will resemble the illustration below.

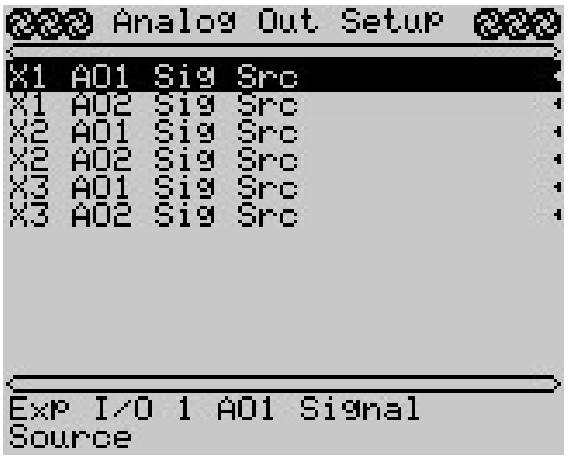


Digital Output Setup (VIEW list)
This screen will show a list of which Alarms and Shutdowns are assigned to the associated digital output. The illustration at left depicts that Analog input number one, high threshold alarm and shutdown (AI1 Hi) are annunciated on digital output one (DO1). Each of the available digital outputs will have a screen similar to this one.

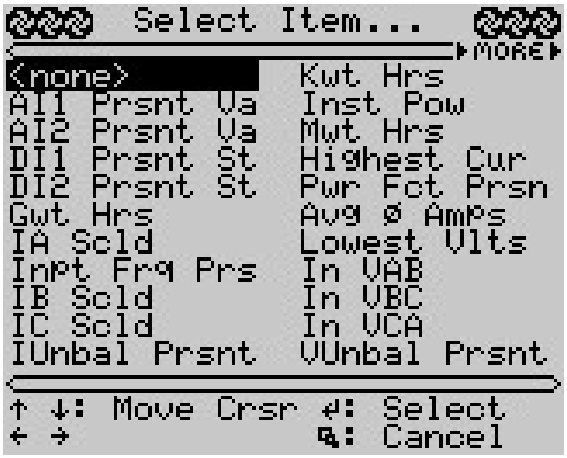


Digital Output Setup (RESET)
This screen allows the user to designate a digital input to be used as the reset or acknowledge signal for the shutdown annunciations. When a GCS is integrated into a process control system, it is common to require all alarm and shutdown annunciations to be cleared before a start is allowed. If this parameter is left in the default state of “none”, the output annunciation will only be reset when the motor is started. If a specific reset/acknowledge input is desired, move the cursor to the correct row in the Reset column, press ENTER, then select the appropriate input from the list shown in the subsequent screen.

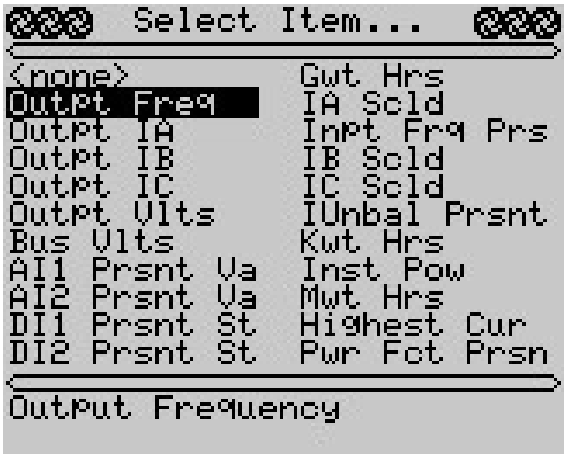
ANALOG OUTPUT CONTROL
The system control and graphic display software now allow the user to select an analog signal source and use it to drive an analog output on the Expansion I/O modules. This function is useful when interfacing the GCS units with an external control system such as is commonly implemented with stand alone Programmable Logic Controllers (PLC). This function formerly required that a User Programmable Logic Function be loaded into the GCS.



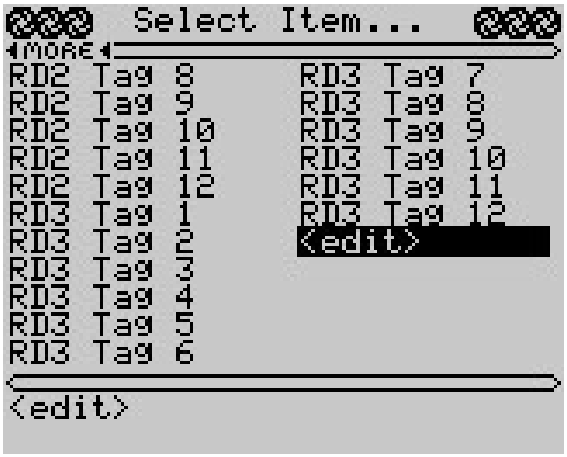
Analog Out Setup
From this screen, the user selects one of the available analog output channels. Once a channel is chosen, the following menu screens provide a means to select the signal that will be driven out of that channel. In the example at left, pressing the ENTER key will allow the user to select a signal source to drive analog output #1 on Expansion I/O module #1



Select Item (None) The default state of the analog output control is for each analog output to have no signals driving it. To return to this state, move the cursor to highlight the <none> menu item and press ENTER.

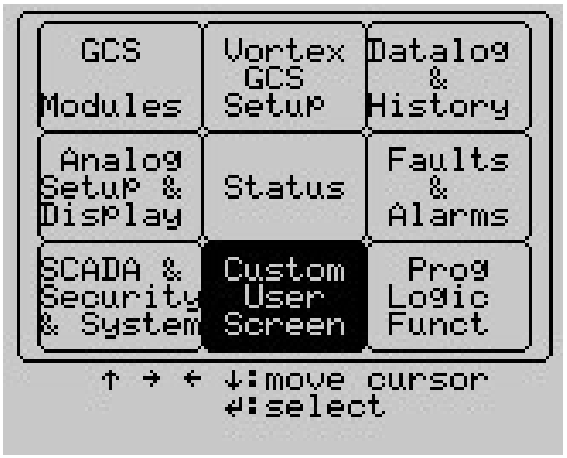


Select Item (Outpt Freq) In the case of a GCS Electrospeed, the user can use the present value of the output frequency to drive a 4-20mA analog output signal. When the signal source is selected, the GCS will set up the analog output parameters to match the units and the span of that source. In most cases those values will be sufficient, but they can be user modified if necessary.

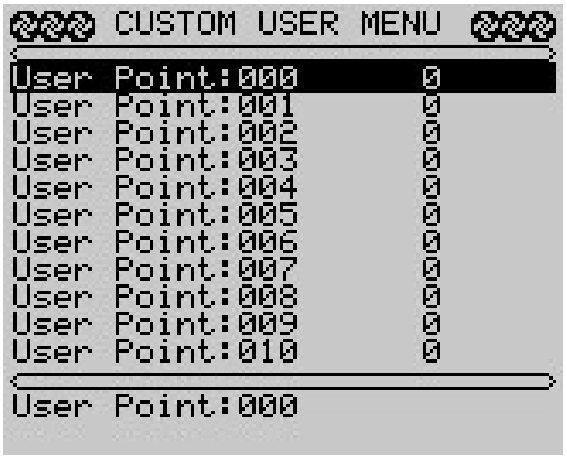


Select Item (Edit) If the desired signal source is not listed in the list of available parts, the user can select any valid Point Identifier (Point ID) number via the (edit) menu item. Move the cursor to highlight this item and press ENTER. Then use the arrow keys to enter the desired Point ID number.

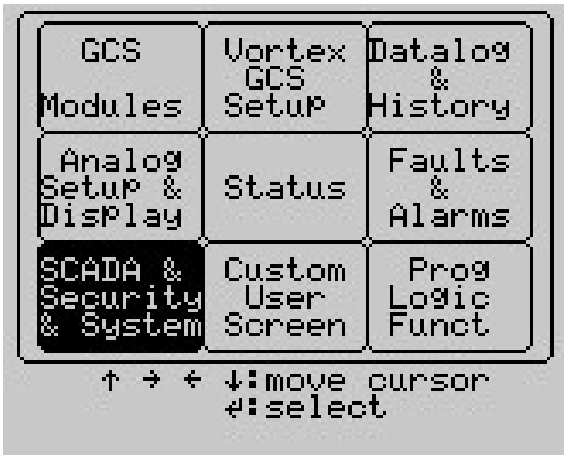
CUSTOM USER SCREEN



The Custom User Screen provides a user configurable display screen. Parameters from other display screens can be copied to this one, allowing the user to create a customized screen of data.



Custom User Menu
As shown in the graphic at left, the Custom User Menu displays eleven data variables. Each of the eleven lines of data can be configured to display any data found in the controller. The factory default configuration shows the value of the first eleven User Data Points. To replace these data points with others, use the Utility Menu function “Add to Custom User”. Refer to the section Utility Menu for further information regarding this function.



SCADA & Security & System

The SCADA & Security & System group of screens provides access to several system maintenance, security and communication options features within the VORTEX GCS.

SYSTEM

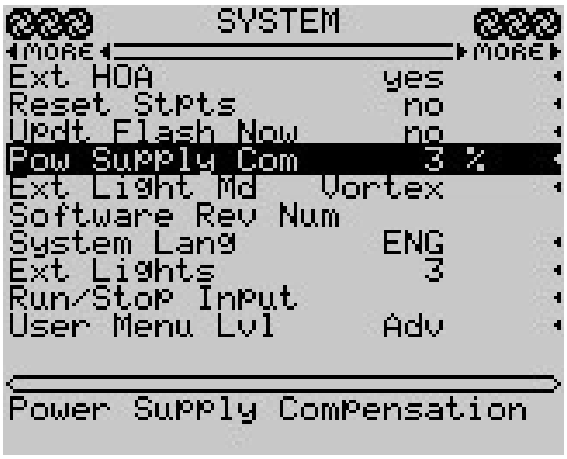
This screen provides access to several parameters concerning overall system maintenance.

Ext HOA This parameter controls whether the GCS controller uses its dedicated digital inputs as control inputs for an externally or remotely mounted HAND-OFF-AUTO or HOA switch. The status of these inputs will then dictate whether the GCS will operate in AUTO mode (automatic restarts) or HAND (manual restarts only). The center or OFF position of this switch is interpreted as a manual shutdown command. See basic operation for information regarding operating modes.

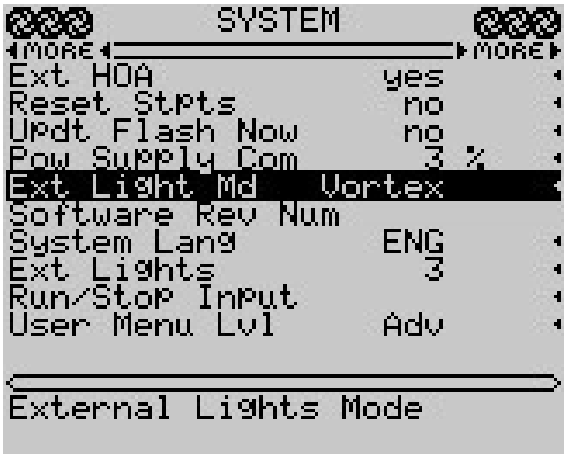
Reset Setpoints This control setpoint will cause the GCS controller to reprogram all of its parameter and setpoint values back to the factory default settings. The function will also reset all timers and counters back to the zeroed state and prepare for re-commissioning the controller. The Run History database stored within the controller will also be erased. This function is typically used when a controller is being moved or re-deployed into another motor control situation. It provides a known, conservative starting point for user setup.

Update Flash Now The Update Flash Now parameter instructs the controller to immediately copy all of its internal parameters, setpoints and values to the onboard non-volatile flash memory storage device. This function can only be used when the motor is not running. If the motor is running when this setpoint is set to “YES”, the display will read “err” and the memory will not be updated. The flash memory storage contains the program, database code as well as user setpoints. It is used at a power on time to verify and if necessary, replace the battery backed RAM copies of software. Whenever the RAM copy of the setpoints are valid, but

differ from the flash memory copy, the controller will automatically update the flash memory copy at power up time. If the controller's memory backup battery has failed or is discharged, the user can execute this command to preserve their configuration in the event of a power failure.



Pow Supply Comp Power supply compensation is used to counteract the voltage drop or sag that can occur on the switchboard's control transformer as a result of large current draw. The GCS VORTEX usually measures the system voltage phase CA by using the 120VAC signal produced by this control transformer. If this transformer is undersized or it is operated near its current limit, it will usually exhibit a sag in output voltage when the motor contactor is engaged. When this happens, the VORTEX will assume that the phase CA line voltage has sagged and could cause an Under Voltage or Voltage Unbalance shutdown. If this situation is suspected, the user can use this set point to compensate for that effect. To determine the percentage of compensation required, monitor the percentage of voltage drop occurring on the high-voltage or line side of the phase CA transformer due to motor current draw. Then adjust this parameter to nullify any additional voltage drop appearing on the low voltage side of the transformer only. This compensation factor only takes effect when the motor is running, ie: the contactor is engaged. Typical setting is 0 to 3%.



Ext Light Md The External Light Mode controls the way the VORTEX controller uses the RED and AMBER panel lights to annunciate shutdowns. In all modes, the GREEN run indicator is turned on when the motor is running and off when the motor is stopped.

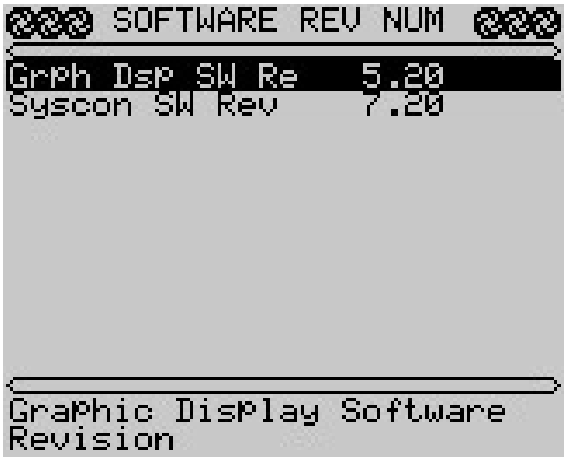
VORTEX: In the default Vortex mode, the RED light is turned on when the motor is shutdown and no automatic restarts will occur. This condition has three possible causes: A lockout condition has occurred; an alarm condition without an associated Bypass Delay is active; or the automatic restarts are not allowed nor enabled. The AMBER light is turned on when the motor is shutdown, but an automatic restart attempt will occur when the restart delay has expired.

KRATOS: In the KRATOS mode, when the motor is shutdown, the controller will activate the RED relay only if the cause of shutdown was Overload. If the shutdown occurred for any other cause, the AMBER relay will be activated.

ICS Em: In the ICS Emulation mode, the controller will activate the RED relay if the cause

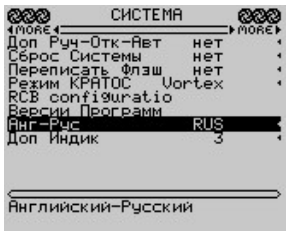
of shutdown was Overload and the AMBER relay if the cause of shutdown was Underload. If the shutdown cause was for any other reason, no external lights will be activated.

No other functions are affected by the selection of External Light mode.

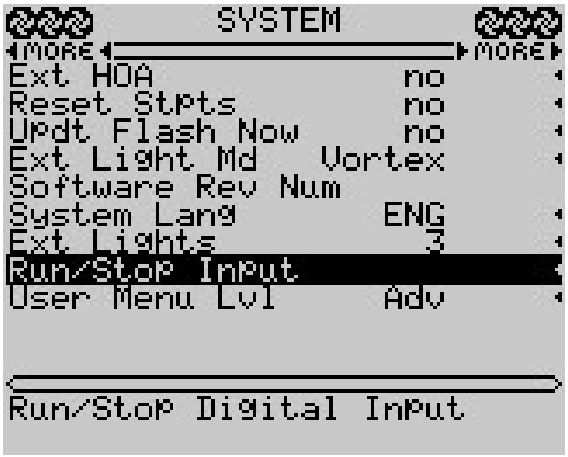


Software Rev Num The software revision levels of the GCS modules connected together in this control system are listed here. Highlight this item and press ENTER to access the subsequent menu illustrated at left.

System Language The GCS controller can support languages other than English on the display screen. At present time, Russian and Spanish are the only alternate languages available. Whenever an alternate language is selected, the selection portion of the System Language menu is always shown in English as illustrated below

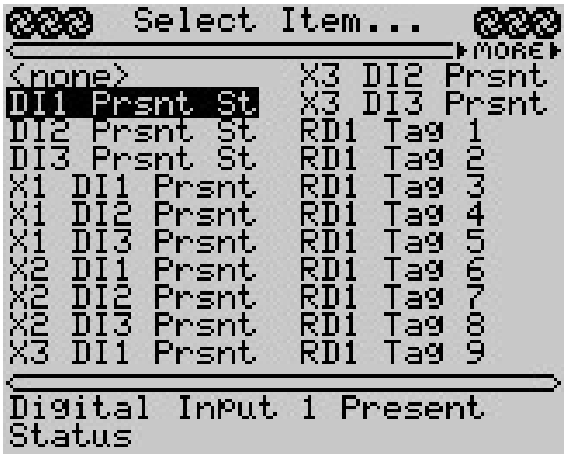


External Lights This parameter is used to control how many of the three onboard relays are utilized for control status annunciation. When set to “three”, the controller will use all three outputs to annunciate operating conditions according to the rules set out in the previously mentioned External Light Mode. When set to “one” the controller will use only the “contactor” relay to annunciate or control the motor. The remaining two relays can be used as general purpose digital outputs. If this parameter is set to none, all three relays are available as general purpose digital outputs. General purpose relays can be used or switched from User PLC programs.

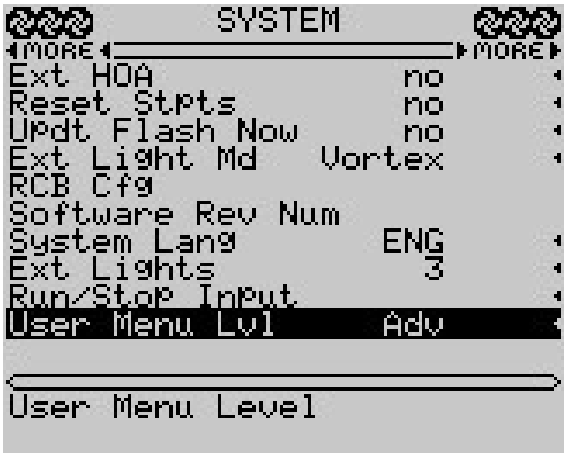


Run/Stop Input Allows the user to select any available digital input to serve as a controlling point to start and stop the drive/motor. When the selected input contacts close, the controller will “RUN”, when the contacts open, the controller will “STOP”. Similar to other

inputs, such as KEYPAD START, if any active, non-bypassed alarms exist, the controller will not start the motor.



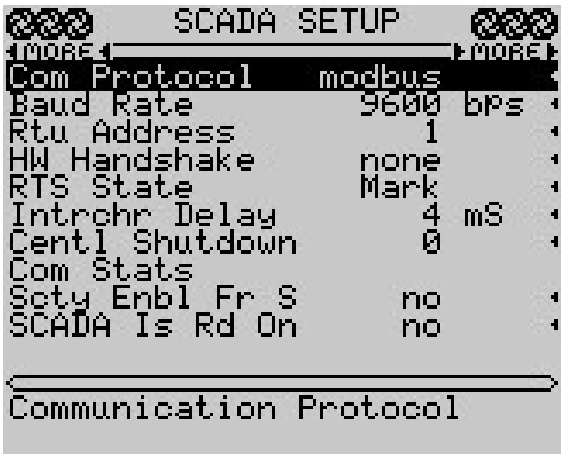
Run/Stop Input – Select Item This screen allows the user to select which digital input will be used to control the motor. Selecting “none” will clear any previous selections.



User Menu Lvl This menu item will allow the user to select advanced or basic menus. The normal default setting is Advanced. When Basic is selected, many of the menu items will not be displayed. This can be used to limit access to certain points or to avoid confusing casual users. The Basic menu version of the system screen is illustrated below.

SCADA SETUP

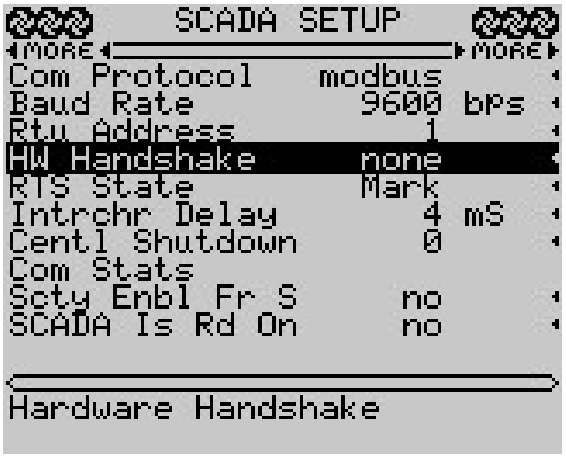
The SCADA SETUP menu groups together the related parameters controlling communications to external computer systems and telemetry devices. Press the right ARROW key from the SYSTEM menu to access this menu.



Com Protocol Communication Protocol allows the user to select the communication language that the controller will use to electronically communicate to telemetry and computer systems. Typical setting is MODBUS™ RTU
Beginning with this software revision, the protocol selection can be set to ICM Em. This setting will cause the GCS to support the MODBUS address map found in the previous generation variable speed drive ICS when equipped with the ICM communication module. Refer to the MODBUS™ register address table in the document “GCS Modbus Protocol Support” for detailed information.

Baud Rate Baud rate sets the speed of serial communication with telemetry and computer systems. Supported rates are 1200 to 9600 baud.

Serial settings are No Parity, 1 Start, 1 Stop, 8 Data Bits



Rtu Address Remote Terminal Unit Address is the variable that assigns a number from 1 to 255 to this controller for the purpose of identifying itself within a communication network.

HW Handshake Hard Ware Handshake is a three state variable that controls the type of communication synchronization that is used on the RS-232 port.

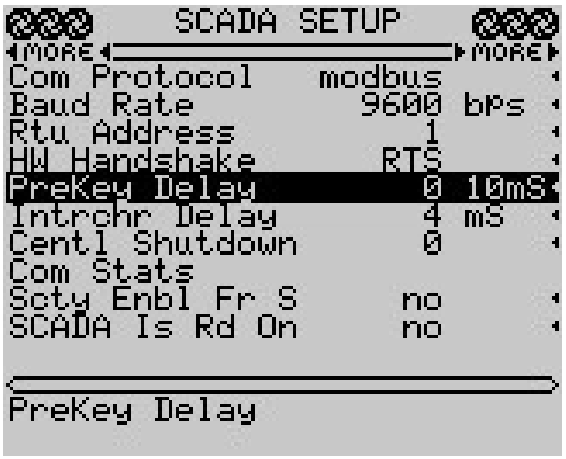
Possible settings are: none, RTS or R/CTS.

None selects a three wire serial communication port setting, (RX,TX,GND).

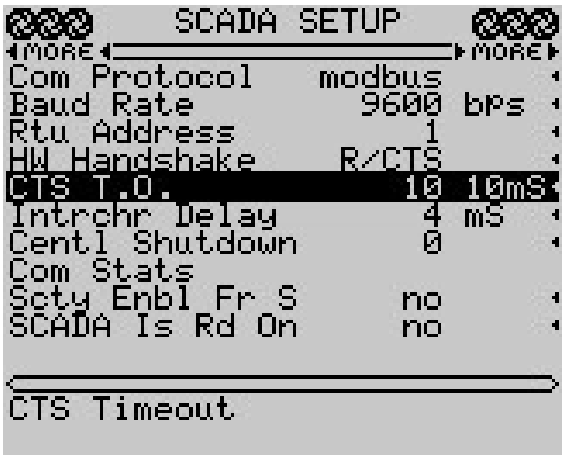
RTS selects a four wire serial communication port setting, (RX,TX,RTS,GND). When RTS is active, while transmitting, the controller will assert the RTS signal line for a time period equal to the value set into the PreKey Delay parameter previously discussed. After this time delay has expired, the data is transmitted.

R/CTS selects a five wire serial communication port setting, (RX,TX,RTS,CTS,GND). While RTS/CTS is active, when transmitting, the controller will assert the RTS signal line and wait until the CTS line is also asserted by the external modem. Once the CTS line is asserted, then the GCS controller will transmit its data.

RTS State When the Hardware Handshake parameter is set to “None”, this menu line appears and allows the user to force the Request To Send (RTS) signal line to either the Mark or Space state. This RTS signal line can then be used to supply “port-powered” communication devices such as infra-red transmitters or RS-485/422 interfaces. The “Space” state will produce approximately +7.75Vdc at up to 20mA. The “Mark” state is -8.5Vdc with the same current rating as the “Space” state.



PreKey Delay When the HW Handshake parameter is set to RTS, this line appears on the screen. PreKey Delay implements a “Push to Talk” or “Request to Send (RTS)” delay timer that is used to assert the “RTS” output at the RS-232 Communication Port for a user specified time before commencing serial data transmitting. This signal and/or delay is commonly used to handshake or synchronize two communication devices. In two-way radio systems, this RTS can be used as the “Microphone/Transmit” signal to enable the radio transmitter prior to serial data output.

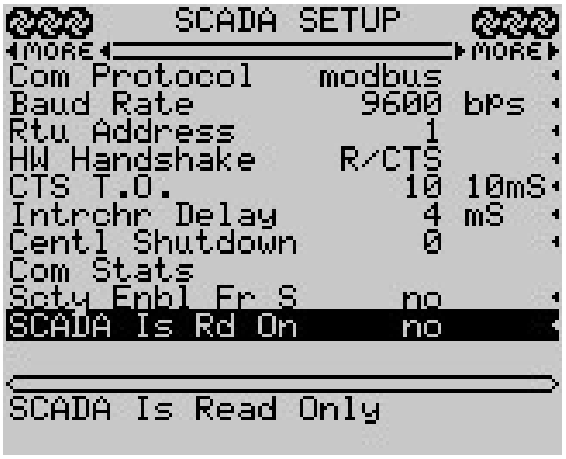


CTS T.O. When the HW Handshake parameter is set to R/CTS, this line appears on the screen. This menu item, Clear to Send Time Out, sets the amount of time that the GCS controller waits for the Clear to Send line to become asserted. If the line is not asserted within this time delay, the controller resets its communication buffers and aborts transmission of the pending message. It then begins listening for a new message.

Intrchr Delay Inter-character delay is a user set variable that controls the allowable time delay between adjacent serial characters of an active message.

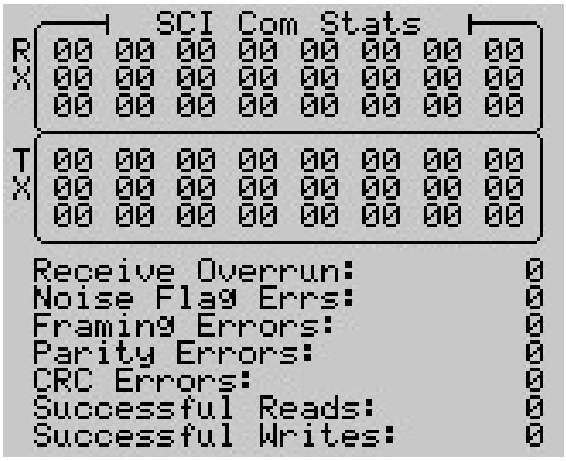
Centl Shutdown Central Shutdown is a system status variable that is dedicated to enunciating the presence of a SCADA or User PLC motor shut down command. When this variable is set to any non-zero value, the controller will stop the motor if running and disallow further restart attempts until cleared. Although this variable can be cleared locally, be cautious if doing so, since another control person or process may require and depend on this unit to remain off.

Com Stats Move the cursor to this menu item and press ENTER to view the communications statistics screen. Refer to the section SCI COM STATS below for a sample screen and description.



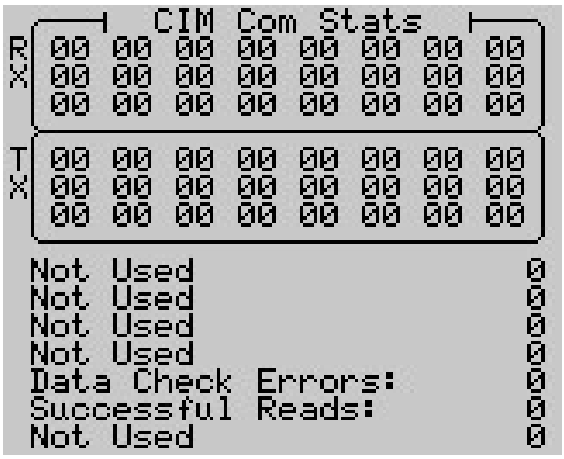
Scty Enbld Fr S This parameter, Security Enabled for SCADA, controls whether a valid password must be entered before allowing a SCADA system to modify parameters or start/stop the motor. If set to “no”, SCADA system messages are acted upon regardless of Security status. If set to “yes” a valid level 2 password must be entered before the SCADA system can make any changes to the system. The password can be entered manually from the display unit or via the SCADA system.

SCADA Is Rd Onl This parameter is used to control whether the SCADA system will be allowed to modify (write) parameters. When it is set to YES, the SCADA system is allowed to read parameter values, but cannot modify any of the values. READ ONLY SCADA Mode is not affected by system security passwords.



SCI COM STATS

This screen displays information pertaining to the operation of the communication control registers and memory buffers. It is useful for diagnosing serial communications with telemetry equipment. It displays accumulators for several error and message counters as well as the first 24 bytes of the transmit and receive memory buffers.



CIM COM STATS

This screen displays the communication statistics associated with the Centinel Interface Module (CIM). This optional module is a down hole measurement tool that can be connected as a slave module to a GCS controller. When a CIM unit is installed and enabled, this screen will display statistics associated with the telemetry between the Centinel Interface Module and the down hole tool

SECURITY

This menu accesses the system security features of the Vortex GCS. Press the right ARROW key from the SCADA SETUP menu to reach this screen.

User Password This parameter, User Password, contains the user's security password. It can be entered here or via the GCS VORTEX SETUP screen.

Level 1 Pswd Level One password is the value that must be entered into the User Password parameter to gain edit access to most setpoints. If the user's password does not equal this one, this variable will display XXXXX.

Level 2 Pswd Level Two password is the value that must be entered into the User Password parameter to gain edit access to all setpoints and system configuration variables. If the user password does not equal this one, this variable will display XXXXX.

Pswd To Clr Lk Password to Clear Lockout controls whether a valid password must be entered before the user is allowed to clear a lockout condition and restart the motor.

User Pswd T.O. User Password Time Out sets the length of time delay after any key press before the GCS VORTEX sets the user password back to zero.

Security Jmp St Security Jumper Status shows whether the Centrilift service man's security jumper has been installed. In the case of a GCS VORTEX controller, a physical jumper does not exist, however, PC Card is available that serves the same function. If this card is plugged into the display unit, the service man is granted full security access.

CURRENT TIME

This screen displays the present settings of the battery backed, real time clock operating in the GCS system. The primary purpose of the clock is to be able to record the dates and times for the Shutdown History and the data logging functions. The GCS VORTEX is year 2000 compliant, no time or date related problems have occurred.

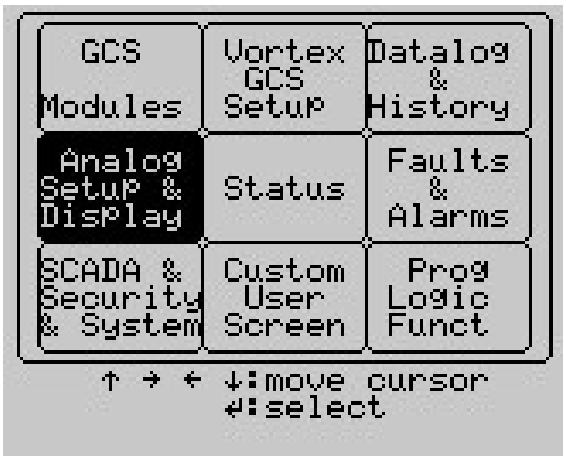
Note the Invalid Time Alarm setpoint. This alarm enunciates the fact that the real time clock does not contain valid data. When this alarm is active, use the SET TIME screen to enter the correct time and date and this alarm will become inactive. This menu line cannot be seen and the alarm cannot be manually disabled unless service man security access is achieved.

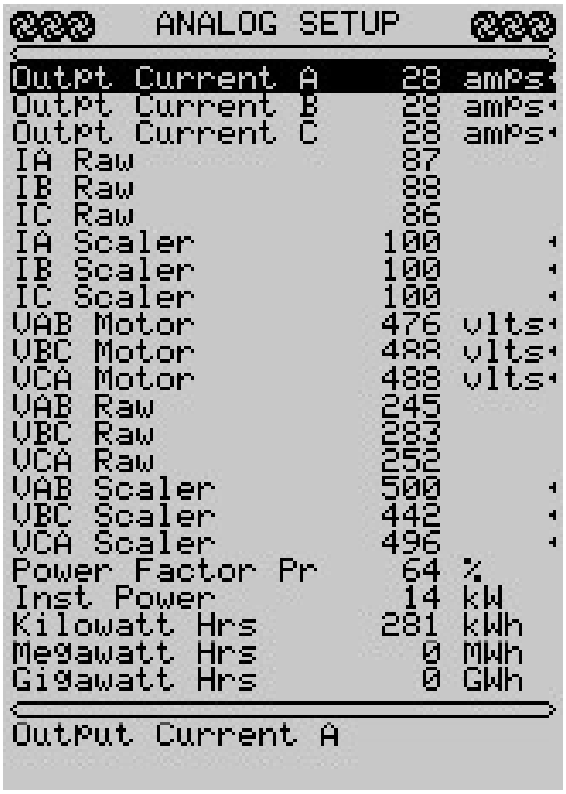
SET TIME

This screen allows access to the time and date settings of the GCS system real time clock. This clock should be reset to the current time and date if the correct time and date is not displayed in the CURRENT TIME menu screen or onboard battery has been changed or disconnected for any reason.

Year The current year, ranges from 2003 to 2038
Month The current month, ranges from 1 to 12
Day The current day, ranges from 1 to 31
Hours The current time in hours, ranges 0 to 23
Minutes The current time in minutes, ranges 0 to 59
Seconds The current time in seconds, ranges 0 to 59

Update Tm When all of the time variables have been set to the current time, set this parameter to "YES" to save the new time and update the GCS system clock.





ANALOG SETUP & DISPLAY

The Analog Setup screen permits adjustment of the output current and voltage readings as well as displaying the current values of the power consumption meters.

ANALOG SETUP

Output Current A Output Current Phase A is the present, scaled value of the output electrical current on phase A of the three phase power system.

Output Current B Output Current Phase B is the present, scaled value of the output electrical current on phase B of the three phase power system.

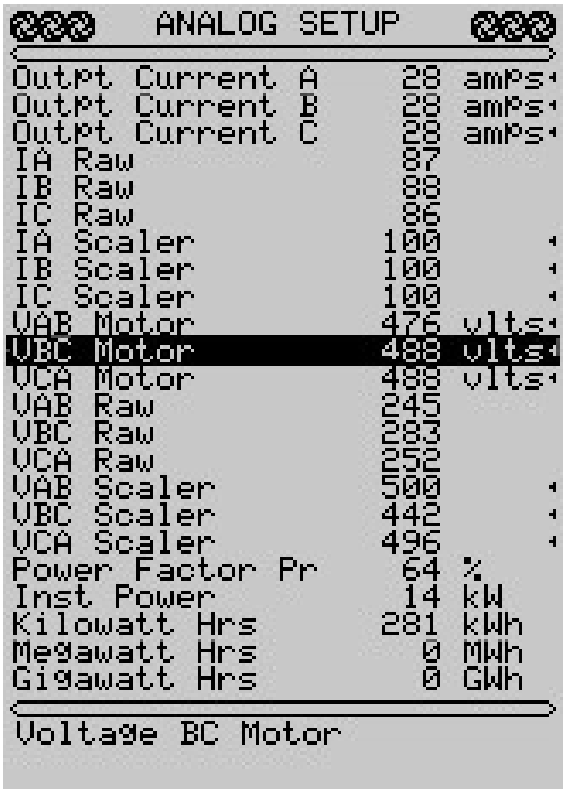
Output Current C Output Current Phase C is the present, scaled value of the output electrical current on phase C of the three phase power system.

IA Raw Current A Raw displays the RMS value of current measured in AtoD (analog to digital converter) “counts”. The AtoD measures the signal from the current transformer and converts that value into a ratio of 0 to 100% full scale or 0 to 512 “counts”. This value is not editable, but is useful for trouble shooting since it provides a positive indication of an incoming signal.

IB Raw Current B Raw displays the RMS value of current measured in analog to digital converter “counts”. Refer to IA Raw, for further explanation of this type of reading. This value is not editable.

IC Raw Current C Raw displays the RMS value of current measured in analog to digital converter “counts”. Refer to IA Raw, for further explanation of this type of reading. This value is not editable.

IA Scaler Current A Scaler holds the multiplier value used to convert the raw AtoD values into engineering units of amperes. The raw AtoD counts are multiplied by the C.T. ratio and this scaler value to arrive at the final scaled reading. Use this parameter to make scaling adjustments to the phase A current readings if necessary. If adjustments to all three currents are required, first adjust the value of C.T. ratio, and then use this parameter for fine scale adjustments. Be careful when adjusting current values as a large change in one reading may be enough to cause a Current Unbalance Overload or Underload shutdown. If the scaled values



must be individually adjusted via this point, it may be wise to disable the three current alarms until adjustments are finalized. Be sure to re-enable those alarms when finished.

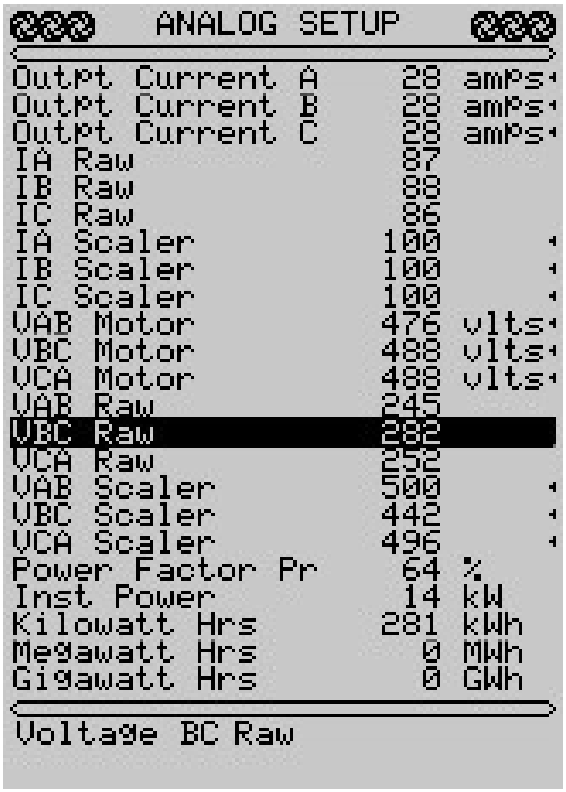
IB Scaler Current B Scaler holds the multiplier value used to convert the raw AtoD values into engineering units of amperes on Phase B. Use this parameter to make fine scale adjustments to the phase B current readings if necessary. Refer to the IA Scaler description above for further information regarding these adjustments.

IC Scaler Current C Scaler holds the multiplier value used to convert the raw AtoD values into engineering units of amperes on Phase C. Use this parameter to make fine scale adjustments to the phase C current readings if necessary. Refer to the IA Scaler description above for further information regarding these adjustments.

VAB Motor Voltage AB motor displays the scaled value of voltage measured across phase A and B of the power system. If only one potential transformer is used in the system, it will be connected across phase CA of the power system and this reading will display zero. If this is the case, the parameter Single Phase Vlts found in the GCS VORTEX Setup menu group should be set to "YES". This will inform the controller that it should ignore this reading and the VBC Motor voltage value when calculating over and under voltage alarms. Voltage unbalance and power rotation are also ignored in this case. If the voltage reading needs to be calibrated, the user may modify this parameter to match the required value. The GCS VORTEX will automatically adjust the VAB span value accordingly.

VBC Motor Voltage BC motor displays the scaled value of voltage measured across phase B and C of the power system. If only one potential transformer is used in the system, it will be connected across phase CA of the power system and this reading will display zero. If this is the case, the parameter Single Phase Vlts found in the GCS VORTEX Setup menu group should be set to "YES". This will inform the controller that it should ignore this reading and the VAB Motor voltage value when calculating over and under voltage alarms. Voltage unbalance and power rotation are also ignored in this case. If the voltage reading needs to be calibrated, the user may modify this parameter to match the measured value. The GCS VORTEX will automatically adjust the VBC span value accordingly.

VCA Motor Voltage CA motor displays the scaled value of voltage measured across phase C and A of the power system. If the voltage reading needs to be



calibrated, the user may modify this parameter to match the required value. The GCS VORTEX will automatically adjust the VCA span value accordingly.

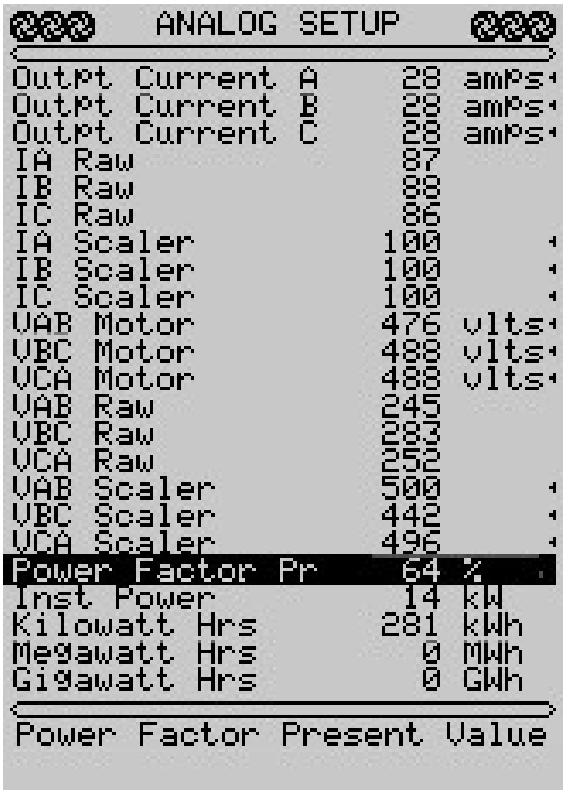
VAB Raw Voltage AB Raw displays the RMS value of the analog to digital converter measurement for the Voltage AB input before any scaling or calibration is applied to it. If only a single transformer is used to measure voltage it will be connected across phase CA and this value will be zeroed. This value is not editable.

VBC Raw Voltage BC Raw displays the RMS value of the analog to digital converter counts for Phase BC before any scaling or calibration is applied to it. If only a single transformer is used to measure voltage it will be connected across phase CA, the parameter Single Phase Volts should be set to “YES”, and this value will read zero. This value is not editable.

VCA Raw Voltage CA Raw displays the RMS value of the analog to digital converter measurement for the voltage phase CA input before any scaling or calibration is applied to it. This value is not editable.

VAB Scaler Voltage Phase AB Scaler holds the multiplier value used to convert the raw analog to digital converter measurement values into engineering units of volts. The raw AtoD counts are multiplied by this scaler value to arrive at the correct final scaled reading viewed in the parameter VAB Motor. Use this parameter to make fine scale adjustments to the phase AB voltage readings. Be careful when adjusting individual phase values as a large change in one reading may be enough to cause a Voltage Unbalance, Overvoltage or Undervoltage shutdown. In fact, it may be wise to disable those three voltage alarms until adjustments are finalized. Be sure to re-enable those alarms when finished. Note, if the parameter Single Phase Volts is set to “YES”, adjusting this value will have no effect upon the VAB motor voltage value.

VBC Scaler Voltage Phase BC Scaler holds the multiplier value used to convert the raw analog to digital converter measurement values into engineering units of volts. The raw AtoD counts are multiplied by this scaler value to arrive at the correct final scaled reading viewed in VBC Motor. Use this parameter to make fine scale adjustments to the phase BC voltage readings if necessary. Be careful when adjusting individual phase values as a large change in one reading may be enough to cause voltage shutdowns. In fact, it may be wise to disable the voltage alarms until adjustments are finalized. Be sure to re-enable the alarms when finished. Note, if the parameter Single Phase Volts is set to “YES”, adjusting this value will have no effect upon the VBC motor voltage value.



VCA Scaler Voltage Phase CA Scaler holds the multiplier value used to convert the raw analog to digital converter measurement values into engineering units of volts. The raw AtoD counts are multiplied by this scaler value to arrive at the correct final scaled reading viewed in the parameter VCA Motor. Use this parameter to make fine scale adjustments to the phase CA voltage readings if necessary.

Power Factor This parameter displays the present value of the systems' power factor or the power consumption efficiency ratio. Most fully loaded ESP systems will exhibit 80% to 95% efficiency. A fully unloaded ESP motor may show an efficiency of 40 to 50%. This parameter is not editable.

Inst Power Instantaneous Power consumption is displayed in this reading. Power consumption in WATTS for sinusoidal three phase loads is defined as:

Watts = Voltage x Current x (Square Root of 3) x Power Factor

Kilowatt Hrs Displays the presently accumulated power consumption of 1000 watt/Hours. When Kilowatt Hours reaches a value of 1000 it will revert to zero and Megawatt Hours will be incremented by one.

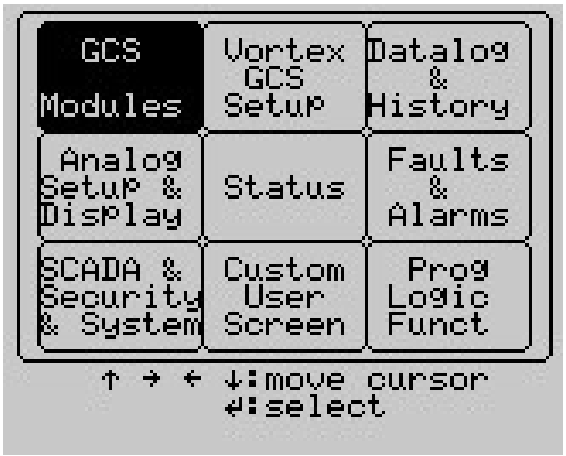
1 Kilowatt Hour = (Watts x Hours) / 1000

Megawatt Hrs Displays the presently accumulated power consumption of 1000 Kilowatt/Hours. When Megawatt Hours reaches a value of 1000 it will revert to zero and Gigawatt Hours will be incremented by one.

1 Megawatt Hour = Kilowatt Hours / 1000

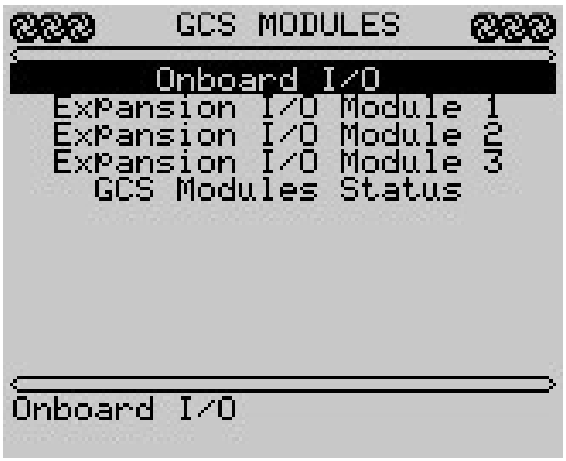
Gigawatt Hrs Displays the presently accumulated power consumption of 1000 Megawatt/Hours.

1 Gigawatt Hour = Megawatt Hours / 1000



GCS MODULES

The GCS MODULES screen allows access to the sub menus providing control of all of the setup parameters dealing with all Input / Output Modules, both built-in (onboard) and optional, externally mounted expansion cards. This menu screen also provides access to the CENTINEL and RDCM module configurations. To select the onboard I/O setup and calibration screens, use the arrow keys to move the cursor bar over the onboard I/O menu item as shown below and press the ENTER key. The GCS will display the first of the calibration screens for the onboard I/O. To access the other setup screens, move the cursor over the menu item desired and press ENTER to display that screen. If the expansion modules are not installed and enabled, their menu items may not appear on the GCS MODULES screen. In this case, proceed to the GCS Modules Status screen and enable the desired modules from there. After the modules are enabled, their access menu lines will be visible in the GCS Modules screen.



ONBOARD I/O

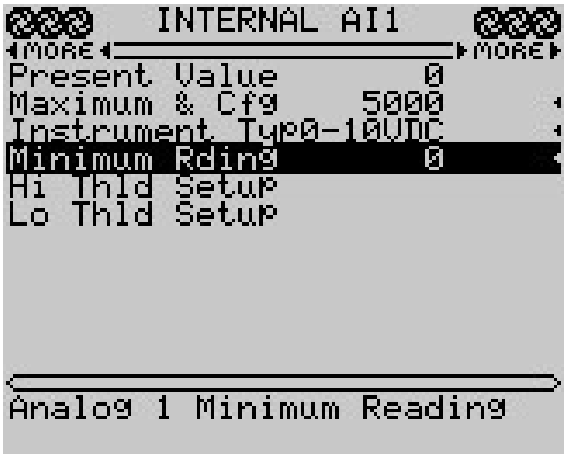
The onboard or built-in I/O consists of two 0-10 volt DC analog inputs and two digital (status, 0-120VAC) inputs. With the cursor highlighting the onboard I/O selection, press the ENTER key for access to the configuration screens. The first screen shown will normally be the internal analog input #1, or, INTERNAL AI1 as shown in the next illustration.

INTERNAL ANALOG INPUT 1

This menu screen provides access to all the parameters related to the 0-10 VDC signal applied to Analog #1 input terminal.

Present Value The number represents the current scaled value of the analog signal present on analog #1 input terminal.

Maximum & Cfg This parameter is used to select the analog input's maximum (displayed reading at maximum input), the location of the decimal point (divide by 10, 100 or 1000) and the engineering units (psi, amps, volts etc.) Move the cursor to highlight this parameter and press the ENTER key. The highlight cursor will change to appear like the illustration at left. At this point, use the left/right arrow keys to move the decimal point left or right as required, and then press ENTER again. The cursor will change to highlight the maximum value of the analog input. Use the up/down or left/right arrow keys to adjust it to the required value, then press ENTER again.



The cursor will change once more and allow the user to select engineering units applicable to the analog input. At this point use the up/down arrow keys to scroll through the available engineering units until the desired one appears, then press ENTER to finalize the configuration.

Instrument Typ Allows selection of the type of signal connected to the analog input. The instrument types are 0-10Vdc, 0-5Vdc, 4-20mA and 10-50mA. To use the current loop type, an appropriate size of resistor should be connected in parallel with the analog input to convert the signal into a voltage. For example, use a 500-ohm resistor to convert 4-20mA into 2 – 10 Vdc. Then set the type to 4-20mA, and the controller will perform the offset calculations required.

Minimum Rding Use this parameter to set the value displayed when the associated analog input signal is zero.

Hi Thld Setup This menu accesses the parameters associated with a high threshold alarm on analog input 1. Highlight this item and press ENTER to access the subsequent menu.

Lo Thld Setup This menu accesses the parameters associated with a low threshold alarm on analog input 1. Highlight this item and press ENTER to access the subsequent menu.

HIGH THRESHOLD SETUP

High Threshold Sets the upper threshold of analog input #1 value that if exceeded, will cause the motor to shutdown.

Hi Thld Alm Enb High Threshold Alarm Enable controls whether the GCS controller will shutdown the motor when the “Present Value” of analog input #1 exceeds the “High Threshold value”.

Hi Thld Lk Enbl High Threshold Lockout Enabled controls whether the controller will “lockout” and prevent further automatic restart attempts when the GCS shuts down the motor because of a High Threshold alarm.

Hi Thld Byp Dly High Threshold Bypass Delay sets the number of seconds that the GCS controller will ignore a High Threshold alarm condition that is present at start-up time.

Hi Thld Sd Dly High Threshold Shutdown Delay sets the number of seconds that the controller will ignore a High Threshold alarm condition that exists while the

motor is running but only after the High Threshold Bypass Delay timer has expired.

Aux Rstrt Parms When set to “YES”, the Auxiliary Restart Parameters setpoint causes the VORTEX controller to use the restart parameters listed below when it shuts down due to an Analog Input 1 High Threshold alarm. If this parameter is set to “NO”, the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to an Analog Input 1 High Threshold alarm and the Aux Rstrt Parms has been set to “YES”.

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to an Analog Input 1 High Threshold alarm and the Aux Rstrt Parms has been set to “YES”.

LOW THRESHOLD SETUP

Low Threshold Sets the lower threshold of analog input value that if exceeded, will cause the motor to shutdown.

Lo Thld Alm Enb Low Threshold Alarm Enable controls whether the GCS controller will shutdown the motor when the Present Value falls below the Low Threshold value.

Lo Thld Lk Enbl Low Threshold Lockout Enabled controls whether the controller will “lockout” and prevent further automatic restart attempts when the GCS shuts down the motor because of a Low Threshold alarm.

Lo Thld Byp Dly Low Threshold Bypass Delay sets the number of seconds that the GCS controller will ignore a Low Threshold alarm condition that is present at start-up.

Lo Thld Sd Dly Low Threshold Shutdown Delay sets the number of seconds that the controller will ignore a Low Threshold alarm condition that exists anytime the motor is running but only after the Low Threshold Bypass Delay has expired.

Aux Rstrt Parms When set to “YES “, the Auxiliary Restart Parameters setpoint causes the Vortex controller to use the restart parameters listed below when it shuts down due to an Analog Input 1 Low Threshold alarm. If this parameter is set to “NO”, the controller will use the

global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to an Analog Input 1 Low Threshold alarm and the Aux Rstrt Parms has been set to "YES ".

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to an Analog Input 1 Low Threshold alarm and the Aux Rstrt Parms has been set to "YES ".

INTERNAL ANALOG INPUT 2

This setup and calibration screen is accessed by pressing the right arrow key while displaying the screen for INTERNAL ANALOG INPUT 1. This second analog input is calibrated and operates in precisely the same way as INTERNAL ANALOG INPUT 1, however, all of the readings and setpoints are based on the analog signal connected to the analog #2 input terminal. Configuration of the settings is more thoroughly explained in the preceding section, INTERNAL ANALOG INPUT 1.

INTERNAL DIGITAL INPUT 1

This menu screen provides access to all the parameters related to the digital status (on / off) signal applied to digital input #1 terminal. The input terminal for this status is labeled as "Spare" on the terminal strip label of the VORTEX GCS. This input and the internal digital input #2 are rated for 120 VAC input and in the factory default setup condition, are defined as "open to alarm". In other words, when 120VAC is applied to the terminal, its status is normal (not in alarm). When the input is open circuited or has 0 VAC applied to it, the status is "in alarm" and if enabled, will cause a motor shutdown. By changing the Active Alarm State parameter, the user can select which state, 0 or 1, will be considered as an active alarm.

Present Status The number displayed represents the current condition of the status signal present on digital input #1 terminal (Spare). An open circuit or 0 VAC on the "Spare" terminal produces a status value of 1 (one). If the switch or sensor connected to the input provides a 120 VAC signal, the status value of that digital input becomes 0 (zero). Using the default Active Alarm State condition, this input is classified as Open to Alarm.

Active Alarm ST The Active Alarm State variable permits the user to select which digital input state is considered an alarm. When the Present Status of the digital input matches this variable, and the alarm is enabled, the controller will begin to process a shutdown. The example depicted shows the Present Status as 0 (zero) and the Active Alarm State as 1 (one) which means that this digital input would be considered to have no active alarm. If the Present Status were to change to one, and the alarm was enabled, this input would be considered to be in an alarm state.

Alarm Enable Controls whether the GCS controller will shutdown the motor when the Present Status of the digital input equals the Active Alarm State. The factory default state is disabled.

Lockout Enabled Controls whether the controller will "lockout" and prevent further automatic restart attempts when the GCS shuts down the motor because of a Digital input 1 alarm.

Bypass Delay Sets the number of seconds that the GCS controller will ignore a Digital input 1 alarm condition that is present at start-up time.

Shutdown Delay Sets the number of seconds that the controller will ignore a Digital input 1 alarm condition that exists while the motor is running, but only after the digital input 1 Bypass Delay timer has expired.

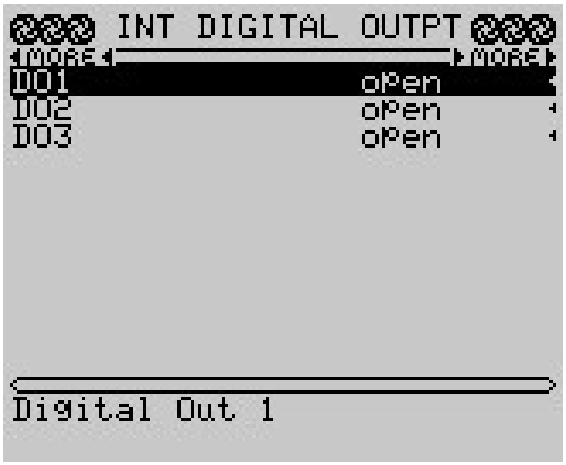
Aux Rstrt Parms When set to "YES", the Auxiliary Restart Parameters setpoint causes the VORTEX controller to use the restart parameters listed below when it shuts down due to an Internal Digital Input 1 alarm. If this parameter is set to "NO", the controller will use the global restart parameters when performing an automatic restart. The global restart parameters are set from the GCS VORTEX setup menus.

Allowed Starts Allowed starts controls how many automatic restarts will be allowed when the controller has shutdown due to an Internal Digital Input 1 alarm and the Aux Rstrt Parms has been set to "YES".

Restart Delay Restart Delay controls the length of time the controller will wait before attempting to restart the motor when it was shut down due to an Internal Digital Input 1 alarm and the Aux Rstrt Parms has been set to "YES".

INTERNAL DIGITAL INPUT 2

This menu screen provides access to all the parameters related to the digital status (on / off) signal applied to digital #2 input terminal. This input is marked as



"Pressure" on the terminal strip label of the VORTEX GCS. It is commonly connected to a well head high-pressure sensor switch and used to protect the pumping system from excessive surface pressure. All of the associated parameters function identically to Internal Digital Input 1 previously described. Refer to the section Internal Digital Input 1 for further explanation.

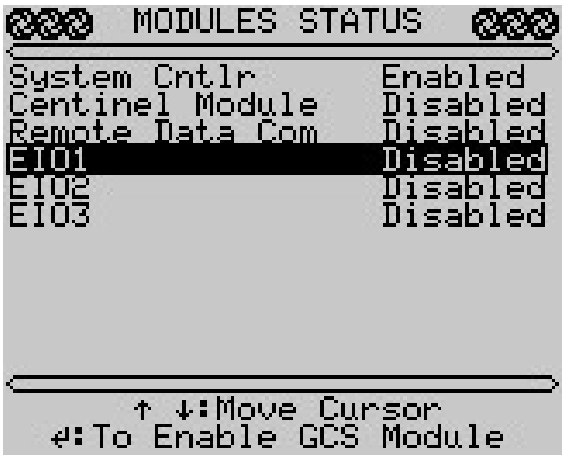
INTERNAL DIGITAL OUTPUT 1, 2 AND 3

If the setpoint, External Lights, found in the SYSTEM menu is set to less than three, then this menu will be visible. It permits direct user access to the digital output relays, when they are configured as general purpose outputs. When configured as such, these relays can be used by User PLC programs.

EXPANSION I/O MODULE 1
EXPANSION I/O MODULE 2
EXPANSION I/O MODULE 3

These menus provide access to the parameters related to installed modules such as expansion input/output cards and the Centinel downhole sensor. Please view menu and parameter descriptions in the operator's manual provided with the applicable module. If these menu items are not visible, go to the GCS Modules Status screen and enable the desired module. Then it will be visible on this menu screen.

GCS Modules Status The GCS Modules Status screen allows the user to enable expansion modules connected to the CITIBus communication bus.



MODULES STATUS

This menu screen shows which of the available expansion modules are enabled to communicate on the CITIBus network. Move the highlighting cursor to the available items and press ENTER to enable that module.

System Cntlr System controller is always enabled.

Centinel Module Enabled if a Centinel GCS down hole measurement module is attached. For further information refer to the Centinel Operator's manual.

Remote Data Com Enabled if an RDCM is connected. For further information refer to the Remote Data Communication Module Operator's manual.

EIO1, EIO2, EIO3 Expansion Input / Output modules 1, 2 and 3 can be added and enabled.

Centrilift

GCS VORTEX

EXPANSION AND OPTIONS

The GCS VORTEX controller can be interfaced to a variety of expansion modules or optional sensors. The information described herein is of a very brief nature. If further data is required, please refer to the documentation supplied with the individual devices.

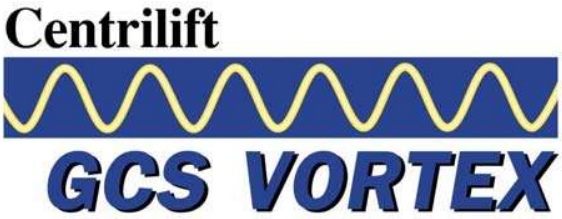
CENTINEL
The Centinel GCS downhole measurement module is available as a stand-alone GCS compatible unit or as an optional expansion module for the GCS VORTEX controller. When utilized as an expansion device, the Centinel will be configured and its data viewed on the same graphic display unit used for the switchboard. The Centinel system unit is installed in the Vortex switchboard enclosure and is integrated into the Graphic Control System by simply connecting the CITIBus data cable from the Vortex, to the Centinel and then finally to the graphic display unit. In this way, the drive is capable of reading and acting upon the downhole data from the Centinel.

REMOTE DATA COMMUNICATION MODULE (RDCM) The Remote Data Communication Module is an expansion module for GCS controllers that provides an interface between the controller and third party, MODBUS compatible devices. The RDCM is configured to poll the MODBUS slaves for user specified data and in turn makes that data available within the GCS control system. Since the retrieved data is kept in digital format throughout, there is no loss of fidelity and no requirement for additional analog and digital inputs.

VORTEX COMMUNICATION INTERFACE MODEL VCI-142
The VCI-142 is a communication interface device designed to convert the VORTEX GCS's RS-232 serial data port into a two wire half-duplex RS-485 port or a four wire half-duplex RS-422 port. Either of the two configurations can be interfaced to a multi-drop cable bus system since each transmitter is driven to a high impedance, standby state when the device is inactive.

CENTRILIFT PHD SENSOR PACKAGE
The PHD sensor package provides a 0-10VDC variable analog signal proportional to the bottom hole pressure of the well that it is installed onto. This 0-10VDC signal is then wired directly into one of the two analog input ports that are standard equipment on the VORTEX GCS.

THIRD PARTY EQUIPMENT
In general, any third party sensors, measurement or detection devices can be used in conjunction with the



GCS VORTEX if they produce a measurable analog output signal or a 0-120VAC status output signal. In the case of analog signals, the output should provide 0-10VDC or a 4-20mA and be self-powered. If a 4-20mA gauge is to be used, it must produce a signal with enough capability to drive a user supplied, 500-ohm resistor that will convert the current into a 2 - 10 VDC signal. Connect the resistor between the analog input terminal #1 or #2 and Analog Ground. Set the Instrument type to 4-20mA and the controller will zero the input at 2 VDC.

If the third party equipment is capable of communicating serially via MODBUS protocol, it may be more efficient to utilize an RDCM as described above.

MAINTENANCE

No adjustments should be necessary on initial start-up. Depending on the application, some common sense maintenance might need to be followed.

Keep Unit Clean:
As with any electronic equipment, cleanliness will enhance operating life.

Keep Connections Tight:
The equipment should be kept away from high vibration areas that could loosen connections or cause chafing of wires. All interconnections should be re-tightened at initial start-up and at six months intervals.

TROUBLESHOOTING

IMPORTANT SAFEGUARDS
All work on this controller must be performed by personnel familiar with its operation and application.

WARNING

The following warnings must be heeded. Failure to do so could result in personal injury!

1. Lethal voltages are present within the cabinet when input power is applied.

2. External voltages could be present in the area of the customer termination area even with all power removed from the input.

3. Always check for voltages across the control voltage (120VAC) inputs first and then the high voltage terminals with an appropriate meter before performing any troubleshooting, part replacement or removal. Lethal voltages (480VAC and higher) can be present under certain conditions.

4. To prevent component damage, do not remove or disconnect any cable connectors without removing all power to the controller AND allow sufficient time to discharge any power factor correction capacitors if used. Usually one minute is sufficient.

Symptom: The display doesn't light up or appear to respond to key presses.

Check the cable connecting the two units for continuity and short circuits between conductors.

Ensure the GCS control unit that it is plugged into is powered on and is producing approximately 24 VDC measured across pins 3 & 4 to 7 & 8. (Pins 3 & 4 are internally electrically connected as are 7 & 8.)

Check if the GCS display unit and / or cable work properly with another controller, or use a known working set

Symptom: The GCS control unit doesn't function and does not communicate with a known working GCS display unit.

Check the control fuses in the switch board or starter enclosure and ensure that 120 VAC nominal is available and present on the GCS VORTEX terminals labeled 120VAC and NEUTRAL. If 120 VAC power is available and the unit still doesn't respond, it may have a burnt internal fuse. Take care not to damage any electronic components exposed when opening the control unit and, if burnt, replacing the fuse with the same type.

250VAC/1 Amp - 5 mm x 20 mm glass
3/16" x ¾" (BUSS GMA)

Symptom: Motor will not start when the display units' START button is pressed and no active alarms are enunciated on the STATUS screen.

If no External HOA switch is installed, ensure that the parameter, Ext HOA found in the SCADA & Security & System menu group, is set to "NO". If not, set it to "NO" and try again.

Symptom: The motor won't start when the optional externally mounted START switch connected to the Start input of the GCS VORTEX controller is depressed.

Check that the switch energizes the Start input with 120 VAC when the switch is pressed and less than 10 VAC when not depressed.

Check that the external HOA switch parameter in the SCADA & Security & System menu group is set to "YES".

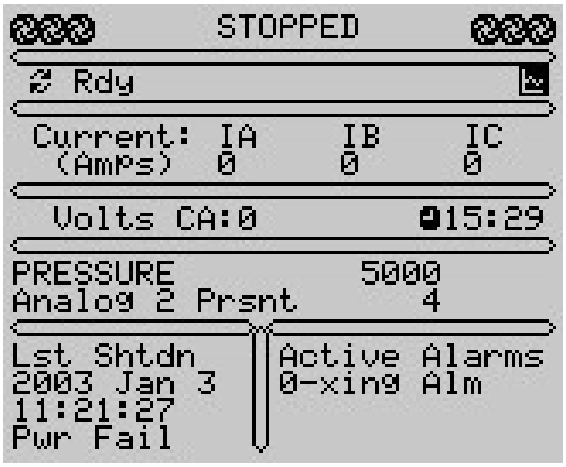
Symptom: The motor won't start when the START switch is pressed, but the STATUS screen indicates RUNNING and the Active Alarm section shows Undld (Underload).

In this situation, the controller believes it has activated the contactor and that the motor is running, but drawing insufficient current. The most common cause is the wiring of the contactor coil to switch the incorrect polarity.

Step 1: Determine whether one side of the contactor coil is connected to 120VAC HOT or NEUTRAL.
Step 2: Ensure that the other terminal of the contactor coil is connected to the Vortex terminal strip labeled CONTACTOR
Step 3: Connect the RELAY COMMON terminal to opposite polarity than that of the contactor coil determined in step 1.

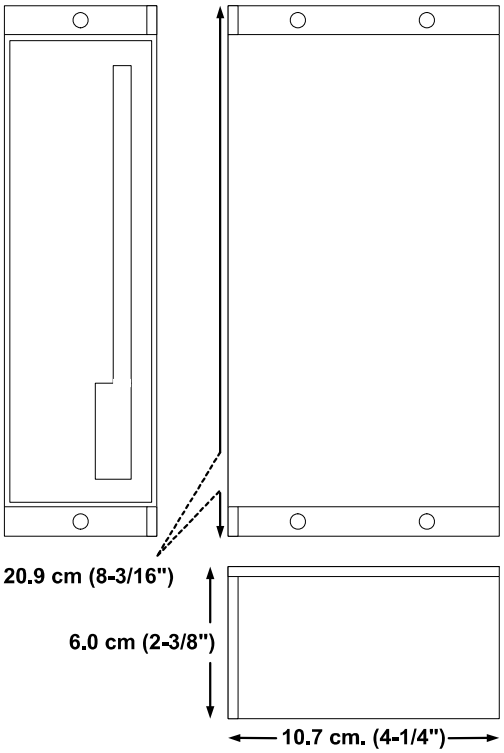
These steps should complete the control circuit for the motor contactor and energize it when the Vortex activates its CONTACTOR relay.

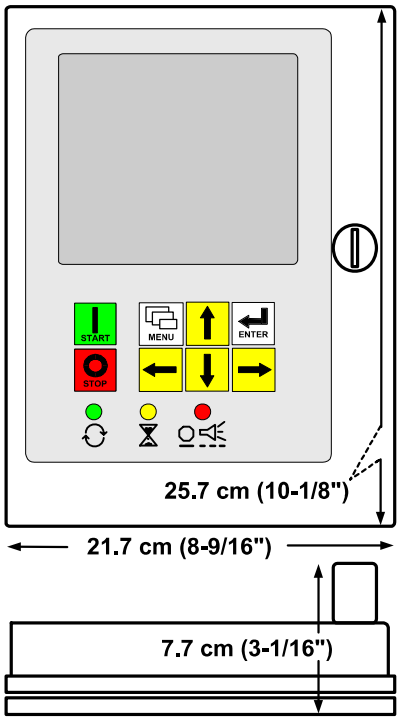
Symptom: The motor won't start when the START switch is pressed and the Active Alarm area of the STATUS screen displays 0-Xing Alarm



The GCS VORTEX uses the AC voltage applied to its terminal #4, 120VAC (Phase CA) to determine the phase rotation and timing of the applied voltage. If no voltage is applied, there is no zero-crossing event to be measured and the controller cannot synchronize itself with the power frequency. If the switchboard's control transformer will be used to power the unit as well as measure the applied line voltage, install a jumper between terminal #4 and terminal # 1, 2 or 3. (Terminals 1, 2 and 3 are internally connected together) If the controller is configured to be powered from a separate 120VAC source than the control transformer, this jumper is omitted, but the control transformer's hot lead must be connected to the unit's terminal #4, 120VAC (Phase CA).

APPENDIX A: SPECIFICATIONS / RATINGS





DIMENSIONS: System Unit	20.9 x 6.0 x 10.7 cm. 8-3/16" x 2-3/8" x 4-1/4"
Display Unit	25.7 x 21.7 x 7.7 cm 10-1/8x 8-9/16 x 3-1/16"
OPERATING TEMPERATURE	-40 to +85 degrees C -40 to 185 degrees F
STORAGE TEMPERATURE	-60 to +85 degrees C
CONTROL POWER	120 VAC 50/60 Hz Nominal (90 to 140 VAC) 0.5 Amps
CONTROL TRANSFORMERS	Main: 120VAC nominal, 500VA Second: (optional) 120VAC nominal, 10VA
CURRENT TRANSFORMERS	Secondary output, 0-1 Amp, 1VA Burden

(Resistive adapters must be used with 0-5 amp output current transformers, If they are not included in the packaging, contact Centrilift)

ANALOG INPUTS	0 - 10 VDC Maximum, 9.4 K ohm input impedance, +/- 0.5% accuracy
PRESSURE & SPARE STATUS INPUTS	120VAC normally, less than 10VAC to alarm
OUTPUT CONTACTS	120VAC, 10 Amps Max. Normally Open
VOLTAGE/ CURRENT INPUT	+/- 0.5% accuracy
TRIP / ALARM DELAY TIMES	+/- 0.1 Seconds
AGENCY CERTIFICATIONS	CSA / NRTL (UL Equivalent)

APPENDIX B: INSTALLATION RECORD

GENERAL SYSTEM INFORMATION						
Customer			County/Province			State/Country
Facility / Field			Unit / Lease No			City
Switchboard S/N			Model	Volts	Amps	Hp
Motor Mfg		Service Factor		Volts	Amps	Hp
Cable Size	Ft/Meters		Temp Factor	Volts/Ft	Cable Drop	
Pump Mfg	Model		Hp	Series	Stages	Type
Intake Type Rotary, Rev-Flow, Std			Min. BPD		Max. BPD	
Check Valve	JAP		Setting Depth		Bottom Hole Temperature	
Xfrmr Mfg	S/N:	Voltage	Ratio	Taps 1	Taps 2	

	Setpoint	Enable	Lockout	Bypass	Shutdown Delay	ARP : Delay : #Starts
Overload						
Underload						
Amps Unbalance						
Over Voltage						
Under Voltage						
Volts Unbalance						
Rotation						
Analog In 1 Hi						
Analog In 1Lo						
Analog In 2 Hi						
Analog In 2Lo						
Digital In 1						
Digital In 2						

Comments / Observations:

APPENDIX C: CALIBRATION & START-UP

NO-LOAD SETUP

The following steps will test for proper switch gear operation. Be certain to disconnect the motor or load and use proper safety and measurement equipment before proceeding.

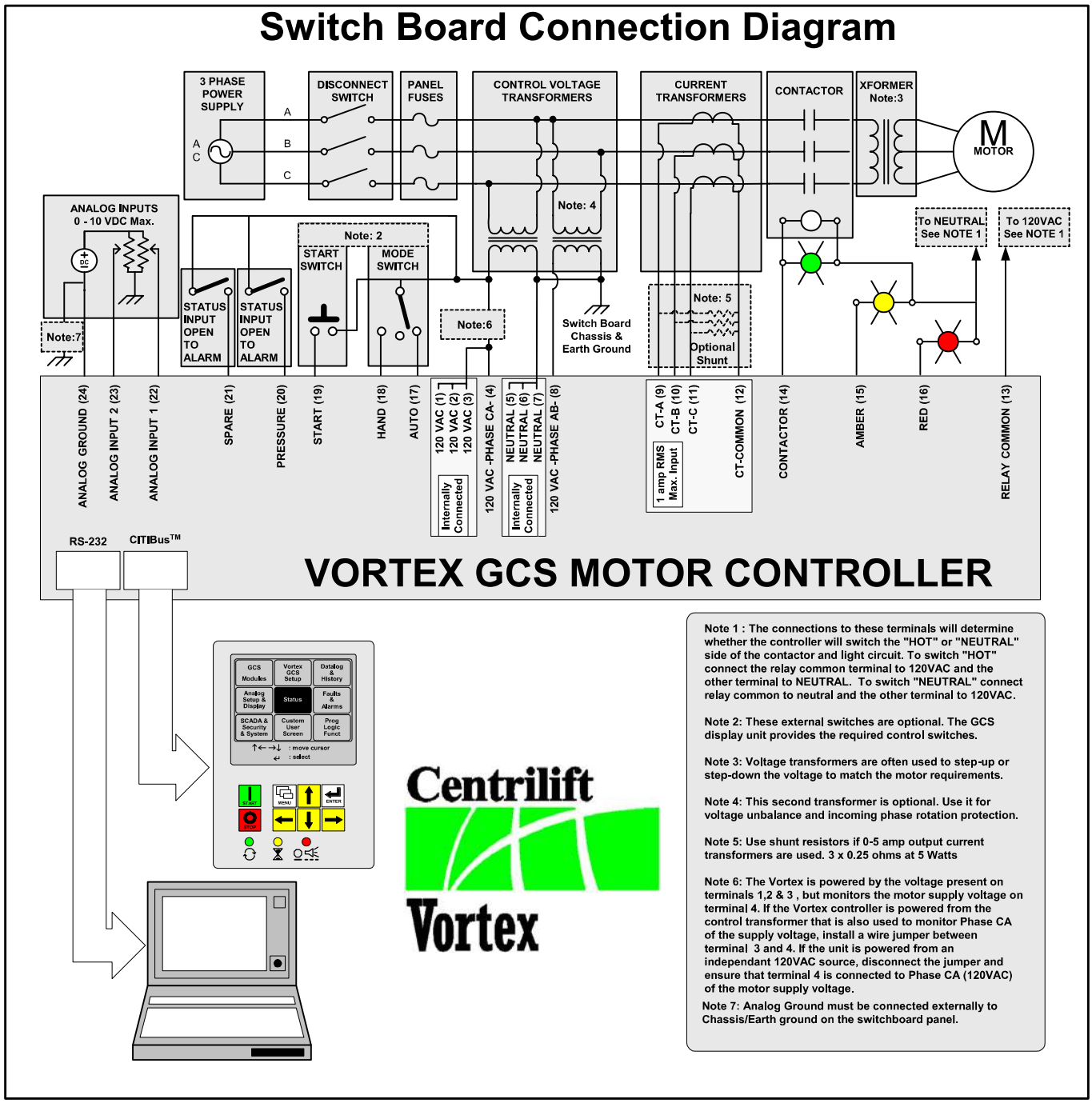
1. Verify the motor or load is disconnected, and then turn on the main input power switch.
2. With an appropriate high voltage meter, measure the phase to phase voltage of the switch board and calibrate the VORTEX GCS's displayed voltage values with these readings.
3. Set OVERLOAD parameter to motor nameplate X transformer ratio X 120%.
4. Set OVER VOLTAGE setpoint to motor nameplate voltage X transformer ratio + 10%
5. Set UNDER VOLTAGE setpoint to motor nameplate voltage X transformer ratio - 10%
6. Set PRESSURE alarm enable setpoint to "NO"
7. Set External HOA to "NO" if using the GCS display unit for start control, or "YES" if a three position, center OFF, 120 VAC mode control switch is installed and connected.
8. Check Active Alarms quadrant of STATUS screen and disable or bypass any further alarms present.
9. Press START switch.
10. Listen for and test to see if the motors' three phase contactor has energized and has connected the high voltage supply to the output terminals that the motor or step-up transformer will be attached to.

START-UP

1. Turn off all power to equipment and verify.
2. Connect output cable to the motor or load.
3. Turn on the power to the switchboard and ensure the control unit becomes functional.
4. From MAIN MENU, select and display the STATUS screen and deal with any Active Alarms.
5. When ready and safe, press the START button.
6. When the motor starts and runs, check output amps and voltage of controller on STATUS screen. Use good quality meters to measure panel input & output amps, voltages to record on start-up sheet and calibrate the GCS VORTEX if required.
7. Set UNDERLOAD setpoint to 10% less than average output phase current while running under normal, stabilized load.

NOTE: OVERLOAD & UNDERLOAD thresholds may need to be reset after well has stabilized

APPENDIX D: SCHEMATIC DIAGRAM



APPENDIX E: MODBUS PROTOCOL

1. Introduction

The GCS (Graphic Control System) products support a subset of the functions of Gould Modbus Protocol in RTU (or binary) format as described in Gould Publication PI-MBUS-300, Rev B, dated January 1985.

This appendix describes the supported functions and the response to each valid request from the host. It is intended to be used in conjunction with the Gould protocol definition and applies to GCS (Graphic Control System) system controller software revision 7.00 or higher. All numeric values shown in the function code request and reply examples are in hexadecimal (base 16) format, even when not denoted with an "H". For a complete list of register addresses, refer to the GCS Modbus Protocol Support document available through Centrilift.

2. Read Output Coil Status (Function Code 01)

Digital output states are read by the host via Function Code 01, "Read Output Status". The first "coil" of this block reflects the state of the motor contactor or RUN state of the controller. If the motor is shut down Coil 0200 H will be set; if it has been requested to start, Coil 0200 H will be clear. All other output status coils will return their status in the same fashion. For a complete list of register addresses, refer to the GCS Modbus Protocol Support document available through Centrilift.

2.1 Example - Function Code 01

Request:

RTU ADDR	FUNC	START ADDR HIGH	START ADDR LOW	# OF PTS HIGH	# OF PTS LOW	CRC
01H	01H	02H	00H	00H	01H	FCH 72H

Response:

RTU ADDR	FUNC	BYTE COUNT	DATA COIL STATUS	CRC
01H	01H	01H	00H	51H 88H

3. Read Input Status (Function Code 02)

Status inputs are accessed by the host via Function Code 02H, "Read Input Status". These status locations receive their values from devices connected to the I/O channels available or internal processes such as alarms, and can only be read, not altered within the system unit or via Modbus protocol. For a complete list of register addresses, refer to the GCS Modbus Protocol Support document available through Centrilift.

3.1 Example - Function Code 02

Request:

RTU ADDR	FUNC	START ADDR HIGH	START ADDR LOW	# OF PTS HIGH	# OF PTS LOW	CRC
01H	02H	01H	00H	00H	10H	78H 3AH

Response:

RTU ADDR	FUNC	BYTE COUNT	DATA COIL STATUS	DATA COIL STATUS	CRC
01H	02H	02H	00H	15H	78H 77H

4. Read Output Registers (Function Code 03)

Output registers are read via Function Code 03, "Read Output Registers". Up to 125 registers can be obtained by one request. For a complete list of register addresses, refer to the GCS Modbus Protocol Support document available through Centrilift.

4.1 Example - Function Code 03

Request:

RTU ADDR	FUNC	START ADDR HIGH	START ADDR LOW	# OF REGS HIGH	# OF REGS LOW	CRC
01H	03H	02H	34H	00H	02H	84H 7DH

Response:

RTU ADDR	FUNC	BYTE COUNT	RETURNING DATA	CRC
01H	03H	04H	00 01 00 00	ABH F3H

5. Read Input Registers (Function Code 04)

Analog inputs are read via Function Code 04, "Read Input Registers". These registers locations receive their values from devices connected to the I/O channels available to the GCS controller and can only be read, not altered directly within the controller or via Modbus protocol. The GCS controller allows up to 125 registers to be obtained by one request. For a complete list of register addresses, refer to the GCS Modbus Protocol Support document available through Centrilift.

5.1 Example - Function Code 04

Request:

RTU ADDR	FUNC	START ADDR HIGH	START ADDR LOW	# OF REGS HIGH	# OF REGS LOW	CRC
01H	04H	01H	30H	00H	06H	71H FBH

Response:

RTU ADDR	FUNC	BYTE COUNT	RETURNING DATA	CRC
01H	04H	0C	00 00 00 00 00 00 00 00 00 00 00 00	95H B7H

6. Force Single Coil (Function Code 05)

Individual digital outputs (coils) are modified by the Modbus host via Function Code 05, "Force Single Coil". The GCS controller has only three physical digital outputs onboard (relay contacts) but many virtual digital outputs that are used to control various processes in the controller.

6.1 Example - Function Code 05

Request:

RTU ADDR	FUNC	COIL ADDR HIGH	COIL ADDR LOW	DATA ON/OFF	DATA	CRC
01H	05H	02H	00H	FFH	00H	8DH 82H

Response:

RTU ADDR	FUNC	COIL ADDR HIGH	COIL ADDR LOW	DATA ON/OFF	DATA	CRC
01H	05H	02H	00H	FFH	00H	8DH 82H

7. Preset Single Register (Function Code 06)

Individual output registers are modified by the host via Function Code 06, "Preset Single Register". For a complete list of register addresses, refer to the GCS Modbus Protocol Support document available through Centrilift.

7.1 Example - Function Code 06

Request:

RTU ADDR	FUNC	REG. ADDR HIGH	REG. ADDR LOW	DATA VALUE HIGH	DATA VALUE LOW	CRC
01H	06H	02H	34H	00H	00H	C9H BCH

Response:

RTU ADDR	FUNC	REG. ADDR HIGH	REG. ADDR LOW	DATA VALUE HIGH	DATA VALUE LOW	CRC
01H	06H	02H	03H	00H	50H	78H 4EH

8. Write Multiple Coils (Function Code 15)

Multiple digital outputs are modified by the host in a single message via Function Code 15, "Write Multiple Coils". The GCS controller has only three physical digital outputs (relay contacts) but many virtual digital outputs that are used to control various processes in the controller. For a complete list of register addresses, refer to the GCS Modbus Protocol Support document available through Centrilift.

8.1 Example - Function Code 15

Request:

RTU ADDR	FUNC	FIRST COIL ADDR HIGH	FIRST COIL ADDR LOW	# OF COILS HIGH	# OF COILS LOW	BYTE COUNT	DATA @ COIL 202H	CRC
01H	0FH	02H	02H	00H	01H	01H	00H	56H B5H

Response:

RTU ADDR	FUNC	FIRST COIL ADDR HIGH	FIRST COIL ADDR LOW	# 0F COILS HIGH	# OF COILS LOW	CRC
01H	0FH	02H	02H	00H	01H	34H 73H

9. Write Multiple Output Registers (Function Code 16)

Multiple output registers are modified by the host via Function Code 16, "Write Multiple Output Registers". For a complete list of register addresses, refer to the GCS Modbus Protocol Support document available through Centrilift.

9.1 Example - Function Code 16

Request:

RTU ADDR	FUNC	START ADDR HIGH	START ADDR LOW	# OF REGS HIGH	# OF REGS LOW	BYTE COUNT	DATA	CRC
01H	10H	02H	20H	00H	01H	02H	00H 22H	02H E9H

Response:

RTU ADDR	FUNC	START ADDR HIGH	START ADDR LOW	# OF REGS HIGH	# OF REGS LOW	CRC
01H	10H	02H	20H	00H	01H	01H BBH

10. Exception / Error Response

When an error or exception occurs within the GCS controller in response to a host request, it sends a response message to the host consisting of the slave address, the function code, with the high order bit set to one, an exception response code and the CRC error detection word. The following table lists the function code and the error response function code.

10.1 Error Response Function Code

FUNCTION CODE	ERROR RESPONSE FUNCTION CODE
02	82
03	83
04	84
05	85
06	86

10.2 Exception Response Code

EXCEPTION RESPONSE CODE	NAME	DESCRIPTION
01	Illegal Function	The requested function is not supported
02	Illegal Data Address	The request contains an out of range data address
03	Illegal Data Value	The request contains out of range data values

11. Status and Register Addresses

The complete list of register addresses can be found in the GCS Modbus Protocol Support document available through Centrilift.

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