SPS-1500/SPS-1501
Operations Manual

Sercel-GRC Corp.
17200 Park Row
Houston, Texas ,77084
E-Mail: sales@Sercel-GRC.com or support@Sercel-GRC.com
Telephone: (1) 281 647 7300

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MODEL:
SPS-1500/SPS-1501 Operations Manual
V4.2 Update

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Sercel-GRC Corp.
17200 Park Row
Houston, Texas 77084
E-Mail: sales@Sercel-GRC.com or support@Sercel-GRC.com
Telephone: (1) 2816477300

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1.0 SPS-1500/SPS-1501 Board Overview

1.1 SPS-1500 Specifications

GRC P/N:	90B3125
Certifications:	CE Compliance Tested (see Appendix)
Dimensions:	3.47”W, 3.68”L, 2.30”H
Voltage Input:	12 to 28 VDC, 0.5 Amp Max
Polling Interface:	RS-485/RS-422 Isolated Modbus
PC Interface:	Isolated USB COM Port for Modbus/Firmware Update
Supported Baud Rates:	1200, 2400, 4800, 9600, and 19200 bps
Display:	16x2 Backlit LCD
Gauge Power Out:	40 to 80 VDC Out (~80mA Current Limited)
Gauge Power Fuse:	100mA, GRC P/N 043-0047-00

1.2 SPS-1501 Specifications

GRC P/N:	10029745
Certifications:	CE Compliance Tested (see Appendix)
Dimensions:	3.47”W, 3.68”L, 2.30”H
Voltage Input:	12 to 16 VDC, 0.5 Amp Max
Polling Interface:	RS-485/RS-422 Isolated Modbus
PC Interface:	Isolated USB COM Port for Modbus/Firmware Update
Supported Baud Rates:	1200, 2400, 4800, 9600, and 19200 bps
Display:	16x2 Backlit LCD
Gauge Power Out:	16 to 32 VDC Out (~80mA Current Limited)

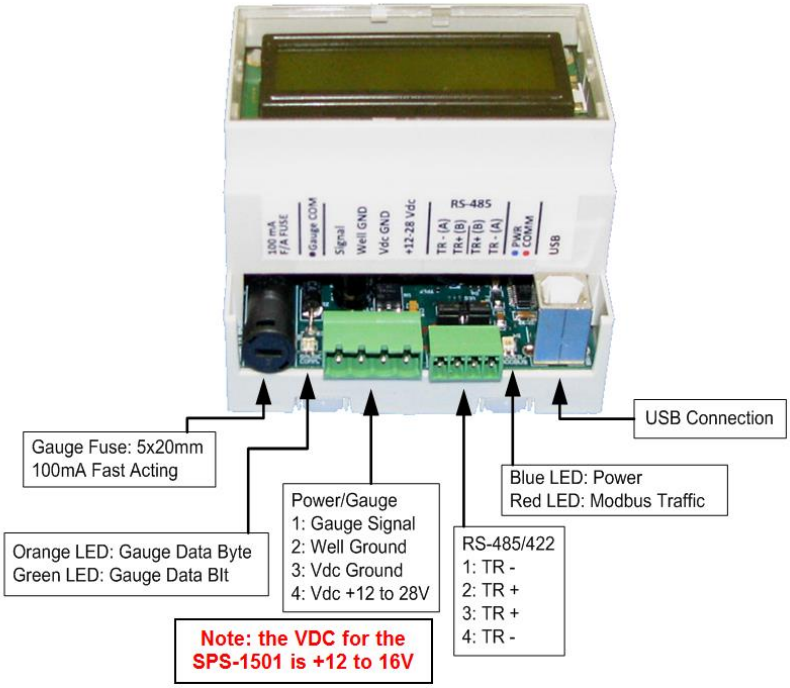
1.3 Default/Factory Settings SPS-1500 & SPS-1501

Polling Interface	RS-485
Baud Rate	9600 bps
Modbus ID	1

1.4 DC Power Supply (Optional)

GRC P/N: 062-0049-00 (Din Rail Power Supply, 12VDC, 3.0A, Mfg. PN#STEP-PS/1AC/12DC/3)

2.0 SPS-1500/SPS-1501 Connections



Gauge Fuse	Gauge signal fuse, 100mA 5x20mm, GRC P/N 043-0047-00
Gauge Comm. Bi-Color LED	Flashes green for every gauge data bit received Flashes orange for every gauge data byte received
Power/Gauge Connections	Gauge Signal Gauge Signal Return/Wellhead Ground Vdc Ground Vdc Power +12v to 28v DC for the SPS-1500 and +12 to 16V for the SPS-1501 ***NOTE: Apply torque of 5 inch-pound to secure the wires firmly.***
RS-485 / RS-422 Modbus Slave	RS-485: Install (2) Jumpers 1. TR - 2. TR + 3. TR + 4. TR - RS-422: Remove (2) Jumpers 1. T - 2. T + 3. R + 4. R – ***NOTE: Apply torque of 2 inch-pound to secure the wires firmly.***
Power/Modbus Bi-Color LED	Solid blue when power is connected Blinks red when a Modbus request is received
USB PC Connection	Modbus and firmware updating via USB Virtual COM Port

Figure 1. SPS-1500/SPS-1501 Connections

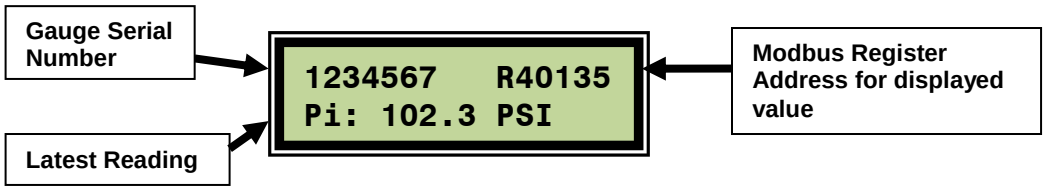
3.0 SPS-1500/SPS-1501 LCD

On power-up the SPS-1500/SPS-1501 displays these screens in sequence:

1. Firmware Version/Date Screen
2. Modbus Information

Then the screen cycles through the analyzing steps to acquire the tool, which takes 2-4 minutes. Once the tool is acquired the LCD automatically scrolls through both gauge readings and diagnostic screens. The display is updated once per second, and the screen advances every 3 seconds by default.

The displayed data includes the gauge serial number, the latest sensor reading and Modbus register addresses where that data can be polled from. All enabled parameters on the tool will be displayed. The screens operate in a loop displaying tool parameters, then diagnostic screens, and back to tool parameters.



3.1 Status & Diagnostic Screens

There are 8 diagnostic screens that display the status and other useful information about the SPS-1500/SPS-1501. They are fully customizable with Sercel-GRC's DataWorks application or other Modbus editing software – you may enable or disable screens and also control the scrolling time of the screens. Section 4.5 of this manual shows how to change the LCD settings.

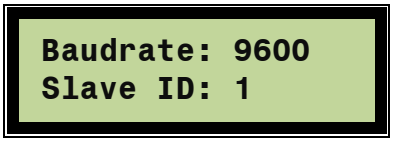
Firmware Version/Date

Displays the firmware revision and date.
By default this screen is only shown on power up.

Tool Information

Top line: Gauge serial number and gauge type.
Bottom line: Tool baud rate

Modbus Information



Displays the device Modbus baud-rate and slave address/id

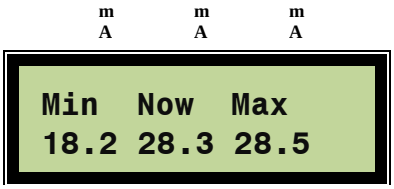
Tool Communication Settings

Displays the tool communication settings, described below:

AAn: Auto Analyze ON/OFF
AVlt: Auto Volt ON/OFF
ABd: Auto Baud ON/OFF
BdL: Tool baud low-high limits

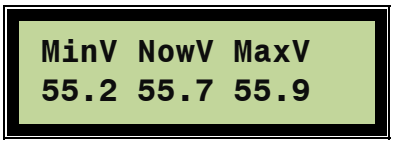
Signal Levels

Displays the minimum (Min), average (Now), and maximum (Max) line current in mA.



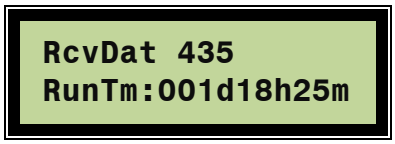
Line Voltage

Displays the minimum (MinV), existing (NowV), and maximum (MaxV) line voltage measured at the surface.



Packet Count and Run Time

Displays the data packet number and elapsed time since the last power on (displayed as elapsed days, hours, minutes).



3.2 Status & Error Message

On power up, the SPS-1500/SPS-1501 will go through 16 analyzing steps to find the optimum tool communication settings. Once the analyze steps are complete, the tool will send its headers and then begin sending tool readings.

Should an error occur, the error will take precedence over the scrolling data and be displayed on the screen. If the error is critical, the board might restart the analyzing steps to reacquire the tool.

See Appendix 4 SPS-1500 Synchronization and Startup to view the complete startup sequence.

4.0 SPS-1500/SPS-1501 DataWorks Software Configuration

DataWorks by Sercel-GRC is a PC software package for configuration, monitoring, and troubleshooting the SPS-1500/SPS-1501. Install the software using the installation program available from Sercel-GRC's Customer Service. Once the software is installed connect the SPS-1500/SPS-1501 to the PC using the USB port on the SPS-1500/ SPS-1501. Run the DataWorks program and set up the serial communication port from the 'Comm Port' button as shown in Figure 2. This button will open the 'Personal Computer Com Port Settings' menu. Select the correct Comm Port and Modbus Slave ID for the SPS-1500/SPS-1501. The default values are shown in Figure 3.

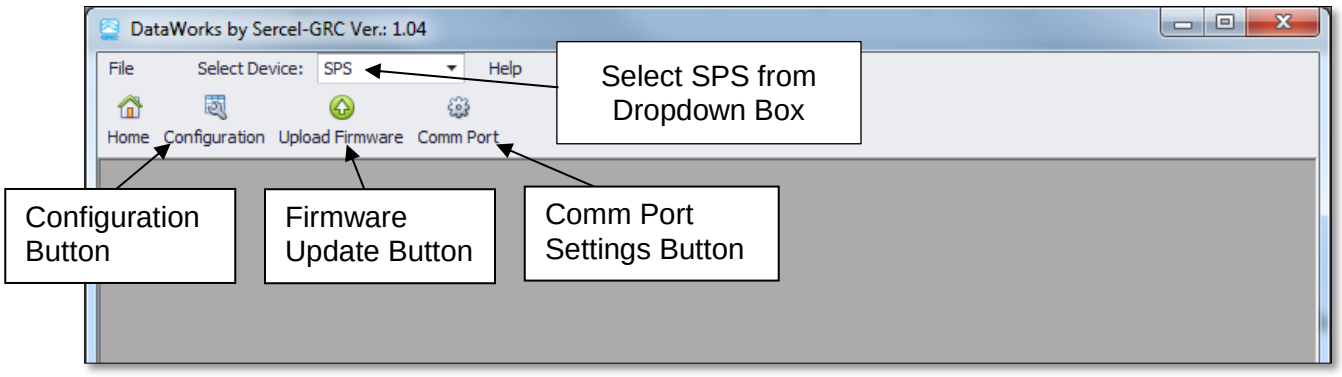


Figure 2. Navigating DataWorks Menu

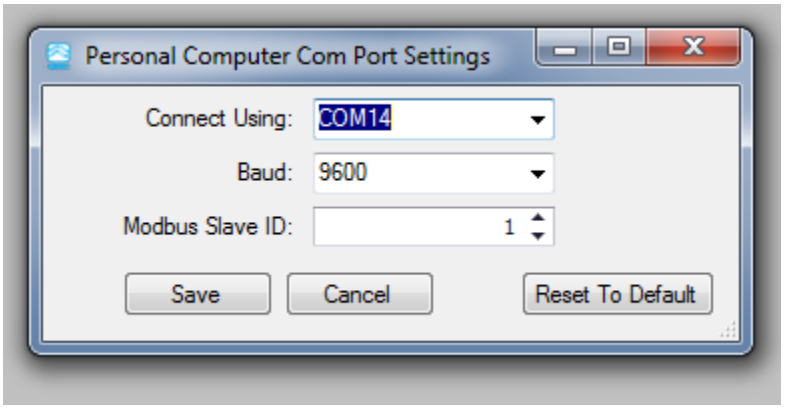


Figure 3. Communication Port Settings Menu

4.1 DataWorks 1.04 Configuration Menu

Once the SPS-1500/SPS-1501 is configured to communicate with the PC, click on 'Configuration' to access different features (as shown in Figure 4).

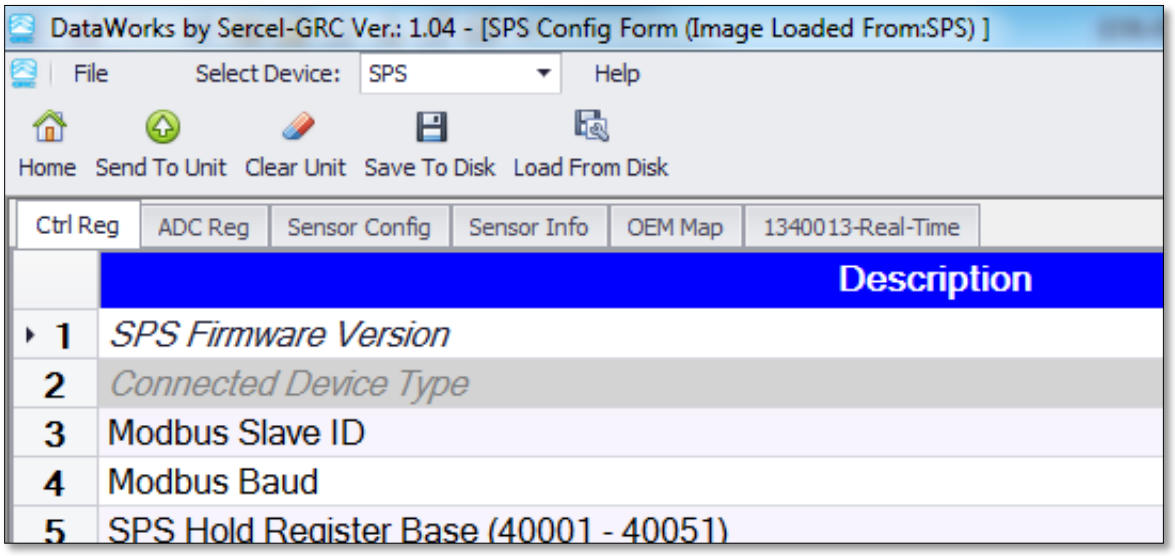


Figure 4. DataWorks 1.04 Configuration Menu

The connected gauge serial number is displayed on the 'Real-Time' tab. Click on 'Real-Time' to enter the graphing window shown in Figure 5.

The Real-Time graph has the following options:

a) Start/Stop Save for Gauge Data. The gauge data can be saved to a computer in the form of ASCII format (*.csv file).

b) Graph any parameter on Primary Y-axis.

c) Edit maximum and minimum limits for Primary/Secondary Y-axis.

d) Graph any parameter on Secondary Y-axis.

e) Select between 'Elapsed Time' and 'Real-Time' on X-axis.

f) Update/Reset. Enter the values in 'Max:' and 'Min:' fields and click on 'Update'. The values can be reset to previously Auto Scaled limits by clicking on 'Reset' button.

g) Chart Controls - Enable/Disable Auto Scale. Disabling Auto Scale will allow the user to change the maximum and lower limits for Y-axis. Enabling Auto Scale will gray out the maximum and lower limit field.

h) Clear All. This option allows clearing the graph and the data grid as well as stops the saving of data.

i) Grid Controls - Enable/Disable Auto Scale. With Auto Scale enabled, the cursor will always point to the latest gauge reading; which appear in the last row of the data grid. With Auto Scale disabled, the cursor does not point to the current gauge reading; the user has to scroll through the data grid.

j) Edit Sample Rate (Data Refresh Rate). The Sample Rate controls the data display rate on the data grid.

k) The chart to plot gauges parameters. All the enabled channels appear in the pull-down menu of Primary/Secondary Y-axis which can be plotted.

l) Gauge data grid. The gauge enable-channels and High-speed-enable-channels appear in a grid with a time stamp.

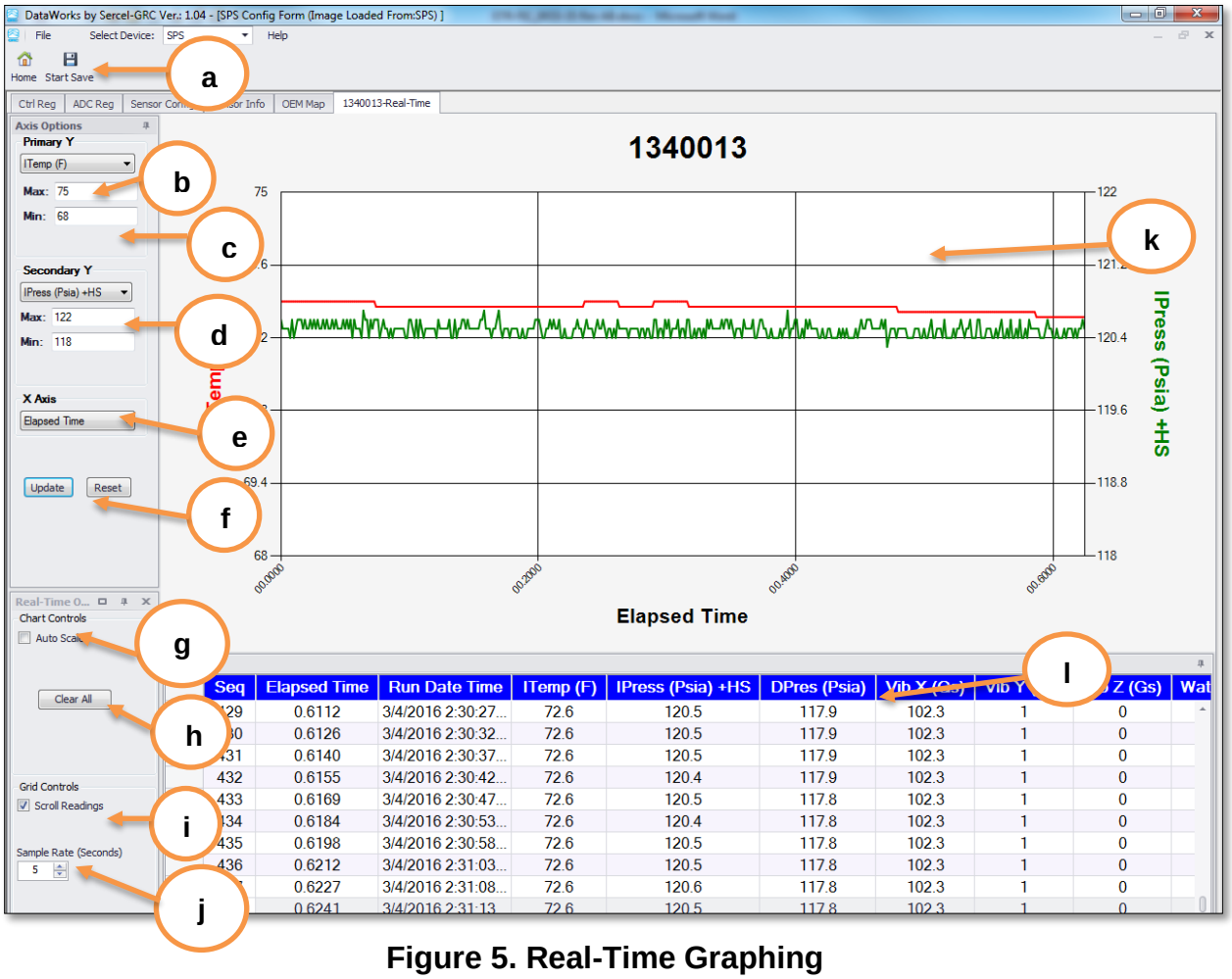


Figure 5. Real-Time Graphing

Gauge data can be saved to the computer in ASCII format (*.csv). Click on 'Start Save' and select the folder location for the gauge data file. The saved file is automatically named using the naming convention of 'Gauge Serial Number Time Stamp'. The gauge data is being written to the file as long as 'Stop Save' button is not clicked. Once the 'Stop Save' is pressed, the data recording stops. The saved 'GaugeSN_timestamp.csv' file can be opened in DataWorks 'Real-Time' window with the following options (see Figure 6):

a) Save Plot – The active plot on the graphing window with the currently selected parameter can be saved in *.png format.

b) Print Plot – This feature prints the graph.

c) Export To CSV – The data file can be saved back after data manipulation.

d) Y axis option – Different parameters can be selected across the 'Primary Y' and 'Secondary Y' axis.

e) Max. and Min. Limits – The upper and lower limit for Primary Y-axis and Secondary Y-axis are adjustable.

f) X Axis – This option allows switching between 'Real-Time' and 'Elapsed Time'. Real-Time is the time with date and timestamp, and Elapsed-Time corresponds to the total number of hours through the operation.

g) Update – Click on ‘Update’ to reflect the newly entered upper and lower limits on the graph.

h) Reset – This feature resets the previously set upper and lower y-axis limits.

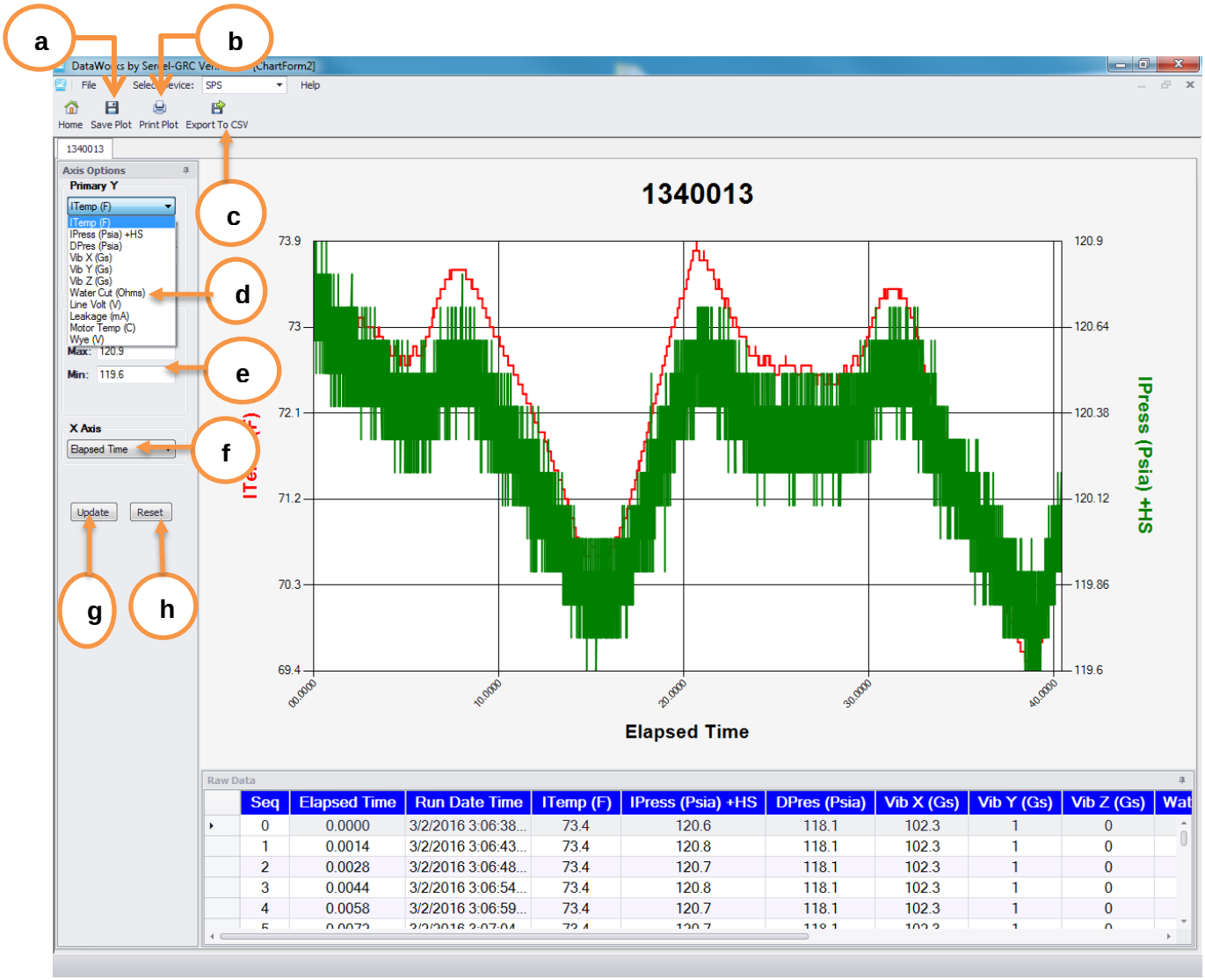


Figure 6. Data Manipulation features from saved gauge data file

4.2 Modbus Communication Map Settings

The Communication Map configures the Gauge Modbus data output from the SPS-1500/SPS-1501. Figure 7 shows the configuration tables for the communication setting menu. Most installations will use the default data table. The Communication Map can change the data type or size for installations located in different regions or with special requirements. The settings allow the user to customize the Modbus map to meet the installation requirements.

The Modbus data registers can be shifted anywhere between holding registers 40001-49999. Changing the Modbus map begins with moving the SPS Holding Register base

address. The SPS Holding Register base address value must be 128 registers from the OEM Holding Register base address.

The default setting for the gauge data parameter range is 40129-40146. To change the gauge parameter address within this range set the 'Order' to the corresponding address. The software will not allow multiple selections to be set to the same value. Setting the 'Order' to '0' will remove the parameter from the Modbus map and also from the SPS-1500/SPS-1501 display.

The 'OEM Map' has the following configurable options:

a) Order – The 'OEM Register Parameter' is mapped to any 'Reg Map' Modbus registers by changing the 'Order' via clicking the up and down arrows.
b) Dec Pts – The decimal places on any gauge parameter are changed by clicking the up and down arrows; adjustable up to 3 decimal places.
c) Unit – The units for the gauge parameter are selectable via a pull-down menu.
d) Length – The bit length for each available 'OEM Register Parameter' is selectable between 16 and 32 via the up and down arrows. If Serial Number is selected for 16-bit, then the Real-Time will show '65536-Real-Time' instead of 'Gauge Serial-Number Real-Time'.

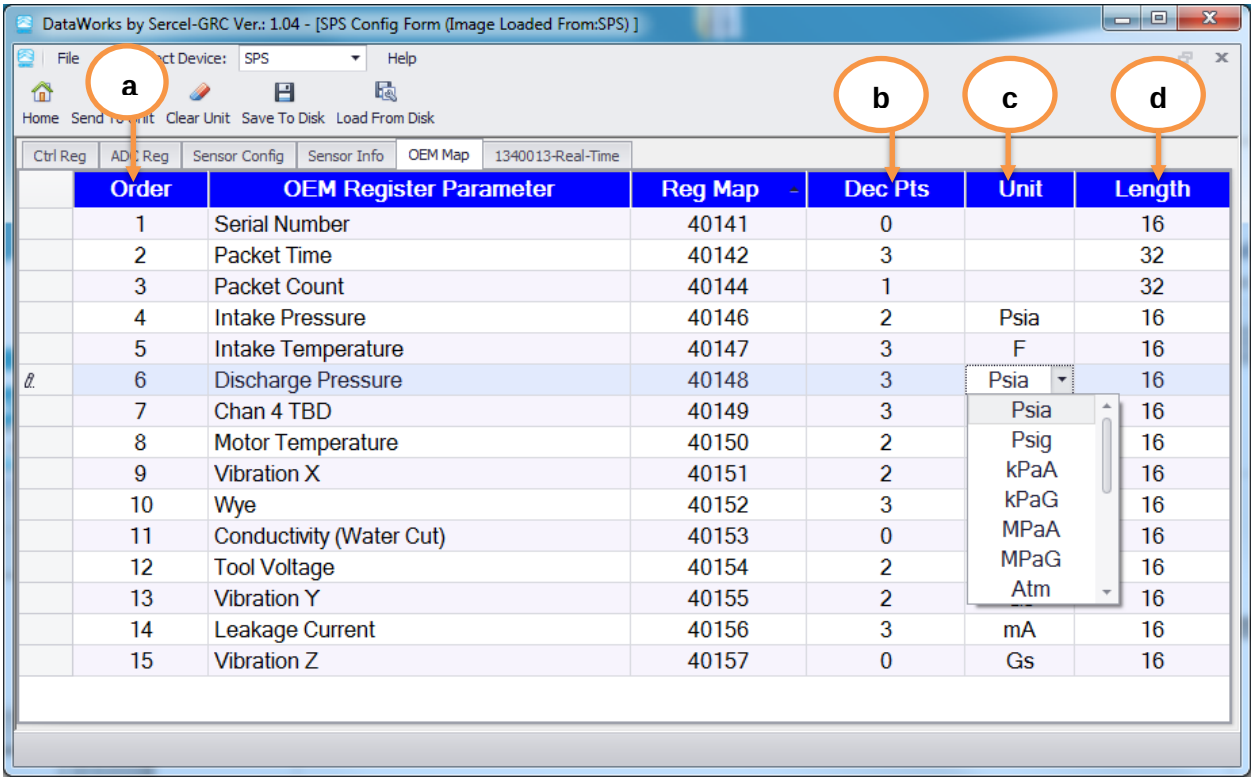


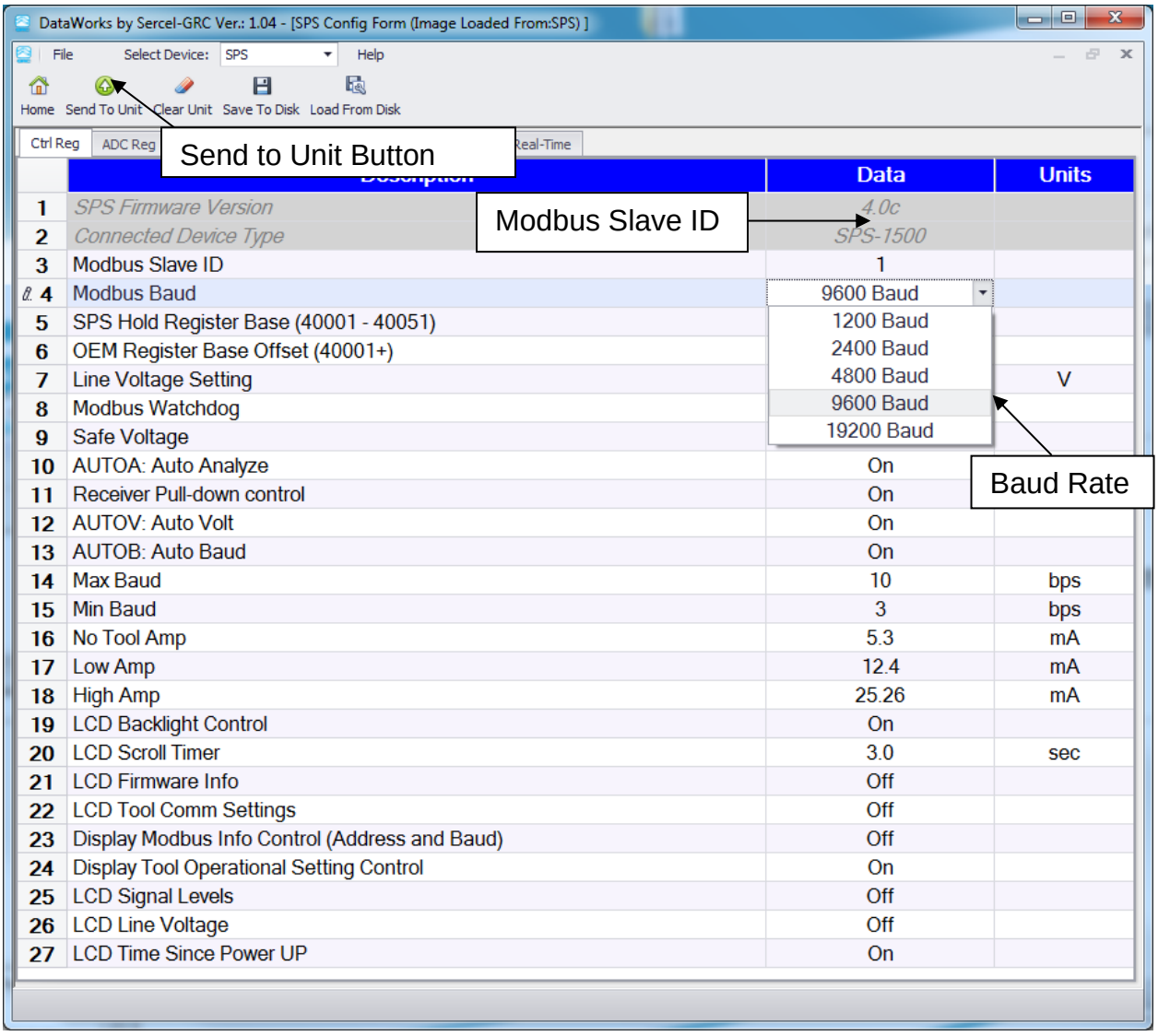
Figure 7. Modbus Communication Map Menu

To set the gauge data parameter range to another range, determine the OEM Holding Register Base address. This will be the lowest register value of the custom Modbus map. Once this value is determined use the scroll boxes for the OEM Holding Register to set this value, then set the SPS Holding Register Base address value to at least 128 registers higher or lower than the OEM Holding Register value. The software will not write Base address values inside the 128 register limit to the SPS-1500/SPS-1501. After

the value is selected click the Parameter in the left column to retain the setting. Once all the values are set, click the ‘Send to Unit’ button to write the configuration to the SPS-1500/SPS-1501. Contact Sercel-GRC Customer Service for additional information on map configuration.

4.3 Modbus Slave ID & Baud Rate Settings

The ‘Ctrl Reg’ tab has several adjustable configuration settings that can be executed in the SPS- 1500/SPS-1501. The Modbus Slave ID is selectable in the range 1 thru 254. The Modbus Baud Rate is selectable from the pull-down menu. Once the desired Modbus slave ID and baud rate have been selected, click on ‘Send to Unit’ to write the configuration to the SPS- 1500/SPS-1501 (see Figure 8). These settings are saved on the EEPROM of SPS- 1500/SPS-1501, so the settings are retained in the next power up.



	Description	Data	Units
1	*SPS Firmware Version*	*4.0c*	
2	*Connected Device Type*	*SPS-1500*	
3	Modbus Slave ID	1	
4	Modbus Baud	9600 Baud	
5	SPS Hold Register Base (40001 - 40051)		
6	OEM Register Base Offset (40001+)		
7	Line Voltage Setting		V
8	Modbus Watchdog		
9	Safe Voltage		
10	AUTOA: Auto Analyze	On	
11	Receiver Pull-down control	On	
12	AUTOV: Auto Volt	On	
13	AUTOB: Auto Baud	On	
14	Max Baud	10	bps
15	Min Baud	3	bps
16	No Tool Amp	5.3	mA
17	Low Amp	12.4	mA
18	High Amp	25.26	mA
19	LCD Backlight Control	On	
20	LCD Scroll Timer	3.0	sec
21	LCD Firmware Info	Off	
22	LCD Tool Comm Settings	Off	
23	Display Modbus Info Control (Address and Baud)	Off	
24	Display Tool Operational Setting Control	On	
25	LCD Signal Levels	Off	
26	LCD Line Voltage	Off	
27	LCD Time Since Power UP	On	

Figure 8. SPS Control Register Settings

4.4 SPS Configuration Settings

The SPS-1500/SPS-1501 controller board is configured from the factory to automatically detect the optimum signal and voltage settings for gauge communication. Some instances may require adjusting the communication settings due to noisy environments, longer wire lengths or other issues that can cause communication problems. DataWorks will automatically detect the SPS configuration and display the current settings. To make changes to the SPS configuration select the parameter to change and make the change using the scroll box. Once all the changes are made click the 'Send to Unit' button.

Cycle SPS-1500/SPS-1501 power to complete SPS configuration changes.

The function 'Save to Disk' saves the SPS-1500/SPS-1501 control register's configurations. Once all the desired settings are done, click on 'Save to Disk' and the window opens up to input a configuration file name. The saved configuration file can be retrieved and loaded back into DataWorks using the function 'Load From Disk'.

4.5 SPS Manual Operation

The SPS-1500/SPS-1501 is designed to automatically detect and operate at optimum levels of communication. The device also has built-in features to protect the electronics from damage. To change the operating modes of the SPS-1500/SPS-1501 select the Configuration register and use the scroll box for the parameter to change the value. The Scroll box will limit the value to the range for the specific register. The LCD configuration can be set using the SPS configuration screen (see Figure 9 for LCD options).

To enable the Manual mode switch the Auto Volt and Auto Analyze off. This will set the line voltage to the Power On Voltage value. To increase the line voltage change the data value to the set voltage required (Min 40V - Max 80V).

Auto Baud sets the tool communication rate to the maximum rate the line conditions will allow. Setting the Min and Max Baud to open the range can eliminate Baud rate errors from the tool. It is common to see 'Baud Fast' or 'Baud Slow' errors during the line analysis. The setting should only change as described in the troubleshooting section of this manual.

The Modbus Watchdog feature monitors the SPS-1500/SPS-1501 Modbus port for communication packets. When the SPS-1500/SPS-1501 receives a valid Modbus packet a timer starts and if the unit does not receive another valid Modbus packet within 5 minutes the unit will reset. If the SPS-1500/SPS-1501 never receives a Modbus packet the unit runs without starting the timer.

Safe Voltage will prevent the SPS-1500/1501 from running if a high line imbalance is detected on the gauge input line. This protects the electronics from overloading the signal when trying to operate over the imbalance (does not apply to the SPS-1501).

SPS Control	Description	Default
Power On Voltage Setting	Sets initial Line Voltage at startup	40.00
MBWD:Modbus Watchdog	Enables 5 Min Modbus packet timer	on
SAFEV:Safe Voltage	Measures Signal Levels before gauge power on	on
Auto Volt	Sets optimum line voltage	on
Auto Analyze	Analyzes for optimum line communication	on
Auto Baud	Toggle Auto Baud	on
Minimum Baud Rate	Edit Minimum tool baud rate	3
Maximum Baud Rate	Edit Maximum tool baud rate	6
Line Voltage Tolerance	Edit Line Voltage Tolerance	4
Low Current	Edit low current threshold	13-14
High Current	Edit high current threshold	24-25
LCD Backlight	Toggle LCD backlight	on
LCD Time	Adjust time between data screens	3
LCD Firmware Information	Toggle Display: Firmware Version	off
LCD Tool Information	Toggle Display: Tool Information	on
LCD Modbus Information	Toggle Display: Modbus Information	on
LCD Wye Imbalance	Toggle Display: Wye Voltage Imbalance	on
LCD Comm Settings	Toggle Display: SPS Communication Settings	on
LCD Signal Levels	Toggle Display: SPS-Tool Signal Levels	on
LCD Line Voltage	Toggle Display: Current Line Voltage	on
LCD Run Time	Toggle Display: SPS-1500/SPS-1501 Power On Time	on

Figure 9. SPS Configuration Control Settings

4.6 Firmware Update

To update the SPS-1500/SPS-1501 firmware version, connect the device to a PC as described in section 4.0. Click the ‘Upload Firmware’ button on the DataWorks Home Screen menu as shown in Figure 10. Verify the Comm Port by clicking ‘OK’ on the SPS Connect window and the Upload Firmware screen will open.

Click the ‘Browse’ button to select the location of the firmware file. When the file is selected begin the update process by cycling the power to the SPS-1500/SPS-1501 immediately after clicking the ‘Begin’ button. The power must cycle within 1 second of sending the ‘Begin’ command. This time period allows the Bootloader to detect the file transfer. Once the firmware upload is completed the SPS-1500/SPS-1501 will return to normal operation.

Note: The SPS-1501 will not communicate with the C-4001T if SPS-1500 firmware is uploaded. Use only firmware designed for the SPS-1501. The same is true for the SPS-1500. Only use firmware designed for the SPS-1500 or it will not communicate with the ESP gauge line.

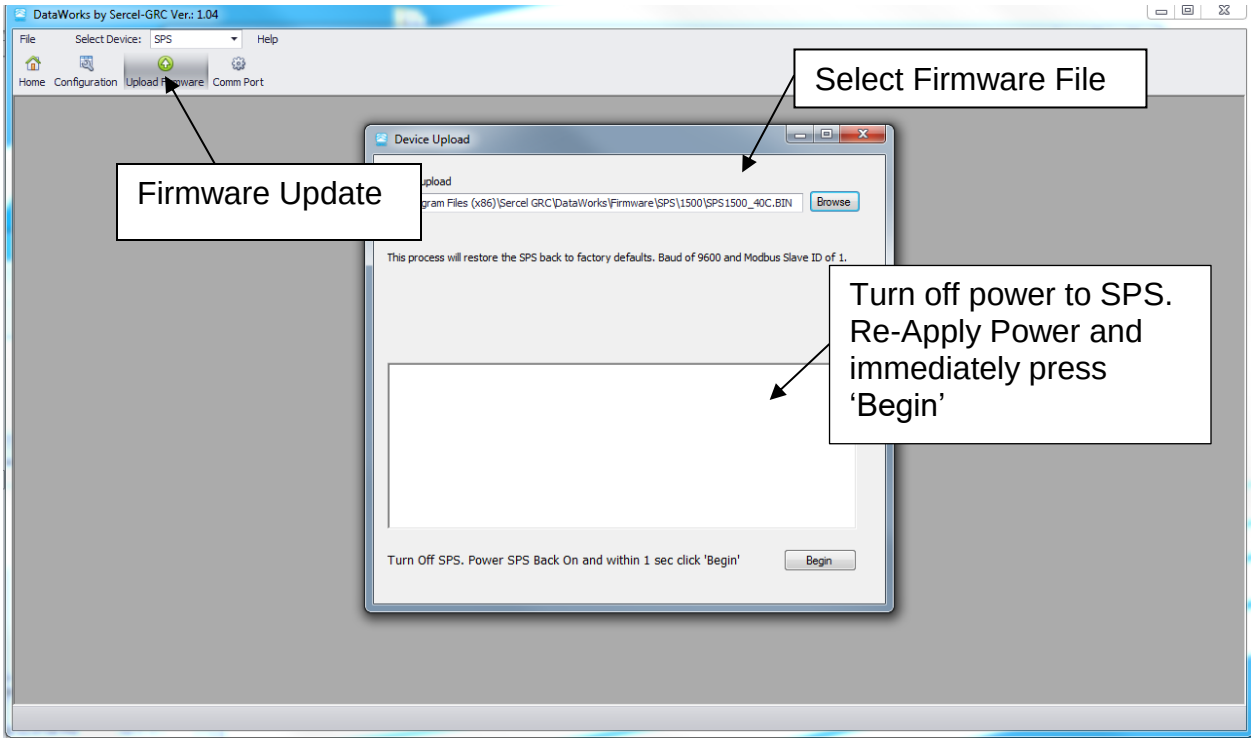


Figure 10. Uploading Firmware in DataWorks

5.0 ESP 'E' Series Sensor Configuration

Sercel-GRC ESP-2500 and ESP-3500 Models are available in an 'E' series. The 'E' series will include a Two-Way Configuration feature. This option allows the user to Enable or Disable ESP Sensor parameters and to configure the Downhole Sensor to communicate at a higher speed data rate using the SPS-1500/1501 and DataWorks Software. Contact Sercel-GRC Sales for 'E' Series Gauge information at sales@Sercel-GRC.com

To utilize the features available on the 'E' Series gauge, allow the SPS-1500/1501 to established data communication with the 'E' Series Downhole Sensor. Once communication is established, DataWorks software will display two additional tabs when the user is on the 'Configuration' page. The additional tabs are labeled 'Sensor Config' and 'Sensor Info', as shown in Figure 11.

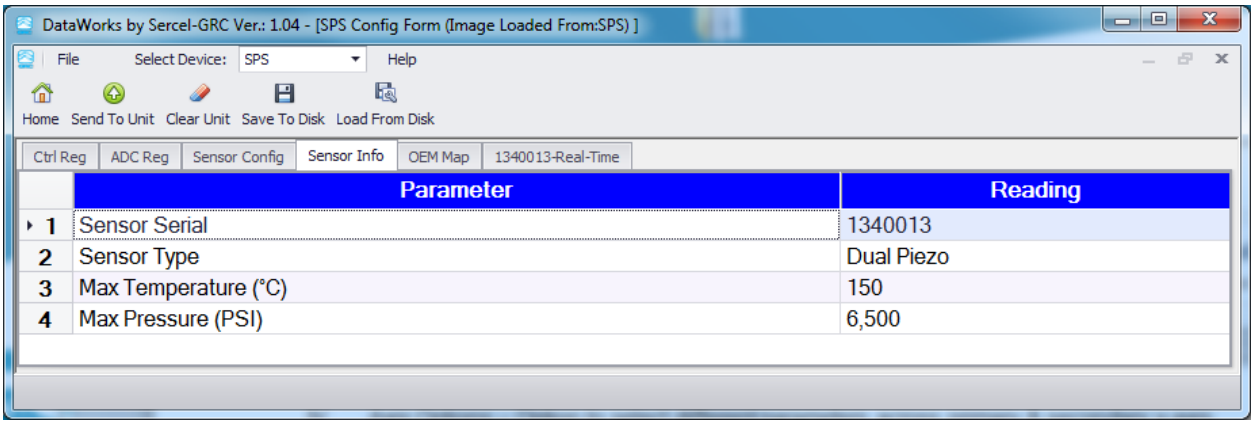


Figure 11. Sensor Information Window

To configure any parameter to transmit data at the high-speed data rate, or to enable or disable any available sensor parameter, click on the Sensor Config tab. Unavailable parameters will be shaded in gray and text will be in italics.

To enable/disable sensor parameters, click on the desired parameter under 'Channel Enabled' and select 'Off' or 'On' from the drop-down box as shown in Figure 12. 'Off' will disable the selected channel and the downhole sensor will no longer send data for the selected parameter to the surface unit. When all desired changes have been made, click the 'Send to Unit' button to send the configuration to the downhole sensor.

To set sensor parameters to transmit at the high speed' data rate, click on the desired parameter under 'High-Speed Enabled' and select 'Off' or 'On' from the drop-down box. When all desired changes have been made, click the 'Send to Unit' button to send the configuration to the downhole sensor.

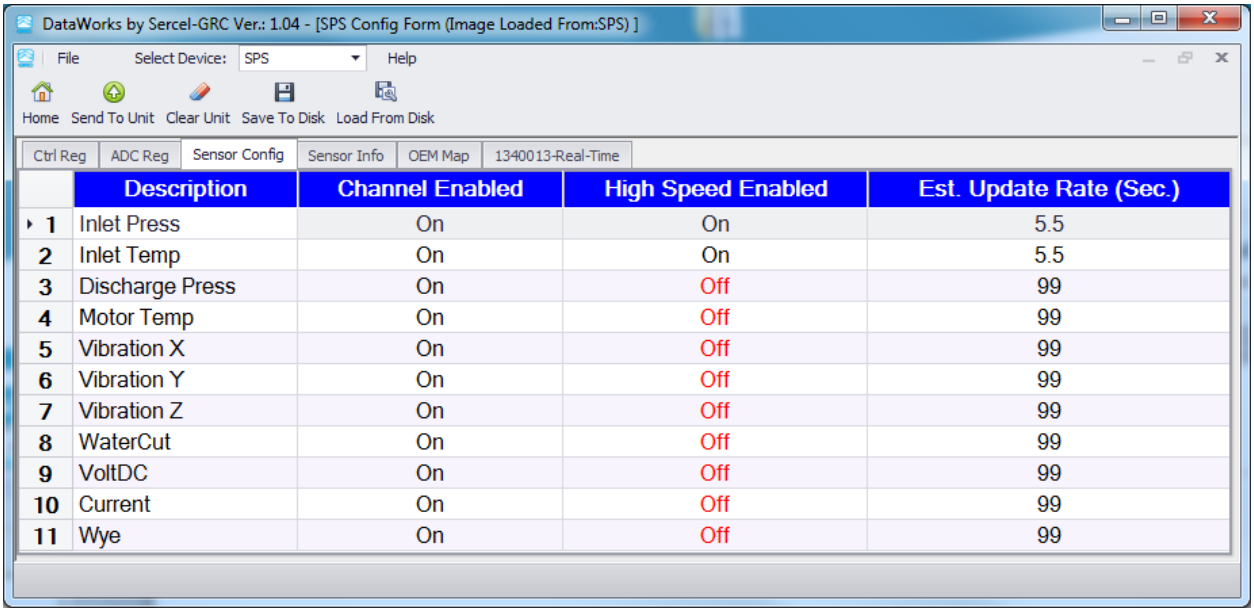


Figure 12. Sensor Configuration Window

After clicking on the ‘Send to Unit’ button, the software will give the message: ‘Do you wish to send the Sensor Configuration?’. Click yes to send the configuration to the downhole sensor, shown in Figure 13.

The SPS-1500/SPS-1501 will restart and give the following display messages:
Power Off
Sync Phase 3
Sync Phase 4
Sync Phase 5
Checking Tool
Programming Tool
Tool Response
Tool Configured!
Rcv Hdr 0
Rcv Hdr 1
Rcv Dat1

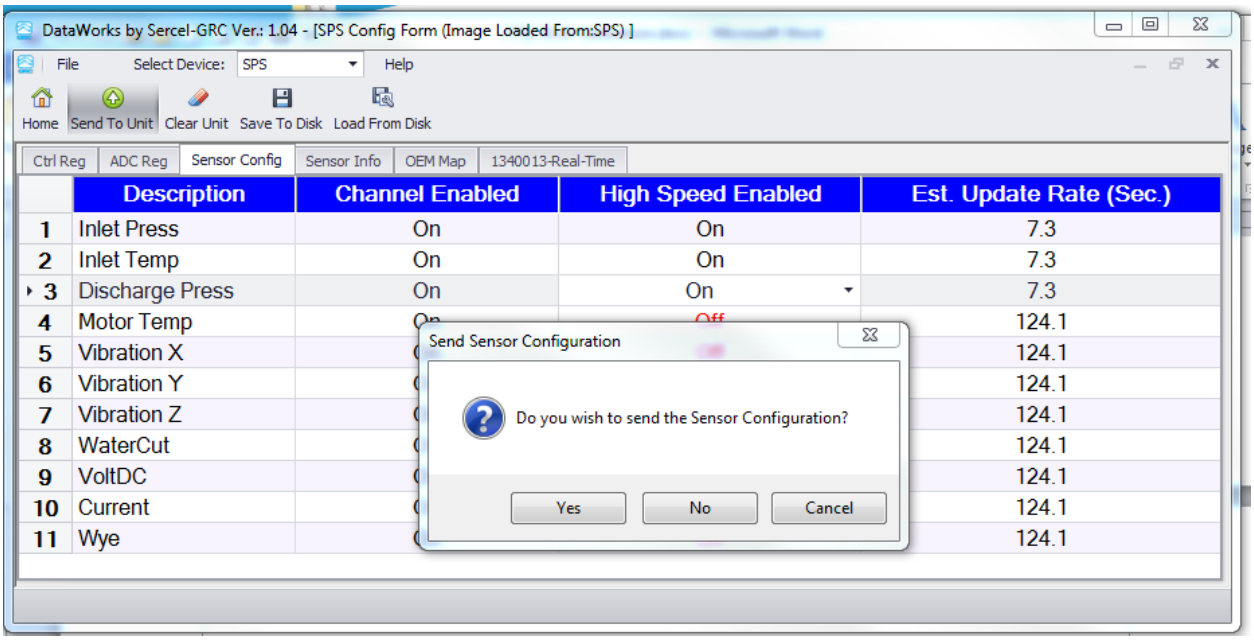


Figure 13. Send Sensor Configuration Message

Selecting ‘No’ to this message will only send changes made to the ‘Config Coils’ tab and the ‘Ctrl Reg’ tab, but will not send any sensor configuration to the downhole sensor.

Selecting ‘Cancel’ to this message will not send any changes to the SPS-1500/SPS-1501.

The Parameter Enable/Disable channel and High-Speed Enable/Disable configurations that are sent to the downhole sensor will be saved in the SPS-1500/1501 and resent to the sensor in the event of a power loss. To return the sensor to the factory default configuration, click the ‘Clear Unit’ button. This will re-enable all default sensor parameters and reset all high speed channels to standard mode.

6.0 High Speed Operation

High Speed operation can be configured on any available sensor channel. The channel(s) that are set to 'High Speed' will update at a higher sample rate than the standard mode. Update Rates for various sensor configurations are shown in Figure 14.

High Speed enabled channels will display 'HS' beside the Modbus register on the SPS-1500/SPS-1501 LCD. While running 'Real Time' via DataWorks software, a High Speed channel will be displayed +HS on the enabled channels column heading (see Figures 15 and 16).

ESP Gauge	High Speed Mode Configuration (High Speed Parameters Enabled)	*High Speed Update Rate for Selected Parameters (Seconds to next update value)	**Full Rate for remaining parameters (Seconds to next update value)
ESP-2500	Standard	None	30
ESP-3500	Standard	None	35
ESP-2500/3500	Intake Pressure ONLY	2.5	none
ESP-2500/3500	Intake Pressure Intake Temperature ONLY	4.5	none
ESP-2500/3500	Intake Pressure Intake Temperature Motor Temp ONLY	6.5	none
ESP-2500	Intake Pressure (All other parameters at Full Rate)	4	60
ESP-2500	Intake Pressure Intake Temperature (All other parameters at Full Rate)	6	72
ESP-2500	Intake Pressure Intake Temperature Motor Temp (All other parameters at Full Rate)	8	80
ESP-3500	Intake Pressure (All other parameters at Full Rate)	4	76
ESP-3500	Intake Pressure Discharge Pressure (All other parameters at Full Rate)	6	126
ESP-3500	Intake Pressure Discharge Pressure Intake Temperature (All other parameters at Full Rate)	8	144
ESP-3500	Intake Pressure Discharge Pressure Intake Temperature Motor Temperature (All other parameters at Full Rate)	10	150

Figure 14. 'High Speed' Data Rates

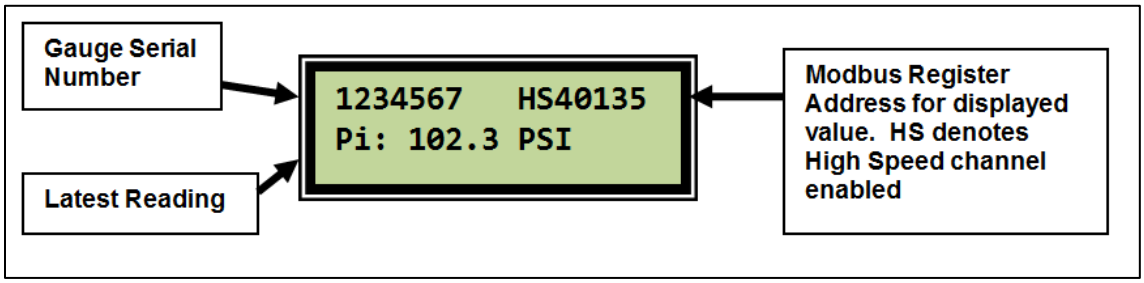


Figure 15. 'High Speed' Enabled Channel Display

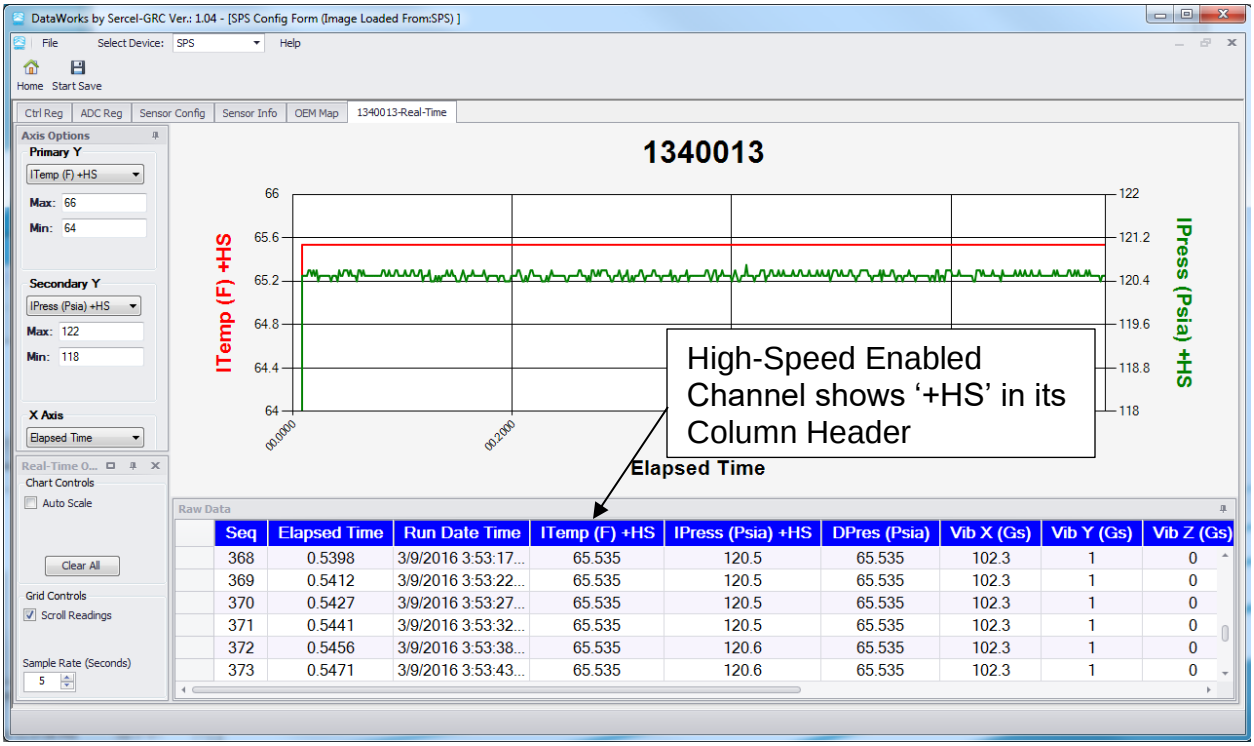


Figure 16. 'High Speed' DataWorks Display

Appendix

1 SPS-1500/SPS-1501 Troubleshooting

The SPS-1500/SPS-1501 may experience communication problems due to noisy environments, grounding problems, or installation issues. The LCD on the SPS-1500/SPS-1501 will display error codes depending on the failure it is detecting. Below is a list of common error codes and possible solutions to assist with troubleshooting the SPS-1500/SPS-1501. To change the settings recommended you will need to use DataWorks as described in section 4.5 of this manual.

Note: During normal start-up communications with the tool you will see error messages such as “High Amp”, “Low Amp”, “DC-DC Bad”, “DC-DC Chk”, “Analyze 1” through “Analyze 16” as well as other normal messages that are all part of acquiring the tool. After the SPS analyzes the line current from the tool you will see the message “SPS Power OFF” a couple of times. Then the SPS will show 2 or 3 phase Sync cycles and then begin to read gauge header data. This is all part of normal operations of the SPS-1500/SPS-1501. There is only a concern when an error message is repeated multiple times and communications is not established with the gauge after five minutes.

Note: Corrections represent individual actions in the sequence they should be tried. If the first one doesn’t work try the next one.

Error	Possible Cause	Troubleshooting Step
DC-DC Bad or DC-DC Chk - *(Voltage measured by SPS is not matching what is sourced by SPS.)*	• Bad Ground Connection • Low Resistance from Gauge Signal to Ground • Excessive Gauge signal line current • Faulty SPS	• Check Downhole readings (Phase-Phase & Phase-Ground (Reverse Polarity Megger)) • Try alternate SPS power supply • Use voltmeter to confirm voltage MAX Voltage is over 45VDC.
Baud Fast – *(Gauge Data is changing at a Rate higher than expected)*	• Set voltage is too high • Motor noise affecting gauge current modulation	• Disable Auto Baud and raise Max Tool Baud to 8-10 • Reboot or cycle power to restart analyzing stage • Disable Auto Volt/ Auto Analyze with DataWorks. Set voltage to ~60VDC.
Low Amps – *(Gauge current is lower than expected)*	• Disconnected from tool • High resistance connection at motor WYE point to gauge • Blown Signal fuse • Low amp setting set to high	• Check Downhole readings (Phase-Phase & Phase-Ground (Reverse Polarity Megger)) • Check all connection(s) • Check Signal fuse • Check Setting of Low amp with DataWorks (15VDC Nominal) • Check Setting of High amp with DataWorks (25VDC Nominal)
High Amps – *(Gauge current is higher than*	• Poor Wellhead grounding • Excessive Gauge Signal Line Current or injection of noise	• Connect to the SPS with “DataWorks” software to manually set the following current settings for the gauge:

expected)	from motor at wye point.	• - Check Setting of Low amp (15mA normally for SPS-1500 and 2-8mA normally for SPS-1501) • - Check Setting of High amp (25mA normally for SPS-1500 and 22-26mA normally for SPS-1501) • Verify Downhole readings (Phase to Phase, Phase-Ground (Reverse Polarity Megger)) • Replace the SPS-1500/SPS-1501
Analyzing – (SPS is adjusting output voltage to analyze gauge signal)	• **Normal Operation message** unless message is continuous or repeating over 5 minutes.	• If message is continuous or repeats over 5 minutes: ○ Check all wire connections ○ Check Phase to Phase and Phase-Ground connection (Reverse Polarity Megger) (Applies to SPS-1500 only) ○ Check Signal fuse ○ Adjust Set voltage (Approx. 60+/- for 1500 and Approx. 40+/- for the SPS-1501). This can be done using "DataWorks" software.
No Tool – (No Tool indicates there is no gauge current)	• Blown SPS Fuse • Blown Surge Protector Fuse/MOV • Bad SPS to Gauge Signal wire connection • No-Tool Current setting incorrect in SPS	• Read the DC current drawn by the gauge with an ammeter in series and DC mode. DC current is normally 15-30mA. • Check all fuses and surface connections. • If connections and equipment okay error may indicate possible downhole connection is open. • Using "DataWorks", verify "No Tool Amp" value is set to 5.3mA (default value).
Line Noisy – (SPS is unable to measure current modulation from gauge)	• Motor WYE phase imbalance voltage is high	• Check all fuses and surface connections. • If connections and equipment okay error may indicate possible downhole problem. • Check line voltage at wye point on surge protector for motor noise injection.
No Signal – (SPS measures gauge current but no modulation current)	• Possible SPS/gauge firmware corruption • Possible SPS/gauge component failure • No-Tool Current setting incorrect in SPS	• Use DC Ammeter to measure DC current from SPS to gauge. Gauge current is normally modulated from approximately 15mA to 25mA. If not modulated, check SPS and connections.
OKAY	• **Normal Operation**, no errors	• SPS is communicating with the gauge

Note: Many problems with the SPS-1500 can be solved with proper grounding techniques. A good ground must be established from the production tubing at wellhead back to the ground point at the surface package for proper operation. This does not apply to the SPS-1501 as it grounds to the TEC line.

2 SPS-1500/SPS-1501 Modbus Map

Default Holding Registers are shown below:

TAG	HEX ADDR	UNITS	DESCRIPTION	COMMENTS	RANGE[1]
40129	0080	Serial Number	Serial Number High	Long Integer Tool Serial Number	0 ↔ 4294967295
40130	0081		Serial Number Low		
40131	0082	Seconds * 10	Packet Time Stamp High	1234 is 123.4s	0.0s ↔ 429496729.5s
40132	0083		Packet Time Stamp Low		
40133	0084	Count Value	Packet Count High	1234 is 1234 packets	0 ↔ 4294967295
40134	0085		Packet Count Low		
40135	0086	Psia * 10	Intake Pressure	1234 is 123.4psia	0.0psia ↔ 6553.5psia
40136	0087	°F * 10	Intake Temperature	1234 is 123.4°F	0.0°F ↔ 6553.5°F
40137	0088	Psia * 10	Discharge Pressure	1234 is 123.4psia	0.0psia ↔ 6553.5psia
40138	0089	°F * 10	Discharge Temperature	not available	
40139	008A	°F * 10	Winding Temperature	1234 is 123.4°F	0.0°F ↔ 6553.5°F
40140	008B	g * 100	Vibration X	123 is 1.23gs	0.00g ↔ 655.35g
40141	008C	Volts	WYE Voltage or Flow	123 is 12.3V	0.0V ↔ 6553.5V
40142	008D	** Kohms for Spy Pro, Ratiometric value for all others	Conductivity (WaterCut)	123 is 123Kohm	0Kohm ↔ 4096Kohm
40143	008E	Volts * 10	Line Voltage	123 is 12.3V	0.0V ↔ 6553.5V
40144	008F	g * 100	Vibration Y	123 is 1.23gs	0.00g ↔ 655.35g
40145	0090	mA * 1000	Leakage Current	123 is 0.123mA	0.000mA ↔ 65.535mA
40146	0091	g* 100/none	Vibration Z/spare	123 is 1.23gs	0.00g ↔ 655.35g
SPS OEM Data Registers.					

[1] Sensor values may not actually span the entire Range shown. Range is shown for decoding purposes only.

Holding 4x Registers				
TYPE	REGISTER	HEX ADR	DESCRIPTION	
	Applicable Modbus Functions: 3: Read Holding Register 6: Preset Holding Register 16: Preset Multiple Holding Registers			
EEPROM	40001	0000	Control	Power On Volt Setting
	40002	0001	Max Slow Baud	Min Slow Baud
	40003	0002	DC-DC Regulator Tolerance	
	40004	0003	Line Voltage Tolerance	
	40005	0004	No Tool Amp	
	40006	0005	Low Amp	
	40007	0006	High Amp	
	40008	0007	DC-DC Warm Time	Power Off Time
	40009	0008	Amps Timeout	Volts Timeout
	40010	0009	Amps Stable Time	Sync Bits Measure
	40011	000A	Signal Wait Time	Signal Measure Time
	40012	000B	Timer0 Stable Count	
	40013	000C	Sync Wait	Max Packet Errors
	40014	000D	Reserved	
	40015	000E	SPS-1500 LCD Config	
	40016	000F	Reserved	
	40017	0010	Flags	
	40018	0011	Status Error	
	40019	0012	Line Set	Voltage Reference
	40020	0013	Baud Setting	
	40021	0014	Elapsed Time Hi Word	
	40022	0015	Elapsed Time Lo Word	
	40023	0016	Packet Count Hi Word	
	40024	0017	Packet Count Lo Word	
	40025	0018	Signal Level Low	
	40026	0019	Signal Level High	
	40027	001A	ADC Line Amps	
	40028	001B	ADC Reference Volts	
	40029	001C	ADC Line Volts	
	40030	001D	ADC DC-DC Volts	
	40031	001E	ADC Minimum Line Amps	
	40032	001F	ADC Minimum Reference Volts	
	40033	0020	ADC Minimum Line Volts	
	40034	0021	ADC Minimum DC-DC Volts	
	40035	0022	ADC Maximum Line Amps	
	40036	0023	ADC Maximum Reference Volts	
	40037	0024	ADC Maximum Line Volts	
	40038	0025	ADC Maximum DC-DC Volts	
	40039	0026	SPS-1500 Volt Imbalance (*no longer valid*)	
	40040	0027	Tool Control	
	40041	0028	Tool Config 1	
	40042	0029	Tool Config 2	
	40043	002A	Tool Config 3	
	40044	002B	Tool Config 4	
	40045	002C	Tool Config 5	
	40046	002D	Tool Config 6	
	40047	002E	Tool Config 7	
	40048	002F	Tool Config 8	

	40049	0030	Tool Config 9	
	40050	0031	Tool Config 10	
	40051	0032	Tool Config 11	
	40052	0033	Tool Config 12	
TYPE	REG	HEX ADR	DESCRIPTION	
Coil 0x Registers				
FLASH	**Applicable Modbus Functions:** 1: Read Coil Status 5: Force Single Coil 15: Force Multiple Coils			
	0	0000	SPS ID	Revision
	1	0001	Modbus Address	Modbus Baud Index
	2	0002	SPS Holding Register Base Address	
	3	0003	OEM Holding Register Base Address	
	4	0004	OEM Gauge Serial Number Length/Order	
	5	0005	OEM Packet Time Length/Order/Precision	
	6	0006	OEM Packet Count Order/Length	
	7	0007	OEM Intake Pressure Length/Order/Unit/Precision	
	8	0008	OEM Intake Temperature Length/Order/Unit/Precision	
	9	0009	OEM Discharge Pressure Length/Order/Unit/Precision	
	10	000A	OEM Discharge Temperature Length/Order/Unit/Precision	
	11	000B	OEM Motor Temperature Length/Order/Unit/Precision	
	12	000C	OEM Vibration X Length/Order/Unit/Precision	
	13	000D	OEM Flow Length/Order/Unit/Precision	
	14	000E	OEM Conductivity Length/Order/Unit/Precision	
	15	000F	OEM Voltage Length/Order/Unit/Precision	
	16	0010	OEM Vibration Y Length/Order/Unit/Precision	
	17	0011	OEM Leakage Current Length/Order/Unit/Precision	
	18	0012	OEM Spare Length/Order/Unit/Precision	
Holding 4x FIFO Queues				
	Applicable Modbus Functions: 24: Read FIFO Queue			
RAM	40257	0100	Tool Header FIFO Queue	
	40513	0200	Tool Data FIFO Queue	
	40769	0300	SPS Analyzer Data Queue	
SPS Configuration Holding Registers				

3 CE Compliance Certifications

EMISSIONS	IMMUNITY
European Regions: ♦ EN55022; 2010, CISPR 22 Ed. 6.0: 2008 Class A Emissions (Radiated) North America Regions: ♦ CFR 47, Part 15, Subpart B, Class A, 2011 ♦ ICES-003 Issue 4, 2004 CAN/CSA-CEI/IEC CISPR 22;02, Class A	European Regions: EN55024 : 2010 and EN 61326-1: 2006 • EN61000-4-2 Ed. 2.0;2008: ESD ± 8 kV Air, ± 4 kV Contact • EN61000-4-3 Ed. 3.2;2010: RF Immunity, 10V/m • EN61000-4-4 Ed. 2.0 Amd.1; 2010 EFT, .5 kV • EN61000-4-6 Ed. 3.0; 2009: Conducted Susceptibility, 3Vrms

4 SPS-1500 Synchronization and Startup

During the initial startup, the SPS tries to acquire the ESP gauge by performing a series of synchronization and analyzing steps. Below is typically what is displayed on the LCD screen, leaving out additional messages.

The additional messages could contain any of the following text: “Okay”, “High Amp”, “Low Amp”, “DC-DC Bad”, and “DC-DC Chk” . These messages indicate the SPS is making adjustments to best set up the gauge for communication, such as compensating for cable length or the data rate. These messages are normal.

Power On-Display:

GRC SPS-1500 Firmware Revision & Revision Date	
SPS Baudrate: 9600 Slave ID: 1	
Stat: Power Off	
Stat: SyncPhs 1	
Stat: SyncPhs 3	
Stat: Analyze 1	
Stat: Analyze 2	
Stat: Analyze 3	
Stat: Analyze 4	
Stat: Analyze 5	
Stat: Analyze 6	
Stat: Analyze 7	
Stat: Analyze 8	
Stat: Analyze 9	
Stat: Analyze 10	
Stat: Power Off Tst: Analyzing	This step could occur in various places during the set up.
Stat: Analyze 11	
Stat: Analyze 12	
Stat: Analyze 13	
Stat: Analyze 14	
Stat: Analyze 15	
Stat: Analyze 16	
Stat: Power Off	
Stat: SyncPhs 3	
Stat: SyncPhs 4	
Stat: SyncPhs 5 Okay	Counts down from 15 to 0
Checking Tool…	
Checking Tool… Improved-ESP	
Stat: Checking T Okay	Checking Tool for 2-way
Rcv Hdr 0 Okay	Counts down from 16 to 0
Sensor Serial Number ISP+/ESP+ Okay	Counts down from 26 to 0

Note: During normal start-up and synchronization with the sensor you will see “Analyze 1” through “Analyze 16”. You may see messages of “High Amp”, “Low Amp”, “DC-DC Bad”, “DC-DC Chk”, as well as other normal messages that are all part of acquiring the tool. During the Analyzing steps, you will see “SPS Power Off” then “Tst: Analyzing” two times and then additional sync phase packets. After the SPS-1500 analyzes the line current from the sensor, it will check for Enhanced Communication capability and begin to receive header data from the tool. This is all part of normal operation of the SPS-1500.

These steps might take anywhere from 2 to 5 minutes to complete. If data is not received after 5 minutes, proceed to the troubleshooting section of this manual **Appendix 1 SPS-1500/SPS-1501 Troubleshooting**.

5 SPS-1500/FIC-1500 LCD SCREEN REPAIR

Please refer the WKI-134192, Please ask Sercel-GRC field Service Or Sales Personnel to get the latest copy of the work Instruction.

Contact Sercel-GRC Customer Service
for any SPS-1500/SPS-1501 problem.

Sercel-GRC Corp.

17200 Park Row ,
Houston, Texas 77084
E-Mail: sales@Sercel-GRC.com or support@Sercel-GRC.com
Telephone: (1) 281 647 7300