TIS 8 RECEIVER

USER'S MANUAL

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Acknowledgments

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Preface

This manual contains information about the TIS-8 hardware and software.

Documentation Format

The documentation is structured to the following format:

- Chapter 1, Software Installation
- Chapter 2, Configuration Software
- Chapter 3, Viewing Data Files
- Appendix A, Hardware Installation
- Appendix B, Hardware Description
- Appendix C, Hardware Data Sheets

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C H A P T E R 1

1.0 SYSTEM REQUIREMENTS & INSTALLATION

This chapter lists the system requirements needed for installing and running the Wavewin software and the TIS 8 Configuration software it also provides technical support information.

1.1 SYSTEM REQUIREMENTS

The system requirements are listed below.

Recommended System Requirements:
1GHz Processor,
1GB of memory,
10GB of hard disk space,
VGA, 8514/A, or compatible graphics adapter,
Microsoft Windows Xp or higher,
Network Interface Card.

Minimum System Requirements:
500MHz Processor,
512MB of memory,
500MB of hard disk space,
VGA, 8514/A, or compatible graphics adapter,
Microsoft Windows 98 or higher,
Network Interface Card.

1.2 SOFTWARE INSTALLATION

The system files are distributed in a compressed format. To install the software follow the instructions for the type of storage media distributed with this manual.

CD: To install the software using a CD, place the CD into the CD-ROM drive. The installation program will run automatically. If the install program does not run automatically open Windows Explorer, navigate to the CD drive and double click on the install.exe application located on the root drive.

Follow the instructions to fully install the software.

Figure 1.1 - Start Software Installation

The default destination folder path is C:\Wavewin COMTRADE. To change the default path either type in a new install path or click on the browse button to select an existing directory.

The destination folder is the location where all the files are to be copied.

Click “Next” to start the installation.

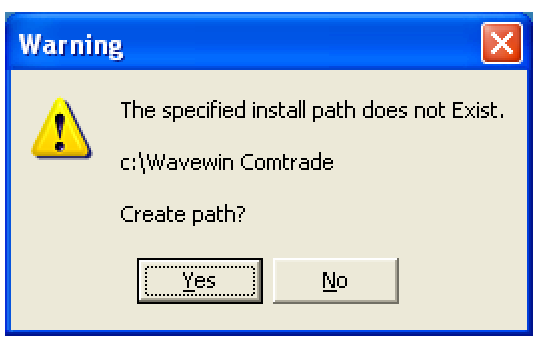


Figure 1.2 - Create Install Path

Click “Yes” to create the path.

Figure 1.3 - Finish Software Installation

The install is now complete click “Finish” to end the installation.

1.3 TECHNICAL SUPPORT

Although this system is easy to use and understand, at some point you may encounter a technical question, feel that the system has improperly operated, or have suggestions for future improvements. In either case, contact SoftStuf using one of the following methods:

Phone: 215-627-8850, hours are from 9:00 a.m. to 6:00 p.m. Mon- Fri, (EST).
Fax: 215-625-2497, response time is 24 hours.
E-mail: support@softstuf.com, response time 24 hours.

C H A P T E R 2

2.0 CONFIGURATION SOFTWARE

This chapter describes how to use the Wavewin Sniffer Configuration Software. To begin, click on the installed desktop icon TISConfig or open the Start Menu, navigate to the installed program folder and click on the TISConfig shortcut.

2.1 CONFIGURATION SOFTWARE

The Configuration software is used to configure and save the device channel properties. To connect, enter the device IP address and click "Connect" or press enter.

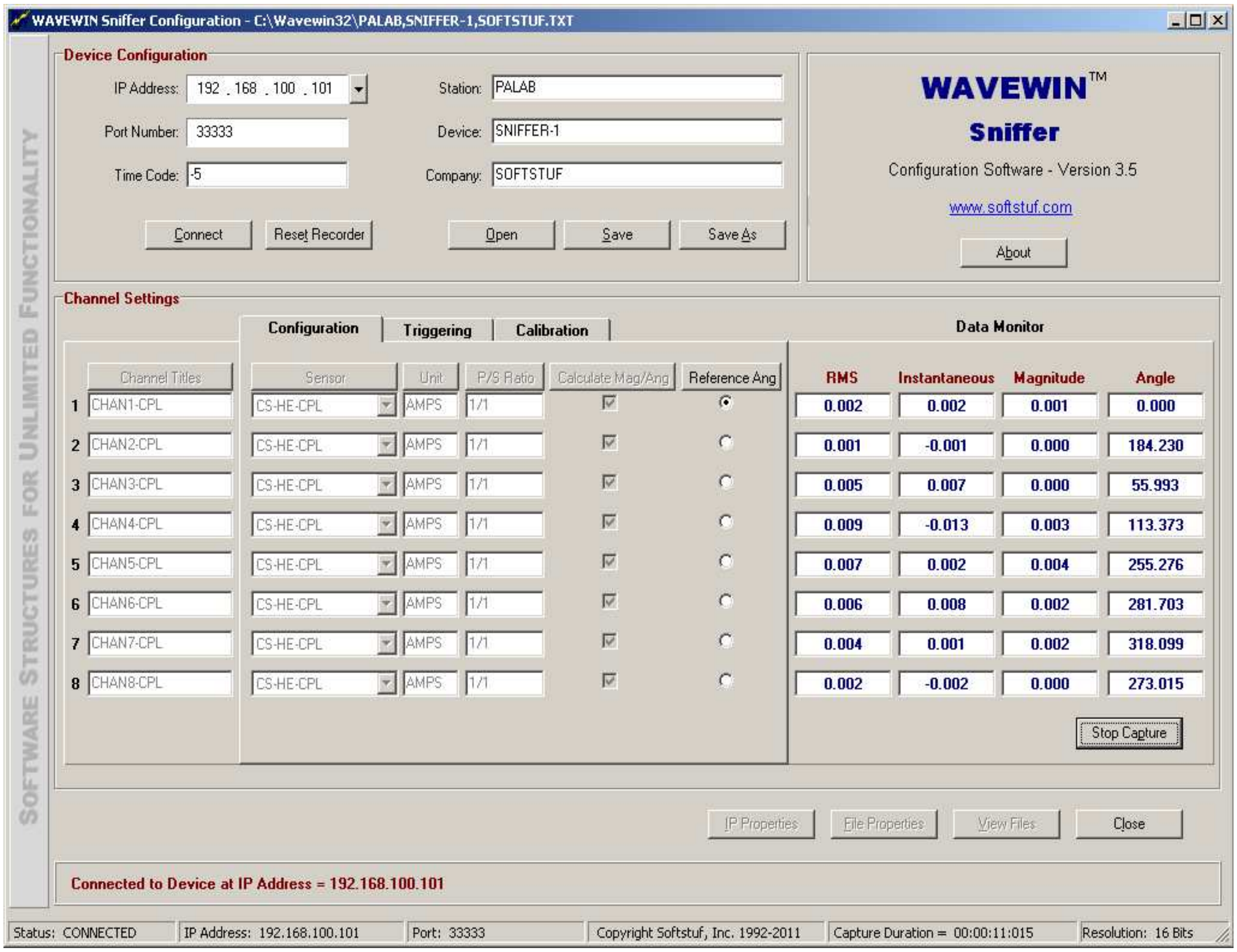


Figure 2.1 - Configuration Software

If the device is connected properly a message will be displayed at the bottom of the window stating "Connected to Device at IP Address =". If an error was encountered connecting, then an error message will be displayed. Refer to Figure 2.2

Figure 2.2 - Error Connecting

If an error message is displayed check the connection of the device to the computer or switch and make sure the device is powered up. Also, make sure the local IP address of the computer is on the same network as the device. Refer to “Configure Window’s IP Address” in Appendix-A and the “Troubleshooting” section in Appendix-B for more information.

2.2 DEVICE CONFIGURATION

This section defines the device configuration fields. Refer to Figure 2.3.

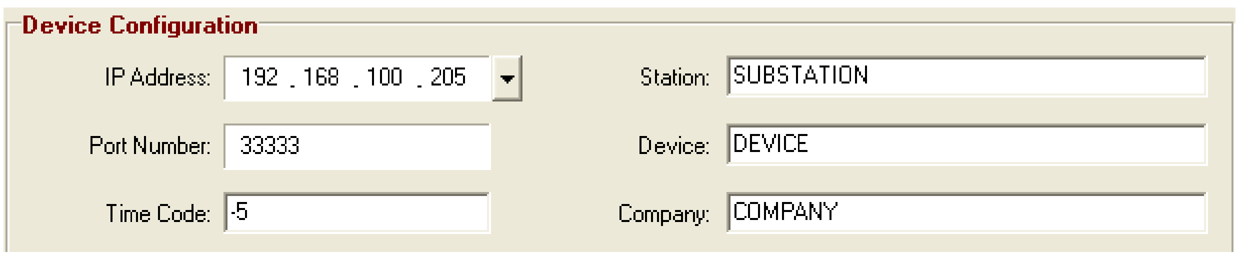


Figure 2.3 - Device Configuration Fields

The table below defines each field in the device configuration section. The IP address, port number, time code, station, device and company name. The subnet mask of the device is fixed at 255.255.0.0 and the resolution is fixed at 16 bits.

Table 2.1 - Device Configuration Information

Field	Description	Default
IP Address	A unique identifier for the device on a TCP/IP network.	192.168.100.205
Port Number	Ethernet port number of the device. This field is automatically populated from the device.	33333
Time Code	Time code where the device is installed. Time is offset from Greenwich Mean Time (GMT).	-5
Station	Name of the substation where the device is installed. The default name is automatically populated in the title of the configuration file if the file is untitled.	SUBSTATION
Device	Name of the installed device. The default name is automatically populated in the title of the configuration file if the file is untitled.	DEVICE
Company	Name of the company that owns the device. The default name is automatically populated in the title of the configuration file if the file is untitled.	COMPANY

2.3 CONFIGURATION FILES

This section defines how to open and save a device configuration. When using the save button while connected to the device, the configuration file will be saved to both the device and the computer. When using the save button while not connected, the configuration file will be saved to the computer only.

The configuration for each device can be saved to the computer's hard disk in an ASCII text file. There are three buttons that allow for saving and reading the configuration of a device to/from disk. This feature is helpful when a device/s need to be deployed in the field. Each device configuration can be setup and saved to disk prior to mounting the device. In the field, each configuration can be easily read from disk and displayed. It is also useful for keeping a backup copy of each device/s configuration and for generating reports. The "File Properties" button defines the Configuration save path, section 2.9.

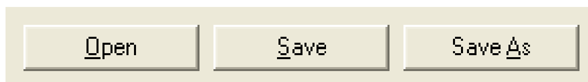


Figure 2.4 - Open/Save Configuration Files

When saving a configuration to disk, the name of the file is automatically defaulted to "Substation, Device, and Company.TXT". This allows for easily filing the configuration files according to what substation they reside in, the name of the device and the company that owns the device. All configurations are automatically assigned the ".TXT" extension. The path and file name of the configuration is displayed in the header of the software. Contents of the configuration file are maintained by the configuration software. The table below describes the features of each button's functionality.

Table 2.2 - Save & Open Configuration Files

Button	Description
Open	Open an existing configuration from disk. The open file dialog is displayed. All configuration files are saved with the .TXT extension. Select a file and click the "Open" button or double click on the desired file. All fields in the connection and channel configuration sections are updated with the information read from the file. If the selected file is not a valid configuration file then an error message is displayed. The path and filename of the selected file is displayed in the header.
Save	Save the active configuration file. An active configuration will be saved to both the connected device and to disk. When the configuration is saved a dialog box will appear confirming the save was successful. If the name of the configuration is listed as "Untitled" in the header then the "Save As" dialog is displayed with the filename defaulted to "Substation, Device, and Company.TXT".
Save As	Save the active configuration under a new name. The Window's "Save As" dialog is displayed with the filename defaulted to "Substation, Device, and Company.TXT".

2.4 CONFIGURATION DOWNLOAD

When connected, click the “Save” button to send the active configuration to the device.

If the configuration was sent successfully a message will be displayed.

Figure 2.5 - Download Successful

To load a configuration from the device, click on the “Connect” button. All device configuration and channel configuration fields will be updated with fields read from the device. Any new unsaved entries made in the software prior to connecting will be lost unless saved before connecting. If an unsaved configuration exists, a prompt will appear “Save Changes before Connecting?” reminding you to save the information entered. To change to a new device edit the IP Address fields in the Device Configuration section and press enter or click on the “Connect” button. To help save time entering an IP address, the IP address dropdown list displays a history of the 12 previously entered addresses, click on an address to select it.

2.5 CHANNEL SETTINGS

The channel settings section defines all the parameters needed to define the sensors, including configuration, triggering and calibration settings.

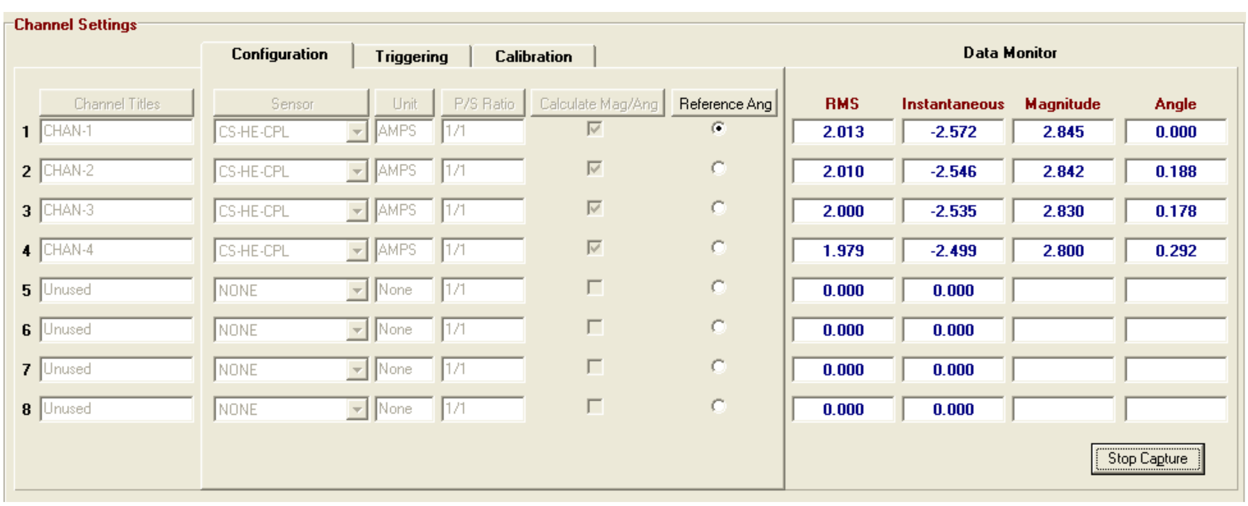


Figure 2.6 - Channel Settings Section

The table below defines each field and option in the Channel Settings section, including the Configuration, Triggering, Calibration and the Data Monitor sections.

Table 2.3 - Channel Settings

Header	Description	Default
Channel Titles	The name of the channel. Channel Titles are listed on the left side of the tabs. By default, the channel title name is “Unused”. Change the default channel title name, when selecting it for polling. This field is saved in the first line of the data file (Enter a name for the sensors connected: required for the data file). Click on the header to default the column to “Unused”.	Unused
Configuration Tab - Channel Settings		
Sensor	The Sensor field indicates the type of sensor connected. From the drop down list, select the type of sensor to be polled. Click on the sensor header to default both the sensor and unit columns to “None”.	None
Unit	The Unit field is directly related to the type of sensor being polled. The units are automatically associated with the type of sensor selected. The units available are: Amps, Volts and °F.	None
P/S Ratio	The primary to secondary ratios for AC measurements. DC primary ratio is always 1/1. Click on the header to default the column to 1/1.	1/1
Calculate Mag/Ang	Calculate the Discrete Fourier Transform (DFT) and display the Magnitude and Angle values in the Data Monitor section. Checked = On. Values are displayed when the selection box is checked. Click the header to turn all on or off.	Checked (On)
Reference Angle	Defines the DFT reference angle and displays it in the Data Monitor section. Only one channel can be selected as the reference angle. Click on the header to default the first channel to the reference angle.	1st Channel
Triggering Tab - Channel Settings		
Trig Value	The trigger value to initiate recording. This field along with the following 6 fields defines when to save an event file to disk. Trigger values can be defined for monitoring Instantaneous, RMS, Magnitude or Angle values. Enter the value to indicate when an event file should be generated then click “Start Capture” to begin polling. Click on the header to clear all trigger values fields.	Blank

Header	Description	Default
Trig Type	The type of values to monitor the entered trigger value: Instantaneous, RMS, Magnitude or Angle. Click on the drop down list to select the desired trigger type. Click on the header to default all trigger types to Instantaneous.	Instantaneous
Duration (ms)	The duration of the trigger before saving an event file. The duration is measured in milliseconds (ms). 2ms are equivalent to 4 consecutive samples. Click on the header to default the column to 0.	0
Upper Hysteresis (Upper)	Upper offset for the trigger level (Trigger Level + Upper Hysteresis = Upper Trigger Level). Click on the header to default the column to 0.	0
Lower Hysteresis (Lower)	Lower offset for the trigger level (Trigger Level - Lower Hysteresis = Lower Trigger Level). Click on the header to default the column to 0.	0
Absolute Values (Abs)	Take the absolute value of the samples before comparing them to the entered trigger value. This option is useful in case the sensor was mistakenly mounted in the reverse polarity direction. Unchecked = Off. Click on the header to turn all on or off.	Unchecked (Off)
Operator	The logic to use when determining if a trigger level is active. There are four types of options available: greater than (>), less than (<), equal to (=), or not equal to (<>). Click on the header to default the column to greater than (>).	Greater Than (>)
Calibration Tab - Channel Settings		
Offset	The Offset is a measure of the distance to the zero reference axis. To set the offset refer to the "Calibrating" section. Click on the header to default the column to 0.	0
Scale Factor	The Scale Factor is a real number used to scale the raw data. This field is automatically populated with a default value when a sensor type is selected. The default values are listed in the "Calibrating" section. To calibrate the scale factor refer to the "Calibrating" section. Set this field to 1 before manually calibrating the sensors that need calibrating. Click on the header to default the column to the default scale factor for the selected sensor type.	
Calibrate Value	The known value for the calibration process.	0

Header	Description	Default
	Enter the expected amount of current injected into the wire during the calibration process. This field is automatically populated with a default value when a sensor type is selected.	
Calibrate	The calibrate selection box is used to indicate if the sensor is active or inactive. If checked, the channel is active for calibration. To calibrate, refer to the "Calibrating" section. Click on the header to make all channels active or inactive.	Checked (Active)
DC Cancellation (DC Cancel)	Defines if the software should automatically calculate the offset value for the sensors connected when polling. The Hall-effect current sensor may drift off the zero reference point over time causing the samples values to be incorrect. Checked = On. Click on the header to turn all on or off.	Checked (On)
Gain	Magnitude Ratio of the analog channels. It increases the magnitude of an input signal. Gain options are: 1, 2, 4, 8, 16, 32, 64, and 128. Useful when measuring very low current levels (below 1 amp). No Gain = 1. Click on the header to default all gain values to 1.	1 (No Gain)
Data Monitor - Channel Settings		
RMS	The Root Mean Square value calculated over a one cycle window. The vales are displayed when the polling begins and cleared when the polling is stopped.	Blank
Instantaneous	Amplitude of the input signal at a particular instant. It is the raw values received from the device minus the offset value, and that quantity multiplied by the scale factor ((raw values-offset)*scale factor). The vales are displayed when the polling begins and cleared when the polling is stopped.	Blank
Magnitude	Magnitude of the input signal. The values are displayed when the "Calculate Mag/Ang" selection box is checked. The vales are displayed when the polling begins and cleared when the polling is stopped.	Blank
Angle	Angle of the input signal. The values are displayed when the "Calculate Mag/Ang" selection box is checked. The vales are displayed when the polling begins and cleared when the polling is stopped.	Blank

2.6 TRIGGERING

Each sensor trigger level is configured using 7 trigger settings: Trigger Value, Trigger Type, Duration, Upper Hysteresis, Lower Hysteresis, Absolute Values, and Operator.

When polling begins (Start Capture), the sniffer scans all of the connected sensors and continuously sends the scans to the software. The software checks each sample value to see if it is above/below the defined trigger value and the number of consecutive samples exceeding the trigger value is counted. When the number of consecutive samples triggered is greater than the defined duration then a trigger condition occurs and an event file is saved to the repository path. The repository paths are defined in the “File Properties” dialog section 2.9. An SOE entry is also added to the SOE text file.

The region between the upper and lower trigger levels is called the Hysteresis region (Region 2 in Figure 2.7). The user can create this region by entering values for the Upper and Lower Hysteresis fields. This region prevents continuous triggering as the input signal from the sensors may drift around the trigger level. The “Operator” field defines what region to trigger. By selecting different logic operators the software can capture signals that are outside or inside of the Hysteresis region. Table 2.4 below shows 4 different logic operators along with their Trigger and Reset regions.

Table 2.4 - Trigger Regions

Logic	Trigger	Reset
=	Region 2	Region 1 or Region 3
<>	Region 1 or Region 3	Region 2
>	Region 3	Region 1
<	Region 1	Region 3

The “Absolute Values” field, if checked, will compare the absolute value of the samples with the trigger levels. This field is helpful in case the sensor was mistakenly mounted in the reverse direction.

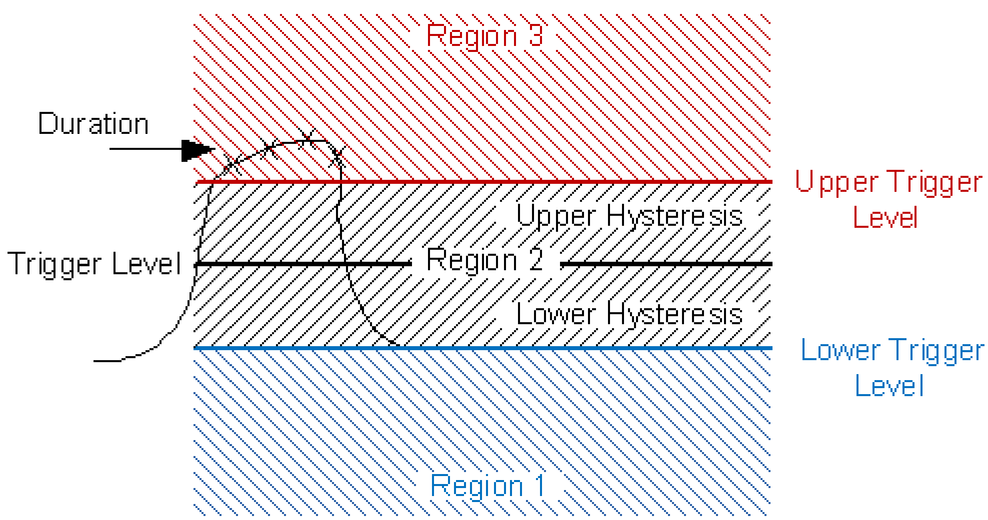


Figure 2.7 - Trigger Regions

2.7 CURRENT DETECTION

The following example describes how to detect a current flow of 2.0 Amps DC or more that last for 2 milliseconds (sampling frequency = 2340 Hz). The input is a DC signal with an AC ripple (DC + AC).

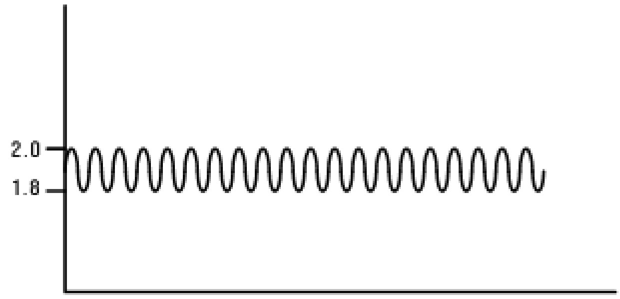
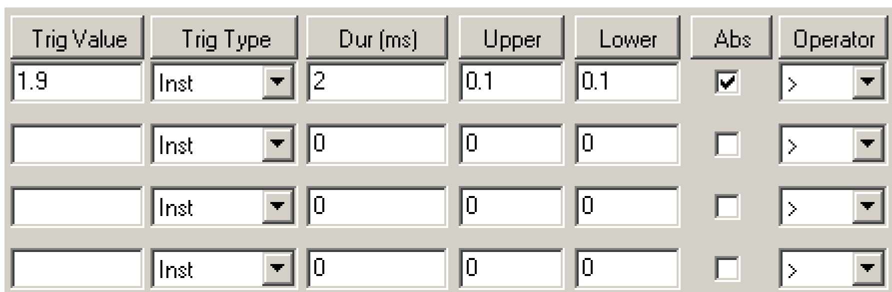


Figure 2.8 - DC + AC Signal



Trig Value	Trig Type	Dur (ms)	Upper	Lower	Abs	Operator
1.9	Inst	2	0.1	0.1	☑	>
	Inst	0	0	0	☐	>
	Inst	0	0	0	☐	>
	Inst	0	0	0	☐	>

Figure 2.9 - Trigger Settings

In order to make the triggering condition less sensitive to noise (AC ripple), create a Hysteresis region:

1. Enter 1.9 in the “Trigger Value” field.
2. Enter 2 in the “Duration (ms)” field.
3. Enter 0.1 in the **“**Upper” hysteresis field.
4. Enter 0.1 in the “Lower” hysteresis field.
5. Select the “Absolute Values” check box.
6. Select > from the “Operator” list.
7. Click on the “Start Capture” button to start polling.

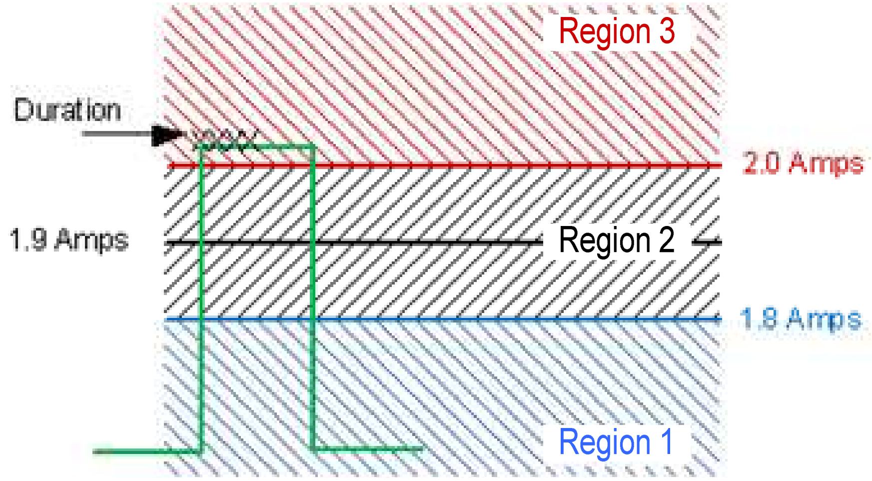


Figure 2.10 - Hysteresis Region

In reference to the example above, if the software detects values of 2.0 Amps or more for a minimum of 2 milliseconds (4 consecutive samples) then a triggered event file will be saved. The trigger will reset when the current goes below 1.8 Amps.

2.8 CALIBRATING

This section explains the fields contained in the Calibration tab and the process of calibrating the sensors. The sensors can be calibrated 2 ways, manually or automatic using the factory default values. To manually calibrate the sensors a number of steps must be followed to ensure the sensors are calibrated properly. The automatic process reads the default factory settings stored in the TIS.INI file located in the Sniffer's install path. The TIS.INI file has a section for each sensor. Each sensor's section includes the offset and scale values. The following describes the manual calibration process in detail.

The “Set Offset”, “Set Scale” and “Start Capture” buttons are used to manually calibrate the sensors. The offset and scale factor columns are used when scaling the raw samples for display in the data monitor section and when plotting the event files.

Figure 2.11 - Calibration Buttons

The calibrate value column defines the value to calibrate the sensors at. When calibrating different sensors you may what to calibrate sensors at different calibration values. The calibrate column allows for turning on or off the calibration process. Checked indicates to calibrate the channel. The DC cancelation column continually calculates and updates the Offset column.

To **manually calibrate** the sensors follow the steps below (general calibration). All the sensors that have the calibrate check box checked will be calibrated. Before calibrating the sensors turn off DC cancellation for the sensors that are being calibrated. Calibration and DC Cancellation check boxes are located under the calibration tab.

1. To begin, enter a channel title and choose the proper sensor type for each sensor to be calibrated. The sensor type fields are located in the configuration tab.
2. Turn off DC cancellation for all of the sensors that are being calibrated. The DC cancellation fields are located in the calibration tab.
3. Select the channels to be calibrated by checking the calibrate check box for each channel. Uncheck the box for sensors that do not need calibrating. The calibrate fields are located in the calibration tab.
4. Set the offset value for each channel to 0. If calibrating all of the sensors click on the “Offset” header button to default the offset fields to 0.
5. Set the scale factor for each channel to 1. Use the up and down arrows to navigate between sensors.
6. Enter the expected amount (calibration value) for each sensor in the calibrate value fields. For example if the current injected for calibration is 4 Amps enter 4 in the calibrate value field or if the injected voltage is 240 volts enter 240.
7. Click the “Start Capture” button.
8. Set the sensor’s offset values <u>without</u> the expected calibration value applied. Wait several seconds (the duration of the capture is displayed in the status bar) after the start capture process then click the “Set Offset” button. Apply the expected current. Then click on the “Set Scale” button. The offset and scale values for each selected channel will be updated. The data monitor will display the scaled RMS, Instantaneous, Magnitude and Angle values.
9. Click the “Stop Capture” button.
10. Click on the “Save” button to save the configuration.

For accuracy, the main purpose of the AC/DC current sensors are for remote target indication (by monitoring the DC side) and relay performance assessment (by monitoring the AC side). The Hall-effect chip used in the current sensors produces an 8 mV output for every 200 mA passing through its core with an accuracy of 2%. When calibrated manually, the over-all system accuracy is 2% around the calibration region.

If a sensor is relocated from the place it was originally calibrated, it will need to be recalibrated at its new position on the wire. Avoid clamping the sensors onto any labels or tape that may be on the wire.

To **automatically calibrate** the sensors using factory default values follow the procedure below (default calibration):

AC/DC current sensor (model, **CS-HE-CPL**): Follow steps 1, 3 & 6 above and then click on “Start Capture” to calculate the Offset. The default Scale Factor value displayed will be **<u>0.00183535</u>**.

AC current sensor (model, **CS-SC-200**): The default Scale Factor value **0.00921306** will be displayed when the sensor type is selected. The Offset is 0.

AC/DC voltage sensor (model, **VS-OA-500**): The default Scale Factor value **0.01508639** will be displayed when the sensor type is selected.

AC voltage sensor (model, **VS-VT-600**): The default Scale Factor value **0.01832161** will be displayed when the sensor type is selected.

Dry Contact sensor (model, **DCS-01/5**): The default Scale Factor value **0.00015259** will be displayed when the sensor type is selected.

IRIG-B (model, **CBL-IRIG-B**): Default Scale Factor value **0.01** will be displayed when the sensor type is selected. Begin the channel name with “GPS” to activate the channel, and select Instantaneous “Inst” for trigger type in the Triggering section.

Save the configuration before existing.

2.9 FILE PROPERTIES

This section defines the options available in the File Properties dialog. These dialog options allow the user to define save paths for the device configuration and data files.

Click on the “Files Properties” button to open the dialog. Refer to table 2.5 for a description of the options available in this dialog.

For more information on configuration files (.TXT extension files), refer to the “Configuration Files” section. For more information on data files (.TIS extension files), refer to the “Viewing Data Files” section.

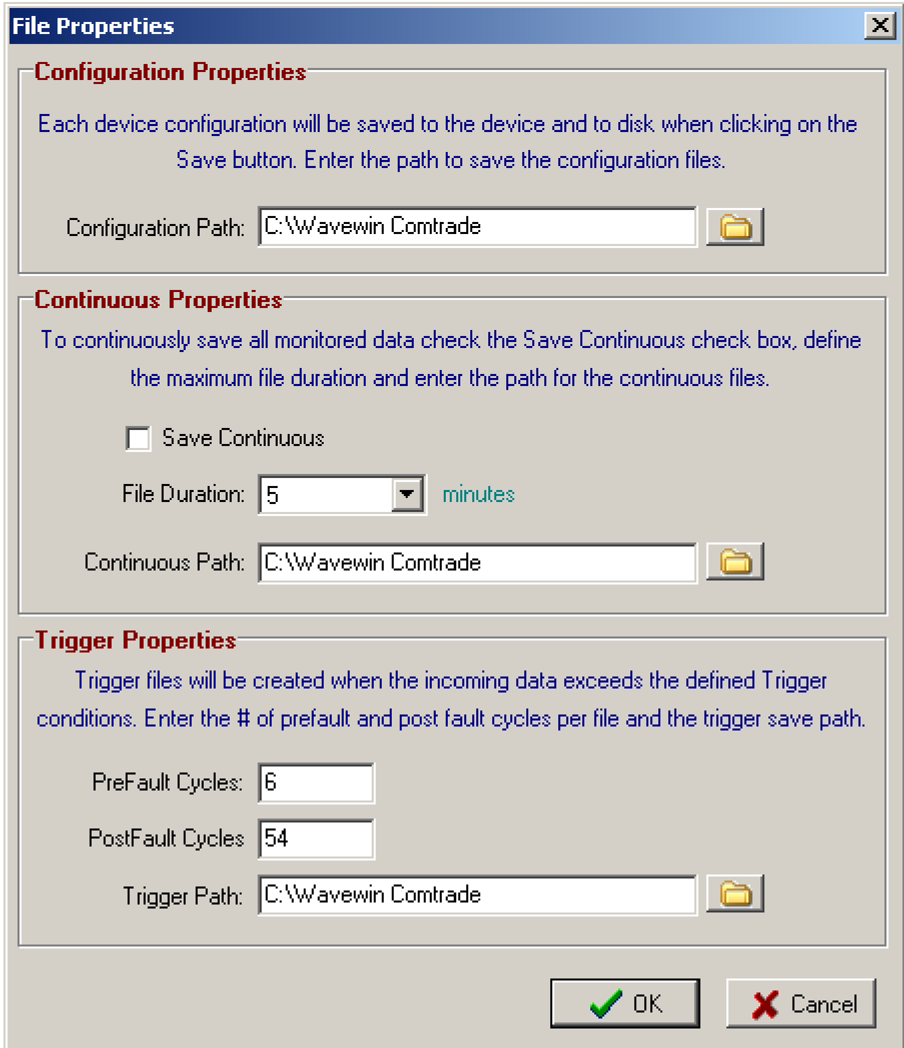


Figure 2.12 - File Properties

The table below defines options available in the File Properties section, including the Configuration, Save Continuous and Triggers save paths.

Table 2.5 - File Properties

Field	Description
Configuration Path	The save path for the device configuration. Files with the (.TXT) extension. Each device configuration will be saved to the device and to disk when clicking on the "Save" button. Enter a save path or click on the folder to browse to an existing folder.
Save Continuous	Continuously save all monitored data files with the (.TIS) extension. Click on the "Save Continuous" box to save all monitored data. Uncheck this box when only capturing event trigger files. By default this box is unchecked = not active.
File Duration	The time duration of the data file measured in minutes. The software will automatically save a new file when the

	maximum file duration is reached. Save options are (1 to 5) minutes. By default the duration is set to 5 minutes.
Continuous Path	The save path for the monitored data files. Files with the (.TIS) extension. The file duration option defines the length of each file. Enter a save path or click on the folder to browse to an existing folder.
Pre Fault Cycles	Defines how many prefault cycles are saved to the event trigger files. The default value is 6 prefault cycles.
Post Fault Cycles	Defines how many postfault cycles are saved to the event trigger files. The default value is 54 postfault cycles. Using the default settings each event file will be 60 cycles in length. The maximum prefault cycles + postfault cycles is 480. If the combined value of the prefault cycles + postfault cycles is greater than 480 then the prefault cycles are automatically defaulted to 6 and the postfault cycles to 54. Each cycle received from the device is 16.667 ms in length. A file with 480 cycles is about 8 seconds in duration.
Trigger Path	The save path for the event trigger files. Files with the (.TIS) extension. These files are measured in milliseconds (ms). Enter a save path or click on the folder to browse to an existing folder. Refer to the “Triggering” section for information on generating event trigger files.

C H A P T E R 3

3.0 VIEWING DATA FILES

This chapter briefly describes how to use the Device Configuration and Wavewin software to locate and display the generated data files. The data files are generating with the ".TIS" file extension and are tagged as TIS (Trip Information System) files. It is not necessary to convert these files to COMTRADE before viewing.

3.1 LOCATE DATA FILES

Wavewin's file manager and analysis windows are used for viewing the captured data files. To locate the data files from the Device Configuration software, click on the "View Files" button. To locate the data files from Wavewin, click on the Wavewin desktop icon to run Wavewin or open the Start Menu and navigate to the Wavewin shortcut.

Wavewin's File Manager is used to manage files on disk, search the contents of a drive or directory, and edit, plot, or draw the contents of a file. The File Manager supports the IEEE Standard C37.232-2007 for naming time sequence data files

To change the active drive from the Device Configuration software, click on the "File Properties" button. From Wavewin, navigate the folder tree or click on the "ChDir" menu button or press F7. Browse to the user defined repository path and click the "Ok" button.

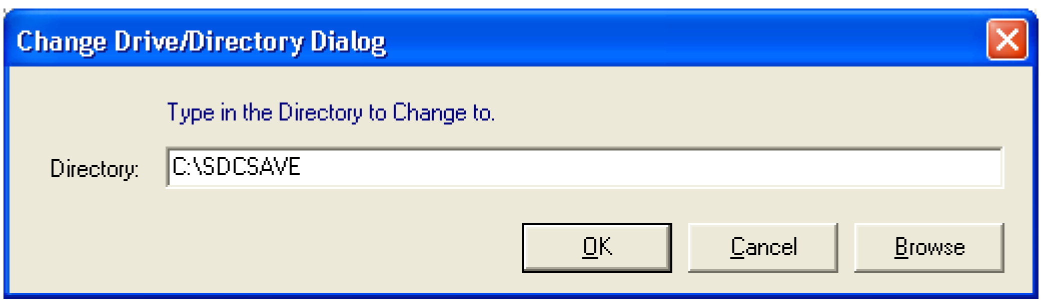


Figure 3.1 - Wavewin Change Directory Dialog

The ".TIS" data files generated are saved in the user defined repository path.

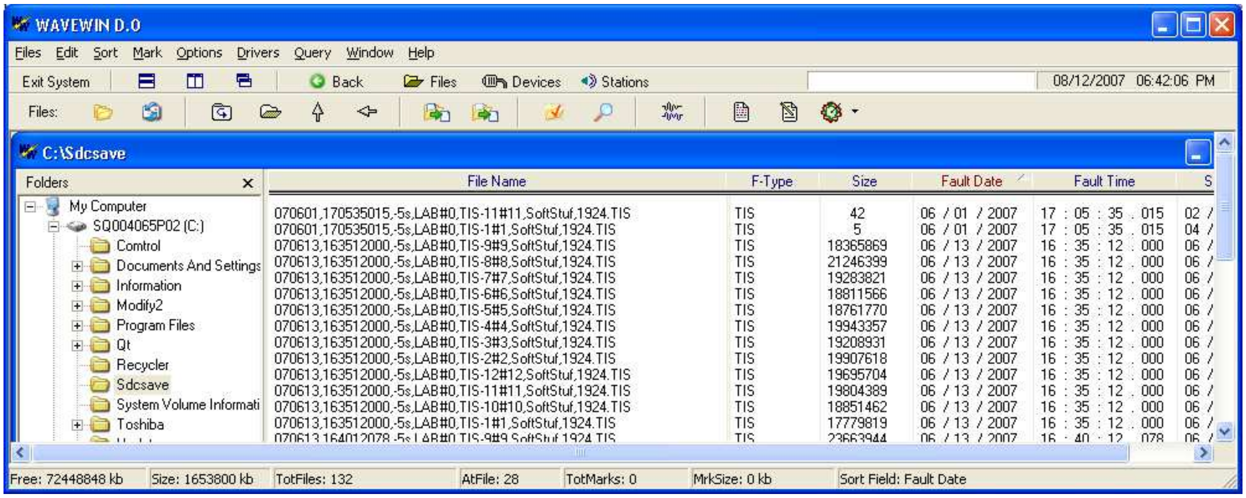


Figure 3.2 - Wavewin Repository Folder

3.2 DISPLAY DATA FILES

To display the data file, double click on the file name. The data display offers a high-resolution graphical interface for displaying, analyzing, and manipulating analog and digital channels of a waveform record or a periodic load file.

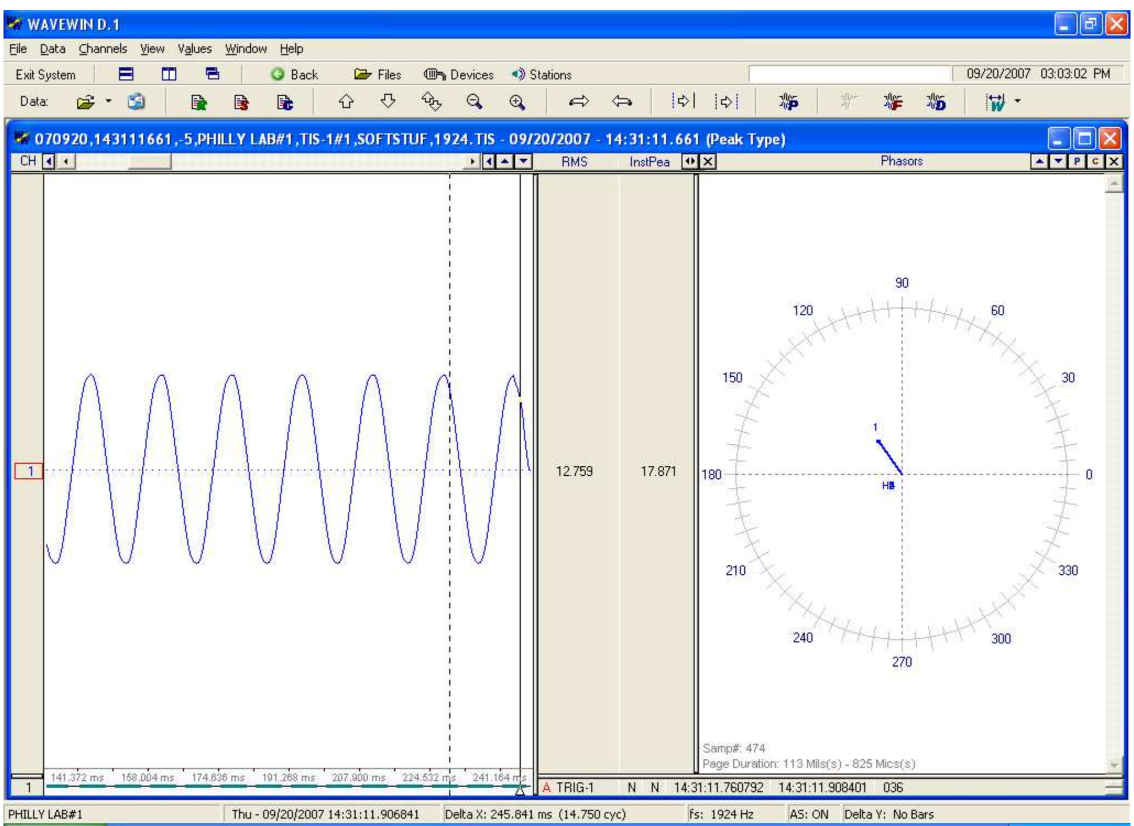


Figure 3.3 - Data Display

A P P E N D I X - A

A.0 HARDWARE INSTALLATION

A.1 CONFIGURE WINDOW'S IP ADDRESS (ETHERNET)

In order to communicate with an Ethernet device, the computer must be on the same network as the device. Follow the steps below to configure the computer with an IP address that resides on the same network as the device IP address.

1. From the desktop, left click on the Start Menu then click on Control Panel.
2. Double click on Network Connections.
3. Double click on Local Area Connection.
4. Select "Internet Protocol (TCP/IP)" then click on Properties, Refer to Figure A.1.
5. Select "Use the following IP address", Refer to Figure A.2.
6. Enter 192.168.100.2 for the computer IP address.
7. Enter 255.255.255.0 for the Subnet Mask.
8. Click on Ok to save the changes and exit.

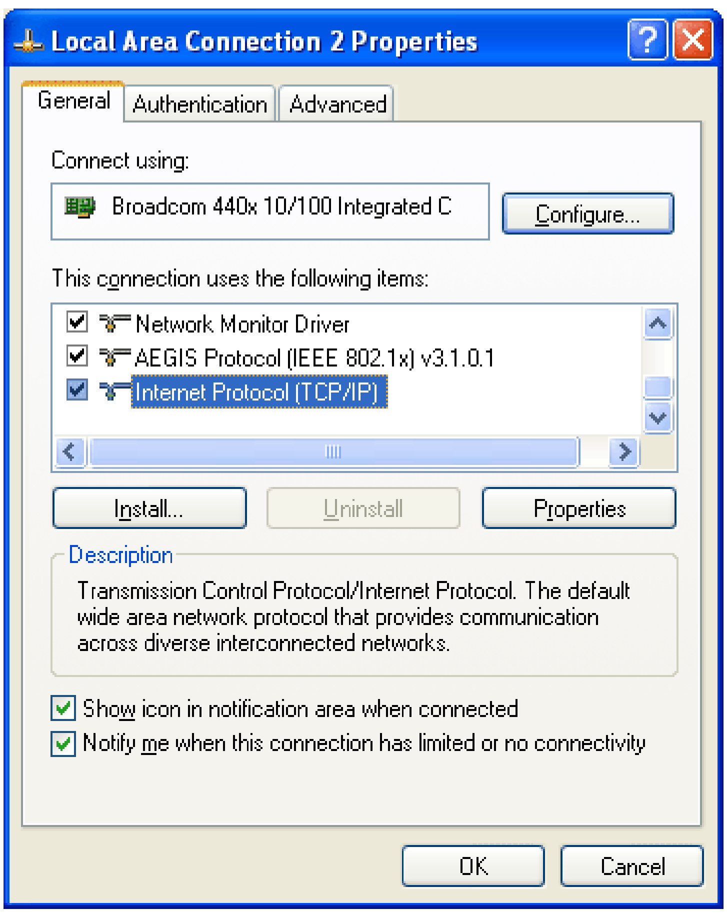


Figure A.1 - Local Area Connection Properties

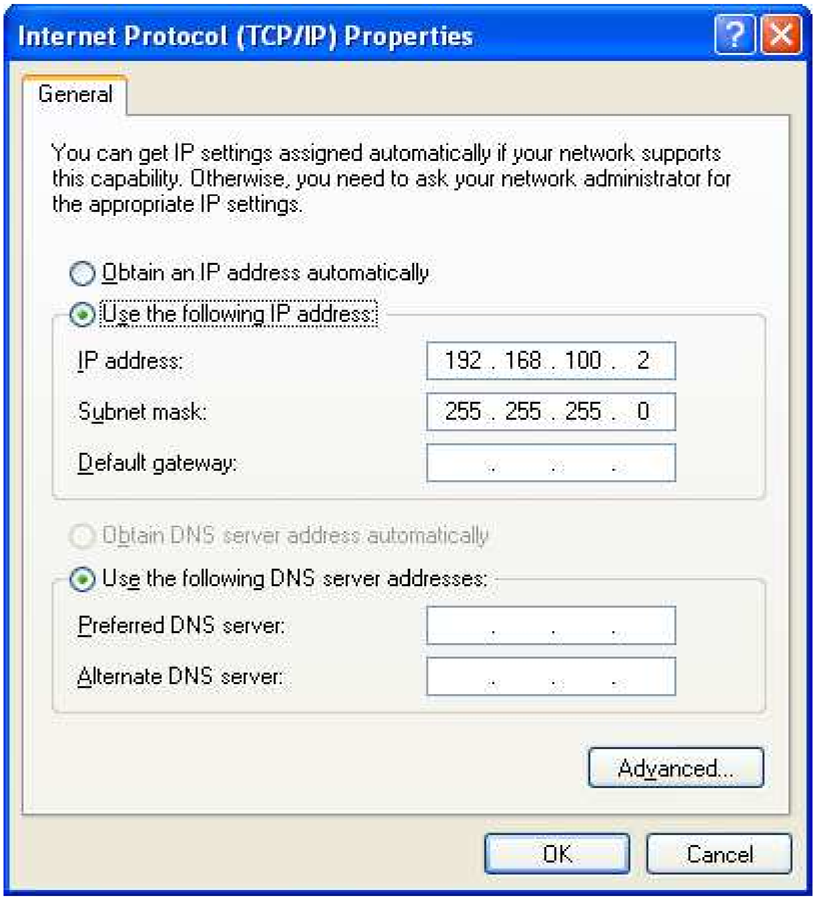


Figure A.2 - Internet Protocol Properties

A basic requirement for TCP communication is that the device IP address must be part of the subnet and not already used. Open a command prompt window and type “ipconfig” to see a listing of the IP address and subnet mask for a particular computer. If the computer shows a subnet mask of 255.255.255.0, that means it can only talk to devices with the same first 3 bytes of the IP address. The default IP address of the device is 192.168.100.205, which will work on a network using the 192.168.100.* subnet (unless another device on the same network is already using the .205 address).

Ping is a useful utility for testing basic Ethernet communication (open a command prompt window and type “ping 192.168.100.205”). It is a good idea to attempt to Ping the desired IP address before connecting, to see if any other device is already using that address. If another device is using the same address an IP conflict will occur and the device will not communicate properly. Each device residing on the same network must have its own unique IP address.

A P P E N D I X - B

B.0 HARDWARE DESCRIPTION

B.1 RECEIVER (TIS-8)

The receiver is a high speed 16-bit sampling unit used for digitizing the outputs of the analog sensors. The receiver transmits data continuously to a host computer over an Ethernet connection and can connect up to a maximum of 8 analog sensors. For more information on the receiver and the sensors refer to Appendix C.

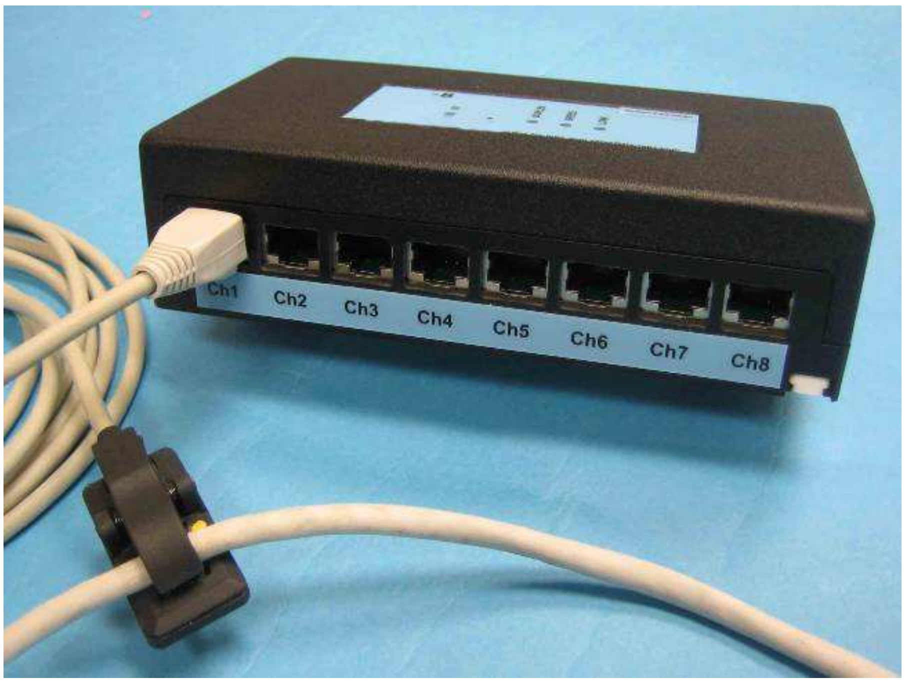


Figure B.1 - Receiver (Model# TIS-8)

B.1.1 INPUT SIGNALS

There are 8 differential analog input channels on the TIS-8 receiver.

Table B.1 - Analog Input Female Connector (Channels 1- 8)

RJ45 Pin #s	Description
1	Power Supplied to Sensor from Receiver (5 Volts)
3	Input Signal - Positive Wire (0 to 5 Volts)
5	Input Signal - Negative Wire (2.5 Volts)
7	Ground (0 Volts)

B.1.2 TROUBLESHOOTING

The "Error Connecting to the Device" message may be caused by:

1. No power. Check the power connection to the receiver.

2. The cross-over Ethernet cable between the computer and receiver is not connected. Use a straight Ethernet cable when connecting the receiver or computer to a switch.

3. The incorrect IP address is entered in the Device Configuration software. Refer to the label (if available) on the receiver for the correct IP address and review the "Configure Window's IP Address" section for the correct network information. The receiver's default IP address is 192.168.100.205.

4. The "Status" (ST) red LED is solid or not on, indicates that the receiver is not operating properly. A blinking red Status LED indicates normal operation.

5. The "Duplex" orange LED is not blinking after connecting the Ethernet cable between the computer and the receiver. A blinking orange Duplex LED indicates a connection has been established. A solid orange Duplex LED indicates that the software is polling data.

6. The "Speed" red LED is blinking or not on. A solid red Speed LED indicates normal operation.

7. The "Link" green LED is not solid after connecting the Ethernet cable between the computer and the receiver. A solid green Link LED indicates a hardware connection has been established.

B.2 AC/DC CURRENT SENSOR (CS-HE-CPL)

Using Hall-effect technology, the sensor measures both AC & DC currents in 12 gauge wires. To calibrate follow the steps in the "Calibrating" section. For more information refer to Appendix C.

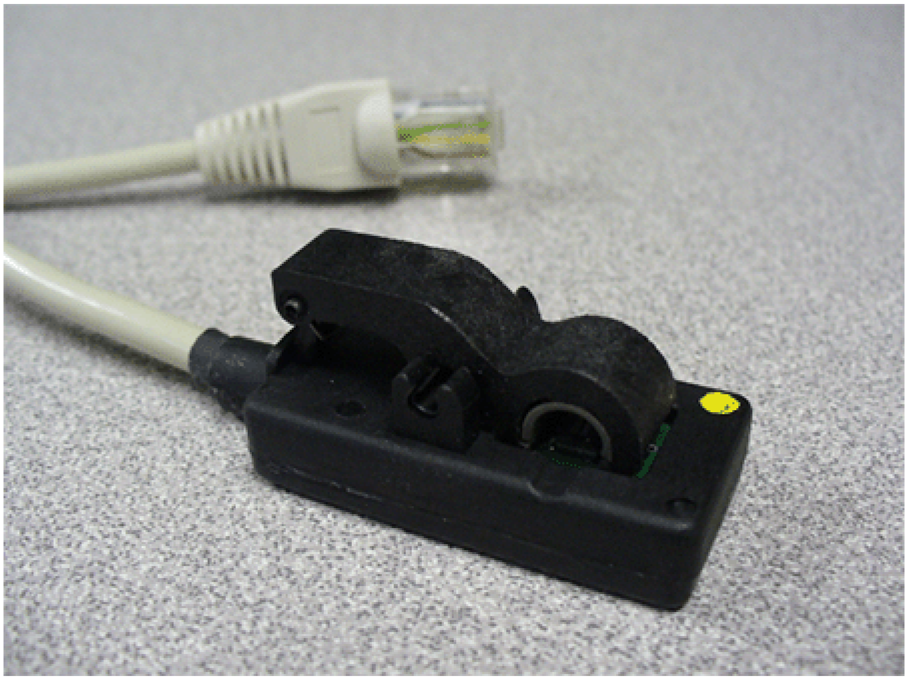


Figure B.2 – AC/DC Current Sensor (Model# CS-HE-CPL)

B.2.1 OUTPUT SIGNALS

The relationship between current and the output voltage is equal to 40mV/Amp.
The receiver works with output signals between pins 3 & 5 from the clothespin sensor.

Table B.2 – AC/DC Current Sensor Male Connector

RJ45 Pin #s	Description
1	Power Supplied to Sensor from Receiver (5 Volts)
3	Output Signal - Positive Wire (0 to 5 Volts)
5	Reference Voltage - Negative Wire (2.5 Volts)
7	Ground (0 Volts)

B.3 AC CURRENT SENSOR (CS-SC-200)

Using a current transformer, the sensor converts AC currents to an equivalent voltage output in 12, 10, and 8 gauge wires. To calibrate follow the steps in the “Calibrating” section. For more information refer to Appendix C.

Figure B.3 - AC Current Sensor (Model# CS-SC-200)

B.3.1 OUTPUT SIGNALS

Table B.3 - AC Sensor Male Connector

RJ45 Pin #s	Description
3	Output Signal (0 to 2.5 Volts)
5	Ground (0 Volts)

B.4 AC/DC VOLTAGE SENSOR (VS-OA-500)

The small, rugged, differential voltage sensor measures AC/DC voltages. Using a built-in isolation amplifier, it converts the high differential input to a low differential output by a ratio of 200:1. To calibrate follow the steps in the “Calibrating” section. For more information refer to Appendix C.

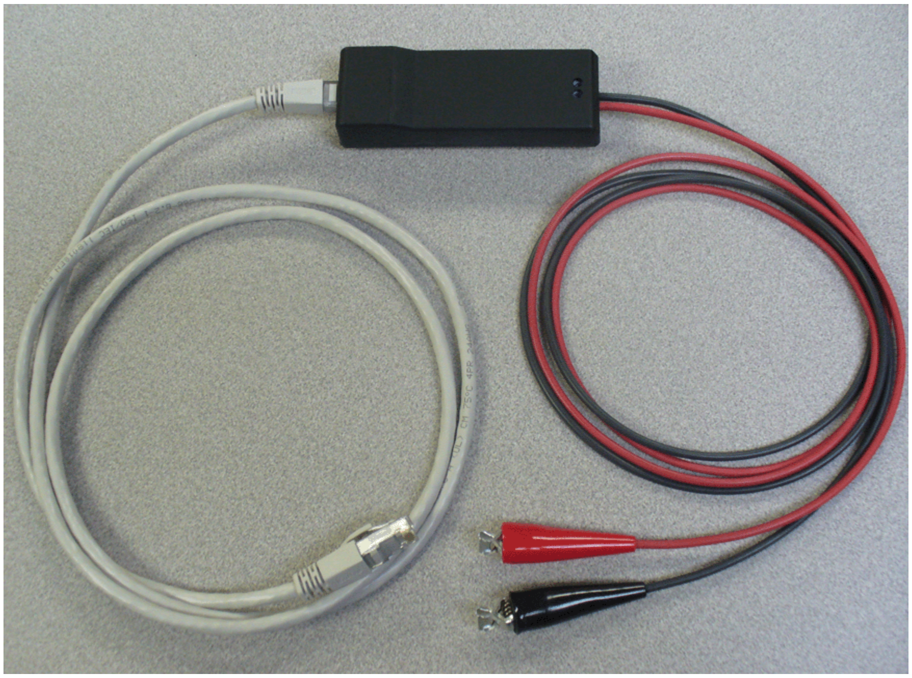


Figure B.4 – AC/DC Voltage Sensor (Model# VS-OA-500)

B.4.1 OUTPUT SIGNALS

The TIS-8 receiver works with output signals between pins 3 & 5 from the voltage sensor.

Table B.4 – AC/DC Voltage Sensor Male Connector

RJ45 Pin #s	Description
1	Power Supplied to Sensor from Receiver (5 Volts)
3	Output Signal - Positive Wire (0 to 5 Volts)
5	Reference Voltage - Negative Wire (2.5 Volts)
7	Ground (0 Volts)

A P P E N D I X - C

C.0 HARDWARE DATA SHEETS

WAVEGRID INC. | **RIS 8 RECEIVER** | ***DATA SHEET***

Part No. **TIS-8**

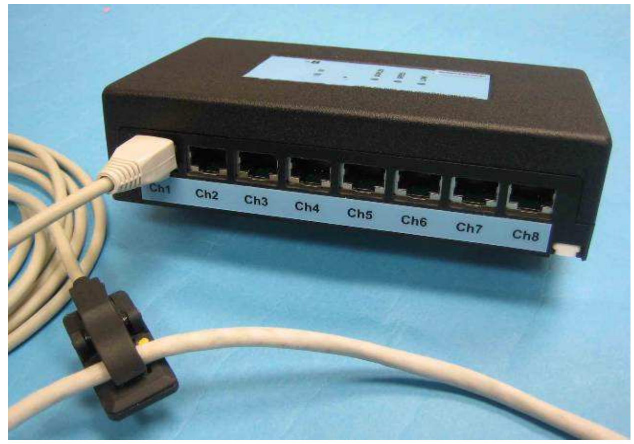


Figure C.1 – TIS 8 Receiver

Receiver Features:

- 8 RJ45 Differential Analog Inputs
- 8 16-Bit A/D Converters for Simultaneous Sampling
- Ethernet Interface for Real-Time Data Transfers
- Programmable Gain Options
- Optical Isolation of Analog Inputs
- 24 Volt DC Power Input with Cascading Option
- Lightweight Rugged Enclosure
- Din Rail or Panel Mounts

Receiver Description:

The receiver is a small, high-speed A/D device that samples at 2340Hz per channel and transmits data continuously to a host computer over an Ethernet connection. The receiver can connect up to 8 analog sensors (current, voltage, temperature or humidity) and has the ability to start and stop data logging by analog triggering. It is also capable of simultaneous sampling and provides 8 programmable gain options. The enclosure provides both panel and DIN rail mounts.

Receiver Specifications:

A/D Resolution	16-Bit
Analog Inputs	8 Differential
Input Range	-2.5 to 2.5 Volts
Sampling Rate	2340 Hz per Channel
Input Gain Options	1, 2, 4, 8, 16, 32, 64, 128
Current Draw	Max 250 Milliamps
Dimensions (L x W x H)	6.25 x 3.5 x 1.65 Inches
Operating Temp Range	-40 to 85 ^{o}C
Humidity Range	0 to 95% Non-condensing
Communication Interface	10/100 Base-T
Ethernet Connector	RJ45 Female
Analog Input Connectors	RJ45 Female
Power Supply	24 Volt DC (External)
Power Connector	Screw Terminal, 6 position

Receiver Inputs/Outputs:

The receiver has 8 differential analog inputs. Each RJ45 female analog input channel utilizes 4 pins. Pin 1 (5 Volts) and Pin 7 (GND) are used to provide power to the connected sensors. Pin 3 is the positive data input (0 to 5 volts) and pin 5 is the minus data input with a maximum of 2.5 volts. To achieve simultaneous sampling each analog input channel has a separate 16-bit A/D converter with programmable gain options available. The analog input voltage range is from -2.5 to 2.5 volts. The receiver has a 10/100Base-T Fast Ethernet communication interface for real time data transfers to a host computer.

Contact Us:

To purchase a TIS 8 receiver, please contact our Sales Department at 800-818-3463, sales@wavegrid.net

Hours: Monday - Friday, 9:00 a.m. to 6:00 p.m. EST
(Visa, Master Card, American Express, & POs accepted)

Mailing Address:

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www.wavegrid.net

Support:

Phone: 800-818-3463
Fax: 609-677-8736
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WAVEGRID INC. | AC/DC CURRENT SENSOR | DATA SHEET

Part No. CS-HE-CPL

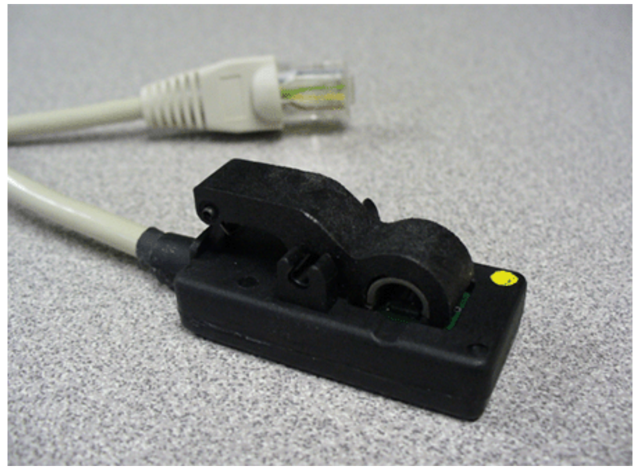

Figure C.2 – AC/DC Current Sensor

Sensor Features:

- Non-Intrusive, Small, Clamp-on AC/DC Sensor
- Hall-effect Technology
- Less than 10 Microseconds Response Time
- Locking Mechanism
- Very High Sensitivity
- Very Low Noise
- Shielded Enclosure (curved mu-metal strip)
- Single Cable for Power and Output Signals

Sensor Description:

The AC/DC Current sensor is a small, non-intrusive, clamp-on sensor that uses a Hall-effect chip in order to sense current flow through electric wires. The current sensor has a curved mu-metal strip for shielding against external magnetic fields and for amplifying internal fields. It has a clothespin like enclosure and is capable of sensing microsecond transients (AC and DC) with a 2% accuracy range at the point of calibration. .

Sensor Specifications:

Differential Output	0 +/- 2.5 VDC
Single-Ended Output	2.5 +/- 2.5 VDC
Supply Voltage	5 VDC
Supply Current	16 Milliamps
Current Range:	0.05 to 50 Amps
Maximum Wire Diameter	0.187" (4.75 mm) 12 AWG
Response Time	10 Microseconds
Bandwidth	DC to 100 kHz
Sensor Accuracy	2 % at calibration point
Dimensions (L x W x H)	1.56 x 0.78 x 0.41 Inches
Temperature Range	-40 to 85 ^{o}C
Humidity Range	0 to 90% Non-condensing
Cable Length	10 ft
Cable Connector Type	RJ45 Male

Sensor Outputs:

The sensor provides a differential output of 0 +/- 2.5V with respect to an internal reference. With zero current, the output is at 0V and will go toward -2.5V when the current is negative and toward 2.5V when the current is positive. It also provides a single-ended output which provides a 0 to 5V analog output with respect to ground. With zero current, the output is nominally at 2.5V and will go toward ground (0V) when the current is negative and the output will go toward 5V when current is positive. 100 milliamps of current flow produces a 6 millivolt increment on the output terminals, zero current floats under 20 millivolts.

Contact Us:

To purchase sensors, please contact our Sales Department at 800-818-3463, sales@wavegrid.net

Hours: Monday - Friday, 9:00 a.m. to 6:00 p.m. EST
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WAVEGRID INC. | **AC CURRENT SENSOR** | ***DATA SHEET***

Part No. **CS-SC-200**

Figure C.3 - AC Current Sensor

Sensor Features:

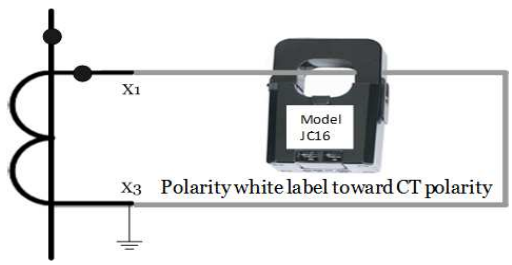
- Clamp-On Current Sensor
- Current Transformer Technology
- Non-Intrusive Installation
- Sensitive to AC Currents (0.1 to 200 Amps)
- Secure Hinge and Snap Locking Mechanism
- Very Low Noise
- High Sensitivity
- Analog Output Voltage

Sensor Description:

The split-core current transformer is a compact, non-intrusive, clamp-on sensor for measuring alternating current in electric wires. It uses a current transformer to convert current flowing through a conductor to an equivalent voltage output. The sensor is equipped with a unique secure hinge and locking snap mechanism that allows it to be mounted directly onto electric wires. The current transformer uses a single RJ45 shielded cable with 2 pins for the output signals.

Sensor Specifications:

Current Range	0.1 to 200 Amps
Accuracy	0.5% Overall
Turns Ratio	3000:1
Weight	75 Grams
Dimensions (L x W x H)	1.16 x 1.22 x 2.16 Inches
Hinge Opening	0.625" (16 mm)
Operating Frequency	50/60 Hz
Output Voltage	2.5 Volts
Operating Temperature	-20 to 50 ^{o}C
Relative Humidity Range	0 to 85% Non-condensing
Cable Connector Type	RJ45 Male
Phase Angle Error	< 1°



Sensor Outputs:

The sensor provides an output signal of 0 to 2.5 volts across pins 3 and 5 of the RJ45 connector. The sensor output is proportional to the actual value of current flow through the wire.

The CT contains a terminating resistor that produces a voltage output and mitigates shock hazard from an open secondary. Careful handling produces the best results, dropping or other impact may cause damage.

Contact Us:

To purchase sensors, please contact our Sales Department at 800-818-3463, sales@wavegrid.net

Hours: Monday - Friday, 9:00 a.m. to 6:00 p.m. EST
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www.wavegrid.net

Support:

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Fax: 609-677-8736
support@wavegrid.net

WAVEGRID INC. | **AC/DC VOLTAGE SENSOR** | ***DATA SHEET***

Part No. **VS-OA-500**

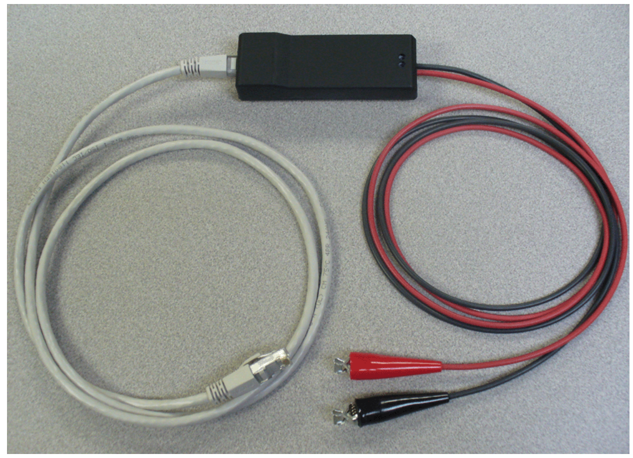

Figure C.4 - AC/DC Voltage Sensor

Sensor Features:

- Small, Rugged, Voltage Sensor
- +/- 500 V Peak Max Voltage Input
- Accurate AC/DC Voltage Measurements
- DC to 5 KHz Bandwidth
- High Accuracy +/- 0.05%
- Single Cable for Power and Output Signals
- DIN Rail Mounts
- UL, CUL Certified
- Fused Input

Sensor Description:

The small, rugged, differential voltage sensor is used for measuring AC/DC voltages. The input is fused to protect the measured source. It utilizes a built-in isolation amplifier to convert the high differential input to a low differential output with a ratio of 200:1. Measurements can be made directly across circuit components without the need for a common ground. Power is provided to the sensor via the data acquisition unit. The sensor uses a single RJ45 cable with 4 pins for both power and output signals.

Sensor Inputs/Outputs:

The sensor provides a 2 position terminal block for the differential input. Attached to the terminal block is a pair of silicone red and black wire leads terminated with steel clips. The input range is from -500 to +500 V peak with a bandwidth up to 5 KHz. The sensor provides a single RJ45 female connector for the differential output. Attached to the female connector is an RJ45 male cable for both the power and output signals. The output voltage range is from -2.5 to +2.5 volts with an accuracy of +/- 0.05%.

Sensor Specifications:

Maximum Voltage Input	+/- 500 V Peak
Output Voltage Range	+/- 2.5 Volts
Ratio	200:1
Bandwidth	DC to 5 kHz
Accuracy	+/- 0.05%
Supply Voltage	5 VDC
Supply Current	30 Milliamps
Input Connector	Screw Terminal, 2 Position
Input Connector AWG	10 to 24 AWG
Input Impedance	1 M Ohm / 10 pF
Dimensions (L x W x H)	4.25 x 1.5 x 1.0 Inches
Absolute Max Isolation	750 Vrms
Fuse 5V Power Input	375 Milliamps
Fuse Differential Input	375 Milliamps
Temperature Range	-40 to 85 ^{o}C
Humidity Range	0 to 95% Non-condensing
Cable (Output)	RJ45 with Male Connector
Silicone Wire Leads	18 AWG

Contact Us:

To purchase sensors, please contact our Sales Department at 800-818-3463, sales@wavegrid.net

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WAVEGRID INC. | **AC VOLTAGE SENSOR** | ***DATA SHEET***

Part No. **VS-VT-600**

Figure C.5 - AC Voltage Sensor

Sensor Features:

- Small, Rugged, Voltage Sensor
- 600 V Max Input Voltage
- Accurate AC Voltage Measurements
- 50 to 400 Hz Bandwidth
- Accuracy 0.5%
- Panel Mounts
- UL, CUL Certified
- Fused Input

Sensor Description:

The small, rugged voltage sensor is used for measuring AC voltages. The input is fused to protect the measured source. It utilizes a built-in voltage transformer to convert the high input to a low output with a ratio of 240:1. Measurements can be made directly across circuit components without the need for a common ground.

Sensor Specifications:

Input Voltage Range	0 to 600 Volts AC
Output Voltage Range	0 to 2.5 Volts
Ratio	240:1
Bandwidth	50 to 400 Hz
Burden	0.4 VA
Input Connector	Screw Terminal, 2 Position
Input Connector Gauge	20 to 2 AWG, Rated 1000V
Input Connector Surge	8000 Volts
Output Connector	RJ45 Female
Dimensions (L x W x H)	3.50 x 2.25 x 2.25 Inches
Temperature Range	-40 to 85 ^{o}C
Humidity Range	0 to 90% Non-condensing
Cable (Output)	RJ45 with Male Connector

Sensor Inputs/Outputs:

The sensor provides a 2 position terminal block for the input. Attached to the terminal block is a pair of 18 AWG silicone red and black wire leads terminated with steel clips for the portable model. The input range is from 0 to 600 V with a bandwidth up to 400 Hz. The sensor has a single RJ45 female connector for the output. Attached to the female connector is an RJ45 male cable for the output signals. The output voltage range is from 0 to 2.5 volts with an accuracy of 0.5%.

Contact Us:

To purchase sensors, please contact our Sales Department at 800-818-3463, sales@wavegrid.net

Hours: Monday - Friday, 9:00 a.m. to 6:00 p.m. EST (Visa, Master Card, American Express, & POs accepted)

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Support:

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WAVEGRID INC. | DRY CONTACT SENSOR | ***DATA SHEET***

Part No. **DCS-01/5**

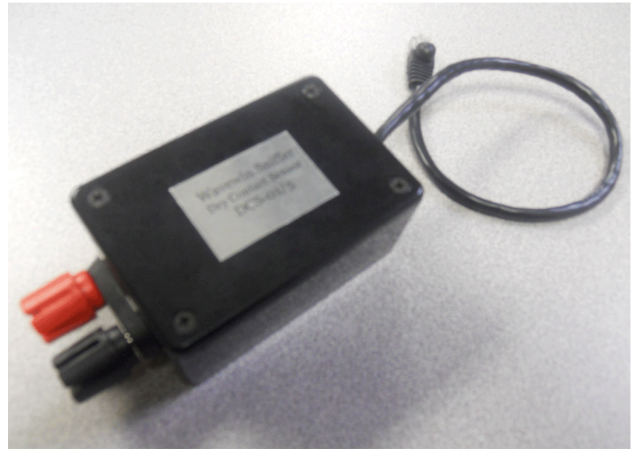

Figure C.6 - Dry Contact Sensor

Sensor Features:

- Small, Lightweight Sensor
- Rugged Binding Posts
- Single Cable for Output Signals

Sensor Specifications:

Voltage Range	0 to 5 Volts
Supply Voltage	5 VDC
Supply Current	1 Milliamps
Contact (Open)	0 Volts
Contact (Closed)	5 Volts
Dimensions (L x W x H)	3.37 x 2.12 x 1.50 Inches
Temperature Range	-40 to 85 ^{o}C
Humidity Range	0 to 90% Non-condensing
Cable (Output) Length	1 ft
Cable Connector Type	RJ45 Male

Sensor Description:

The dry contact sensor provides a low voltage across a contact for the purpose of determining the state of the contact, 0 Volts = open and 5 Volts = closed. It provides a way of monitoring a contact that has no applied voltage. It is not for use on live circuits. The sensor uses a single RJ45 shielded cable for the output signals.

Sensor Outputs:

The sensor provides a single 1ft RJ45 shielded cable for the output signals. The voltage range is from 0 to 5 Volts. It comes equipped with a pair of red and black binding posts for the monitored contact.

Contact Us:

To purchase sensors, please contact our Sales Department at 800-818-3463, sales@wavegrid.net

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SOFTSTUF INC. | IRIG-B CABLE | DATA SHEET

Part No. CBL-IRIG-B

Figure C.7 - IRIG-B Cable

Cable Features:

- IRIG-B Time Code Signals
- One-Second Time Frame
- 100 Pulses-Per-Second Bit Rate
- Stranded Coaxial Cable
- BNC Male Twist On Connectors
- BNC T-Type Female Adapters
- Stranded Twisted Pair Cable
- RJ45 Male Connector

Cable Description:

The cable transmits the IRIG-B protocol for time synchronization from the GPS Satellite Controlled Clock to the analog receiver. The IRIG-B cable is part coaxial cable and part twisted pair cable. The coax cable segment is terminated with a BNC Male connector and the twisted pair cable is terminated with an RJ45 male connector to carry the unmodulated IRIG-B signals to the receiver. Assembled in 1 ft segments using BNC T-Type adapters the cable can transmit IRIG-B signals to multiple receivers.

Cable Pins:

RJ45 Connector	BNC Connector
3 + Data Wire (Output Signal)	Center (IRIG-B Signal)
7 (GND)	Shield (GND)

Cable Specifications:

Coaxial Cable	Stranded Copper
Coaxial Connector	BNC Male Twist On
Coaxial Cable Length	1 ft Segment
Mating Connector	BNC T-type Adapter
Output Cable	Stranded Twisted Pair
Output Cable Connector	RJ45 Male
Output Cable Length	1 ft Segment

Contact Us:

To purchase cables, please contact our Sales Department at 800-818-3463, sales@wavegrid.net

Hours: Monday - Friday, 9:00 a.m. to 6:00 p.m. EST
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