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# ***VR101S***

***Voltage Event Recorder  
System***

***Users Manual***

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# **VR101S**

## *Users Manual*

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# **Chapter 1**

## **Getting Started**

### ***Introduction***

#### ***Features of the Voltage Event Recorder System***

The VR101 Voltage Event Recorder, hereafter referred to as the recorder, records sags, swells, transients, outages, and frequency variations on the power line. It is self powered and easy to use—parameters can be set by a few easy keystrokes from your PC equipped with EventView Software™.

The recorder can retain 4,000 events. The existence of recorded events is indicated by the recorder's flashing light.

Communication between a PC and the recorder is carried via the Optical Interface Cable. By using this optical data transfer, the PC remains electrically isolated.

***A Quick Overview***

The following steps are discussed in detail throughout this manual:

1. Read the next five pages on safety and battery care.
2. Install EventView Software on your PC.
3. Plug the VR101 into the closest wall socket.
4. Connect your computer to the VR101 with the optical cable.
5. Use EventView to adjust the settings on your VR101.
6. Disconnect the optical cable and move the VR101 to the receptacle you want to monitor.
7. After monitoring, use EventView to download the results.

## Safety

### Attention

**Carefully read the following safety information before using the recorder.**





### Safety Precautions

Specific warning and caution statements, where they apply, will be found throughout the manual.

**A Caution identifies conditions and actions that may damage the recorder.**

**A Warning identifies conditions and actions that pose hazard(s) to the user.**

Symbols used on the VR101 and in this manual are explained in the next table.

	See explanation in manual		Disposal information
	Recycling information		Double Insulation (Protection Class)

### Warning

**The recorder is designed and certified to work only on single-phase systems. Attempting to modify the recorder or operating it improperly may cause circuit damage which can ultimately result in property damage, personal injury, or death.**

### *Plugging in a recorder*

The recorder is designed to plug into a standard convenience outlet. As a safety precaution, the unit should be in a place where it can be easily unplugged. This will also make it accessible for data retrieval. The recorder does not require a protective earth connection for safety since there are no exposed metal parts. The earth conductor is used to measure neutral to ground

(N-G) events and to measure the recorder's polarity, indicated by the LED. Also see below under "Using an Ungrounded Outlet". The ground prong may be electrically disconnected (as long as it is not exposed). The recorder does not need special ventilation, however, its ambient temperature should not be allowed to rise above the operating limit. (See Chapter 7 "VR101 Specifications").

### ***Using an Ungrounded Outlet***

Plugging the recorder into an ungrounded outlet has the following consequences:

1. Polarity indication by the LED is not valid.
2. Neutral to ground events captured are not valid.
3. If the recorder is plugged in improperly (improper polarity), hot to neutral events captured are shifted 180 degrees and indicated with the opposite polarity.

### ***Polarity Indication***

In some countries outlets are not polarized. This means that the recorder can be plugged in improperly (hot and neutral swapped). Improper polarity connection will not cause damage to the recorder but events will not be correctly recorded and the results may cause misinterpretation.

#### *Note 1:*

*When plugging in the recorder improperly (improper polarity connection), the LED will blink quickly during 8 to 16 seconds (also see Note 2). When plugging in correctly, the LED lights steadily during 8 to 16 seconds. Polarity indication starts from 0 to 8 seconds after plugging in.*

#### *Note 2:*

*The LED on the recorder also blinks when an event is captured, but then it blinks slowly.*

## ***Electrical Immunity***

The recorder's internal circuitry is solid-state with built-in EMI and RFI protection to ensure reliable readings. The recorder will withstand exposure to a 3,400V transient for a duration of 20 ms.

## ***Safety Inspection***

We recommend that you inspect the recorder periodically for visible damage. To ensure that it operates safely, inspect for missing labels, cracks in the case, or bent and/or broken blades.

## ***Battery Care***

The recorder contains a lithium battery which will, under normal circumstances, allow it to operate for 7 years. Exposing the recorder to extreme temperatures for extended periods of time may reduce battery life by as much as 50%. The recorder is designed for INDOOR USE. It should not be exposed to direct sunlight.

Do not store the recorder with the event indicator flashing. This consumes battery power and reduces battery life. (See page 17 for information on how to clear the recorder's events from memory.)

To extend battery life, keep the recorder plugged into a standard convenience outlet (even when not in use). This conserves battery power especially when frequently downloading stored events.

### **Warning**

**Battery poses fire, explosion and severe burn hazard. Do not recharge, disassemble, heat above 212 °F (100 °C), incinerate, or expose contents to water**

*Note:*

*The VR101 contains a lithium battery. Do not dispose of the VR101 with other solid waste. The VR101 should be disposed of by a qualified recycler or hazardous materials handler. Contact your authorized FLUKE Service Center for recycling information.*

**Maintenance**

The recorder is a maintenance-free product. However, it is recommended that it be kept clean to allow for easy visual inspections. To clean the recorder, unplug it from the outlet and wipe it with a dry, clean cloth.

**Product Service**

The recorder has no user-serviceable parts inside. The fuse and battery inside the recorder are NOT REPLACEABLE. Opening the case, or attempting to do so, will void the warranty and safety certification.

The Optical Interface Cable is the only replacement part in the VR101S package.

If you require service, please contact your local dealer or an authorized Fluke service center. (See under "Service Centers" in the front of this manual.)

## **What You Need to Run Fluke EventView Software**

In order to run Fluke EventView™ software, your computer system must include:

- IBM PC or 100% compatible, with Windows 3.1 or Windows 95/98/NT installed and operating
- At least one free serial port, 9-pin
- A pointing device (recommended)
- 2 MB hard drive space
- 4 MB RAM (8 MB for Windows 95/98/NT)

*Optional Equipment:*

- A printer port with a printer supported by Microsoft Windows

## **What's in the VR101S Package**

The VR101S package contains the following items:

- VR101/xxx Voltage Event Recorder unit.
- EventView™ software and Users Manual, located on CD
- Optical Interface Cable
- Product Registration Card + return envelope

EventView software enables you to set up the recorder, download all the stored events and display the stored information.

## ***Installing EventView software***

1. Before installing EventView software, close other applications, or restart Windows.
2. For Windows 3.1, open **Program Manager**, select **File** from the menu bar and choose **Run...**

Windows 95/98/NT users select **Start** from the Taskbar on the desktop and choose **Run...**

3. Insert EventView Disk 1 of 2 in your computer's disk drive. In the Run dialog box, type **a:setup** for drive A and press **Enter** (the Return key on some keyboards). If you are using drive B, type **b:setup**.
4. EventView supports several languages. If one of these languages has been specified in the Windows control panel, EventView uses the same language. If any other language is specified in Windows, the EventView setup procedure displays a language selection menu. Select the desired language.

During the following steps, change diskette as indicated.

5. A "*Welcome!*" dialog box will appear asking you to click **Next** if you want to start installing the EventView Software on your hard drive.
6. An information screen appears to inform you about some important items for installation and use of EventView Software. Read this carefully. Click **Next**.
7. Select the Destination Directory for the EventView Software. If you want to install the software in the default directory, click **Next**. If you prefer another directory, click **Browse** to select this directory, then click **Next**.
8. A dialog box appears asking if you would like to back up replaced files. It is a good idea to do so (select "Yes".) Click **Next**.



9. Specify a backup directory or just click **Next** to select the default directory. (Note: The backup directory will be empty if no files are replaced.)

10. Windows 95/98/NT users click **Next** to begin installation.

For Windows 3.1 users a dialog box appears to select or to create the Windows Program Group to add the EventView Software to. Click **Next** to create the Fluke PQ Tools program group. (PQ stands for Power Quality.)

Click **Next** to begin installation.

11. Finally click **Finish** to exit EventView Software installation.

## **Setting the Time and Date**

It is very important that your PC system's time and date are correct before running the EventView program.

When retrieving data from the recorder, the EventView program uses the PC's internal clock for time and date reference. (See the following note.)

- With Windows running, set the time from the Control Panel in Program Manager.
- Windows 95/98/NT users open the Control Panel from the Taskbar by choosing **Start, Settings,** and **Control Panel.**

Information about setting the time can be found in the Windows User's Guide.

### *Note*

*If your PC's internal clock switched from summer time to winter time or vice versa during the period that the VR101 is capturing events, you should correct the Start Time and the End time (if date and time indicated) of the events that occurred up to the time change by adding or subtracting one hour. (See "Viewing the Events Tab on page 23.*

## Chapter 2

# Setting Up the VR101

### Introduction

This chapter explains how to use EventView™ software to program the internal settings of the recorder.

### Connecting the Optical Interface Cable

The EventView program communicates with the recorder via the Optical Interface Cable.

- Plug this cable into an available 9-pin COM port in your computer.

If your computer has only a 25-pin COM port, plug a 9- to 25-pin adapter (not included with your interface package) into your computer, and plug the interface cable into the adapter.

### Starting EventView

- Windows 3.1 users double-click the Fluke EventView program icon EV101 in the Fluke PQ Tools group window.  
*(Double-click the Update Readme icon to read the latest information about the VR101S.)*



## VR101S

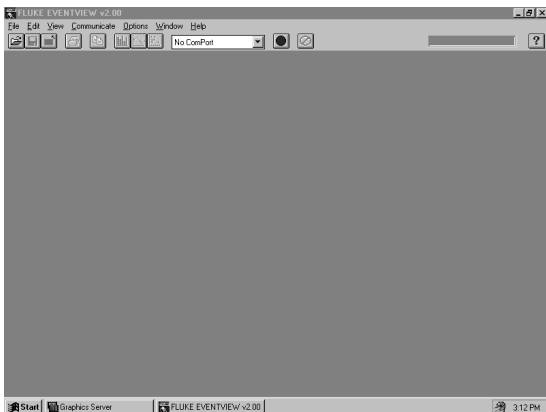
### Users Manual

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- Windows 95/98/NT users click **Start** on the Taskbar, and choose **Programs, Fluke PQ Tools** and then **EventView**.

*(Select Update Readme to read the latest information about the VR101S.)*

The main FLUKE EVENTVIEW window will open.



### Selecting a COM Port

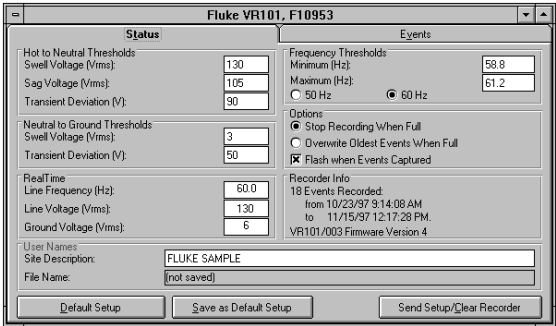
- With the main FLUKE EVENTVIEW window open, from the Communicate menu choose the COM port that the Optical Interface Cable is connected to.

The Communicate menu displays the available COM ports on your computer.

When you have chosen the correct port, the optical wand and the red scanning button on the ToolBar will start to flash. When the wand is flashing it is ready to communicate with the recorder. If the wand doesn't flash, please refer to Chapter 5 "Troubleshooting".

### Opening the Site Report Window

1. With the main VR101 window open, the Optical Interface Cable connected to a COM port, and the red scan button flashing, point the optical wand at the optical port of the recorder (from 0.25" away or closer) or plug the wand directly into the recorder's recessed optical port.  
The Site Report Window will open.



The Site Report window displays the recorder's settings and its recorded events.

If the VR101 is not plugged into a power source, an information box will appear saying "No voltage detected on recorder. Realtime halted to conserve power." Click **OK** to continue.

2. Remove the optical wand from the recorder.

### ***Setting Thresholds on the Status Tab***

The thresholds are in three categories on the Status tab: Hot to Neutral, Neutral to Ground, and Frequency. To change any threshold setting, double-click the setting and then type in the new value.

#### ***Voltage Transients***

Transients are fast voltage fluctuations (sometimes called spikes). They can be positive or negative and can occur on the hot-neutral line or on the neutral-ground line. The voltage potential of a transient can be quite large; hundreds of volts is not uncommon. Transients typically have a duration far below one cycle and can be detected down to 1  $\mu$ s.

The recorder will record as a transient any voltage deviation of less than one cycle that exceeds the transient threshold for more than 1  $\mu$ s.

#### ***Voltage Swells***

Swells are increases in voltage that last at least  $\frac{1}{2}$  cycle. Swells can occur on the hot-neutral lines or on the neutral-ground lines. Typically, swells are in the order of tens of volts and last from several cycles to several seconds.

If the voltage exceeds the swell voltage threshold for longer than one cycle, a swell event will be recorded.

### *Voltage Sags*

Sags are decreases in line voltage lasting for at least  $\frac{1}{2}$  cycle. Sags are only measured on the hot-neutral lines. Typically, a sag will be a few volts or tens of volts below normal.

If the voltage drops below the sag threshold a sag event will be recorded. If it drops to below 70Vrms the event will be recorded as an outage.

### *Line Frequency Variations*

Frequency variations are changes in frequency above or below the nominal frequency (60Hz in North America, 50Hz in Europe, for example). Variations in frequency are typically a few cycles and can be from seconds to minutes in duration.

If the frequency drops below the minimum threshold a low frequency event will be recorded; if it exceeds the maximum threshold a high frequency event will be recorded.

For a 120V recorder version the frequency will default to 60Hz.

### **Viewing the Default Threshold Settings**

The EventView program has factory-installed default threshold settings. These settings are adequate for most applications.

- To see the default threshold settings on the Status tab, click the **Default Setup** button.

If you are concerned that some of your electronic equipment may have particular power quality requirements, we suggest that you call the equipment manufacturer for that information. You may discover that you should alter some of the recorder's threshold settings in order to monitor power quality more closely.

### **Choosing and Saving New Default Threshold Settings**

If the factory-installed default threshold settings of the recorder do not suit your application you may choose new settings and designate them as the default settings.

1. Make your changes to the settings.
2. Click the **Save as Default Setup** button.
3. In the dialog box that appears, click **OK** to confirm that the default settings will be changed.  
These settings are now saved in your computer and can be sent to any recorder that you communicate with by clicking **Send Setup/Clear Recorder**.

### **Choosing Operating Options**

#### **Stop Recording When Full or Overwrite Oldest Events When Full**

A recorder can store 4,000 events. You can program it to either stop recording events or to continue recording when it is full and record over the oldest events in its memory.

- Choose either **Stop Recording When Full** or **Overwrite Oldest Events When Full**.

#### **Flash When Data Available**

- Check **Flash When Data Available** if you want the recorder to blink when it has stored one or more events (default condition).

### ***Describing the Site***

*Site Description* gives you the opportunity of specifying the location of the recorder, for instance, if you need to distinguish between the locations of three recorders in one office. You may describe the site in your own words using up to 30 characters. The site description will also appear as the title of a Quick Summary, a Transient Graph, and an Event Distribution Graph.

### ***Viewing Realtime Readings of the Recorder***

After establishing communication, leave the wand in the optical port while the recorder is plugged into an outlet to see, in real time:

- Line voltage readings (the voltage between the hot and neutral lines)
- Ground voltage readings (the voltage between the neutral and ground lines),
- Line frequency readings (the frequency between the hot and neutral lines)

These readings appear under the *RealTime* heading.

You can turn realtime reading off and on by clicking on the red Scan button.

#### *Note:*

*The recorder can NOT record events during realtime reading. Click the red scan button to stop realtime reading and to resume event recording.*

Note that if the recorder is not plugged into an outlet while the wand is in the optical port, real time reading will stop after a few seconds to conserve power.

### ***Viewing Recorder Information***

Under the heading, *Recorder Info*, you will be able to see the number of events saved in the recorder and the time span over which the data was collected.

If no events have been gathered, the words *No Events Stored* will be displayed.

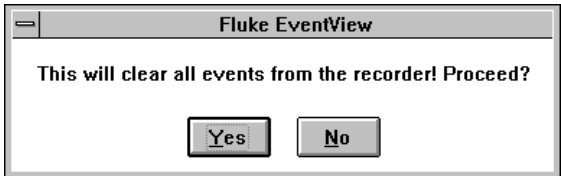


### ***Sending the Setup to the Recorder***

and as a consequence,

### ***Clearing all events from the recorder***

1. Place the wand into the optical port of the recorder.
2. If you have changed threshold settings or you are leaving the settings the way they are, click **Send Setup/Clear Recorder** button.  
If you are changing the recorder's settings to the default settings, click **Default Setup** and then click **Send Setup/Clear Logger** button.
3. In the dialog box that appears, click **Yes** to confirm that all previous events will be cleared from the recorder.



- The new settings will be saved in the recorder.
4. Remove the optical wand from the recorder.

The recorder will begin monitoring as soon as it is plugged into a standard convenience outlet.

*Note:*

*Plugging in and unplugging the recorder can cause invalid events being captured.*

### ***Starting Event Recording***

The VR101 does not start recording until the wand has been removed from the recorder's optical port. After approximately 16 seconds, the VR101 will begin to record voltage events. Recording can also be initiated by deactivating the red Scan button on the EventView toolbar. You may then leave the wand in the recorder's optical port.



# ***Chapter 3***

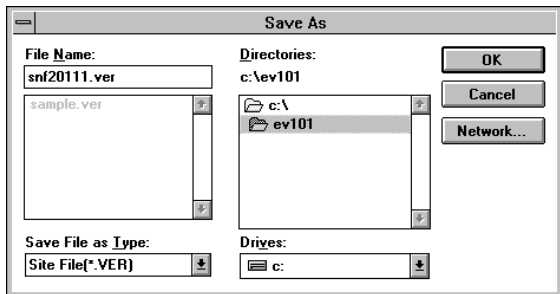
## ***Retrieving and Saving Events***

### ***Retrieving Events from a Recorder***

1. With the Main VR101 window open, and with the Optical Interface Cable connected to your computer, ensure that the wand is blinking. If it is not, choose **Scan** from the **Communicate** menu (or, on the ToolBar, click the red scan button so that it flashes).
2. Place the wand into the recorder's optical port. The Site Report window will open at the Status tab.
3. To download the recorder's stored events to your computer, click the **Events** tab.  
Downloading will start. During download the Cancel Download button (to the right of the Scan button) will become activated enabling you to stop the download.
4. When all events have been copied to your computer, you may remove the wand from the recorder.

## Saving Events

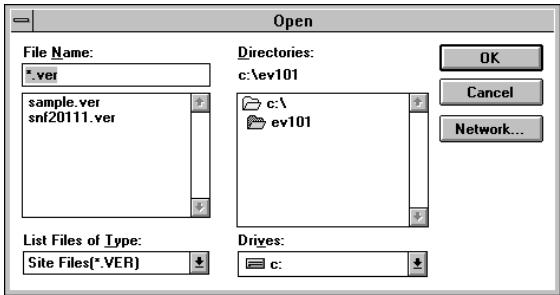
1. To save the events that you have downloaded choose **Save** from the **File** menu or click the Save button on the ToolBar.  
The Save As dialog box will appear with the current file name highlighted in the File Name box.



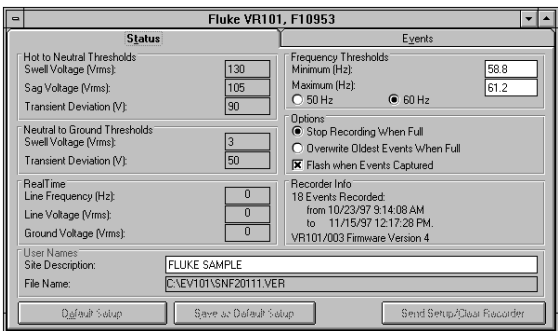
2. You have two save options:
  - Save the file with the existing name—this means that you will overwrite the previous file of the same name along with all its data. To do this, click **OK** and then click **Yes** to replace the previous file.
  - Save the file with a new name—this means that you will type a new name for the file so that the previous file, along with its name and its data, will still exist. To do this:
    1. Go to "Save File as Type:"
    2. Click the scroll bar and select the desired file type.
    3. Once you have selected the file type, go back up to "File Name:"
    4. Change the file extension to match that of the file type selected in step 2.

### Opening an Already Saved File

1. From the **File** menu choose **Open Site File**.  
The Open dialog box will appear.



2. Scroll through the list of site files until you find the file you want.
3. Double-click the selected file (or click it and then click **OK**) to open the Site Report window.  
The Site report window will open at the Status tab.



On the Status tab you will notice that the items that cannot be changed are displayed dimmed. Only the site description and the file name can be changed.



# Chapter 4

## **Displaying and Printing Events**

### **Displaying Events**

EventView software enables you to view events in different forms:

- The Events tab in the Site Report window lists all events that the recorder has gathered.
- Sags, swells and transients can be displayed in a Quick Summary bar graph.
- A single transient can be displayed as a graph.
- An Event Distribution Graph can be displayed.

### **Viewing the Events Tab**

Having downloaded events from the recorder, and with the Events tab still open, you can view and analyze the data that the recorder has gathered since it was last cleared. The recorder can store up to 4,000 events.

Events are displayed in the order of closing (end time). An event that is closed (ended) most recently is displayed at the top of the list.

#### *Note*

*As events can occur simultaneously while their duration differ, the display order can differ from the order of their start times. For example, during a sag event transients can occur. Though the start time of the sag is earlier than that of the transients, the sag event will be displayed later in the list because its end time is later.*

Fluke VR101, F10953					
Status			Events		
Event #	Start Time	Event	Extreme	End time/Duration/Degree	
0	11/15/97 12:15:44 PM	Outage	0 Vrms	Open Event	
18	11/15/97 12:15:44 PM	9 N-G Transients	-469 Vp	271°	
17	11/15/97 12:15:36 PM	9 H-N Transients	+414 Vp	91°	
16	10/25/97 8:51:36 AM	Outage	0 Vrms	11/15/97 12:15:28 PM	
15	10/25/97 8:51:20 AM	Outage	0 Vrms	00:00:08	
14	10/25/97 8:46:40 AM	Low Frequency	58.8 Hz	0.5 cycles	
13	10/25/97 8:44:08 AM	Outage	0 Vrms	00:02:32	
12	10/25/97 8:44:00 AM	Outage	0 Vrms	7.5 cycles	
11	10/25/97 8:43:52 AM	N-G Swell	26 Vrms	22.0 cycles	
10	10/25/97 8:43:44 AM	H-N Sag	86 Vrms	17.5 cycles	
9	10/25/97 8:43:44 AM	H-N Swell	141 Vrms	16.0 cycles	
8	10/25/97 8:43:44 AM	1 N-G Transient	+414 Vp	330°	
7	10/25/97 8:43:36 AM	1 N-G Transient	-405 Vp	266°	
6	10/25/97 8:43:36 AM	1 N-G Transient	+423 Vp	111°	
5	10/25/97 8:43:36 AM	1 H-N Transient	-1049 Vp	278°	
4	10/25/97 8:43:36 AM	1 H-N Transient	+561 Vp	259°	
3	10/25/97 8:43:28 AM	1 H-N Transient	929 Vp	100°	

### Event # column

The Event # column displays the number of each event. The most recent events are displayed first. You may have to scroll down (use the scroll bar on the right of the window) to view all the events that the recorder has recorded. The number 0 is given to an *open* event—an event that is still in progress at the time that the events were downloaded from the recorder.

### Start Time column

The Start Time column displays the time that an event started. The resolution of the time stamp in a recorder is eight seconds. Therefore, if a transient occurred once every second starting at 12:00:00, the first eight transients would all be reported to have the same time of 12:00:00. The next eight transients would be reported as having the same time of 12:00:08. Also, if identical information was downloaded twice from a recorder, the two “identical” site reports could show a time difference of eight seconds.

### Event column

The Event column displays the types of events that occurred.



**Transient Events** The recorder can detect both positive and negative transients down to one  $1\ \mu\text{s}$  in duration on either the H-N and N-G circuits. If the voltage exceeds the transient deviation threshold for any given half cycle, a transient event will be recorded. A transient event can include one or more transients occurring within the same half cycle. The event column will display the number of transients that the recorder was able to count.

An example of a transient event can be seen in the Event tab shown. Event #8 shows a single transient on the N-G circuit. The polarity for this transient was positive, the voltage was 414 volts. The transient was detected at a phase angle of 330 degrees.

Multiple transients can sometimes occur within a  $\frac{1}{2}$  cycle. For example, a large single transient followed by several cycles of high frequency ringing.

Since there are an infinite variety of wave shapes that can be classified as multiple transients, it is impossible to determine the accuracy of the reported information under these conditions.

Event #18 shows an example of a multiple transient event. This event indicates 9 transients that were detected starting at a phase angle of 271 degrees. The detected polarity was negative and the voltages of the transients were measured as 469 volts.

An important point to note about a multiple transient event such as #18 above, is that the voltage reading in the Extreme column will be the maximum voltage (positive or negative) of any transients that occur more than  $100\ \mu\text{s}$  apart. The degree (in the fourth column) will be the position in the cycle of the first transient. The angle of neutral-ground transients is referenced to the start of the hot-neutral sine wave.

If a transient is less than  $1\ \mu\text{s}$  in length, the recorder will indicate the magnitude of the transient but will be unable to determine the polarity. In this case, the recorder will show the sign of the transient as “+”.

**Sag and Swell Events** Sag and swell events are decreases and increases in line voltage that exceed the thresholds for at least  $\frac{1}{2}$  cycle. Swells can occur on the

hot-neutral lines or on the neutral-ground lines. Sags are only measured on the hot-neutral lines.

**Outage Events** Outage events less than one second duration are recorded with half cycle resolution. Longer outages are recorded with 8 second resolution.

Sags and outages are events that are closely related as far as a VER is concerned. If the sag voltage falls below the minimum operating voltage for longer than one second, the event will be recorded as an outage. The VER will go into a low power mode in order to conserve battery life under these conditions.

During the low power mode operation, the VER will only check for adequate line voltage every eight seconds. When the line voltage is restored, normal logging operation is resumed. This mode switching can present confusing event data, especially when sags and outages occur in a sequence.

The following table shows some examples for a 120V VER. The minimum operating voltage for a 120V VER is 70Vrms and the settings are as follows:

**Hot to Neutral Thresholds**

Swell Voltage (Vrms):	128
Sag Voltage (Vrms):	105
Transient Deviation (V):	200

**Neutral to Ground Thresholds**

Swell Voltage (Vrms):	10
Transient Deviation (Vrms):	100

**Frequency Thresholds**

Maximum (Hz):	61.2
Minimum (Hz):	58.8

Examples 1 to 6 represent events that are recorded due to line voltage sags of varying voltages and duration. Examples 7 to 12 show events that are recorded when sags and outages occur in sequence.

#	Hot - Neutral Voltage	Duration	Hot - Neutral Voltage	Duration	VER Data
1	100V	2 cycles	120V	1 hour	Sag 100V, 2 cycles
2	40V	2 cycles	120V	1 hour	Sag 40V, 2 cycles
3	100V	2 seconds	120V	1 hour	Sag 100V, 2 seconds
4	40V	2 seconds	120V	1 hour	Outage, 8-16 seconds
5	0V	2 cycles	120V	1 hour	Outage, 2 cycles
6	0V	2 seconds	120V	1 hour	Outage, 8-16 seconds
7	0V	2 seconds	100V	2 cycles	Outage, 8-16 seconds
8	0V	2 seconds	100V	2 seconds	Outage, 8-16 seconds
9	0V	2 cycles	100V	2 seconds	Outage, 2 cycles and Sag, 2 seconds
10	100V	2 seconds	0V	2 cycles	Outage, 2 seconds
11	100V	2 cycles	0V	2 seconds	Outage, 8-16 seconds
12	100V	2 cycles	40V	2 seconds	Outage, 8-16 seconds

Example #10: Since the VER reports the extreme value of a sag, the event is recorded as an outage (extreme value of 0V).

**High and Low Frequency Events** Frequency events are recorded when the frequency exceeds the frequency thresholds.

### *Extreme Column*

The Extreme column displays the maximum value measured during the event.

### *End Time/Duration/Degree Column*

This column displays the duration of an event, or the time that the event ended, or (in the case of a single transient) the event's position on the sine wave (in degrees).

The way the information is displayed depends on the length of the event.

- Events of less than one second are displayed in numbers of cycles.
- Events of one to 119 seconds are displayed in seconds.
- Events of between two minutes and 24 hours are displayed in hours, minutes and seconds (for example, 07:51:24, which means 7 hours, 51 minutes, and 24 seconds).

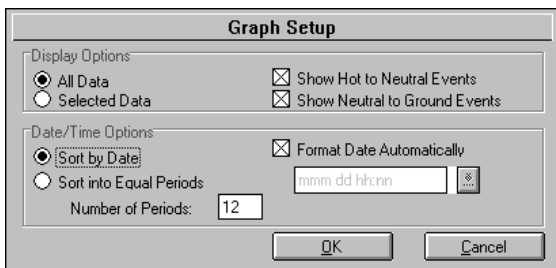
- Events that last longer than 24 hours display the end time (date and time).

If an event was still in progress when data was downloaded from the recorder, the event will be designated as an *open event* in this column. Open events are assigned the number zero in the Event # column.

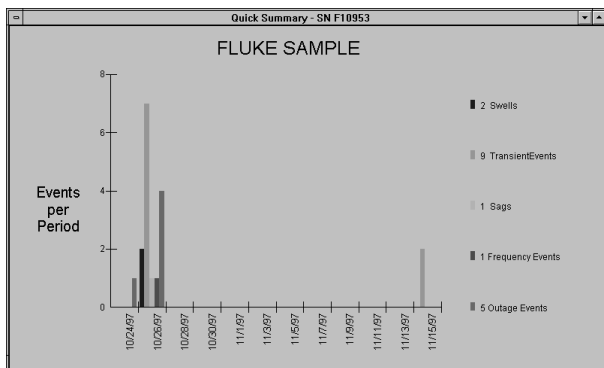
## Viewing Events as a Bar Graph (Quick Summary)

Quick Summary displays the number of sag, swell, transient, outages, and frequency events as bars on a graph.

1. With the Site Report window open at the Events tab, choose **Quick Summary** from the **View** menu (or click the Quick Summary button on the ToolBar).



2. Make your choices from the following options:
  - All Data** or **Selected Data** To display all sag, swell, transient, and frequency events, click **All Data**. To display a block of events from the Events tab, select those events by dragging the pointer through them to highlight them.
  - Show Hot to Neutral Events** Check this box to display all hot to neutral events.
  - Show Neutral to Ground Events** Check this box to display all neutral to ground events.
  - Sort by Date** or **Sort into Equal Periods** If you want the horizontal axis divided into 24-hour periods, click **Sort by Date**. If you want to divide the horizontal axis into shorter or longer periods, click **Sort into Equal Periods** and type the number of periods you want to display.
3. When you have finished choosing your options, click **OK** to close this dialog box and to open the Quick Summary.



The horizontal axis displays time; the vertical axis displays the number of events that occurred in each time period. In the bar graph above, the time periods are sorted by date.

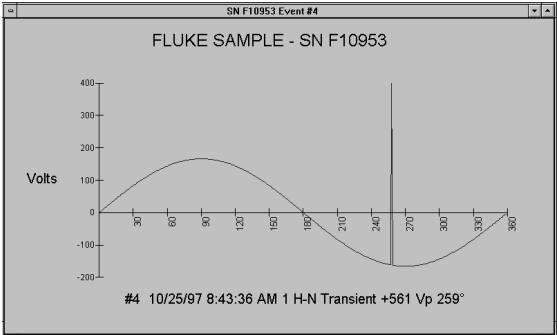
Note that the thickness of a bar and its position in a time period is irrelevant—the bar only displays the number of events and the time period they occurred in.

### ***Viewing a Single Transient as a Graph***

A single transient event between hot and neutral or neutral and ground can be displayed as a graph enabling you to see if the transient is causing zero crossings. A transient graph is produced using the amplitude, direction and position (in degrees) of the event. The graphical representation is not intended to show what the wave form looks like nor does it show the duration of the transient.

To graph a transient you must choose an event that contains only one transient—it is not possible to graph an event consisting of multiple transients.

1. With the Site Report window open at the Events tab, double-click the single-transient event you want to graph.  
(There are two other ways of opening a transient graph: select the single-transient event you want to graph by clicking it, and then, either choose **Single Transient...** from the **View** menu, or click the **View Single Transient** button on the ToolBar.)

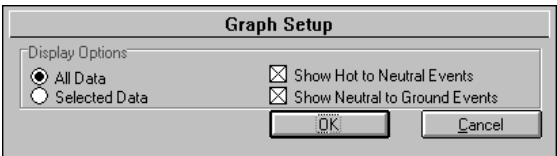


- To open a dialog box of display options, right-click the mouse with the pointer in the graph. Also see under “Changing Graph Styles” on page 33.

### Viewing Events as an Event Distribution Graph

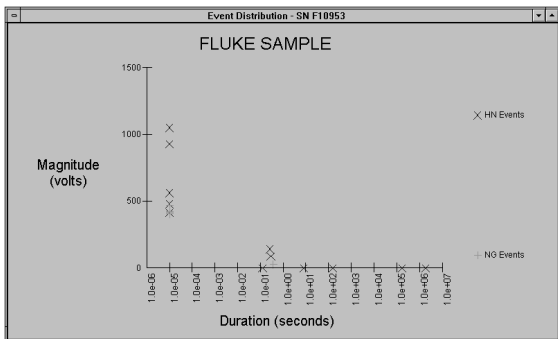
The Event Distribution Graph plots the magnitude of an event against duration on a logarithmic scale in order to determine the importance of the data. For example, a single random event may not be as significant as a cluster of recurring events. This information can be interpreted using the CBEMA Curve found in Chapter 6, *Power Quality Issues*, in this manual.

- With the Site Report window open at the Events tab, choose **Event Distribution Graph** from the **View** menu (or click the Event Distribution button on the ToolBar).



The Graph Setup dialog box will appear enabling you to make your display choices. An explanation of these choices is given under “Viewing Events as a Bar Graph” on page 29.

- Click **OK** to close this dialog box and to display the Event Distribution Graph.



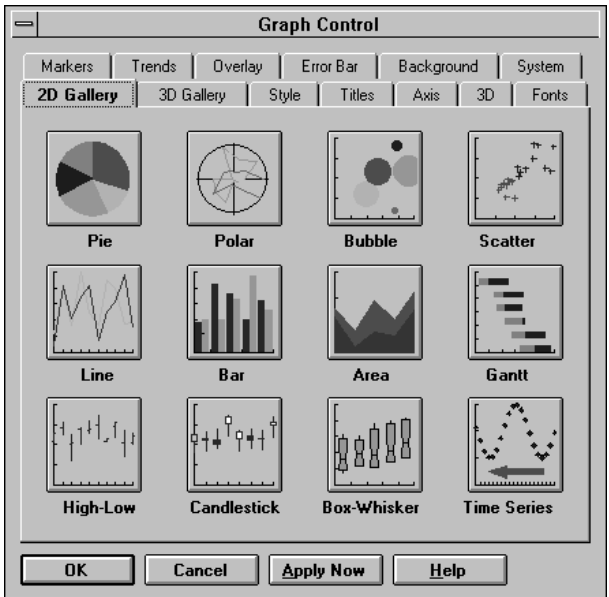
Since the transients have a duration that is unknown, they are represented as having a width of 10  $\mu$ s.



### Changing Graph Styles

The Graph Control dialog box contains a number of edit features that enable you to change the way a graph appears. These features include naming and placing titles, using 3D effects, and saving a graph in different formats.

- Open the Graph Control dialog box by right clicking anywhere in a graph. For explanations of the various features click the Help button.



## **Printing Events**

### *Printing Events from the Events Tab*

1. With the Events tab displayed, choose **Print** from the **File** menu (or click the print button on the ToolBar).
2. Choose the option you want from the Print dialog box (printing all events, printing one or more pages, or printing a number of events that you selected).
3. Click **OK**.

## **Printing a Graph**

1. With a Quick Summary, a Transient Graph, or an Event Distribution Graph open, choose **Print** from the **File** menu (or click the print button on the ToolBar).
2. Click **Setup** from the **Print** dialog box.
3. If you want the horizontal axis longer than the vertical axis, choose **Landscape** orientation from the Print Setup dialog box.
4. Click **OK**.
5. Choose the options you want from the Print dialog box and click **OK**.

If you are printing a Quick Summary or an Event Distribution Graph with a color printer, EventView software gives event types different colors so that you can distinguish between them. If you do not have a color printer, the software assigns patterns instead of colors to different event types.

# Chapter 5

## Troubleshooting

### ***Optical Interface Cable***

Many manufactures of PC software and hardware use the COM (serial) port(s). It is difficult to predict potential COM port conflicts. If the Optical Interface Cable's wand tip is not flashing, there are a few steps that can be taken in order to find the source of the problem.

- **Make sure that the Optical Interface Cable is securely plugged in.** The Optical Interface Cable may appear to be properly connected but only be partially plugged in.
- **Try a different serial port.** If the PC has more than one serial port, try another port to see if the Optical interface flashes.
- **Determine if you have any other Windows programs using the serial port.** PC faxing programs or other programs that use the COM port can cause conflicts during data transmission. To verify that no other programs are running and causing communication problems, shut down your computer and restart it before you run EventView software.
- **Verify that your serial port settings are correct.** In Windows 3.1 you can use the Microsoft Diagnostics program, *MSD.EXE*, to find out the number of installed serial ports in your PC, and their settings. These settings should be the same as those displayed in the advanced section of "Ports" in the Windows 3.1 Control Panel. Exit Windows or restart the computer in MS-DOS mode before running *MSD*. If you have an internal

modem, MSD may detect the modem's serial port. This serial port cannot be directly used with the Optical Interface Cable.

Windows 95/98/NT users verify port settings in Device Manager. Device Manager is found on the TaskBar by choosing **Start, Settings, Control Panel, System, and Device Manager.**

Common Serial Port Settings:

Port	I/O Address	IRQ
COM1	3F8h	4
COM2	2F8h	3
COM3	3E8h	4
COM4	2E8h	3

- **Verify that your serial port is functioning properly.** You can use any standard Windows communications program to ensure the port is functioning. Examples of these are *ProComm*, Windows 3.1 *Terminal* or Windows 95/98/NT *HyperTerminal*.

Exit all programs (including the EventView program) and connect the Optical Interface Cable to the port. Run the communications software and set the local echo to "off" and hardware flow control to "none". If you are using HyperTerminal, choose a direct connection to the port. Open the port with the communications software. Any alphanumeric character you type on the keyboard should cause the optical interface to flash, and the character to appear on the screen.

If the optical interface does not flash when you type, disconnect it and use a piece of wire to connect serial port pins 2 and 3 together. Any alphanumeric character you type on the keyboard should appear on the screen. If no characters appear, the port may be broken or incorrectly configured. If characters appear, your Optical Interface Cable may be broken.

If the optical interface flashes when you type, it should also work with EventView software. Exit the communications program, and re-start the

EventView program. If you are unable to make the optical interface flash when running the program, re-install EventView software.

- **Check your mouse driver.** Certain older or inferior drivers for mice, trackballs and laptop “pointing sticks” are known to interfere with serial port operation. If, after disabling your mouse driver, the optical interface functions normally, try using a different mouse driver such as Logitech or Microsoft.
- **Try another computer if you have one.** An alternative to serial port troubleshooting is to use a different computer. Another computer with its serial ports set up correctly will confirm that there is an incorrect setup or software/hardware conflict with the original PC.

## ***Printers***

- Verify that the printer is plugged in, turned on, and has paper.
- Verify that Windows is set up correctly. Windows uses its own printer drivers. Setup is done through the Windows Control Panel. If you need help, follow the instructions in the Windows 3.1 Guide under **Printers/Setup**; in Windows 95/98/NT click **Help** and choose **Troubleshooting Printers**.
- Try printing from another program to eliminate the possibility of a hardware conflict.

## ***Voltage Event Recorder***

- **The voltage readings of the recorder differ on different meters.** A recorder reads voltage in average RMS. Some manufacturers’ meters may have a True RMS display.
- **Date and/or time are not correct.** The recorder uses the PC’s internal clock to reference the time of downloaded data. Set the PC’s internal clock to the current time. The Windows 3.1 User’s Guide, under System Time and Date, will explain this procedure; in Windows 95/98/NT click **Help, time**, and **changing your computer’s time**. Make sure that the time format is either 24-hour or AM/PM, not both.

- **Two recorders have different transient readings on the same circuit.** Locally generated transients can carry relatively little power. One recorder can absorb some of the energy leaving less for the next one to read.
- **VER Records long periods of large NG swell.** The VER is plugged into a convenience outlet that has been wired with the hot and neutral lines reversed.
- **VER does not record any data.** The VER does not record events while communicating. Make sure that you stop the realtime display. The VER will be ready to record events in 8-16 seconds.

### ***Technical Support***

If you are experiencing problems with your recorder system, please contact your local dealer or an authorized Fluke service center. (See under "Service Centers" in the front of this manual.)

# **Chapter 6**

## **Power Quality Issues**

### ***Power Quality Background***

#### ***Why Is It Such a Concern?***

Many people blame the power utility for degrading power when, in most cases, the problem is caused by poor power distribution within a facility. Equipment such as computers, TVs, phone systems, alarm systems, process controls and even the heating, ventilation and air conditioning system in your building use microprocessor technology to function. As a result, you must ensure that your electrical environment has good power to ensure reliable system operation.

Studies have found that most power line disturbances are caused by the equipment being operated inside a building and that few are utility generated. Lightning, wildlife, and human contact with transmission lines are the major contributors to power line disturbances on the distribution grid.

Major causes of power line disturbances in a building are:

- Overloaded circuits
- Power factor correction capacitors
- Fast switching of large loads
- Incorrect or poor wiring connections

#### ***The Effects of Poor Power Quality within Your Organization***

Power line disturbances can cause far more trouble than just equipment damage. By looking at it from a cost perspective, one can see that there is a far larger loss from poor power quality.

For example, more than likely your business uses microprocessor-based systems. If these devices are continually affected by voltage disturbances, they can be damaged and cause a shutdown. The downtime will result in financial losses.

Power quality monitoring should be considered an integral part of any maintenance program. Continual monitoring is an easy way to determine whether your power quality is adequate. It can also help predict your future power quality requirements.

### ***Common Questions about Power Quality***

#### *Why Not Use a Meter and Check?*

Determining whether a power quality problem exists is very difficult with traditional meters and scopes. The difficulty is that they cannot tell you what has happened in the past. In addition, power quality problems occur faster than the blink of an eye. Many power quality problems result from various types of incompatible equipment operating simultaneously. Equipment such as air conditioning units, heavy machinery and office equipment are the major culprits. Because buildings are wired with numerous circuits, traditional methods of pinpointing the source of power conflicts are almost useless. Data logging can tell you where your problems occur, at what time, and how often.

#### *Why Not Buy a Protection Device?*

Protection devices such as constant voltage transformers, UPS's and transient protection devices may not provide the correct protection for the types of problems that are occurring on your power line. The only way to know what type of protection device is required is to analyze the nature of the power line disturbances.

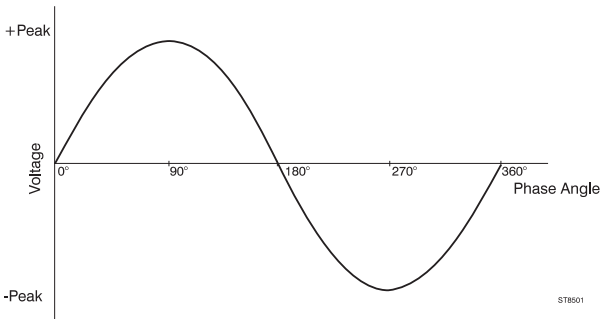
For instance, there are many UPS's at different price ranges, each claiming to offer some protection. But some UPS's cause more problems than they solve. Outfitting your entire electrical environment with power quality enhancing devices could cost a large amount of money not to mention extended downtime. Data logging your electrical environment before and after choosing a correction method is the only way to find out whether you have chosen the best method.



## Power Quality Definitions and Standards

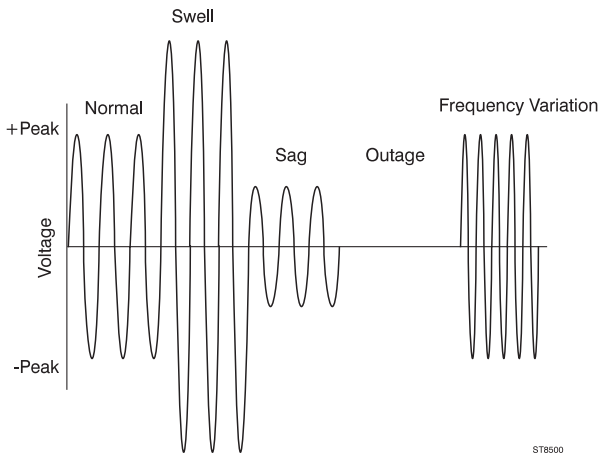
### Power Line Disturbance Definitions

#### Disturbance-Free Voltage



#### Common Power Line Disturbances

Many terms are used to describe power line disturbances. Below are some graphic examples of power line disturbances recorded by a recorder followed by definitions of the terms.



**Sag** An operating voltage of 90% of nominal volts or less

**Swell** More than one cycle above 10% of nominal

**Dropout** Power loss of 1 ms to 1 s

**Outage** More than 1 s of power loss

**Positive Transient** A momentary overvoltage of 4 ms or less

**Negative Transient** A momentary undervoltage of 4 ms or less

**Frequency Variation**  $\pm 1$ Hz of the fundamental frequency (50 or 60Hz)

### ***How Bad is Bad?***

Manufacturers of electrical equipment may specify requirements for power quality. The tolerances below are general and do not apply to all manufacturers of sensitive electronic equipment. Generally, sensitive equipment (computers) can operate within the following voltage tolerances:

#### **Swells**

- Up to 10% above nominal continuously
- Up to 30% above nominal for less than 0.5 seconds

#### **Sags**

- Down to 10% below nominal continuously
- Down to 30% below nominal for less than 0.5 seconds
- Down to 0 volts for 4 ms (acceptable but not recommended)

#### **Transients**

- Not to exceed  $\pm 150\%$  of sine voltage for more than 0.2 ms

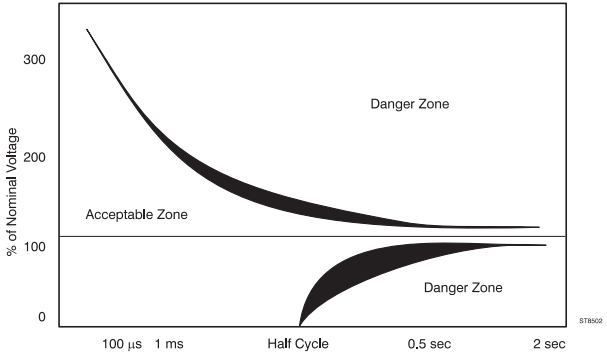
#### **Frequency Variation**

- $\pm 1$ Hz

### ***The CBEMA Curve***

The Computer Business Equipment Manufacturers Association (CBEMA) has published a susceptibility graph detailing how various types of power line disturbances affect sensitive electronic equipment (see below).

Although this graph does not apply to all equipment, it does apply to a vast amount of equipment in the marketplace.



## ***Causes and Effects of Poor Power Quality***

### ***Causes of Poor Power Quality***

#### **Swells**

- Shutdown of heavily loaded equipment
- Abrupt power restoration
- Utility switching

#### **Sags**

- Abrupt increase in load
- Dropouts/Outages
- Lightning
- Outdoor contact with transmission lines
- Ground Faults
- Equipment failures
- Acts of nature

#### **Transients**

- Switching loads on and off
- Utility switching
- Lightning
- Normal computer operation
- Fault clearing
- Power factor correction capacitors

**Frequency Variation**

- Major load increases
- Utility switching

***How Power Line Disturbances Affect Your Equipment***

Depending on their degree and frequency, power line disturbances can cause corrupted data or permanent damage in sensitive electronic equipment. The following list shows the effects that power line disturbances can have on various types of sensitive electronic equipment.

**Swells**

- Discomfort from flickering lights
- Computer damage
- Degradation of power protection equipment

**Sags**

- Equipment shutdown
- Power-down circuitry in power supply operates incorrectly
- Computer lock-ups
- Diminished speed of disk drives (data errors)

**Dropouts/Outages**

- Data loss
- Equipment downtime
- Computer lock-ups
- Clock timing errors

**Transients**

- Electronics damage (through bypassing protection circuitry)
- Insulation breakdown in transformers and motors
- Data errors, data loss

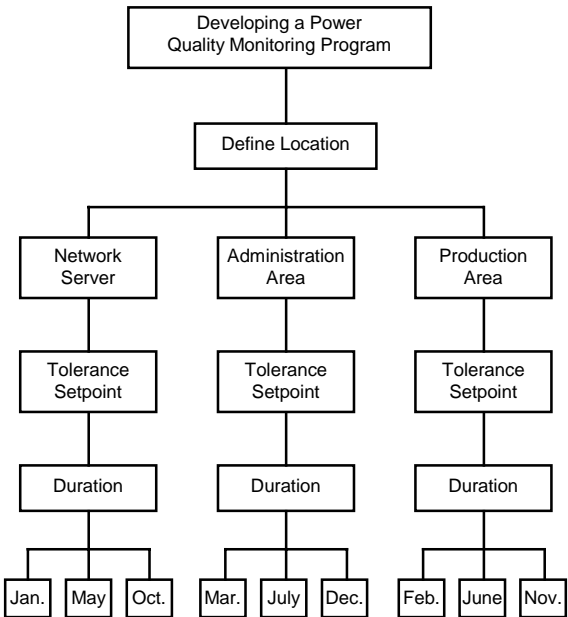
**Frequency Variation**

- Incorrect clock timing
- Writing errors in any electronic writing device (magnetic tapes, disk drives)

## Performing a Power Quality Study

### Developing a Power Quality Monitoring Program

A power quality monitoring program is a simple, useful process that helps determine the best method for assessing an electrical environment's power quality. Before you monitor power quality, develop a monitoring plan. The plan should define the duration and location of your power quality studies. Here are a few basic steps to developing a power quality study.



**Sample Power Quality Monitoring Program**

#### *Developing a Location Plan*

Depending on the size of the organization, number of departments, and importance of certain locations, note the priority locations. The location plan may change throughout the power quality study as clues may direct you to a possible problem location.

#### *Developing a Tolerance Plan*

Thresholds should reflect the equipment being used. Even a heavy piece of machinery such as a CNC machine may be considered sensitive since it has electronic circuits.

The default settings function in EventView software is adequate for most sensitive loads. Some equipment may require tighter tolerances. If so, use the tolerances provided by the manufacturer of the equipment.

#### *Developing the Study Duration Strategy*

In order to determine how long to monitor the site, determine the organization's workload cycle. A workload cycle is the duration of production, whether it is a product or service. A site should be monitored over the entire workload cycle.

Another consideration is the workload cycle vs. the time of day, month or season. At 10:00 AM the organization may be using all of its equipment at once. Air conditioners tend to operate more often in the summer months and space heaters tend to operate in the winter months. This, in conjunction with your organization's workload cycle, can cause equipment conflicts throughout the year. To determine a workload cycle, answer the questions that are appropriate for your study.

**Manufacturing** How long does it take to produce a run of your product?

**Services** How often do you provide your service (daily, seasonally)?

**Administration** How does your staffing or workload vary (monthly, seasonally)?

#### *Finalizing the Power Quality Monitoring Plan*

The key to finalizing the power quality monitoring plan is to publish and assign responsibility for it. The power

quality monitoring program will help make the organization more productive and will possibly save money.

*Final Note*

This is only one strategy that can verify power quality. Different situations may call for different strategies in order to investigate and solve power quality concerns.

***Now That I Have This Information, What Do I Do with It?***

There are two ways to solve most power line disturbances: either rewire the electrical system to separate the sensitive loads from the problem branches, or place a number of UPS's or other protection devices in mission critical areas. The problem with using a UPS is it may introduce more disturbances downstream of the electrical system as it may use a switch mode power supply. A UPS is only a temporary solution. The real problem is probably located somewhere in your electrical distribution system. Poor wiring, poor connections, poor load distribution or improper grounding may be the problem.

When trying to solve power line disturbances, consider the following:

- The power requirements of the sensitive electronic equipment
- The severity of the problem
- The effectiveness of each possible type of power conditioner
- the performance/price relationship

***Repetitive / Cycling Events***

These types of events are usually caused by incompatible loads on a circuit. HVAC systems, laser printers, and large motors may cause conflicts when they cycle. These types of conflicts occur because the building's electrical demand has increased, and there is no one responsible for monitoring the load on the system until there is a problem. Moving sensitive loads to a separate circuit may solve this problem.

***Unrepetitive / Isolated Events***

These types of disturbances are usually caused by the location of the organization. If you are in an area where there is lightning, high winds, or if the equipment is being used only occasionally, simple power line conditioners and filters may help to protect most of the equipment. Many power line disturbances are easy and inexpensive to prevent (depending on their frequency and magnitude).



The following power conditioning suggestion chart is useful for choosing an adequate protection device for unrepeatitive power line disturbances.

	<b>Transient/ Swell Protector</b>	<b>Power Line Filter</b>	<b>Uninterruptible Power Supply</b>
Transients	X*	X	X
Swells	X*	X	X
Sags			X
Outages			X

\* Used only when transients and swells are moderate in quantity or else damage may occur to the power protection device.

When considering a protection device, make sure that it covers the entire operating range. It is a waste of money buying a protection device rated to remove transients of up to 1000 volts if you have recorded transients of more than this.

The difference between power line filters and protectors is that filters can catch fast transients of high magnitudes. Filters tend to be more expensive than protectors.

The information you receive from your recorder will enable you to make an informed decisions about protection devices.

Please note that this appendix is not a comprehensive study of power quality, nor does it attempt to provide all solutions to power quality problems.

Power quality is a complex issue. It may be necessary to make additional measurements such as: line current levels, harmonic content, and distortion using other power quality diagnostic equipment.



# Chapter 7

## **VR101 Specifications**

The following specifications are valid only when the Voltage Event Recorder is plugged into a grounded standard convenience outlet and when the LED indicates correct polarity.

Specifications subject to change without notice.

### ***Equipment Ratings***

Model number **VR101/xx3**

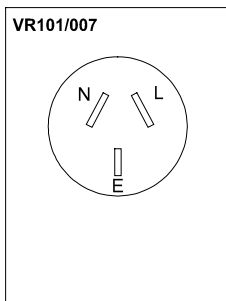
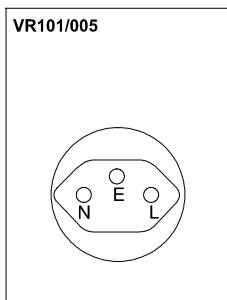
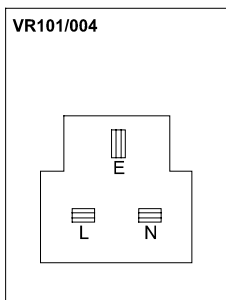
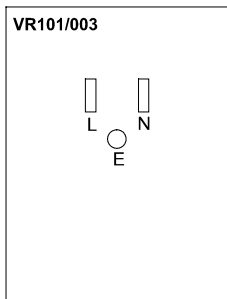
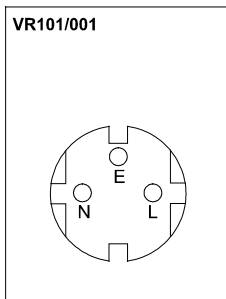
<i>Nominal Supply:</i>	120V
<i>Operating Range:</i>	70 to 140V
<i>Operating Frequency:</i>	50/60Hz
<i>Power:</i>	2W

Model numbers **VR101/xx1, /xx4, /xx5, and /xx7**


<i>Nominal Supply:</i>	240V
<i>Operating Range:</i>	140 to 270V
<i>Operating Frequency:</i>	50/60Hz
<i>Power:</i>	3W

**Plug Configurations**

Back view of country versions



L = LINE  
N = NEUTRAL  
E = EARTH

<i>Memory Size:</i>	32kB, 4000 events
<i>Storage Method:</i>	First-in First-out, or Fill-then-stop
<i>Sampling Method:</i>	Continuous (half cycle integrated)
<i>Alarm Type:</i>	Optical; red LED slowly blinks when there are events stored in memory.
<i>Polarity Detection:</i>	Within 8 s after plugging in.
<i>Polarity Indication:</i>	Red LED lights steadily during 8 to 16 seconds if polarity is OK. Red LED quickly blinks during 8 to 16 seconds if improper polarity.
 <i>Size:</i>	85mm x 68mm x 35mm (3.35 in x 2.65 in x 1.35 in)
<i>Weight:</i>	120g (4 oz)
<i>Operating Limits:</i>	-40 to 160 °F (-40 to 70 °C) (excluding Optical Interface Cable) 0 to 95% RH (non-condensing) 15,000 feet (4.57 km) altitude.
<i>Battery:</i>	3.6V Lithium (non-replaceable)
<i>Expected Battery Life:</i>	7 years (provided that maximum battery care is taken, see under “Battery Care” on page 5)
<i>Fuse:</i>	1/16A Fast-blow (non-replaceable)

## **Sag, Swell & Outage Measurement**

### **Hot to Neutral**

Model number **VR101/xx3**

*Range:* 0 to 200Vrms

*Accuracy:*  $\pm 2$ Vrms\*

*Resolution:* 1Vrms

Model numbers **VR101/xx1, /xx4, /xx5, and /xx7**

*Range:* 0 to 270Vrms

*Accuracy:*  $\pm 4$ Vrms\*\*

*Resolution:* 2Vrms

### **Neutral to ground**

Model number **VR101/xx3**

*Range:* 3 to 150Vrms

*Accuracy:*  $\pm 2$ Vrms

*Resolution:* 1Vrms

Model numbers **VR101/xx1, /xx4, /xx5, and /xx7**

*Range:* 3 to 150Vrms

*Accuracy:*  $\pm 2$ Vrms

*Resolution:* 1Vrms

\* sags less than 70V for > 1s will be reported as 0V

\*\* sags less than 140V for > 1s will be reported as 0V

## **Transient Measurement**

### **Range**

*Hot to Neutral:* 100 to 2500Vpeak

*Neutral to Ground:* 50 to 2500Vpeak

*Accuracy:*  $\pm 10\%$  of reading + 10V

*Resolution:* 10V

*Width Detection:* 1  $\mu$ s minimum

### **Phase Angle**

*Range:* 20° to 180°, 200° to 360°

*Accuracy:*  $\pm 1^\circ$

*Resolution:* 1°

## **Frequency Measurement**

*Range:* 45 to 65Hz

*Accuracy:*  $\pm 0.1$ Hz (3 cycles minimum)

*Resolution:* 0.1Hz

## Time Measurement

### Events <1 s(econd)

#### Accuracy

*Hot to Neutral:*  $\pm 0.5$  cycle\*

*Neutral to Ground:*  $\pm 1$  cycle\*\*

#### Resolution

*Hot to Neutral:* 0.5 cycle

*Neutral to Ground:* 1 cycle

Clock accuracy:  $\pm 2$  s/day

**Timer counter capacity** 4.25 year (24 bit counter, resolution 8 seconds)


\* Outages are reported with  $\frac{1}{2}$  cycle resolution until the VER goes into low power mode. A VER will go into the low power mode after approximately one second of an outage condition. In low power mode, the resolution becomes 8 seconds.

Swell, sag, and frequency events have  $\frac{1}{2}$  cycle resolution up to approximately 10 minutes after which the resolution becomes 8 seconds.

\*\* Neutral to Ground swells have 1 cycle resolution up to approximately 10 minutes after which the resolution becomes 8 seconds.



## Approvals

 **Safety:** This device is safety approved by CSA and CSA(NRTL/C) for measurements on 300V CAT III, Pollution Degree 2, double insulation, per:  
UL3111-1 (1994)  
IEC1010-1 (1990)  
CSA C22.2 No. 1010.1 (1992)  
EN61010-1 (1993)

*Environmental:* MIL-T-28800E, Type III, Class 3

*EMC:* FCC rules part 15.

89/336/EEC

Emission: EN50081.1

Immunity: EN50082.2

(IEC1000-4-2, -3, -4, -5)

## ***Declaration of Conformity***

for  
Fluke VR101  
Voltage Event Recorder

### **Manufacturer**

Fluke Industrial B.V.  
Lelyweg 1  
7602 EA Almelo  
The Netherlands

### **Statement of Conformity**

Based on test results using appropriate standards,  
the product is in conformity with  
Electromagnetic Compatibility Directive 89/336/EEC  
Low Voltage Directive 73/23/EEC

### **Sample tests**

Standards used:

EN 61010.1 (1993)  
Safety Requirements for Electrical Equipment for  
Measurement, Control, and Laboratory Use

EN 50081-1 (1992)  
Electromagnetic Compatibility.  
Generic Emission Standard:  
EN55022 and EN60555-2

EN 50082-2 (1992)  
Electromagnetic Compatibility.  
Generic Immunity Standard:  
IEC1000-4 -2, -3, -4, -5

The tests have been performed in a  
typical configuration.

This Conformity is indicated by the symbol **CE**,  
i.e. "Conformité européenne".

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