Fluke 89-IV & 189 Event Logging

FlukeView Forms Technical Note

One of the major features of the Fluke 89-IV & 189 meters are their ability to "do logging". This technical note explains what kind of logging the Fluke 89-IV & 189 meters can perform, how to use the event logging feature and the information that can be provide to you. This note also discusses briefly how the FlukeView Forms PC software is used as a key element to increase the functionality of the logging feature. There are other application notes that explain in more detail how to use the FlukeView Forms PC software to enhance the Fluke 89-IV & 189 event logging feature.

Table of Contents

Differences between Fluke 89-IV & 189 and Data Logger

First and foremost, the Fluke 89/189 meters were not built to do data logging in the traditional sense, like a data logger would. Typically, the goal of a data logger is to sample an input signal at a rate sufficient enough to be able to track something of interest that you expect to be contained within the signal. This often means that it is desirable to sample the signal as fast as possible so you "don't miss anything." The problem with this approach is you need a large storage place for the fast data sampling that is taking place. You can also end up with a lot of redundant data that is considered "normal" and not of interest. You must wade through the normal data to find the exceptional data (or lack thereof) that you are interested in seeing.

With the Fluke 89-IV / 189 meters, there is not a large memory to store large amounts of data. Yet, it can still do an effective job of monitoring and logging data for an input signal in order to detect when and if a system is operating normally or abnormally. This is accomplished by something we call *event logging*.

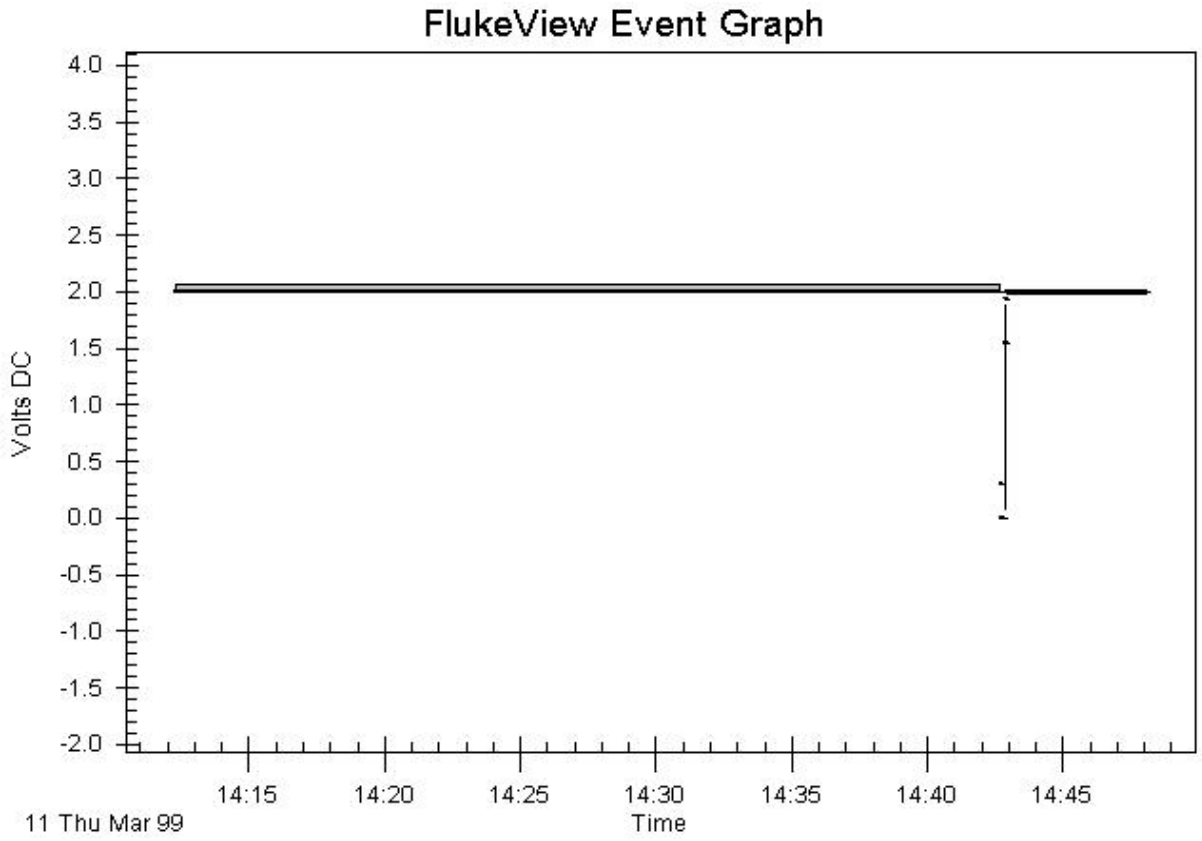
Introduction to Event Logging, Stable Period, Unstable Period, and Event Data

Event Logging can be thought of as an extension of the "Touch Hold" feature of the original Fluke 87. (Touch Hold is now called "Auto Hold" in the model 87/89, series IV & model 187/189.) When the Touch Hold feature works is activated, the meter will wait until a period of stability has been reached, then it will beep and freeze (hold) a stable reading on the display for the user to see. If the input changes to the point that it is no longer stable, then becomes stable again, the meter will beep a second time and hold a new reading on the display.

Event logging encompasses a similar scheme. When the Fluke 89-IV/189 is logging it is looking for changes from the last stable reading. What happens during the logging process is that as each period of stability or instability ends the meter will log information about that period to its internal memory. The information that is logged for each of stable or unstable period is a start time, stop time, and the maximum, minimum, and average readings detected during that period of time. The approach with event logging is to only store enough information to describe a series of *changes* (i.e., events) that have happened to the input signal. Thus, the term "event logging" was coined. The goal is to focus on detecting transition events in order to characterize the input signal. The information recorded for the transition events is referred to as event data.

An Example - Viewing what Event Logging Data Looks Like

The Fluke 89 / 189 excels at performing the logging of transition events, but does not have the large graphical display needed to view the event data. This is where the FlukeView Forms software comes into the picture. The only way to view event data is to load it into the FlukeView Forms application (from the meter you can only view interval data, which is explained later). FlukeView Forms is able to display the data in table or various graph formats. An example is shown below:



Logged Readings Table

	Start Time	Duration	High	Average	Low	Description	Stop Time
1	3/11/99 2:12:17 PM	0:30:27.3	2.0625 V DC	1.9962 V DC	1.9898 V DC	Stable	3/11/99 2:42:44 PM
2	3/11/99 2:42:44 PM	0:00:00.9	1.8022 V DC	0.3092 V DC	0.0058 V DC	Unstable	3/11/99 2:42:45 PM
3	3/11/99 2:42:45 PM	0:00:07.6	0.0050 V DC	-0.0000 V DC	-0.0005 V DC	Stable	3/11/99 2:42:53 PM
4	3/11/99 2:42:53 PM	0:00:01.3	1.8836 V DC	1.5379 V DC	0.0600 V DC	Unstable	3/11/99 2:42:54 PM
5	3/11/99 2:42:54 PM	0:00:01.1	1.9625 V DC	1.9319 V DC	1.8865 V DC	Stable	3/11/99 2:42:55 PM
6	3/11/99 2:42:55 PM	0:05:10.7	1.9986 V DC	1.9974 V DC	1.9642 V DC	Logging Stop	3/11/99 2:48:06 PM
7							

Looking at this data, you can see that the logging session started at 2:12:17 PM and ended at 2:48:06 PM with an elapsed time around 36 minutes. You can also see that signal being measured was stable at 2 volts for most of the logging session. However, there were 2 occurrences of instability detected by the meter during a 11 second period just before 2:43 PM. The graph gives a visual indication of what happened around that time. What is interesting about this example is that the table of data shows that only 6 "events" needed to be stored in the meter memory over the entire 36 minutes of logging to capture the essence of what happened.

What this illustration shows is that with event logging, only a very small amount of memory was needed to store the information. To capture the same data using traditional data logging would require a 0.100 second sample rate and thus 21,600 records for the 36 minute session . Compare this with the fact that the Fluke 89-IV / 189 only has room for 995 logged readings. It becomes clear why event logging makes sense for a handheld meter with limited memory.

Definition of a Stable and Unstable Signal

So what determines if a signal is stable or unstable? The original Touch Hold feature of the Fluke 87 that was mentioned earlier uses the criteria: "if the input signal changed more than 4% of the current measurement range" then a period of instability would be started. Once the input signal settles to within that 4% window for at least 1 second, then a period of stability begins again.

For event logging, a similar approach is taken, but percent of reading is used instead of percent of range. This event stability window defaults to 4% . While this value can be modified with the FlukeView Forms software (version 1.5 or later), we will continue to refer to the default value in this document.

A stable period will continue to be stable if the input signal does not vary more than ± 4% from the input signal amplitude at the beginning of a stable period. If the input signal jumps or drifts outside the ± 4% window and is detected by the meter as being outside the window, the meter will end that stable period and log (record) the input signal's high, low and average values for that stable period of time and the timestamps. The meter will then attempt to start another stable period. If the meter finds the input signal can not stay within the ± 4% window after trying to start a new stable period, it then defines a period of time as unstable. When it becomes stable, the meter will log the high, low, average and timestamps for the period of instability, the 'unstable' event.

Minimum Event Duration Time

If the input signal jumps outside of the ± 4% window and then quickly returns back into the window, the duration of the event may be too short for the Fluke 89 / 189 to detect. There is a minimum amount of time an event must exist outside of the 4% window before the meter will detect and record the event. The table below shows some typical minimum event duration times for the various input functions.

Input Function	Minimum Detectable Event
VAC, mVAC, VDC, mVDC, Ohms, Continuity, Diode, AAC, mAAC, µ AAC, ADC, mADC, and µ ADC	50 ms
Exceptions: 50 mVDC, 500 Ohms, 5A DC, 50mA DC, 500 µ ADC	100 ms
AC+DC V, AC+DC mV, AC+DC A, AC+DC mA, AC+DC µ A	1.5 sec
Exception: AC+DC 5V	3 sec
Conductance	250 ms

Capacitance (1 μF is 6.7 samples per second)	300 ms
Temperature	500 ms
Frequency while in: VAC, mVAC, VDC, mVDC, Ohms, Continuity, Diode, AAC, mAAC, μ AAC, ADC, mADC, and μ ADC	50 ms
Frequency while in: 50 mVDC, 500 Ohms, 5A DC, 50mA DC, 500 μ ADC	100 ms

How Long can the Meter log data?

The meter has room for 995 events. It can log until that memory is full, at which point logging will automatically stop. Further, the meter's batteries will sustain logging for about three days. When the batteries get low, logging will stop.

Since you can not know in advance how many input events will be logged, how do you ensure that data will be logged over the entire test period? This is where the logging interval comes into play.

The meter reserves enough memory to log an 'interval event' every 15 minutes for 3 days (288 events). In practice that means that after 707 (995 events – 288 reserved for interval events) stable/unstable events have been logged, the meter would disable further detection of stable/unstable periods but continue to log the highest, lowest, and average value detected in each interval period.

Logging Interval - An additional Twist

If you have already looked at the Fluke 89 / 189 logging feature somewhat, you are probably aware that the meter has a *Logging Interval* setting. This is a time value that can be set in the meter setup function. The meter will allow you to set the value anywhere from 0:00 to 99:59 (hours:minutes). The factory default value is 15 minutes.

Lets go back to the 36 minute example shown in the first graph and table. For the first 30 minutes, 27.3 seconds, nothing significant happened. If the logging interval for that session had been set to say 5 minutes, then at 12:17:17 (5 minutes after starting logging), the meter would have logged the highest, lowest, and average values of that first 5 minutes, and started a new event. At 12:22:17, it would have logged the second event with the highest, lowest, and average measured between 12:17:17 and 12:22:17, etc. Now on the graph, you would probably have to look closely, because those additional events would all look almost identical.

So why set an interval?

1) **To insure that you have data for the entire test time.**
   Lets say during out 36 minute test, that the signal had a little 300 ms noise spike (greater than 4% of the reading) every 3 seconds. The meter would have logged 1 stable event period of 2.7 seconds, followed by a 0.3 second unstable period, every 3 seconds. If there had been no interval, the memory would have filled up in under 25 minutes. With the 5 minute interval, the first 17 some odd minutes would have been filled with these pairs and the remaining test time (19 minutes) would have had an event every 5 minutes . We wouldn't have as much detail in this 19 minute period, but we would still know the highest, lowest and average readings taken in 5 minute steps.

2) **You need to have a record broken down into fixed time periods.**
   For example, lets say your utility bills according to 15 minute load cycles. Setting a 15 minute interval will insure that you have data in 15 minute increments.

3) **The meter has a very limited capability for displaying logged data.**
   The meter displays only the 'average' value of each interval period. (Can you imagine trying to view 995 individual sets of high/low/average data on the meter display?) For our 36 minute example, the only value viewable on the meter after the logging session would have been the average value of the entire 36 minute session. If the interval had been set to 5 minutes, there would have been 8 average values to view on the meter. (see Viewing Logging Data using the Meter)

Note that the interval events are logged in addition to the input events! So if you use a logging interval, plan on seeing a mixture of data within the logging session - some generated from the event logging, and some generated from using the interval (see How Events and Intervals Blend Together).

Keep in mind that using the logging interval is optional. Setting it to 00:00 will mean that no logging interval will be used and the meter will do pure event logging only.

Interactive event logging simulation:

FlukeView Forms (1.5 or greater) has, as part of it's logging setup dialog an interactive explore the event logging. An 'Example log' graph and summary is shown where the current logging settings are applied to a sample data set. You can "Change Example Data" by setting the initial value, noise, drift, and "significant event" values.

Calculating what Logging Interval to Use

Instead of thinking about how small you should set the interval, it is often better to determine how large you need to set it.

For example, say you want to monitor for three days or 72 hours. You want to be certain you have some logging data over the entire 72 hours regardless of how stable or unstable your signal is. Calculate the necessary interval as follow:

[Length of Test] divided by 288 = Minimum logging interval

For 3 days or 72 hours this works out as: 4320 minutes / 288 memory locations = 15 minutes
where
4320 minutes = 3 days X 24 hours per day X 60 minutes per hour and
288 is the number of memory locations reserved for interval data

This result shows that a 15 minute or greater interval is needed to guarantee that there will be enough interval data storage for the full 72 hours.

If you believe your signal is going to be mostly stable and therefore generating only a few logging events, you could make the logging interval smaller. A five minute interval would generate 864 events in 72 hrs, but if there were more than 131 input events detected, the memory would fill and logging stop before the 72 hours were up.

Keep in mind, even with the longer logging intervals, the Fluke 89 / 189 will catch events each time the input signal jumps outside the ± 4% stability window.

Automatic Range Changes

You should also be aware that each automatic range change will eat up two logging interval memory locations. If the meter were to change range 6 minutes into a 15 minute interval, the meter would display the logged data as a 6 minute interval and a 9 minute interval. A few range changes would likely be okay, but if there could be a lot, then you should place the meter into manual range. Select the input range needed to measure the highest expected signal.

Cases where a Smaller Logging Interval is Valuable

For most uses, the factory default value of 15 minutes for the logging interval is sufficient to provide some logging data regardless of what happens with the event logging portion of the logging process. There are some times however, when it may be desirable to use a smaller interval:

- You need to have definite minimum, maximum, and average values "on paper" for set intervals that are less than 15 minutes in length
- You have a slow changing signal and want more detail about what is happening within the 4% stability window
- Your logging session will not be very long in duration and you know that the meter will be able to hold all the interval data you plan to log

- If you don't have FlukeView Forms software. If this is the case, you will not have a way to see the event data. The only logging data you can see on the meter is the average value and stop time of each interval. So if your logging application allows, it might be advantageous to use a smaller interval so more data can be collected that is viewable on the meter

Cases where a Larger Logging Interval is Valuable

In some instances, you may want the logging interval to be longer than the 15 minute factory default:

- You need to have definite minimum, maximum, and average values "on paper" at set intervals that are more than 15 minutes in length
- You want minimal interference between the interval data and any event data - you are mainly focused on capturing transition data from the event logging process . Note that in FlukeView Forms, the logging table and event graph can be set to view all the events taken, or to display only the interval data or only the input event data.

Starting and Stopping a Logging Session from Meter

Starting a logging session on the meter is pretty simple. Once you select the desired meter input function, you start the logging function by pressing the LOGGING key (the yellow Shift button followed by the REL button). If there is already some logging data in the meter memory, the meter will prompt with a message of "CLR?" in order to ask if it is OK to clear this out. Press the YES button (up arrow) if this is OK, or the NO button (down arrow or let timeout) to cancel the logging session. Once memory is cleared, logging will begin. The display will show the LOG annunciator at the top, the elapsed time of the logging session will appear in the lower right corner, and the index number of the interval in progress appears in the lower left corner. There will also be a small flashing MEM symbol just above the index number to show that logging data is going into the meter memory. The index number begins at 001 and increments at the start of each new interval (or range change). Note that the index number will <u>not</u> increment when events are detected.

To stop logging, press CANCEL (the yellow Shift button followed by the Hz button) or press LOGGING (yellow Shift button followed by the REL button). Turning the rotary switch will halt the logging session as well, but this is not recommended since it is possible for stray readings to be logged while the rotary switch is being moved.

The logging session will also stop if the battery becomes low or if the memory becomes full. If the memory does fill up, the word "End" will appear in place of the index number in the lower left corner of the display.

Viewing Logging Data using the Meter

After a logging session is complete, you have two choices on how to view the logging data. You can transfer the data to the FlukeView Forms software, or you can choose to view a limited portion of the data directly on the meter display. Keep in mind that the meter is not able to show any of the separate input event data that was collected or the minimum and maximum value for interval data. The meter will process any stable/unstable events that occurred during the interval and show the average value.(thus if signal had alternated between +2V and -2V about half the time each during the interval, the meter would display an average value of about 0V).

To view the logged averages for the intervals, turn the rotary switch to the VIEW MEM position, then press Logging (press the yellow button followed by the REL button).

The meter will begin by showing the average reading during the first interval. The index number in the lower left corner will read 001 to indicate this fact. The time that the interval concluded is shown in the lower right corner. This is a time of day value with a format of hour and minute. Since seconds are not shown, you would see the same time for more than one interval if the logging interval was set to less than one minute.

To see the average of the next interval, press the Up-arrow button. The index number will change to 002. If you want to move backwards through the data, press the Down-arrow button. When you reach the end of the data, the up button will wrap the data around to show the beginning again. Likewise, when you are at the beginning of the data, the down button will show you the last interval.

If one or more overloads happen during an interval, an OL will be displayed in the secondary reading area of the display. Overload readings are ignored in calculation of the average for the interval with the overload.

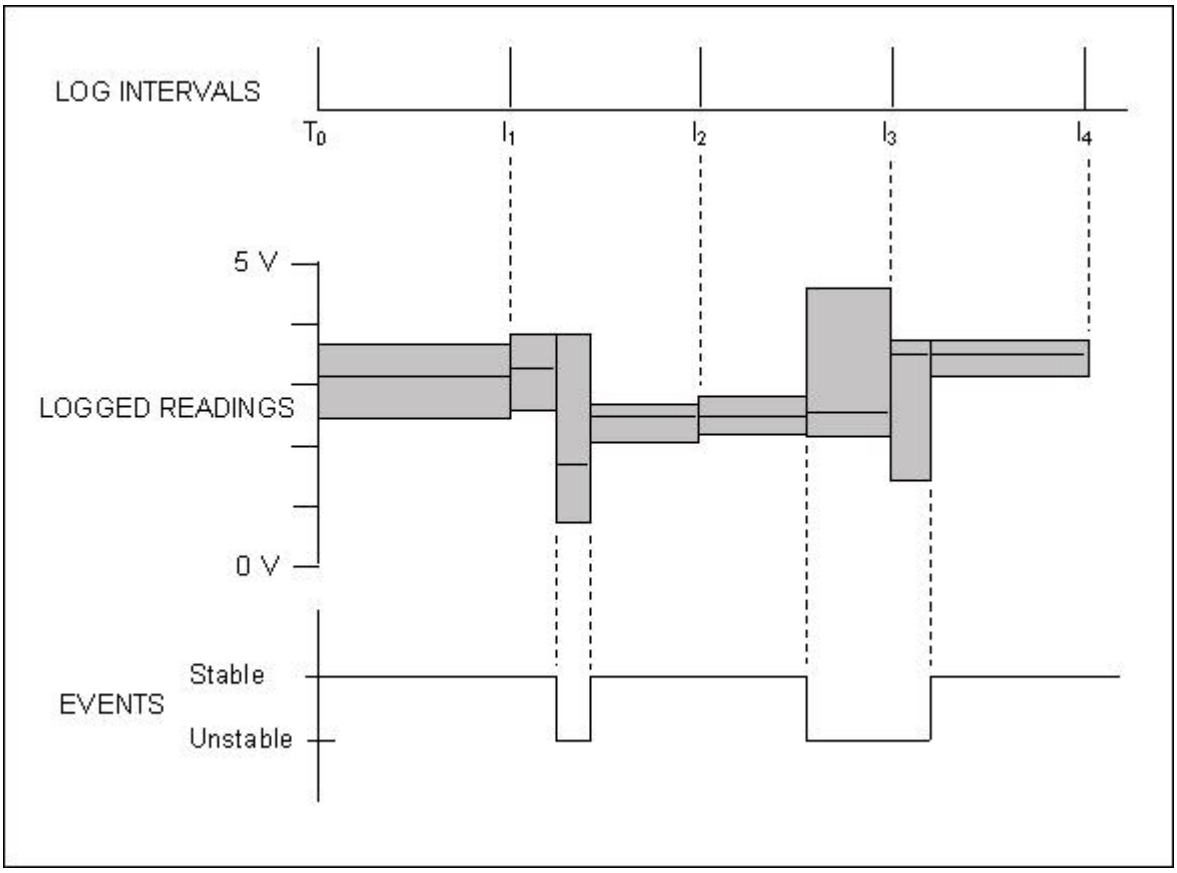
If a range change happens during an interval, the meter will record the data for the portion of the interval spent in each range. In such a case, the meter will display the average reading for each portion - the time of day reading will have reflect the partial interval. This is a side effect of using Auto Range during a logging session. When a range change is logged it will occupy one of the 288 reserved interval locations. If this is a concern you can set the meter in manual range before beginning a logging session.

Viewing Logging Data using FlukeView Forms PC Software

If you want additional viewing capabilities for your logging data, you can use the FlukeView Forms software to transfer the data from the meter memory into a PC. FlukeView Forms has various ways to view the data in graphical and tabular form (see An Example - Viewing what Event Logging Data Looks Like). An important feature is the ability to "zoom in" on graphs containing event data to get more visual detail of what took place. The data can also be saved in a database on the PC or printed for later review. There are online application notes that explain how to use FlukeView Forms and how to create your custom form.

How Events and Intervals Blend Together

One of the main points emphasized in this article: The Fluke 89/ 189 will log event data in addition to interval data at regular time intervals. Since two types of data are being logged, it can be confusing to think about how both of these mix together to make up the logging session as a whole. FlukeView Forms enables you to see all this data obtained during a logging session. The following diagram illustrates how the meter ends up storing this mixture of data and how it will appear graphically in the FlukeView Forms software:



At the top of the diagram is a time line indicating when the end of one logging interval takes place and the start of another logging interval begins. The logging session starts at time T0. Intervals are shown ending at times I1, I2, I3, and I4. At the bottom of the diagram is a time line showing when the meter is logging a stable or unstable signals. The logging session starts with a stable signal, then shows 2 periods of an unstable signal occurring.

In the center of the diagram, an event graph is depicted which looks like an Event Graph in the FlukeView Forms software. The dashed lines indicate when the Fluke 89 / 189 will log for the preceding time period the high, low, and average measurement and the ending time stamp. The FlukeView Forms software constructs a box, whose vertical height represents the high and low measurements for a given logging period and whose horizontal length represents the period duration. The average for that period is shown as a straight line through the box. An explanation for each box in the above diagram follows:

Box #	Explanation
1	The first box is generated because a logging interval (I1) came to an end.
2	A stable signal went unstable, the box will represent the stable period that has come to a close.
3	The signal became stable again, data is logged about the unstable period.
4	A second logging interval (I2) has expired. (This interval has been split into 3 pieces because of some events.)
5	A stable signal went unstable.
6	The third logging interval (I3) expired.
7	The unstable period ended.
8	A fourth logging interval (I4) has ended.

Looking at this diagram shows that the logging intervals get added to the logging results at regular periods of time. The events also get added to the logging results whenever a transition to or from a stable state occurs. Note that when an interval expires, it will "split up" any period of stability (or instability) and cause a new logging period (box) to be started. FlukeView Forms logged readings table and logged readings graph have the capability to show just the interval data or just the event data if this is preferred. You can do this by placing the mouse pointer over the Logged Readings Table, clicking the right mouse key and selecting show data. While you are doing this, you also might want to try right clicking while the mouse pointer in over one of the Event Graphs and selecting View.

Real Time Event Logging using the FlukeView Forms PC Software

FlukeView Forms software 1.5 and higher support event logging on the PC for additional selected Fluke meters, even if they do not offer internal logging.

When used with the Fluke 89 / 189, you have an option to let the meter determine the events, or use let the PC determine the events.

> If you choose to have the meter determine the events, you maintain the best time resolution (minimum detection time) for detecting and recording events. The meter has a temporary buffer of 10 memory locations that FlukeView Forms reads, so that short events are not lost.

If you choose to have the PC determine the events, you have a slower detection time, but gain the ability to log both the primary and secondary display's data as well as choosing either a fixed threshold (stable window) size, or a relative threshold and set both the threshold % and a minimum threshold size.

FlukeView Forms also allows you to specify different levels of compression above or below some values when real time logging. For instance, you might specify that you only want interval data for reading between 100 and 130 VAC, but want interval and input data above the 130V limit, and minimum data (combine interval and input data) below the 100V limit.

Real time event logging with FlukeView Forms is discussed in another tech note, "Interactive Logging with FlukeView® Forms (Version 1.5 and later)".

FlukeView Forms (1.5) allows you to change the meter's stored 'event stability window size' parameter. This allows you to specify the amount of change you consider significant for your application.
