FLUKE®

Data logging on the Fluke 884X with TrendPlot™

Application Note

Advances in analog and digital technology and consumer demand for better performance and higher quality are presenting new challenges to research, development, and test engineers. Today engineers are designing circuits to tighter tolerances, using precision components and sophisticated circuits to ensure optimum performance and mean time before failure (MTBF).

Parameters like short-term stability, drift, and fluctuations are critical variables required to understand a circuit's behavior in either controlled or un-controlled environments. In some cases, to troubleshoot a device, the engineer may find himself looking for elusive problems like intermittent dropouts or glitches.

When tasked to measure these parameters, the engineer may have to gather multiple instruments and write custom software routines to capture and analyze thousands of measurement data points.

Limitations in traditional precision digital multimeters raise some questions: "If I want to read 100 times per second over four hours, what do I do with all that data?" "How can I see small changes and still track the overall trend?"

The Fluke 884X is the first precision multimeter to offer a simple method of capturing and displaying measurement changes as small as parts per million in real-time, without time-consuming setup or custom programming.

The Fluke 8845A and 8846A include a TrendPlot™ function that is essentially a technique for reducing a time-series of measurements into a form that is easy to store and analyze, while still maintaining detail. Thanks to on-board signal processing power and a high-performance analog-to-digital converter and graphical display, the Fluke 884X is the first precision 6.5 digit multimeter to offer TrendPlot capability.

Methods for trending

Sometimes a spot measurement doesn't give the whole picture. Parameters change from instant to instant. Power supplies and current or voltage references may drift over time. Oscillators may change with temperature. Connectors may open under tension.

Trendplot applications for design validation

- Power supply stability over time
- Verify circuit design specifications
- Capture intermittent events/troubleshooting random shut-downs (plot key parameters for critical test points looking for changes that correlate to fluctations)
- Trend critical parameters per test point during climate testing temperature cycle
- Temperature controlled crystal oscillator circuit tests
- Temperature monitoring

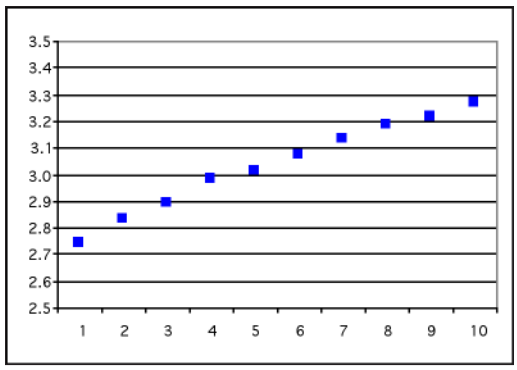


Figure 1. To illustrate how sample rate is proportionate to memory size, this plot example shows 10 samples recorded at a fixed interval 10 minutes. The shorter the time interval between each sample, the shorter the recorded time span and vice versa.

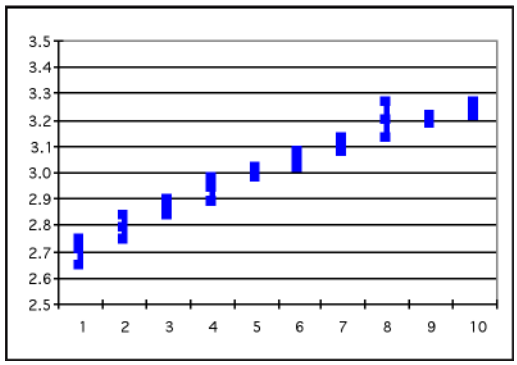


Figure 2. For each sample interval, a minimum and maximum value is plotted, calculated from a large (buffered memory) sample set captured at higher speed. This captures the major changes while still plotting the overall trend without compromises.

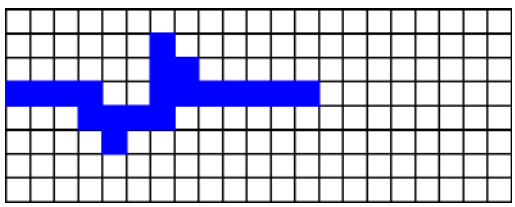


Figure 3. Shows a section of the Fluke 884XA dot matrix graphical display. A minimum and maximum data point is plotted in each column of pixels drawing a TrendPlot across the display.

Changes in environment can lead to unpredictable results. By taking multiple measurements over minutes, hours or days you can quantify these changes. Parameters like dc voltage, dc current, frequency, and resistance can be recorded directly. AC voltage and current can be plotted as rms measurements. Temperature, pressure and humidity can be converted into dc voltages by using the appropriate transducer.

In the simplest form of digital recording, a series of "snapshot" measurements are taken with a fixed interval in between. In this scenario the instrument takes a single measurement for each interval and stores it in memory. A very short measurement interval can catch fast changes, but unfortunately it will use memory quickly. Conversely, with more data points it takes more time to write the last data point to memory, affecting the sample interval. Even if you have a very large memory, like a hard drive or flash drive, you still face a daunting task of pouring over vast numbers of measurements. High-speed, fixed interval recording is easy to understand and can be accomplished with relatively simple hardware, but it is usually not practical for logging over minutes or hours. The user has to select a reading rate and is forced to compromise. "Do I want to record for a long time or do I want to see fast changes? Why can't I do both?"

Min/Max recording

This technique also stores readings at the end of each preset recording interval. But instead of taking just one reading per recording interval, the instrument takes many high-speed measurements over each interval. Processors within the instrument crunch through the measurements and log a minimum (min) and a maximum (max) for each interval. The min and max indicate the worst-case, short-duration events, and can be as short as a few milliseconds. Graphs from these instruments will often plot min and max on the same graph.

Automatic time compression and TrendPlot

TrendPlot is a recording technique available in Fluke instruments, including the 884X Multimeter. It shows the same detailed data as min/max recording, but it is simple to set up and automatically gives you the best time resolution with the available memory.

TrendPlot is a form of min/max recording in which the meter automatically compresses the timescale each time the trend approaches the end of memory. As the meter starts to run out of memory, signal processors quickly go to work. They combine adjacent recording intervals into a new min and max. You still get to see the worst-case measurements and the overall trend. And because you choose when to stop the measurement, you automatically get the best time resolution with the available memory.

To set up TrendPlot, simply set up as you would for any measurement. Select a measurement function, voltage, current, resistance, temperature or any of the other functions on the 884X. Check to make sure the reading looks right—is the resolution OK? Are the leads in the right jacks? Then press the ANALYSE button, select TrendPlot, and hit START.

When to Trendplot, and when to collect raw data

TrendPlot™ graphically plots a trend of measured values over time. The Fluke 8845A and 8846A capture and plot values over extended periods of time, starting with a short time span then gradually, through a data compression algorithms, plot the trend of values over extended periods of time. The compression algorithm will always retain and display the max and min values, thereby plotting the peak deviation of a signal over the entire time span.

TrendPlot provides a quick look (graphically) at data of interest. It does not provide detailed raw data for download and further analysis. The user can't set the display resolution for both the vertical and horizontal scale—it's a fully automatic function.

With the 8846A/45A TrendPlot, you can plot ac power supply voltage to see if it's stable and meets specifications. After an hour or two, you should have enough data for a quick visible check. You can also use this function to see the charging curve on a battery. But if you want to collect raw data, don't use TrendPlot. Instead, set the 8846A/45A to capture the data into a memory stick and download the data into a spreadsheet for more detailed analysis.

When to use TrendPlot versus a fast sampling digital oscilloscope

The Fluke 8846A 6.5 Digit Precision Multimeter will measure milli or micro volts with an accuracy unmatched by any other measuring device in its class. To achieve this, the meter employs a multi-ramp integrating analog to digital converter. The benefits of this patented design is that it offers higher resolution up to 100 nano volts, 0.0024 % accuracy, improved linearity and common mode noise rejection. However, due to the multi slope integration times, the fastest reading rate is several hundred readings per second depending on function, range, and measurement setup conditions.

Today's common oscilloscope sample rates can reach as fast as 2.5 GSa/s or a sample interval as short as 400 pico seconds. At this fast rate, the oscilloscope can only capture very short time spans, as little as 20 nano seconds. Also, resolution is limited to the vertical sensitivity typically around 5 mV per division and at a measurement accuracy of 1.5 %.

For those applications that require higher resolution and accuracy, or longer time spans, the precision multimeter with TrendPlot mode is the answer.

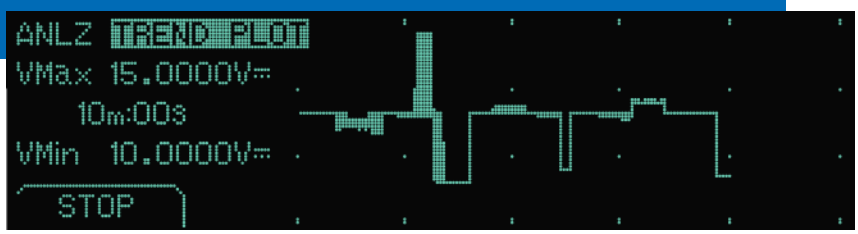
How TrendPlot works

1. Each plot line represents the max and min values measured over the time period represented by each vertical line. The top of the vertical line is the maximum value measured and the bottom of the vertical line is the minimum value measured.
2. TrendPlot places a vertical line representing the measured value range for all the measurements taken since the previous vertical plot was laid down.

   The first time slot (one pixel width) sets the vertical axis by making the bottom of the scale equal to the minimum measured value and the top of the scale equal to the maximum measured value in that time period. Depending on the meter's resolution and the signal's characteristics, there can be from zero to many measurements in one time slot.
3. When the meter has gathered all the measurements for the next time slot, it adjusts the vertical axis to meet the minimum and maximum of the two time slots. The exception to this is when the minimum and maximum are equal. Then the first plot (a single pixel) is placed in the middle of the plot.
4. The horizontal axis scaling depends on a number of highly variable rate/timing factors. The meter takes its best guess at an appropriate time per slot and maintains from the first plot on. When the horizontal axis is compressed, each min/max value on the vertical plot is combined with its neighbor plot. So, if plot one has a max of 5.001 V and a minimum of 4.9992, and the plot that it's combined with has a max of 5.000 and a minimum of 4.998, then the result is one vertical plot with a line between 5.001 and 4.998.

Tip: You can also log each individual measurement to memory, download into a USB memory stick, and analyze the data on a PC. Remember that instead of real-time display data, memory data is compromised. The longer it records, the more it compresses the data (see sidebar). By logging to the memory stick, you can retain higher data resolution.

The bitmapped vacuum fluorescent display on 884X allows the instrument to show the plot without connection to a PC. The trend line can show changes as small as parts per million and can even be seen from a distance.



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Fluke Corporation
PO Box 9090, Everett, WA USA 98206

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (800) 443-5853 or
Fax (425) 446-5116
In Europe/M-East/Africa +31 (0) 40 2675 200 or
Fax +31 (0) 40 2675 222
In Canada (800)-36-FLUKE or
Fax (905) 890-6866
From other countries +1 (425) 446-5500 or
Fax +1 (425) 446-5116
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