Datalogging with TrendPlot™ on DMM4050 and DMM4040 Multimeters

Application Note

As the circuits in embedded system designs become more sophisticated with tighter tolerances, new problems are arising during design debug and validation. Parameters like short-term stability, drift, and fluctuations must be measured to understand a circuit's behavior over time. Elusive problems like intermittent transients and glitches can delay projects by days or weeks if they are not found quickly.

To troubleshoot elusive problems and measure device behavior over extended periods of time, engineers must capture and analyze thousands of measurement data points. This requires logging large quantities of data or tracking measurement trends over time, something traditional precision digital multimeters are unable to do.

The Tektronix DMM4050 and DMM4040 bench multimeters address this need with a unique feature. TrendPlot™ paperless recorder mode offers 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. Utilizing on-board signal processing power and a high performance analog-to-digital converter, TrendPlot reduces a time-series of measurements into a form that is easy to store and analyze, while still maintaining detail.
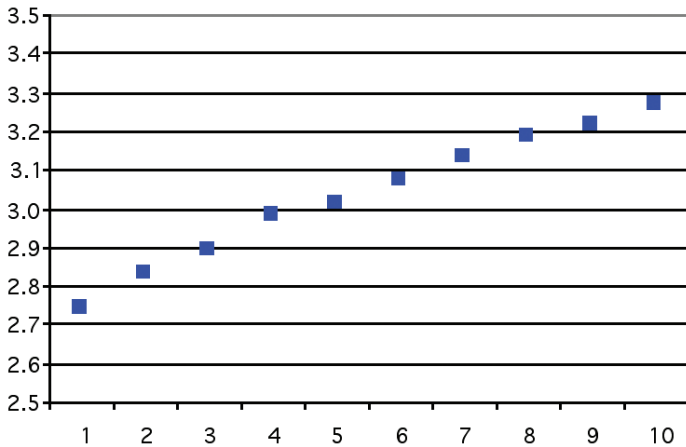
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Figure 1. To illustrate how sample rate is proportionate to memory size, this plot example shows 10 samples recorded at a fixed interval of 10 minutes. The shorter the time interval between each sample, the shorter the recorded time span and vice versa.
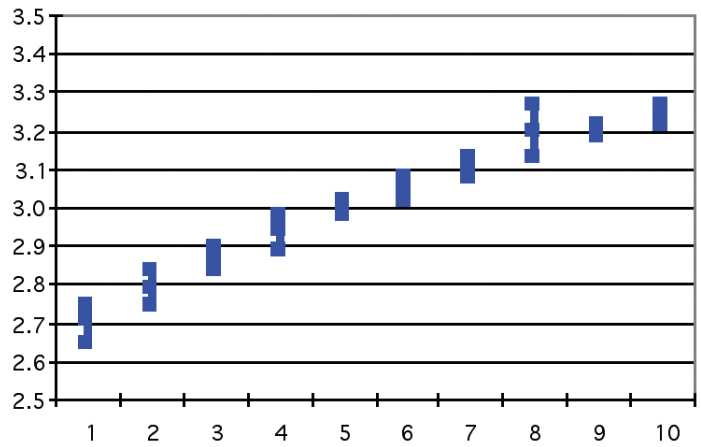

Figure 2. For each sample interval, a minimum and maximum value is plotted, calculated from a large (buffered memory) sample set captured at higher speed. This captures the major changes while still plotting the overall trend without compromises.

Methods for Trending

Sometimes, more than just one measurement at one moment in time is required. Parameters can 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. Changes in environment can lead to unpredictable results. By taking multiple measurements over minutes, hours or days you can quantify these changes with TrendPlot™. 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.

TrendPlot applications for design validation

- Power supply stability over time

- Verify circuit design specifications

- Capture intermittent events and troubleshoot random shut-downs (plot key parameters for critical test points looking for changes that correlate to fluctuations)

- Trend critical parameters per test point during climate testing temperature cycles

- Temperature controlled crystal oscillator circuit tests

- Temperature monitoring

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 will use memory quickly. Conversely, with more data points it takes more time to write the last set of data 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?"
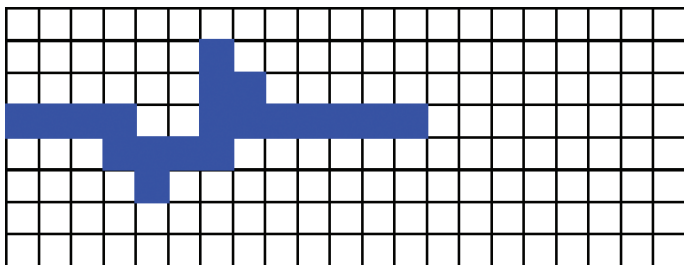
Figure 3. Shows a section of the DMM4050/4040 dot matrix graphical display. A minimum and maximum data point is plotted in each column of pixels drawing a TrendPlot across the display.

Figure 4. TrendPlot display on the DMM4050/4040.

Min/Max Recording

This technique also stores readings at the end of each preset recording interval. 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 which can be as short as a few milliseconds. Graphs from these instruments will often plot min and max on the same graph.

A New Method: Automatic Time Compression with TrendPlot™

TrendPlot™ is a recording technique available on the DMM4050 and DMM4040 multimeters. 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 combine adjacent recording intervals into a new min and max. This allows you to see the worst-case measurements and the overall trend. Since 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 DMM4050/4040. Check to make sure the reading looks right—is the resolution OK? Are the leads in the right jacks? Then press the ANALYZE button, select TrendPlot, and hit START.

TrendPlot graphically plots a trend of measured values over time. The DMM4050/4040 captures and plots values over extended periods of time, starting with a short time span then gradually, through the data compression algorithm, plots 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.

When to TrendPlot and When to Collect Raw Data

TrendPlot provides a quick look (graphically) at data of interest. It does not provide detailed raw data for download and further analysis. Since it is a fully automatic function, you won't be able to set the display resolution for both the vertical and horizontal scale.

With TrendPlot, you can plot your ac power supply voltage to check stability and that the device 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. For collecting raw data for in-depth analysis, you can set the DMM4050/4040 to capture the data using internal memory (up to 10,000 measurements) or into a memory stick and download the data into a spreadsheet for further analysis.
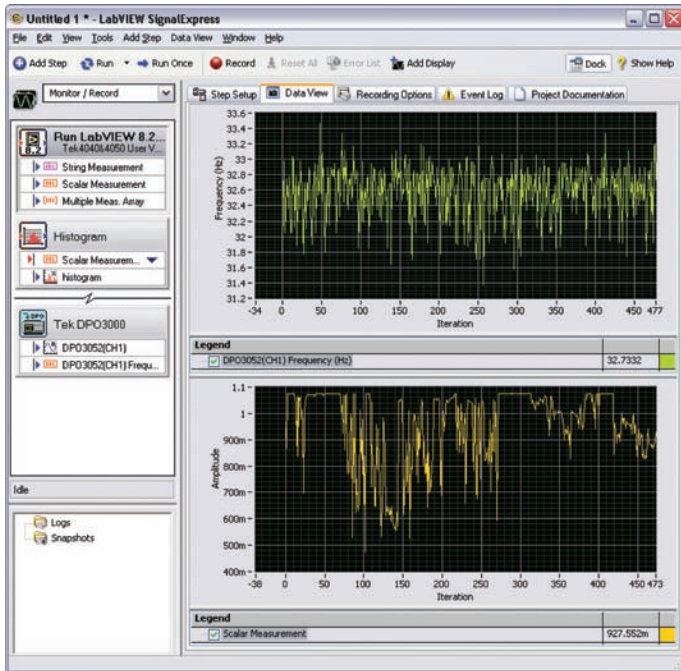
Figure 5. Signal Express acquiring data from Tektronix DMM4050 and DPO3052.

Figure 6. Signal Express used to export DMM4050 data into Excel.

Using SignalExpress™ Software for Extensive Analysis

For extensive analysis, the Tektronix Edition of National Instrument LabVIEW SignalExpress™ software allows you to easily capture, save and analyze measurement results from your multimeter. Every DMM4050 and DMM4040 includes a copy of the Limited Edition version of LabVIEW SignalExpress for basic instrument control and data logging. The optional Professional Edition offers over 200 built-in functions that provide additional signal processing, advanced analysis, sweeping, limit testing, advanced data logging and user-defined step capabilities.
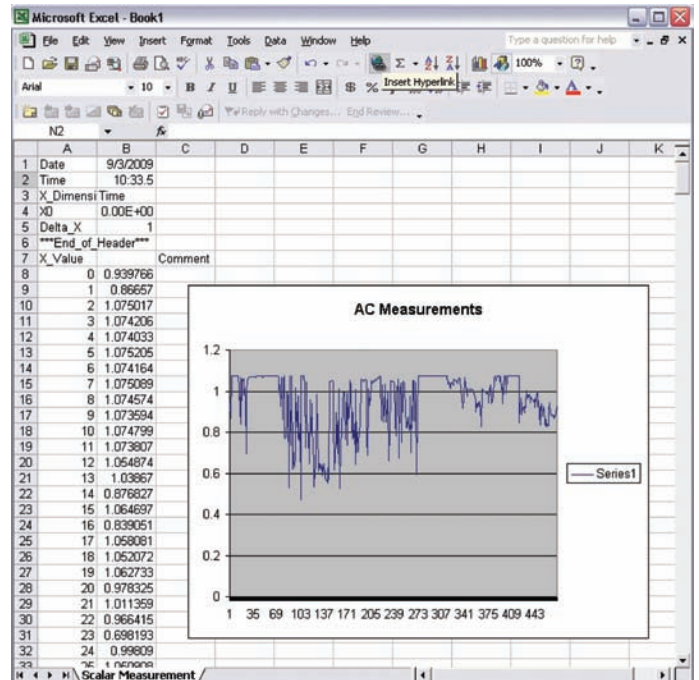
Datalogging with SignalExpress is as simple as connecting the multimeter to your computer's USB port with the included cable. Once you've launched SignalExpress, you choose your DMM4000 Series multimeter from the list of Tektronix instruments and press Record. After you choose the signal to record, SignalExpress will log data until you click the Stop button. You can then view your logged data, panning throughout your record and zooming in on details of interest.

The DMM4050/4040 multimeters offer several ways to log data, enabling you to troubleshoot elusive problems and measure device behavior over extended periods of time. TrendPlot™ provides a quick and easy way to look at measurement trends right on your multimeter. The front-panel USB port can be used to log large quantities of data to a memory stick, while SignalExpress offers an easy way to log data through a simple connection to your PC.

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. 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.

Which multimeter is right for you?

The DMM Series offers a range of models to meet your needs and your budget.
The following multimeters offer the TrendPlot™ analysis mode.

	DMM4050	DMM4040
Resolution	6.5 digit	6.5 digit
Basic V dc accuracy	0.0024%	0.0035%
Measurements	V ac, V dc, I ac, I dc, Ω, Continuity, Diode, Frequency, Period, Temperature, Capacitance	V ac, V dc, I ac, I dc, Ω, Continuity, Diode, Frequency, Period
Analysis Modes	TrendPlot™, Statistics, Histogram	TrendPlot™, Statistics, Histogram
USB Port (Front Panel)	Yes	Yes

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For Further Information

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

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