

# Trend recording and analysis with the Fluke 289 DMM

Establishing line voltage/mains stability in a switched circuit

## Application Note



## Testing Functions Case Study

### The problem

Our test engineers needed to verify the stability of switching the Mains (line voltage) to an Equipment Outlet (EO). In the device under test (DUT) for this case study, the Mains was routed to the EO through relays, which could potentially develop high impedance connections, interfering with internal measurements and cause overheating. Switching the Mains was necessary for the product design, for testing polarity and to protect individual circuit conductors.

Electrical safety test standards require reversing Hot and Neutral, and opening and closing Neutral and ground individually. We had to ensure that the relays don't develop high impedance under normal workloads.

### The proposed solution

We needed to monitor the Mains for a period of time before entry to the product, such as at the wall receptacle. Once we established the baseline, we could then repeat the process while measuring at the EO. We wanted to repeat the process several times during the complete product test cycle: once at the beginning, once in the middle and again at the end. That way we could compare the data and look for any overall degradation or sudden instability introduced by using the relays. A half hour for each recording sessions seemed like a good starting place to establish base behavior and for comparison sessions.

### Procedure

1. Set up the Fluke 289 Digital Multimeter (DMM) to measure Mains voltage (Hot-to-Neutral) at the incoming power cord of the product every second for 30 minutes.
  - a. Select Vac
  - b. Push F2 "Save"
  - c. Select "Record" (Use Arrow keys if necessary to navigate until Record is selected and then press F1)
  - d. Select "Set Sample Interval" with the arrow keys and then "Edit" (F1)
    - i. Configure a 1 second recording interval with the arrow keys and then press "OK" (F1)
  - e. Select "Set Duration" with the arrow keys and then "Edit" (F1)
    - i. Configure the duration for 30 minutes with the arrow keys and then press "OK" (F1)
  - f. When ready press "Start" (F2)
2. In the ac Volts function, use the Save button to save the data when the session is complete. Choose a session name that you will remember from the available list on the 289.
3. Use the graphical view on the 289 screen to review the session to look for obvious instability in the incoming Mains power.
  - a. From the normal Vac mode, press "Save" (F2)
  - b. Select "View Memory" with the arrow keys and then press "View" (F1)

**Tools:** Fluke 289 DMM

**Tester:** Gary Allen, Product Validation Engineer

**Tests:** Voltage trending over time and FlukeView Forms

- c. Select "Recording" with the arrow keys and then press "View" (F1)
    - i. If multiple sessions are saved, you can then choose the session you want to view...in this case it will be the one you just saved.
  - d. The session screen will recall the configuration data and number of samples collected.
  - e. Press "Trend" (F3) to show a graphical plot of the data points and a vertical cursor.
    - i. Move the cursor to points of interest with the arrow keys
    - ii. Note the voltage of that data point and the time-stamp
    - iii. Continue examining as required
  - f. Return to the "Summary" (F3) screen or "Close" (F4) the session and return to the main VAC function menu
4. Attach a second DMM of equal or greater accuracy and precision to the incoming Mains as a moment-by-moment comparison tool for the next step.
  5. Repeat the recording process, now measuring at the EO.
  6. Document the incoming Mains voltage, monitored by the second DMM, at several points during the second recording session.
  7. Observe the difference in Mains voltage between the incoming Mains connection and the EO.

When the second recording session is complete, import the saved data into FlukeView Forms (v3.3 or later) when the application prompts you, or from the FVF menu if needed. Once the data is imported, reexamine both sessions and look for inconsistencies that might suggest instability or a significant voltage drop between the incoming Mains and the EO. In this case, a visible fluctuation from the baseline of more than a couple of volts indicates a potential problem.

If needed, the data in FVF can be exported to applications like Microsoft Office "Excel" or OpenOffice "Calc" for additional graphical or numeric analysis. Another approach would be to perform both incoming Mains and EO recording sessions at the same time-- two Fluke 289 meters are required to accomplish that.

### Meter configuration

The Fluke 289 is very easy to configure for the tests identified in this document. The recording feature is very powerful and saving the results is a snap. The following screens help demonstrate the convenience.

### The results

After approximately two weeks of heavy use of the device under test, during which the EO was switched repeatedly with heavy current loads plugged in, we documented no obvious degrada-

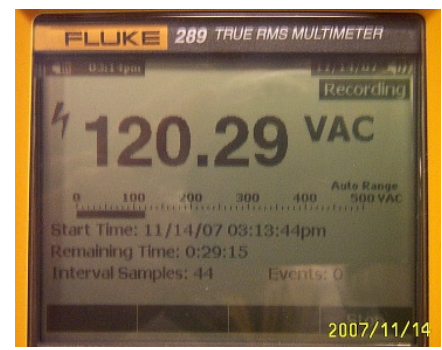
tion of Mains voltage on the EO. We concluded that none of the switching relays were damaged.

Our test loads for robustness testing included a high current induction motor and a bank of incandescent lamps connected in parallel. We used an induction motor to test the design's resistance to damage from reverse-EMF and lamp fixture in the same way to test the design's resistance to damage from loads with high inrush current.

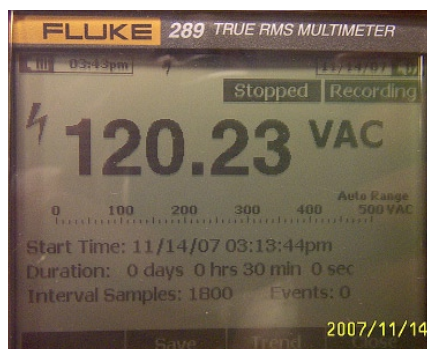
The following screen shots from FlukeView Forms shows a Mains voltage baseline and voltage drops during switching. The absence of large reverse-EMF spikes from switching loads with a lot of inductance and the absence of enormous drops from switching loads with very low start-state resistance provide confidence that the design is adequately protected from damage by those potentially destructive dynamic loads.



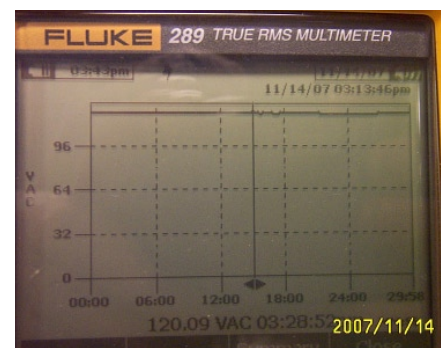
Fluke 289 recording setup.



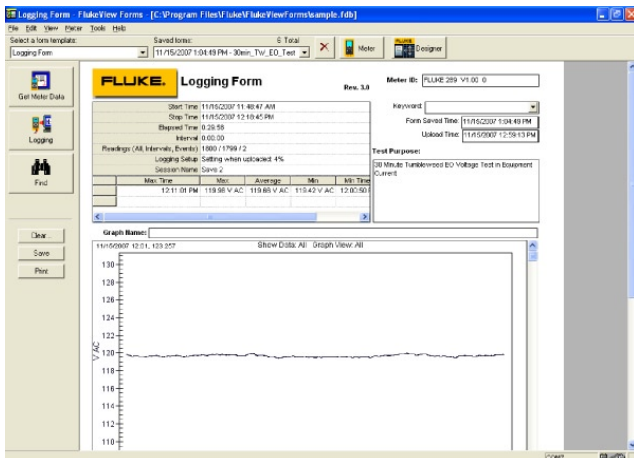
Fluke 289 recording voltage data.



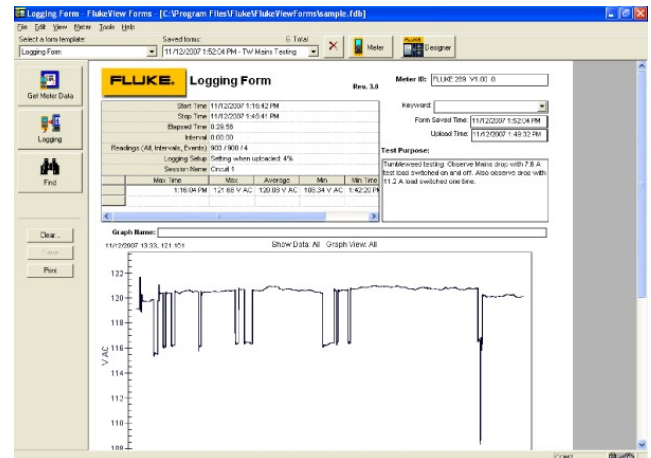
Fluke 289 recording complete.



Fluke 289 recording session summary.



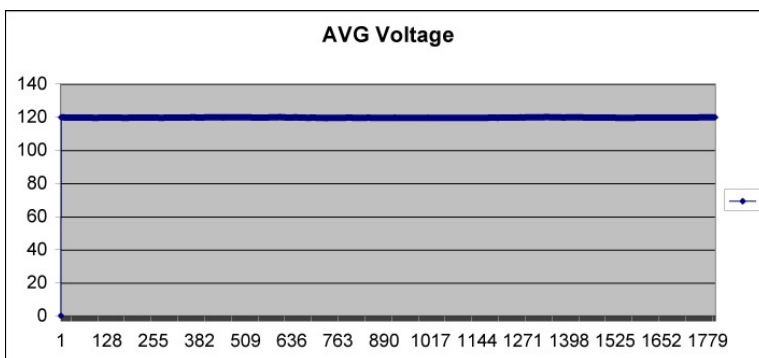
**Figure 1.** The first screen shot shows a plot of steady output from the EO with a moderate, stable, load connected. The results are after two weeks of testing with potentially destructive loads. The conclusion is that no contact impedance problems were introduced during the robustness tests.



**Figure 2.** This second screen shot shows the initial baseline, plus some switching of both types of test loads. What stand out are the stability of the incoming Mains voltage and the relatively minor voltage drops from the two different loads.

## Using spreadsheets

The data from FlukeView Forms can be exported, as stated earlier, for additional data analysis. A look at the average voltages from the interval readings shown in the first FlukeView Forms screen shot, using Microsoft Office Excel, shows a clearly stable Mains input to the instrument over a 30 minute period:



## Other trend possibilities

This same test method can be applied in many other similar scenarios. One example would be testing the stability of a low voltage DC power supply in a design that operates the supply continuously near the maximum recommended current capacity.

Although it's generally considered bad design practice to do that, there may be designs in which no other choice was available. In addition to a good oscilloscope, a Fluke 289 DMM with FlukeView Forms PC software can be a useful tool to help identify potential problems.

## Tips for analyzing data in FlukeView Forms

- You can customize report graphs in FVF to show only intervals or events, to better focus on the measurements of interest.
- FVF exports data in a ".csv" format for import to Excel. It's a good idea to re-save the worksheet from .csv to a standard worksheet, so that you can use Excel to create custom graphs, calculate averages over different time periods, and so on.

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