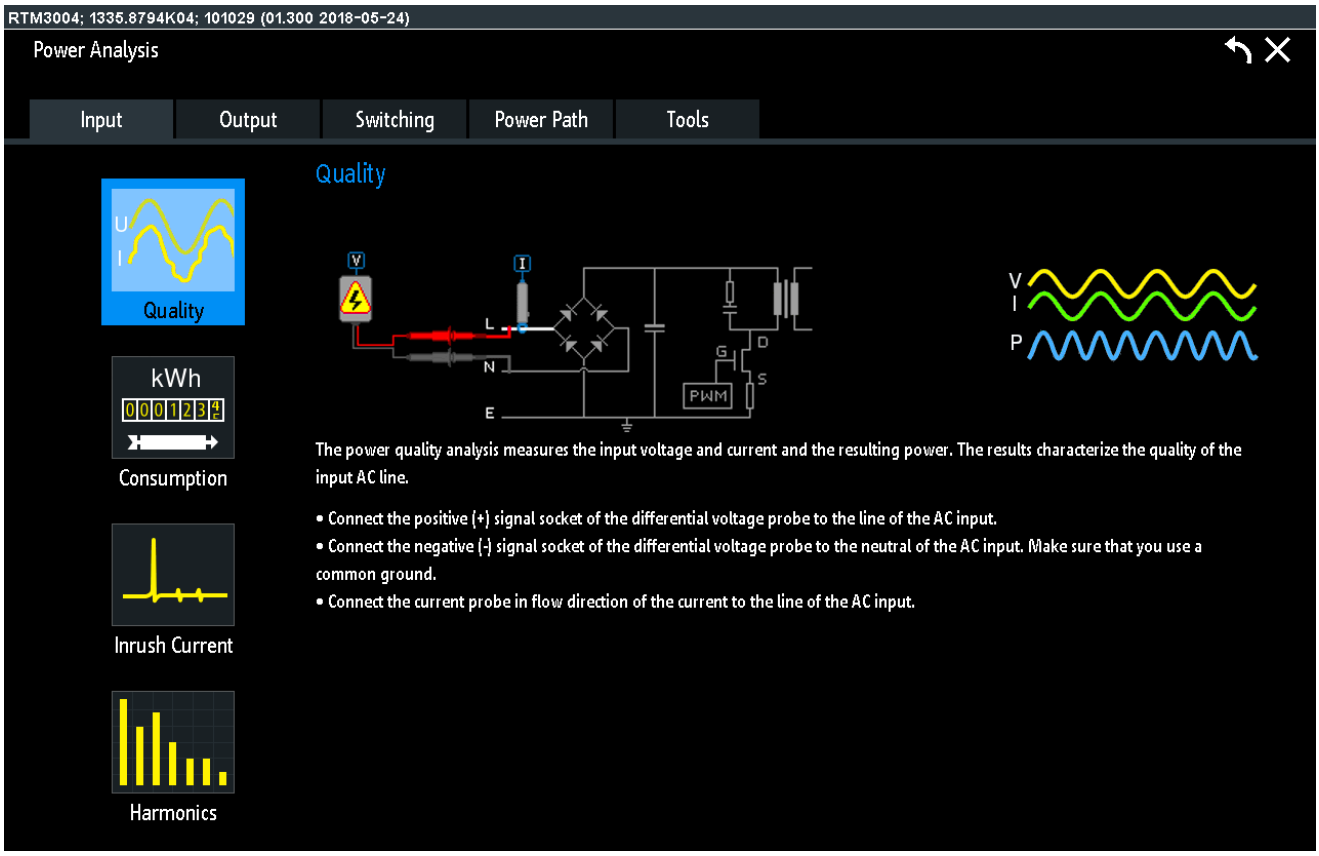
Gough Lui's Blog: R&S RTM3004 RoadTest in Depth – Chapter 6: Power Analysis

Posted by Gough Lui Jul 22, 2018

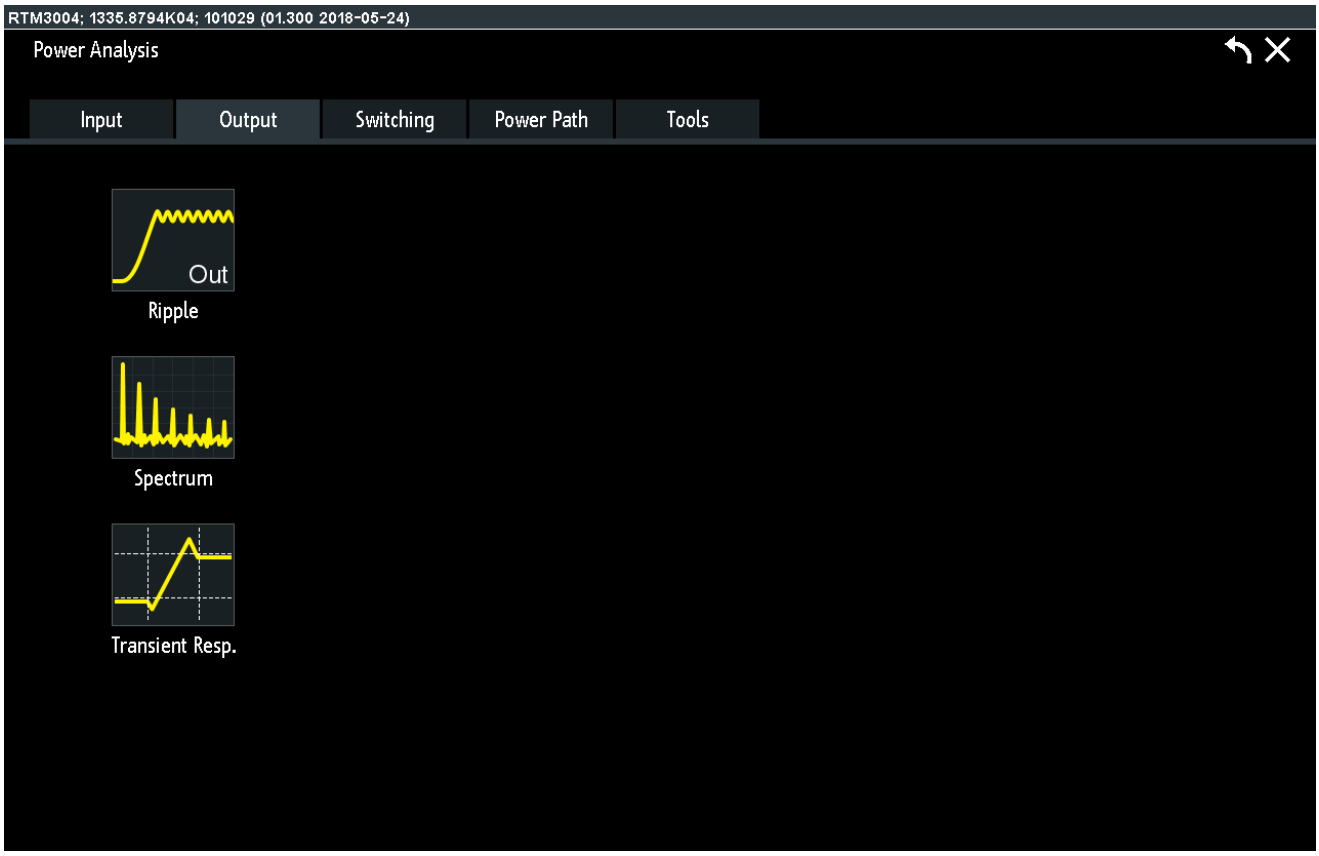
With modern electronics operating at ever-lower voltages and power efficiency being a prime concern amongst portable electronics, analysis of switching power converters is a common application for high-end oscilloscopes. While the RTM3004 can be used ordinarily to analyse such signals, this is made much easier with the RTM-K31 Power Analysis option which provides applications pre-configured for measurement tasks such as evaluating power quality, harmonics, inrush current, power consumption, slew rate, modulation, dynamic-on resistance, efficiency, switching loss, safe-operating area, turn on/off time, ripple, spectrum and transient response.

Power Analysis Modes

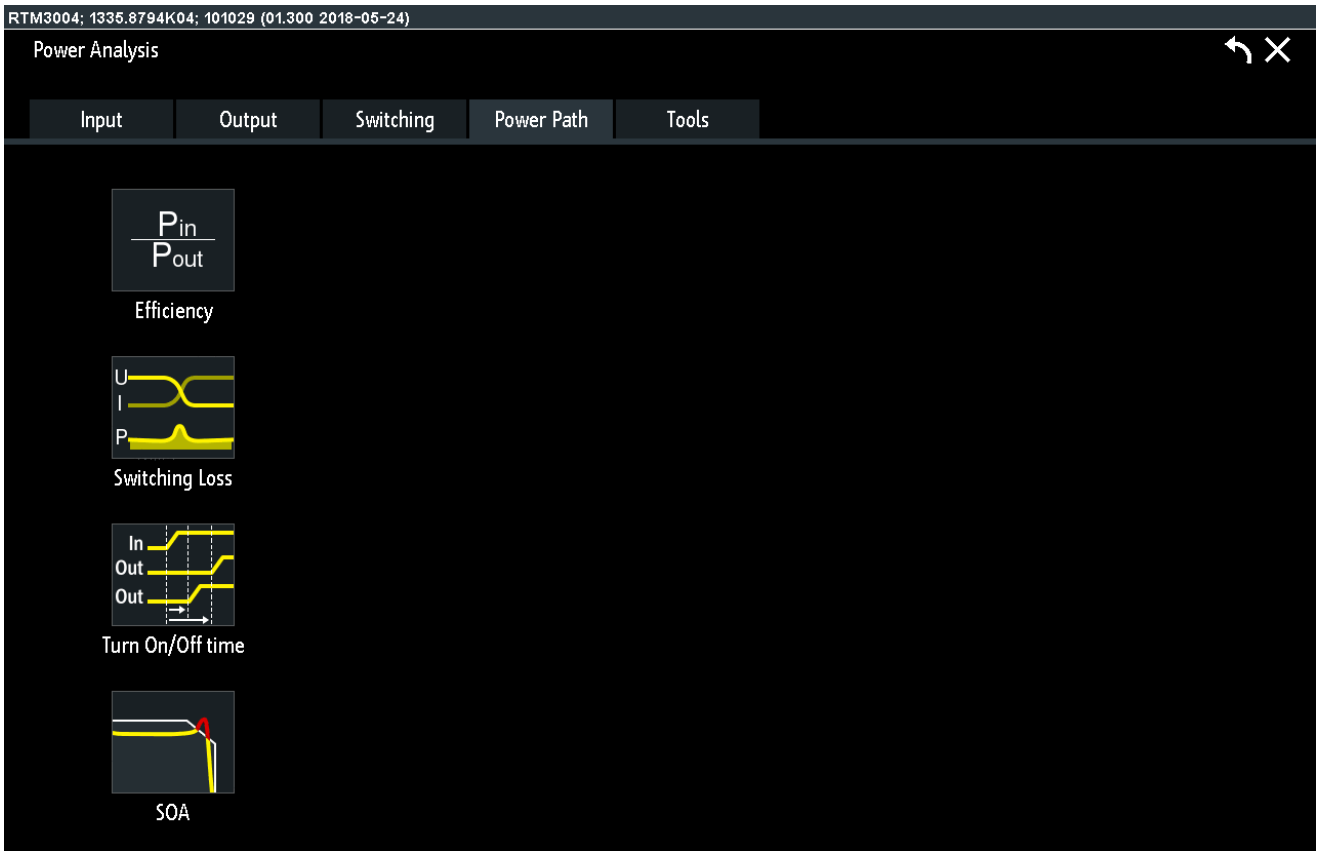
Access to the power analysis features is via Power Analysis icon from the Apps menu. This brings up the applications separated into five categories – Input, Output, Switching, Power Path and Tools.

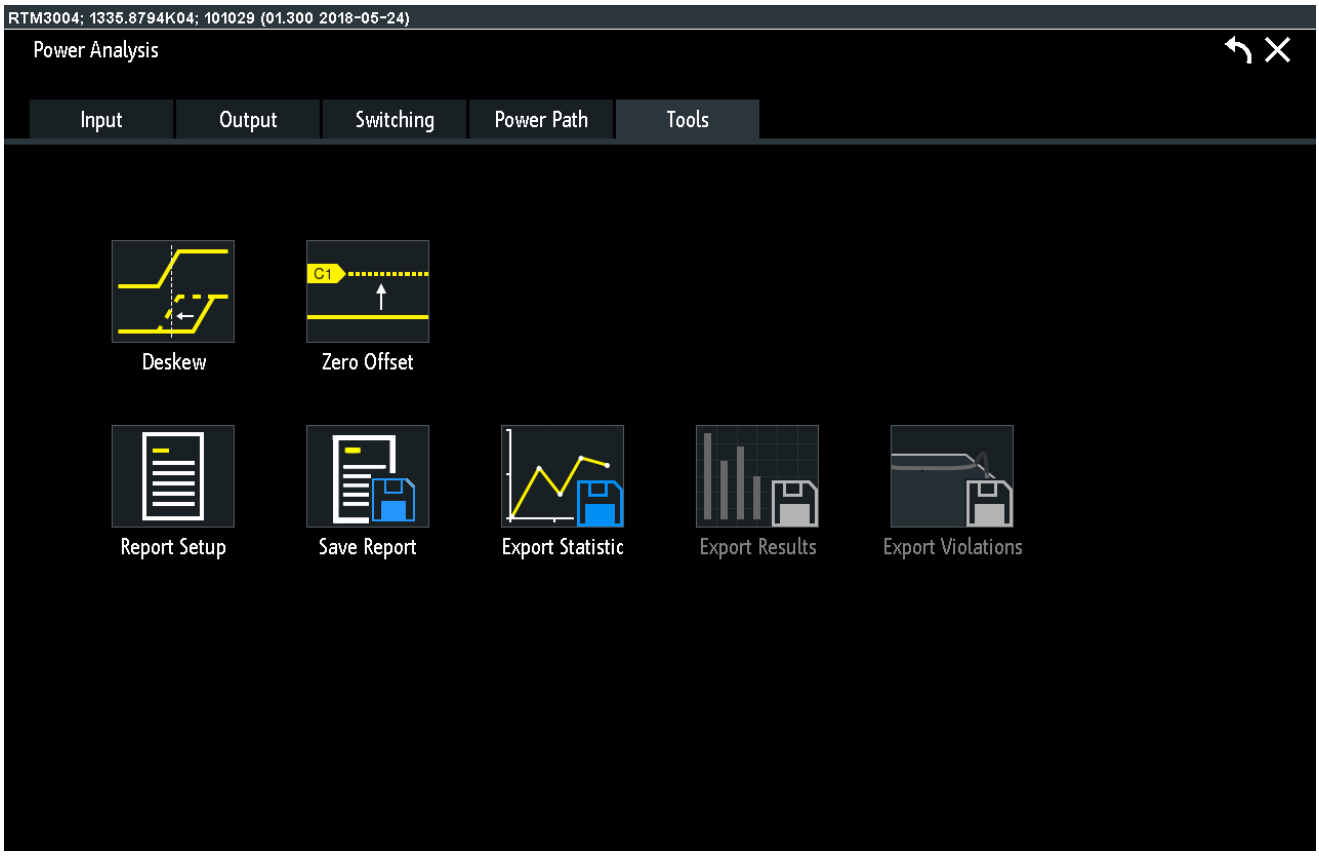


Selecting an application provides a description of what the function is used for, along with a diagrammatic indication of how measurements for that particular mode are to be configured.


RTM3004; 1335.8794K04; 101029 (01.300 2018-05-24)
Power Analysis
Input
Output
Switching
Power Path
Tools
Out
Ripple
Spectrum
Transient Resp.

RTM3004; 1335.8794K04; 101029 (01.300 2018-05-24)
Power Analysis
Input
Output
Switching
Power Path
Tools
Slew Rate
Modulation
D
G
S
Dynamic On Res.


RTM3004; 1335.8794K04; 101029 (01.300 2018-05-24)
Power Analysis
Input
Output
Switching
Power Path
Tools
Pin
Pout
Efficiency
U
I
P
Switching Loss
In
Out
Out
Turn On/Off time
SOA



Looking at the available applications, the input tab appears to be very much related to mains-input type measurements that might be performed with a more traditional power analyser. The output measurements are more concerned with the quality of the power output from an AC to DC converter which is commonly analysed with an oscilloscope. The switching tab concerns itself with the operational characteristics of the power converter itself, which is useful for design and evaluation of switching converters. The power path measurements focus on the whole converter performance and aid break-down of where losses are occurring. Finally, the tools are used to align the system and configure reporting options.

As a number of these applications involve connection to power supplies, it is important to remember that the oscilloscope inputs are NOT intended for measurements requiring a category rating (i.e. directly connected to mains input). Due to the nature of the earthed-connection of the oscilloscope, applying mains to 10:1 probes is strongly not recommended owing to safety issues and the possibility of high-voltage impulses which could damage the instrument. **The manual illustrates the use of high-voltage differential active probes and specialised active current probes with a deskew fixture for inputs.** As I did not have these probes, I could not fully evaluate the power analysis module, but I did try my best.

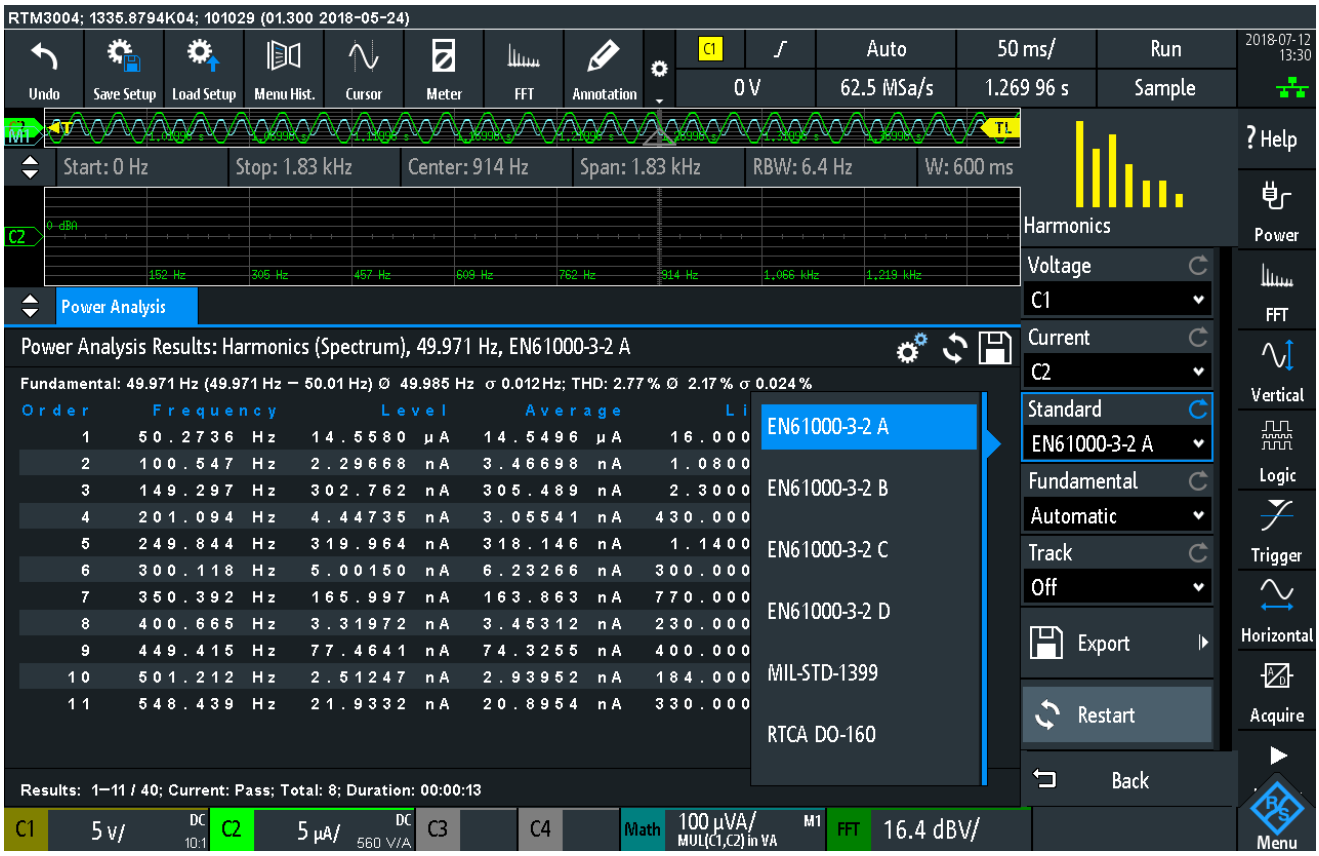
To exercise the power analysis feature without having the proper probes, I decided to test **only separated extra-low-voltage (SELV) circuits**. Do not connect mains directly to oscilloscope inputs!

Experiment: Mains Power Test

In order to safely attempt to measure the mains quality, I decided to use an 240V AC to 9V AC transformer. As this is a fully isolated low-voltage system, it should be safe for measurement, but the transformer core is likely to introduce distortion into the waveform and thus the readings cannot be taken as being accurate. The transformers also often show a higher voltage than expected when unloaded or lightly loaded. In my case, I had a random value resistor as the load, so I set C2 to 560V/A to provide a dummy current value.

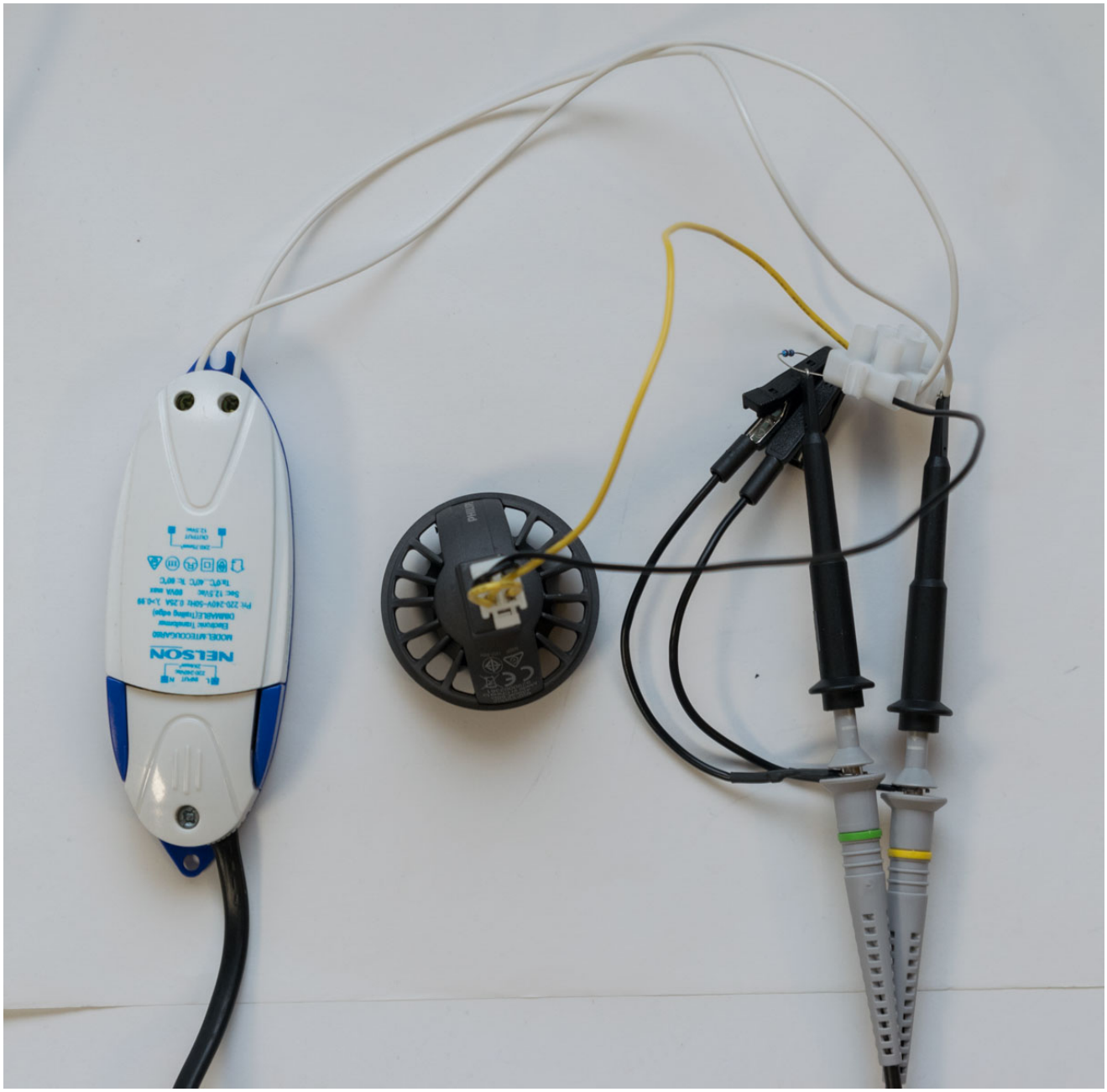
As expected, the power factor is 1, for a purely resistive load, and the crest factor seems reasonable. Frequency is as expected, and voltage is a little high as expected as well. This is very similar to the results a dedicated power analyser can produce.

I decided to add a diode to result in the resistive load having a half-wave rectified output, and the results change accordingly as expected. I guess if you have AC-based SELV circuits, you *could* get away with not using active probes.

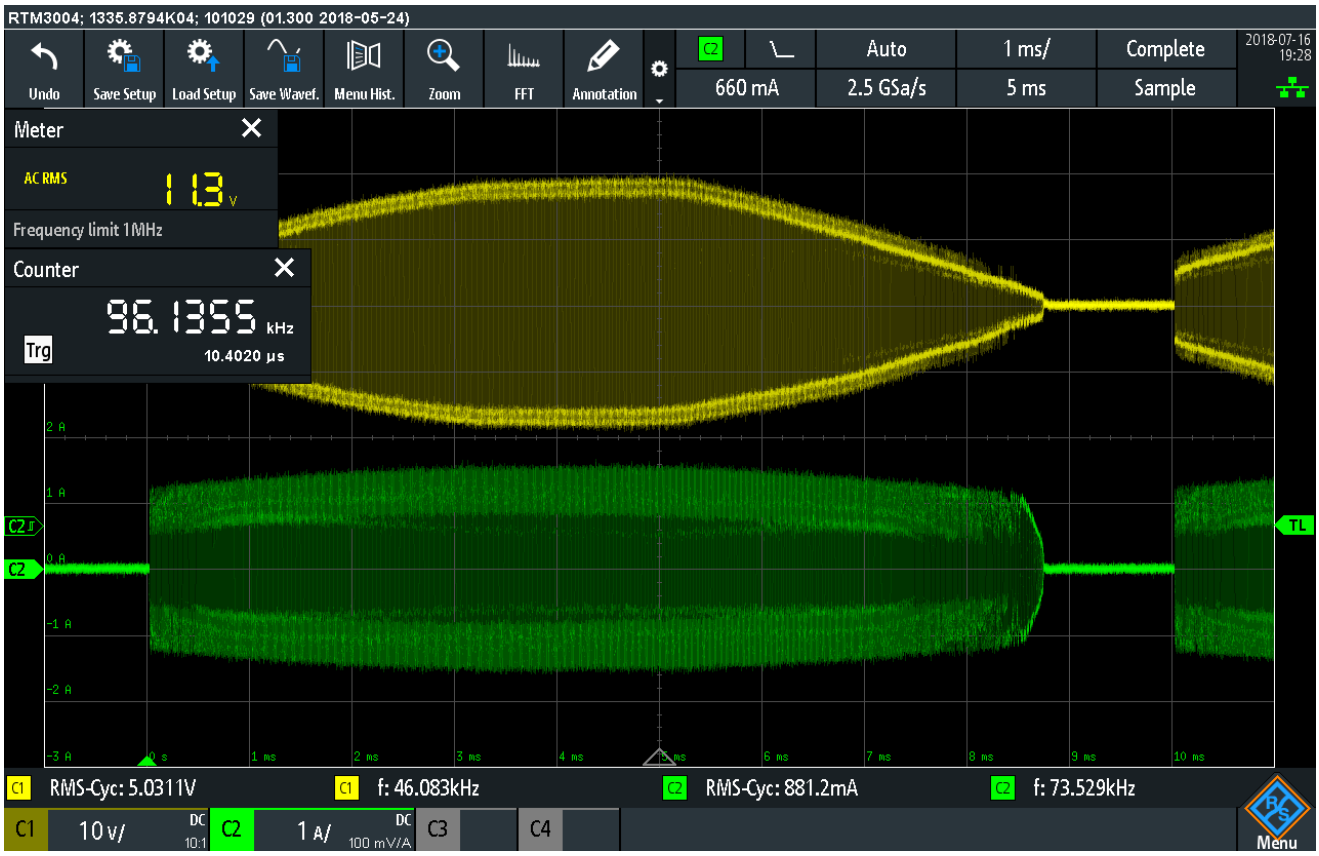


While I don't have a set-up to test it, I thought it was still interesting to see how this mode looked and what standards it could test for – including EN61000-3-2 A/B/C/D, MIL-STD-1399 and RTCA DO-160.

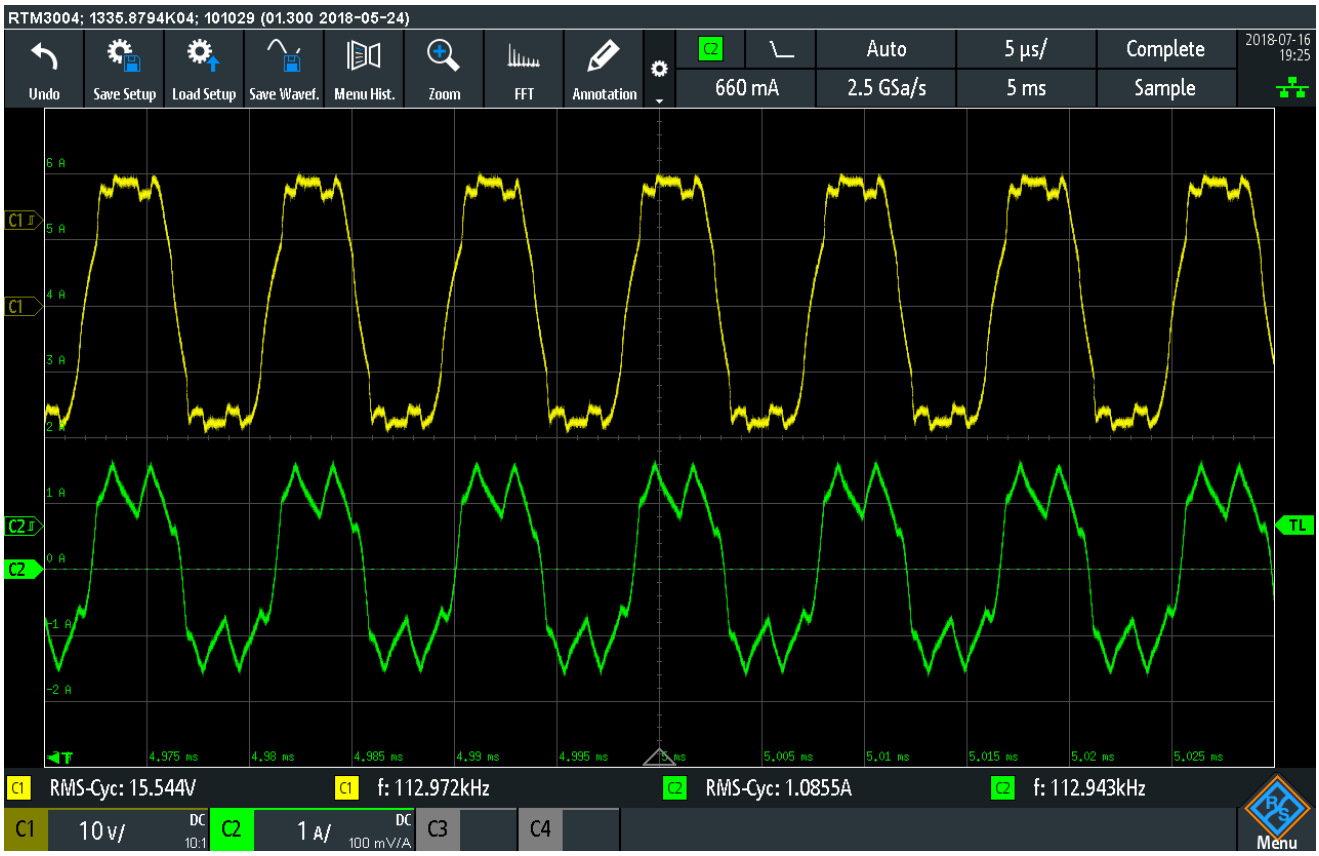
Experiment: MR16 Downlight



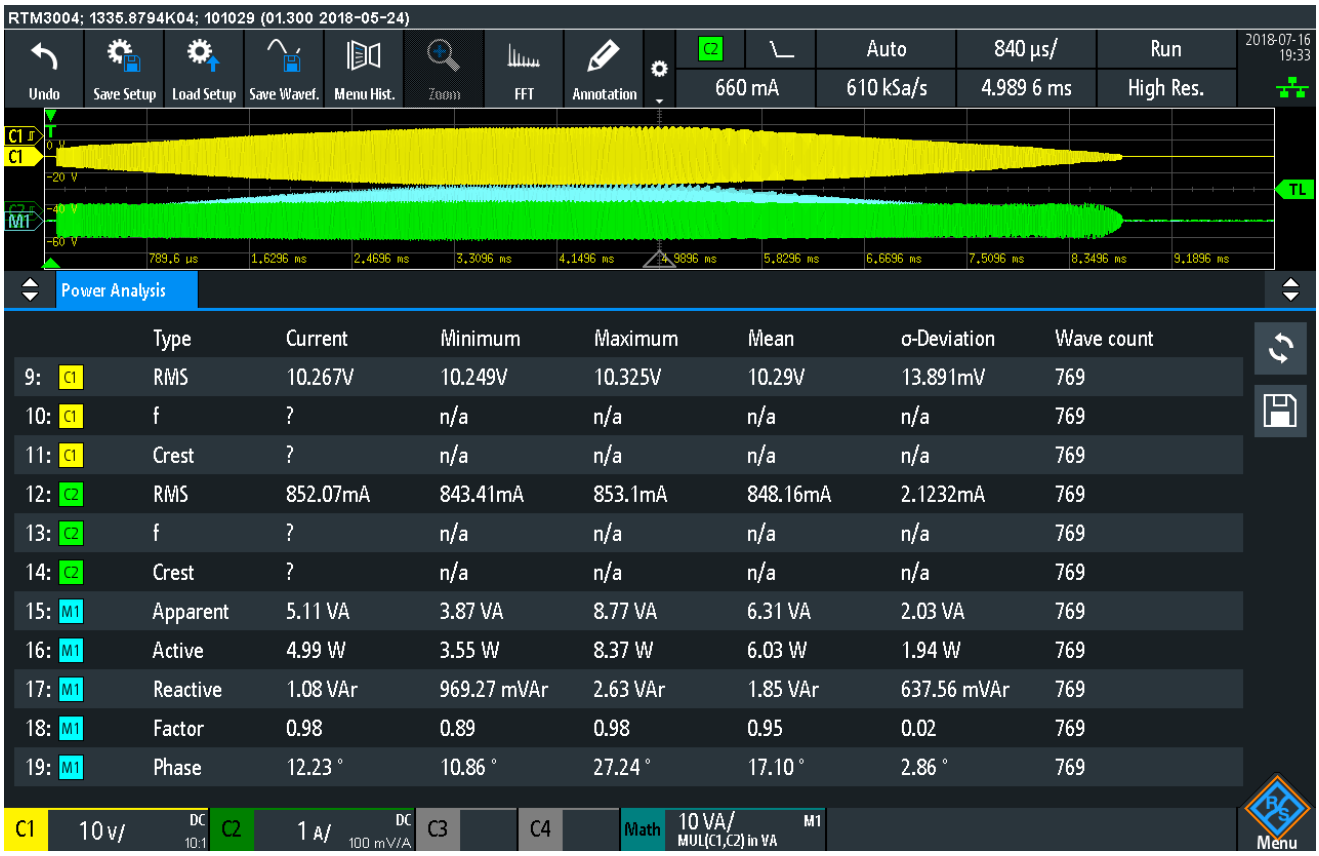
Electronic downlight transformers are known for putting out a fairly choppy and noisy waveform, especially when driving LED-retrofit globes, so I thought it would be a good candidate to stretch the abilities of the RTM3004's Power Analysis module. I measured current through a 1-ohm resistor and voltage across the whole-assembly.



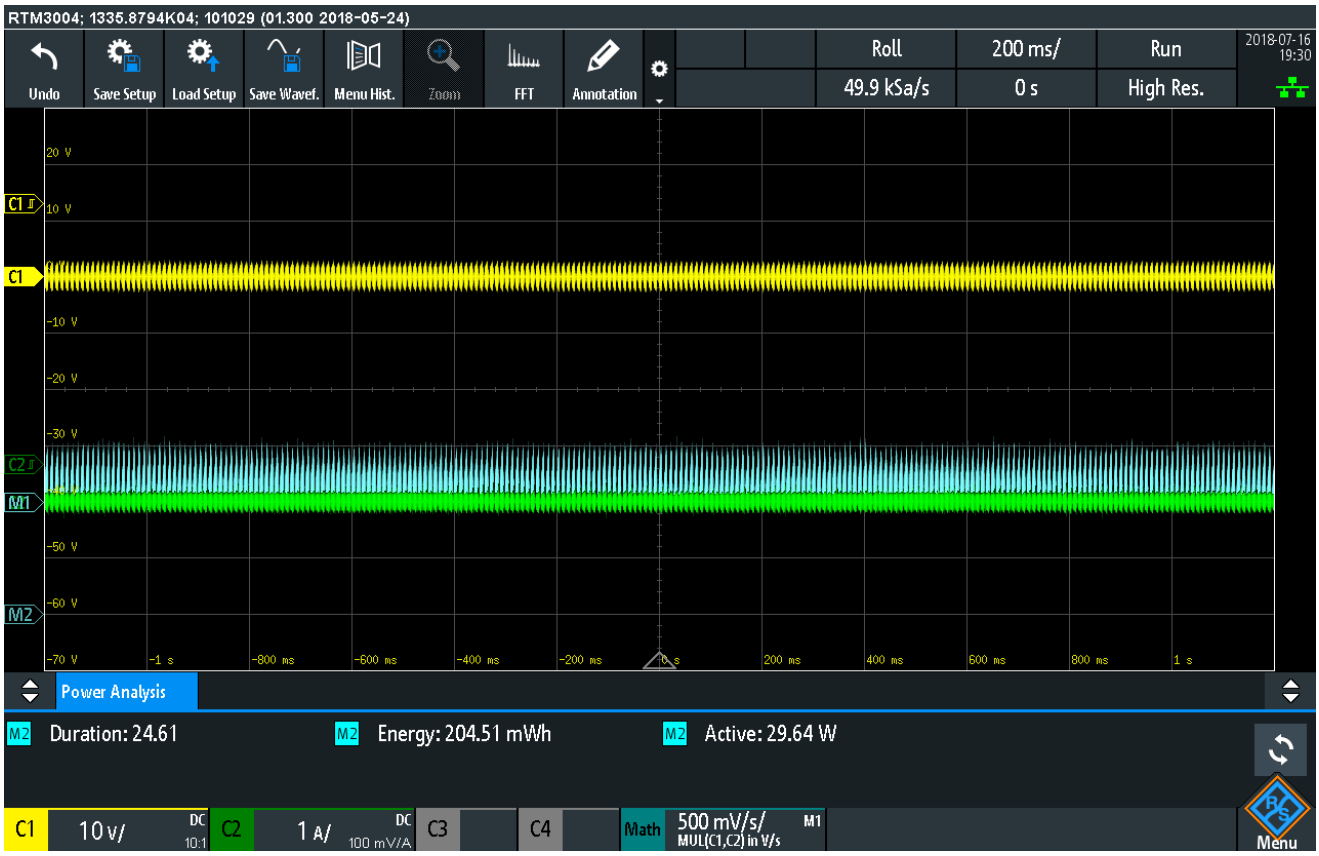
Viewing in regular mode, we can see that the waveform follows the mains envelope, but is rapidly chopped at a rate of around 96kHz. The output voltage measures 11.3V according to the hardware voltmeter feature, which is a lot more reasonable compared to the measure-results underneath.



The current driven into the globe varies as a function of where in the mains cycle it is, as the output voltage varies. To get the actual power consumption requires measurement over the whole cycle – notice how close-up, the measurement values vary.

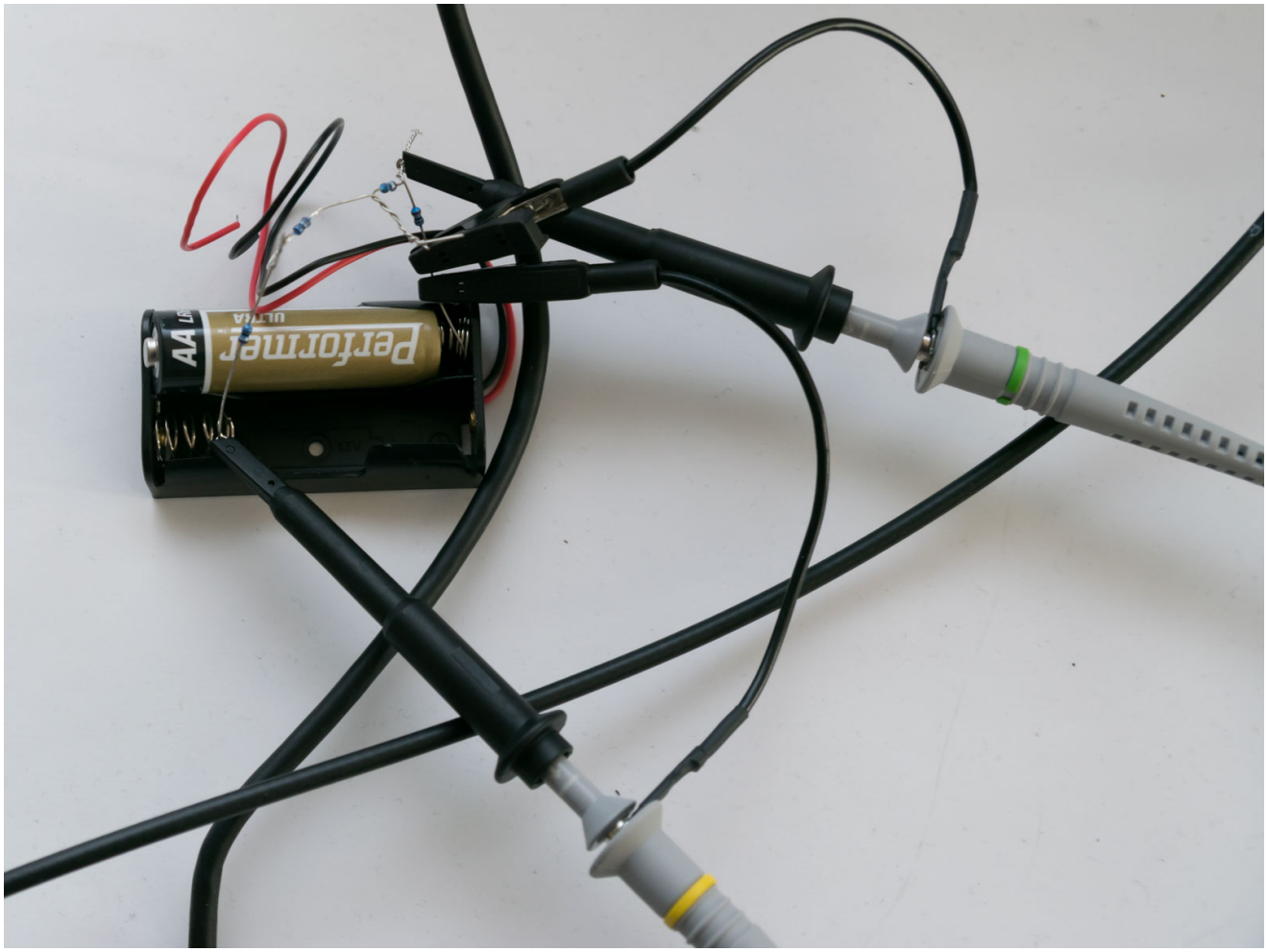


Using the power analysis mode and setting up the timebase carefully, it was possible to get readings, however, they seemed unstable. Part of this may have to do with the use of High Resolution mode for power analysis by the application which may result in some averaging occurring. The values in the mean-column seem to be quite reasonable, however, with the “claimed” 7W Philips globe measuring about 6W consumption with a mean AC RMS input of 10.29V which compares similarly to the hardware voltmeter claim of 11.3V. Because of the non-constant frequency, the measurement values for f and Crest are not available.

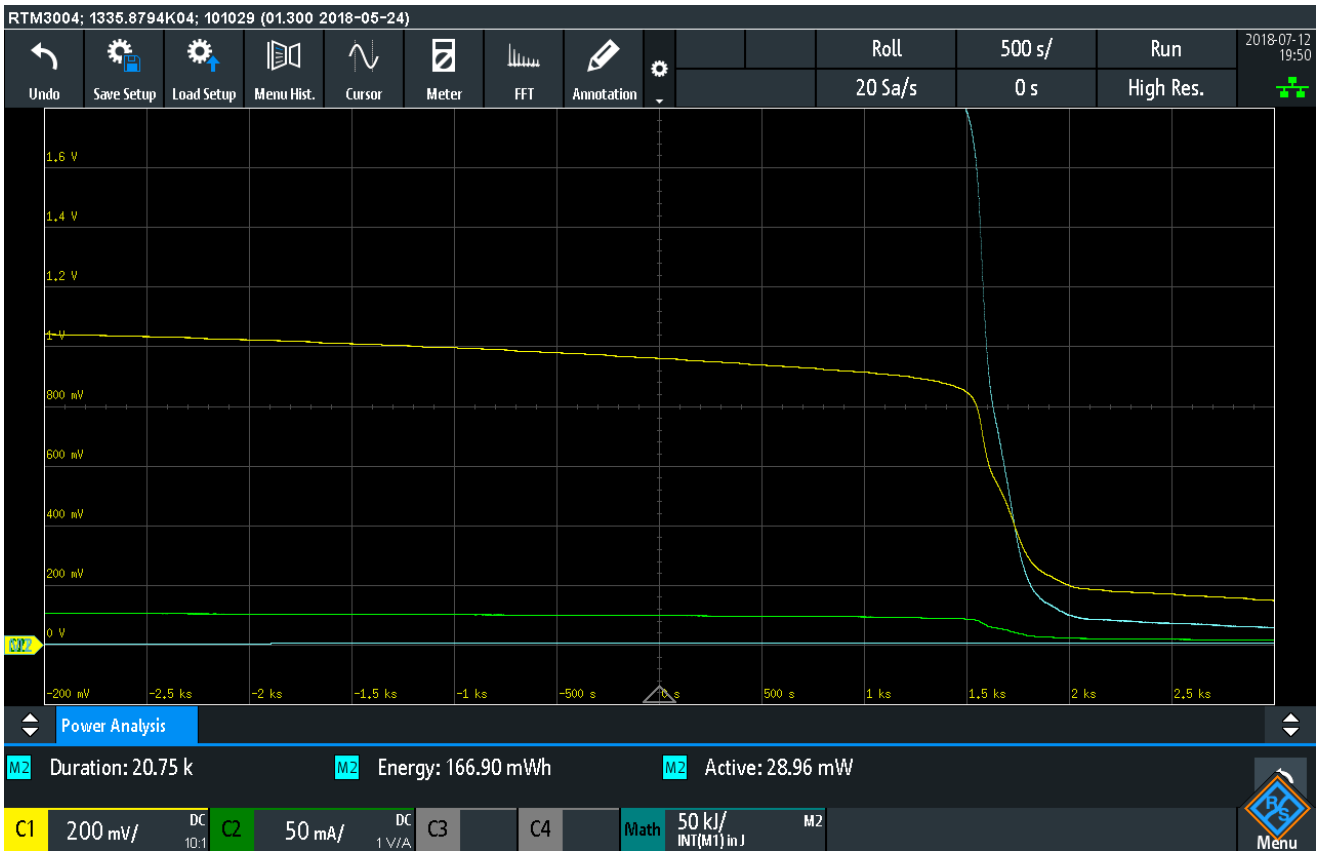


Using the consumption module resulted in some strange values which may be related again to the timebase/ sample rate of ~50kSa/s and High Resolution mode. It claimed an active power of 29.64W which is too high, although this may have been my fault in some way as I only did this experiment in a pinch.

Experiment: Alkaline Battery Discharge



Unsure about the consumption mode behaviour, I also tried a simpler test using an alkaline AA battery and four 1-ohm resistors in series as a load. The bottom 1-ohm resistor is used as the current shunt. Because I failed to account for the 10x probe resistance, the values are off by a factor of 10, but otherwise it seems like it worked just fine – an energy reading of 1669mWh doesn't seem entirely implausible given the unknown nature of the cell condition initially. However, it does seem that measurement over very long timebases is not easily visualised on the screen.



Conclusion

Use of the power analysis feature is safest and best performed with the use of specialised active probes to provide the isolation necessary to protect the oscilloscope inputs and the user. Unfortunately, as I don't have access to any of these active probes and deskew fixtures and am not currently designing a switching mode converter, I could not fully assess the features offered by all of the power analysis option applications.

However, in testing separated extra-low-voltage circuits using the passive probes and resistive shunt, it seems that the tools do simplify the amount of work necessary to consistently analyse power quality and load characteristics. The reporting options also provide additional value to those who are routinely performing power analysis with their oscilloscope, making it a potentially worthwhile option for those users.
33 Views Tags: oscilloscope, roadtest, rohde&schwarz, rohde and schwarz, rtm3000, mixed signal oscilloscope, rtm3k-com4, rtm3004

There are no comments on this post