Counter measurements with a Fluke ScopeMeter® 190 Series

Application Note

Oscilloscopes are primarily designed to display waveforms and to show the dynamics of electronic or electrical signals. As well as displaying the signal, modern oscilloscopes all offer other functions; for instance timer/counter functionality to measure frequency, rise- and fall time, pulse width and duty cycle.

Time-interval measurements are also possible using cursors to an accuracy of two or three digits. This accuracy is sufficient to check for the presence of a signal and to characterize some of its parameters.

When more accuracy is needed, a dedicated measuring instrument like a timer/counter that gives 6- to 12-digit accuracy should be used. Oscilloscopes are also used with timer/counters to show the presence of a signal and show the setting of the counter-like trigger level. This application note describes the verification and calibration of energy meters using a Fluke PM6681 Timer Counter and a ScopeMeter 190 Series.

Energy meters

Modern energy meters generate an electrical pulse each time a quantity of energy is consumed (for example, one pulse may be generated for every watt-hour consumed, analogous to one rotation of the disc of an old-fashioned mechanical meter). A running total of the pulses is kept by a digital counter, from which the energy consumption can be read. Such an energy meter is calibrated by applying a known steady power to the meter and measuring the number of pulses generated in a given time. Unfortunately, the pulses arriving from a modern meter are not spaced evenly in time, being subject to digital jitter. Laboratory-grade meters have a very fast pulse rate and can be calibrated using a conventional digital frequency counter, but industrial-grade meters have a very slow pulse rate and are difficult or impossible to calibrate at the lower part of their demand curve. This part of the demand curve is important in energy conservation as it measures "standing losses".

Figure 1: *Modern energy.*

The pulse rate for a typical industrial-grade meter can be 1 pulse per second at say 5 A and 230 V with a power factor of unity. If the PF is shifted to 0.5, the pulse rate will drop to 1 pulse every 2 seconds. To explore its characteristics, downrange at 110 V and 1 A, the pulse rate will drop to 1 pulse every 10 seconds for a PF of unity and 1 pulse every 20 seconds for a PF of 0.5. These pulse streams have noticeable jitter.

Typical measurement requirements

1. A pulse stream of 10 pulses with the pulses spaced at approximately 1-minute intervals and a pulse width of 1 ms and amplitude of 10 V.
2. A pulse stream of 100 pulses with the pulses spaced at approximately 1.01 second intervals, a pulse width of 1 ms and an amplitude of 10 V. Each of these streams should have slight timing jitter. Measure the total time of the 10 pulses from the leading edge of the first pulse to the leading edge of the last pulse.

Visualizing with ScopeMeter®

Using a scope for the measurement of 10 pulses with an interval of 1 min each is a problem. The slowest timebase setting of the scope is 5 sec per division, i.e. 1 minute for a full screen. To make this slow signal visible the TrendPlot mode of the ScopeMeter is used measuring Vpeak.

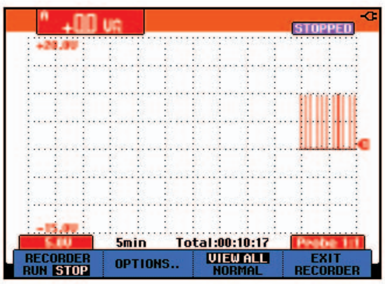

Figure 2: *ScopeMeter 199C TrendPlot mode measuring V_{peak} 5 min/div.*
After 10 pulses the recorder is stopped manually, so there is some time before the first pulse was fired and some time to stop the recorder. Total capture time is 10 min and 17 s.

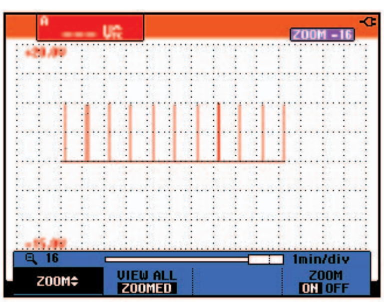

Figure 3: *The complete cycle can be shown on screen using the zoom function.*

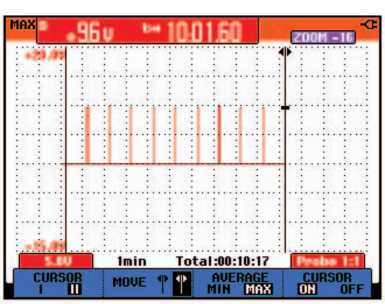

Figure 4: *Using cursors to measure the time interval between the 1st and the 10th peak.*

Figure 5: *PM6681 Timer Counter.*

The ScopeMeter can be used to check these energy meters in the field. To calibrate these energy meters in the calibration lab much greater accuracy is needed, so the calibration has to be done with a Timer/Counter as available for example on the model PM6681 from Fluke.

Calibrating energy meters with the Fluke PM6681 Timer/Counter

Default Time Interval setting on a timer/counter will measure the interval from the first pulse to the next. To measure time interval over a number of pulses, Hold Off delayed by number of trigger events has to be used. Time Interval Measurement is performed on Channel A and B. The Hold Off counting is done via the third measuring channel E. Measuring result after 10 pulses of 1 minute interval on the counter 602.4090739 s. So the counter gives a reading with 10 digits. The accuracy of this reading is determined by the accuracy of the frequency reference from the oven-controlled oscillator, i.e. 10^{-8} or a Rubidium reference at 10^{-10}.

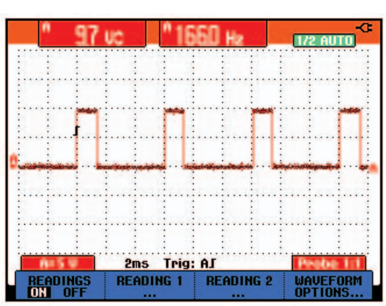

Figure 6: *Two readings are selected Vpp and **Hz.** Typical Timer/Counter measurements on the ScopeMeter 190 are:*

- *Hz*
- *Period*
- *Rise time*
- *Fall time*
- *Pulse width*
- *Duty cycle*

Timer/Counter functionality of the ScopeMeter 190 Series

In the preceding example TrendPlot with cursor was used to measure time interval.
Here we describe the timer/counter functionality of the ScopeMeter 190 Series in the normal Scope Mode.

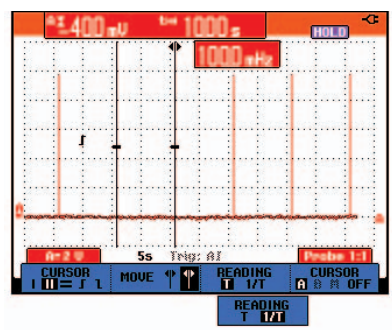

Figure 7: *Period measurement using cursors on one period. The reference level for the cursor measurements is set automatically to 50%. Toggling from **Period T** to **Frequency 1/T** gives **s** or **Hz** reading.*

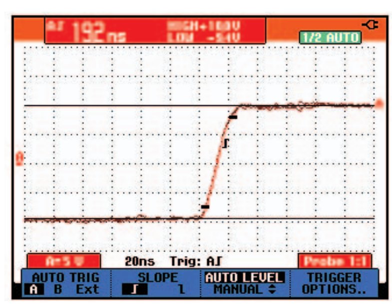

Figure 8: Rise or fall time
The 10 % and 90 % levels are set automatically after measuring the upper and lower reference levels by means of a histogram function.
This prevents over- or undershoot influencing this level. Trigger level setting can be changed manually.

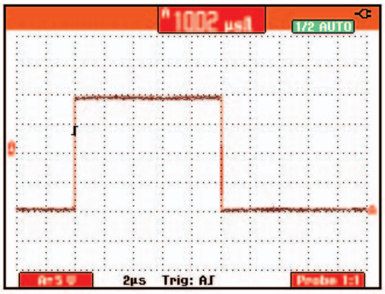

__Figure 9: Positive pulse width__, or Negative pulse width.

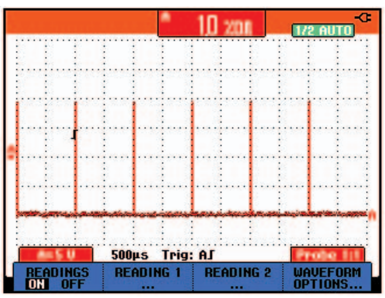

__Figure 10: Positive duty cycle__, or Negative duty cycle.

Conclusion

The ScopeMeter 190 Series can be used to check the presence of these low frequency signals and visualize them with reasonable accuracy. Cursors can be used for time-interval measurements. The ScopeMeter 190 Series has many dedicated timer/counter measuring functions with automatic settings. When more accuracy is demanded for calibration, a dedicated timer/counter such as the Fluke PM6681 has to be used.

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