

## Easy capture of in-rush currents with a Fluke 190 Series ScopeMeter®

### Application Note

The measurement and analysis of in-rush current is a valuable technique in determining a circuit's parameters. This application note explains the procedures for capturing and analyzing in-rush current with the Fluke 190 Series II ScopeMeter portable oscilloscope. Viewing the captured waveform allows the determination of how fast the current drops from startup current to running current levels. ScopeRecord mode makes it possible to capture the whole in-rush cycle for several seconds and the zooming functions enable it to examine the in-rush current signal in full detail and check on peak currents drawn at startup.

#### In-rush current

In-rush current is the initial surge of current drawn by a circuit when voltage is first applied. Motors, power supplies, fluorescent lighting and High Intensity Discharge (HID) lamps all have in-rush current characteristics that can be captured and analyzed to help identify circuit problems. Although the example in this application note is based on a motor, the procedure would be the same for any circuit. The measurements shown in the illustrations are actual measurements taken on a three-phase motor with Wye/Delta switch.

#### Principle of Wye/Delta switched asynchone motor

Wye/Delta switching of asynchone motors reduces the in-rush current by a factor  $\sqrt{3}$ .

In the Wye configuration, (Figure 1) the 3 phase voltage is applied to two coils of the motor

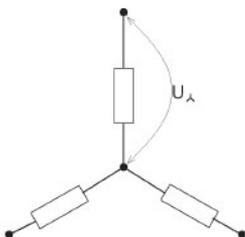


Figure 1. Wye configuration.

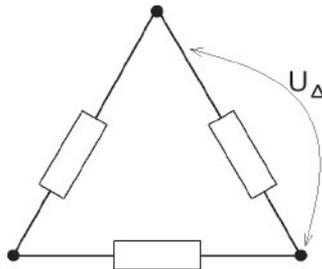


Figure 2. Delta configuration.

circuit switched in Wye mode. This means that the star voltage  $U_{\lambda}$  of 230 V (115 V) is available for the motor winding.

In the Delta configuration, (Figure 2) the full phase to phase voltage  $U_{\Delta}$  of 400 V is available for the motor winding.

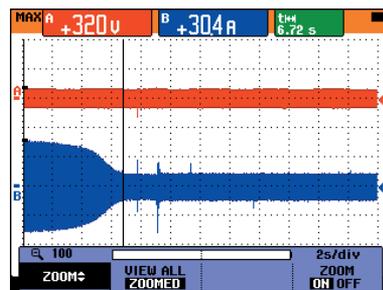


Figure 3. Captured trace with cursor readings. VIEW ALL for a quick impression of the complete inrush current. Zoom range of -100 up to +10. In-rush peak current 30.4 A Wye In-rush current time 6.72 s Delta In-rush after 9 s.



#### Setting up the instrument

The ScopeMeter is connected with a 10:1 voltage probe to the supply voltage (Figure 4) and with a current probe to one of the 3 phase current conductors (Figure 5).

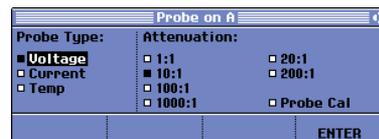


Figure 4. Attenuation factor 10:1.

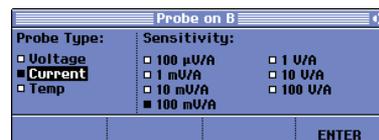


Figure 5. Current probe setting 100 mV/A sensitivity.

### Setting up reading

The option to show actual measurement values in the top banner of the display is an important feature. A range of values can be made visible. Figures 6 and 7 show these options. Pressing the ENTER button will activate the specific reading.

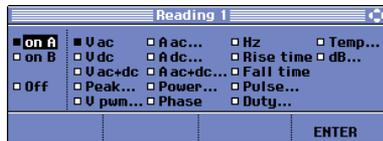


Figure 6. V ac reading on channel A. See all the possible readings.

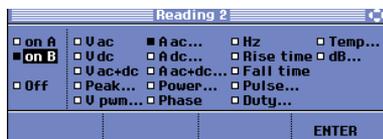


Figure 7. Aac reading on channel B.

### Measuring in-rush reading

In-rush currents are measured in the ScopeRecord mode. For this measurement, the amplitude and position on screen have to be adjusted for a non-overlapping optimal display. The in-rush current is measured on a 3 phase motor from a ventilation unit. An external triggering is possible making use of a different input than the one which is used for the 3 phase measurement. Switching is controlled by a relay with time-delay. Due to this delay, external triggering is needed to start capturing the ScopeRecord mode at the moment of switching.

The meter inputs are used for external triggering.

### Analyzing the in-rush current of a Wye/Delta switched motor

Three-phase motors obtain their starting motion from the phase difference between the three voltages. The three-phase voltage creates a rotating field that causes the stator to turn. A single-phase motor, however, requires an auxiliary winding and a capacitor to create a rotating field for initial turning torque. This starting circuit is switched off after the motor reaches a specified speed.

Each motor has unique starting characteristics that must be taken into consideration when analyzing in-rush current. Not only the internal motor design but also external factors such as voltage amplitude, ambient temperature and load affect in-rush current. All these factors should be recorded and considered when trending or analyzing a motor over time. In the case of three-phase motors, it is important to measure the in-rush current on the phase that is applied first.

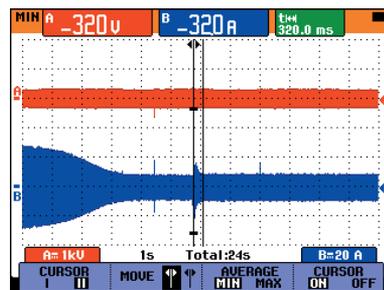


Figure 8. Wye/Delta switchover in-rush current. Negative current peak of 32 A.

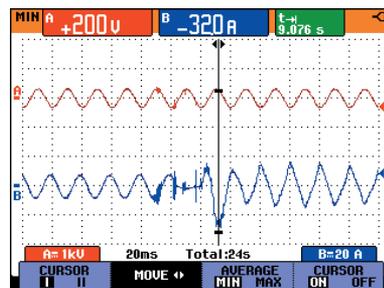


Figure 9. Zooming in on the negative Wye/Delta in-rush current peak.

Looking at the peak current drawn at startup (Figure 8), knowledge of the time it takes to go from lock-rotor to normal running current and of the amount of normal running current can help identify excessive loads and defective starter circuits. The Zoom function allows for a more detailed study of the inrush current. Figure 9 shows the details whereby the cursor position reveals the actual current at the specific moment in time.

### Conclusion

With the ScopeMeter 190 Series II it is easy to capture in-rush currents in the ScopeRecord mode showing the whole in-rush cycle. The captured data can be saved in the ScopeMeter's memory on location and examined afterwards with FlukeView software. Current peaks and switch time parameters can be determined with full detail using cursors and zooming functions. These measurements with the ScopeMeter 190 Series allow the determination of circuit design parameters beforehand and provide a check on operating condition afterwards. The ScopeMeter 190 Series with three independently floating isolated inputs is certified for safe measurements in CAT IV environments up to 600 V and CAT III environments up to 1000 V.

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