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Start Monitoring Motor Starts!

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Electric Motor Testing

Electric motor testing has developed into a preeminent technology. Utilizing test instruments for analyzing de-energized and energized motor data can avert catastrophic failures of critical motor assets. A motor testing programs success is going to be determined by how much of the motors operational parameters can be monitored. Motor test equipment's provide considerable data, however, one area that is not or is under utilized is monitoring motor starts or in-rush.

Motor starting can result in a current draw that is 10 times the full load amperage listed on the motor nameplate. Imagine a 480V 500HP motor developing close to 6000 amps within a fraction of a second after initiating a start. Not only is the amperage high, but the motor will heat anywhere current flows at a measurable amount; I^2R. The current squared times the resistance it flows through. The windings, rotor bars and even the eddy currents and hysteresis within the stator and rotor cores will experience significant heating. Motor starts are the most stress a motor experiences during normal operation. That is why we have developed numerous starting circuits to diminish in-rush. These circuits include:

1. Soft Starts
2. Solid State Reduced Voltage Start
3. Variable Frequency Drives
4. Series Resistance
5. Series Reactance
6. Wye Start – Delta Run
7. Auto Transformer Reduced Voltage Start
8. Partial Winding Start

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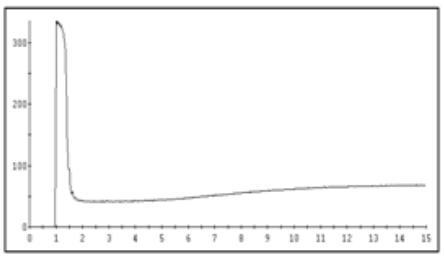

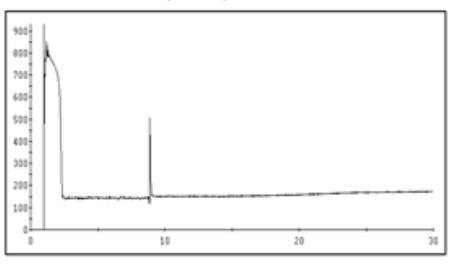

Above are to single channel In-Rush profiles. The first is a 75HP across the line and the second is a 400HP that utilizes a Solid-State Reduced Voltage Start (Soft Start.) The 75HP is drawing 320 amps. The 400HP could easily experience currents close to 5000 amps across the line.

Some motor test units allow the capture of voltage and current providing invaluable 6 channel data. With only one channel of current, several things can be monitored.

In-Rush

In the next In-Rush Profile, a Solid-State Reduced Voltage Start circuit is being utilized. The peak current and transition to run time provide valuable trendable data for determin-

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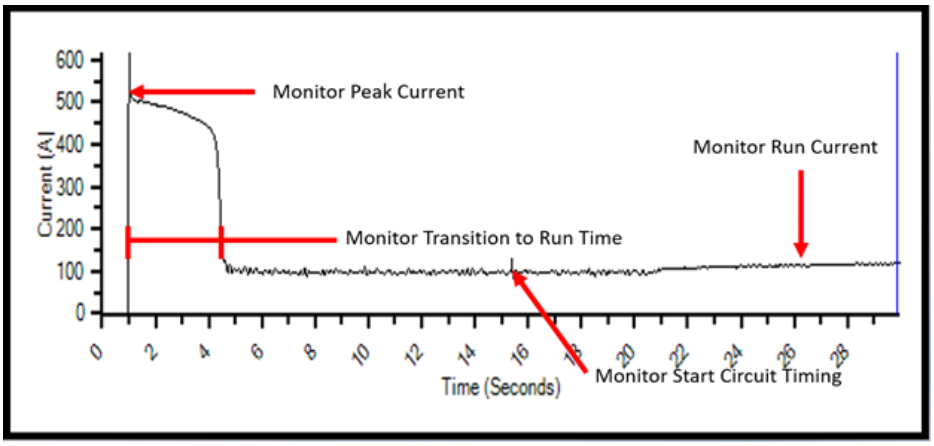
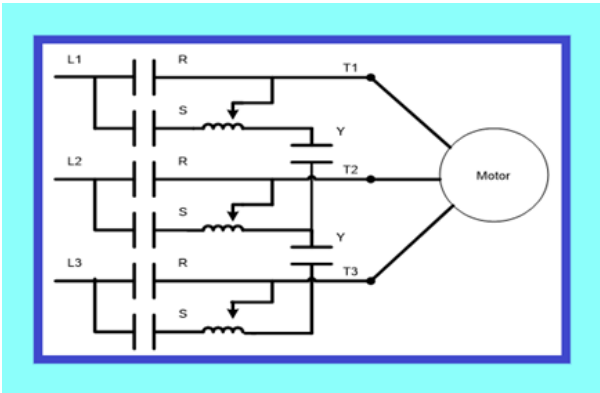


ing circuit, rotor or driven load faults. The timing of the start or transition to run, when the soft start time out is also measurable and trendable. Once the motor transition to run the run current can also be monitored and trended.

A six-channel capture enables monitoring and comparison of 3 phases of voltage and current. Balance and symmetry can easily be determined with any type of start circuit, including VFDs. If you only monitor single channel current; you will most certainly miss many opportunities to diagnose problems. At one of our customer sites, they were experiencing intermittent tripping of several variable frequency drives. The eventually noted that the tripping occurred when stating a particular motor. It was difficult to relate as they had 2 other motors of the same voltage and horsepower that started off the same bus and they did not cause any problems with the VFDs. An In-Rush capture of the suspect motor immediately showed the cause.



The motor was a 4160V 2000HP, that utilized an Auto Transformer Reduced Voltage Start circuit. During the start sequence a start reactor / inductor is placed in series with each phase supplying the motor. That series reactance drops voltage and reduces current during starts. After approximately 20 seconds the motor contacts shift to across the line. The start circuit provides taps that can select 80%, 65%, or 50% of the windings during the start up.

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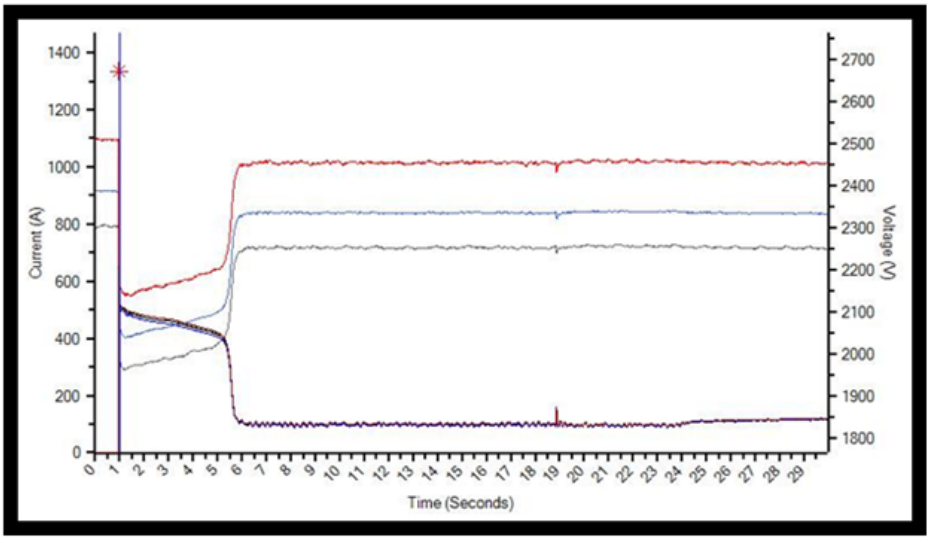
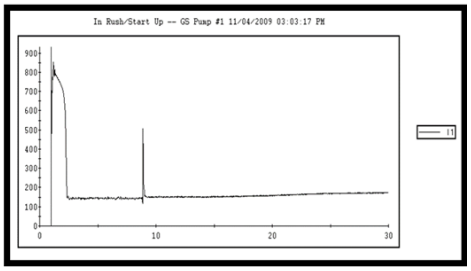
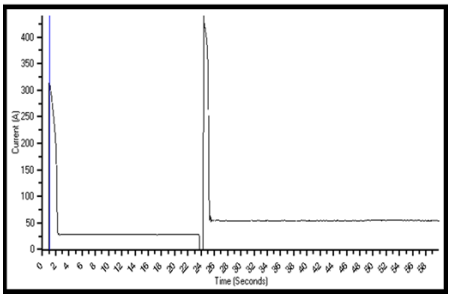


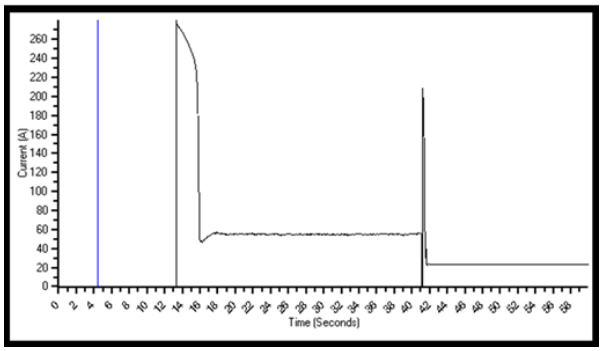
The motor was shut down and it was noted that all three phases were tapped differently on the reactors. They were all set to 80% and the VFDs no longer experienced shutdowns. Without 6 Channel In-Rush this problem may not have been found. It was only apparent during the 20 second start period.





Above right is the In-Rush for a 2-speed fan, that starts in slow and shifts to fast.

Monitoring motor starts can be used to verify timing and proper event sequence. Note the peak at around 8 seconds. That is when the soft start times out and the motor switches to across the line.



Above is another 2-speed fan that was wired backwards. It started in fast and shifted to slow.

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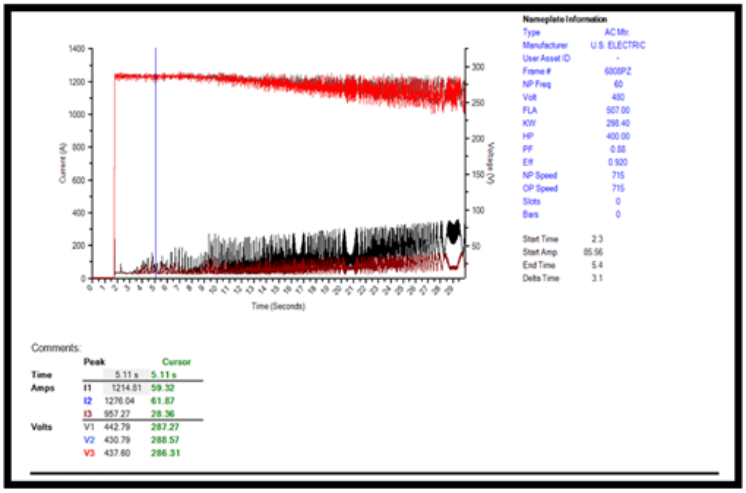
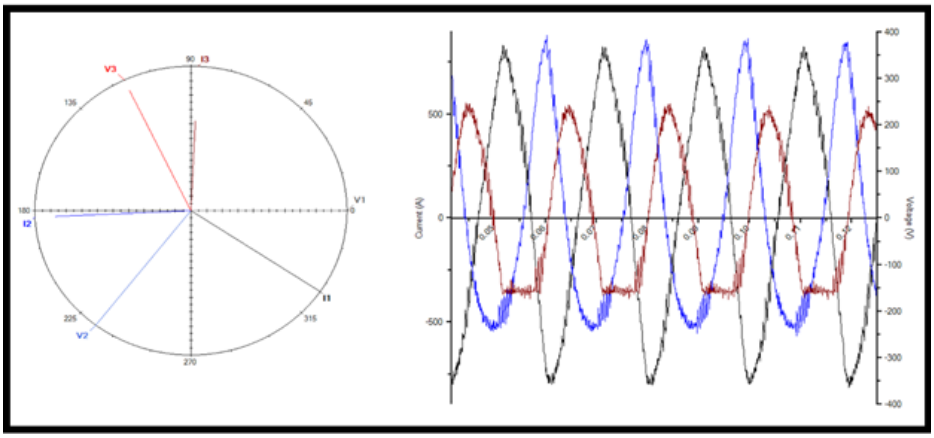
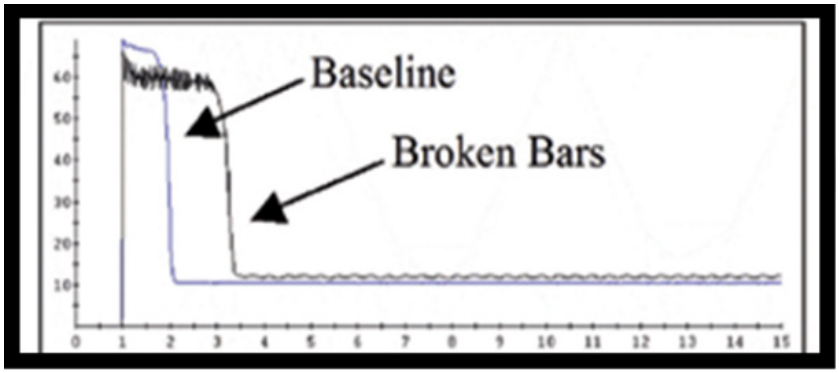


A VFD In-Rush showing a severe current unbalance upon starting. Additional data was taken that confirmed the problem identified during starting.



Note the length of phase 2 and 3 current vectors. The time domain shows that a drive malfunction is clipping over a third phase 2 negative half cycles and more than half of the phase 3 negative half cycles. There were no drive alarms.



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Trending In-Rush

Trending In-Rush provides a considerable benefit. Motors that draw higher current during start and take longer to transition to run more than likely have developing mechanical problems with the driven load. If current is low in one phase, it could indicate a connection anomaly in the starting circuit or power circuit.

Current Peak Trend	Transition to Run Time	Analysis
Normal	Normal	Normal
Lower in one channel	Longer	High Resistance Connection
Higher in all channels	Longer	Mechanical Load Problem
Lower in one or more channels	Longer	Rotor Fault (May also have ripple)

The table above simplifies the capabilities of monitoring I-Rush.

Monitoring In-Rush is an essential part of any motor reliability program. The expedient collection of data and the capabilities provided make this testing invaluable.

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