

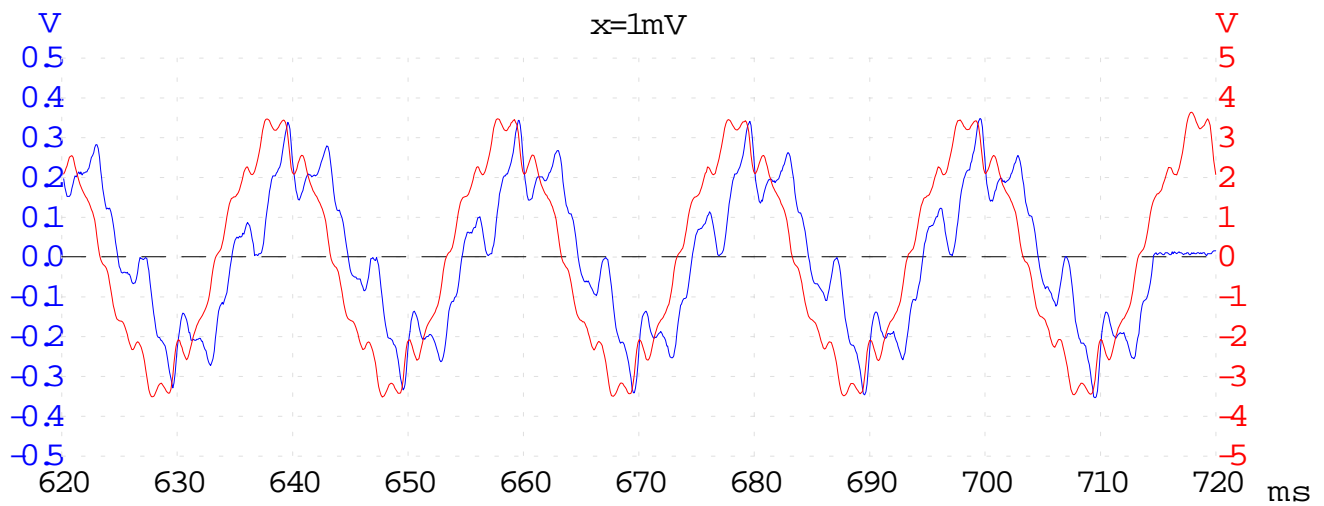
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Date:
To:
Att:
From: Steve Orlando.
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Chiller No1. Mod: YKCEDBG4 5CKE Ser: PBKMG41205
Chiller No2. Mod: YKCEDBG4 5CKE Ser: PBKMG41204
Chiller No3. Mod: YKCEDBG4 5CKE Ser: PBKMG41203

Please find a breakdown of the problems encountered. The above site suffered from Power Faults (Half Phase Trips) on a running Chiller during the starting of a second. Initial investigations of the Solid State Starter Logic Board, showed irregularities on the Current Transformers and Line Voltage waveforms on the running Chiller during the above event, as identified by Figure 01 capturing a trip.



ChillerNo1.
Mod:YKCEDBG4 5CK E Ser:PBKMG41203

Blue Trace -Phase B Peak Current. (1mV=1Amp)
Red Trace -Phase B Peak Volts. (100:1 Probes)

Compressor 3 Starting -Compressor1 Running 40% FLA .
19Jun2001 13:18

Figure 01.

Further investigation showed that the starting Chiller was inducing a harmonic on the running chillers voltage supply, hence the whole 415 Vac network supplied by the 6.6kV Chiller Transformer. This in turn is initiating additional SCR switching on the running chillers motor. This switching is prevalent at lower loads and is current going to 0 Amps through the SCR prematurely, not additional gating of the SCR. This can be explained as the Motors back EMF being greater than line voltage and current trying to flow out of the motor to the 415 Vac network. This flow in turn is being stopped by the bias of the SCR's hence the 0 Amp current

draw we are seeing in the incorrect places.

As part of the Half Phase Safety circuit, the Solid State Starter Logic Board monitors the three current phases. It rectifies the 3 signals and applies a differential algorithm to it. It looks at the difference between the maximum and minimum of the rectified signal. Find following actual representations taken from site logs, calculating the 3 phases rectified waveforms based on the above captured trip as per Figure 01. These are Figure 02, one second before the second Chiller starting and Figure 03, during the second Chiller starting capturing the running Chiller trip.

Normal Running Conditions

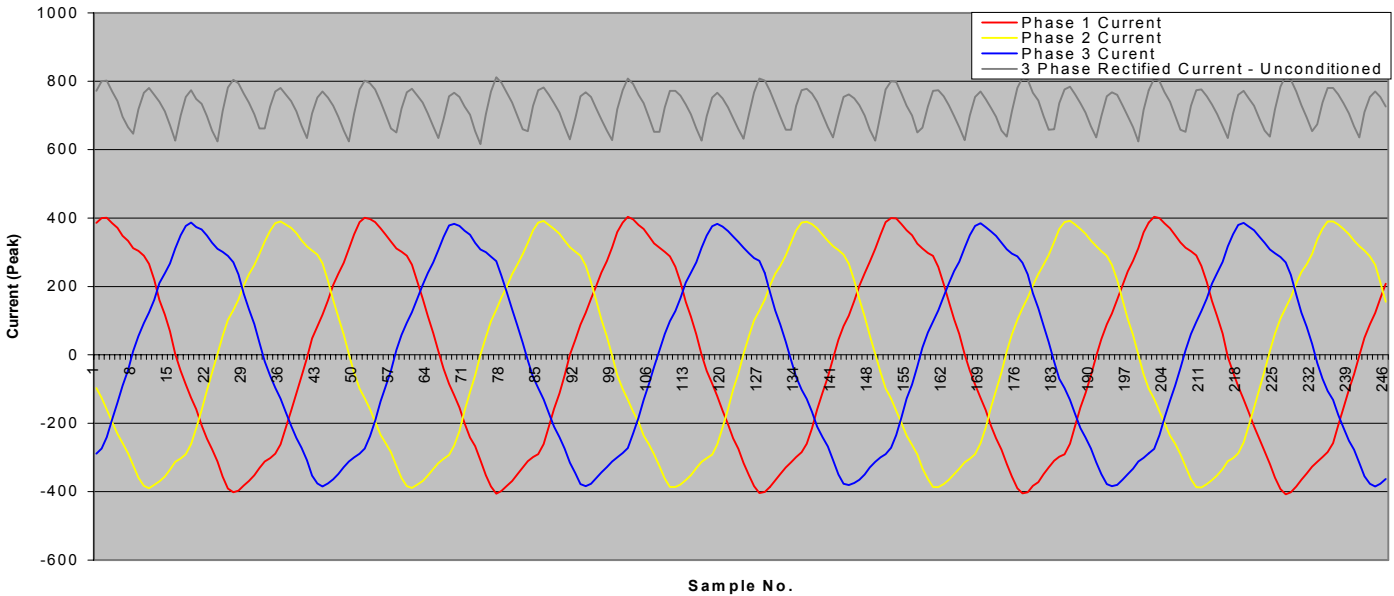


Figure 02.

Captured Trip Condition

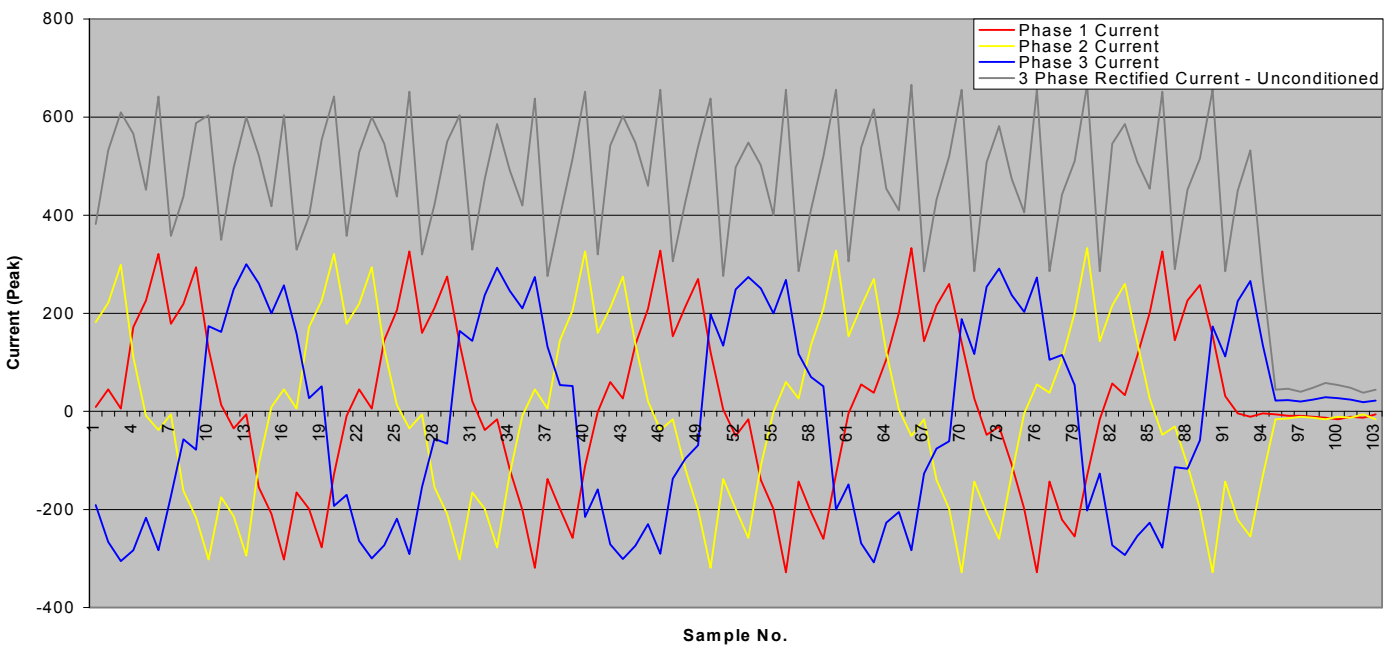
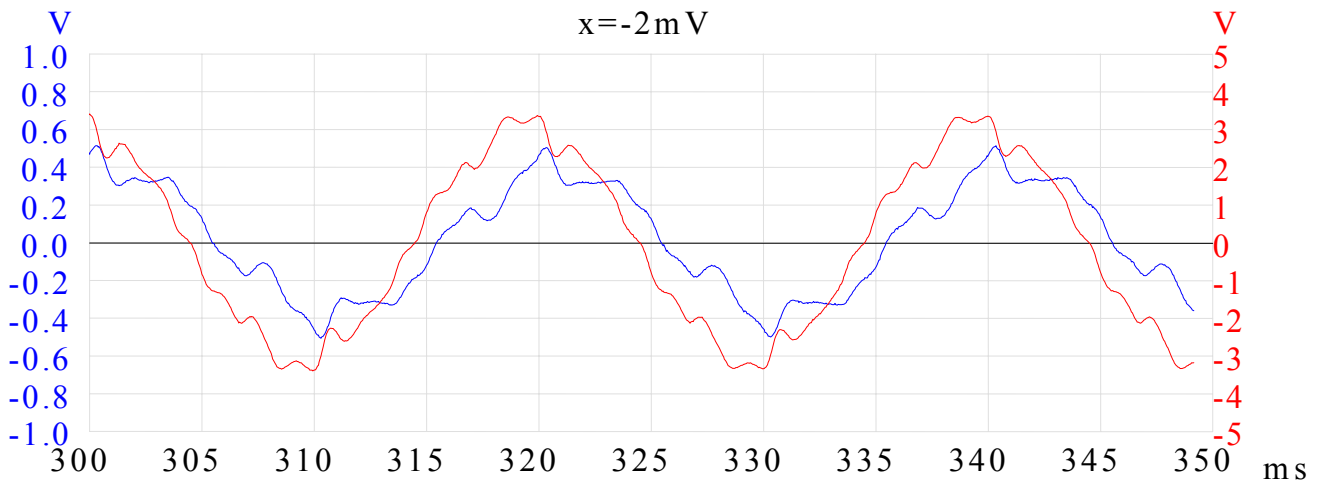


Figure 03.

It can be seen from figures 02 & 03 that the additional SCR switching induced by the starting harmonic on the running Chiller, causes the 3 phase rectified waveform to distort to a level where the Half Phase Trip is invoked.

At higher loads there is no additional switching, but the distortion is still present having amplitude offset as reflected in Figure 04. This is due to the Motors back EMF being closer to the line voltage and current flow through the SCR's not prematurely going to 0 Amps.



Chiller No1.
Mod: YKCEDBG4 5CK E Ser:PBKMG41203

Blue Trace - Phase B Peak Current. (1mV=1Amp)
Red Trace - Phase B Peak Volts. (100:1 Probes)

Compressor 3 Starting - Compressor 1 Running 70% FLA.
19Jun2001 14:21

Figure 04.

Fundamentally the running compressor motor is decelerating during the starting of another compressor. This is due to the Voltage Distortion on the 415Vac Network during the start and the reduced resultant RMS Voltage available to the running compressor motor.


These events all point to the choler's 415Vac network being undersized to cope with a running compressor and the starting inrush of another, this shortfall I suspect to be the 6.6kV to 415 Vac transformer.

During site testing the Transformer's Electronic Circuit Breaker was set to achieve maximum capacity during the running and starting event, it is however approaching a fault condition, which again suggests the shortfall is with the transformer not being able to adequately supply the Chillers during a maximum power demand. In addition the chillers starting inrush currents were reduced to 36% of LRA, a deviation from manufacturers recommendation of 45% LRA, to accommodate the Transformers Fault Protection. One effect of this is prolonged motor acceleration times, in this example from 4 seconds to 9 seconds.

Currently the site has ensured that the running compressor is at 70% FLA before the second Chiller is started, to overcome the running Chiller tripping on Half Phase.

I do not think it acceptable to leave the above short-term fix as a final solution. The waveform distortions are still present and effecting the running Chiller even at this higher loading. I cannot say that any damage will be incurred to the Driveline or the system as a whole if no further action is taken. I have forwarded this report to the manufacturers Product Support Team to comment on whether this is acceptable and in turn if it invalidates any warranties.

Regards,

A handwritten signature in black ink, appearing to read "Steve Orlando". The signature is stylized with a large, looped initial "S" and "O".

Steve Orlando
Partner