KENEXIS

Memorandum

From:	Edward M. Marszal
To:	Professional Staff, Technical Memo File
CC:	
Re:	SIL Verification of Motor Starters
Date:	26 August 2005
Reference:	TM004.emm
Keywords:	Motor Starters

Stopping a pump or compressor is a common action that is taken by safety instrumented functions to move process to a safe state. The action of stopping the pump or compressor is performed by removing power from its motor. Power to pumps and compressors in the process industries is typically in the form of 3 Phase power at a significantly higher voltage than control circuits. As such, the power interruption must be performed by relaying the control circuit signal to a device that will interrupt the 3-Phase power to the motor. This device is the pump or compressor's motor starter.

Motor starters come in a wide variety of styles and configurations, but can generally be separated into "low power" and "high power varieties (diagrams of a typical "low power" motor starter circuit is shown on the attached diagram). The Kenexis SISDEB toolkit includes corresponding options in the final element database for SIL verification calculations. Nominally, low power motor starters apply to 600 Volts and less, and high power motor starters apply to higher voltages, such as 2kV, 4kV, and 13kV. While separate options for high and low power exist in the database, and the design of the two types of motor starters is significantly different, the failure performance in terms of failure rate and safe failure fraction is very similar for the two types of devices.

A low power motor starter is almost always of the electromechanical relay type, where the 3-Phase power contacts are held in by an electromechanical relay which is powered by the control circuit. If power to the control circuit is interrupted, the control coil de-energizes and the 3-Phase power is then interrupted.

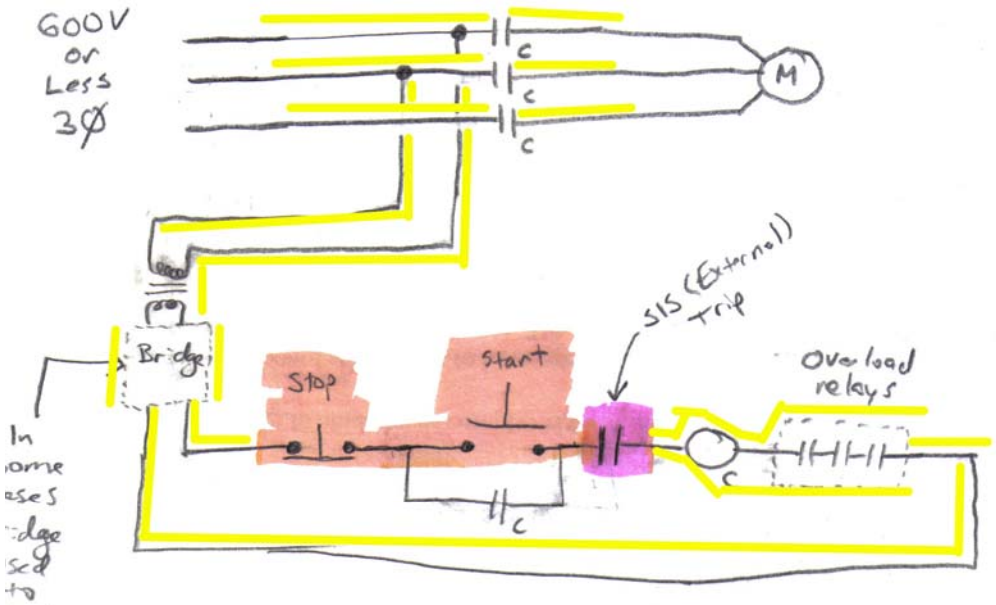
There is a much greater degree of diversity in high power motor starters. Some varieties employ the same electromechanical concept that is used for the low power starters, but others use a mechanically latched system concept. In this type of system, the motor starter electromechanically closed and then mechanically latched, which compresses and latches a spring system. De-energizing the circuit is subsequently performed by energizing a trip coil that will remove the latch from the spring, and allow decompression of the spring to open the 3-Phase circuit and de-energize the equipment under control. It is very common for the trip coil circuit to be energize-to-trip, to move the latch to the position where the spring can decompress.

In terms of conceptual design review and SIL verification, several considerations must be made in the design of a motor starter shutoff. First, the scope of the motor starter

must be carefully defined. While the motor starter is a collection of equipment, it is treated as a single component in terms of SIL verification calculations. The failure rate data in the Kenexis database for the motor starter device is inclusive of all of the components of the motor starter. All of these components will reside inside an enclosure in the motor control center that is called a motor starter cubicle or "bucket". The shutdown signal from the SIS to the motor starter will interrupt the control circuit inside the motor starter. This interruption will be performed by a device that is technically part of the motor starter and is not included in its failure characteristics. The interruption will either be performed directly by the SIS logic solver output card or an interposing relay. The logic solver card or interposing relay are not considered part of the motors starter and the failures associated with these components are not included in the failure rate description of the motor starter. These devices are handled separately design SIS conceptual design and SIL verification calculations.

Where high voltage logic solvers are used and they employ an energize-to-trip trip relay in a mechanically latching system, circuit integrity monitoring is not required "internal" to the motor starter ("in the bucket"). Ensuring circuit integrity is only required for the portion of the circuit that goes from the logic solver to the "bucket". Kenexis recommends that this circuit be de-energize-to-trip and the normally closed contacts of the interposing relay be used to activate the trip coil in the case that an energize-to-trip circuit be used for a high power motor starter. If this philosophy is followed, no circuit integrity monitoring is required.

Low Voltage Motor Starter



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Items highlighted in yellow are "in the bucket" and considered a "single component" for SIS analysis

Items highlighted in orange are field equipment that are "non-interfering" and not considered in the SIL verification calculation

Items shown in pink may reside "in the bucket" but are part of either the logic solver or a final element interface device (i.e., interposing relay). Failures of this device are not included in the motor starter "component".