



Understanding Type 2 Coordinated Protection in Motor Branch Circuits

Technical Overview

INTRODUCTION

The new IEC (International Electrotechnical Commission) standard, publication 947 "Low Voltage Switchgear and Control, Part 4-1: Contactors and Motor Starters," has been recognized by UL (Underwriters Laboratories) and is becoming widely accepted by designers and users of motor control in the U.S. This standard addresses coordination between the branch circuit protective device and the motor starter. It also provides a method to measure performance of these devices if a short circuit occurs. This standard defines two levels of component protection in the event of a short circuit: Type 1 and Type 2 coordination.

This Product Data Bulletin describes:

- How to conform to the new standard using motor controls built to meet NEMA and IEC standards
- Related benefits associated with Type 2 coordination

TWO LEVELS OF PROTECTION

The IEC standard for motor starters and contactors, 947-4-1, defines two levels of protection/coordination for the motor starter (contactor and overload relay) under short circuit conditions. Each level of protection is achieved by using a specific combination of motor starter and short circuit protective device.

- Type 1 Coordination

Under short circuit conditions, the contactor or starter shall cause no danger to persons or installation and *may not* be suitable for further service without repair and replacement of parts.

- Type 2 Coordination

Under short circuit conditions, the contactor or starter shall cause no danger to persons or installation and *shall be* suitable for further use. The risk of contact welding is recognized, in which case the manufacturer shall indicate the measures to be taken in regards to equipment maintenance.

Faults in electrical systems are most likely to be of a low level, which are handled well by motor controllers built to meet Type 1 coordination standards. After the fault is cleared, the only action necessary is to reset the circuit breaker or replace the fuses. In situations where available fault currents are high and any period of maintenance downtime is crucial, a higher degree of coordinated protection may be desirable.

Many industries are dependent upon the continuous operation of a critical manufacturing process. In these conditions, it is especially important to understand that Type 1 protection may not prevent damage to the motor starter components. In order to ensure that high level fault or short circuit does not interrupt a critical process, it may be prudent to consider implementation of Type 2 coordination in the selection and application of low voltage motor controllers.

Type 2 coordination, which has no equivalent U.S. standard, does not permit damage to the starter beyond light contact welding, easily separated by a screwdriver or several coil operations. Type 2 coordination does not allow replacement of parts (except fus-

es) and requires that all parts remain in service. Beyond providing basic electrical and fire protection, it also minimizes lost production, reduced productivity and unscheduled disruptions resulting from downtime needed to replace or repair a starter.

NORTH AMERICAN MARKET AND UL 508

Standard industry practice in North America is to use components listed by UL (Underwriters Laboratories), or certified by the CSA (Canadian Standard Association) and applied according to the NEC (National Electrical Code) and CEC (Canadian Electric Code). Under most circumstances, motor starters designed to meet the requirements of UL 508 and installed in compliance with the NEC are safe for the operator and provide adequate protection for the components under most low and high level short circuit conditions. However, UL, CSA and NEC testing and application procedures are primarily oriented toward fire safety, with limited concern for maintaining productivity or preventing downtime under severe short circuit conditions.

The following excerpts from UL 508 Section 58.56, "Controllers Intended for Use on Circuits Capable of Delivering High Fault Currents," illustrates this point.

- A. There shall be no discharge of parts. Welding or complete disintegration of contactor contacts and burnout of the current element of an overload relay is acceptable. The controller may be inoperative at the conclusion of the test.
- B. The door or cover shall not be blown open, and it shall be possible to open the door or cover. Deformation of the enclosure is acceptable.
- C. There shall be no breakage of insulating bases to the extent that the integrity of the mounting of live parts is impaired.

EVOLUTION OF TYPE 2 COORDINATION

The concept of Type 2 coordination started in Europe and has now spread to North America because of two main reasons:

1. Components meeting IEC standards are designed for application very close to their maximum capacity. They are physically smaller than traditional starters built to NEMA standards used in North America. Both styles of starters, if applied properly, will perform adequately. However, when compared to starters built to NEMA standards, starters built to IEC standards present unique problems when subjected to short circuit overcurrents. Generally, the smaller the starter, the lower its ability to withstand short circuits and the more susceptible it is to damage from higher fault currents.
2. IEC standards for short circuit protective devices do not specify maximum allowable let-through currents and let-through energies. The more energy let through by the short circuit protective device, the more potential damage to the starter and vice versa.

In Europe, users of motor control components requested that manufacturers specify a particular short circuit protective device to be used for each starter size. They also wanted to know the type of damage likely to result if a short circuit occurred.

The manufacturers conducted short circuit tests for each starter with specific short circuit protective devices. These tests enabled them to determine what level of damage a specific starter would experience at a given voltage and short circuit current level. In Europe, tests were witnessed and results certified by a unbiased third party. The exact test procedure was refined so all motor starters could be evaluated on the same basis. The result was IEC 947-4-1, a new standard for motor starters.

SHORT CIRCUIT CURRENT LEVELS

One solution to limit short circuit current levels is to limit the amount of available fault current to a system installation where motor starters are installed. This is not always practical because the upstream short circuit protection usually exists and is costly to replace. Today, industry trends favor facilities with higher levels of available fault current, not less.

Short circuits damage motor starters due to excessive current. This damage is caused by magnetic forces and excessive heat. Magnetic forces are manifested through instantaneous peak let-through current (I_p) passed by the short circuit protective device. These forces can cause the contacts of the starter to blow apart and can also break the housing of the device.

Heat is proportional to the let-through energy (I^2t) passed by the short circuit protective device during opening. Excessive heating energy may cause the starter contacts to weld after magnetically blowing apart and may also cause thermal unit burnout.

The key to Type 2 coordinated protection is to use a protective device that limits the peak current and clears in less than 8 milliseconds, or the first half cycle.

BENEFITS OF TYPE 2 COORDINATION

There are three key benefits of Type 2 coordination:

1. **Safety:** Type 2 coordination is intended to provide safety for operating personnel, facility and the installed equipment.
2. **Reduced costs:** When a starter is properly protected from short circuits, all components of the branch circuit remain intact and operational. Only fuses may need to be replaced. Savings result from a reduction in labor required to perform maintenance after a short circuit and in the amount of replacement parts and required equipment. Savings are also realized by minimizing spoiled or lost production in a continuous process environment, such as may occur in some food and chemical process plants.
3. **Increased productivity:** The manufacturing process relies on continuous motor operation. If starters are damaged and must be repaired or replaced, the motors are shut down and the manufacturing process stops. By implementing Type 2 coordination, manufacturing processes should function with minimum disruption from short circuits on the motor circuits.

SQUARE D, TELEMECANIQUE AND TYPE 2 COORDINATION

Square D motor control products such as circuit breakers, combination motor starters and motor control centers are built to meet the performance requirements of UL 508 and, when applied according to the NEC, provide satisfactory protection in most industrial applications.

Square D has developed component selection tables. These tables offer engineers, designers and plant electricians the opportunity to implement Type 2 coordination protection using standard Square D motor control products.

Currently, the following product lines have been tested to Type 2 performance criteria with independent certification by UL and CSA:

- Class 8536 Type S Starters, built to meet NEMA standards, NEMA size 00 through 5
- Class 8538 Combination Starters, Fusible Disconnect Switch Type, NEMA size 0 through 5
- Class 8998 Motor Control Centers, with Type S or D-Line Starters
- Telemecanique D-Line and F-Line Starters, built to meet IEC standards
- Telemecanique Integral 18, Integral 32 and Integral 63 Self-Protected Starters, rated from 1 to 40 hp @ 480 VAC

The following fusible disconnect switches have been tested to the appropriate withstand level and can be used in Type 2 applications. They can accommodate all fuses shown in Square D's published Type 2 Coordination fuse selection tables.

- D10
- 9421N
- 9422T

REFERENCES

IEC Publication 947, Low-Voltage Switchgear and Controlgear, Part 4: Contactors and Motor-Starters.

IEC Publication 292-1, Appendix C: Coordination with Short-Circuit Protective Devices.

Underwriters Laboratories Standard UL 508, Standard for Safety: Industrial Control Equipment.