SELECTION OF OVERCURRENT PROTECTION

The most important aspect of circuit protection selection is a complete understanding of the system to be protected. Because the protection design is usually the last consideration, and time is always at a premium, this aspect of design is usually rushed. If time is devoted to this important aspect of design, however, and the following methodology utilized, your design will be safe, economical, and properly specified.

The methodology is contained in a seven-step process:

1. Determine what is to be protected and why—i.e., device(s), components(s), circuit(s).
2. Determine how damaging overcurrents and natural inrush currents and surges can be developed in those items listed above.
3. Determine where a current interruption device should be placed—coordination is an issue of importance in this step.
4. Calculate the magnitude and duration of the potential fault currents of Step 2 as they relate to those items listed in Step 1.
   Determine maximum voltage requirements of the protective device.
5. List the supplementary requirements for the protective device—i.e., auxiliary switch for an alarm circuit, lighted actuation, environmental considerations, electrical trip, relay trip, etc.
6. Determine regulatory requirements.
7. Choose a protector that meets the requirements of your application.

For a complete discussion of this methodology, please refer to Chapter 8 of ***The Theory and Practice of Overcurrent*** Protection by Dr. Patrick J. McCleer, available by contacting MP.

When considering what is to be protected and why, keep the dynamics of circuit protection in mind.
In order to avoid nuisance trips attributable to start-up inrush and harmless surges within power systems, it is necessary to provide a margin of tolerance between the steady state current of the circuit and the rating of the protector. In general, the recommended margin for fuses is 25%; for circuit protectors, 15 to 20%. Additionally, there is a trip window or tolerance on the calibration of the protection device. For precise circuit breakers, this tolerance is between 25% and 35%. This means that a circuit breaker will hold 100% and will trip between 100% and 125 to 135% within an hour. Based on this common industry specification as an example, a 10.0 amp rated protector can be expected to hold 10.0 amps or 100%. It can also be expected to trip at 12.5 or 13.5 amps within an hour. The expected trip point is governed by the Maximum Ultimate Trip (MUT) specification. In this example, the Maximum Ultimate Trip is 125% or 135% depending on the circuit breaker's specifications.

The most important considerations when matching potential fault protection to a circuit protector are the I2t factor and the fault trajectories. The I2t factor projects the potential for damage in a component —i.e., wire, motor, power rectifiers, transformers, etc. Generally, this factor is a measure of what a device can absorb and still survive. The measure is a function of current in amps versus time in seconds.

The fault trajectory is simply a graphic representation of a fault and, if it is specified as a current in amps and time in seconds, then both the I2t and fault trajectory can be put on the same graph. The point at which the two lines cross on the graph represents the condition where circuit or component damage can be expected. For further clarification, the trip curve of the specified circuit breaker can be superimposed on this graph, giving a visual indication of the level of protection offered by the circuit breaker and its suitability for the application.

It is necessary to consider all the aspects of the circuit protector that affect its published operating characteristics when considering its trip curve graph. Specifically, variations in performance can be encountered when factoring: 1) position differences in magnetic circuit breakers, 2) ambient temperature changes in fuses, thermal circuit breakers and magnetic circuit breakers, 3) the potential for overreaction to inrush currents often encountered in magnetic breakers, and 4) the effect of voltage on the published trip characteristics of magnetic circuit breakers.

Having considered all these variables, the designer must also weigh the ancillary product considerations of circuit protection—i.e., allowances between product cost and performance, supplementary requirements, and regulatory approvals.

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