

distortion is high enough, it can cause overheating of system neutrals and transformers. Square D offers application assistance and measurement and analysis services.

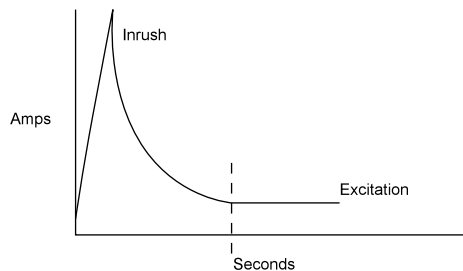
Overcurrent Protection for Lighting Transformers

The National Electrical Code, Article 450-3 requires both primary and secondary overcurrent protection, either in the form of circuit breakers or fuses. Square D offers application assistance in breaker and fuse sizing.

Transformer Performance Considerations

Inrush and Excitation Current

- **Definitions** – Inrush is a high, initial peak of current occurring during the first few cycles of transformers energization. Excitation current is the steady-state current that keeps the transformer energized after the inrush has dissipated.



- **Inrush problems when backfeeding transformers** – The magnitude of the inrush is significantly increased when backfeeding a transformer (the amount of increase is dependent on the individual design). This high inrush can cause breakers to trip unnecessarily or fuses to blow. Increasing the rating of the primary overcurrent protection may be necessary.

Note: When operating Delta-Wye transformers in reverse, the neutral connection must not be connected or grounded when the Wye side is used as a primary.

Impedance

- **Definition** – Impedance, usually designated as %IZ, is a way of expressing the amount of current-limiting effect the transformer will represent if the load side of the transformer becomes short-circuited. Considered along with the X/R ratio, the information is used for systems analysis to determine proper interrupting ratings and coordination of protective devices.
- **Use of impedance to determine interrupting capacity** – Knowing the maximum current available on the load side of a transformer is necessary to properly choose current interrupting values for disconnects and overcurrent protective devices. Here is a simple method of estimating short circuit current:

$$\text{SECONDARY SHORT CIRCUIT CURRENT} = \frac{\text{TRANSFORMER SECONDARY FULL LOAD RATING}}{\text{TRANSFORMER IMPEDANCE}}$$

EXAMPLE: A TRANSFORMER WITH 208 AMPERES FULL LOAD CURRENT AND 5% IMPEDANCE

$$\text{SECONDARY SHORT CIRCUIT} = \frac{208}{.05} = 4160 \text{ AMPERES}$$

Other factors besides impedance affect short circuit current. Primary system capacity and motor current contribution from the load side will change the short circuit value obtained using the above simplified method. Make sure to take all factors into account to ensure that device interrupting ratings are properly coordinated. Contact your local Square D representative for information on system analysis service.

Transformer Performance Considerations

Impedance

- **When not to specify impedance** – Transformer impedance will vary depending on transformer size, voltage, winding material and many other factors. Although non-standard impedances are obtainable, they usually require additional cost. Only a specific reason should prompt specifying impedance, allowing manufacturers to supply their standard designs is more cost effective.

Transformer Voltage Regulation

- **Definition** – Transformer regulation is defined as the percentage difference between voltage at the secondary terminals under no-load condition and voltage under full load. This value depends on the load power factor and is usually reported at 1.0 PF and 0.8 PF.
- **Motor Starting Calculations** – The starting current of a motor can be as high as six or seven times the full-load running current. This initial high current can cause excessive voltage drop because of transformer regulation. Reduced voltage can cause the motor to fail to start and remain in a stalled condition, or it can cause the starter coil to release or “chatter”. A typical goal is to allow 10-12% maximum voltage drop at start. The voltage decrease during motor starting can be estimated as follows::

$$\text{VOLTAGE DROP (\%)} = \frac{\text{MOTOR LOCKED ROTOR CURRENT}}{\text{TRANSFORMER SECONDARY FULL LOAD RATING}} \times \text{IMPEDANCE (\%)}$$

EXAMPLE: TRANSFORMER HAS 833 AMPERES FULL LOAD CURRENT AND 6.3% IMPEDANCE AND IS SUPPLYING A MOTOR WITH 2500 AMPERES LOCKED ROTOR CURRENT

$$\text{VOLTAGE DROP (\%)} = \frac{2500}{833} \times 6.3 = 18.9\%$$

- **Other High Inrush Load Applications** – Certain control voltage requirements, such as magnetic starters and contactors, require better transformer regulation than that available with standard lighting transformers. Square D offers a full line of control power transformers designed for these high inrush applications.

Transformer Loss and Cost of Operation

Energy Savings with Low Temperature Rise Transformers

The phrase “lower losses” means reduced electrical costs to keep the units energized and running, reduced heat generation,

