

ARTICLE

455

Phase Converters

Part I. General

455.1 Scope. This article covers the installation and use of phase converters.

A phase converter is an electrical device that converts single-phase electrical power to 3-phase for the operation of equipment that normally operates from a 3-phase electrical supply. Phase converters are of two types: static, with no moving parts, and rotary, with an internal rotor that must be rotating before a load is applied.

See also

Article 100 for definitions of the terms *phase converter*, *rotary* and *phase converter*, *static*

Phase converters are frequently used to supply 3-phase motor loads in locations where only single-phase power is available from the local utility. Electrical installations on farms and in other remote or rural areas are examples of such locations. Although their most common loads are motors, phase converters are increasingly used to supply loads such as cellular telephone and other communication transmitter sites.

455.3 Other Articles. Phase converters shall comply with this article and with the applicable provisions of other articles of this *Code*.

455.4 Marking. Each phase converter shall be provided with a permanent nameplate indicating the following:

- (1) Manufacturer's name
- (2) Rated input and output voltages
- (3) Frequency
- (4) Rated single-phase input full-load amperes
- (5) Rated minimum and maximum single load in kilovolt-amperes (kVA) or horsepower
- (6) Maximum total load in kilovolt-amperes (kVA) or horsepower
- (7) For a rotary-phase converter, 3-phase amperes at full load

455.5 Equipment Grounding Connection. A means for attachment of an equipment grounding conductor termination in accordance with 250.8 shall be provided.

455.6 Conductors.

(A) Ampacity. The ampacity of the single-phase supply conductors shall be determined by 455.6(A)(1) or (A)(2).

Informational Note: Single-phase conductors sized to prevent a voltage drop not exceeding 3 percent from the source of supply

to the phase converter may help ensure proper starting and operation of motor loads.

(1) Variable Loads. Where the loads to be supplied are variable, the conductor ampacity shall not be less than 125 percent of the phase converter nameplate single-phase input full-load amperes.

(2) Fixed Loads. Where the phase converter supplies specific fixed loads, and the conductor ampacity is less than 125 percent of the phase converter nameplate single-phase input full-load amperes, the conductors shall have an ampacity not less than 250 percent of the sum of the full-load, 3-phase current rating of the motors and other loads served where the input and output voltages of the phase converter are identical. Where the input and output voltages of the phase converter are different, the current as determined by this section shall be multiplied by the ratio of output to input voltage.

Calculation Example

Determine the minimum ampacity for the single-phase input conductors supplying a phase converter used to supply 3-phase receptacles for electric welders. The number of welders connected at any one time is variable. The phase converter has a 230 V, single-phase input and a 230 V, 3-phase output. The phase converter input current is 105 A.

Solution

Because the loads are variable, 455.6(A)(1) applies.

$$1.25 \times 105 \text{ A} = 131.25 \text{ A}$$

If the same phase converter is used to supply only two 3-phase, 5 hp, 230 V motors, what is the minimum ampacity of the single-phase input conductors?

Solution

Because the loads are fixed, 455.6(A)(1) applies. According to Table 430.250, the full-load current (FLC) for a 10 hp, 230 V, 3-phase motor is 15.2 A. Thus,

$$2.5 \times (15.2 + 15.2) = 76 \text{ A}$$

(B) Manufactured Phase Marking. The manufactured phase conductors shall be identified in all accessible locations with a distinctive marking. The marking shall be consistent throughout the system and premises.

The *phase, manufactured (manufactured phase)* as defined in Article 100 is the phase that is created within the rotary or static equipment and is not solidly connected to the input conductors. Identification of the manufactured phase is necessary to help installers comply with 455.9, which does not permit single-phase loads to be supplied from the manufactured phase. The method of identification is not specified by the NEC®; therefore, it could be by any means acceptable to the AHJ. While many phase converters are installed to supply a specific item of equipment such

as a motor or heating equipment, the use of a 3-phase distribution equipment such as a panelboard supplied from the output of a phase converter is also acceptable and may be desirable as a central point from which to run branch circuits to equipment. Identification of the manufactured phase conductor at a central distribution point such as a panelboard provides the installer with visible indication of the phase conductor that cannot be used to supply any single-phase loads that have branch circuits originating from that equipment.

455.7 Overcurrent Protection. The single-phase supply conductors and phase converter shall be protected from overcurrent by 455.7(A) or (B). Where the required fuse or nonadjustable circuit breaker rating or settings of adjustable circuit breakers do not correspond to a standard rating or setting, a higher rating or setting that does not exceed the next higher standard rating shall be permitted.

(A) Variable Loads. Where the loads to be supplied are variable, overcurrent protection shall be set at not more than 125 percent of the phase converter nameplate single-phase input full-load amperes.

(B) Fixed Loads. Where the phase converter supplies specific fixed loads and the conductors are sized in accordance with 455.6(A)(2), the conductors shall be protected in accordance with their ampacity. The overcurrent protection determined from this section shall not exceed 125 percent of the phase converter nameplate single-phase input amperes.

455.8 Disconnecting Means. Means shall be provided to disconnect simultaneously all ungrounded single-phase supply conductors to the phase converter.

(A) Location. The disconnecting means shall be readily accessible and located in sight from the phase converter.

(B) Type. The disconnecting means shall be a switch rated in horsepower, a circuit breaker, or a molded-case switch. Where only nonmotor loads are served, an ampere-rated switch shall be permitted.

(C) Rating. The ampere rating of the disconnecting means shall not be less than 115 percent of the rated maximum single-phase input full-load amperes or, for specific fixed loads, shall be permitted to be selected from 455.8(C)(1) or (C)(2).

(1) Current Rated Disconnect. The disconnecting means shall be a circuit breaker or molded-case switch with an ampere rating not less than 250 percent of the sum of the following:

- (1) Full-load, 3-phase current ratings of the motors
- (2) Other loads served

(2) Horsepower Rated Disconnect. The disconnecting means shall be a switch with a horsepower rating. The equivalent locked rotor current of the horsepower rating of the switch shall not be less than 200 percent of the sum of the following:

- (1) Nonmotor loads
- (2) The 3-phase, locked-rotor current of the largest motor as determined from Table 430.251(B)
- (3) The full-load current of all other 3-phase motors operating at the same time

(D) Voltage Ratios. The calculations in 455.8(C) shall apply directly where the input and output voltages of the phase converter are identical. Where the input and output voltages of the phase converter are different, the current shall be multiplied by the ratio of the output to input voltage.

455.9 Connection of Single-Phase Loads. Where single-phase loads are connected on the load side of a phase converter, they shall not be connected to the manufactured phase.

455.10 Terminal Housings. A terminal housing in accordance with the provisions of 430.12 shall be provided on a phase converter.

Part II. Specific Provisions Applicable to Different Types of Phase Converters

455.20 Disconnecting Means. The single-phase disconnecting means for the input of a static phase converter shall be permitted to serve as the disconnecting means for the phase converter and a single load if the load is within sight of the disconnecting means.

455.21 Start-Up. Power to the utilization equipment shall not be supplied until the rotary-phase converter has been started.

455.22 Power Interruption. Utilization equipment supplied by a rotary-phase converter shall be controlled in such a manner that power to the equipment will be disconnected in the event of a power interruption.

Informational Note: Magnetic motor starters, magnetic contactors, and similar devices, with manual or time delay restarting for the load, provide restarting after power interruption.

455.23 Capacitors. Capacitors that are not an integral part of the rotary-phase conversion system but are installed for a motor load shall be connected to the line side of that motor overload protective device.

ARTICLE 460

Capacitors

N Part I. General

▲ 460.1 Scope. This article covers the installation of capacitors on electrical circuits.