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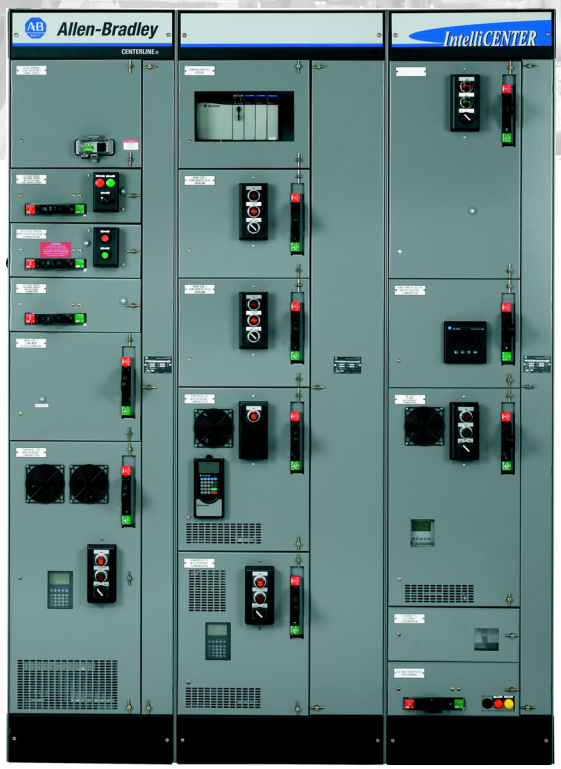
POWER SYSTEM CONSIDERATIONS FOR PRODUCT SELECTION

Application Techniques



CENTERLINE® 2100
Motor Control Centers

ALLEN-BRADLEY • ROCKWELL SOFTWARE

Rockwell Automation

Power System Considerations for Product Selection

Power System Considerations for Product Selection

Introduction

Proper selection of CENTERLINE 2100 Motor Control Centers (MCCs), units and options needs to account for the characteristics of the different power system configurations which may be used to feed power to the MCC. There may be national and local electrical codes, standards and other criteria which affect the selection of MCCs, units and options. Only those MCC features, units, and options which may be impacted by the power system configuration will be discussed. Many other selection decisions need to be made for MCCs and units which are not dependent on the type of power system used. For more information about selection criteria and available MCC options, units, and unit options, consult the CENTERLINE 2100 Motor Control Center Catalog, publication *2100-CA001x-EN-P*.

CENTERLINE 2100 MCCs have been designed and tested for use on 3-phase, 3-wire or 4-wire Wye connected power systems, rated 600 V or less, 50 or 60 Hz, which have a solidly grounded neutral.

CENTERLINE 2100 MCCs are also suitable for use on the following power system configurations (some units and options may not be available):

- 3-phase, 3-wire Wye systems rated 600Y/347 V or less, with resistance grounded neutral
- 3-phase, 3-wire, ungrounded closed-Delta systems, rated 600 V or less

Other power systems not listed above, such as:

- 3-phase, 3-wire, corner-grounded, closed-Delta systems
- 3-phase, 4-wire, center-tap-grounded, "high-leg," closed-Delta systems rated 240 V

can be provided in the custom-engineered delivery program. Please contact your local Allen-Bradley distributor or Rockwell Automation Sales office for application assistance.

Required Power System Information

There are many important questions which need to be answered in order to describe the power system which is feeding the MCC.

How is the power system configured?

Either Wye or Delta power systems can be used, subject to other considerations.

What is the nominal line-to-line system voltage and frequency?

Supported voltages are 208, 240, 480 and 600 V at 60 Hz and 380, 400 and 415 V at 50 Hz.

What is the maximum available short circuit fault current?

Available bus short circuit withstand ratings are 42, 65 and 100 kA.

Unit short circuit withstand and short circuit interrupting ratings range from 5 kA to 100 kA and are dependent on the disconnecting means and protective devices that are selected.

What is the maximum available line-to-ground fault current?

This will impact the selection of circuit breakers in a corner-grounded Delta power system.

Is the power system 3 phase, 3-wire or 4-wire?

If only the three phase conductors are being brought to the MCC, the power system is a 3-wire system. If a solidly grounded neutral conductor is also being brought to the MCC, the power system is a 4-wire system.

An equipment grounding conductor (ground wire) must be brought to all MCCs and is not included in the "wire" count when describing the power system.

If the power system is 4-wire, then:

What is the size and quantity of neutral cables?

Are any line-to-neutral loads served?

What is the total amount of line-to-neutral load?

How large is the single largest line-to-neutral load?

Is neutral power bus required in the MCC?

Neutral bus is available in the MCC and various options are available to connect neutral load cables. If any single line-to-neutral load is larger than 280 A, special engineering considerations need to be made.

Will this MCC need to contain a Service Entrance Disconnect?

Main Circuit Breaker and Main Fusible Switch units are available and are suitable for use as Service Entrance disconnects.

What is the required ampacity rating for the MCC?

Available bus ampacity ratings range from 600 A to 3000 A.

Power System Configurations

In order to properly select MCCs units and options, it is important to be aware of the different types of power system configurations which may be used to feed power to MCCs.

It is not enough to only know that "three phase power" is being brought to the MCC. Additional information needs to be obtained to determine the configuration of the power system.

Is the connection Wye or Delta? Is the system grounded? If grounded, how is it grounded? Is a grounded conductor (neutral) being used?

As you will see below, the presence of an equipment grounding conductor does not ensure that the power system is grounded. The following examples illustrate typical Wye and Delta power system configurations.

Wye Systems

Wye connected power systems are characterized by having a common neutral point. This neutral point is typically either solidly grounded or grounded through a resistance. In some installations, it is possible that the neutral point is not grounded. The neutral must be solidly grounded for a Wye power system which has line-to-neutral loads.

Figure 1: Wye, 3-phase, 4-wire with solidly grounded neutral.

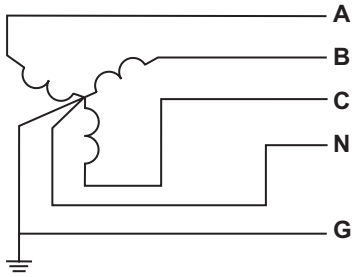


Figure 1 shows the most common power system configuration. In addition to serving line-to-line loads, this system also can serve line-to-neutral loads.

Figure 2: Wye, 3-phase, 3-wire with impedance grounded neutral.

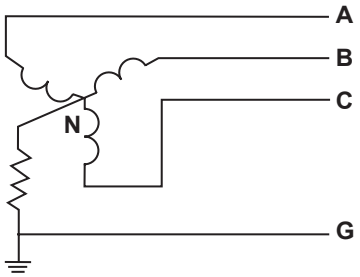
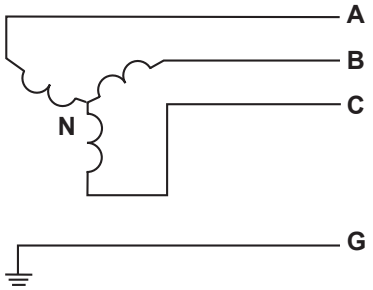


Figure 2 shows a power system that is gaining popularity, especially when continuity of power is critical. Impedance is installed between the neutral point of the Wye and ground. The value is selected to limit ground fault current to a low value, typically 10 A or less.

After the occurrence of the first line-to-ground fault, a low level of ground fault current will flow. Since this current is typically lower than the trip threshold of overcurrent protective devices, they will not open. This provides continuity of power until the condition which caused the ground fault can be corrected. A method of detecting ground faults is required with this type of power system.

Since the neutral is not solidly grounded, line-to-neutral loads cannot be served with this system.

Figure 3: Wye, 3-phase, 3-wire with ungrounded neutral.



The ungrounded power system shown in Figure 3 is typically found in older industrial power systems. This system allows continuity of power after the occurrence of the first line-to-ground fault. The first line-to-ground fault simply causes the system to become grounded. Since there is no path for ground fault current to flow, overcurrent protective devices will remain closed.

A means to detect the occurrence of a ground fault is required.

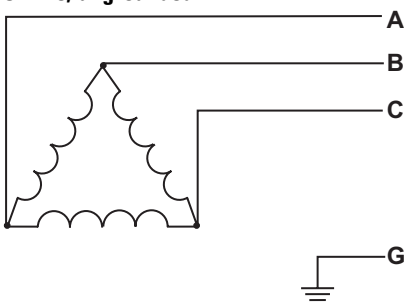
In an ungrounded system, line-to-ground voltages could exceed line-to-line voltage due to transients and other abnormal conditions.

Since the neutral is not solidly grounded, line-to-neutral loads cannot be served with this system.

Delta Systems

The examples which follow show typical closed Delta power system configurations. Delta connected power systems are sometimes supplied as "open delta" — two single-phase transformers are connected together to form two sides of the delta. This system provides three-phase power, typically with a lower installed equipment cost than providing three single-phase transformers, or a single, three-phase transformer. MCC units and options for open Delta power systems can be selected as if the system were a closed Delta power system.

Figure 4: Delta, 3-phase, 3-wire, ungrounded.



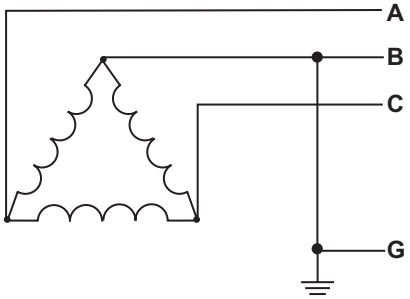
The ungrounded Delta power system shown in Figure 4 is the most common Delta configuration used in industrial power systems. Like the ungrounded Wye system, this system allows continuity of power after the occurrence of the first line-to-ground fault. The first line-to-ground fault simply causes the system to become grounded. Since there is no path for ground fault current to flow, overcurrent protective devices will remain closed.

A means to detect the occurrence of a ground fault is required.

In an ungrounded system, line-to-ground voltages could exceed line-to-line voltage due to transients and other abnormal conditions.

Since there is no neutral point, line-to-neutral loads cannot be served with this system.

Figure 5: Delta, 3-phase, 3-wire, corner-grounded.

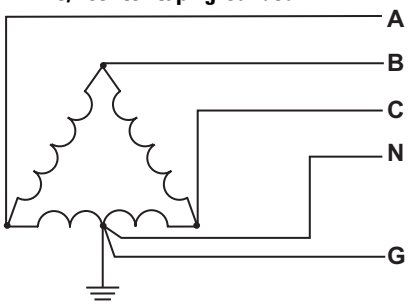


The corner-grounded Delta power system shown in Figure 5 is typically found in older industrial power systems. By grounding one phase, line-to-ground voltages are stabilized at the nominal line-to-line voltage.

Circuit breakers typically cannot be used in this type of system due to their low single-pole, line-to-ground fault ratings.

Since there is no neutral point, line-to-neutral loads cannot be served with this system.

Figure 6: Delta, 3 phase, 4-wire, "center-tap" grounded.



The 4-wire Delta power system shown in Figure 6 is typically used in 240 V line-to-line systems in which 120 V loads need to be served.

The phase-to-ground voltage for the phases on each end of the tap is 120 V. Line-to-neutral loads can be served from these phases.

It is important to note that the phase-to-ground voltage of the phase opposite the center tap can be as high as 208 V. Since this is a higher voltage-to-ground than for the other two phases, the phase opposite the tap is referred to as the "high leg." Whenever the grounded conductor is present with the high-leg conductor, the high-leg conductor must be marked or identified by effective means to indicate that it is the high leg.

Disconnecting Means Selection

There are two types of disconnecting means available for MCC units, circuit breakers and fusible switches. The choice will be dependent on the power system configuration, whether or not the system is grounded, and of course, user preference.

Typically, circuit breakers or fusible switches with integral ground-fault protection can only be used on Wye connected systems with solidly grounded neutral. An exception is that for a Wye power system with impedance grounded neutral, special ground fault protection breakers can be used provided that the protection level is compatible with the maximum expected ground fault current.

Circuit Breakers

Circuit breakers can be used as disconnecting means when the power system is Wye or Delta. However, this does not mean that all circuit breakers can be used with all variations of these power systems. Careful analysis of the circuit breaker's voltage rating and interrupting rating must be made to ensure that the circuit breaker selected is suitable for the power system.

Circuit breaker interrupting ratings are typically given for specific voltage ratings, which are given as either a "slash" voltage rating or a "straight" voltage rating. It is quite likely that a particular circuit breaker will have interrupting ratings for slash voltage ratings and straight voltage ratings.

Circuit breakers which have only slash voltage ratings (for example 480Y/277 V) are only allowed to be used on Wye connected power systems with a solidly grounded neutral where the line-to-ground voltage doesn't exceed the lower of the two values and the line-to-line voltage doesn't exceed the higher of the two values. For slash voltage interrupting ratings, a line-to-ground fault would be interrupted by a single pole of the circuit breaker, with the lower of the two voltages present across the single pole; a line-to-line fault would be interrupted by two or more poles, with the larger of the two voltage ratings present across these multiple poles.

Since the line-to-ground voltage on 3-phase power systems, other than solidly grounded Wye, could exceed the line-to-ground voltage rating of a slash rated breaker, slash rated breakers are only allowed to be used on solidly grounded Wye systems. For other power systems, circuit breakers with appropriate straight ratings should be used.

Circuit breakers with straight voltage ratings (for example, 480 V) are tested to interrupt faults with a single pole, or with multiple poles when the rated voltage is present. However, unless the circuit breaker manufacturer has conducted additional single-pole interrupting tests, the single-pole interrupting rating may not be the same as the interrupting rating for line-to-line faults. The UL standard for molded case circuit breakers (which are the most common type of circuit breaker used in motor control centers) is UL 489. This standard only requires single pole interrupting tests with relatively low values. For example, a 480 V straight rated circuit breaker is only required to be tested for a single-pole interrupting capacity of 8,660 A. This value is typically much lower than the actual short circuit current that would flow during a line-to-ground fault.

The table below shows examples of interrupting and voltage ratings for circuit breakers typically used in lighting panels (LP), panelboards (PB) and MCC units:

Table 1 Interrupting and Voltage Rating Examples

CB Type	Poles	120 V	120/240 V	240 V	277 V	480Y/277	480 V	600 V
LP	1	–	10 kA	–	–		–	–
LP	2, 3	–	10 kA	–	–		–	–
PB	1	65 kA	–	–	14 kA		–	–
PB	2, 3	–	–	65 kA	–	14 kA	–	–
MCC	1	–	–	–	65 kA		–	–
MCC	2, 3	–	–	100 kA	–		65 kA	25 kA

An example of a typical "slash" voltage rating is 120/240 V, as for the "LP" circuit breaker shown in Table 1. Since this circuit breaker only has slash ratings, it can only be used on a power system where the line-to-ground voltage is 120 V or less, and where the line-to-line voltage is 240 V or less. Therefore, this circuit breaker could be used on 208Y/120 V solidly grounded, Wye power systems. These "LP" circuit breakers could not be used on 240 V Delta power systems. On those systems, the line-to-ground voltage would be 240 V, which is clearly larger than the maximum line-to-ground voltage rating of 120 V. For a 240 V Delta power system, the "PB" circuit breaker could be used, since it has interrupting ratings for the "straight" voltage of 240 V.

Table 1 indicates that, in addition to interrupting ratings for the "straight" voltage of 240 V, the "PB" circuit breaker has a "slash" voltage rating of 480Y/277 V. This means that the "PB" circuit breaker would be suitable for use on a 480Y/277 V, solidly grounded Wye power system. A single pole can interrupt a 65 kA fault at 277 V, and a two- or three-phase 65 kA fault at 480 V. The "PB" circuit breaker could not be used on a 480 V Delta system, because of the possibility that the line-to-ground voltage during a single line-to-ground fault voltage could be as high as 480 V, which exceeds the lower voltage rating of 277 V.

Based on the data in Table 1, if the power system is a 480 V delta, the "MCC" circuit breaker would have to be used.

A circuit breaker may be selected which has a straight voltage interrupting rating that matches the line-to-line voltage of the power system. For example, the "MCC" circuit breaker, at 480 V, has a 2- or 3-pole interrupting capacity of 65 kA. It also has a straight voltage rating for 1-pole of 65 kA that is at 277 V. These ratings do not automatically make it suitable for use with all 480 V power systems. Circuit breakers used on systems that are not solidly ground Wye must address the single pole interrupting rating of the circuit breaker. As previously discussed, the UL 489 interrupting requirement for a single pole, at full voltage, can be much lower than the 2 or 3-pole rating of the circuit breaker. Using the example of the "MCC" circuit breaker, it may be rated to interrupt a line-to-line fault of 65 kA, but may have only been tested to interrupt a single pole fault of 8,660 A. Table 1 indicates that a single pole can interrupt 65 kA at 277 V, but does not indicate any rating for 1 pole at 480 V. In a corner-grounded Delta power system, when a line-to-ground fault occurs with one of the ungrounded conductors, a single pole of the circuit breaker must interrupt the fault, with full line voltage across the single pole. This line-to-ground fault level can approach the 3-phase fault level. A circuit breaker for use on a corner-grounded Delta power system must have a single-pole interrupting rating, at the line-to-line voltage, which meets or exceeds the maximum available line-to-ground short circuit fault current.

On impedance-grounded Wye power systems, the line-to-ground fault current is limited to a low level, typically 10 A or less. It would seem that there is no need to be concerned with the single-pole interrupting capacity of the circuit breaker. However, if the line-to-ground fault is not removed and a second line-to-ground fault occurs, on a different phase, and, is on the line side of the

circuit breaker, a single pole of the circuit breaker may have to interrupt the fault with full voltage across it. On resistance grounded power systems, ground detection systems are used to alert the user to the presence of a ground fault so that it can be removed in a timely manner. If a second line-to-ground fault occurs, it would have to occur on a different phase to cause the full voltage situation. Even then, it is quite likely that there will be another pole of another circuit breaker interrupting the fault. In addition, the impedance in the two ground faults is likely to reduce the line-to-ground fault current to levels within the single-pole interrupting capability of the circuit breaker(s) involved. The double fault-to-ground situation could also occur on ungrounded Delta or Wye power systems.

Due to the low likelihood of a low impedance, high fault current, double fault-to-ground occurring; molded case circuit breaker manufacturers have advised that listed, 2- and 3-pole, molded case circuit breakers, can be used on ungrounded and impedance-grounded power systems without the need for higher individual pole interrupting ratings.

If it is likely that line-to-ground faults could be allowed to remain for extended periods of time before being removed, or if there is concern regarding the single-pole interrupting performance in the double fault-to-ground situation, then circuit breakers should be selected which have a single-pole interrupting rating, at the line-to-line voltage, which meets or exceeds the maximum available line-to-ground short circuit fault current.

Fusible Switches

Since the fuses which are used in fusible switches are listed to interrupt their listed currents at their voltage rating (typically 250 V or 600 V), it is acceptable to use fuses on all types of power system configurations, provided the correct voltage class is used.

When fusible switches are used on corner-grounded Delta power systems, fuses are not allowed in the phase with the grounded phase conductor. This can be accomplished by either using “dummy” fuses in the phase with the grounded phase conductor, or by designing the unit so that fuse clips are not present in the phase with the grounded conductor. There is an exception to this rule that requires fuses to be used in the phase with the grounded conductor when the fuses are sized and used for motor overload protection. However, in motor control centers, fuses are used for short circuit and ground fault protection and a dedicated motor overload relay is used for motor overload protection.

Unit Selection

Proper selection of MCC units needs to account for the characteristics of the power system which will be used to feed power to the MCC. The need to select units based on such characteristics as system voltage and short circuit withstand or interrupting capacity are obvious. However, other characteristics

play an important part in the selection for certain units. These requirements will be discussed in the following sections.

Incoming Unit Selection

There are three types of incoming units available for MCCs: main lug only, main circuit breaker and main fusible switch. Main circuit breakers and main fusible switches are suitable for use as Service Disconnects.

If the power system is 3-phase, 4-wire, Wye with solidly grounded neutral, and a horizontal neutral bus is required, the main incoming unit must be provided with a main incoming neutral bus. If a horizontal neutral bus is not required, then, depending on the size, the main incoming unit may be able to be provided with a neutral connection plate. Refer to the section titled "Neutral Bus and Neutral Options" for more information.

National and local electrical codes need to be consulted to determine whether or not ground fault protection is required. The U.S. National Electrical Code (N.E.C.) requires, with a few exceptions, that Wye connected Services, with solidly grounded neutral, rated 1000 A or more be provided with ground fault protection.

If the power system is an ungrounded Delta, "Ground Detection Lights" are available to indicate when a ground fault has occurred.

If the system is a corner ground Delta, the main incoming unit will need to be processed on the custom engineered delivery program so that the phase connected to the grounded conductor can be marked to indicate that it is the grounded conductor. In addition, if the main incoming unit is a circuit breaker or fusible switch, then it will need to be engineered to account for the requirements discussed in the section titled "Disconnecting Means Selection."

Metering Unit Selection

Metering units should be selected which have been designed to work with the power systems in which they will be used.

If analog metering units are described as being designed for 3-phase, 3-wire power systems, they may be used on 3-phase, 4-wire power systems. However, line-to-neutral voltage and neutral current metering will not be available. If analog metering is required to provide indication of line-to-neutral voltage and neutral current, then the unit will need to be processed on the custom engineered delivery program.

If digital metering units are used, care must be taken to ensure that the maximum line-to-ground voltage of the unit is not exceeded. If the line-to-ground voltage exceeds the limitations of the metering unit, then external voltage transformers will need to be provided and the unit will need to be processed on the custom engineered delivery program.

Surge Suppressor Unit Selection

Surge suppressor units should be selected which have been designed to work with the power systems in which they will be used.

If a surge suppressor unit is required for use with a 3-phase, 4-wire, center-tap-grounded Delta power system, the unit will need to be processed on the custom engineered delivery program.

Feeder Unit Selection

Considerations for selection of feeder units which are circuit breakers or fusible switches will have the same considerations as discussed in the "Disconnecting Means Selection" section of this paper.

Starter Unit Selection

Considerations for selection of starter units which have circuit breakers or fusible switches will have the same considerations as discussed in the "Disconnecting Means Selection" section of this paper.

If the starter is supplied with ground fault monitoring or protection (which may be a feature of the overload relay), then the detection level must be compared with the available line-to-ground fault current to determine if the ground fault monitoring or protection can be used. For example, if the monitoring level is 20 A, but the system has an impedance grounded neutral such that the ground fault current is limited to 10 A, the ground fault monitoring or protection provides little value. However, it may provide value if a double line-to-ground fault occurs which is too low to trip the overcurrent protection devices which are in the circuit.

Variable Frequency Drive Unit Selection

When variable frequency drives are used, the drive installation or user manual should be consulted to determine the existence of protection circuitry that is referenced to ground. If these circuits exist, they are typically rated for voltages present on solidly grounded Wye power systems. When drives with these protective circuits are used on ungrounded, impedance grounded, or corner grounded Delta power systems, these circuits must be removed or isolated from ground to prevent their continuous operation and shortening of life that will occur in the presence of higher than expected line-to-ground voltages.

Lighting Panel and Plug-In Panelboard Unit Selection

As discussed previously in the section titled "Circuit Breakers," it is important to know the voltage and interrupting ratings of the circuit breakers that will be used.

For example, if a lighting panel can only use circuit breakers rated 120/240 V, it cannot be fed from an MCC which is being fed from a 240 V Delta power system or a Wye power system with a resistance grounded neutral.

For another example, if a panelboard uses circuit breakers rated 480Y/277 V, it cannot be fed from an MCC which is being fed from a 480 V Delta power system or a Wye power system with a resistance grounded neutral.

If line-to-neutral loads are served from the plug-in panelboard, the user must ensure that the panel neutral is connected to the neutral of the power system which is supplying power to the MCC.

Neutral Bus and Neutral Options

MCCs which are fed from 3-phase power systems with a solidly grounded neutral can be fed with either only the three phase wires (a 3-wire system) or with the three phase wires and a solidly grounded neutral conductor (a 4-wire system).

When the solidly grounded neutral conductor is brought to the MCC as part of a 4-wire power system, appropriate accommodations need to be made to provide a connection point for the grounded conductor. In addition, if line-to-neutral loads are served from the MCC, then accommodations also need to be made for the connection of neutral conductors for these loads.

Horizontal Neutral Bus

Horizontal neutral bus can be provided in the MCC. It is available with two ratings. One rating matches the full ampacity rating of the main power bus, and the other rating is half the ampacity of the main power bus.

If horizontal neutral bus is required, and the user does not require it to run through the entire length of the MCC, it may not necessarily need to be provided in all of the MCC sections. If the only need is to terminate the neutral cables and to provide connection points for a small number of outgoing neutral loads, the horizontal neutral bus can be provided in limited numbers of sections.

For front mounted MCCs, the horizontal neutral bus can be supplied in all sections, or up to four adjacent sections (which would include the section with the main incoming unit).

For back-to-back MCCs, the horizontal neutral bus can be supplied in all sections, just the section with the main incoming unit, or two sections (one section on the front and its corresponding section on the back), or four sections (two sections on the front and their corresponding sections on the back). When only two or four sections with neutral bus are used, they must be located on one end of the MCC or the other and include the section with the main incoming unit. A factory-installed back-to-back neutral bus link will be provided to ensure continuity between neutral bus in the front and back sections.

Shipping blocks are not allowed to have some sections with horizontal neutral bus and some sections without horizontal neutral bus; except that in a back-to-back MCC where only the section with the main incoming unit has neutral bus, it is allowed to be back to back with a single section which does not contain neutral bus.

Incoming Neutral Bus

When horizontal neutral bus is provided, the main incoming unit must be supplied with an incoming neutral bus. This provides a means to connect the incoming grounded conductor(s) to the horizontal neutral bus. For full rated horizontal neutral bus, the incoming neutral bus is provided with lugs of a size and quantity to match those supplied on the main incoming unit phase conductors. For half rated horizontal neutral bus, the incoming neutral bus is provided with lugs in the quantities listed in Table 2.

Table 2 Lugs Supplied for Half-rated Incoming Neutral Bus

	Lug quantity			
Per phase quantity of incoming phase conductors	1 or 2	3 or 4	5 or 6	7 or 8
Incoming neutral bus lug quantity	1	2	3	4

The incoming neutral bus for main circuit breaker or main fusible switch units is also provided with an appropriately sized main bonding jumper, which can be used to bond the neutral to the ground bus, if needed to meet Service Entrance requirements.

Neutral Connection Plates

A neutral connection plate is a ¼" x 2" x 12" copper bar mounted on insulated supports and rated to carry a maximum current of 280 A. It is supplied with a single lug for use with an incoming or outgoing neutral cable. This lug can accommodate one #6-250 kcmil cable.

As an alternative to providing horizontal neutral bus and an incoming neutral bus, an incoming neutral connection plate can be provided for some main incoming units. Incoming neutral connection plates for main circuit breaker or main fusible switch units are provided with an appropriately sized main bonding jumper, which can be used to bond the neutral to the ground bus, if needed to meet Service Entrance requirements.

Neutral connection plates are also available in the top or bottom horizontal wireway or in a 0.5 space factor unit space. These neutral connection plates can be used to provide a neutral connection point closer to the unit which is feeding a line-to-neutral load. It is important to note that if horizontal neutral bus is not supplied, these neutral connection plates will be isolated from one another and from the incoming neutral connection plate. It is the user's responsibility to connect between the incoming neutral connection plate and any other neutral connection plates with an appropriately sized cable.

If horizontal neutral bus is provided, some way must be provided to allow connection of the neutral wires for line-to-neutral loads. Neutral connection plates in the top or bottom wireway will be cable connected (at the factory) to the horizontal neutral bus. This eliminates the need for the user to connect multiple connection plates together. Connection points for outgoing neutral cables or for line-to-neutral control connections can be provided by an optional vertical neutral bus (rated 200 A, 300 A, or 600 A) which is installed on insulated supports in a 9" wide vertical wireway and is factory connected to the horizontal neutral bus.

Main Incoming Units Rated 400 Amperes or Less

If a solidly grounded neutral conductor will be brought to the MCC and there are no line-to-neutral loads or minimal line-to-neutral loads (280 A or less), an incoming neutral connection plate can be selected for main incoming units rated 400 A or less. These main incoming units are:

- Main lug only, rated 300 A
- Main circuit breaker, 400 A or smaller frame
- Main fusible switch, 400 A or less

The incoming neutral connection plate is supplied with a single #6-250 kcmil lug. If additional lugs are needed, or if the cable size exceeds 250 kcmil, please contact your local Allen-Bradley distributor or Rockwell Automation sales office for application assistance.

NOTE: When an incoming neutral connection plate is used, the neutral wire for line-to-neutral loads will need to be terminated at the main neutral connection plate unless additional neutral connection plates are supplied. Neutral connection plates can be located in the top or bottom horizontal wireway, or in a 0.5 space factor unit space. It is important to note that these neutral connection plates will be isolated from one another and from the incoming neutral connection plate. It is the user's responsibility to connect between the incoming neutral connection plate and any other neutral connection plates with an appropriately sized cable.

If horizontal neutral bus is used, the main incoming units listed above must be supplied with an incoming neutral bus option.

Main Incoming Units Rated More Than 400 Amperes

If a solidly grounded neutral conductor will be brought to the MCC and the main incoming unit is rated more than 400 A, an incoming neutral bus option and horizontal neutral bus must be selected. However, as previously discussed in the section on “Horizontal Neutral Bus”, the horizontal neutral bus may not need to be provided in all MCC sections.

Conclusion

It is simply not enough to know that there is "three-phase power" coming to the MCC. Having only three phase conductors coming to the MCC does not give any information in regard to how the power system is configured. In addition, the presence of an equipment grounding conductor does not provide any indication as to whether the power system is grounded.

A list of questions was provided which can be used to obtain the information necessary to understand the characteristics of the power system which is feeding the MCC. A discussion was made of the most typical three-phase power systems as well as factors which affect the selection of circuit breakers and fusible switches. Specific selection criteria were discussed for units whose selection is dependent on the power system characteristics. Finally, an examination was made of neutral bus, incoming and outgoing neutral options, and the restrictions imposed on main incoming unit selections to ensure that the MCC can accommodate the incoming neutral conductors and neutral conductors for line-to-neutral loads.

It should be noted that there may be national and local electrical codes, standards and other criteria which affect the selection of MCCs, units and options. This paper has demonstrated the importance of power system characteristics in the selection of MCCs, including units and options.

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