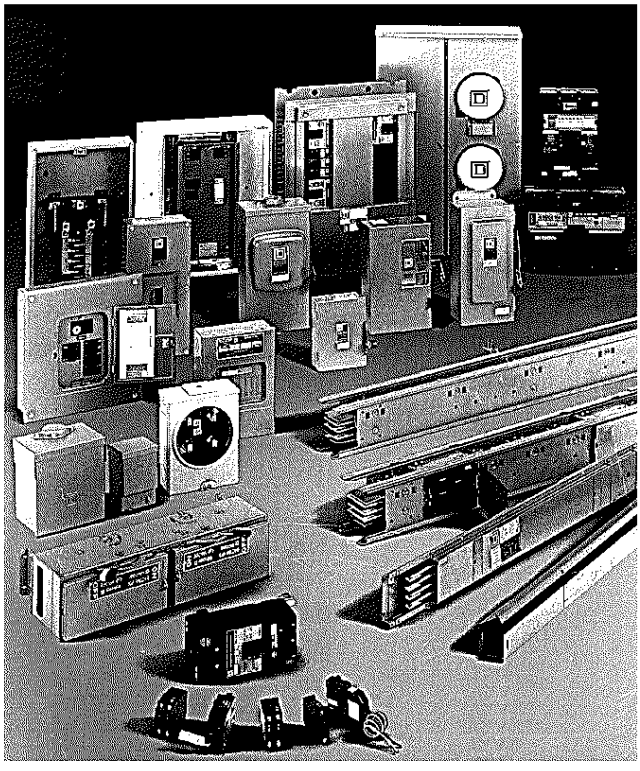
DISTRIBUTION EQUIPMENT FUNDAMENTALS

TERMS AND CONCEPTS FUNDAMENTAL
TO THE UNDERSTANDING OF SQUARE D
DISTRIBUTION EQUIPMENT
AND ITS APPLICATION



SQUARE D®

CONTENTS

0.0 INTRODUCTION

This manual has been prepared to familiarize those who use it with terms and concepts which are fundamental to an understanding of distribution equipment and its application. Since the manual is not intended to serve as an engineering text, the material covered will be general in nature. Study of the definitions, symbols, diagrams and illustrations, however, will provide a background in the language and basic principles associated with distribution equipment products.

0.1 SELECTION OF DISTRIBUTION EQUIPMENT

Distribution equipment is generally intended to carry and control electrical current, but is not intended to dissipate or utilize energy. Eight basic factors influence the selection of distribution equipment:

(1) CODES AND STANDARDS

Suitability for installation and use, in conformity with the provisions of the NEC and all local codes, must be considered. Listing or labeling implies suitability of the equipment intended for specific uses.

(2) MECHANICAL PROTECTION

Mechanical strength and durability must be considered. For parts designed to protect and enclose other equipment, the adequacy of the protection provided must also be considered.

(3) WIRING SPACE

Wire bending and connection space is provided according to UL and NEC standards in all distribution equipment. When unusual wire arrangements or connections are to be made, extra wire bending space, gutters, and terminal cabinets should be considered.

(4) ELECTRICAL INSULATION

All distribution equipment carries labels showing the maximum voltage level that should be applied. The electrical supply voltage should always be equal to, or less than, the voltage rating of distribution equipment.

(5) HEAT

Heating effects under normal conditions of use, and also under abnormal conditions likely to arise in service, must be constantly considered. Ambient heat conditions, as well as wire insulation ratings, along with the heat rise of the equipment must be evaluated during selection.

(6) ARCING EFFECTS

The normal arcing effects of overcurrent protective devices must be considered when the application is in or near combustible materials or vapors. Enclosures are selected to prevent or contain rapid combustion created by normal operation of the equipment. When the desired location of the equipment poses a potentially hazardous condition, an alternate, or more suitable area should be considered.

(7) CLASSIFICATION

Classification according to type, size, voltage, current capacity, interrupting capacity and specific use must be considered when selecting distribution equipment. Loads may be continuous or noncontinuous and the demand factor must be determined before distribution equipment can be selected.

(8) PERSONNEL PROTECTION

Other factors must be considered which contribute to the practical safeguarding of people using, or likely to come in contact with the equipment. The equipment selected for use by "qualified personnel only" may require fewer safety latches, interlocks and warnings than equipment used or applied where unqualified people may come in contact with it.

1.0 LOW VOLTAGE POWER SYSTEMS

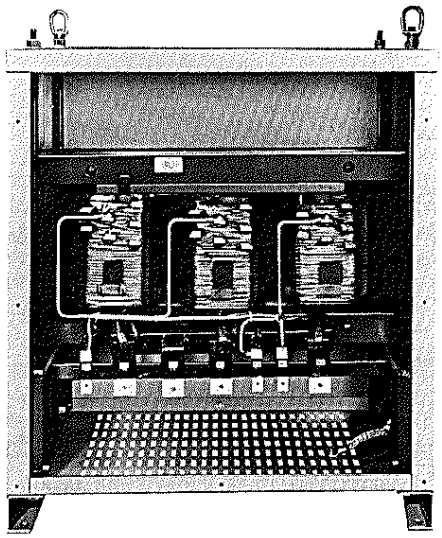
Voltage is the force that makes current flow from the generator, through the transmission lines, pass across transformers and ultimately reach the load where some kind of work is to be done. Voltage is one of the first ratings required when selecting electrical equipment. There are other ratings just as important, such as current, ambient temperature, frequency and interrupting capacity. For now, we will only study the voltage ratings as they pertain to low voltage power systems.

Voltage constantly changes in value. In some applications, it has to be regulated and made to stay at one value or at least very close to a chosen value. But with electricity as supplied to us from a utility and used in our everyday life, voltage will vary as loads are connected and disconnected from the system. Standard values of voltage have been established for the various systems. They are known as the "nominal" values of voltage. Nominal supply voltage ratings, as established by ANSI (American National Standards Institute), will be used throughout this book.

We will talk in terms of voltage as it appears at the secondary terminals of the transformer. Voltage at this point may be slightly different from that found at the load end of a wire and conduit run, but the nominal value will remain the same. Since we will be including transformers in our diagrams, maybe we should take a close look at them now.

1.1 TRANSFORMERS

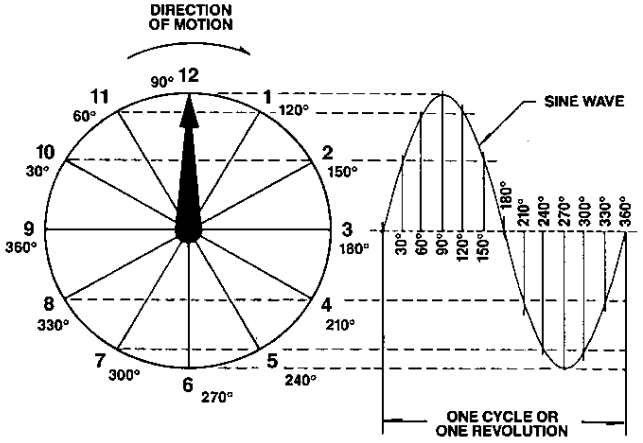
A transformer is defined as an electrical device, without moving parts that is capable of transferring electrical energy from one circuit to another. Transformers may be used to increase or decrease the voltage level on a system. They do not change the frequency of the system.



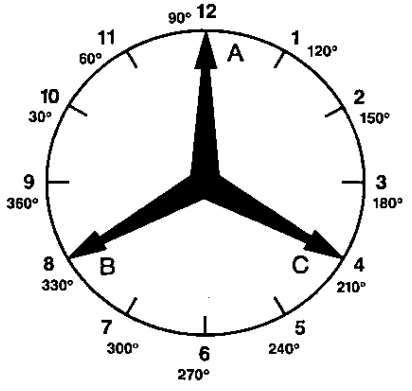
Transformers are constructed by winding two insulated coils of wire around a common steel core. One coil is connected to the electrical supply system. We call this the "primary" winding. The other is connected to the load circuit, and we call this the "secondary" winding. For simplicity, we'll only talk in terms of the secondary windings. More detailed information about transformers can be obtained from the SORGEL Dry-Type Transformer Study Course.

1.2 PHASE

Now let's try to understand "phase" as we are about to use it. A single phase system is much like a clock with only one hand. The voltage on a single phase system varies much like the clock's hand. Imagine a line drawn across the clock which passes through the three and nine o'clock positions. Each time the hand passes this line, picture the voltage as being zero. A curve, as traced by the moving hand, will pass through zero or across the line twice, with each complete revolution. This curve is similar to the varying voltage on a single phase sytem.



A three phase system may be pictured in a similar manner. In this case, the clock will have three hands mounted on a common shaft. The hands are equally spaced around the face. For example, at one instant a hand may be on



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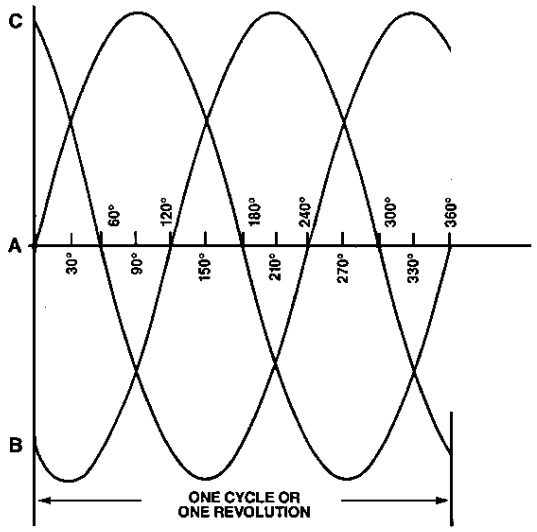
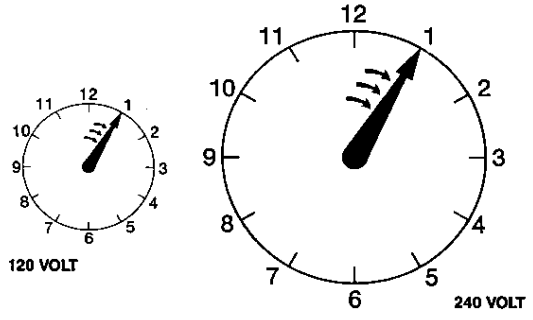
the twelve, another on the four and the third on the eight o'clock positions. Each hand will trace a separate curve and all three curves are being traced at the same time. Each hand will pass across the zero line twice during a complete revolution of the clock's face. These curves will be similar to the varying voltages on the three phase system.



"Phase," as we will use it, is the existence of the voltage curves on the systems. Single phase means there is only one voltage curve present, while three phase indicates that there are three voltage curves present on the system simultaneously.

1.3 VOLTAGE & FREQUENCY

The hands of the clock may also be imagined as depicting the value of voltage on the system. For example, a 120 volt single phase system could be represented by a two-inch hand, while a four-inch hand could represent a 240 volt single phase system. The speed of the hand traveling around the clock could represent the frequency of the system. We will be thinking in terms of 60 hertz systems normally, so the hands will be spinning around 60 times a second. At other frequencies, the hands will spin faster or slower.

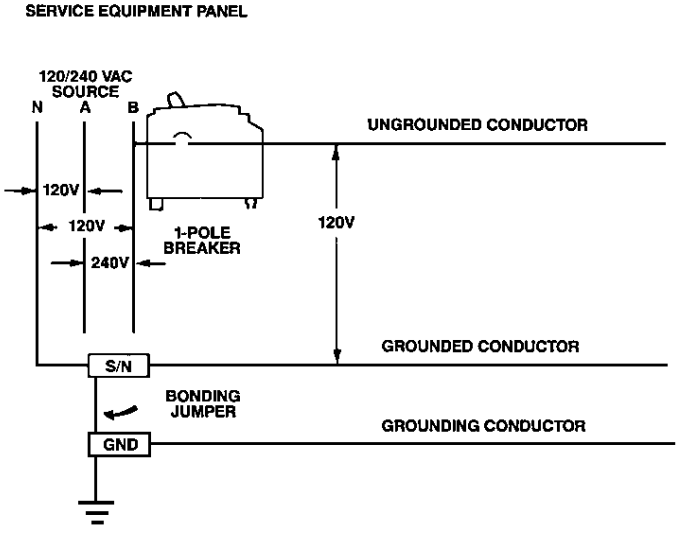


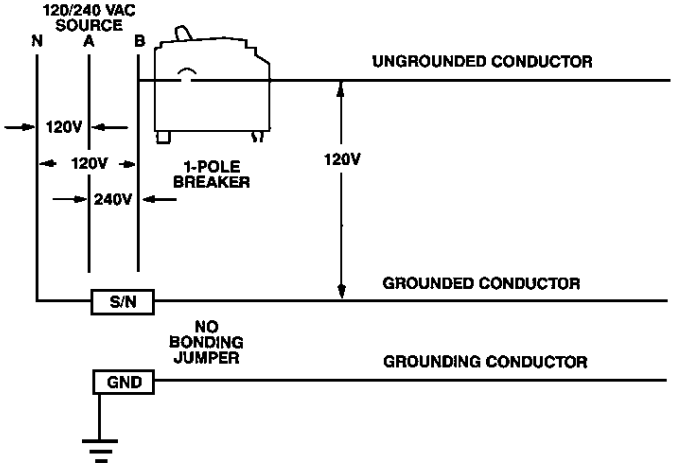
1.4 GROUNDING

One very important aspect of an electrical system is the method used for grounding. People handling and operating the equipment are normally considered to be at the same voltage level as the ground. So the grounding method, or lack of it, will determine how much insulation should be provided with the equipment and how hazardous may be the system.

Two methods for grounding are in use today. One method is external from the system and is used to protect people from electrical shocks while the other is internal to the system and is used to limit the available voltage level exposed to people. The first is called a "grounding" conductor and the latter is called a "grounded" conductor.

Grounding conductors may be green or bare wires, or could be the metal enclosures on a raceway housing the circuit conductors. In any case, grounding conductors are





used to reduce the possibility of shock by keeping all exposed metallic parts at what might be termed as zero voltage. These are not considered as current carrying conductors. Grounded or neutral conductors are part of the electrical system. They are identified by the white or natural gray colored insulation on the conductor. These wires are connected in various ways to the system in an effort to limit the generated or static voltage level on the system where it may be exposed to the operator. These are considered current carrying conductors in most systems.

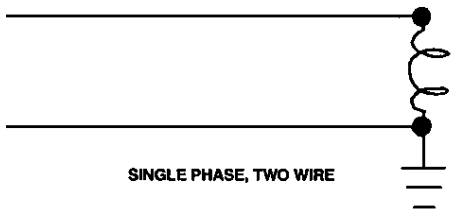
A few loads require an ungrounded system because of their particular application. The best known are possibly the systems used in hospital operating areas, but many industries also use ungrounded systems. A white (grounded) conductor will not be present in such systems. The green (grounding) conductor or even a more elaborate grounding system should always be present in every electrical system. You should get familiar with the symbol used to indicate a connection to ground and learn how to identify a grounding conductor from a grounded conductor.

1.5 SYSTEMS

Electrical power systems may be grouped into three principle types of connections. These are single phase, two and three wire; three phase, three wire; and three phase, four wire systems.

SINGLE PHASE SYSTEMS

Single phase connections normally occur as either two wire or three wire systems.

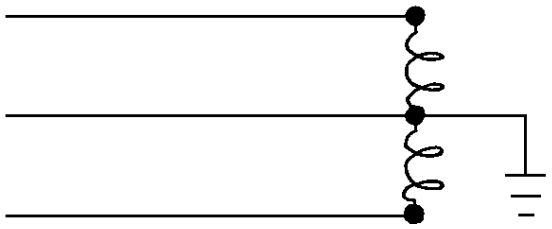


SINGLE PHASE, TWO WIRE

A single phase, two wire system will normally have one grounded conductor and one ungrounded conductor. A typical system is the 120 volt, single phase, two wire system. Note the order of describing the system. The voltage is stated first (120 volts), followed by the phase, (single phase), and the number of wires third (two wire). The system is grounded and this feature may be added to the description in some cases.

Load voltage available from this system is usually limited to 120 volt, single phase, two wire. The load voltage from this system is identical with the system rating, but with other systems we study they will differ somewhat.

A single phase, three wire system will normally have two ungrounded conductors and one grounded conductor. The grounded conductor is usually located equally



SINGLE PHASE, THREE WIRE

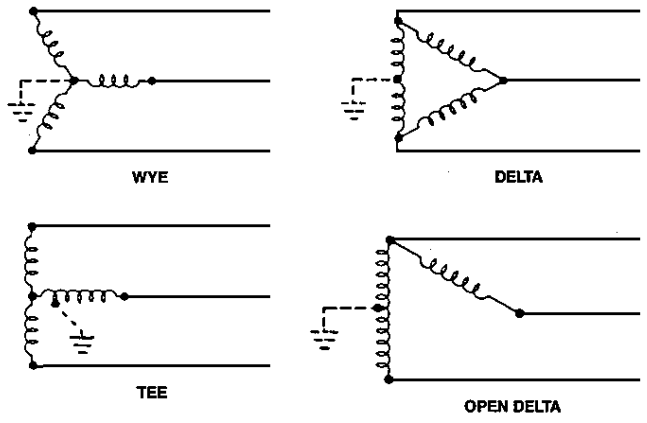
between the two ungrounded conductors. The most popular system connected in this manner is the 120/240 volt, single phase, three wire system.

Three load voltages may be obtained from this system. they are (1) 120 volt, single phase, two wire; (2) 240 volt, single phase, two wire; and (3) 120/240 volt, single phase, three wire.

In both of these single phase systems, the maximum voltage-to-ground is limited to 120 volts because of the grounded conductor location. Electrical equipment selected to be operated on these systems need to be insulated for 120 volts maximum to ground in order to protect the equipment operator from an electrical shock or to prevent current leakage to ground.

THREE PHASE, THREE WIRE SYSTEMS

The second principal group of electrical power systems are the three phase, three wire systems. Included in this group are the wye, tee, delta and open delta systems.

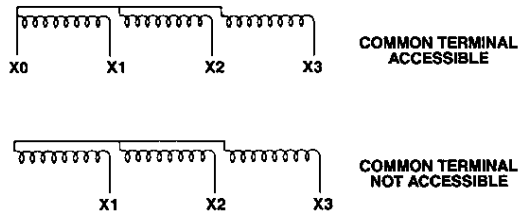


These systems may or may not be grounded but a grounded conductor is not available at the loads.

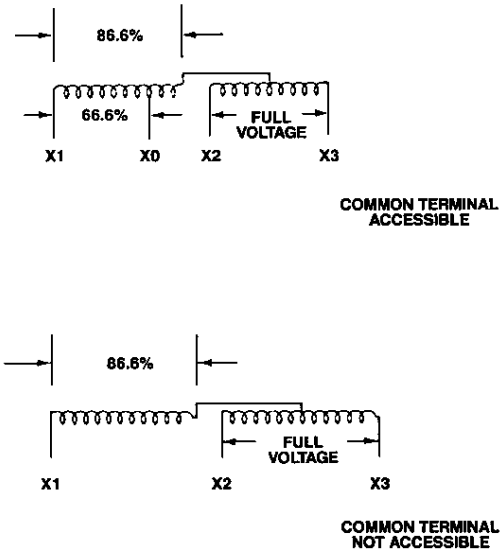
The first is a wye system. This system is obtained by connecting one terminal from three equal voltage transformer windings together making a common terminal.

This common or neutral terminal may or may not be made accessible. Its accessibility is determined during manufacturing according to the requirements of the system to which the transformer will be applied. The most popular system of this type is rated 480 volt, three phase, three wire. When the neutral is not accessible, the maximum voltage-to-ground is considered to be 480 volts. If the neutral is accessible and grounded solidly (no intentional impedance in the main grounding conductor), the maximum voltage-to-ground is reduced to a value of 277 volts. Feeder and branch circuits connected to this 480 volt, three phase, three wire system can supply loads rated:

(1) 480 volt, single phase, two wire and
(2) 480 volt, three phase, three wire.



Another three phase, three wire system is the 240 volt "tee" system. This system has 240 volts between each ungrounded conductor. Only two windings are required to construct this system. A full voltage winding with its center tap connected to a 86.6% voltage winding is used to construct the system. A neutral terminal for the system may be provided by a tap located 66.6% from the ungrounded terminal of the short winding.



The neutral terminal may or may not be accessible for grounding the system. If the neutral terminal is ungrounded, the maximum voltage-to-ground is considered to be the same as the maximum voltage between ungrounded conductors or 240 volts in this example.

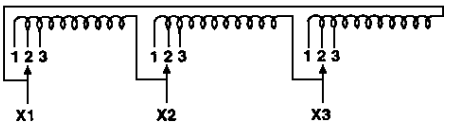
Feeder and branch circuits connected to this 240 volt, three phase, three wire system can supply loads rated:

(1) 240 volt, single phase, two wire, and
(2) 240 volt, three phase, three wire.

The "tee" or Scott connected transformers (as they are sometimes called) are available only in the smaller kVA ratings. There are few outward physical differences between a "tee" connected transformer and any other comparable three phase, three wire device. The main difference exists in the wiring diagrams. You should be aware of these diagrams and be capable of answering wiring questions presented by the customer.

When the neutral terminal is accessible and solidly grounded during the installation, the maximum voltage-to-ground will be 139 volts.

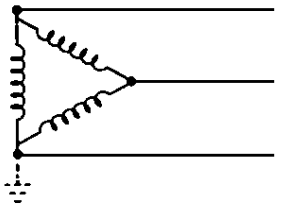
Another three phase, three wire system is the "delta" arrangement. This system is constructed by connecting three single phase transformers or three windings together end-to-end. System ratings normally available are 240, 480 and 600 volts. We will explore the 240 volt system because it is used with various connections that may not occur with the 480 and 600 volt delta systems.



"DELTA" CONNECTION (WITH SECONDARY TAPS)

Maximum voltage-to-ground for the ungrounded system is considered to be the same as the maximum voltage appearing between the ungrounded conductors. This is 240 volts in our example 240 volt, three phase, three wire system. This value will be 480 or 600 volts when the system is rated 480 or 600 volts respectively.

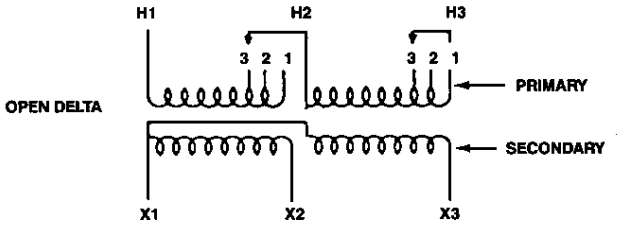
Two options exist for grounding the delta system. The first option may be to have a center tapped transformer installed in one leg of the delta system. This center tap may be connected to ground. Center tapped transformer grounding is more prevalent with three phase, four wire systems than with three phase, three wire systems, so we will wait and discuss the results of this grounding method as we talk about four wire systems. The second option is to ground one of the corner terminals of the system. This is commonly called "B" phase or corner grounding. Maximum voltage-to-ground with this type grounding will be the system voltage rating.


GROUNDED "B" PHASE OR CORNER GROUNDED DELTA SYSTEM

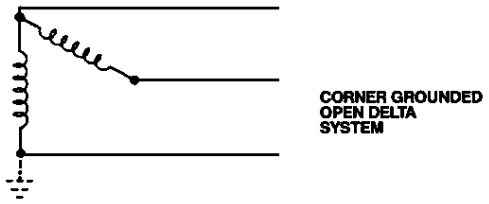
Feeder and branch circuits connected to the 240 volt, three phase, three wire, ungrounded and grounded "B" phase systems can supply loads rated:

(1) 240 volt, single phase, two wire and
(2) 240 volt, three phase, three wire.

A fourth type of three phase, three wire system is the "open" delta system. This system is a slight variation from the delta system we have discussed with three single phase transformers.



The open delta system utilizes only two transformers producing 57.7 percent of the capacity of a three transformer bank. Many utilities desire the open delta installation when they know definitely the load will be increased in the future.



Open delta systems may be installed as ungrounded or as grounded systems. Grounding methods are the same as with the delta system, that is, either the center tapped ground or the corner grounding method is used.

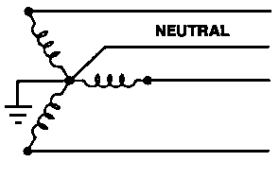
Feeder and branch circuits connected to the 240 volt, three phase, three wire, open delta system can supply:

(1) 240 volt, single phase, two wire and
(2) 240 volt, three phase, three wire.

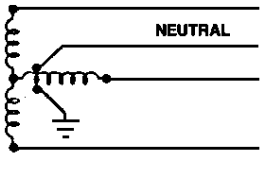
Similar load circuits may be connected to the 480 and 600 volt open delta system.

THREE PHASE, FOUR WIRE SYSTEMS

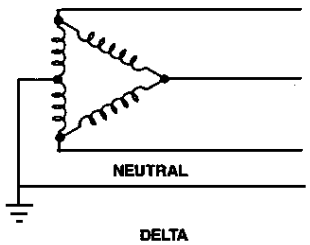
The last principal types of low voltage electrical power systems are the three phase, four wire systems. Included in this group are the wye, tee, delta and open delta systems. Each of these systems are solidly grounded, and the grounded conductor (neutral) (white wire) is available to be utilized by the load.



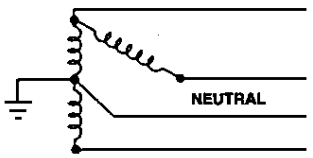
WYE



TEE

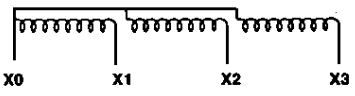


DELTA



OPEN DELTA

The first is a "wye" system. This system is obtained by connecting one terminal from three equal voltage transformer windings together at a common terminal which is grounded. The white grounded system conductor is connected to this grounded terminal. Two popular ratings are available with this system. They are the 208Y/120 volt, three phase, four wire system and the 480Y/277 volt, three phase, four wire systems.



THREE PHASE, FOUR WIRE WYE SYSTEM

Maximum voltage-to-ground is 120 volts for the 208Y/120 volt system and 277 volts for the 480Y/277 volt system.

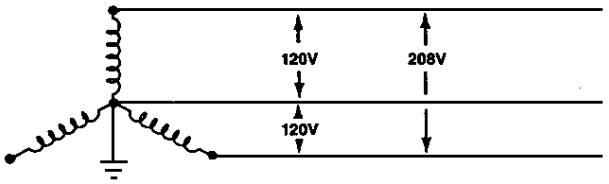
Feeder and branch circuits connected to the 208Y/120 volt, three phase, four wire systems can supply loads rated:

(1) 120 volt, single phase, two wire;
(2) 208 volt, single phase, two wire;
(3) 208 volt, three phase, three wire; and
(4) 208Y/120 volt, three phase, four wire.

Feeder and branch circuits connected to the 480Y/277 volt, three phase, four wire systems can supply loads rated:

(1) 277 volt, single phase, two wire;
(2) 480 volt, single phase, two wire;
(3) 480 volt, three phase, three wire; and
(4) 480Y/277 volt, three phase, four wire.

The 208Y/120 volt, three phase, four wire system yields a unique supply for loads rated 208Y/120 volt requiring only three wires.



208Y/120 VOLT THREE WIRE

These loads usually include such items as cooking units, washers and dryers used in high-rise apartments.

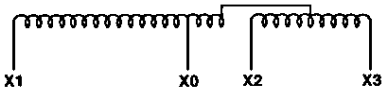
The second three phase, four wire power system is the "tee" connected type. This system is normally available only rated 208Y/120 volt, in the four wire configuration, and only in the smaller power ratings such as 15 kVA and down.

LOW VOLTAGE POWER SYSTEMS

Feeder and branch circuits connected to the 208Y/120 volt, three phase, four wire "tee" system can supply loads rated:

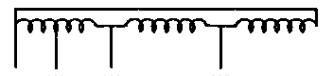
(1) 120 volt, single phase, two wire;
(2) 208 volt, single phase, two wire;
(3) 208 volt, three phase, three wire; and
(4) 208Y/120 volt, three phase, four wire.

Appliance loads for apartment houses rated 208Y/120 volt, three wire may also be supplied from the four wire "tee" system.



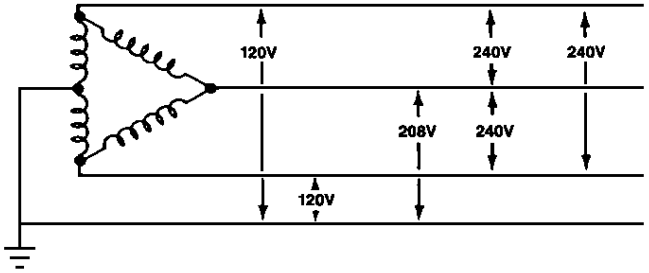
THREE PHASE, FOUR WIRE TEE SYSTEM

The third three phase, four wire power system is the "delta". This system includes one transformer which is center tapped. The center tap terminal is used to ground the system. There are 120 volts between the center tap terminal and each ungrounded terminal on either side.



THREE PHASE, FOUR WIRE DELTA SYSTEM

There are 240 volts across the full winding of each transformer in the system. These are the only usable voltage ratings available from the system for powering electrical equipment. 208 volts exist between the center tap and the remaining terminal. The available voltage level existing between the center tap terminal and the high voltage terminal of 208 volts should not be ignored. Although 208 volts is a usable rating available from the 208Y/120 volt, three phase, four wire system we discussed earlier, it is never used in this system to power equipment. But, this unusual voltage level must be taken into consideration whenever equipment is being selected for application on this system. The equipment connected between the high voltage terminal and a grounded conductor must be insulated to withstand the 208 volts present or insulation breakdown may occur causing a hazardous condition to exist.

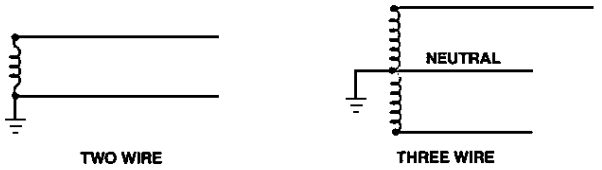


Feeder and branch circuits connected to the 240/120 volt, three phase, four wire delta system can supply loads rated:
(1) 120 volt, single phase, two wire;
(2) 240 volt, single phase, two wire;
(3) 120/240 volt, three phase, three wire;
(4) 240 volt, three phase, three wire.

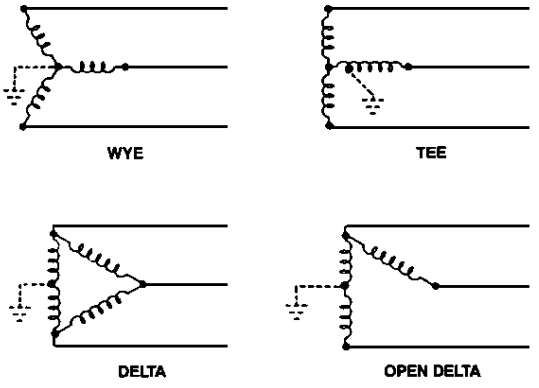
We have discussed the major low voltage power system ratings designed around the two, three and four wire configurations shown below. These are the principal or what may be called the basic systems. There are voltage ratings in use for transformers with slight variations to the system descriptions we have just discussed. If you understand the basic low voltage power systems, the variations should present no problems.

BASIC LOW VOLTAGE SYSTEMS DIAGRAMS

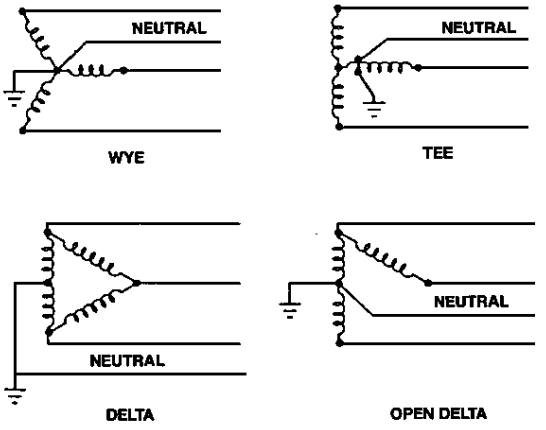
SINGLE PHASE SYSTEMS



THREE PHASE, THREE WIRE SYSTEMS



THREE PHASE, FOUR WIRE SYSTEMS



A helpful hint for remembering electrical systems is to be consistent in your method of describing the system. We suggest you state the voltage first, followed by the number of phases, and then, the number of wires. Then add special features, such as grounding methods.

Example: 240V, 3Ø3W, grounded "B" phase.

2.0 CIRCUIT BREAKERS

Circuit breakers are overcurrent protective devices that are used in an electrical circuit to provide service entrance, feeder and branch circuit protection in accordance with the National Electrical Code NFPA70. The following paragraphs deal with low voltage (600 volts and below) molded case circuit breakers as manufactured by Square D.

2.1 DEFINITION

Underwriters Laboratories, Inc. (UL), the National Electrical Manufacturers Association (NEMA) and the National Electrical Code (NEC) define a circuit breaker as "A device designed to open and close a circuit by non-automatic means, and to open the circuit automatically at a predetermined overcurrent without injury to itself when properly applied within its rating."

2.2 CIRCUIT BREAKER TYPES

CIRCUIT BREAKER IDENTIFICATION

The catalog numbering system of Square D molded case circuit breakers is relatively easy to learn because it describes the breaker according to type, poles, rating, etc. Catalog Class 600 describes the method to build a catalog number.

All industrial molded case circuit breakers have a highly durable faceplate label which contains application information required in all correspondence with the factory concerning the condition of the breaker for replacement services. Faceplate label information includes catalog number, series number, dual UL/IEC (International Electrotechnical Commission) interrupting ratings, calibration temperature, UL type designation, modifications, electrical accessories, lug data and the manufacturing date code. To view this information, removal of the breaker from the panelboard or switchboard is not necessary.

THERMAL-MAGNETIC

The most widely used overcurrent protection devices are thermal-magnetic circuit breakers. These general purpose circuit breakers are the industry standard. They use bimetals and electromagnetic assemblies to provide both thermal and magnetic overcurrent protection. Their characteristic inverse time tripping (discussed in Section 2.5) is ideally suited for many applications varying from residential loads to heavy industrial loads.

MAGNETIC ONLY

MAG-GARD instantaneous trip circuit breakers are similar in construction to thermal-magnetic breakers, except they provide short circuit protection only. They do not provide any thermal protection and are used in combination with motor starters. MAG-GARD circuit breakers are intended for motor circuits which often have high starting inrush currents.

MOLDED CASE SWITCH

Molded case switches provide no overcurrent protection and are used as disconnect switches only. Because of their molded case construction they are more compact than conventional disconnect switches and will accept electrical accessories for added flexibility.

Molded case switches are of two types: standard and automatic. Neither provide any overcurrent protection. Continuous current ratings of molded case switches are dependent upon frame size (i.e. FAL36000M is a 100A frame which therefore carries a maximum of 100 amperes).

FIGURE 2.2.1

The switches are marked with withstand ratings which specify the amount of rated short circuit current the switch can endure and continue to operate for a short period without sustaining damage, Figure 2.2.1.

STANDARD MOLDED CASE SWITCH

The standard molded case switch is a device without trip elements. It consists of the standard breaker contacts, bussing and lugs for the highest ampere rating in each breaker frame size and is manually operated only. Although these devices are primarily used in motor branch circuits, they need not be horsepower rated because normally their withstand ratings are much greater than the locked rotor currents produced on such circuits. Withstand ratings of standard molded case switches are usually 10,000 amperes.

AUTOMATIC MOLDED CASE SWITCH

This switch will operate the same as nonautomatic switches except at high fault short circuit currents where it will open and protect itself. The automatic switch is available in type FA, KA, LA, MA, NA, PA, and PC frame sizes. Withstand ratings of automatic molded case switches range from 10,000-125,000 amperes.

CURRENT LIMITING

Current limiting circuit breakers do the same job as thermal-magnetic circuit breakers but go one step further by limiting the amount of current that normally passes through a breaker during a severe fault. Square D I-LIMITER current limiting circuit breakers were the first in the industry to offer current limitation without fuses. I-LIMITER's are generally used as main circuit breakers to allow the use of lower interrupting capacity rated breakers downstream. They are discussed in detail in Section 2.5.

SOLID STATE TRIP

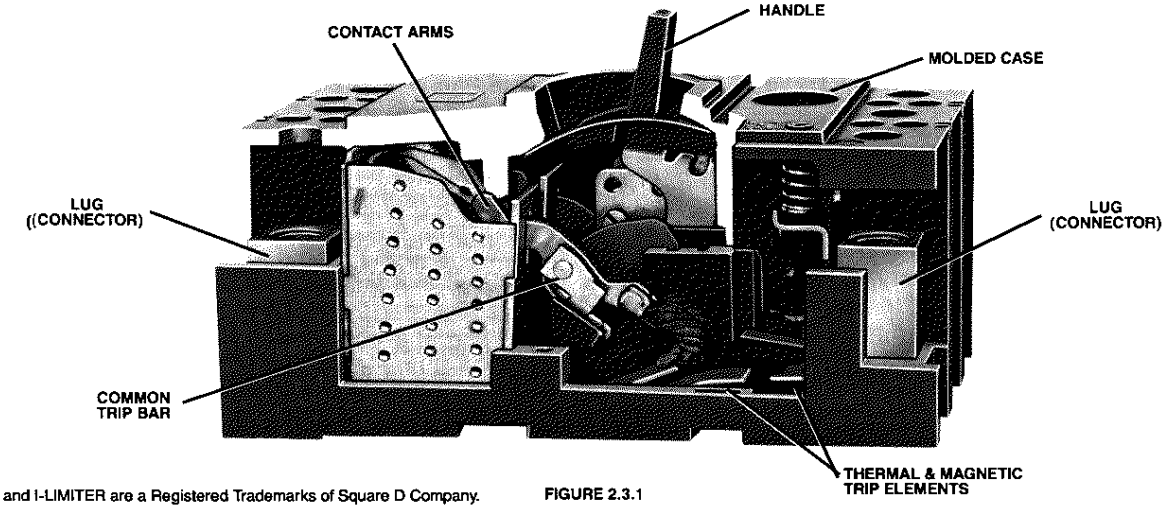
Solid state trip circuit breakers use current transformers and solid state circuitry to measure current levels and trip the circuit breaker at predetermined times. Solid state breakers are especially useful for coordination purposes because of their many trip setting adjustments. They are discussed in Section 2.5.

2.3 CONSTRUCTION

Several key components are common to all circuit breakers. These are: the molded case, trip elements, an operating mechanism and line and load connectors. These and other components found in circuit breakers are as follows:

MOLDED CASE

The function of the molded case is to provide an insulated housing to mount all of the circuit breaker components (see Figure 2.3.1). The case is molded from a phenolic material which combines high dielectric strength with ruggedness. Maximum current, voltage, and interruption capacity determine the size and strength of the molded case. In general the higher the ratings the stronger the case must be.



SQUARE D and I-LIMITER are a Registered Trademarks of Square D Company.

FIGURE 2.3.1

TRIP ELEMENTS

An overcurrent trip element is a device with which any given pole of a circuit breaker detects an overcurrent and transmits the energy necessary to trip the circuit breaker automatically. This can be done three ways: thermally, magnetically, or electronically.

THERMAL TRIP

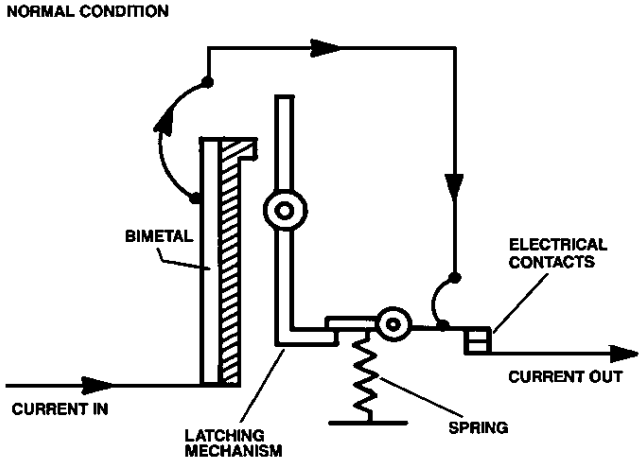
The thermal trip element consists of a bimetal constructed from metals of dissimilar properties bonded together. Due to the different rates of expansion of these metals, the heat generated by current passing through them causes the bimetal to bend. The bending force of the bimetal is then used to trip the circuit breaker. (See Figure 2.3.2).

These elements have inverse time characteristics, (i.e., the tripping time decreases as the magnitude of the current increases). For example: On light overloads at 135% rating, it might take 200 seconds to trip the breaker and at 500% rating, it might take only 2 seconds to trip.

MAGNETIC TRIP

The magnetic trip or instantaneous trip, is that part of a trip unit which contains an electromagnetic assembly to trip the circuit breaker instantaneously at or above a predetermined value of the current. All Square D thermal-magnetic and magnetic only circuit breakers and automatic molded case switches have a magnetic trip element in each pole. This element responds to a given value of overcurrent and is independent of the thermal element. (See Figure 2.3.3).

NORMAL CONDITION



THERMAL TRIP CONDITION

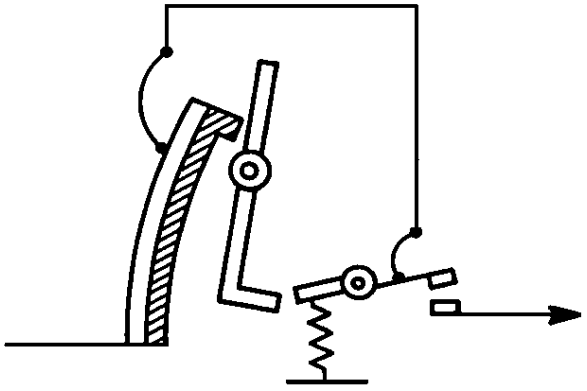


FIGURE 2.3.2

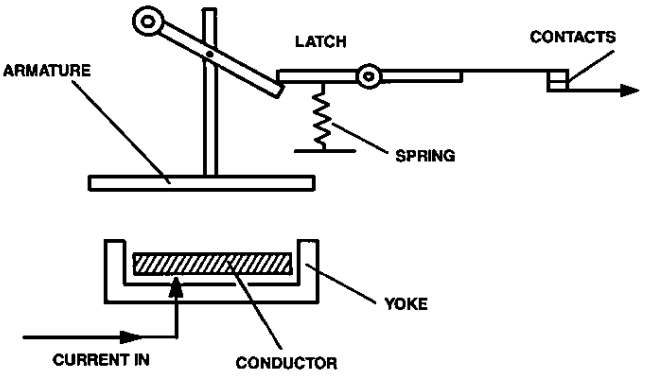


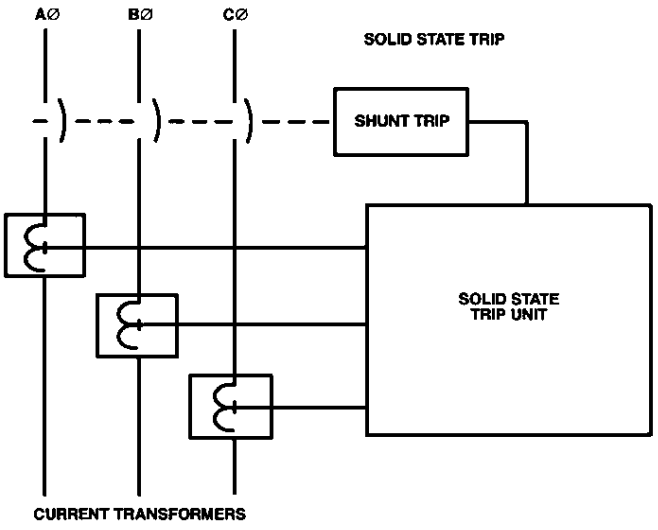
FIGURE 2.3.3

Both fixed and adjustable type magnetic trip elements are available. 100A frame breakers and below have fixed magnetic trip elements. Circuit breakers larger than 100A frame have adjustable magnetic trip elements.

A feature of Square D circuit breakers is the single control adjustment of the magnetic trip. This one adjustment will set all poles simultaneously and at the same value of tripping current. The adjustment is continuous from approximately 5-10 times the breaker's continuous current rating. The only exception is the IL current limiting circuit breaker with three individual adjustments.

SOLID STATE TRIP

Solid state trip circuit breakers offer much greater reliability and accuracy in sensing overcurrents and initiating tripping of the circuit breaker. Through the use of current transformers and solid state components, current levels are measured and timed, then compared to predeter-



mined values. When the predetermined current and time levels have been reached, the solid state trip unit sends a signal to an internal tripping solenoid which trips the circuit breaker.

The ME, NE, PE and SE family of solid state trip circuit breakers are available from 225A through 4000A frame sizes. Individual current ratings are determined by interchangeable rating plugs. Rating plug values determine the continuous current rating of the breaker.

Because of the reliable accuracy of solid state components, the circuit breaker will trip at the same point time after time. In addition, solid state trip breakers offer the versatility of adjustments which can be made to various discrete portions of the time-current characteristic tripping curve. Trip unit adjustments are available for various functions and will be discussed in Section 2.5.

OPERATING MECHANISM

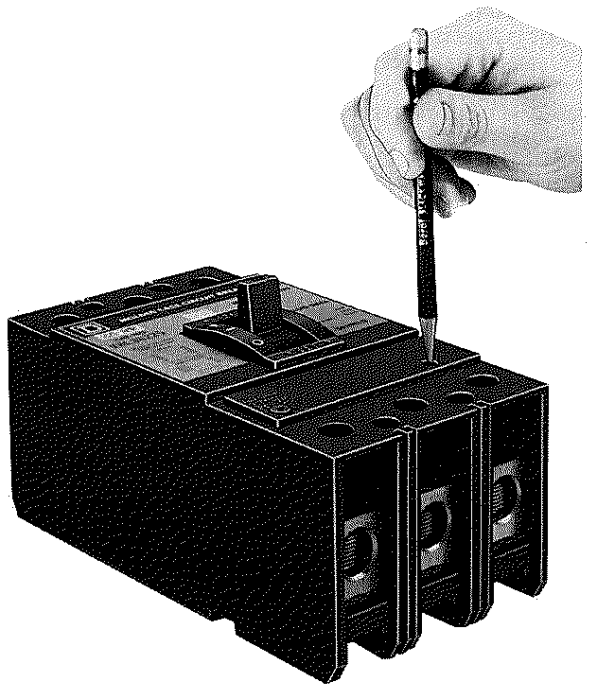
Most single and multi-pole circuit breakers have a single operating handle. This handle acts directly through the operating mechanism against the contact arms. Multiple pole circuit breakers have a common trip bar assuring positive action for all poles on manual and automatic operation.

Square D circuit breakers have a trip-free, over-center toggle mechanism which allows the circuit breaker to trip even though the handle may be locked closed by means of a padlock attachment. Without this attachment the handle will assume a central position between ON and OFF when the circuit breaker trips.

PUSH-TO-TRIP

Push-To-Trip is a standard feature of Square D industrial circuit breakers which permits the operator to manually trip the circuit breaker without exposing the operator to live parts.

During normal operations the handle will manually open and close the circuit breaker contacts but will not "exercise" the tripping mechanism. In order to do this and also exercise any associated accessories, the yellow Push-To-Trip button on the face of the breaker must be depressed. In addition, maintenance personnel use it to check the alarm circuit, emergency circuit, and motor sequencing operations, and to diagnose electrical problems. Also, once the breaker is tripped, the alignment of external handle operating mechanisms can be checked to assure resetting capabilities. The Push-To-Trip feature assures the user that the breaker mechanism is in operable condition since all its operating parts are exercised when tested in this manner.



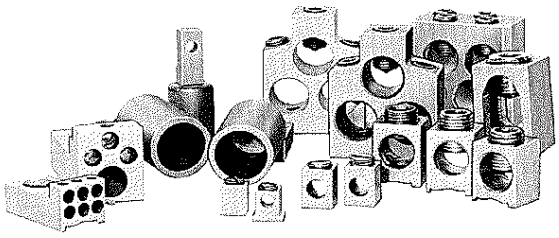
LINE & LOAD CONNECTIONS

All circuit breakers have provisions for making line and load connections into an electrical circuit. Compression-type lugs or mechanical-type lugs can be provided for all breakers up to 2500A frame size (except SE breakers). All terminal lugs are UL listed for their proper application and are listed for either Al/Cu or Cu only cable.

Additionally, there are plug-on connectors similar to those used on residential breakers. They are designed for rapid installation and removal of the breakers. I-LINE plug-on connectors are discussed on page 15. All Square D terminal connectors are rigorously tested. These terminal connections must not only pass UL tests but must also meet Square D quality requirements.

COPPER-ALUMINUM & COPPER ONLY LUGS

Lugs which are suitable for both copper and aluminum cable are generally made of aluminum. "Copper only" lugs, made of copper and suitable for use only with copper wire, are also available.



I-LINE PANELBOARD & SWITCHBOARD MOUNTING

I-LINE panelboard and switchboard mounting, a Square D exclusive, is available for Q2, FY, IF, IK, IL, FA, KA, LA, MA (800A maximum), ME, NA and NE circuit breakers. Specially designed insulated line side connectors are factory installed to the circuit breaker to allow the breaker to be mounted in I-LINE plug-on panelboards and switchboards. This feature is a big time saver when assembling panelboards or when changing out individual circuit breakers. These circuit breakers include plug-on connectors and a steel mounting bracket specifically designed to allow levering of the breaker into position (Fig. 2.3.4) and to support the circuit breaker when mounted on the bus bar stack. Special mounting adapters are also available to mount QO breakers in I-LINE panelboards if desired. Also, bolt-on I-LINE connections are available on 400A frame breakers or smaller. (For more information on I-LINE panelboards, see Section 5.4)

2.4 RATINGS

VOLTAGE RATING

The established voltage rating of a circuit breaker is based on design parameters which include the clearances of current carrying parts and dielectric withstand tests, both through air and over surfaces. Circuit breaker voltage ratings indicate the maximum electrical system voltage on which they can be applied. Underwriters Laboratories, Inc. (UL) recognizes the following ratings:

Volts for Alternating Current (AC)	Volts for Direct Current (dc)
120	125
120/240	125/250
240	250
277	600
480Y/277	
480	
600	

A circuit breaker can be rated for either alternating current (AC) or direct current (dc) system applications or for both. Circuit breaker voltage ratings must be equal to or greater than the nominal voltage of the electrical system on which they are used. Square D circuit breakers and their group identifications are shown in Table 2.4.1.

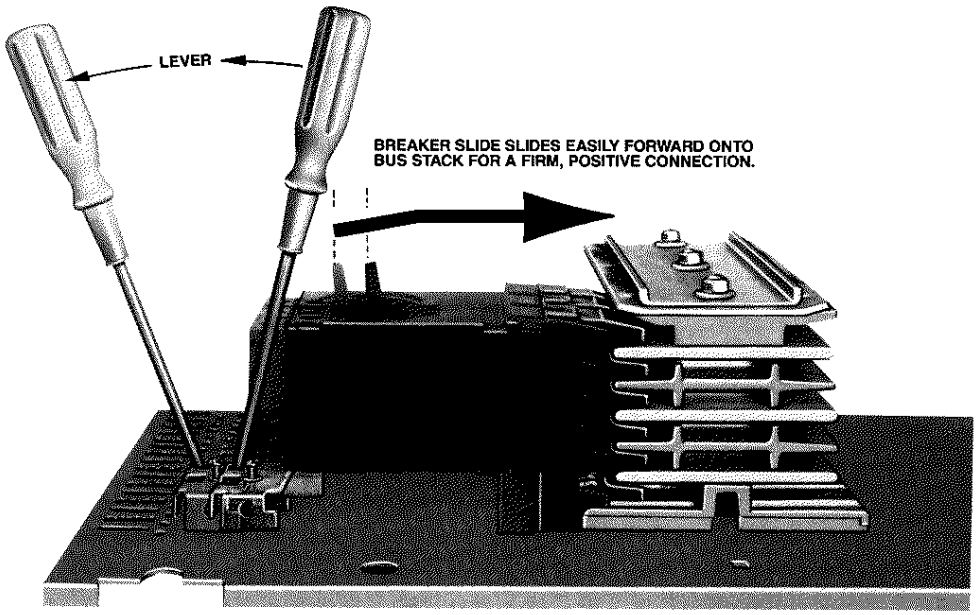


FIGURE 2.3.4

TABLE 2.4.1

CIRCUIT BREAKER GROUP IDENTIFICATION

Catalog Number Prefix	No. Poles	Maximum AC Voltage Rating	Ampere Rating
QO-GFI, QOB-GFI	1 2	120 120/240	15-30 15-60
QO-VHGFI, QOB-VHGFI	1	120	15-30
QH, QHB	1 2 3	120/240 120/240 240	15-30 15-30 15-30
QO, QOB	1 2 3	120/240 120/240 240	10-70 10-125 10-100
QO-EM, QOB-EM	1 2 3	120/240 120/240 240	10-20 10-60 15-60
QO-H, QOB-H	2	240	15-100
QOT	1 2	120/240 120/240	15-20 15-20
QO-VH, QOB-VH	1 2 3	120/240 120/240 240	15-30 15-125 15-100
QOU	1 2 3	120/240 120/240 240	10-100 10-100 10-100
QOH, QOHB	2	120/240	35-125
Q2, Q2L	2 3	120/240 240	100-225 100-225
Q2-H, Q2L-H	2 3	240 240	100-225 100-225
Q4, Q4L	2 3	240 240	250-400 250-400
EH, EHB	1 2 3	277 480Y/277 480Y/277	15-60 15-100 15-100
EHB-EM	1 2 3	480Y/277 480Y/277 480Y/277	15-30 15-30 15-30
QCB	2 3	240 240	100-150 100-150
QOB-VH	2 3	240 240	150 110-150

Catalog Number Prefix	No. Poles	Mounting Spaces	Maximum AC Voltage Rating	Ampere Rating
EHB-EM	1 2 3	2 3 4	480Y/277 480Y/277 480Y/277	15-30 15-30 15-30
QCB	2 3	4 6	240 240	100-150 100-150
QOB-VH	2 3	4 6	240 240	150 110-150

Catalog Number Prefix	No. Poles	Maximum AC Voltage Rating	Ampere Rating
FY	1	277	15-30
FA, FAL	1 2 3	120 240 240	15-100 15-100 15-100
FA, FAL	1 2 3	277 480 480	15-100 15-100 15-100
FA, FAL	2 3	600 600	15-100 15-100
FH, FHL	1 2 3	277 600 600	15-100 15-100 15-100
FC, FCL	2 3	480 480	20-100 20-100
IF, IFL	2 3	600 600	20-100 20-100
KA, KAL	2 3	600 600	70-250 70-250
KH, KHL	2 3	600 600	70-250 70-250
KC, KCL	2 3	480 480	110-250 110-250
IK, IKL	2 3	600 600	110-250 110-250
LA, LAL	2 3	600 600	125-400 125-400
LH, LHL	2 3	600 600	125-400 125-400
IL-ILL	3	480	250-400
MA, MH	2 3	600 600	125-800 125-800
MAL, MHL	2 3	600 600	125-1000 125-1000
ME, MEL	2 3	600 600	100-800 100-800
NA, NAL	2 3	600 600	600-1200 600-1200
NC, NCL	2,3	600	600-1200
NE, NEL	2,3	600	600-1200
PAF	2 3	600 600	600-2000 600-2000
PHF	2 3	600 600	600-2000 600-2000
PEF, PEC	2 3	600 600	600-2500 600-2500
PCF	2 3	600 600	1600-2500 1600-2500
SE	3	600	100-4000

CURRENT RATING

Circuit breakers have two types of current ratings: continuous current rating and short circuit current interrupting rating.

CONTINUOUS CURRENT RATING

The continuous current rating of a circuit breaker is defined by the National Electrical Manufacturers Association (NEMA) as: "The maximum direct current or rms current in amperes at rated frequency which a device or assembly will carry continuously without exceeding the specified limits of observable temperature rise." Continuous current ratings of ciruit breakers are established based on standard UL ampere ratings. These are 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1000, 1200, 1600, 2000, 2500, 3000, 4000, 5000, 6000 amperes. UL states that circuit breakers must carry the current ratings indefinitely at 40°C in free air.

When labeling the current rating UL, NEMA and the NEC all state that "The continuous current of a circuit breaker rated 100 amperes or less shall be molded, stamped, etched or similarly marked into the handle or escutcheon of the circuit breaker so as to be visible without removing the trim or cover of the enclosure." If the continuous current rating is marked on the handle of the circuit breaker, the numerical value alone is considered to be adequate. Above 100 ampere frame breakers the continuous current rating must be marked so that "it is visible for inspection without disassembling or removing the device after it has been installed in the indicated manner."

SUITABLE FOR CONTINOUS OPERATION AT 100% OF FRAME RATING IF USED IN A MINIMUM ENCLOSURE 34 IN. X 27 IN. X 72 IN. HIGH WITH A MINIMUM OF 45 SQ. IN. OF VENTILATION ON THE TOP AND 45 SQ. IN. OF VENTILATION ON THE BOTTOM OF THE ENCLOSURE.

As explained in the 1987 National Electrical Code (NEC) paragraph 220-3a: "The branch-circuit rating shall not be less than the noncontinuous load plus 125 percent of the continuous load." Exception to this paragraph states: "Where the assembly, including overcurrent devices, is listed for continuous operation of 100 percent of its rating." The 100% rating means that the breaker can actually carry 100% of its rated load in an enclosure. In some cases this rating can reduce the ampacity of the wiring and circuit breaker needed. The ME, NE, PE and SE solid state trip circuit breakers are available in 100% rated construction.

INTERRUPTING CAPACITY RATING

The ampere interrupting capacity (AIC) rating of a circuit breaker is the highest current at rated voltage that the circuit breaker is intended to interrupt under standard test conditions. Where the circuit breaker can be used at more than one voltage, the interrupting rating will be shown for each voltage level. For example, the LA type circuit breaker has 42,000 amperes symmetrical interrupting rating at 240 volts AC, 30,000 amperes symmetrical at 480 volts AC, 22,000 amperes symmetrical at 600 volts AC, and 10,000 amperes at 250 volts dc. These interrupting capacities are determined by actual testing in sophisticated Square D laboratories.

600 AMP 40°C

CATALOG NO. MAL36600 SERIES 2
INTERRUPTING RATING RMS SYMMETRICAL AMPS
UL & NEMA 60 HZ

VOLTS	AMPS
240	42K
480	30K
600	22K

IEC 157-1 (P1) 50 HZ SQUARE D CERTIFIED

VOLTS	AMPS
380/220	50K
415/240	50K

Interrupting rating is an important consideration when choosing distribution equipment. To choose a circuit breaker one must be sure the interrupting rating is equal to or greater than the available short circuit current at the point where the circuit breaker is applied in the system.

AMBIENT TEMPERATURE RATING

The ambient temperature rating of a circuit breaker is the temperature at which its continuous current rating is based. Ambient temperature is the temperature of the air immediately around the circuit breaker which can affect the thermal (overload) tripping characteristics of thermal-magnetic circuit breakers. It must be considered for effective application. Solid state trip breakers, however, are insensitive to normal ambient conditions (-20° to 50°C).

As stated in the thermal trip section, thermal-magnetic circuit breakers use bimetal strips that bend when heat is applied. Current flowing through the breaker creates most of the effective heat used for this tripping action. The ambient temperature surrounding the breaker either adds to or subtracts from this available heat.

UL recognizes ambient temperatures of 25°C and 40°C. Square D circuit breakers are all UL listed at 40°C. A thermal-magnetic circuit breaker will carry its rated current continuously when the air surrounding it is at the same temperature as the rated ambient temperature. At lower than rated ambient termperature, these circuit breakers may carry more than their rated current which can cause wire and equipment damage if not properly addressed.

When applied at higher than rated temperature, these breakers will carry less than their rated current. Additional application guidance should be obtained when applying thermal magnetic breakers at extreme high & low temperatures.

FREQUENCY RATING

The standard rated frequency for circuit breakers is 60 hertz. Square D circuit breakers can also be applied on systems with 50 hertz frequencies without being thermally or magnetically derated. Other frequencies can affect the thermal, magnetic and short circuit characteristics of the breakers. Additional application guidance should be obtained before applying breakers on systems with higher or lower frequencies including dc ratings.

SERIES CONNECTED RATINGS

The current limiting ability of the I-LIMITER circuit breaker permits the use of downstream circuit breakers with lower interrupting capacities on systems capable of delivering fault currents up to 200,000 RMS symmetrical amperes (see Table 2.4.2). Circuit breaker combinations suitable for this purpose are recognized by Underwriters Laboratories and appear in the Recognized Component Directory under the "Circuit Breakers—Series Connected" product category.

Even on systems not requiring the full 200,000 ampere rating of the I-LIMITER main, considerable savings can often be realized by using the I-LIMITER main (see Table 2.4.2). For example, FA breakers can be used with an IK main instead of using all FH branches. For user convenience, I-LIMITER breakers are also available in I-LINE construction.

TABLE 2.4.2

UL RECOGNIZED SERIES CONNECTED INTERRUPTING RATINGS
200,000 RMS SYMMETRICAL AMPERES

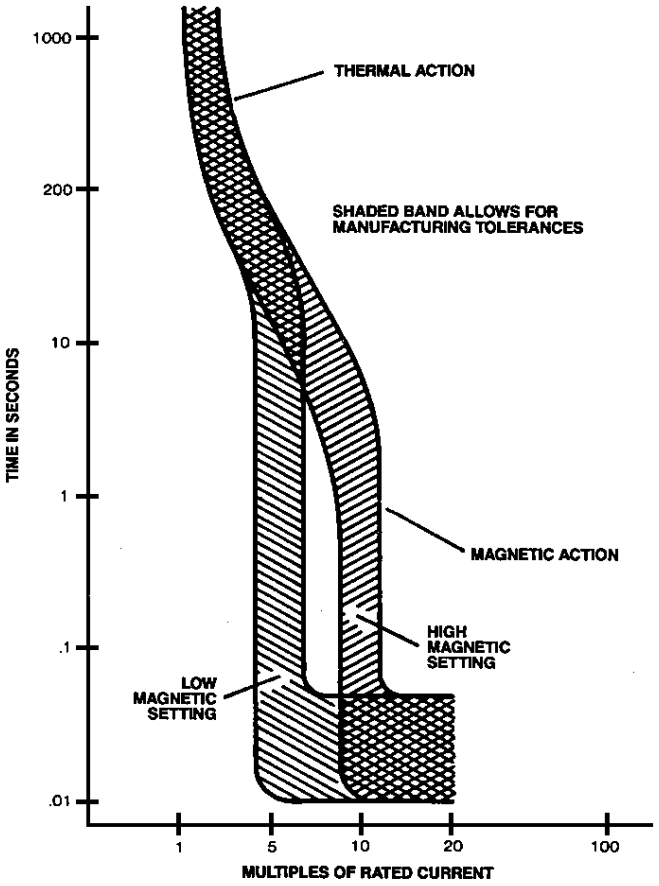
Maximum Voltage	Main Breaker	Branch Breaker		Poles
		Catalog Prefix	Ampere Rating	
120/240	IF, IFL	QO, QOB	15-70	1
120/240	IF, IFL	QO, QOB	15-100	2
240	IF, IFL	QO, QOB	15-60	3
120/240	IF, IFL	QOT	15-30	1
120	IF, IFL	QO-GFI	15-30	1
120/240	IF, IFL	QO-GFI	15-30	2
277	IF, IFL	EH, EHB	15-60	1
480Y/277▲	IF, IFL	EH, EHB	15-60	2,3
277	IF, IFL	FY	15-30	1
277	IF, IFL	FA, FAL, FAB	15-100	1
480	IF, IFL	FA, FAL, FAB	15-100	2,3
600★	IF, IFL	FA, FAL, FAB	15-100	2,3
120/240	IK, IKL	QO, QOB	15-70	1
120/240	IK, IKL	QO, QOB	15-100	2
240	IK, IKL	QO, QOB	15-60	3
120/240	IK, IKL	QOT	15-30	1
120	IK, IKL	QO-GFI	15-30	1
120/240	IK, IKL	QO-GFI	15-30	2
277	IK, IKL	EH, EHB	15-60	1
480Y/277▲	IK, IKL	EH, EHB	15-60	2,3
277	IK, IKL	FY	15-30	1
277	IK, IKL	FA, FAL, FAB	15-100	1
480	IK, IKL	FA, FAL, FAB	15-100	2,3
480	IK, IKL	KA, KAL, KAB	70-225	2,3
600★	IK, IKL	FA, FAL, FAB	15-100	2,3
600★	IK, IKL	KA, KAL, KAB	70-225	2,3
120/240	IL, ILL	QO-VH, QOB-VH	15-30	1,2
240	IL, ILL	QO-VH, QOB-VH	15-30	3
240	IL, ILL	Q2-H, Q2B-H, Q2L-H	100-225	2,3
240	IL, ILL	FA, FAL, FAB	15-100	2,3
277	IL, ILL	FY	20-30	1
277	IL, ILL	FH, FHL, FHB	20-100	1
480	IL, ILL	FH, FHL, FHB	15-100	2,3
480	IL, ILL	KA, KAL, KAB	70-225	2,3

★ Series connected interrupting rating of 100,000 amperes.
▲ Series connected interrupting rating of 65,000 amperes.

2.5 CIRCUIT BREAKER CHARACTERISTICS

THERMAL-MAGNETIC CHARACTERISTICS

As stated earlier in Section 2.3, thermal-magnetic circuit breakers have an inverse time tripping characteristic (due to the bimetal) and an instantaneous tripping characteristic due to the electromagnetic portion of the breaker. The following trip curve displays these two circuit breaker tripping characteristics, Figure 2.5.1.



TYPICAL TIME-CURRENT CHARACTERISTIC CURVE FOR A 600 AMPERE FRAME SIZE MOLDED CASE CIRCUIT BREAKER

FIGURE 2.5.1

The characteristic trip curve varies according to time and current levels. As the current increases, the tripping time decreases. The upper portion of the curve represents the thermal action and is determined by the bimetal deflection.

For example, at 200% overload it would take 30 seconds before the bimetal would deflect far enough to hit the trip bar causing the breaker to open the circuit. If, for example, a short circuit at 2500% or 25 times the handle rating was encountered, it would be cleared in approximately .016 seconds, or roughly one cycle.

As shown by the diagram, it can sometimes be difficult to determine whether the circuit breaker will trip by thermal or magnetic action (i.e. 600%). It is evident though that the circuit breaker will trip once subjected to overload or short circuit currents. All the values shown on the Square D thermal-magnetic circuit breaker characteristic curves have been determined through extensive testing.

CURRENT LIMITING CHARACTERISTICS

The time-current characteristic curves of current limiting circuit breakers have basically the same shape and contain essentially the same type of information as those for conventional molded case circuit breakers. The thermal and magnetic areas of operation may be identified as on any other breaker.

The difference is the current limiting action, displayed at higher fault levels. Although the threshold of current limitation is not clearly defined. Fig. 2.5.2 shows that at higher interrupting currents, the circuit breaker reacts faster than a thermal-magnetic breaker. On high level short circuit currents, I-LIMITER breakers have a total interruption time of 2 to 4 milliseconds. The following is a more in-depth discussion of current limitation.

POINT OF INITIATION AND TIME DURATION

I-LIMITER current limiting circuit breakers are designed to take advantage of the electromagnetic repulsion created by closely spaced, parallel contact arms carrying current in opposite directions. This repulsion, intensified by the "O" shaped magnet surrounding the contact arms causes the contacts to blow open in less than one millisecond under high level fault conditions.

This high speed contact separation enhances the ability of I-LIMITER circuit breakers to limit both peak current and I^2t let-through energy.

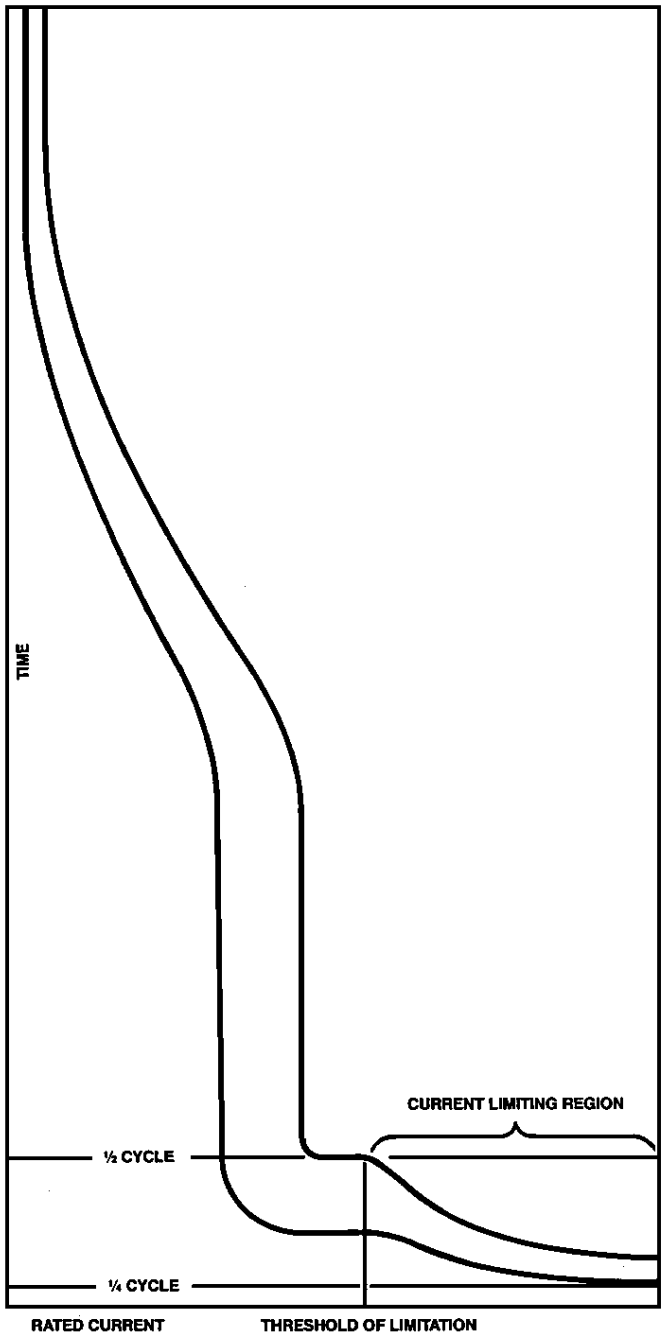


FIGURE 2.5.2

In Figure 2.5.3, the available current (I) curve is represented by the solid black line. As the diagram shows, the peak let-through current of the I-LIMITER circuit breaker is limited to a small fraction of the available peak current.

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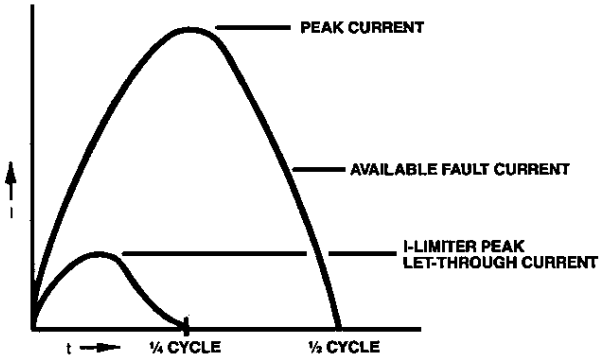


FIGURE 2.5.3

In Figure 2.5.4, the available ½ cycle I^2t and let-through I^2t are represented by the area under their respective I^2 curves. Here again, the I^2t let-through is reduced to a small fraction of the available I^2t.

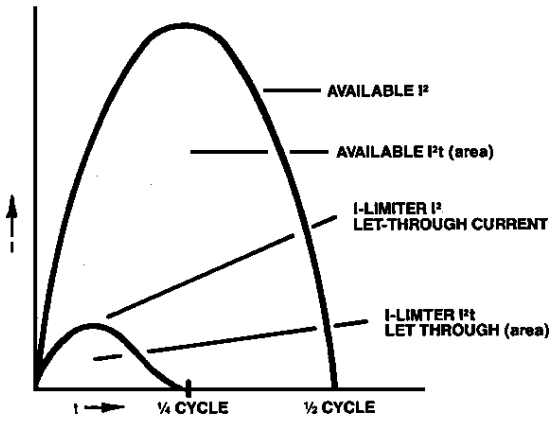


FIGURE 2.5.4

In these diagrams arc interruption is complete in less than ¼ cycle. The time duration of the fault current is dependent upon the magnitude of the fault current and by the point in time on the system voltage wave where the fault is initiated. Even though there will be variations in the current duration, for short circuit currents well into the current limiting range of the circuit breaker the current duration will be less than ½ cycle.

PEAK LET-THROUGH CURVES

The graph that is shown in Figure 2.5.5 gives peak let-through current versus the available fault current and deserves some discussion.

The slanting lines marked 15%, 25%, and 45% power factor show the maximum theoretical peak currents that could flow in a faulted circuit having that particular short circuit power factor, assuming no current limiting device is in the circuit. Circuits which produce high fault currents typically are associated with low short circuit power factors or high X/R ratios.

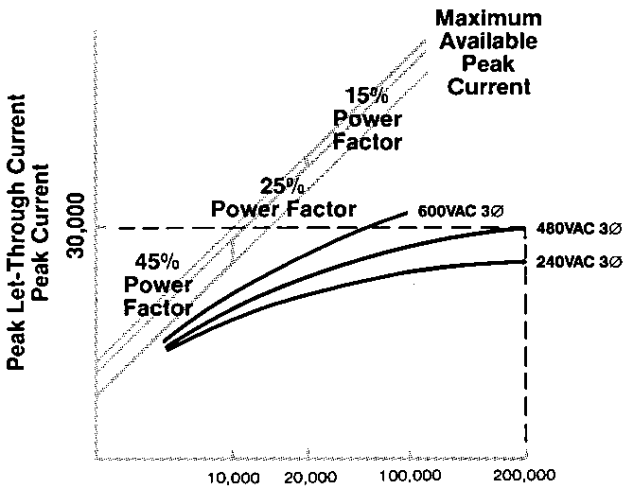


FIGURE 2.5.5

Since different portions of a system will exhibit various available fault levels and power factors associated at those levels, UL has established that the following power factors be used in short circuit testing.

Test Current (Amperes)	Power Factor (Percent)
10,000	45-50
10,001-20,000	25-30
Over 20,000	15-20

Since the peak current let-through curves for the I-LIMITER were derived from tests at the current levels and power factors indicated above, the degree of current limitation is indicated by the differential between the maximum available peak current and the actual test let-through peak current. The curves extend from the threshold of current limitation to the maximum rated interruption capacity of current limiting circuit breakers.

I^2t LET-THROUGH CURVES

These curves in Figure 2.5.5 and 2.5.6 show the extent to which I-LIMITER circuit breakers limit energy under short circuit conditions. For comparison, the theoretical I^2t let-through of ½ cycle of symmetrical sinusoidal current is calculated. At 200,000 amperes RMS, this would be 3.33 x 10^8 amperes^2 seconds if no current limiting device were in the circuit. In contrast, the IF breaker for example would limit the energy flow to .51 x 10^6 ampere^2 seconds at 480 volts or .20 x 10^6 ampere^2 seconds at 240 volts with 200,000 RMS symmetrical short circuit amperes available in each case. This energy limitation assists in testing the series combinations listed on page 18. Square D uses actual tests to determine which breaker combinations can be used.

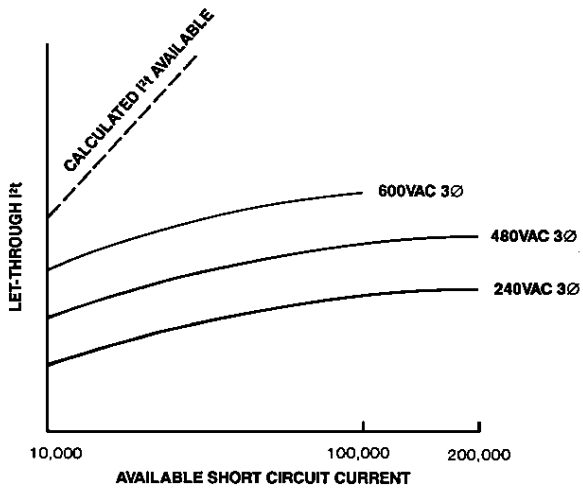


FIGURE 2.5.6

SOLID STATE TRIP CHARACTERISTICS

Solid state trip circuit breaker characteristic curves are similar to thermal-magnetic trip curves except that the different tripping actions are more clearly defined and can be adjusted. Available tripping functions for solid state trip circuit breakers include long time, short time, instantaneous, and ground fault. These tripping actions are described in detail on the following pages.

LONG TIME FUNCTION

The long time trip characteristic is displayed by the top portion of the curve in Figure 2.5.7. The vertical section is the pickup region and is adjusted by the ampere rating switch. The pickup point at which the breaker begins its timing mode is set at approximately 1.15 times the ampere rating for the SE circuit breaker and 1.10 times for the ME, NE and PE circuit breakers. The long time delay function represented by the sloping band inserts specific inverse time delays into the trip function. This function is intended to prevent the breaker from tripping when, for example,

temporary inrush currents apply light overloads on the electrical system. The long time function simulates the thermal action of thermal-magnetic breakers.

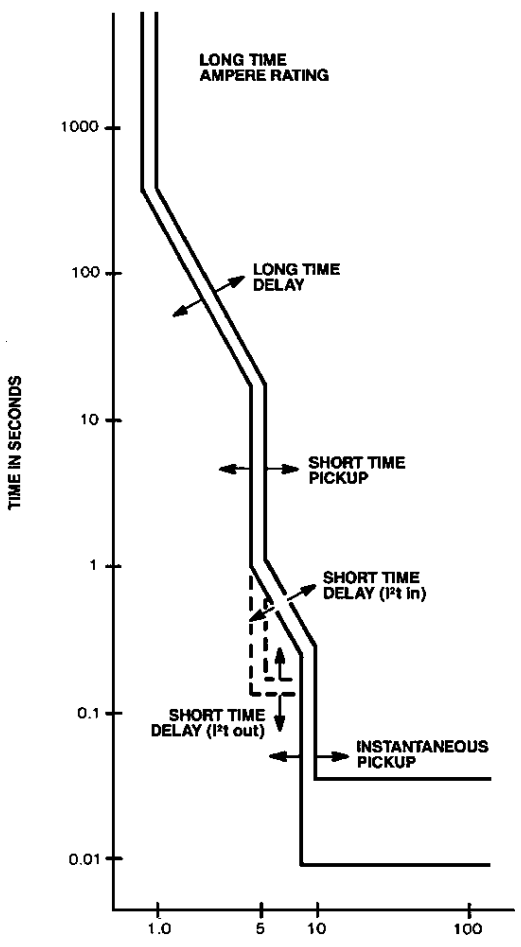


FIGURE 2.5.7
TIME-CURRENT CHARACTERISTIC CURVE
FOR SOLID STATE TRIP CIRCUIT BREAKER

SHORT TIME FUNCTION

The short time characteristic curve is just below the long time curve (Fig. 2.5.7). This tripping function is designed to detect low level short circuit conditions and trip the breaker after a specified delay. The pickup level adjusts the point at which the breaker will first sense minor short circuits and the delay adjustment inserts an adjustable delay in the timing mode. The delay can be set with the I^2t ramp function IN which helps to better coordinate with upstream or downstream breakers or fuses or I^2t OUT when coordinating with other solid state trip breakers.

INSTANTANEOUS FUNCTION

The instantaneous function provides protection against short circuit currents. This function determines the level at which the breaker will trip with no intentional delay. It simulates the magnetic tripping action of thermal-magnetic circuit breakers.

GROUND FAULT FUNCTION

Integral ground fault characteristics are shown in Figure 2.5.8. All Square D solid state trip breakers can be ordered with integral equipment ground fault protection. The trip unit compares current flow to and from the load. If the currents are balanced, they cancel each other out, but if an imbalance should occur, the difference of current will go to ground and the trip unit sends a signal to trip the breaker. Ground fault adjustments set the pickup point and delay desired.

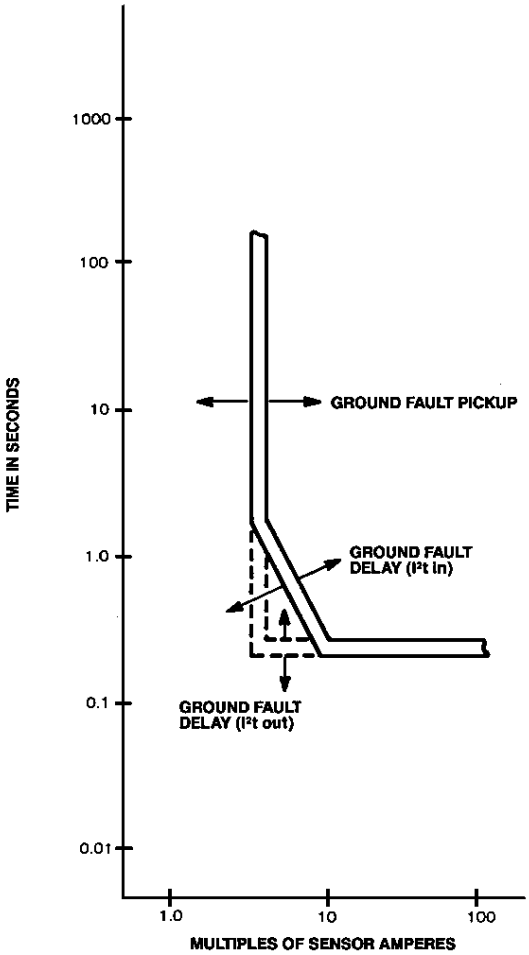
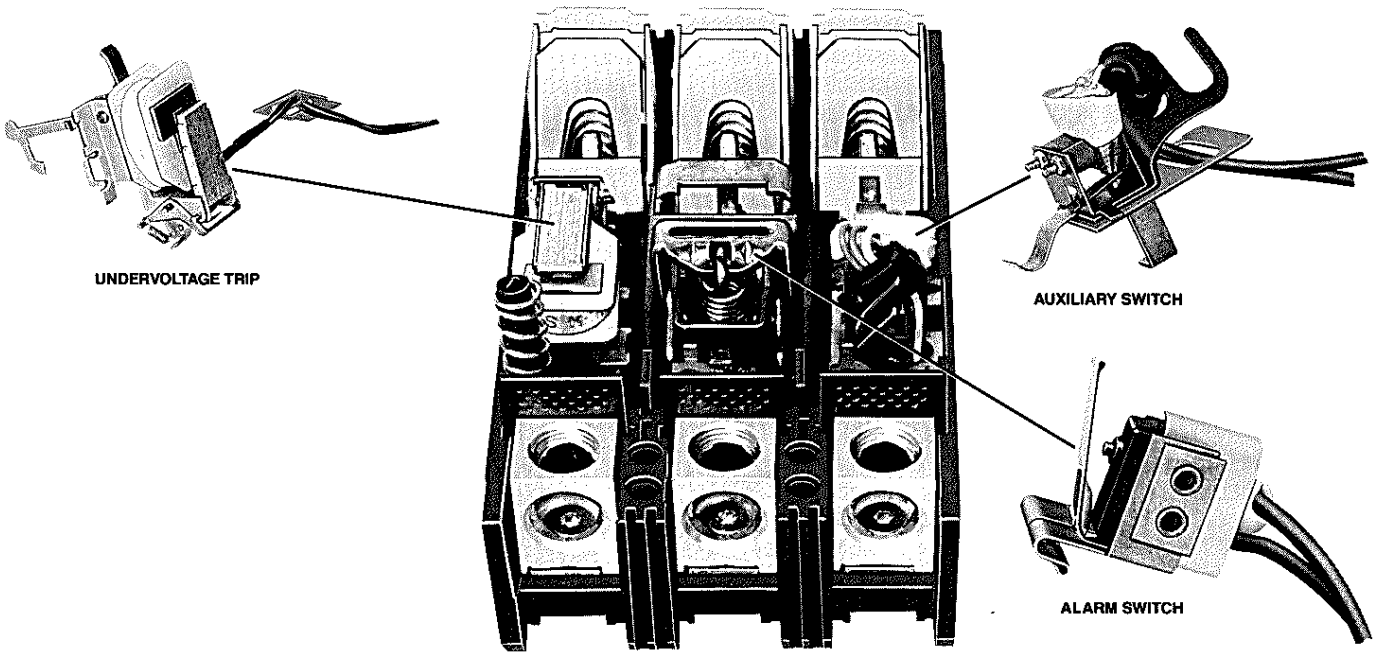


FIGURE 2.5.8
GROUND FAULT CHARACTERISTIC TRIP CURVE
FOR SOLID STATE TRIP CIRCUIT BREAKER

All solid state trip breakers with ground fault have push-to-test and ground fault trip indication as standard. This new feature eliminates the need for any additional ground fault testing equipment.



ASSEMBLED
AUXILIARY DEVICES

2.6 ACCESSORIES

A wide range of accessories are available for circuit breakers to make them fit a particular application. Accessories for type LA, MA, NA, NE, PA, PE, PC breakers may be field installed. Refer to Catalog Class 690. These accessories are available on most Square D circuit breakers.

SHUNT TRIP

A shunt trip is a mechanism which trips the circuit breaker by means of a solenoid which is energized from a separate source or power source. The solenoid circuit is closed by an external relay, switch or other means. Most shunt trip coils do not have continuous current rating, so a coil clearing switch is included to break the solenoid circuit when the circuit breaker opens. Standard shunt trips are rated 12, 24, 48, 125, and 250 volts dc and 120, 208, 240, 277 and 480 volts AC. Other voltage ratings are available upon special request. The shunt trip is available on residential/commercial breakers in 1, 2 and 3-pole configuration. For industrial breakers, the shunt trip is available in 2 or 3-pole versions. The control leads for the shunt trip are color coded black.

UNDERVOLTAGE TRIP

The undervoltage trip is a device which trips the circuit breaker automatically when the main circuit voltage falls below 35-70% of its specified value. The breaker cannot be returned to service until the voltage returns to at least 85% of rated value. These trips are available in the same breaker as the shunt trip. They are supplied as standard in the same voltage ratings as the shunt trip except that undervoltage trips rated above 24 volts dc or 240 volts AC are suppled with external resistors. The control wires for undervoltage trips are color coded brown. An undervoltage trip time delay unit is available for the undervoltage trip accessory. Its adjustable time delay feature allows the undervoltage trip to ignore momentary voltage fluctuations without tripping the breaker.

NOTE: The shunt trip and undervoltage trip cannot be supplied in the same pole of the circuit breaker, but only one of these devices is necessary to perform both purposes when they are installed in the same electrical system. Normally closed contacts, such as those used in stop buttons, can be installed in the control circuit to open the breaker via an undervoltage trip in a manner similar to a shunt trip.

AUXILIARY SWITCHES

An auxiliary switch is one which is mechanically operated by the circuit breaker blades and is used for signaling, interlocking, and indicating contact position. An "A" type contact is one which is open when the breaker contacts are open. The "B" type contact is closed when the breaker contacts are open. Auxiliary switches are available in the same combination as shunt and undervoltage trip. They are rated for 10 amperes at 120/240VAC, 4 amperes for 120VAC ampere loads, ½ ampere at 125Vdc and ¼ ampere at 250Vdc.

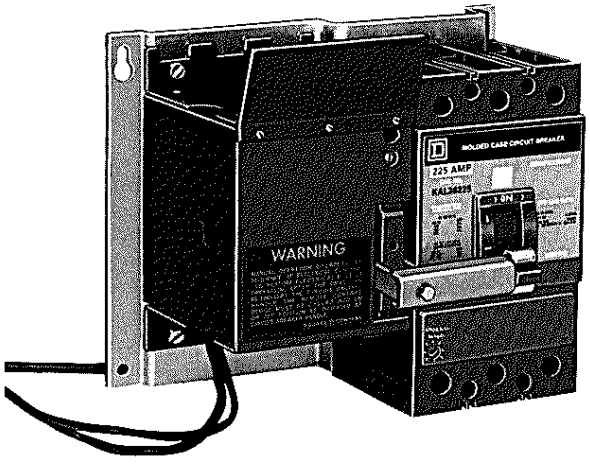
Control leads for "A" contacts are color coded yellow and the "B" contacts are blue. The common leads are color coded blue with yellow stripes. When two or more of the same contacts are required (two N.O. or N.C.), the color coding remains as above with the leads identified by numbered tabs.

ALARM SWITCH
The alarm switch is a single contact that is activated when the breaker is in the tripped position. It is used to actuate bell alarms and warning signals. The leads are color coded red.

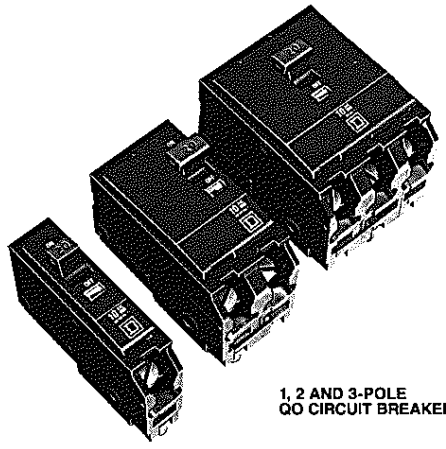
LOCK-ON/OFF ATTACHMENTS
Attachments are available for all Square D molded case circuit breakers which permit the locking or padlocking of the breaker handle in the OFF and/or ON positions. These attachments are used for safety reasons and/or to prevent routine switching of such circuits as clocks, emergency lights, etc. They do not interfere with the automatic tripping of the mechanism of the circuit breaker. (Remember all Square D circuit breakers have trip-free operation).

Field installable lock-off attachments are available for QO, QOT, QOU, QOM, Q2, Q4, EH, FY, IF, IK, IL, FA, KA, LA, MA, ME, NA, NE and SE circuit breakers. Molded holes in the industrial size breaker covers are provided to mount these attachments. PA, PC and PE lock-off devices are built into the handle and provided as standard on these breakers.

ELECTRICAL OPERATORS
Electrical operators for FA, KA, IF, IK, LA, Q4, MA, PA and PE circuit breakers are available to remotely turn the circuit breaker ON or OFF/RESET. These operators can be very convenient, especially if the circuit breaker is located in a remote location. Should the circuit breaker trip, one can readily turn a switch to have the circuit breaker reset and turned back on once the reason for tripping has been alleviated.



2.7 QO, QOB AND QOT CIRCUIT BREAKERS



1, 2 AND 3-POLE
QO CIRCUIT BREAKERS

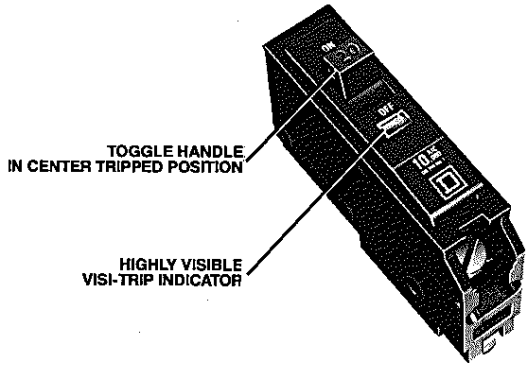
QWIK-OPEN
Single pole 15 and 20 ampere type QO and QOT circuit breakers provide additional flash protection by means of an especially low magnetic trip point.

A flash is the result of a low current short circuit which can occur, for example, when several strands of a frayed extension cord touch each other. The resulting spark or flash could start a fire although not enough current is drawn to trip a conventional overcurrent protector.

Fuses do not open fast enough to protect the smaller conductors beyond the branch wiring from many repeated arcing or flash type shorts. Frayed lamp cords and defective electrical appliance extension cords are fire hazards. With 15 and 20 ampere single pole type QO and QOT breakers, the circuit is opened instantaneously with the first flash of many flash type shorts, greatly reducing hazards of these low current short circuits.

VISI-TRIP TRIP INDICATION

All QO and QOT circuit breakers have VISI-TRIP trip indication which provides a visual identification of the tripped circuit as shown in Figure 2.7.2. When the breaker is tripped, the operating handle assumes a center TRIPPED position midway between ON and OFF and the VISI-TRIP indicator appears in the breaker case window. The VISI-TRIP indicator is only visible when the circuit breaker is tripped. Trip indication immediately distinguishes the circuit from any other circuit which is merely in the ON and OFF position.



CIRCUIT BREAKER TYPES

All QO plug-on, QOB bolt-on and QOT plug-on tandem breakers are UL listed for use in Class CTL panelboards. (For information on Class CTL, see Section 4.0 and 5.0). The tripping mechanism is a thermal-magnetic type. 15 and 20 ampere single pole breakers (except QOT and QO-GFI) are UL listed as SWD (switching duty) for switching fluorescent lighting loads.

QOT plug-on tandem breakers are two individual single pole breakers in one case. They require the same amount of mounting space as a single pole QO plug-on breaker. QOT breakers are for use in QO load centers only. (For information on QO load centers, see Section 4.0).

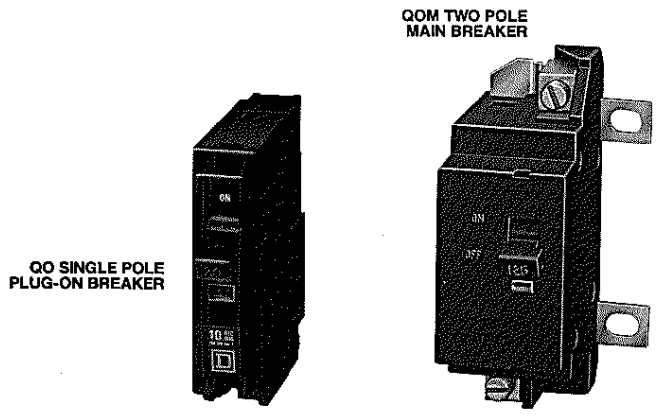
QO-GFI plug-on and QOB-GFI bolt-on QWIK-GARD breakers combine Class A ground fault protection. (For information on Class A ground fault protection, see Section 7.0) with conventional overload and short circuit protection.

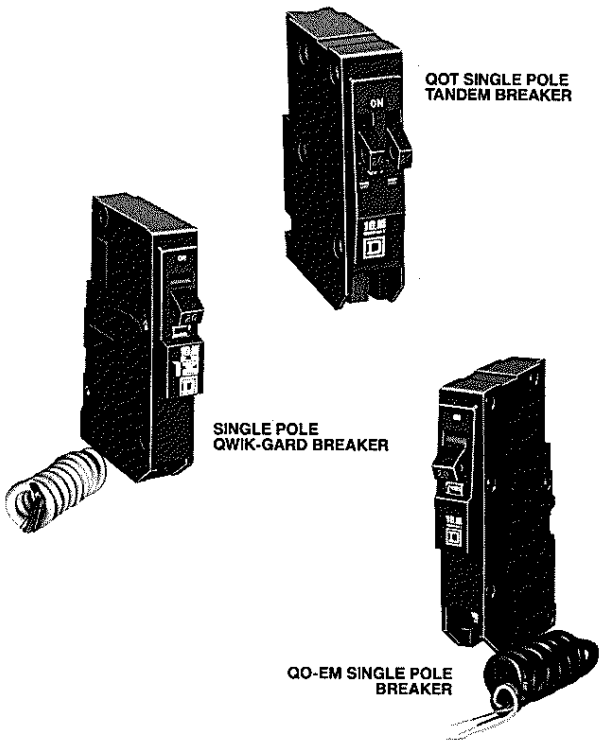
QO-EM plug-on and QOB-EM bolt-on breakers provide remote control switching capability and are HID rated. (For information on HID rating, see following paragraph on QO-HID breakers).

QO-HID plug-on and QOB-HID bolt-on breakers are for use on circuits feeding fluorescent and High Intensity Discharge (HID) lighting systems such as mercury vapor, metal halide, or high pressure sodium. These breakers are physically interchangeable with standard QO plug-on and QOB bolt-on breakers.

QOM breakers are two pole breakers designed for field installation as the main breaker in convertible main lugs QO load centers. (For information on QO load centers, see Section 4.0).

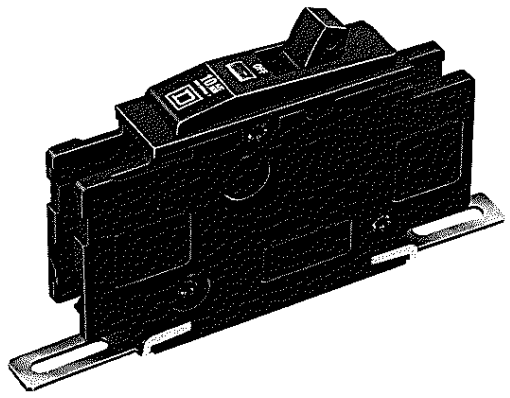
QOU breakers are QO breakers with wiring terminals for making line and load connections into an electrical circuit. They are for individual unit mounting applications (Figure 2.7.4). Flush or surface mounting is provided by a set of mounting feet.



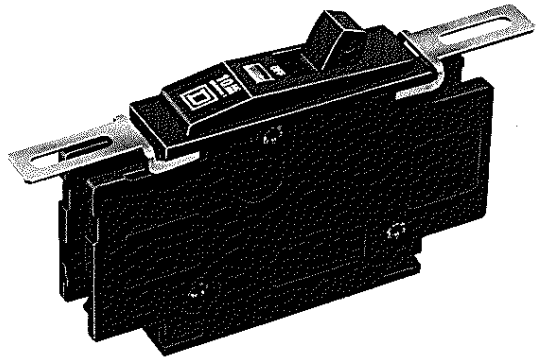


2.8 EH AND EHB CIRCUIT BREAKERS

EH plug-on and EHB bolt-on breakers are UL listed for use in Class CTL panelboards. (For information on Class CTL, see Section 5.0). The tripping mechanism is a thermal-magnetic type. 15 and 20 ampere single pole breakers are UL listed as SWD (switching duty) for switching fluorescent lighting loads.



QOU CIRCUIT BREAKERS



EH-HID plug-on and EHB-HID bolt-on breakers are for use on circuits feeding fluorescent and High Intensity Discharge (HID) lighting systems such as mercury vapor, metal halide, or high pressure sodium. These breakers are physically interchangeable with standard EH plug-on and EHB bolt-on breakers.

2.9 ENCLOSURES

Up to this point in this section, the circuit breaker has been discussed without any consideration given to the enclosure in which it may be mounted.

The majority of circuit breakers are used in some type of enclosure (e.g. panelboards, switchboards, motor control centers, individual enclosures, etc.)

In this section, only the individually enclosed molded case circuit breaker will be discussed.

The industry has established enclosure designations because individually enclosed circuit breakers are used in so many different types of locations, weather and water conditions, dust and other contaminating conditions, etc. The designation (e.g. TYPE 12) indicates an enclosure type to fulfill requirements for a particular application.

Types of enclosures available are as follows:

TYPE 1
Indoor use primarily to provide a degree of protection against contact with the enclosed equipment and against a limited amount of falling dirt.

TYPE 3R
Outdoor use to provide a degree of protection against falling rain and sleet; undamaged by the formation of ice on the enclosure.

TYPE 4
Indoor or outdoor use to provide a degree of protection against splashing water, windblown dust and rain, and hose directed water; undamaged by the formation of ice on the enclosure.

TYPE 4X
Indoor or outdoor use to provide a degree of protection against splashing water, windblown dust and rain, and hose directed water; undamaged by the formation of ice on the enclosure; resists corrosion.

TYPE 5
Indoor use to provide a degree of protection against fibers and flyings, lint, dust and dirt.

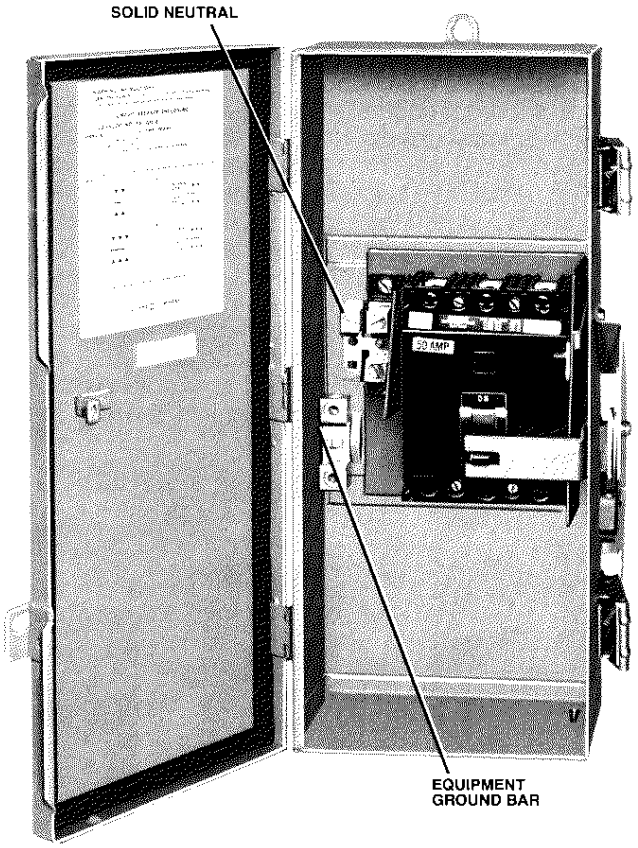
TYPE 7
Indoor use for locations defined by the National Electrical Code as Class I, Groups C or D hazardous locations.

TYPE 9
Indoor use for locations defined by the National Electrical Code as Class II, Groups E, F or G and Class III hazardous locations.

TYPE 12
Indoor use to provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids. (These enclosures are provided without knockouts).

TYPE 12K
Indoor use to provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids. (These enclosures are provided with knockouts in top and bottom endwalls).

NEUTRALS
An insulated, groundable and bondable neutral is provided in all QO, Q2 and EHB TYPE 1 and 3R enclosures. Bonding screws and straps are provided, but not installed, where the enclosure may be used as a service entrance device. Neutrals are available for installation in most other enclosures but are merchandised separately as 100, 225, 400, 1000 and 1200 ampere ratings, Figure 2.8.1



SELECTING AND PRICING REFERENCE — SQUARE D DIGEST
Pricing for the most popular molded case circuit breaker devices and accessories is found in the Digest. Pricing for devices less popular but readily available is found in the Supplementary Price Book. Prices for special devices not listed on published sheets can be obtained from the factory through Square D field engineers.

Particular items of interest in pricing (1) A price break occurs in the 100 ampere circuit breaker devices at the 60 ampere rating. 15-60 ampere devices are priced lower than 70-100 ampere devices using the same frame size breakers. (2) Neutrals are included in QO, Q2 and EHB, TYPE 1 and 3R devices at no increase in price. There is an increase in price for the neutral in all other Type enclosures. (3) MAG-GARD type breakers are priced at the same level as the standard breaker in the same frame size. (4) High interrupting breakers are available in the same enclosures as the standard breakers.

Where Digest pricing is not shown, the price list supplied with the Digest should be consulted. Pricing of all special devices and modified equipment can be obtained through the Square D field engineer. Specials and modifications may include such things as moisture fungus proofing, special paint colors, special markings and packaging and pricing for overseas shipments.

In order to select and price unit circuit breakers without enclosures and individually enclosed circuit breakers, the following ten-step procedure is suggested:

1. Determine circuit voltage—from customer or plans and specifications.
2. Determine required continuous current rating—from customer or plans and specifications.
3. Determine required short circuit current interrupting rating—from customer or plans and specifications.
4. Determine the number of poles—from customer or plans and specifications.
5. Determine type and quantity of breaker accessories required—from customer or plans and specifications.
6. Determine type of breaker required using information listed for points 1-5 or from customer or plans and specifications.
7. Determine type of enclosure and type of mounting—from customer or plans and specifications.
8. Determine if solid neutral and/or any other enclosure mounted accessory is required—from customer or plans and specifications.
9. Select catalog number and price of circuit breaker with or without enclosure as required. Following catalog number, list required accessories and prices.
10. Calculate total commercial net price and establish discount.

Problem No. 1
A customer wants an enclosed circuit breaker for a four-wire, 480Y/277 volt, 350 ampere service with 20,000 ampere short circuit rating available. The customer is an electrical contractor buying the breaker as a main disconnect on the service entrance to a small machine shop. The circuit breaker is to be mounted on the outside of the building. What is the catalog number and commercial net price of the circuit breaker that you would sell him from your stock?

Answer
After checking the Square D Digest, you would find that the following would be the catalog numbers and prices of the units which would satisfy the job requirements:

1 - Cat. No. LAL36350 ..... $_____
1 - Cat. No. LA400R ..... $_____
1 - Cat. No. 400SN ..... $_____
1 - Cat. No. PKOGTA2 ..... $_____
Total $_____

A neutral assembly would be required since the voltage indicates that the system is three-phase, four-wire.

Problem No. 2
A gadget manufacturing company wants to buy five circuit breakers as the main disconnect, overcurrent and short circuit protection for five identical machines. These machines are located in the plastic molding department. Ratings for the circuit breakers are: 208Y/120 volts, 3-pole, 125 ampere, available short circuit current 50,000 amperes symmetrical with an alarm switch to indicate when a circuit breaker is tripped.

Answer
Since these circuit breakers are to be used in an industrial plant and in particular in the plastic molding department where dust is prevalent, the recommendation would be for a TYPE 12 industrial enclosed circuit breaker. Since the available short circuit current is greater than standard for a 125A breaker, a high interrupting circuit breaker is required.

The catalog numbers and prices are:

5 - KHL36125-2100 ..... $_____
5 - KA225AWK ..... $_____
5 - SN225A ..... $_____
Total $_____

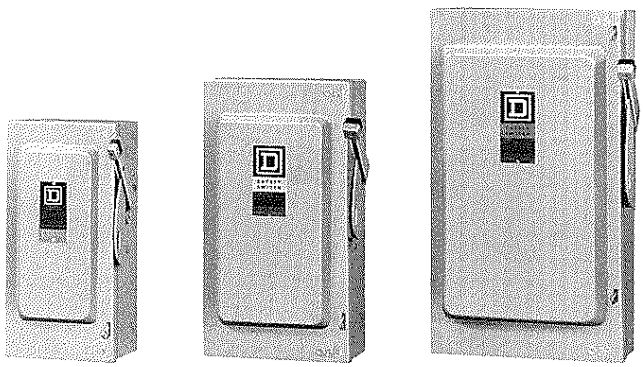
3.0 SAFETY SWITCHES
GENERAL INFORMATION

Square D manufactures two complete lines of enclosed single throw safety switches to meet industrial, commercial, and residential requirements. These are referred to as General Duty Type GD and Heavy Duty Type HD. Square D also manufactures a complete line of Double Throw Switches which have enclosures with features similar to the general and heavy duty designs.

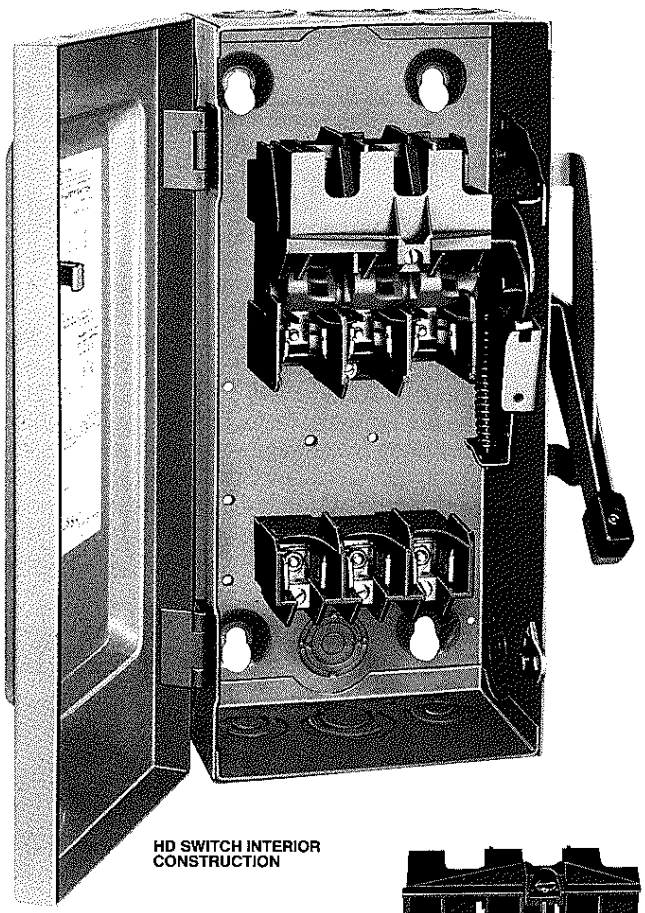
All of these switches have visible blades and safety handles. The switch blades are in full view when the door is open and there is visually no doubt when the switch is OFF. Switch handles are an integral part of the box, not the cover, so that the handle is in control of the switch blades under normal conditions. (Square D safety switches in TYPE 7 & 9 enclosures do not feature visible blades or some of the other features discussed in the following paragraphs. Refer questions regarding these enclosures to your local Square D field office).

3.1 HEAVY DUTY SWITCHES

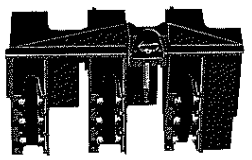
Heavy duty switches are intended for applications where ease of maintenance, rugged construction, and continued performance are primary concerns. Heavy duty switches can be used in atmospheres where general duty switches would be unsuitable. Heavy duty switches are widely used by such industries as automobile manufacturers, breweries, foundries, and shipyards. Square D's line of heavy duty switches are rated 30 thru 1200 amperes and 240 to 600 volts AC or dc. Switches with horsepower ratings are capable of opening a circuit up to six times the rated current of the switch. When equipped with Class J or Class R fuses on 30 thru 600 ampere switches, or Class L fuses on 800 and 1200 ampere switches, Square D fusible heavy duty safety switches are UL listed for use on systems with up to 200,000 RMS symmetrical amperes available fault current. This is the highest short circuit rating available in the industry. Applications include use where the required enclosure is TYPE 1, 3R, 4, 4X, 5, 7, 9, 12 or 12K. (See Section 2.9 for summary of enclosure types.)



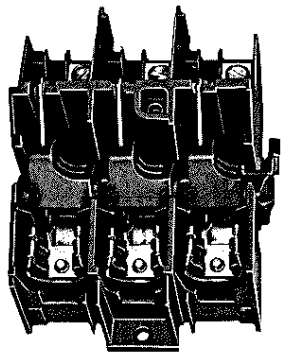
30 AMPERE 60 AMPERE 100 AMPERE



HD SWITCH INTERIOR CONSTRUCTION



ARC SUPRESSOR ASSEMBLY

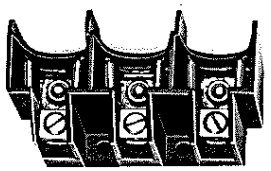


SWITCH BASE ASSEMBLY

LINE LUG

BLADE JAW

SWITCH BLADE ASSEMBLY



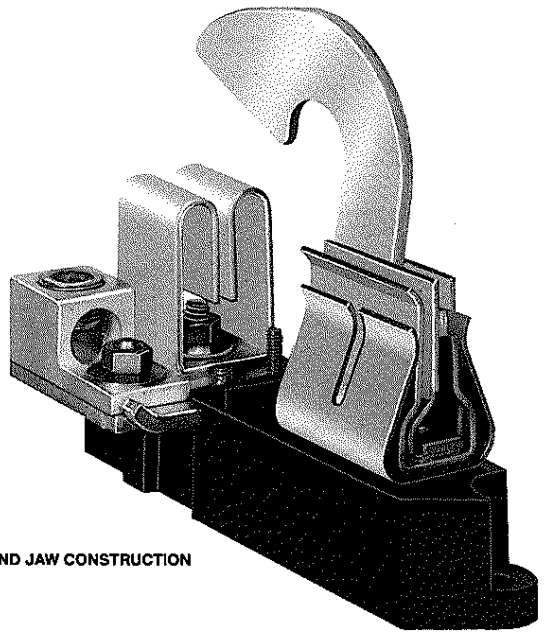
FUSE BASE ASSEMBLY

FUSE CLIP

LOAD LUG

SWITCH BLADE AND JAWS

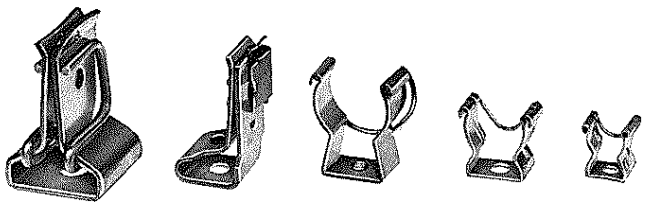
Two types of switch contacts are used by the industry in today's safety switches. One is the "butt" contact; the other is a knife-blade and jaw type. On switches with knife-blade construction, the jaws distribute a uniform clamping pressure on both sides of the blade contact surface. In the event of a high-current fault, the electromagnetic forces which develop tend to squeeze the jaws tightly against the blade. In the butt type contact, only one side of the blades contact surface is held in tension against the conducting path. Electromagnetic forces due to high current faults tend to force the contacts apart, causing them to burn severely. Consequently, Square D uses the knife blade and jaw type construction on all heavy duty switches. The action of the blades moving in and out of the jaws aids in cleaning the contact surfaces. All current-carrying parts of these switches are plated to reduce heating by keeping oxidation at a minimum. Switch blades and jaws are made of copper for high conductivity. Spring-clamped blade hinges are another Square D feature that help assure good contact surfaces and cool operations. "Visible blades" are utilized to provide visual evidence that the circuit has been opened.



BLADE AND JAW CONSTRUCTION

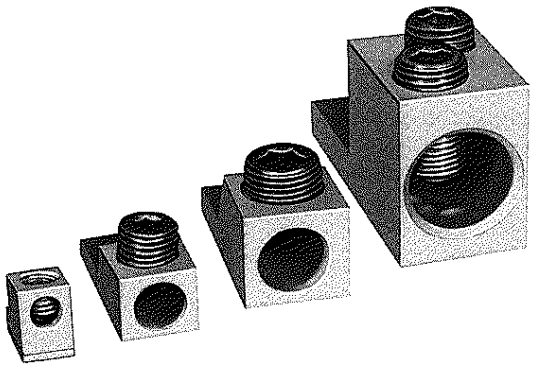
FUSE CLIPS

Fuse clips are plated to control corrosion and to keep heating to a minimum. All fuse clips on heavy duty switches have steel reinforcing springs for increased mechanical strength and firmer contact pressure.



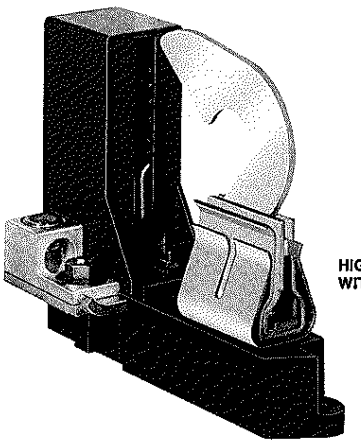
TERMINAL LUGS

The complete heavy duty switch line has front removable, screw-type terminal lugs. All switch lugs are suitable for copper or aluminum wire except TYPE 4, 4X, 5 stainless and TYPE 12 & 12K switches which have all copper current carrying parts and lugs designated for use with copper wire only. Heavy duty switches are suitable for the wire sizes and number of wires per pole as listed in tables 3.1.1 and 3.1.2.



INSULATING MATERIAL

As the voltage rating of switches is increased, arc suppression becomes more difficult and the choice of insulation material becomes more critical. Arc suppressors used by Square D consist of a housing made of insulation material and magnetic suppressor plates when required. All arc suppressor materials have been thoroughly tested to assure proper control and extinguishing of arcs.



HIGH VOLTAGE BASE WITH ARC SUPPRESSOR

TABLE 3.1.1

TYPE 1 AND 3R
HEAVY DUTY TERMINAL LUG DATA

Ampere Rating	Conductors Per Phase	Wire Range Wire Bending Space Per NEC Table 373-6	Lug Wire Range	Optional VERSA-CRIMP Compression Lug Field Installable
30	1	#12-6 AWG (Al) or #14-6 AWG (Cu)	#12-2 AWG (Al) or #14-2 AWG (Cu)	—
60	1	#12-3 AWG (Al) or #14-3 AWG (Cu)	#12-2 AWG (Al) or #14-2 AWG (Cu)	—
100	1	#12-1/0 AWG (Al) or #14-1/0 AWG (Cu)	#12-1/0 AWG (Al) or #14-1/0 AWG (Cu)	VCEL-021-14S1
200	1	#6 AWG-250 MCM (Al/Cu)	#6 AWG-300 MCM (Al/Cu)	VCEL-030-516H1
400	1 or 2	#3/0 AWG-750 MCM (Al/Cu) or #6 AWG-300 MCM (Al/Cu)	#3/0 AWG-750 MCM (Al/Cu) and #6 AWG-300 MCM (Al/Cu)	VCEL-075-12H1 or VCEL-030-516H1 and VCEL-050-12H1
600	2	#3/0 AWG-500 MCM (Al/Cu)	#3/0 AWG-500 MCM (Al/Cu)	VCEL-050-12H1
800	3	#3/0 AWG-750 MCM (Al/Cu)	#3/0 AWG-750 MCM (Al/Cu)	—
1200	4	#3/0 AWG-750 MCM (Al/Cu)	#3/0 AWG-750 MCM (Al/Cu)	—

TABLE 3.1.2

TYPE 4, 4X, 5 STAINLESS, AND TYPE 12 AND 12K
HEAVY DUTY TERMINAL LUG DATA

Ampere Rating	Conductors Per Phase	Wire Range Wire Bending Space Per NEC Table 373-6	Lug Wire Range	Optional VERSA-CRIMP Compression Lug Field Installable
30	1	#14-6 AWG (Cu)	#14-2 AWG (Cu)	—
60	1	#14-4 AWG (Cu)	#12-2 AWG (Cu)	—
100	1	#14-1 AWG (Cu)	#14-1 AWG (Cu)	VCEL-021-14S1
200	1	#6 AWG-250 MCM (Cu)	#6 AWG-250 MCM (Cu)	VCEL-030-516H1
400	1 or 2	#1/0 AWG-600 MCM (Cu) or #6 AWG-250 MCM (Cu)	#1/0 AWG-600 MCM (Cu) and #6 AWG-250 MCM (Cu)	VCEL-075-12H1 or VCEL-030-516H1 and VCEL-050-12H1
600	2	#4 AWG-350 MCM (Cu)	#4 AWG-350 MCM (Cu)	VCEL-050-12H1

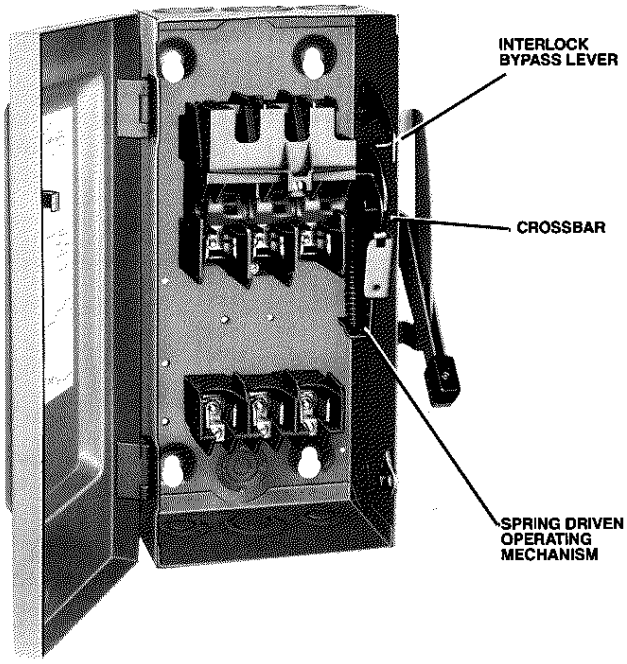
VERSA-CRIMP is a Registered Trademark of Square D Company.
NEC is a Registered Trademark of the National Fire Protection Association.

OPERATING MECHANISM & COVER LATCHING

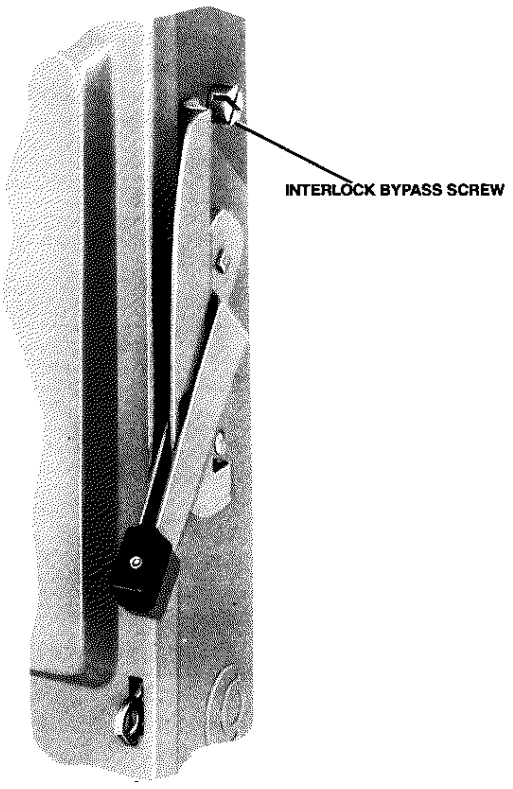
Square D heavy duty safety switches have a spring driven quick-make, quick-break mechanism. A quick-breaking action is necessary if the switch is to be safely switched OFF under a heavy load.

The spring action, in addition to making the operation quick-make, quick-break firmly holds the switch blades in the ON or OFF position. The operating handle is an integral part of the switching mechanism and is in direct control of the switch blades under normal conditions.

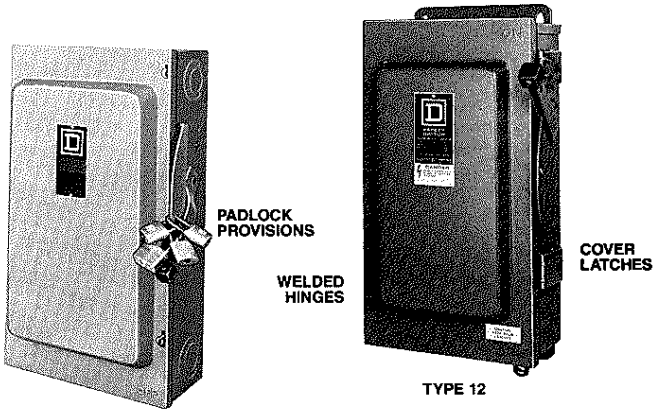
A one-piece cross bar, connected to all switch blades, adds to the overall stability and integrity of the switching assembly by promoting proper alignment and uniform switch blade operation.



Dual cover interlocks are standard on all heavy duty switches (except TYPE 7 and 9 which feature bolted covers.) The dual interlock prevents the enclosure door from being opened when the switch handle is in the ON position and prevents the switch from being turned ON while the door is open. A means of bypassing the interlock is provided to allow the switch to be inspected in the ON position.



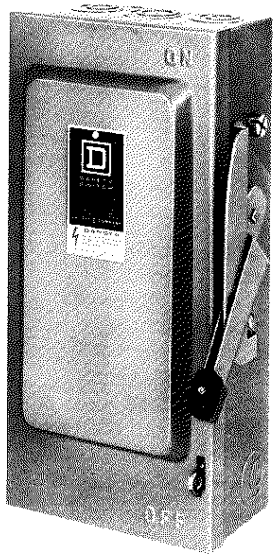
TYPE 1, TYPE 4, 4X, 5 stainless, and TYPE 12 and 12K enclosures feature four point latching doors. This means that, with the door closed and the switch ON, the door is held firmly to the enclosure near each of the four corners by hinges and latching mechanisms. This provides additional protection should a fuse rupture occur within the enclosure. Heavy duty switches can be padlocked in the OFF position with up to three padlocks.



TYPE 12

ENCLOSURE

Square D heavy duty switches are available in a variety of enclosures which have been designed to conform to specific industry requirements based upon the intended use. Sheet metal enclosures (eg., TYPE 1) are constructed from cold-rolled steel which is phosphatized and finished with an electrodeposited enamel paint. The TYPE 3R rainproof and TYPE 12 and 12K dusttight enclosures are manufactured from galvannealed sheet steel and painted to provide better weather protection. The TYPE 4, 4X and 5 enclosures are made of corrosion resistant Type 304 stainless steel; no painting required. TYPE 7 & 9 enclosures are cast from copper-free aluminum and finished with an enamel paint.

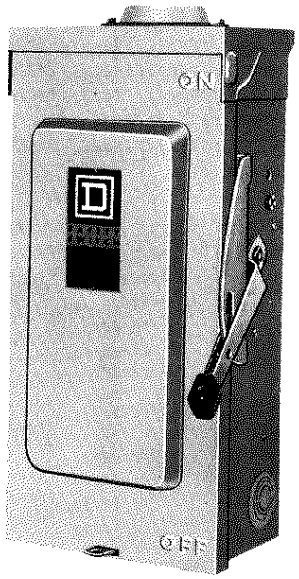


TYPE 1 HEAVY DUTY SWITCH

TYPE 1 switches are general purpose and designed for use indoors to protect the enclosed equipment from falling dirt and personnel from live parts. Switches rated through 200 amperes are provided with ample knockouts. 400 through 1200 ampere switches are provided without knockouts.

TYPE 3R switches are designated "rainproof" and are designed for use outdoors.

TYPE 3R enclosures for switches rated through 200 amperes have provisions for interchangeable bolt-on hubs at the top endwall. TYPE 3R switches rated higher than 200 amperes have blank top endwalls. Knockouts are provided (below live parts only) on enclosures for 200 ampere and smaller TYPE 3R switches. TYPE 3R switches are available in ratings through 1200 amperes.



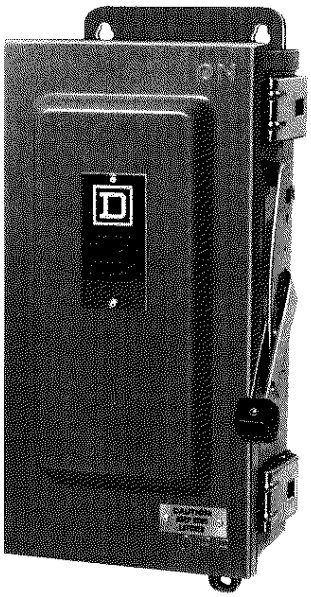
TYPE 3R HEAVY DUTY SWITCH

TYPE 4, 4X, 5 stainless steel switches are designated dusttight, watertight and corrosion resistant and designed for indoor and outdoor use. Common applications include commercial type kitchens, dairies, canneries, and other types of food processing facilities, as well as areas where mildly corrosive liquids are present. All TYPE 4, 4X and 5 stainless steel enclosures are provided without knockouts. Use of watertight hubs is required. Available switch ratings are 30 through 600 amperes.

TYPE 4, 4X, 5 STAINLESS HEAVY DUTY SWITCH

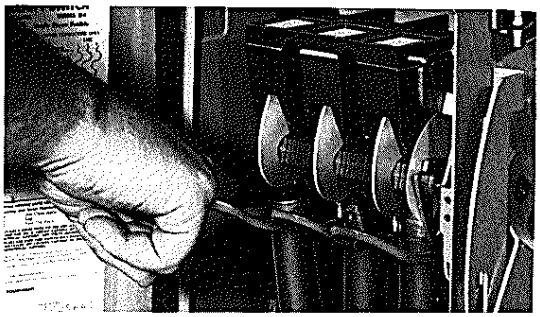
SAFETY SWITCHES

TYPE 12 and TYPE 12K switches are designated dusttight (except at knockout locations on TYPE 12K) and are designed for indoor use. In addition, Square D TYPE 12 safety switches are designated as raintight for outdoor use when the supplied drain plug is removed. Common applications include heavy industries where the switch must be protected from such materials as dust, lint, flyings, oil seepage, etc. TYPE 12K switches have knockouts in the bottom and top endwalls only. Available switch ratings are 30 through 600 amperes in TYPE 12 and 30 through 200 amperes in TYPE 12K.



TYPE 12 HEAVY DUTY SWITCH

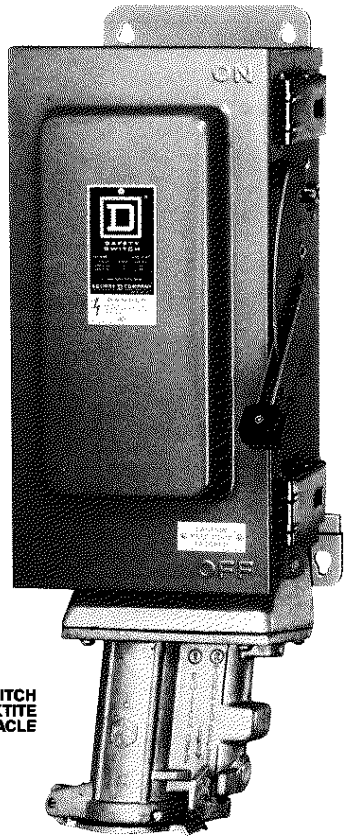
All Square D TYPE 4, 4X, 5, TYPE 12, and TYPE 12K switch enclosures feature positive sealing to provide a dusttight and raintight (watertight with stainless steel) seal. Enclosure doors are supplied with oil resistant gaskets. Switches rated 30 through 200 amperes incorporate unique spring loaded, quick-release latches. 400 and 600 ampere switches feature single-stroke sealing by operation of a cover mounted handle. 30, 60 and 100 ampere switches in these enclosures are provided with factory installed fuse pullers.



FUSE PULLERS

INTERLOCKED RECEPTACLES

60 ampere TYPE 1 and TYPE 12 switches with either a HUBBELLOCK or ARKTITE interlocked receptacle are also provided. This receptacle provides a means for connecting and disconnecting loads directly to the switch. A non-defeating interlock prevents the insertion or removal of the receptacle plug while the switch in is the ON position. It also prevents operation of the switch if an incorrect plug is used.

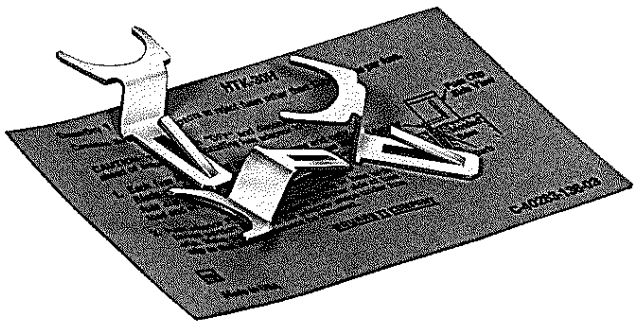


TYPE 12 SAFETY SWITCH WITH CROUSE-HINDS ARKTITE INTERLOCKED RECEPTACLE

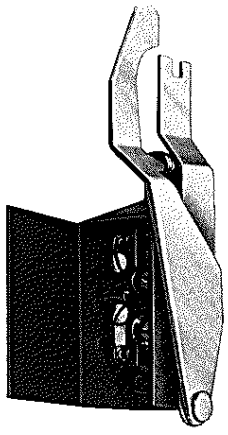
ACCESSORIES

Accessories available for field installation include Class R fuse kits, fuse pullers, insulated neutrals with grounding provisions, equipment grounding kits, watertight hubs for use with TYPE 4, 4X, 5 stainless or TYPE 12 switches, and interchangeable bolt-on hubs for TYPE 3R switches.

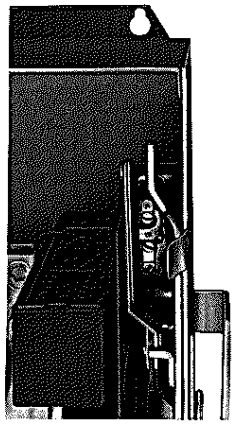
CLASS R FUSE KIT



Electrical interlock consists of auxiliary contacts for use where control or monitoring circuits need to be switched in conjunction with the safety switch operation. Kits can be either factory or field installed, and they contain either one normally open and one normally closed contact or two normally open and two normally closed contacts. The electrical interlock is actuated by a pivot arm which operates directly from the switch mechanism. The electrical interlock is designed so that its contacts disengage before the blades of the safety switch open and engage after the safety switch blades close.



ELECTRICAL INTERLOCK



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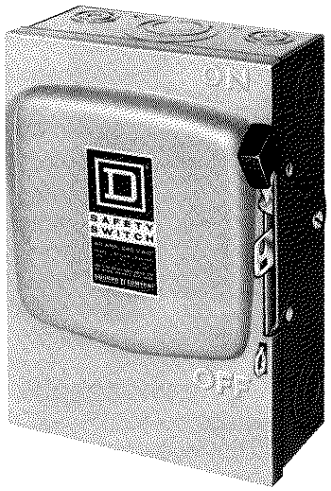
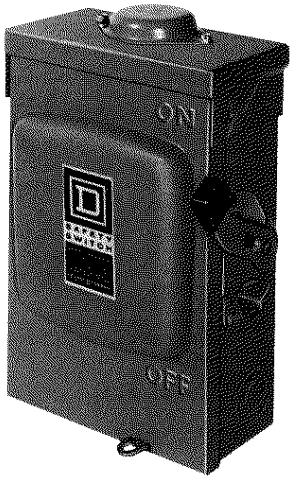
3.2 GENERAL DUTY SWITCHES

General duty switches for residential and light commercial applications are used where operation and handling are moderate and where the available fault current is 10,000 RMS symmetrical amperes or less. Square D general duty safety switches exceed this specification in that they are UL listed for application on systems having up to 100,000 RMS symmetrical amperes of available fault current when Class R fuses and Class R fuse kits are used. Class T fusible switches are also available in 400, 600 and 800 ampere ratings. These switches accept 300VAC Class T fuses only. Some examples of general duty switch application include residential, farm, and small business services entrances, and light duty branch circuit disconnects.



GENERAL PURPOSE TYPE 1

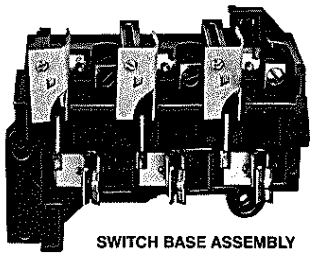


RAINPROOF TYPE 3R

General duty switches are rated up to 600 amperes at 240 volts AC in general purpose (TYPE 1) and rainproof (TYPE 3R) enclosures. These switches are horsepower rated and capable of opening a circuit up to six times the rated current of the switch.

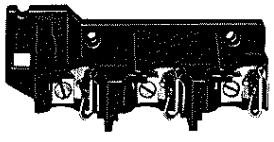
SWITCH BLADES AND JAWS

All current carrying parts of general duty switches are plated to minimize oxidation and reduce heating. Switch jaws and blades are made of copper for high conductivity.

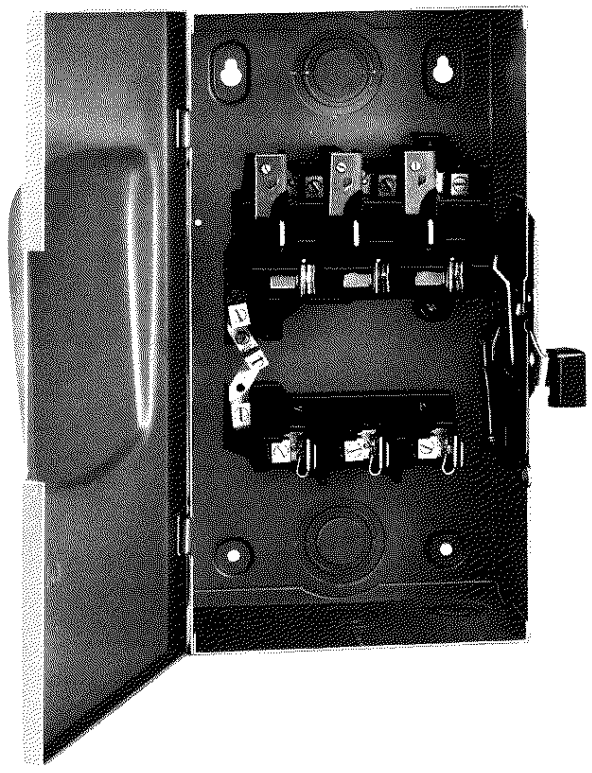


SWITCH BASE ASSEMBLY

FUSE BASE ASSEMBLY



FUSE CLIP AND LOAD LUG



Where required, a steel reinforcing spring increases the mechanical strength of the jaws and contact pressure between the blade and jaw. Good pressure contact maintains the blade-to-jaw resistance at a minimum, which in turn, promotes cool operation. All general duty switch blades feature visible blade construction. With the door open, there is visually no doubt when the switch is OFF.

FUSE CLIPS

Fuse clips are plated to control corrosion and keep heating to a minimum. Where required, steel reinforcing springs are provided to increase the mechanical strength of the fuse clip. The result is a firmer, cooler connection to the fuses as well as superior fuse retention.

TERMINAL LUGS

All Square D general duty safety switches are furnished with mechanical set screw lugs which are suitable for aluminum or copper conductors.

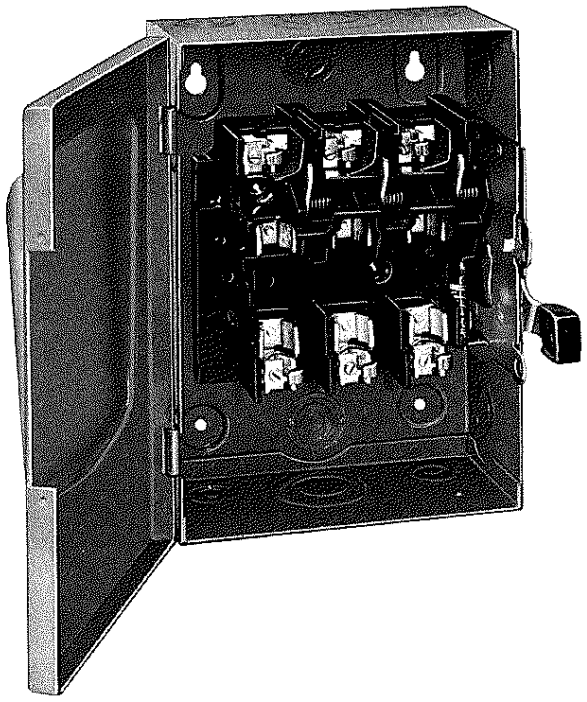
GENERAL DUTY — TERMINAL LUG DATA

Ampere Rating	Conductors Per Phase	Wire Range Wire Bending Space Per NEC Table 373-6	Lug Wire Range
30 Line Load	1 1	#12-6 AWG (Al) or #14-6 AWG (Cu) #14-8 AWG (Al/Cu)	#12-6 AWG (Al) or #14-6 AWG (Cu)★ #14-8 AWG (Al/Cu)
60	1	#10-3 AWG (Al) or #14-3 AWG (Cu)	#10-2 AWG (Al) or #14-2 AWG (Cu)
100	1	#12-1 AWG (Al) or #14-1 AWG (Cu)	#12-1/0 AWG (Al) or #14-1/0 AWG (Cu)
200	1	#4 AWG-250 MCM (Al/Cu)	#4 AWG-300 MCM (Al/Cu)
400	2	#1/0 AWG-250 MCM (Al/Cu)	(1) #1 AWG-600 MCM (Al/Cu) (2) #1 AWG-250 MCM (Al/Cu)
600	2	#4 AWG-500 MCM (Al/Cu)	#4 AWG-600 MCM (Al/Cu)
800	3	#3/0 AWG-500 MCM (Al/Cu)	#3/0 AWG-500 MCM (Al/Cu)

★Excluding #8 AWG solid.

INSULATING MATERIAL

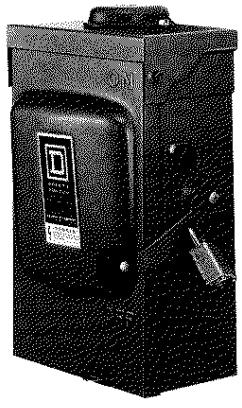
Switch base and fuse bases are made of a strong, non-combustible, moisture-resistant material which provides the required phase-to-phase and phase-to-ground insulation for applications on 240VAC systems.



OPERATING MECHANISM AND COVER LATCHING

Although not required by either the UL or NEMA standards, Square D general duty switches have spring-driven quick-make, quick-break operating mechanisms. Operating handles are an integral part of the operating mechanism and are not mounted on the enclosure cover. The handle provides indication of the status of the switch. When the handle is up, the switch is ON. When the handle is down, the switch is OFF. A padlocking bracket is provided which allows the switch handle to be locked in the OFF position. Another bracket is provided which allows the enclosure to be padlocked closed.

COVER PADLOCK PROVISION



HANDLE LOCKOFF PROVISION

ENCLOSURES

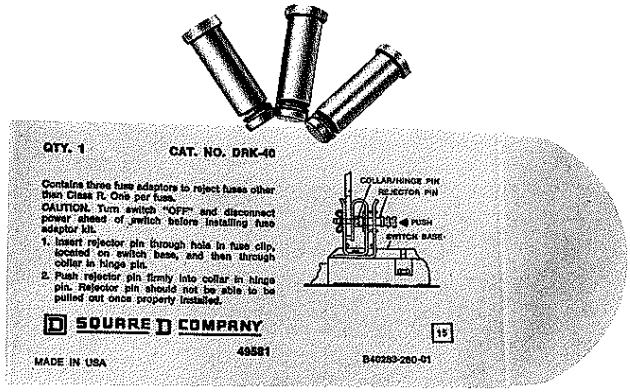
General duty switches are available in either TYPE 1 for general purpose, indoor applications, or TYPE 3R for rainproof, outdoor applications. (See Section 2.9 for information on enclosure types). Adequate wiring space and a sufficient number of knockouts are provided.

TYPE 1 switch enclosures are made from code gauge steel which is given a rust-inhibiting treatment and a gray electrodeposited enamel finish. These enclosures are provided with front operated handles and minimum cover draws which allow 30 through 200 ampere switches to be mounted very close to each other.

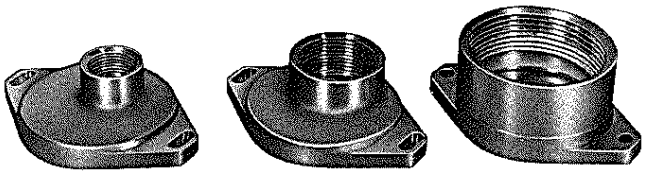
TYPE 3R rainproof enclosures are constructed from galvannealed sheet steel which is given a rust-inhibiting treatment and a gray electrodeposited enamel finish. Enclosures for switches rated through 200 amperes are supplied with provisions for interchangeable bolt-on hubs. All knockouts are provided below the level of the lowest live parts to maintain the integrity of the rainproof design.

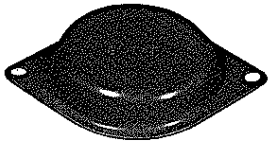
ACCESSORIES

Class R fuse kits are available for field installation in general duty switches. When these fuse kits and Class R fuses are installed, Square D general duty switches are UL listed for use on systems having an available fault current up to 100,000 RMS symmetrical amperes. Also available are insulated neutrals with grounding provisions and equipment grounding kits. Interchangeable bolt-on hubs are available for use with TYPE 3R switches.



CLASS R FUSE KIT





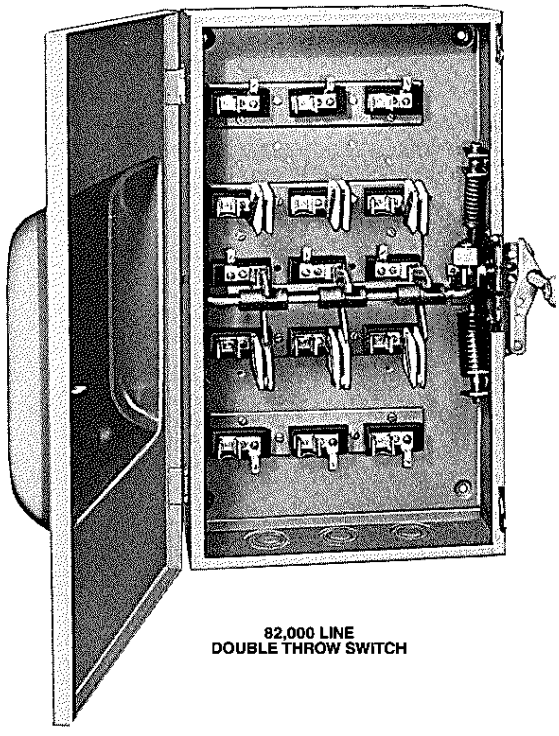
INTERCHANGEABLE
BOLT-ON HUBS

3.3 DOUBLE THROW SAFETY SWITCHES

Double throw switches are used as manual transfer switches and are not intended for use as motor circuit switches; thus, horsepower ratings are generally unavailable. Square D has three lines of double throw switches, and they are designated by either an 82, 92 or DTU catalog number prefix.

82,000 LINE

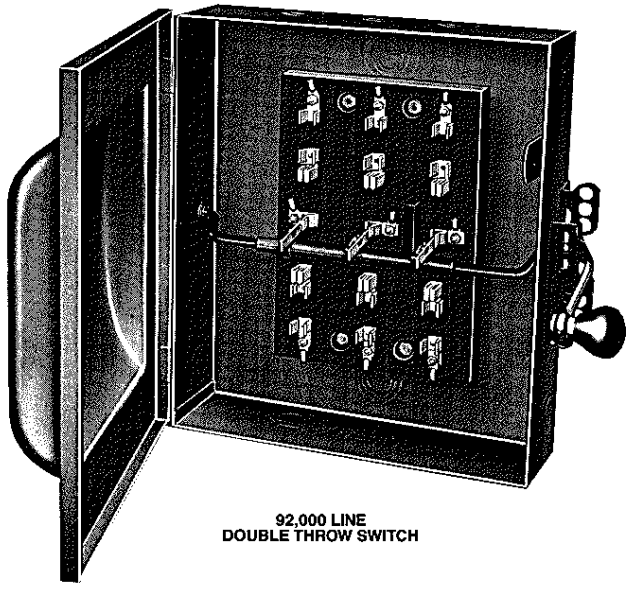
Those with 82 catalog number prefixes are available as either fused or not fusible devices. These switches feature quick-make, quick-break action, plated current carrying parts, a key controlled cover and switch interlock mechanism and mechanical lugs. Arc suppressors are supplied on all switches rated above 240 volts. Provisions for up to three padlocks are available to lock the handle in the OFF position. These switches are available from 60 to 200 amperes with 2 or 3 switchable poles at 240 or 600 volts AC and come in either TYPE 1 or TYPE 3R enclosures. (See Section 2.9 for information on enclosure types). The 60 and 100 ampere designs at 240VAC are rated at 15 hp. The 60, 100 and 200 ampere designs at 240 volts have provisions for field installable Class R fuse kits.



82,000 LINE
DOUBLE THROW SWITCH

92,000 LINE

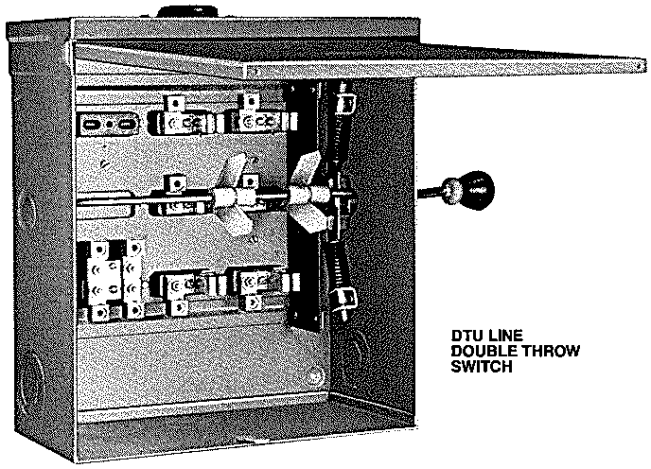
Those with 92 catalog number prefixes are slow-make, slow-break and are available in both fused and not fusible versions. Padlocking provisions are standard. Standard enclosure types are TYPE 1 and TYPE 3R. These switches are available in 30 amperes at 240 volts AC, 400 and 600 amperes at 240 and 600 volts AC with 2 or 3 switchable poles, and 60 through 600 amperes with 4 switchable poles at 240 or 600 volts AC.



92,000 LINE
DOUBLE THROW SWITCH

DTU LINE

Double throw switches with a DTU catalog number prefix are available in a not fusible TYPE 3R version only at 240 volts AC. These devices are quick-make, quick-break, are supplied with a factory installed neutral, and include a closing cap with provisions for bolt-on hubs. The DTU switches are available in 100 and 200 ampere ratings for 2 or 3 switchable pole applications and are rated 15 hp. DTU double throw switches are UL listed and suitable for use as service equipment.

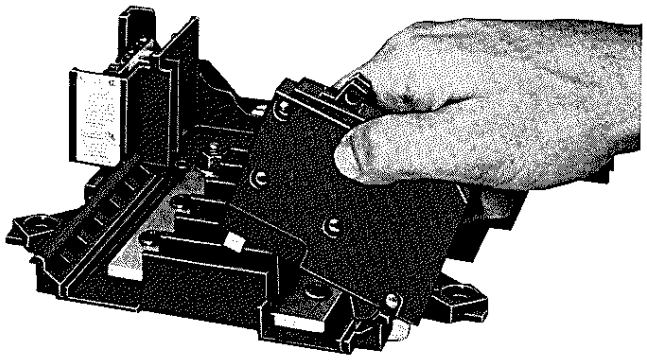


DTU LINE
DOUBLE THROW
SWITCH

NOTES

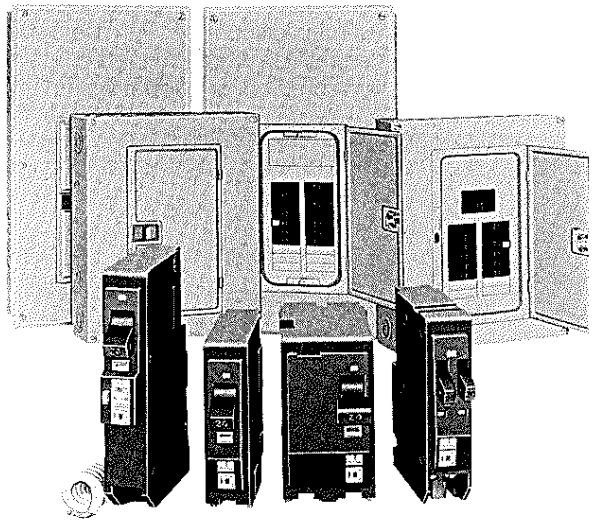
4.0 LOAD CENTERS GENERAL

QO Load centers are UL listed Class CTL (circuit limiting) panelboards. The National Electrical Code (NEC) requires that lighting and appliance branch-circuit panelboards be provided with physical means to prevent the installation of more overcurrent devices than that number for which the panelboard was designed, rated and approved. QO load centers are designed as lighting and appliance branch panelboards — that is a panelboard that has more than 10 percent of its overcurrent devices rated 30 amperes or less, for which neutral connections are provided and that does not have more than 42 overcurrent devices installed (other than those provided for in the mains). Class CTL is the UL designation of a panelboard which meets these NEC requirements.



CLASS CTL CIRCUIT LIMITING TANDEM BREAKER

For example, if a load center is designed, rated and approved for 24 overcurrent devices, this could be accomplished by a load center with 12 spaces — all of which would accept QOT tandem breakers — a total of 24 overcurrent devices; or by a load center with 16 spaces — 8 of which would accept QOT tandem breakers and 8 of which would accept QO breakers only — a total of 24 overcurrent devices; or by a load center with 24 spaces — all of which would accept QO breakers only — a total of 24 overcurrent devices. QO breakers can be installed in any load center space; QOT tandem breakers can be installed only in those spaces having provisions for these breakers. All load centers meet Federal Specification W-P-115b, Type 1 Class 2 for use in Government Housing.



Each QO load center has provisions for installation of an equipment ground terminal assembly, which is sold separately.

SERVICE

QO load centers are rated for use on 1Ø2W, 1Ø3W, 3Ø3W and 3Ø4W systems, 240VAC maximum.

RATINGS

Main Lugs
Single phase load centers are rated 30 amperes through 600 amperes. Three phase load centers are rated 60 amperes through 600 amperes.

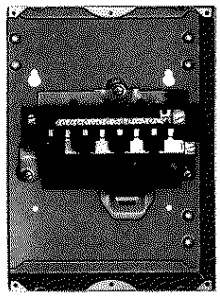
Main Breaker
Single phase load ceners are rated 100 amperes through 400 amperes. Three phase load centers are rated 100 amperes through 400 amperes.

Mobile Home and Trailer
Single phase load centers are rated 30 amperes through 200 amperes.

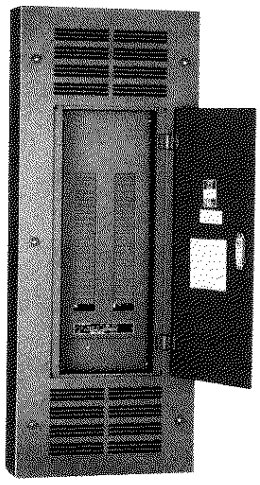
Riser Panels
Single phase load centers are rated 125 amperes.

4.1 MAIN LUGS LOAD CENTERS

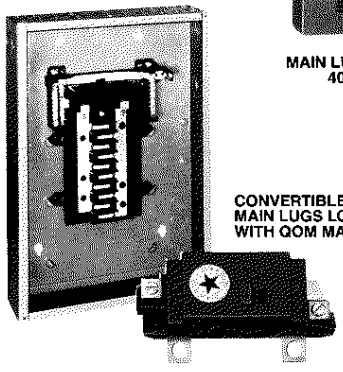
Main lugs load centers are for providing distribution of electrical power where a main disconnect with overcurrent protection is provided separately from the load center. All terminals are suitable for aluminum or copper conductors.



MAIN LUGS INDOOR LOAD CENTER
WITH COVER REMOVED



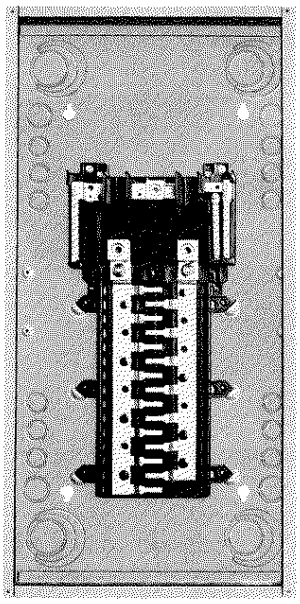
MAIN LUGS INDOOR LOAD CENTER
400-600 AMPERE, 3Ø4W



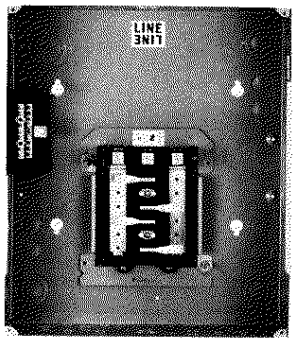
CONVERTIBLE
MAIN LUGS LOAD CENTER
WITH QOM MAIN BREAKER KIT

Main lugs load centers have factory installed main lugs. They are available in single phase from 30 through 100A, 400A and 600A. They are available in three phase from 60 through 600A. A main lugs load center can be converted to a main breaker load center by installing a circuit breaker onto the bus bars and then "back-feeding" that breaker with the service or feeder conductors. "Back-feeding" means that the incoming conductors are connected directly to the load side terminals of the circuit breaker so that the incoming power flows through the breaker and to the bus. After this breaker is installed, the number of spaces available for branch circuits is equal to the number of original spaces in the load center less the number of spaces taken up by this breaker.

Single phase, 125 through 225A, main lugs load centers are supplied with factory installed main lugs and can be converted to main breaker load centers without loss of branch circuit space. The conversion is accomplished by simply removing the main lugs from the bus and installing a main breaker kit in its place. Stocking space is greatly reduced, because main breaker kits are much smaller than total devices and can be stored in place of total devices, along with the desired amount of convertible main lugs devices. In either use, the mains are connected to the bus with mounting studs and keps nuts. When converting from main lugs to main breaker, it is important to remember that the main breaker rating must not exceed the amperage rating of the bus in the load center. Unlike other main lugs load centers, convertible load centers do not require use of branch breaker space when they are converted from main lugs to main breaker.

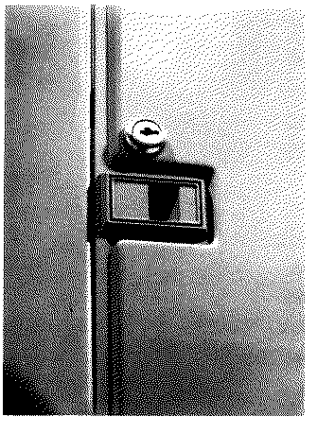


CONVERTIBLE MAIN LUGS
LOAD CENTER



3Ø4W MAIN LUGS
LOAD CENTER

Along with being easily modified, convertible load centers offer many beneficial features. Covers for these devices are universal main lugs/main breaker, meaning fewer covers must be stocked. Upon conversion to main breaker, the factory installed main breaker twist-out is simply removed and the cover is ready for main breaker use. The 14.25" wide enclosure used for all convertible load centers, provides more side gutter wiring space and easy installation between 16" centered studs. Since the neutral terminals are split and located near the mains, straight-in wiring is accomplished saving installation time, wire and side gutter space. All convertible covers have low profile hinges and "designer" latches, while convertible flush covers have rounded corners and beveled edges for a more pleasant appearance. Automatic flush adjustment and triple lead cover screws reduce installation time. Triple lead screws require only one third the time to install as conventional cover screws.

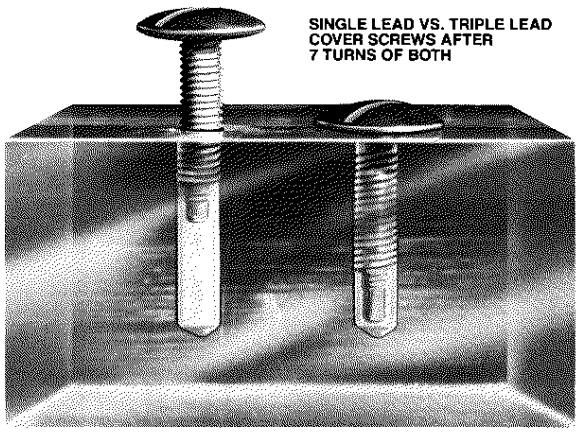


"DESIGNER" COVER LATCH
WITH FIELD INSTALLABLE LOCK

AUTOMATIC
FLUSH ADJUSTMENT
FEATURE

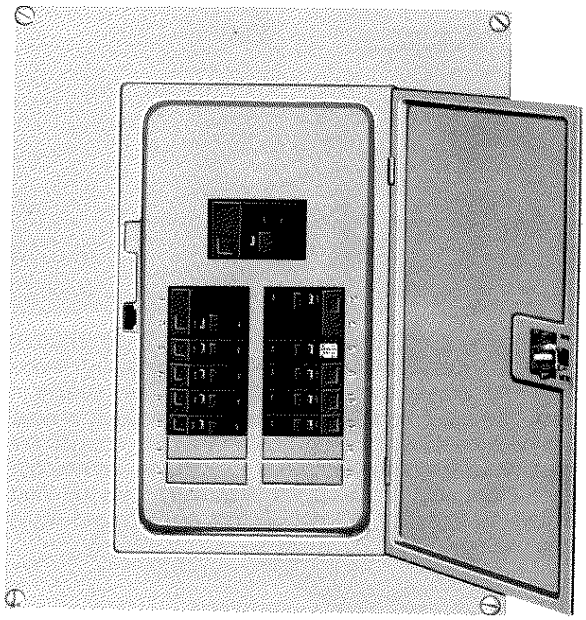
4.2 MAIN BREAKER LOAD CENTERS

Main breaker load centers also come in convertible and non-convertible construction. The 300A and 400A single phase main breaker load centers and all three phase main breaker load centers are supplied with a factory installed main breaker and can not be modified to main lugs devices. The 100A through 225A single phase main breaker devices are convertible with the same beneficial features as the convertible main lugs load centers. Installation time and cost are reduced because the main breaker is factory installed, and modification to main lugs is just as easy as converting main lugs to main breaker. The conversion is accomplished by removing keps nuts and the main breaker and installing main lugs in its place. As an alternative to stocking main lug devices and main breaker kits, main breaker devices can be stocked with main lug kits. Either plan will save stocking costs. The main lugs rating does not exceed the ampere rating of the bus in the device.



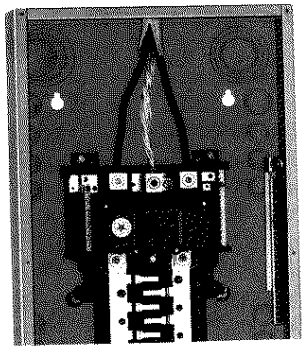
SINGLE LEAD VS. TRIPLE LEAD
COVER SCREWS AFTER
7 TURNS OF BOTH

The 600A type HQ2 mains lugs load center is available for garden, townhouse and other types of two to six unit apartment complexes where individual metering is not required. It is UL listed as service entrance equipment only and the neutral is factory bonded to the box. This load center will accept plug-on type FA or Q2 2-pole circuit breakers through 200A.

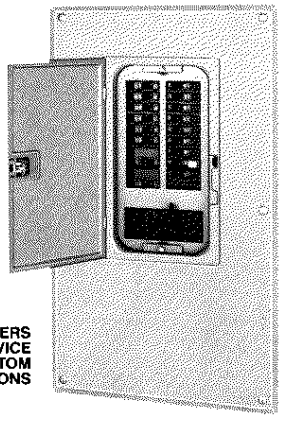


CONVERTIBLE MAIN BREAKER LOAD CENTER
WITH BRANCH BREAKERS AND COVER INSTALLED

The neutral terminals for branch circuits in both main lugs and main breaker load centers are suitable for use with #14-#4 AWG copper or #12-#4 AWG aluminum wire. The main line-side terminals in both main lugs and main breaker devices are suitable for use with copper or aluminum conductors.

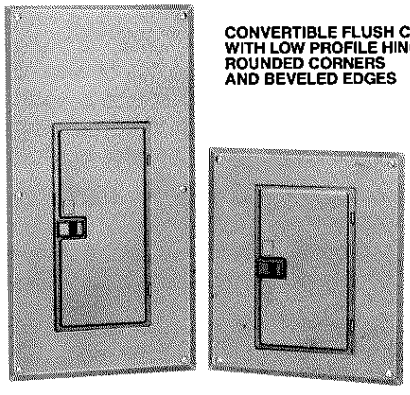


CONVERTIBLE MAIN BREAKER LOAD CENTER WITH MAIN TERMINALS LOCATED FOR EASY WIRING



CONVERTIBLE LOAD CENTERS UL LISTED FOR ENTIRE DEVICE TO BE ROTATED FOR BOTTOM FEED APPLICATIONS

Both the single phase main lugs and main breaker convertible load centers are UL listed for the entire device to be rotated in bottom-feed applications. The interiors in these devices are easily removable for the pulling of wire, and have captive mounting screws that will not get lost when the interior is removed. Covers for convertible devices are sold and shipped separately from the load centers so that they will not get lost or damaged while construction is still in progress.

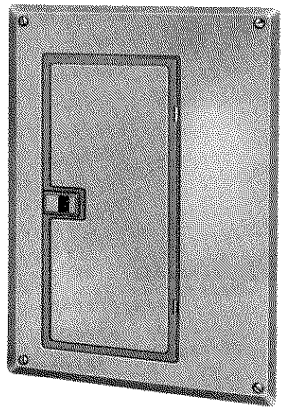


CONVERTIBLE FLUSH COVERS WITH LOW PROFILE HINGES, ROUNDED CORNERS AND BEVELED EDGES

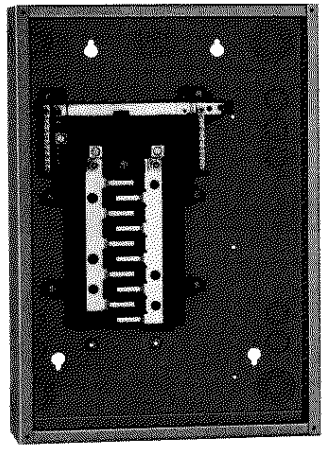
4.3 RISER PANELS

Convertible main lugs riser panels have an offset interior so that they can be utilized on low rise office buildings and certain apartment complexes. The offset interior permits

CONVERTIBLE RISER PANEL WITH FLUSH COVER



riser cable to be run through the extended gutter space and tapped to the main lugs or main breaker. These are single phase three wire devices rated 125. Flush covers are shipped with these devices.

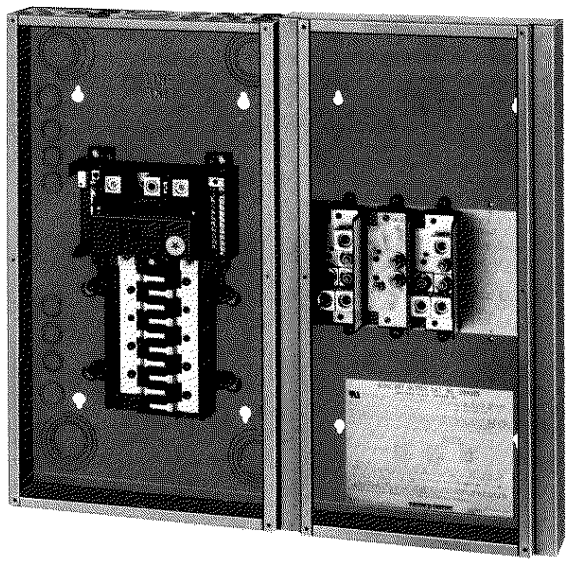


CONVERTIBLE RISER PANEL WITH COVER REMOVED

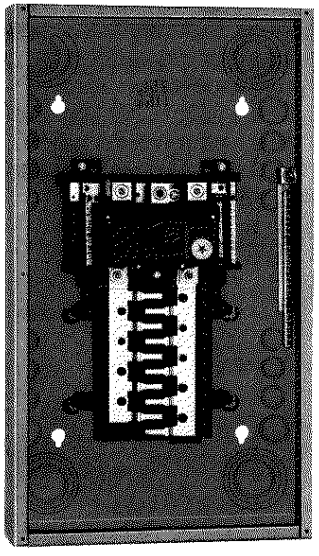
A standard load center may be converted in the field to a riser panel by adding one of the appropriate auxiliary gutters, that may be attached to either the right or left side of the load center. Auxiliary gutters and tap kits are sold separately.

4.4 MOBILE HOME & TRAILER LOAD CENTERS

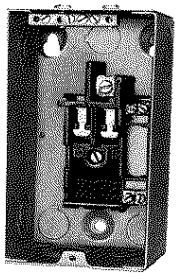
Mobile home and trailer load centers are single phase two wire and single phase three wire with factory installed main lugs from 30A through 100A and factory installed main breaker from 100A through 200A. A 70A single phase two wire main breaker device is available with field installed standard QO single pole breaker. They are all shipped with covers included and contain a factory installed ground bar in the side gutter. The main lugs models are fixed mains while the 100 through 200A main breaker models are of convertible construction.



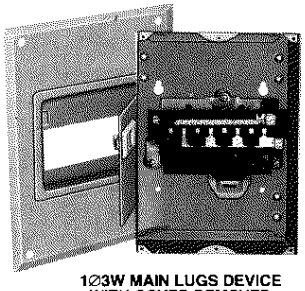
CONVERTIBLE LOAD CENTER AND AUXILIARY GUTTER AND TAP KITS



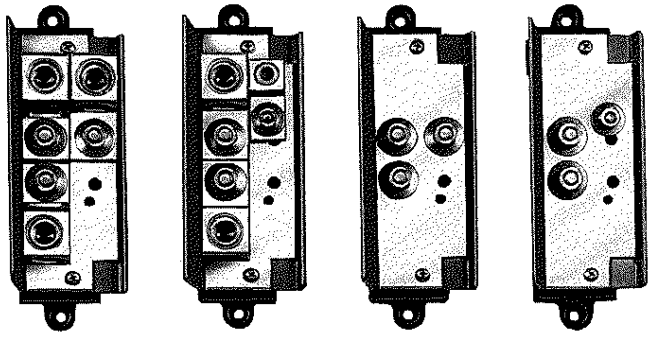
1Ø3W MAIN BREAKER DEVICE WITH COVER REMOVED



1Ø2W MAIN LUGS DEVICE WITH COVER REMOVED

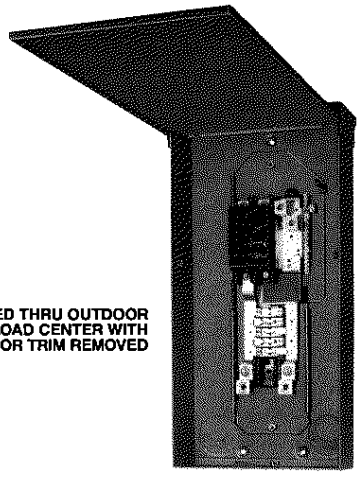


1Ø3W MAIN LUGS DEVICE WITH COVER REMOVED



TAP KITS

Service equipment for a mobile home must be located outside the mobile home. Outdoor feed-thru QO load centers can be used for this application. In these panels,



FEED THRU OUTDOOR LOAD CENTER WITH INTERIOR TRIM REMOVED

QO is a Registered Trademark of Square D Company.

the incoming service is connected to a main breaker at the top of the panel. Feed-thru lugs are connected to the panel bus at the bottom end of the panel. The panel inside the mobile home is connected to the feed-thru lugs. The branch breaker spaces in the feed-thru panel are used for circuit breakers to supply power to load outside the mobile home.

4.5 EQUIPMENT GROUND KITS

Ground bar terminals are suitable for one #14 to #4 AWG copper wire, one #12 to #4 AWG aluminum wire, two #14 or #12 AWG copper wires and two #12 or #10 AWG aluminum wires. Ground bars are to be used in nonservice entrance (sub-feed) installations where the neutral and ground wires are required to be kept separate in the load center. They are also used in service entrance applications where additional ground wire terminals are required. Ground bar kits are available with 3 through 27 terminals. All QO load centers have ground bar mounting provisions. The wiring diagram in each load center indicates the proper ground bar kit for that device.

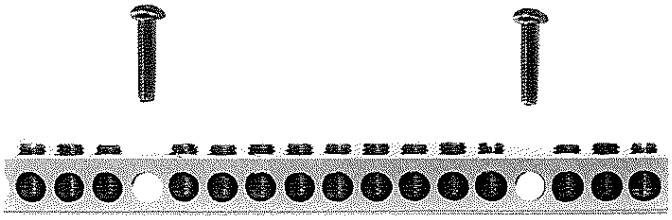
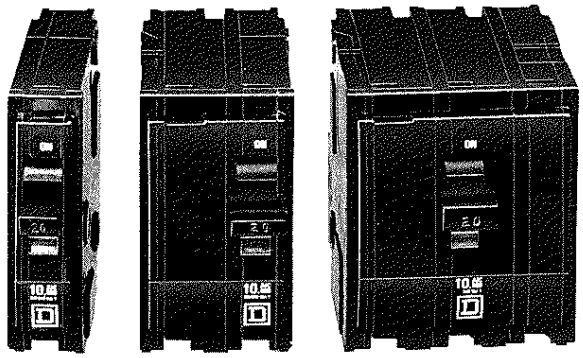


FIGURE 4.5.1

4.6 BRANCH CIRCUIT BREAKERS

A complete line of 1, 2 and 3-pole QO plug-on breakers are available with ratings through 125 amperes. Various QO breaker types combine with QO load centers to provide tailor made circuitry to meet specific applications. For additional information on QO breakers, refer to Section 2.7.



QO 1, 2 AND 3-POLE PLUG-ON BREAKERS

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4.8 EXAMPLE PROBLEMS

Example #1

Question

The customer needs a main breaker load center to be used indoors on a 1 phase 3W, 120/240VAC system, with a suface cover. It is to be used as service entrance equipment. The branch breakers needed are as follows:

Quantity	Amperes	No. of Poles Per Breaker
1	50	2
1	20	2
3	20	1
1	20 GFI	1

What catalog numbers would you select for the load center, cover and circuit breakers considering the customer does not want to use tandem breakers and (a) the main breaker must be 60A and (b) the main breaker must be 70A?

Answer (a):

This application requires a 60A main breaker in a load center, and this is not available as a factory assembled device. You will need a main lugs load center and you will install a 60A plug-on QO circuit breaker at the site as a main breaker. This breaker will have to be back fed by the incoming wires in order to feed the bus bars in the load center.

First, determine the number of spaces needed in the load center. The circuit breakers determine this.

Equation (1):
(Quantity of a specific type of breaker)
times
(Number of spaces per breaker)
equals
(Total number of spaces needed in load center)

Circuit Breaker Catalog No.	Quantity Needed	No. Spaces Per Breaker	Total No. Spaces Needed in Load Center
QO260 Main Breaker	1	2	2
QO250	1	2	2
QO220	1	2	2
QO120	3	1	3
QO120GFI	1	1	1
		Total	10

In the Digest, on the Main Lugs—Indoor Load Centers page, the second column reads "Spaces". The number in this column must be a minimum of 10. Also, the "Mains Rating Amperes" column must be at least 60. The smallest device which fits this description is a QO12L100DS. The cover does not have to be ordered for this load center because it is shipped with the device. Therefore, the correct bill of material for part (a) of this order is

Quantity	Catalog Number
1	QO12L100DS
1	QO260
1	QO250
1	QO220
3	QO120
1	QO120GFI

Answer (b):

This situation requires a 70A main breaker in a load center, which is also not available as a factory assembled device. However, this application can be accomplished by modifying a convertible main lugs load center in the field. You will select the QOM70VH main breaker kit from the appropriate Digest page and use it to modify the appropriate main lugs load center from the Main Lugs — Indoor Load Center page. Since the number of spaces required for this application is known to be 8 (the original 10 spaces less the 2 spaces taken up by the back-fed QO260), the smallest load center with the lowest commercial net price which fits the description is the QO16L125. The main lugs on this device are simply unbolted from the bus and the QOM70VH main breaker kit is installed in their place. The surface cover to be used is a QOC16US. Therefore, the total bill of material for part (b) is:

Quantity	Catalog Number
1	QO16L125
1	QOC16US
1	QOM70VH
1	QO250
1	QO220
3	QO120
1	QO120GFI

Example #2

Question:
The customer wants a 200A main breaker load center with a flush cover to be used indoors. It is to be used as non-service entrance equipment on a 1 phase 3W, 120/240VAC system. The breakers needed are as follows:

Quantity	Amperes	No. of Poles Per Breaker
1	125	2
2	50	2
2	40	2
6	20	1
10	15	1
2	15 GFI	1

What catalog numbers would you select for the load center, cover, ground bar and circuit breakers, considering (a) the customer does not want to use tandems and (b) the customer does want to use tandems?

Answer (a):
Not using tandems, first determine the number of spaces needed in the load center by counting the number of circuit breakers and multiplying by the number of spaces per breaker.

Equation (1):
(Quantity of a specific type of breaker)
times
(Number of spaces per breaker)
equals
(Total number of spaces needed in load center)

Circuit Breaker Catalog No.	Quantity Needed	No. Spaces Per Breaker	Total No. Spaces Needed in Load Center
QO2125	1	2	2
QO250	2	2	4
QO240	2	2	4
QO120	6	1	6
QO115	10	1	10
QO115GFI	2	1	2
		Total	28

In the Digest, on the Main Breaker—Indoor Load Centers page, the second column reads "Spaces". The number in this column must be, at the minimum, equal to the total number of spaces needed in the load center (28). The only device which has at least 28 spaces and a 200A main breaker is the QO30M200. The flush cover is a QOC30UF.

The correct bill of material for part (a) of this order is:

Quantity	Catalog Number
1	QO30M200
1	QOC30UF
1	QO2125
2	QO250
2	QO240
6	QO120
10	QO115
2	QO115GFI
1	PF18GTA

Answer (b):
Using tandems, first convert all the circuit breakers possible to tandem breakers. (Make sure that the amperage rating you need is available as a tandem.) Table 1-a gives the full sized breakers from part (a) which can be changed into tandem breakers.

Table 1-a

Full Sized Circuit Breaker Catalog No.	Quantity Needed	No. of Circuits Per Breaker	Total No. of Circuits
QO120	6	1	6
QO115	10	1	10
		Total	16

Now, convert the above full size breakers in Table 1-a to tandems. This is shown in Table 1-b.

Table 1-b

Tandem Circuit Breaker Catalog No.	Quantity Needed	No. of Circuits Per Breaker	Total No. of Circuits
QOT2020	3	2	6
QOT1515	5	2	10
		Total	16

NOTE: When converting to tandems, make sure the number of circuits remains the same.

List all the circuit breakers needed and find the total number of spaces needed in the load center using equation (1) in part (a).

Catalog No.	Quantity	No. Spaces Per Breaker	Total No. Spaces Needed in Load Center
QO2125	1	2	2
QO250	2	2	4
QO240	2	2	4
QOT2020	3	1	3
QOT1515	5	1	5
QO115GFI	2	1	2
		Total	20

Therefore, the load center needed here must have a minimum of 20 spaces for all the breakers. The number of spaces needed in the load center for the tandems only is 8 (3+5=8). (Also Note: The total number of spaces needed in the load center in part (a) minus the total number of spaces needed in the load center in part (b) is equal to 8).

In the Digest, on the Main Breaker—Indoor Load Centers page, the fourth column is titled "Maximum number of tandem circuit breakers" the number in this column must be at least 8. Also, in that same load center, column 2 must be at least 20. Therefore, the smallest load center you could use would be a QO20-40M200, since 40-20=20. The flush cover is a QOC20UF.

A QO40M200 would not have worked since it does not hold any tandem breakers.

Therefore, the total bill of material for part (b) is:

Quantity	Catalog Number
1	QO20-40M200
1	QOC20UF
1	QO2125
2	QO250
2	QO240
3	QOT2020
5	QOT1515
2	QO115GFI
1	PK23GTA

NOTES

5.0 PANELBOARDS
GENERAL

Square D manufactures a complete line of lighting and distribution panelboards, most of which are available either ready-to-assemble from distributor stock or factory assembled. Types and voltage ratings are:

Circuit Breaker —
NQOD (Plug-on and Bolt-on) — 240VAC max.
NEHB (Plug-on and Bolt-on) — 480Y/277VAC max.
I-LINE — 600VAC max., 250Vdc max.

Fusible —
QMB — 600VAC max., 250Vdc max.

All types are UL listed and meet Federal Specification W-P-115b. Additionally, all Square D panelboards have UL listed short circuit current ratings.

Construction details and individual ratings of circuit breaker panelboards are covered in the following discussion.

5.1 NQOD PANELBOARDS

NQOD panelboards are rated for use on the following AC systems: 120/240V, 1Ø3W; 240/120V, 3Ø4W delta; 240V, 3Ø3W delta; 240V, 3Ø3W grounded "B" phase; and 208Y/120V, 3Ø4W. NQOD panelboards are available either factory assembled or ready-to-assemble.

This type panelboard is suitable for use in industrial buildings, schools, office and commercial buildings and institutions where the largest branch breaker does not exceed 225 amperes and the system voltage is not greater than 240 volts AC.

NQOD panelboards have maximum mains ratings of 400A main breaker and 600A main lugs. All main lug interiors, up to 400 amperes, can be converted to a main breaker interior using a main breaker adapter kit and a circuit breaker. A larger box is required. Branch circuit breakers are catalog prefix QO, QO-H, QO-VH, QH, QOB, QOB-H, QOB-VH and QHB, 1, 2 or 3-pole — featuring plug-on or bolt-on bus connections. QO and QOB circuit breakers are standard with a 10,000 AIC rating. Breakers with up to a 65,000 AIC are available. The UL listed short circuit current rating of the panelboard with branch breakers installed is a maximum of 200,000 RMS symmetrical ampere when an I-LIMITER main breaker is used. Other ratings for specific applications are also available.

QWIK-GARD branch circuit breakers with ground fault circuit interruption may also be used in type NQOD panelboards. Rated up to 22,000 AIC symmetrical, these GFI devices provide UL Class A (5 milliampere sensitivity) ground fault protection as well as overload and short circuit protection for branch circuit wiring.

NQOD ready-to-assemble panelboards are available as follows:

(1) Branch breakers
(2) Main lug interior with solid neutral (100-600A)
(3) Main breaker interior with solid neutral (100A)
(4) Main breaker adapter kit and circuit breaker (100-400A)
(5) Box, 14" wide x 5¾" deep or 20" wide x 5¾" deep
(6) MONO-FLAT front with door and flush lock
(7) Type 3R, 3S and 12 enclosures
(8) Accessories

NQOD factory assembled panelboards are identical in construction to the ready-to-assemble type. Mains ratings and branch circuits are the same. Unlike ready-to-assemble panelboards, however, the main and branch breakers are factory installed.

NQOD PANELBOARD WITH MONO-FLAT FRONT

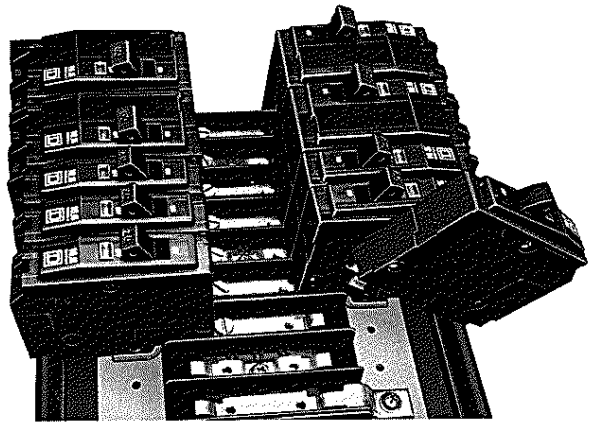
NQOD CONSTRUCTION

Factory assembled and ready-to-assemble boxes for indoor applications are constructed of galvanized steel. Endwalls are removable. One endwall is provided with knockouts; the other is blank. Interiors mount directly to box studs and do not require separate mounting brackets. 225A maximum interiors are available in 14" wide x 5¾" deep or 20" wide x 5¾" deep boxes. Boxes for 400-600A maximum interiors are 20" wide x 5¾" deep.

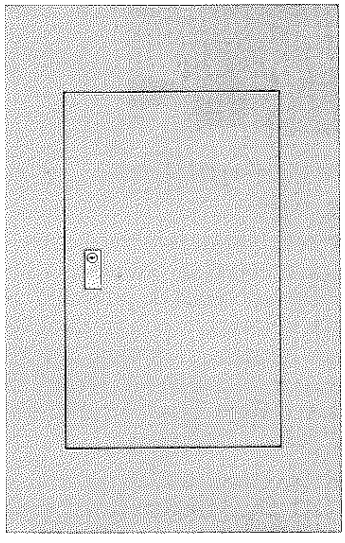
Interiors are suitable for top or bottom feed and will accept either plug-on or bolt-on QO, QOB branch circuit breakers. All interiors have single row bus construction and are available with tin plated copper or aluminum bus bars. All branch circuit breaker connectors are tin plated copper.

225-400A main lug interiors are field convertible to main breaker by adding a main breaker adapter kit and appropriate main breaker. 100-225A interiors have a split neutral and 400-600A interiors have neutrals located opposite the mains to remove larger branch neutral wires from the branch gutter space.

Main lugs are Underwriters Laboratories listed for use with either copper or aluminum cable. Main lugs and FAL, KAL or LAL main breaker lugs may be replaced by the appropriate type VCEL crimp lug, when required. Lug catalog numbers and crimp tool type are indicated on the panelboard wiring diagram.



QO AND QOB CIRCUIT BREAKER MOUNTING



MONO-FLAT FRONTS PROVIDE SECURITY PLUS AN ATTRACTIVE APPEARANCE

MONO-FLAT fronts are available for 100-225A devices. They are constructed of one-piece steel and finished in gray baked enamel. Door hinges and trim screws are completely concealed. After the panelboard is locked, the front cannot be removed — a desirable feature when used in schools, commercial and industrial buildings and institutions. With the MONO-FLAT front, it is extremely easy to either paint or wallpaper over the trim to match the wall covering. These fronts are available for flush or surface mounting. Fronts for 400-600A devices are louvered and are mounted using trim clamps. The door hinges are concealed and a flush door lock is provided.

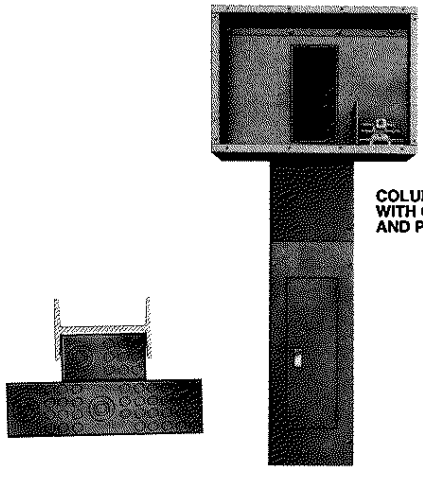
Enclosures such as rainproof and dusttight types are available for ready-to-assemble and factory assembled NQOD panelboards.

Many additional features are available on factory assembled panelboards. Increased mains, split bus, subfeed lugs and breakers, lighting contactors and time clocks are among the special features available. Finishes other than standard gray (USAS #49) are also available on factory assembled panelboards.

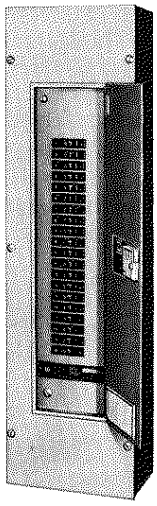
A list of frequently requested additional features available on factory assembled panelboards may be found in the current Square D Digest. Inquiries for other features should be referred to the nearest Square D field office. It should be noted that these additional features are not generally available on NQOD ready-to-assemble panelboards.

5.2 NQO/NQOB COLUMN WIDTH PANELBOARDS

In industrial buildings the only place to centrally locate lighting panelboards is often within the web of a structural steel column. Column width panelboards are frequently used with cable trough and a pull box for maximum wiring space. The neutral connections may be made in the pull box to reduce the number of wires in the necessarily narrow cable trough (wireway). The number of wires in the cable trough is governed by limitations of NEC Section 362-5. For such installations, column width NQO and NQOB panelboards are available. Boxes 8⅝" wide are designed for installations in 10" wide flange structural steel columns and boxes 6⅞" wide are designed for installation in 8" wide flange structural columns.



COLUMN WIDTH PANELBOARD WITH CABLE TROUGH AND PULL BOX



COLUMN WIDTH
NQO-LX PANELBOARD

NQO COLUMN WIDTH PANELBOARDS

NQO column width panelboard interiors are constructed so that QO plug-on circuit breakers do not twin mount but are mounted in a single vertical row. The size of the wiring gutter limits the branch breaker to 60 ampere maximum. Due to space limitations, the MONO-FLAT front cannot be furnished on either the 6⅞" or the 8⅝" column width panelboard. The front uses conventional hinges and is mounted with external screws.

NQO column width panelboards are available ready-to-assemble in the 8⅝" wide x 5" deep box size. Refer to latest Square D Digest. Factory assembled panelboards are available in either box size.

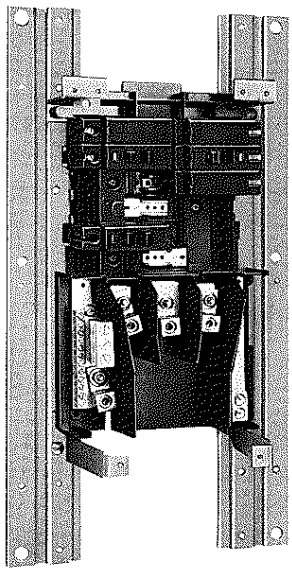
NQOB COLUMN WIDTH PANELBOARDS

NQOB column width panelboards are available factory assembled only. This type of panelboard is identical to the NQO column width panelboard with the exception that QOB bolt-on circuit breakers are used.

5.3 NEHB PANELBOARDS

Type NEHB panelboards are for use on 480Y/277VAC systems or other voltage systems where the phase-to-ground voltage does not exceed 277VAC. NEHB panelboards are available through 600 ampere main lugs and 400 ampere main breaker. These panelboards can be ordered ready-to-assemble or factory assembled.

The NEHB interior accepts either bolt-on EHB or plug-on EH branch circuit breakers, making it easy to meet most customer specifications from stock. All EH and EHB breakers are UL listed and have the VISI-TRIP indicator providing visual identification of a tripped breaker. Also, all 15 and 20 ampere, single pole EH and EHB breakers are UL listed as switching duty rated for 277VAC and 240VAC fluorescent lighting application and are marked "SWD". Plug-on EH breakers are available in 15 through 60 ampere ratings and bolt-on EHB breakers in 15 through 100 ampere.



The UL listed short circuit current rating of the panelboard with branch breakers installed is 200,000 RMS symmetrical amperes when an I-LIMITER main breaker is used. Otherwise, the maximum short circuit current rating is 14,000 RMS symmetrical amperes at 480Y/277VAC and 65,000 RMS symmetrical amperes at 240VAC.

NEHB CONSTRUCTION

Boxes for indoor applications are constructed of galvanized steel and are standard 20"W x 5¾"D. A split solid neutral is located adjacent to the main lug compartment and provides easy access for connecting main and branch cables. An improved MONO-FLAT front is self-leveling eliminating the need for interior adjustment on flush applications.

All main lug interiors, up to 400 amperes, can be converted to a main breaker interior using a main breaker kit. A larger box is required.

Enclosures such as rainproof and dusttight types are available for ready-to-assemble and factory assembled NEHB panelboards.

5.4 NEHB COLUMN WIDTH PANELBOARDS

NEHB column width panelboard boxes are 8⅝" wide and are designed for installation in 10" wide flange structural steel columns. Applications with pullboxes and cable troughs are identical to those indicated in Section 5.2.

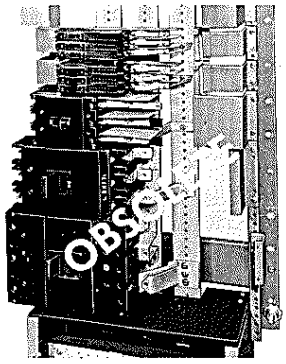
Column width panelboard interiors are similar in construction to standard width interiors with the exception that the circuit breakers do not twin mount but are mounted in a single vertical row. Each interior accepts a maximum 60 ampere branch circuit breaker. Due to space limitations, the MONO-FLAT front is not available in column width panelboards. Standard fronts include conventional hinges, a flush lock and are mounted with external screws.

NEHB column width panelboards are available ready-to-assemble or factory assembled with main lugs or main breaker ratings through 225 amperes.

5.5 I-LINE PANELBOARDS

The I-LINE circuit breaker panelboard by Square D is exclusive and is a totally different concept in panelboard design. Conventional distribution panelboard construction has individually mounted bus bars secured parallel to the mounting pan, with the edges of the bars adjacent to each other. Connections from the bus bars to the line end of the breakers are made by using one or more intermediate connectors. Branch circuit breakers are usually mounted to the interior pan with brackets and an assortment of miscellaneous hardware.

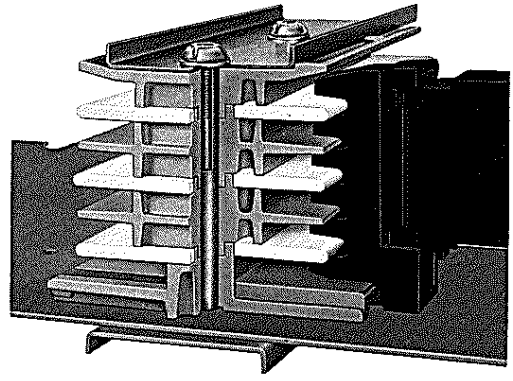
The photo below is typical of the construction of conventional circuit breaker distribution panelboards as supplied by various manufacturers. There is a definite restriction as to placement of branch breakers. Different frame size branches cannot be mounted opposite one another since common connectors feed both sides of the panelboard. Circuit changes cannot be readily and easily made.



CONVENTIONAL DISTRIBUTION CIRCUIT BREAKER PANELBOARD

These restrictions do not apply to the I-LINE panelboard. There is much more flexibility in mounting branches. I-LINE panelboards require no "mounting assemblies" to add or change a branch. All connectors are built into the branch breaker.

Bus Assembly — The following photo shows how the plated bus bars are assembled onto the interior pan in a single vertical stack. Flat sides of the bars are adjacent to one another. A full length set of molded polyester glass insulators is assembled between each phase bus bar and grounded metal. The bus bar stack is then sandwiched between steel channels and held to the interior pan by S.A.E. Grade 5 bolts insulated by high dielectric strength polycarbonate sleeves.



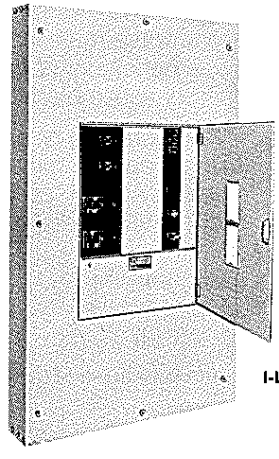
CUTAWAY OF I-LINE BUS STACK

Circuit breakers have connectors permanently fastened to the line end of the breaker and enclosed in an insulating shroud. All connection parts are factory assembled to the breaker — no loose connectors or hardware are required. The load end of each branch breaker has a mounting bracket which engages slots in the interior pan. This bracket has "ratcheting provisions" for levering the circuit breaker jaws onto the bus stack.

With this type assembly, the restriction requiring circuit breakers of the same frame size to be mounted opposite each other is eliminated. Each breaker mounts independently.

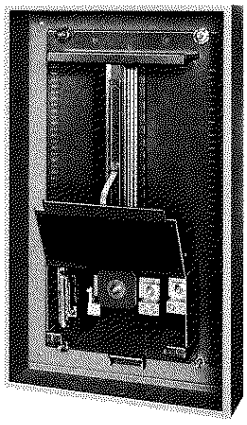
When required, I-LINE circuit breakers are available with bolt on provisons for line side connections.

I-LINE panelboards are suitable for use on systems rated up to 600VAC or 250Vdc. Main lugs and main breaker panelboards have a maximum current rating of 1200A.



I-LINE DISTRIBUTION PANELBOARD

Main Lug Compartment — The following photo illustrates the main lugs and solid neutral compartment for most interiors. With the cover closed, the main lugs are shielded. The lugs are UL listed for use with both Cu or Al cable. When a solid neutral is required, it is mounted adjacent to and in the same compartment as the main lugs. This feature permits all incoming cables to be the same length. A barrier is also provided at the end of the interior opposite the main lugs.



Interiors — Five basic interior configurations are used in I-LINE panelboards.

HCN interiors are designed to accommodate QO*, FA, FH, FC, FY, Q2, Q2-H and Q2H branch circuit breakers. 15 and 20 ampere QO and FY breakers are rated for switching duty (SWD). This permits branch circuits up to 100A at 600V maximum or branch circuits up to 225A at 240V maximum. Main lugs ratings up to 600A and main breaker ratings up to 400A are available in this construction.

HCM interiors accommodate all of the circuit breakers listed for HCN interiors and also accept the IF, KA and KH branch circuit breakers. This extends the range of branch circuits up to 250A at 600V maximum. Main lugs and main breaker ratings up to 800A are available in this construction.

HCW interiors accept all of the breakers listed for the HCN and HCM interiors, plus KC, IK, Q4, LA, IL and LH branch circuit breakers (one side only). This extends the range of branch ratings through 400A at 600V maximum. Main lugs ratings up to 1200A and main breaker ratings up to 800A are available in this construction.

HCWM interiors accept all the breakers listed for the HCN, HCM and HCW interiors in addition to the MA, ME and MH branch circuit breakers. Main lugs rating is 1200A (Maximum main breaker rating of 800A can be obtained in this interior by branch mounting and back-feeding an MA breaker).

*QO circuit breakers require an adaptor for mounting in panelboard.

The HCWM-U interior accepts all the breakers listed for the HCN, HCM, HCW and HCWM interiors, in addition to the NA, NC, and NE branch circuit breakers. Main lugs rating is 1200A maximum using a lug kit. Main breaker is rated at 1200A maximum by back-feeding an NA, NC or NE breaker.

Boxes are sized to correspond with the type of interior used. 26" wide indoors boxes are fabricated with knockouts in the sides and end walls. 32" and 42" wide boxes have blank sides and removable endwalls without knockouts.

The following table gives the indoor box width for each type of I-LINE interior:

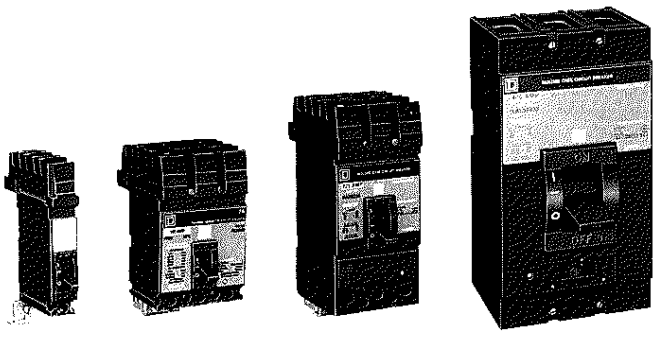
Panelboard Type	Box Width	Box Depth
HCN	26"	6½"
HCM	32"	8¼"
HCW	42"	9½"
HCWM	42"	9½"
HCWM-U	42"	9½"

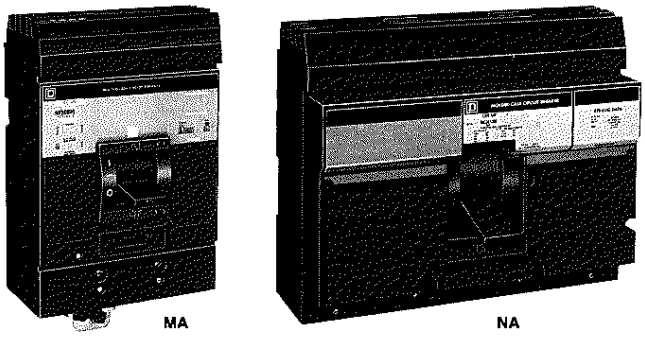
Box heights depend on the number of branch circuits required. Height varies from 48" to 86".

Fronts with exposed trim clamps and door hinges can be furnished on all indoor I-LINE panelboards. Standard surface fronts are four piece with no door. I-LINE panelboards utilizing 1200A HCW, HCWM, and HCWM-U interiors have top and bottom ventilating louvers in the front.

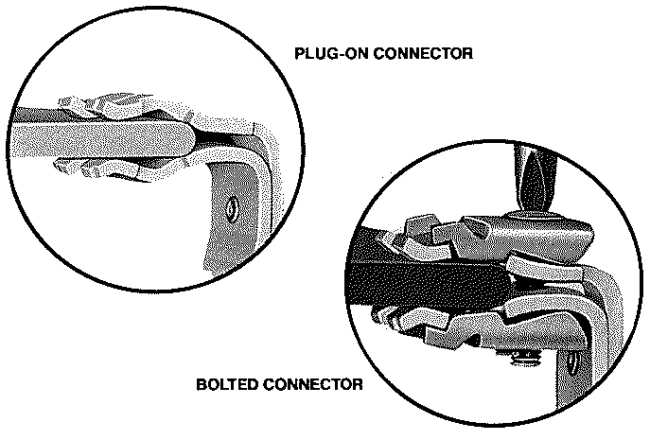
CIRCUIT BREAKERS FOR I-LINE PANELBOARDS

Branch circuit breakers are available in a full range from 15 through 1200 amperes. High interrupting branch circuit breakers with up to 65,000 amperes RMS symmetrical interrupting capacity and I-LIMITER branch circuit breakers with up to 200,000 amperes RMS symmetrical interrupting capacity are also available.





Branch circuit breakers through 1200 amperes permit maximum circuit flexibility. I-LINE circuit breakers use "blow-on" type line side connectors. The parallel line side connectors "clamp" around the bus bars. In case of a short circuit, the increased magnetic flux causes the connectors to grasp the bus bars even tighter.



I-LINE breakers with bolted connections have clamp-on jaws that are bolted around the main bus, as shown above.

Also available are auxiliary devices built into circuit breakers, such as alarm switch, shunt trip, undervoltage trip and auxiliary contacts.

FY breakers are available as 1-pole branch breakers in ratings of 15 through 30 amperes at 277 volts. 15 and 20 ampere FY breakers are marked 'SWD" indicating that they are UL listed as switching duty breakers.

FA breakers are available in 1, 2 or 3-pole construction, 15 through 100 amperes at 240, 277,480 or 600VAC and 125 or 250Vdc.

Q2 breakers are rated 120/240VAC or 240VAC, 2 or 3-pole, 100 through 225 amperes.

KA breakers are available in ratings of 70 through 250 amperes, 2 or 3-pole construction and have a maximum voltage rating of 600VAC or 250Vdc.

Q4 breakers are rated 240VAC, 2 or 3-pole, 250 through 400 amperes.

LA breakers are rated 125 through 400 amperes, 2 or 3-pole, at 600VAC or 250Vdc.

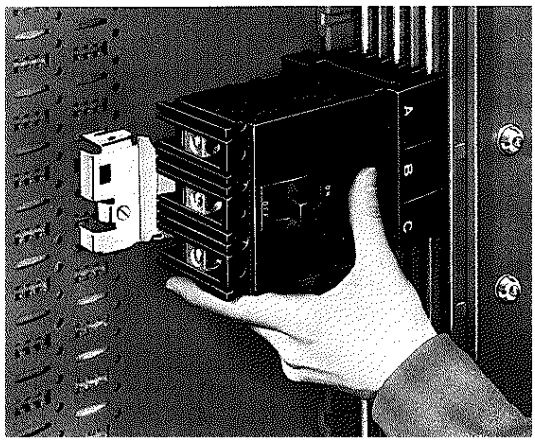
MA breakers have a 600VAC or 250Vdc rating; 2 or 3-pole breakers are available in ratings of 125 through 800 amperes.

NA breakers have a 600VAC or 250Vdc rating: 2 or 3-pole breakers are available in ratings of 600 through 1200 amperes.

All I-LINE circuit breakers (except Q2 and Q4) are equipped with a "Push-To-Trip" mechanism as a standard feature. This mechanism mechanically trips the breaker when pushed. The "Push-To-Trip" feature permits periodic maintenance checks to assure operation of the circuit breaker trip mechanism and any auxiliary devices which may be associated with the trip mechanism.

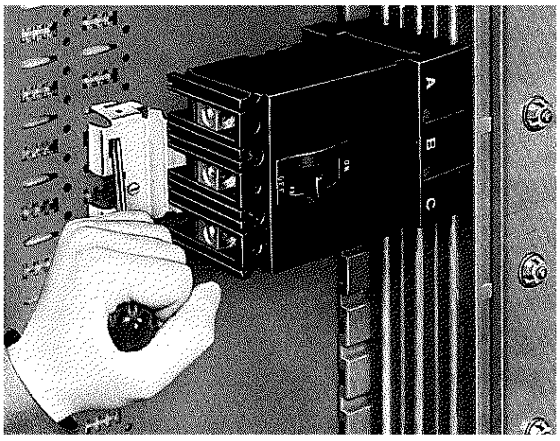
The line connectors are an integral part of the I-LINE breaker, as is the breaker mounting bracket. Separate mounting kits are not required when changing or adding branch circuits. Only three simple steps are required to add or change an I-LINE circuit breaker —

1. First, with panelboard de-energized, the line end of the breaker is positioned on the bus bar stack. A notch in the base insulator of the bus bar stack fits a ridge at the bottom of the breaker's jaw shroud, for sure "straight-on" seating. The breaker mounting bracket fits neatly into "tear-drop" slots in the pan.

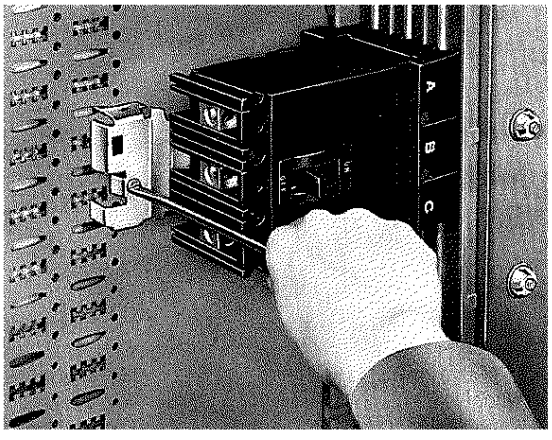


I-LINE is a Registered Trademark of Square D Company.
UL is a Registered Trademark of Underwriters Laboratories, Inc.

2. Next, a screwdriver is inserted in the ratchet slot to lever the breaker firmly onto the bus bars.



3. Then the breaker retaining screw is tightened, locking the breaker in place.



MA branch breakers mount using a positive cam action rather than being levered in place with a screwdriver. MA breaker mounting requires a 3/8" hex wrench.

With I-LINE panelboard construction, mounting of branch breakers of different frame sizes opposite each other no longer presents a problem. Branch breakers mount independently on either side of the bus bar stack.

For additional information and complete application data, see Square D Digest (Circuit Breakers, Molded Case listing): also Distribution Products Catalog, Class 600 (General Molded Case Circuit Breakers listing).

I-LINE panelboards are available either ready-to-assemble or factory assembled in the full range of main and branch circuit breaker ratings.

I-LINE panelboards have a UL listed short circuit current rating, which is the complete panelboard rating with branch circuit breakers installed. It is based upon actual short circuit tests of representative devices with a fault at the load terminals of branch breakers. In addition to withstanding the primary effects of the extensive forces resulting from the short circuit current, the short circuit current rating also verifies its withstanding the secondary effects, such as ionized gas blow out.

PANELBOARD SELECTION AND PRICING

The price (and the component catalog numbers, when required) can be determined from the Catalog Digest after selecting the type of panelboard, given the mains, branch circuits and accessories required. Follow the pricing procedure as given in the respective panelboard pages of the Digest.

5.6 FUSIBLE PANELBOARDS GENERAL

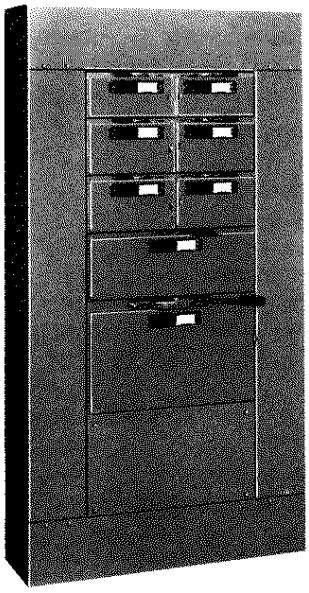
Square D fusible panelboards are Underwriters Laboratories listed and meet Federal Specification W-P-115b, Type II, Class 1 for fusible panelboards. Also, fusible distribution panelboards are suitable for use as service equipment when a main disconnect is provided or six or less branches are used.

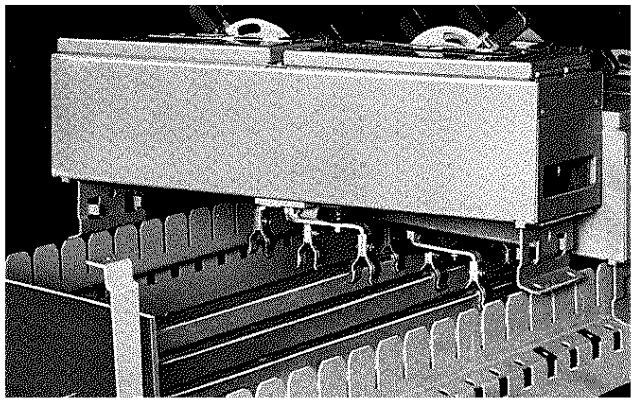
QMB FUSIBLE DISTRIBUTION PANELBOARDS

QMB fusible distribution panelboards are rated for use on the following systems: 1Ø2W, 1Ø3W, 3Ø3W, 3Ø4W, and 3Ø Grounded "B" phase, 240VAC or 250Vdc and 600VAC. QMB panelboards are available as ready-to-assemble components or completely factory assembled. Ready-to-assemble panelboards are available up to a maximum 1200 amperes main lugs, 600 amperes fusible main switch or 400 amperes main circuit breaker.

Factory assembled panelboards are available up to a maximum 1600 amperes main lugs and 800 amperes main switch.

Fusible power panelboards consist of the fusible branch switch units, the interior assembly, and the enclosure (box and front). As in the circuit breaker panelboard, the interior assembly includes the mains, the bussing for distributing power to the branches, insulators to support the bussing, a pan to support the bussing and a pan to support the entire assembly.

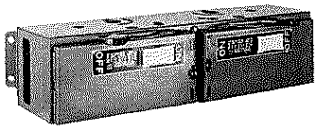




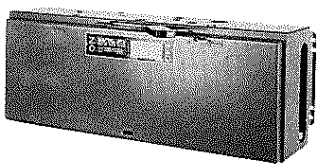
QMB FUSIBLE SWITCH UNITS

QMB fusible switch units are rated 250VAC or 250Vdc, or 600VAC (30-800 amperes) or 480Y/277VAC (100-200 amperes).

Plug-on bus connections are utilized on 30-800 ampere branch switches. 30-100 ampere branches are twin mounted (two switches side by side having common bus connectors) except for switches rated 480Y/277VAC. 200 ampere and larger branches are single mounted. 100 and 200 ampere switches rated 480Y/277VAC are twin mounted.



TWIN MOUNTED SWITCH UNIT

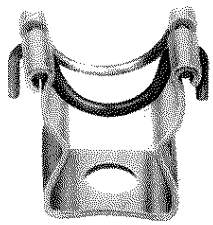


SINGLE MOUNTED SWITCH UNIT

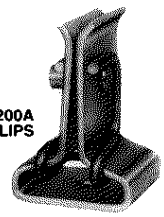
Plug-on connections use the "blow-on" principle which increases the connection tightness in proportion to the magnitude of short circuit current.

QMB fusible switches accept Class H, R or J fuses 30-600 ampere ratings (except for switches rated 480Y/277VAC which will accept Class T fuses only) and Class L fuses for 800 ampere rating. In addition, 100-800 ampere switch units which accept Class T fuses only are available.

QMB fusible switches, with Class R*, J, L or T fuses installed, have a short circuit rating of 200,000 amperes RMS symmetrical amperes at maximum 600VAC.



TYPICAL 30A THROUGH 60A CLASS R FUSE CLIPS



TYPICAL 100A THROUGH 200A CLASS R FUSE CLIPS

Operating Handle — The handle is "flange mounted" and is always in control of the switch mechanism. Also, the handle is color-coded red and black to indicate whether the switch is "ON" or "OFF".

For locking the switch in the "OFF" position, handles on switches have provisions for three ⅜" shackle padlocks.

All QMB switches have mechanical interlocks which prevent opening the cover of the switch when the mechanism is in the "ON" position. An interlock bypass is provided.

Two pole units, 30-600 amperes, are furnished with the outside (A and C phase) connectors assembled to the units. The center (B phase) connector is furnished with each switch for easy field conversion to A-B or B-C phase connections.

*Exception: When used with Class R fuses, 600VAC, 600 ampere switches are suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes.

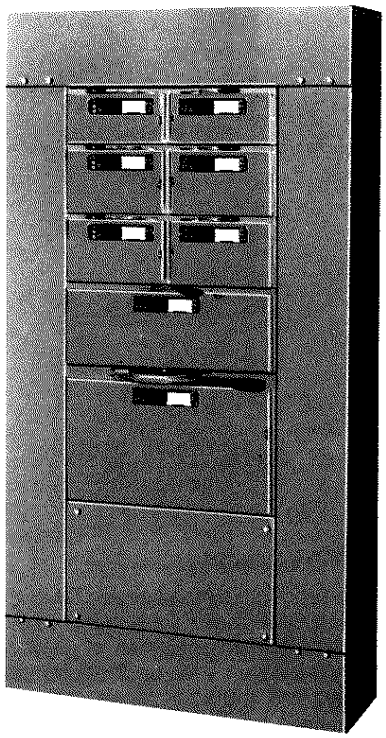
READY-TO-ASSEMBLE QMB PANELBOARDS

Ready-to-assemble QMB panelboards are merchandised as follows:

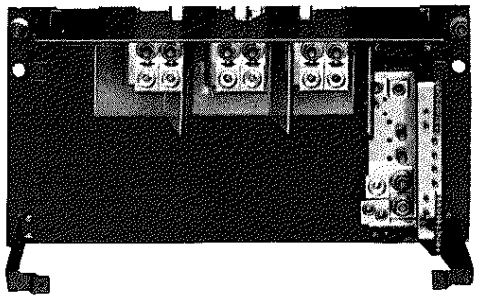
(1) branch units
(2) interior
(3) box (indoor)
(4) front (indoor)
(5) blanks and neutral assemblies
(6) accessories

RATINGS:
(1) Branch Units—Fusible switch units up to 800 amperes
Circuit breaker units up to 400 amperes

(2) Interior—Main lugs only up to 1200 amperes
Fusible main switch 200-600 amperes



The solid neutral, when required, is mounted in the mains compartment. This permits all incoming cables to be the same length, resulting in considerable cable and labor savings while leaving more space for the side gutter wiring.



SOLID NEUTRAL ASSEMBLY IN MAIN LUG COMPARTMENT. CRIMP LUGS OR MECHANICAL LUGS MAY BE INSTALLED

Type VCEL compression lugs are available for ready-to-assemble and factory assembled main lugs only panelboards and for 200 through 800 ampere main and branch switches.

Fronts are fabricated of steel finished in gray baked enamel and are of four-piece construction, without a door. The trim clamps are concealed, non-removable, self-aligning type.

Indoor boxes are fabricated of galvanized steel. Box size is 35" wide, 11.5" deep or 38" wide, 11.5" deep, and the height is determined by the mains ampacity and total branch unit height. The box contains no knockouts.

FACTORY ASSEMBLED QMB PANELBOARDS

Factory assembled devices are sold as complete panelboards but can be shipped as three separate components — box, interior with branches, and front. Fronts with a door and Type 3R/12 enclosures are available.

RATINGS:
(1) Branch Units — Fusible switch units up to 800 amperes. Circuit breaker units up to 400 amperes.

(2) Interior — Main lugs only up to 1600 amperes
Fusible main switch up to 800 amperes
Main circuit breaker up to 400 amperes

As in ready-to-assemble panelboards, 30 ampere through 800 ampere units are plug-on construction.

Indoor boxes are fabricated of galvanized steel, without knockouts. Box size for factory assembled panelboards is either 35" wide, 11.5" deep or 38" wide, 11.5" deep. The box height for both size boxes is determined by the mains and branch unit requirements as shown in the Digest. 35" wide boxes are used for panelboards having a maximum of 200 ampere main or branch switch. 38" wide boxes are used for panelboards having a 400 ampere through 800 ampere main or branch fusible switch unit. Thus, box width is determined by the largest switch (main or branch), not the main bus rating.

SELECTION AND PRICING

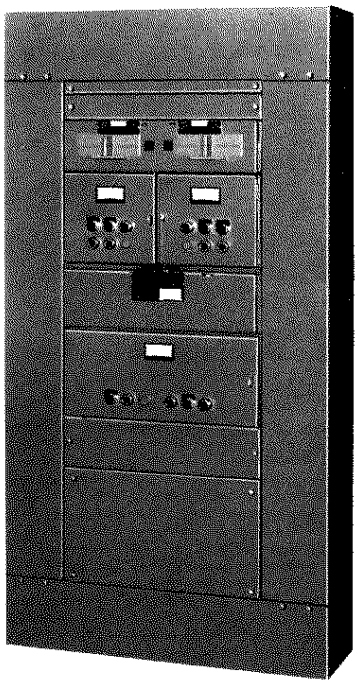
In order to select the panelboard components, the following information is necessary.

1. Line voltage, frequency and system (phases or dc)
2. Total connected load current (mains rating)
3. Branches required (list quantity, amperage and number of poles)
4. Type overcurrent protection required (e.g. fusible or circuit breaker)
5. Type of branch or main fuse
6. Additional features or equipment

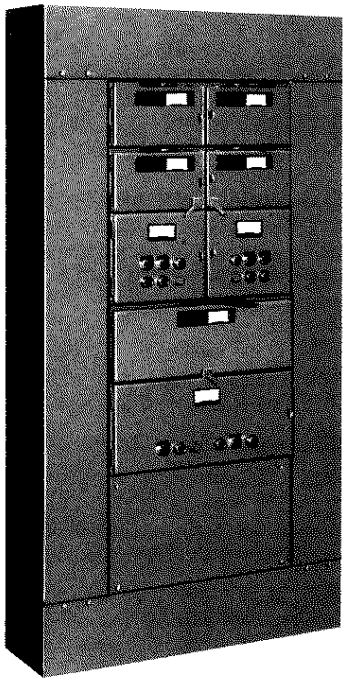
The price can be determined from the latest Digest. Contact your local Square D field engineer for pricing features not shown in the Digest.

5.7 QMB FUSIBLE MOTOR STARTER CENTERS

For centralized motor control applications, motor control centers are used. Many times though, the QMB motor starter center could be selected. Where only a few motors are to be controlled in an area where a panelboard is required, it is simple to include the motor disconnect and starter in a QMB panel with fusible switch or circuit breaker units used for other type loads.



QMB MOTOR STARTER CENTER WITH CIRCUIT BREAKER DISCONNECTS



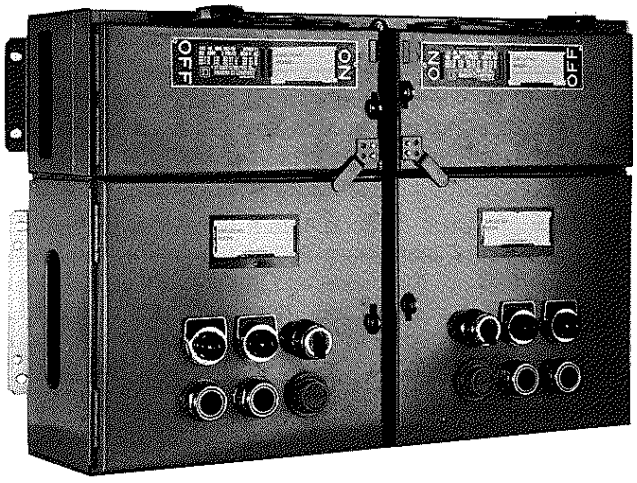
QMB MOTOR STARTER CENTER WITH FUSIBLE SWITCHES

Certain specifications require that the motor disconnect be a circuit breaker, rather than a fusible switch. QMB panelboard disconnect units are available as either circuit breaker or fusible switches. Circuit breakers are often specified for motor disconnects due to inherent limitations of fuses. Some of these limitations are: (1) single phasing, (2) improper fuse replacement, (3) fuse replacement time and (4) lack of trip indication.

QMB motor starter centers are standard QMB distribution panelboards with QMB motor starter units. A QMB motor starter, mounted in its own enclosure, is combined in the interior with QMB fusible switch or circuit breaker units.

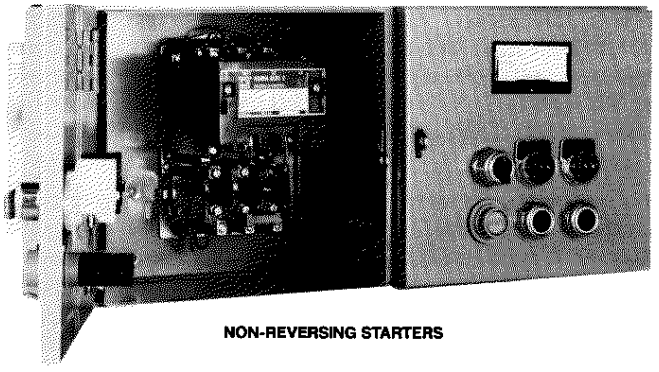
STARTERS

Motor starter units are available in NEMA Size 0 through 3, reversing or on-reversing. Each starter door is mechanically interlocked with its respective disconnect door, as shown in the photo. The switch must be turned "OFF" and its door opened in order to open the starter door. Authorized personnel can operate the interlocked release on the switch to inspect or test the switch and starter without de-energizing either. The motor starter unit in a factory assembled panelboard is factory wired to its disconnect.



QMB FUSIBLE SWITCH AND MOTOR STARTER UNIT WITH MECHANICAL INTERLOCKS

Non-reversing starter units are Class 8536, Type S, Size 0 through 3, and are mounted in pairs with individual doors over each starter compartment. An external reset mechanism and a card holder are provided on each door. Twistouts are provided for the addition of Type K pilot devices.



NON-REVERSING STARTERS

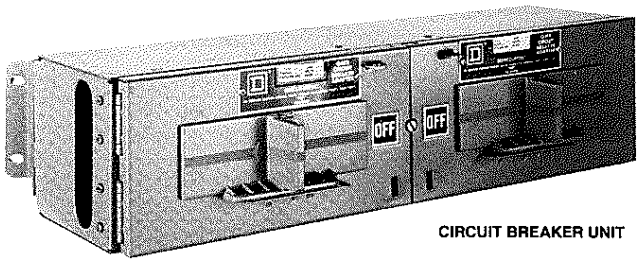
Reversing starter units are Class 8736 and are mounted in single compartments, with a single door. An external reset mechanism and cardholder are provided on the door. Reversing starters are Type S in Sizes 0, 1, 2 and 3.

FUSIBLE DISCONNECTS

Fusible disconnect switches are Type QMB. See Section 5.6.

CIRCUIT BREAKER DISCONNECTS

Circuit breaker disconnects as shown in the photo below are available in ratings of 15-400 amperes. Type FA, 15-100 ampere circuit breaker disconnects are furnished as twin mounted units. 110-400 ampere disconnects are Type KA and LA circuit breakers and are single mounted. All feature unit plug-on connection and breaker Push-To-Trip mechanism. Refer to the latest Digest for accessories available for circuit breakers.



CIRCUIT BREAKER UNIT

ADDITIONAL FEATURES

Motor Starter Accessories — push buttons, selector switches and pilot lights may be mounted in the doors of starter enclosures. These pilot devices, (Class 9999 and 9001) are available from stock for field installation, or mounted and wired in factory assembled panelboards.

Electrical interlocks, power pole adders and timer attachments are also available for use with Type S starters. These may be easily installed in the field or at the factory.

When a separate control circuit voltage is required, the necessary transformer and fuse block are easily field installed.

SELECTING AND PRICING

Follow the procedure given in the QMB motor starter center section of the latest Digest.

NOTES

6.0 METERING EQUIPMENT GENERAL

Square D manufactures and markets different lines of metering equipment for exact job specifications in many portions of the electrical market. Equipment is designed with maximum flexibility and convenience as first considerations in meeting customer requirements.

Square D individual meter sockets are units which are marketed for single family residential applications. The units act as the point of placement for the utility company supplied detachable watt-hour meter and are commonly used in conjunction with the load center located inside the home. The most common applications for this product line are 120/240VAC 1Ø3W systems.

Applications requiring an outside disconnect are easily remedied using a meter/main device. This unit includes a meter socket and provisions for a disconnect to be installed to meet NEC and local code requirements for outside disconnects. Again, the most popular applications are for 120/240VAC 1Ø3W systems.

Square D also manufactures multi-metering equipment for many of today's market segments. These applications include two or more meter sockets/circuit breaker combinations grouped together to provide a compact, easy to install means of individual tenant metering. Meter-pak (MP) and EZ METER-PAK (EZM) are two of the product lines commonly used for residential applications such as duplexes and apartment complexes. The EZ METER-PAK line of products also enters into the light commercial applications such as shopping malls and office buildings. These products are applied on 120/240VAC 1Ø3W, 208Y/120VAC 3Ø4W and 240/120VAC delta 3Ø4W systems.

For the larger commercial multi-metering projects, Commercial Metering Equipment (CME) will fill most requirements. Product flexibility using modular branch sections and plug-in meter socket units allows the complete cost of the meter center to be spread out over a longer period of time. CME is designed for use on 480Y/277VAC 3Ø4W systems and fills the gaps between EZM equipment and metering switchboards.

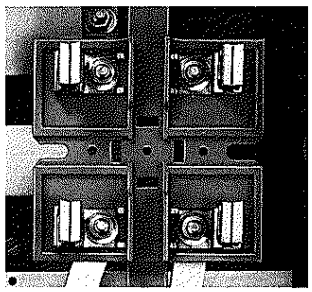
6.1 THE METER SOCKET

The meter socket is the heart of all metering products. The most common meter socket consists of an assembly of matching jaws to accommodate the blades of a detachable watt-hour meter and a base for proper support and positioning of these jaws. These type of assemblies are available in continuous current ratings up to 320 amperes and accept Type S watt-hour meters. Meter sockets in the 400 ampere class are bolt-on style meter sockets and require a bolt-on Type K watt-hour meter.

Meter sockets generally consist of three-types:

1. A NON-CIRCUIT CLOSING meter socket. This means that when the watt-hour meter is removed, service downstream is interrupted.
2. AUTOMATIC CIRCUIT CLOSING meter sockets. These devices incorporate a spring and plunger mechanism which activates a jumper bar to complete the circuit between line and load meter socket jaws as the watt-hour meter is removed.
3. MANUAL CIRCUIT CLOSING meter sockets. These sockets have a mechanism which may provide continued service by manual operation of the bypass before removal of the watt-hour meter. The types of bypass mechanisms are as shown below:
   a. SLIDER type manual bypass work by sliding jumpers between the line and load meter socket jaws before the meter is removed.
   b. HORN type bypass operates in conjunction with a utility supplied jumper cable. The cable is provided with two connector ends which is inserted over bus studs at the line and load jaws. This type of circuit closing requires a ringless meter socket trim, so that the meter may remain in position while revealing the bus studs.
   c. LEVER type bypass meter sockets operate by moving an operating lever on the meter socket to jumper between the line and load jaws of the meter socket. The most common lever bypass meter sockets incorporate a "jaw release" mechanism which releases tension on the watt-hour meter blades when the lever is operated. Although not very common, there are lever bypass sockets available without the jaw release feature. As with the horn type bypass sockets, lever bypass circuit closing also requires a ringless meter socket trim, so that the meter may remain in position while revealing the bypass lever.

Generally, circuit closing devices are rated at 50% of the meter socket current rating, since they are intended to allow uninterrupted service during the removal and testing of a watt-hour meter. A circuit closer is not intended for use as a switch and should never be operated as a load-make/load-break mechanism.



4-JAW METER SOCKET

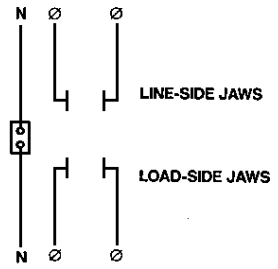
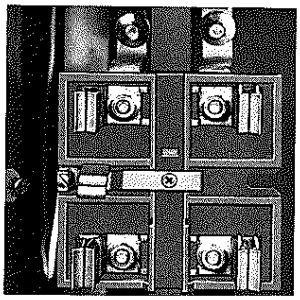


FIGURE 1
4-JAW METER SOCKET
120/240VAC



5-JAW METER SOCKET

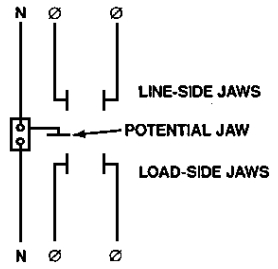
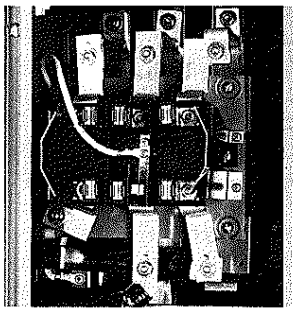


FIGURE 2
5-JAW METER SOCKET
120/208VAC "NETWORK"



7-JAW METER SOCKET

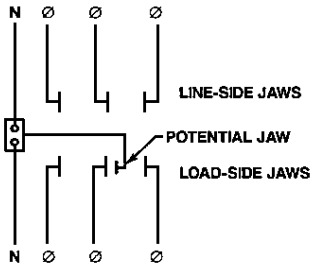


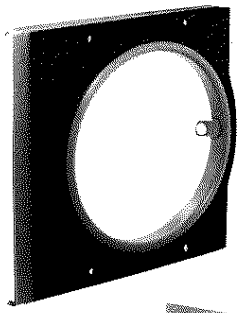
FIGURE 3
7-JAW METER SOCKET
208Y/120VAC, 240/120VAC, Δ
480Y/277VAC

Service and Application of Meter Sockets:

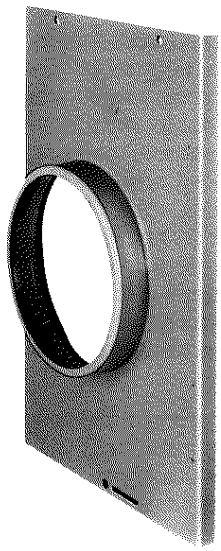
1. 4-jaw meter sockets are designed for use on 1Ø3W, 120/240VAC services. The four jaws consist of two line side jaws connected to the incoming phase or "hot" wires and the two load side jaws wired to the outgoing load conductors (see Fig. 1). Note that the neutral is not used in the metering process.
2. 5-jaw meter sockets are designed for "network" metering applications where single phase loads are to be connected and metered from a 3Ø4W, 208Y/120VAC system. The fifth jaw is also called a potential jaw and is connected to the neutral of the system to allow for proper operation of the watt-hour meter. The fifth jaw is generally located in the 9 o'clock position (see Fig. 2).
3. 7-jaw meter sockets are designed for metering application involving three-phase loads. They may be applied on 3Ø4W 208Y/120VAC, 3Ø4W 240/120VAC delta and 3Ø4W 480Y/277VAC systems. The seventh jaw is connected to the neutral of the system to allow for proper operation of the watt-hour meter (see Fig. 3).

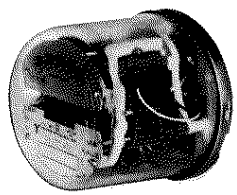
METER SOCKET TRIMS

Meter socket trims are available in two general types, RING type and RINGLESS type.



RING TYPE TRIM





RINGLESS TRIM

A RING type meter socket has a rim on the meter socket cover which works in conjunction with a sealing ring to retain the watt-hour meter in position. Once the watt-hour meter is installed in the trim and the sealing ring is in place the watt-hour meter cannot be removed without breaking the seal on the sealing ring.

A RINGLESS type meter socket has a draw which fits over the watt-hour meter after the meter is installed in the meter socket assembly. This cover then acts as the retaining means for the watt-hour meter and has provisions for sealing or locking.

SEALING METHODS

The utility utilizes sealing as a method to determine if the enclosure sealing ring or trim has been removed by unauthorized persons. Sealing devices are supplied by the utility company serving the equipment.

Utility company sealing methods vary widely from one utility to the next. A seal in its simplest form is a wire loop which may be inserted into the sealing ring or locking hasp of a meter socket and locked into place. Although there are several different designs of wire seals, they will be destroyed when removed.

Many utility companies will also utilize padlocks or special locking devices called "barrel locks" to seal a meter enclosure.

ENCLOSURES

Metering enclosures are available in both indoor and rainproof construction. Internal barriers and trim arrangements are designed to prevent access to isolated unmetered conductors by unauthorized personnel.

6.2 INDIVIDUAL METER SOCKETS AND METER MAINS

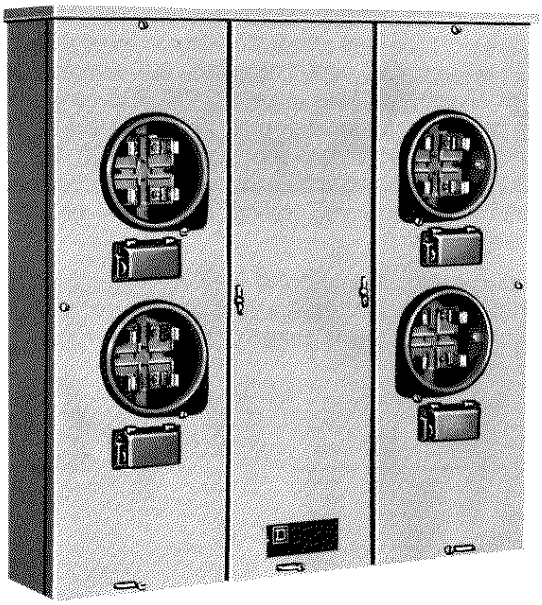
Square D markets a line of individual meter sockets for use primarily in the residential portion of the electrical market. These units are 4-jaw construction and are available in 100 and 200 ampere ratings.

The enclosures are Type 3R (rainproof) construction and will accept "A" type bolt on hubs for conduit entry into the top endwall. Sizes of enclosures vary depending on the amperage rating and whether the service conductors are entering from overhead or underground.

Meter main devices are available for use on applications requiring a meter socket with a disconnect connected to the load terminals. These devices are commonly applied in areas which have a local code requiring outside disconnects or in applications requiring a local disconnect due to the location of the indoor load center. Meter mains are also Type 3R construction and will accept "B" type bolt on hubs for conduit entry into the top endwall. These units may be fed from both overhead and underground.

6.3 METER-PAK

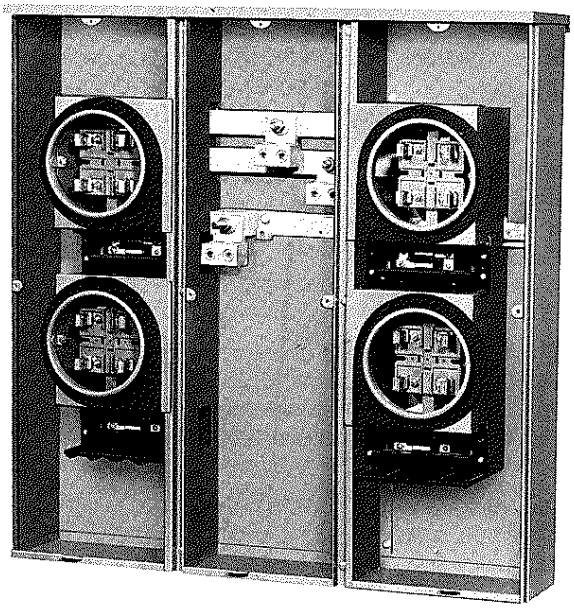
Meter-pak is a self-contained line of multi-metering equipment for use in applications requiring two to six watt-hour meters to be installed in one location. The unit contains up to six meter sockets and circuit breakers in one easy to install enclosure. It is ideally suited for indoor and outdoor applications. Specifically designed for apartment and townhouse applications, it will act as the point of termination for the utility company's incoming service cables and is suitable only for use as service equipment.



METER-PAK UNIT

Each device has an incoming service pull section with a continuous current rating of 200, 300, 400, 600 or 800 amperes. This section of the meter-pak device has ample space for utility termination and is sealable for the protection of unmetered conductors.

Factory bussing distributes the power to each of the meter sockets in the meter-pak unit. The meter sockets are rated 200 amperes continuous and are equipped with spring reinforced, front removable meter socket jaws. The jaws are securely supported by a durable glass fiber filled polyester base.

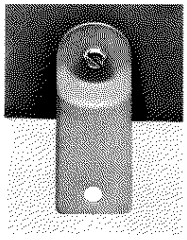


METER-PAK UNIT WITH TRIMS REMOVED

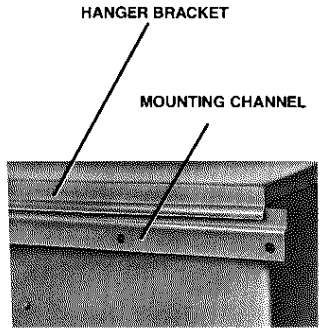
METERING EQUIPMENT

The load side of the meter sockets are factory bussed to a circuit breaker position directly underneath each socket. 125 ampere devices have provisions for field installed 60-125 ampere QO circuit breakers. 200 ampere devices have provisions for field installed 100-200 ampere Q2M circuit breakers. Meter-pak units are UL listed for use on systems capable of delivering up to 10,000, 22,000 or 42,000 RMS symmetrical amperes of short circuit current depending on the AIC rating of the circuit breakers installed.

Each meter-pak is equipped with equipment grounding terminals installed in the wiring gutter. These terminals are located close to the breaker positions to minimize wire waste.



SWINGABLE MOUNTING BRACKETS



MOUNTING CHANNEL-REAR VIEW

INSTALLATION

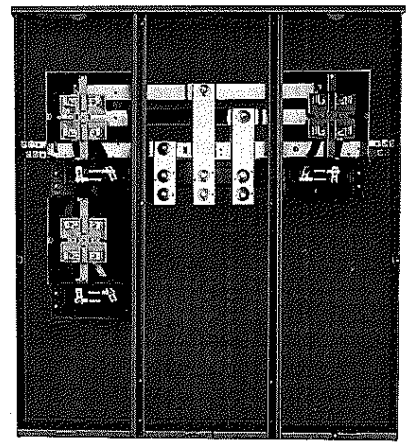
Installation of meter-pak is quite easy. A separate mounting channel is supplied with each meter-pak device for ease of mounting. The proper height of the device is determined and the channel is attached to the wall. The device is then simply hung onto the channel and the unique rotating mounting feet are secured to the wall. The rotating design of the feet keep the device from having to be removed from the wall for drilling and anchoring. Finally, the device is wired for service.

ACCESSORIES

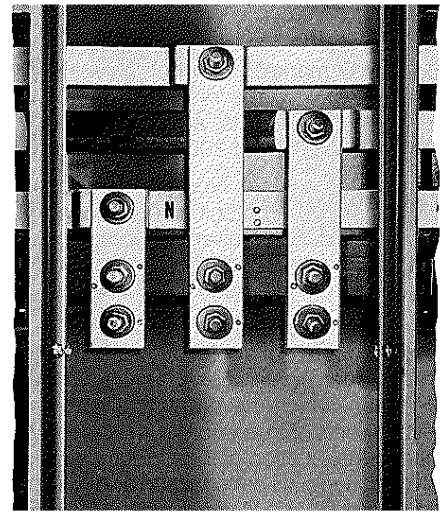
The following accessories are available for meter-pak equipment:

- — Slider-type manual circuit closing
- — Automatic circuit closing
- — Fifth jaw kits for network metering applications
- — Meter socket cover plates
- — Sealing rings

MP devices are also available with special utility company terminations called "Lug Landings". These kits meet certain utility specifications which require a bus pad and studs for terminating the incoming service cables. Lug landings are most commonly required when the utility wishes to terminate with crimp-type lugs.



METER-PAK UNIT WITH LUG LANDINGS



PULLBOX SECTION WITH LUG LANDINGS

SELECTION AND PRICING

1. Know the local utility company requirements regarding the application of metering equipment on their system. They may require an initial approval of the equipment before installation.
2. Determine the service type and amperage size required (200 through 800 amperes) to select the proper MP device.
3. Determine the required short circuit current rating.
4. Select the MP device which will supply the necessary number of meter sockets and required circuit breaker ampere ratings.
5. Select the branch circuit breakers (QO type or Q2M type) as determined in steps 3 and 4.

6. Select any accessories required to meet job or utility specifications.
7. Add prices of each component selected to obtain the complete meter center price.

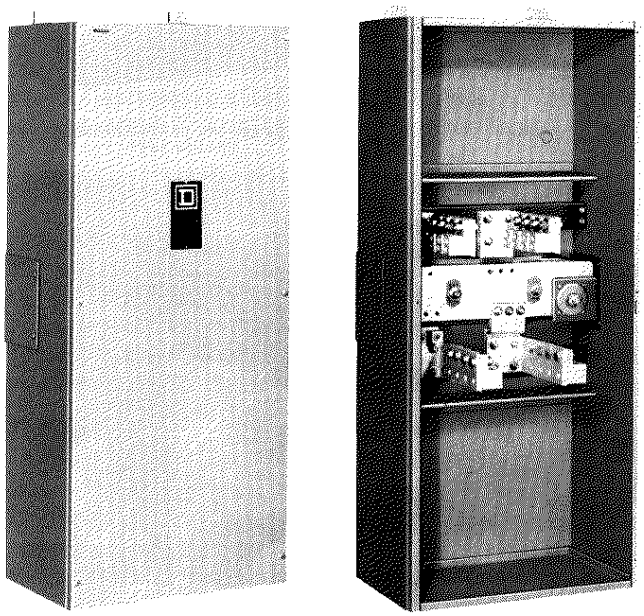
6.4 EZ METER-PAK

EZ METER-PAK is another step in meeting requirements for multi-metering applications. Unlike meter-pak, EZ METER-PAK requires a main device to be installed ahead of the meter socket sections. By utilizing a main, the number of meter sockets per meter center is limited by only physical space and the amperage of your main device.

The EZ METER-PAK system is very versatile in meeting customer requirements and providing the most flexible system on the market. Each EZM meter center must consist of a main device, branch sections and tenant circuit breakers. Meter centers with UL listed short circuit current ratings up to 100,000 RMS symmetrical amperes can be provided.

MAIN DEVICES

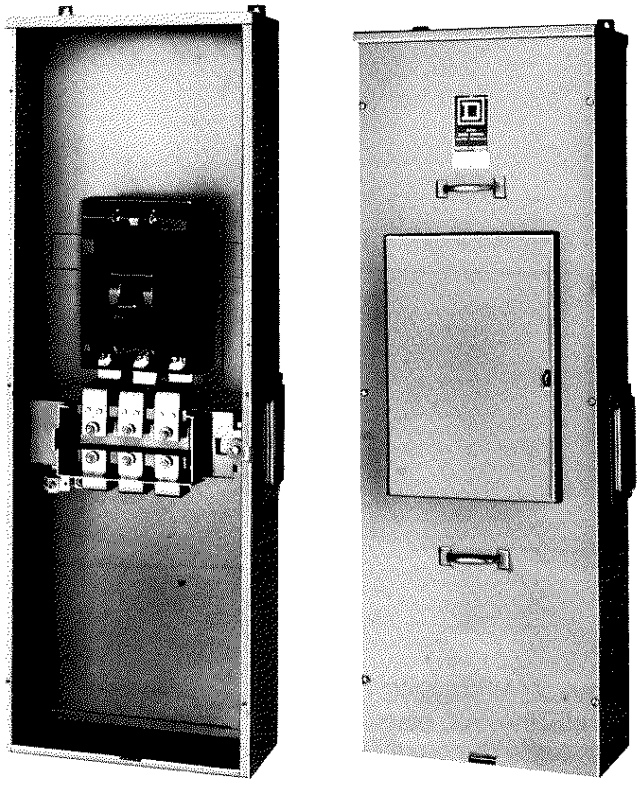
An EZM main device is always required to terminate the incoming conductors. Selection of a main device depends upon the system to which the unit will be connected and the available fault current of the system. Devices may be selected for use on 1Ø3W 120/240VAC, 3Ø4W 240/120VAC delta or 3Ø4W 280Y/120VAC systems.



EZ METER-PAK
MAIN LUGS TERMINAL BOX

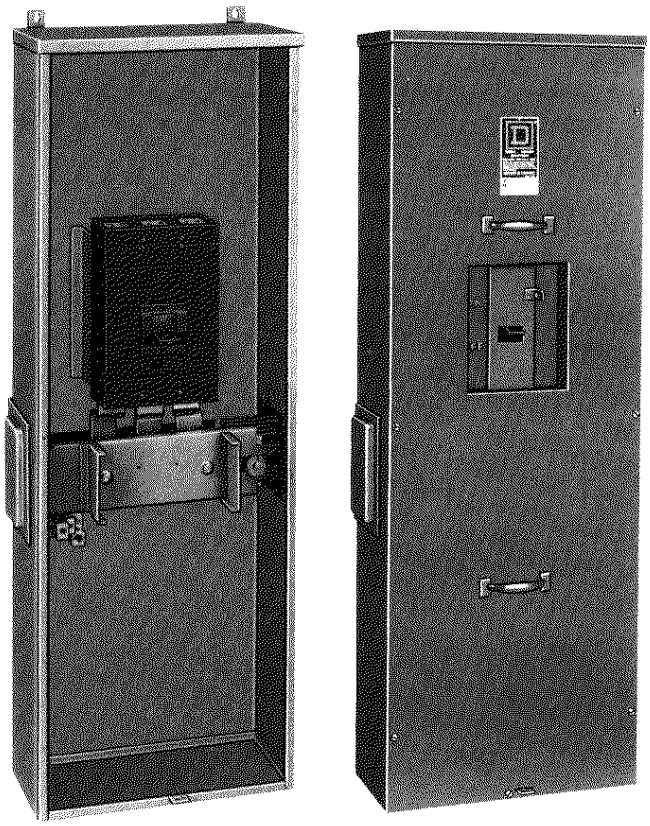
1. A main lugs TERMINAL BOX is an enclosure which includes the required bussing and lugs to terminate incoming conductors. It may be used to apply EZM in six subdivision service applications or to feed the meter center from a remotely located main device.

   Terminal boxes are available in 225, 800 or 1600 ampere ratings.

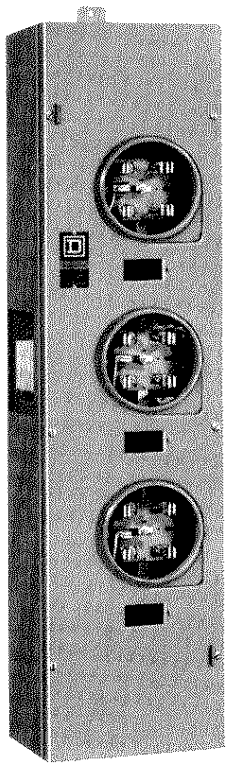


EZ METER-PAK
MAIN FUSIBLE SWITCH

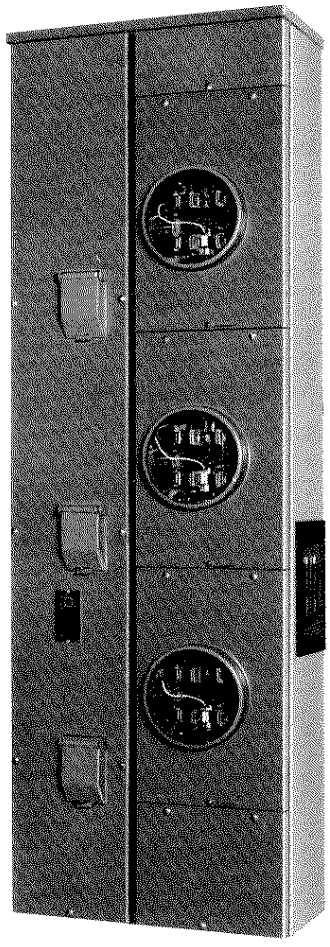
2. Main FUSIBLE SWITCHES are available in 400, 600 and 800 ampere construction. They are designed with a Square D Molded Case Switch in series with 300VAC Class T fuses. The devices have a front operating handle and an interlocked fuse access door. The fusible switch provides a termination point for the incoming conductors and a bus structure which connects it to the branch metering devices.
3. Main CIRCUIT BREAKER devices utilize Square D molded case circuit breakers to provide overcurrent and short circuit protection. Type LA, LH, MA, MH, NH and PA circuit breakers are employed in the EZM designs. Available ampere ratings are 400 through 1600 amperes.



EZ METER-PAK
MAIN CIRCUIT BREAKER



125 AMPERE EZ METER-PAK
BRANCH UNIT



200 AMPERE EZ METER-PAK
BRANCH UNIT

BRANCH METERING UNITS

EZ METER-PAK branch metering units consist of an enclosure with a grouping of meter sockets and provisions for tenant circuit breakers. Each metering unit is completely bussed for maximum convenience and easy installation. A captive sliding one bolt joint-pak with a VISI-TITE bolt is used for the electrical connection to other units.

Any number of metering units may be interconnected to obtain the required number of meter sockets for the job.

Each of the metering sections are sealable. All unmetered conductors are isolated behind steel barriers or sealed trims.

RESIDENTIAL EZM

These units are available with 4-jaw or 5-jaw 200 ampere continuous duty meter sockets. Meter sockets with ring or ringless type configurations are available.

125 ampere devices are available with 3, 4, 5, 6, 7, 8 and 10 meter sockets per device. Each meter socket has an associated tenant breaker position for field installed 2-pole 60-125 ampere type QO circuit breakers. These units have 800 ampere rated main cross bus.

200 ampere units are available with 3, 4, 6, 7 and 8 meter sockets per device. Tenant breaker positions will accept 2-pole 100-200 ampere type Q2M circuit breakers. An adapter kit is available for applications requiring a breaker less than 100 amperes to be installed in these metering units. These units have 1200 ampere rated main cross bus.

800 ampere and 1200 ampere main cross bus may be interconnected.

Units designed for network metering applications are arranged so that grouping of units will provide a closely balanced system. Phase balancing is important to proper system operation. Transformer overload could result if proper balancing is not considered. Each metering unit is phased balanced as follows:

Catalog Number	Phase Connection		
	A-B	B-C	C-A
EZM43-	1	1	1
EZM44-	1	2	1
EZM45-	2	1	1
EZM46-	2	2	2
EZM47-	2	3	2
EZM48-	3	2	3
EZM410-	3	4	3

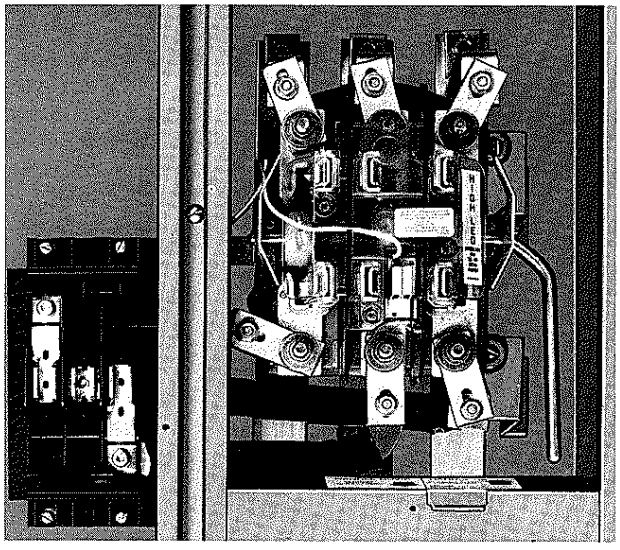
COMMERCIAL EZM

Commercial single-phase and three-phase metering units use a 200 ampere continuous duty rated meter socket. These units are available with a variety of meter sockets to meet various utility company requirements. All commercial EZM units have provisions for field installed EH (60A) or QE-VH (70-200A) circuit breakers.

For applications requiring tenant loads of 400 amperes, a line of branch metering units is available with factory installed 400 ampere LAL circuit breakers. These units are available in 5-jaw and 7-jaw construction and have 320 ampere continuous duty meter sockets.

Devices with 4-jaw meter sockets are for use in areas where the utility company requires a lever bypass type meter socket. A Duncan HQ-4 meter socket with lever bypass and jaw release is used. These units are for use on 120/240VAC 1Ø3W systems.

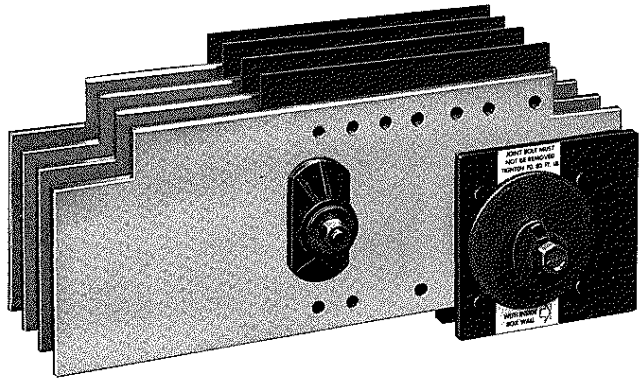
Devices with 5-jaw or 7-jaw meter sockets are available with different type meter sockets. The most popular devices utilize Duncan HQ-5 (5-jaw) and Duncan HQ-7 (7-jaw) meter sockets which are equipped with lever bypass and jaw release. Devices with 5-jaw and 7-jaw meter sockets which are equipped with lever bypass and without jaw release are available. Devices with 7-jaw meter sockets without meter bypass are also available.



7-JAW METER SOCKET WITH LEVER BYPASS AND JAW RELEASE

5-jaw meter socket devices are designed for "network" metering applications where the incoming system is 208Y/120VAC 3Ø4W. Each 5-jaw meter socket has an associated tenant breaker position for field installed 2-pole EH (60A) or QE-VH (70-200A) circuit breakers. 7-jaw meter socket devices are designed for use in three-phase metering applications on 208Y/120VAC 3Ø4W and 240/120VAC delta 3Ø4W systems. Each 7-jaw meter socket has an associated tenant breaker position for field installed 3-pole EH (60A) or QE-VH (70-200A) circuit breakers.

All commercial EZM metering units have 1200 ampere horizontal cross bus. 7-jaw and 5-jaw metering units may be interconnected. NOTE: Commercial EZM and residential EZM may be interconnected.



INSTALLATION

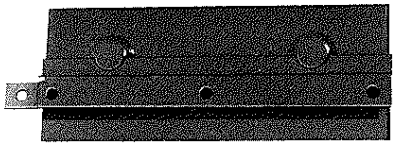
EZ METER-PAK installation is the easiest and most efficient in the industry. Reduced installation time is accomplished with mounting channels, external mounting brackets and a captive sliding joint-pak with VISI-TITE bolt.

The installation procedure is as follows:

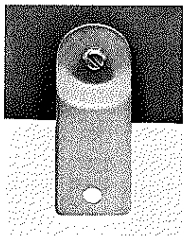
STEPS 1 & 2

1) Determine the proper height of the mounting channel and draw guide line on the wall. Mounting channel height is determined by the required meter mounting heights of the local utility.

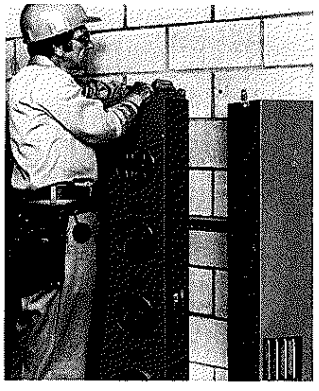
2) Attach the mounting channel to the wall to provide temporary alignment and mounting. A mounting channel is packed externally to each device so that no trims need to be removed to mount the devices.



MOUNTING CHANNEL—REAR VIEW

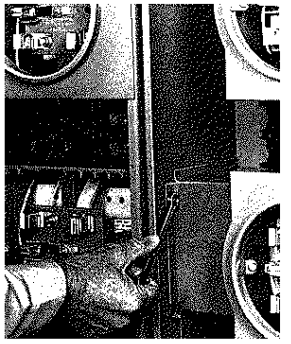


SWINGABLE MOUNTING BRACKETS



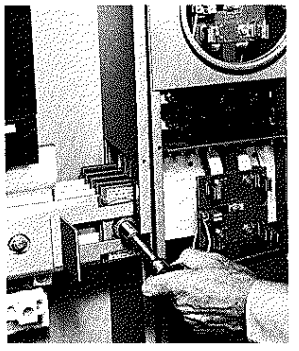
STEP 3

3) Hang each device on the channel and position tightly together before permanently attaching to the wall. The external swingable mounting brackets are then attached to the wall without time consuming adjustments.



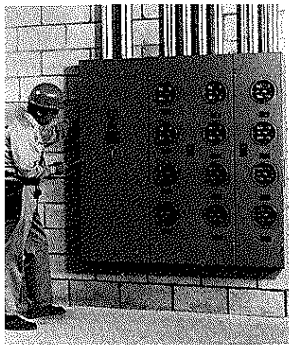
STEP 4

4) Bolt enclosures together using the supplied hardware to provide positive ground continuity throughout the meter center.



STEP 5

5) Complete the main horizontal cross bus connection by sliding the captive joint-pak into position and tighten the VISI-TITE joint bolt. The captive self-aligning assembly eliminates any job delays resulting from lost or missing main bus kits and parts. A VISI-TITE bolt is the only bolt which must be tightened to complete the bus connection. No special tools are required to properly tighten this connection. The special bolt has an outer head which will twist off at the proper torque for the connection. This is accomplished using a standard socket and ratchet. An inner head remains on the assembly.



STEP 6

6) Wire meter center and install trims.

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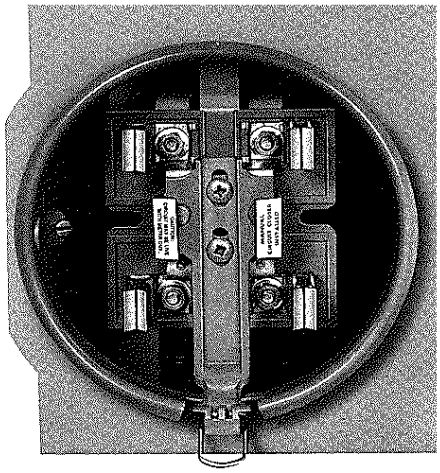
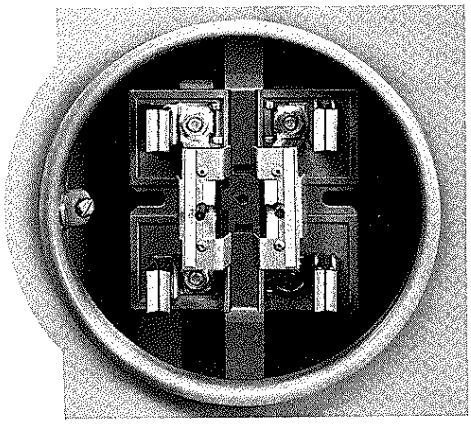
ACCESSORIES



SLIDER-TYPE MANUAL CIRCUIT CLOSER

AUTOMATIC and SLIDER-TYPE MANUAL CIRCUIT CLOSERS are available for job requirements.



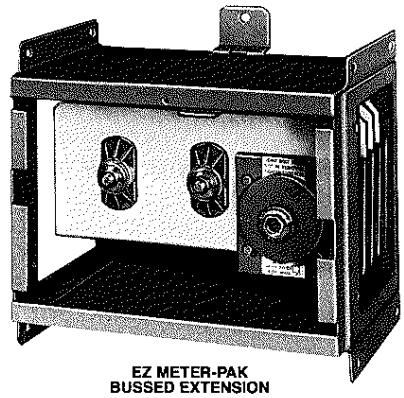
AUTOMATIC CIRCUIT CLOSER

FIFTH JAW KITS are available for applications where the meter center is fed by 2 phases and the neutral of a 208Y/120VAC 3Ø4W system.

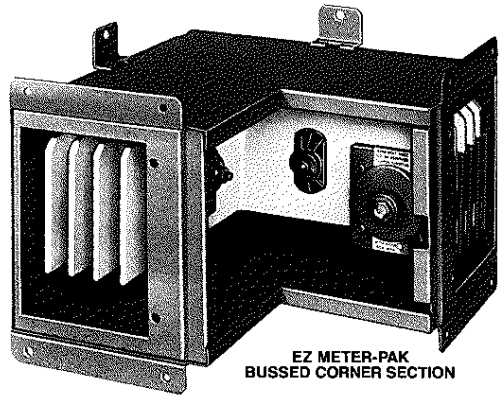
A BUSSED EXTENSION is used to meet utility requirements where extra spacing is required between the EZM main device and metering units.

The BUSSED CORNER SECTION accessory provides a method to install the meter center in small meter rooms. The corner section allows device mounting on two adjacent walls to best utilize wall space.

BUSWAY TAP main devices allow the meter center to be applied in high-rise building applications where I-LINE or I-LINE II busway is used as a feeder from floor to floor. The EZM main with busway tap will plug directly into the busway to provide a compact distribution system.

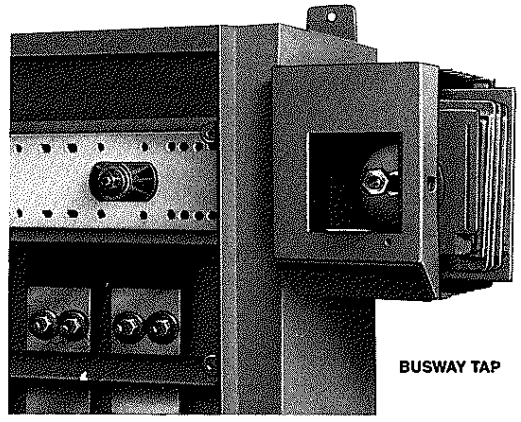


EZ METER-PAK
BUSSED EXTENSION



EZ METER-PAK
BUSSED CORNER SECTION

METER SOCKET COVER PLATES are installed in unused meter positions to provide protection from access by unauthorized personnel. The cover plates cannot be removed without first breaking the utility company seal.



BUSWAY TAP

I-LINE and EZ METER-PAK are Registered Trademarks of Square D Company.

SELECTION AND PRICING

A. Know the local utility company requirements and insure that the equipment meets their standards.

B. Determine the size and type of service required.

C. Determine the required short circuit current rating of the meter center.

D. Choose the main device. This can be a terminal box, a main circuit breaker or a main fusible switch.

E. Choose the metering devices necessary to provide the required number of meter sockets and required amperages.

F. Select the tenant circuit breakers as required. Two pole circuit breakers for single phase and network metering and three-pole circuit breakers for three-phase metering.

G. Add any accessories required to meet the job or utility company requirements.

H. Layout the meter center and confirm that all job requirements are met.

1. Check to see if main device must be center located.
2. Confirm that the meter center will fit into the allotted space.
3. Determine the proper phase balancing of all 5-jaw network metering devices.
4. Draw a sketch of the layout.

I. Price all components of the meter center.

6.5 CME - COMMERCIAL METERING EQUIPMENT

All of the metering products discussed in proceeding sections have been for applications on 240VAC maximum systems. Commercial Metering Equipment or CME is multi-metering equipment designed for system applications up to 480Y/277VAC maximum. This type of system is very popular for strip malls and office complexes.

CME applications, like EZM, also require a main disconnect for service termination and have horizontal cross bus for connection to branch sections. The unique design of CME allows the job layout to go one step further in satisfying job requirements. CME utilizes a plug-in meter socket unit which is purchased separately from the branch section. This allows installation of the branch sections as the building is under construction and the installation of the plug-in meter socket units as the tenants begin to move into the building.

CME uses 85" tall floor standing, floor or wall secured enclosures. All unmetered conductor compartments are sealable by the utility company.

A complete CME meter center consists of a main device, branch sections, plug-in meter socket units and tenant circuit breakers. CME has UL listed short circuit current ratings up to 100,000 RMS symmetrical amperes at 480Y/277VAC maximum.

MAIN DEVICES

A CME main device is always required to terminate the incoming service conductors. Selection of a main device depends upon the amperage requirements for the meter center and the available fault current of the system. CME main devices have horizontal cross bus to allow right, left or center mounting in the meter center. Note that since branch sections are supplied with 1200 ampere cross bus, some main devices must be center located to prevent cross bus overloading.

1) MAIN LUGS TERMINAL BOXES have lug landing pads which will accept mechanical or crimp-type lugs. These units are designed for underground feed and include the horizontal cross bus to connect to branch sections. Devices are available in 800, 1200, and 2000 ampere ratings.

2) CME MAIN FUSIBLE SWITCHES are available in 600 and 800 ampere ratings and accept 600VAC Class T fuses. A Square D Molded Case Switch in series with the Class T fuses provides the ON and OFF operation of the device. When a fusible switch is used a terminal box is not required for service termination.

3) CME MAIN CIRCUIT BREAKER UNITS utilize thermal-magnetic breakers up to 800 ampere. For mains rated 1000 amperes and above the PE electronic trip circuit breaker with integral ground fault is used. The NEC requires equipment ground fault protection in service equipment greater than 1000 amperes on 480Y/277VAC systems.

There are also CME main devices available with dual molded case circuit breakers which may feed up to 800 amperes of metering to the left of the main and up to 800 amperes of metering to the right of the main.

CME main circuit breaker units are available in 600 through 2000 ampere ratings.

BRANCH SECTIONS

The CME branch sections are supplied with blank metal cover plates installed over each meter position. This allows the branch section to be installed initially and the plug-in meter sockets later. The branch section is sealable by the utility company without the plug-in meter sockets installed.

Each branch section will accept up to three meter socket plug-in units rated 200 amperes maximum. The branch sections have 1200 ampere rated horizontal cross bussing for connection to additional branch sections.

CME also has a branch section for 400 ampere tenant service. Since this requires a special bolt-on watthour meter, the 400 ampere branch section is not a plug-in design. This branch section is available with one or two meter sockets and factory installed LHL circuit breakers. The meter socket is a Duncan K-7 (7 terminal) bolt-in meter base.

PLUG-IN METER SOCKET UNITS

Plug-in meter socket units consist of a meter socket and provisions for field installed tenant circuit breakers. Units are available with standard or lever-type bypass meter sockets. Plug-in units with 100 or 200 ampere Class T fusible pullouts or with provisions to accept IFL or IKL current limiting circuit breakers are also available.

All meter sockets are 200 amperes continuous duty rated and 7-jaw construction.

INSTALLATION

1) Place CME main device where required on concrete pad or floor. Secure the device to the floor or wall.
2) Place CME branch sections next to main device and bolt enclosures together using the supplied hardware.
3) Make the required bus connections by sliding the captive sliding joint-pak into position and tighten the VISI-TITE bolt. The VISI-TITE bolt is the only bolt which must be tightened to make the phase and neutral connections. No special tools are required since the special bolt has an outer head which will twist off when the proper torque is reached. An inner head remains.
4) The plug-in meter socket units are installed in the branch sections by removing the blank metal plate from the device and plugging the unit in place. The meter socket trim is installed upon placement of the watthour meter.
5) Tenant circuit breakers are installed and wiring is completed.

SELECTION AND PRICING

A. Know the utility company requirements and insure that the equipment will meet their standards.
B. Determine the size and type of service required.
C. Determine the short circuit current rating of the meter center.
D. Choose the main device. This main can be a terminal box, main fusible switch or main circuit breaker.
E. Choose the number of branch sections required to obtain the number of meter sockets required.
F. Select meter socket plug-in units. Fusible pullout and circuit breaker units are available.
G. Price all components of the meter center.

NOTES

7.0 GROUND FAULT PROTECTION FOR PEOPLE

Ground fault protection for people is a subject of interest to all of us, both personally and professionally. A ground fault exists when an unintended path is established between an ungrounded conductor and ground. This situation can occur not only from worn or defective electrical equipment but also from accidental misuse of equipment that is in good working order.

Will a conventional overcurrent device (fuse or circuit breaker) detect a ground fault and open the circuit before irreparable harm is done? Before we can answer this question, we need to take a look at the effects of current on the human body.

EFFECTS OF CURRENT ON THE HUMAN BODY

Hand-to-hand body resistance of an adult lies between 1,000 and 4,000 ohms, depending on moisture, muscular structure and voltage. The average value is 2,100 ohms at 240VAC and 2,800 ohms at 120VAC.

Using Ohm's law, the current resulting from the above average hand-to-hand resistance values is 114 milliamperes (0.114 amperes) at 240VAC and 43 milliamperes (0.043 amperes) at 120VAC. The effects of 60 Hz alternating current on a normal healthy adult are as follows (note that current is in milliamperes, or 1/1000 amperes):

More than 5 mA — generally painful shock
More than 15 mA — sufficient to cause "freezing" to the circuit for 50% of the population
More than 30 mA — breathing difficult (possible suffocation)
50 to 100 mA — possible ventricular fibrillation *
100 to 200 mA — certain ventricular fibrillation *
Over 200 mA — severe burns-muscle contractions.

**Ventricular fibrillation is defined as "very rapid uncoordinated contractions of the ventricles of the heart resulting in loss of synchronization between heart beat and pulse beat". Once ventricular fibrillation occurs in man, it usually continues and death will ensue within a few minutes.*

Now, will a conventional overcurrent device open a circuit before irreparable harm is done? NO! Here's why.

The current that would flow from a defective electric drill, for example, through the metal housing and through the human body to ground would be 43 milliamperes, calculated using 2,800 ohms as average body resistance. Using 1,000 ohms as body resistance, the current flow would be 120 milliamperes.

43 milliamperes is only 0.29% of the current required to open a 15 ampere circuit breaker or fuse, and yet it approaches the current level which may produce ventricular fibrillation. Obviously, the standard circuit breaker or fuse will not open the circuit under such low levels of current flow.

7.1 GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)

"People protector" devices are built as Class A devices in accordance with Underwriters Laboratories (UL) Standard No. 943 for Ground Fault Circuit Interrupters. UL defines a Class A device as one that "will trip when a fault current to ground is 6 milliamperes or more." the tripping time of such units cannot exceed the value obtained by the equation:

$$T = \left(\frac{20}{I} \right)^{1.43}$$

where T is time in seconds and I is the ground fault current in milliamperes. Also, Class A devices must not trip below 4 milliamperes.

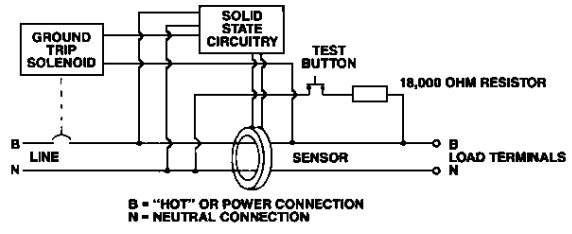
Class A GFCI's include a self contained means of testing the ground fault circuitry, as required by UL. To test, simply push the test button and the device will respond with a trip indication. UL requires that the current generated by the test circuit shall not exceed 9 milliamperes. Also, UL requires the device to be functional at 85% of the rated voltage.

UL is a Registered Trademark of Underwriters Laboratories, Inc.

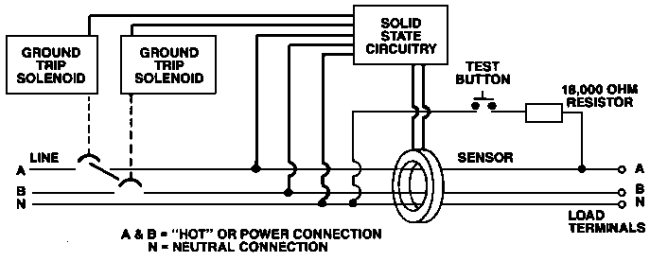
HOW THE GFCI OPERATES

The GFCI sensor in single pole QWIK-GARD circuit breakers continuously monitors the current balance in the ungrounded "hot" load conductor and the neutral load conductor. If the current in the neutral load wire becomes less than the current in the "hot" load wire, then a ground fault exists, since a portion of the current is returning to the source by some means other than the neutral load wire. When an imbalance in current occurs, the sensor sends a signal to the solid state circuitry which activates the ground trip solenoid mechanism and breaks the "hot" load connection. A current imbalance as low as 6 milli-amperes will cause the circuit breaker to interrupt the circuit. This will be indicated by the VISI-TRIP indicator as well as the position of the operating handle centered between "OFF" and "ON".

Square D manufactures two types of GFCI devices: the QWIK-GARD circuit breaker and the plug-in QWIK-GARD receptacle.



SINGLE POLE QWIK-GARD BREAKER

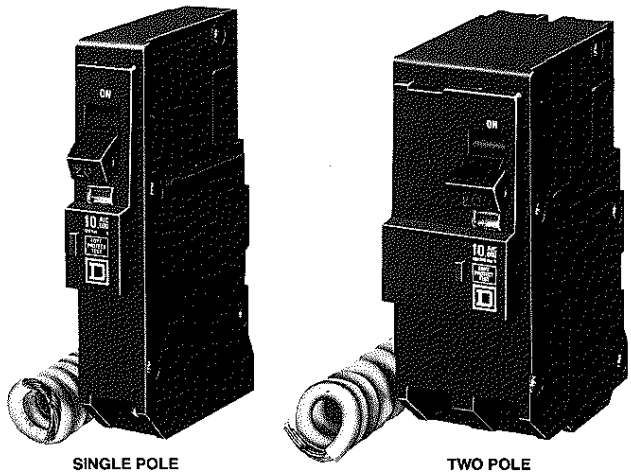


TWO POLE QWIK-GARD BREAKER

The two pole QWIK-GARD circuit breaker continuously monitors the current balance between the two "hot" conductors and the neutral conductor. If a neutral load conductor is not used, then the two pole QWIK-GARD circuit breaker continuously monitors the current balance between the two "hot" conductors. As long as the sum of the three or two currents is zero, the device will not trip; e.g., if there were 10 amperes current in the A load wire, 5 amperes in the neutral, and 5 amperes in the B load wire, then the sensor is balanced and will not produce a signal. A current imbalance from a ground fault condition as low as 6 milliamperes will cause the sensor to produce a signal of sufficient magnitude to trip the device.

7.2 QWIK-GARD CIRCUIT BREAKERS

QWIK-GARD circuit breakers require the same mounting space as standard QO circuit breakers and provide the same branch circuit wiring protection as standard QO circuit breakers. They also provide Class A ground fault protection.



SINGLE POLE TWO POLE

QWIK-GARD breakers are UL listed and available in both single and two pole construction. Single pole breakers are available in 15, 20, 25 and 30 ampere ratings and are available in 10,000 or 22,000 ampere interrupting capacity. Two pole breakers are available in 15, 20, 25, 30, 40, 50 and 60 ampere ratings and have a 10,000 ampere interrupting capacity. Single pole units are rated 120VAC and two pole units 120/240VAC.

QWIK-GARD circuit breakers not only can be used in Square D load centers and panelboards, but they are also available factory installed in HITCH-N-POST meter pedestals and SERVICEPAK power outlet panels for RV parks and construction sites.

SINGLE POLE QWIK-GARD CIRCUIT BREAKERS

The single pole breaker (Figure 1) has two load lugs and a white wire "pigtail" in addition to the line side plug-on or bolt-on connector. The line side "hot" connection is made by installing the QWIK-GARD breaker in the panel the same as you would install any QO or QOB circuit breaker.

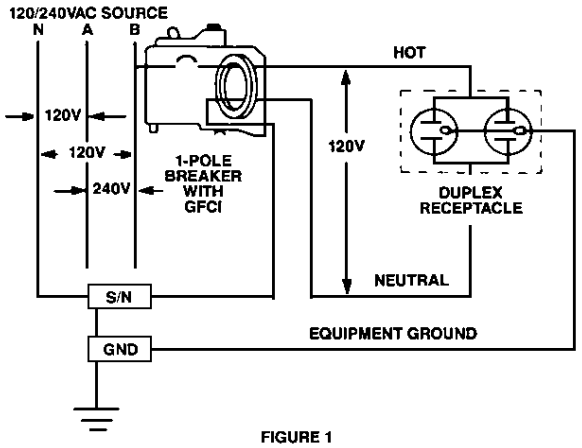


FIGURE 1

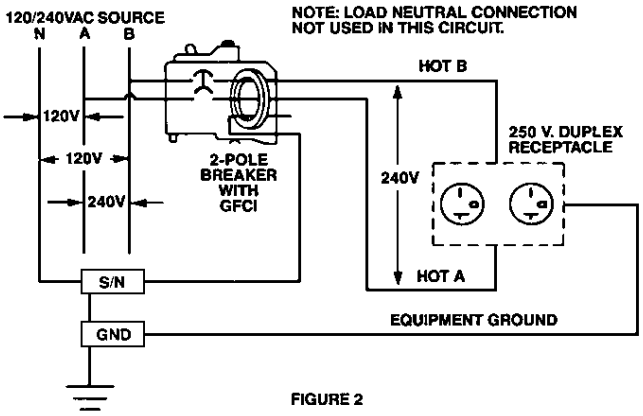


FIGURE 2

The white wire "pigtail" is connected to the panel neutral (S/N) assembly. Both the neutral and "hot" wires of the branch circuit being protected are terminated in the QWIK-GARD breaker. The two load lugs are clearly marked "LOAD POWER" and "LOAD NEUTRAL" by moldings in the breaker case. Also molded in the case is the identifying marking for the "pigtail", "PANEL NEUTRAL".

Single pole QWIK-GARD circuit breakers must be installed on independent circuits. Circuits which employ a neutral common to more than one "hot" conductor cannot be protected against ground faults by a single pole breaker because a common neutral cannot be split and retain the necessary "hot" wire-neutral wire balance under normal use to prevent the QWIK-GARD circuit breaker from tripping.

Care must be exercised when installing QWIK-GARD breakers in existing panels to be sure the neutral wire for the branch circuit corresponds with the "hot" wire of the same circuit.

Always remember that unless the current in the neutral wire is equal to that in the "hot" wire (within 6 milliamperes), the QWIK-GARD breaker senses this as being a ground fault.

TWO POLE QWIK-GARD CIRCUIT BREAKERS

A two pole QWIK-GARD circuit breaker can be installed on a 120/240VAC 1 phase 3 wire system, the 120/240VAC portion of the 120/240VAC 3 phase 4 wire system, or two phases and neutral of a 208Y/120VAC 3 phase 4 wire system. Regardless of the application, the installation of the breaker is the same — connections made to two "hot" busses and the panel neutral assembly. When installed on these systems, protection is provided for two wire 240VAC or 208VAC circuits (Figure 2); three wire 120/240VAC or 120/208VAC circuits (Figure 3) and 120VAC multi-wire circuits (Figure 4).

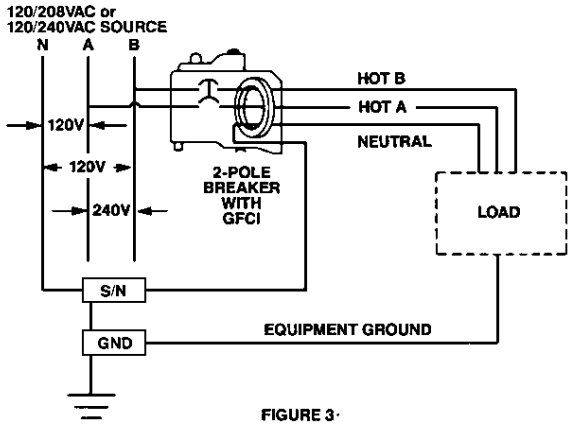


FIGURE 3

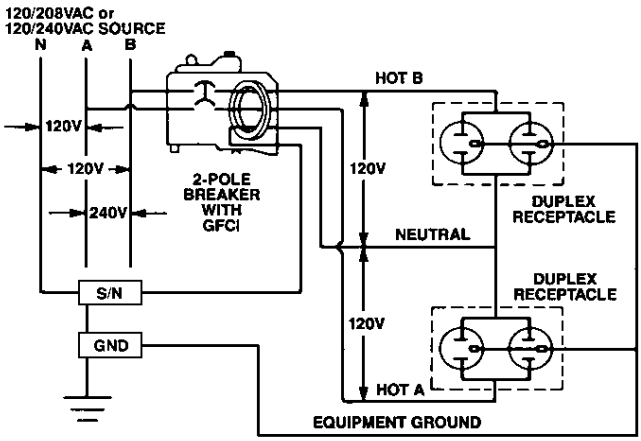


FIGURE 4

QWIK-GARD is a Registered Trademark of Square D Company.

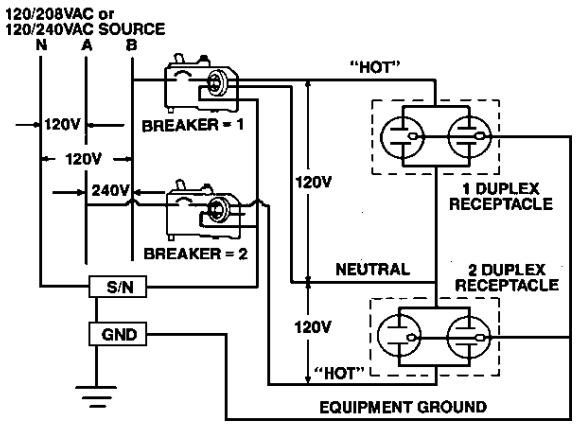


FIGURE 5

The circuit shown in Figure 5 can be used to illustrate the problems that would be encountered if a common load neutral were to be used for two single pole GFCI breakers. Either or both breakers would trip when a load is applied at #2 duplex receptacle. The neutral current for #2 duplex receptacle would be flowing through breaker #1; this increase in neutral current through breaker #1 causes an imbalance in its sensor, thus causing it to produce a fault signal. At the same time, there is no neutral current flowing through breaker #2; therefore, it also senses a current imbalance. What happens if a load is applied at #1 duplex receptacle? As long as there is no load at #2 duplex receptacle, then neither breaker will trip because neither breaker will sense a current imbalance.

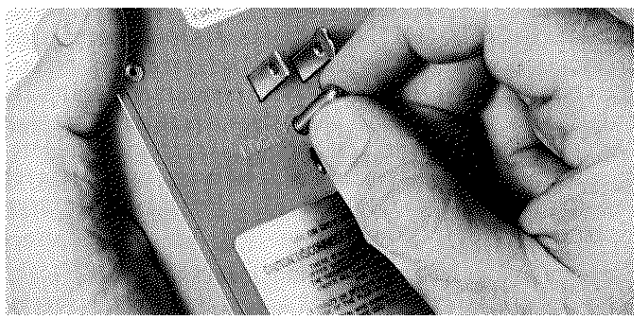
The two pole QWIK-GARD circuit breaker eliminates the problems encountered when trying to use two single pole QWIK-GARD breakers with a common neutral. Because both "hot" currents and the neutral current pass through the same sensor, under normal load condition, no imbalance in current occurs between the three currents and the breaker will not trip. (see Figure 4).

Wiring practices often used in junction boxes can also present problems when the junction box is used for taps for more than one branch circuit. Even though the circuits are not wired using a common neutral, sometimes all neutral conductors are connected together. Thus, parallel neutral paths would be established, producing an imbalance in each QWIK-GARD circuit breaker sensor, causing them to trip.

7.3 PLUG-IN QWIK-GARD RECEPTACLE

The plug-in QWIK-GARD receptacle is the first plug-in ground fault protection adapter for use in either two or three wire 120VAC receptacles. This device has a unique retractable ground pin which makes it possible to provide ground fault protection at existing two-wire polarized receptacles as well as on three-wire receptacles. This unit provides two Class A GFCI protected receptacles.

To use the unit on three-wire receptacles, lock the ground pin on the back of the unit. For two-wire receptacles, unlock the ground pin. The ground pin will retract automatically as the unit stabs are inserted into the receptacle. A yellow indicator pin on the front shows when the ground pin is retracted.



When tripped, the plug-in QWIK-GARD receptacle has a red fault light which illuminates. To reset the unit, just push the blue reset button.

SUMMARY

All QWIK-GARD units:

1. are UL listed
2. provide Class A ground fault protection
3. have the Push-To-Test feature
4. have noise suppressed modules

QWIK-GARD devices by Square D provide Class A ground fault protection for any purpose. QWIK-GARD circuit breakers can be used to comply with 1987 NEC articles as follows:

CLASS A GROUND FAULT CIRCUIT INTERRUPTER MEETS 1987 NEC ARTICLES.

210-8(a)	For Dwelling Units
210-8(b)	For Hotels and Motels
215-9	For Feeders
305-6(a)	For Construction Sites
422-8(d)	For Portable High Pressure Spray Washers
426-31	For De-icing and Snow Melting Equipment
427-26	For Heated Pipelines or Vessels
511-10	For Commercial Garages
550-8(b), 8(e)	For Mobile Homes
551-9(c)	For Recreational Vehicles
551-22(b)	For Shower Fixtures
551-42	For Recreational Vehicle Parks
555-3	For Marinas
680-5(b)	For Pools
680-6(a)	For Receptacles Near Swimming Pools
680-6(b)	For Lighting Fixtures and Lighting Outlets Near Swimming Pools
680-20(a)	For Underwater Swimming Pool Lighting
680-26(b)	For Electrically Operated Pool Covers
680-31	For Storable Swimming Pools
680-40	For Outdoor Spa and Hot Tub Receptacles
680-41(a)	For Indoor Spa and Hot Tub Receptacles
680-41(b)	For Indoor Spa and Hot Tub Lighting Fixtures and Outlets
680-51(a)	For Fountains
680-56	For Cord and Plug-Connected Fountain Equipment
680-62(a)	For Therapeutic Pools and Tubs
680-62(f)	For Therapeutic Pool and Tub Receptacles
680-70	For Hydromassage Bath Tubs
680-71	For Hydromassage Rooms

NOTES

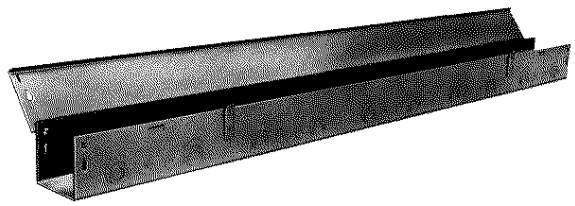
8.0 WIREWAY

Wireways are steel enclosed troughs designed to carry feeders, branch circuits, and other groups of electrical conductors and to afford mechanical protection against damage to wires or cable. Wireway should be installed only for exposed work where it will not be subject to severe physical damage (NEC Article 362 and 374). The reference to "exposed" is intended to prohibit concealment in walls or floors although the duct may pass through drywall or partitions if in unbroken lengths at the pass through point. Square D manufactures wireway for general purpose use, raintight use and industrial use, manufactured to the specifications of the NFPA 84 Council.

Square D wireway may be used for a variety of applications and, in most cases, it can be installed faster and at less expense than conduit. Incoming cable runs and feeder circuits from switchboards to power and lighting panels; distributing power in industrial plants, ganging equipment such as motor control, safety switches, and metering equipment; and vertical runs of cable in elevator shafts are just a few applications where wireway is ideal. When comparing wireway with conduit, wireway has numerous distinct advantages. It weighs less, is easier to install, conductors can be laid in, additions to the wiring system are easier, tap offs are possible, and wireway is reusable.

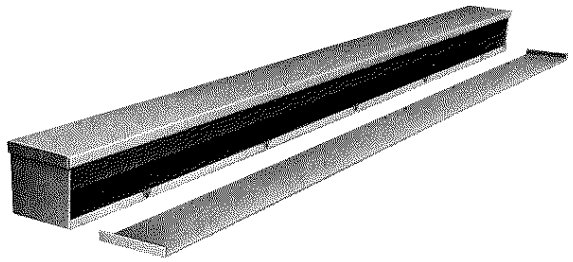
8.1 SQUARE-Duct

SQUARE-Duct is a steel enclosed wiring trough, wireway and auxiliary gutter with a hinged cover that can be used as either hinge cover wireway or screw cover trough. A complete set of fittings is available so that an entire wireway system can be installed regardless of bends, offsets or other building contours which may be encountered. Fittings have removable covers and sides to permit a complete "lay-in" installation and to permit access to wires throughout the entire length without any alterations to the system. SQUARE-Duct is UL listed as wireways and auxiliary gutters. Good electrical and mechanical continuity is assured through the direct connection of threaded screws at every connector. SQUARE-Duct is manufactured in standard lengths of 1, 2, 3, 4, 5 and 10 feet in 2½"x2½", 4"x4", 6"x6", 8"x8" and 12"x12" sizes.



8.2 RAINTIGHT TROUGH

Raintight trough is a steel enclosed wiring trough, designed to be used in outdoor applications and in other areas where raintight construction is required. It has a removable cover with provisions for sealing, and is UL listed for ganging meters, switches and other equipment suited for outdoor use. Raintight trough is available in standard lengths of 1, 2, 3, 4, 5, 6 and 10 feet in 4"x4", 6"x6", 8"x8" and 12"x12" sizes.

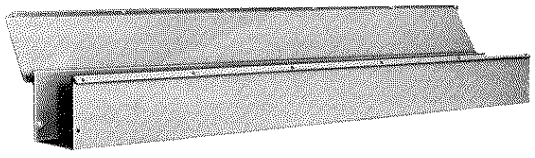


8.3 OILTIGHT LAY-IN WIREWAY

Oiltight lay-in wireway is a UL listed metal wiring trough manufactured to NFPA 84 specifications for Industrial Control Equipment and is used to protect electrical wiring from oil, water, dirt or dust, for large machine tools or special machine wiring and also industrial installations where protection against these elements is needed. Oiltight lay-in wireway comes in standard lengths of 1, 2, 3, 4, 5 and 10 feet in 2½"x2½", 4"x4", 6"x6", 8"x8" and 12"x12" sizes. Various fittings are available for each size to accommodate any type of layout.

8.4 RAINTIGHT LAY-IN WIREWAY

Raintight lay-in wireway is a UL listed steel enclosed gangable wireway and auxiliary gutter designed to be used outdoors to protect runs of electrical wiring against rain and sleet as well as physical damage and may be used indoors where moisture is a problem. The wireway is available in 4"x4" and 6"x6" cross-sectional sizes in standard lengths of 1, 5 and 10 feet and a complete line of fittings and mounting hardware.



8.5 SQUARE-Duct ADVANTAGES

SQUARE-Duct is steel enclosed wireway which houses feeders, branch circuits, control wires, and other groups of insulated conductors. Cables and wires installed in SQUARE-Duct are accessible throughout the entire length allowing changes, additions, or inspection of the wiring system without the necessity of alterations or additional equipment.

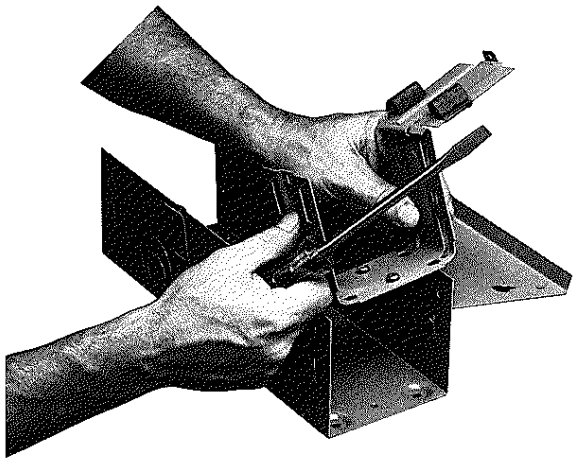
SQUARE-Duct combination wireway must be figured as the most economical wireway for machine shops, laboratories, automated lines, lighting feeds, ganging gutter and many other electrical jobs.

SQUARE-Duct can be used to an advantage in most smaller distribution systems where multiple runs of conduit would be required. It is superior to conduit in most instances for exposed work, especially where additions or alterations to the distribution system can be expected. SQUARE-Duct can be installed without expensive tools as are required in conduit systems. Normally a screwdriver and wrench are all that are required to install SQUARE-Duct lengths and fittings.

Full width openings are provided on all lengths of wireway since there are no flanges to reduce the opening into SQUARE-Duct. Each section is die-formed at the ends to facilitate use with either a connector, closing plate, reducer or panel adapter.

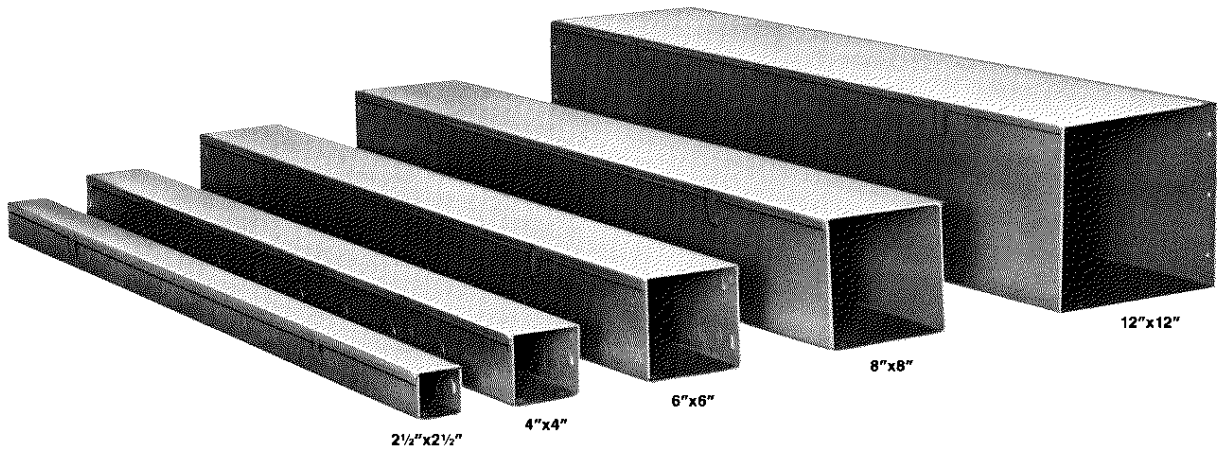
Lengths are manufactured in cross-sectional sizes of 2½"x2½", 4"x4", 6"x6", 8"x8" and 12"x12". Lengths of SQUARE-Duct are available in standard sections of 1, 2, 3, 4, 5 and 10 feet. Sizes are available with or without knockouts except the 8"x8" and 12"x12" wireway which is available only without knockouts.

Finish: ANSI-49 gray epoxy paint applied by a cationic electrodeposition paint process over a corrosion resistant phosphate primer. The wireway is also available in galvanized steel.



QUICK, RIGID CONNECTIONS ARE MADE BY SIMPLY SLIPPING CONNECTOR IN PLACE AND TIGHTENING THE CAPTIVE SCREWS

Reduced installation time is a big advantage of SQUARE-Duct over conventional types of wireway systems. The system can be assembled in sections on the floor and raised into position by hand. Square D's patented slip-on connector reduces installation time to a minimum. The connector slips in place between each length with no nuts or bolts required. Captive, self-tapping, paint cutting screws included in each connector provide ground continuity. Once the connector is slipped in place, the captive screws need only to be run down to assure positive electrical and mechanical continuity. Connector covers are hinged so that wires may be laid in the full wireway length. Removable covers and sides on all fittings continue the "lay-in" feature throughout the entire installation. Installation time is reduced considerably over competitive makes of wireway.

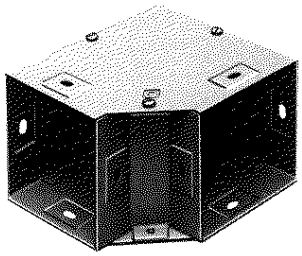


FIVE CROSS-SECTIONAL SIZES OF SQUARE-Duct

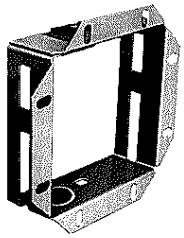
SQUARE-Duct COMPONENTS

A complete set of fittings is available so that an entire wireway system can be installed regardless of turns, offsets or other building contours which may be encountered.

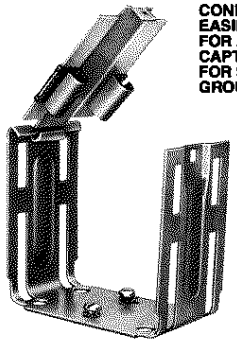
Fittings have removable covers, bottoms and sides to permit a complete "lay-in" installation and to provide access to wires throughout the entire length without any alterations to the system. SQUARE-Duct is UL listed as wireway and auxiliary gutter. Good electrical and mechanical continuity is assured through the direct connection of lengths by threaded screws at every connector.



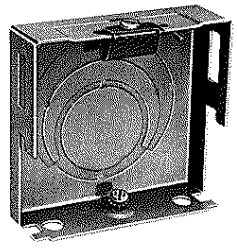
ELBOWS ARE AVAILABLE IN 22½° 45° and 90° FOR MAKING BENDS OR FITTING AROUND BUILDING CONTOURS. ALL COVERS AND SIDES ARE REMOVABLE



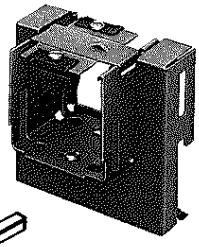
PANEL ADAPTERS ARE USED TO CONNECT DUCT TO PANELBOARDS OR TELEPHONE CABINETS. A SOLID CONNECTION, FREE FROM ROUGH EDGES, IS POSSIBLE



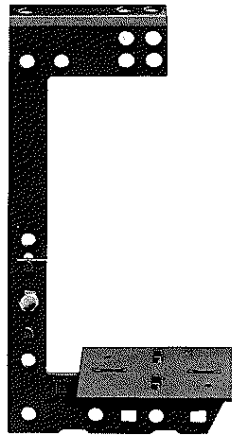
CONNECTORS CAN BE EASILY SLIPPED INTO PLACE FOR A FAST, RIGID CONNECTION. CAPTIVE SCREWS ARE PROVIDED FOR SECURE FASTENING AND GROUND CONTINUITY

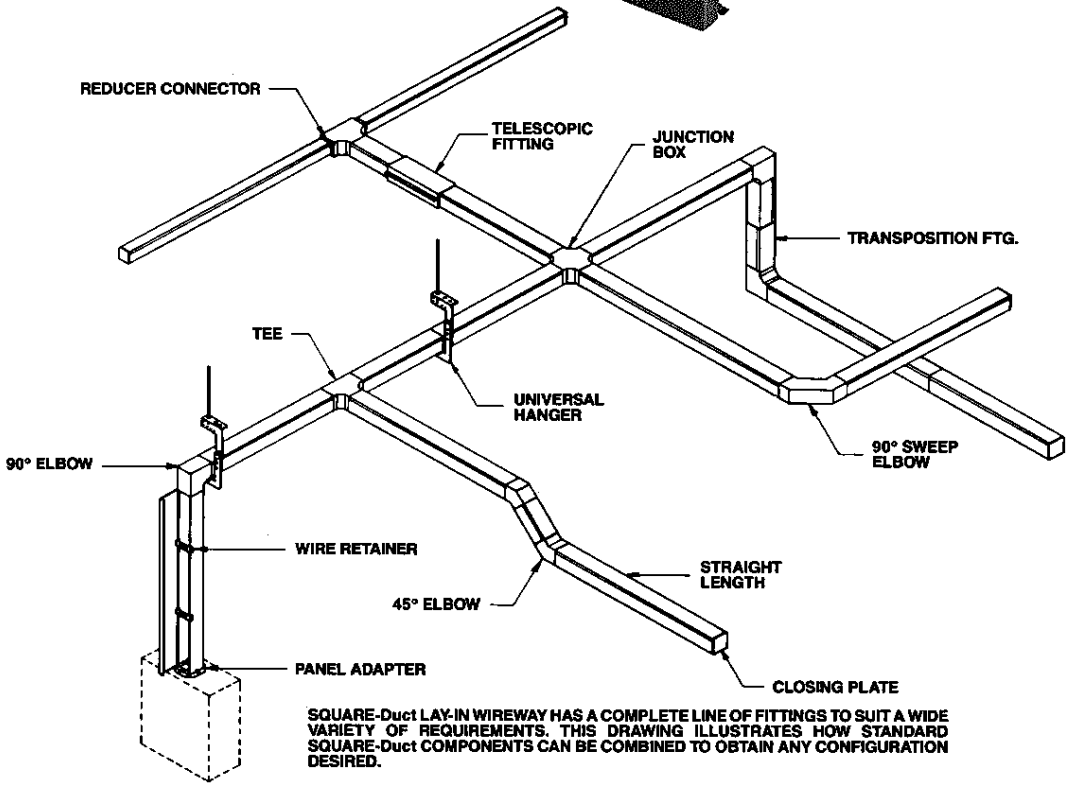


CLOSING PLATES ARE USED TO SEAL ENDS OF THE DUCT OR FITTINGS. KNOCKOUTS IN CLOSING PLATE ALLOW EXTENSION OF THE WIREWAY THROUGH USE OF CONDUIT OR TUBING



REDUCER FITTINGS ARE AVAILABLE FOR JOINING 4"x4" SQUARE-Duct TO 2½"x2½", 6"x6" TO 4"x4", 8"x8" TO 6"x6", AND 12"x12" TO 8"x8" SQUARE-Duct





SQUARE-Duct LAY-IN WIREWAY HAS A COMPLETE LINE OF FITTINGS TO SUIT A WIDE VARIETY OF REQUIREMENTS. THIS DRAWING ILLUSTRATES HOW STANDARD SQUARE-Duct COMPONENTS CAN BE COMBINED TO OBTAIN ANY CONFIGURATION DESIRED.

8.6 WIREWAY CONDUCTOR FILL

Conductors in wireway do not have to be derated (NEC 362-5) as is the case of conduit (NEC 310-16). The following are code requirements for wireway.

Conductors: Wireways are approved for circuits up to and including 600 volts. Regulations pertaining to wireway installations are as follows:

a. Tables 310-16 through 310-19 of the National Electrical Code give the allowable current carrying capacity for copper and aluminum conductors. The note indicates that the conductors must be derated when three or more are placed in raceways or cable. **This note does not apply to conductors placed in wireway** (NEC 362-5 and 374-5). Each conductor can carry the allowable current specified in the above material tables provided the number of conductors and the cross-sectional area they occupy within the duct does not exceed the limits specified below.
b. Not more than 30 conductors shall be installed in the wireway unless special permission from the authority enforcing the Code is obtained for installing a larger number or unless the conductors are for signalling circuits or are the control wires between a motor and its starter and are used only for starting duty.
c. No conductor larger than that for which the wireway is designed shall be installed in any wireway. When entering and exiting from either end of the wireway the conductor size is limited only to the 20% fill requirement.
d. The sum of the cross-sectional areas (this includes the cross-sectional area of the wire plus insulation) of all contained conductors shall not exceed 20% of the interior cross-sectional area of the wireway. Thus, in a 4x4 inch wireway a cross-sectional area of 3.2 square inches of conductors is permissible. (See table below).
e. Splices and taps may be installed if accessible and insulated by approved methods and which, together with the conductors, only fill the duct to 75% of its area.
f. Wireways shall be securely supported at intervals not exceeding 5 feet unless specially approved for supports at greater intervals.

The table below shows the number of conductors which may be installed in wireways in accordance with the 20% of area limitations imposed by the National Electrical Code. Combinations of different sizes of conductors may be computed from the values as follows.

Problem: It is desired to install three 4/0 conductors in one 4"x4" wireway and to use the remaining capacity of the wireway for No. 6 conductors. How many No. 6 conductors may be installed?

Solution:
Area of wireway, 4"x4" = 16 sq. in.
Area of 20% of wireway = 16 x .2 = 3.2 sq. in.
Space reserved for three 4/0 = 3x.3904 = 1.1712 sq. in.
Space remaining for No. 6 conductors = 3.2 - 1.1712 = 2.0288 sq. in.
Space required for 1 No. 6 conductor = 2.0288 ÷ .0819 = 24.77
24 No. 6 conductors, therefore, meet the requirements.

CONDUCTOR TABLE
NO DERATING NECESSARY UP TO CONDUCTORS OR 20% FILL — NEC 362-5

Conductor Size	Area of Conductor (In²)		Maximum Number of Conductors All of One Size at 20% Fill									
	Type T TW THW	Type THHN THWN XHHW	2½"x2½" Duct ‡1.25 in²		4"x4" Duct ‡3.2 in²		6"x6" Duct ‡7.2 in²		8"x8" Duct ‡12.8 in²		12"x12" Duct ‡28.8 in²	
	A	B	A	B	A	B	A	B	A	B	A	B
14	.0135●	† .008	*92	*143	*237	*368	*533	*827	*950	*1471	*2133	*3310
12	.0172●	† .0117	*72	*107	*186	*273	*428	*615	*744	*1094	*1674	*2461
10	.0224●	† .0184	*55	* 68	*142	*174	*321	*391	*570	* 695	*1285	*1565
8	.0471●	† .0373	26	* 33	* 68	* 85	*153	*193	*271	* 343	* 611	* 722
6	.0819	† .0519	15	24	* 39	* 61	* 87	*138	*156	* 246	* 351	* 555
4	.1087	.0845	11	14	29	* 38	* 66	* 85	*117	* 151	* 264	* 341
3	.1263	.0995	9	12	25	* 32	* 57	* 72	*101	* 128	* 228	* 289
2	.1473	.1182	8	10	21	27	* 46	* 61	* 87	* 108	* 195	* 243
1	.2027	.1590	6	8	15	20	* 35	* 45	* 63	* 80	* 142	* 181
0	.2367	.1893	5	6	13	17	20	* 38	* 54	* 67	* 121	* 152
00	.2781	.2265	4	5	11	14	25	* 31	* 46	* 56	* 103	* 127
000	.3288	.2715	3	4	9	11	21	26	* 39	* 47	* 87	* 106
0000	.3904	.3278	3	4	8	9	18	22	* 32	* 39	* 73	* 88
250MCM	.4877	.4026	2	3	6	8	14	18	26	* 31	* 59	* 71
300MCM	.5581	.4669	2	2	5	7	12	15	22	27	* 51	* 61
350MCM	.6291	.5307	2	2	5	6	11	13	20	24	* 45	* 54
400MCM	.6969	.5931	1	2	4	5	10	12	18	21	* 41	* 48
500MCM	.8316	.7163	1	1	4	4	8	10	15	18	* 34	* 40
600MCM	1.0261	.8792	1	1	3	3	7	8	12	14	* 28	* 32
700MCM	1.1575	1.0011	1	1	2	3	6	7	11	12	* 24	28
750MCM	1.2252	1.0623	1	1	2	3	5	6	10	12	23	27

* NOTE: The 1987 National Electrical Code limits installation to 30 conductors in one wireway except where derated according to table 310-16 through 310-18 NEC, or where special permission has been obtained from local authority enforcing the Code or where conductors in excess of 30 are for signalling circuits or are control wires between a motor and its starter and used only for starting duty, and other exceptions are noted in 520-5 (theaters), 620-32 (elevators), and 374-5 (auxiliary gutters).
† Areas for Type XHHW are .0131, .0167, .0456, and .0625 for sizes 14, 12, 10, 8, and 6 respectively.
● Areas for Type THW are .0206, .0251, .0311, and 0.598 for sizes 14, 12, 10, and 8 respectively.
‡ These values represent 20% of the interior cross-sectional area of the various sizes of the wireway.

8.7 SQUARE-Duct WIREWAY SYSTEMS PLANNING

The demand for SQUARE-Duct wireway as a raceway for power and communications cables is increasing. The convenience and location of concentric and tangential knockouts on both sides and the bottom, along with the complete lay-in capability of all straight lengths and fittings makes all types of wiring simple and less time consuming than all other types of wiring. With the covers being captive, the universal hangers allowing for complete opening of covers and pre-assembly on the floor, there are no loose pieces to be lost or left off the completed installation. With the frequency of changes in work stations now commonplace in commercial buildings, easy access is permitted throughout the entire run and changes are simplified greatly. The National Electrical Code requirements are changing rapidly to take into account the concern for fire spread and toxic fumes so that SQUARE-Duct wireway is the most economical choice for overhead distribution systems.

Feeder wiring is distributed in SQUARE-Duct wireway suspended above the drop ceilings. This raceway is readily accessible for wiring changes as they become necessary. From this system, power and communications and even CRT services are delivered to work stations in the room below.

SQUARE-Duct Wireway: 2½"x2½", 4"x4", 6"x6" are practical sizes of wireway that can be used in overhead distribution systems. In all cases, wireway can be used to distribute 125 volt power and 277 volt lighting and all communication circuits.

Partitions are field installable to allow for separation of conductors of different systems. Conductors of light and power systems of 600 volts or less may occupy the same enclosure. However, conductors for signal or radio circuits must not occupy an enclosure with a 600 volt system.

PLANNING FOR POWER AND TELEPHONE EQUIPMENT IN AN OFFICE BUILDING IS OF PRIME IMPORTANCE BECAUSE ALMOST 100% ACCESSIBILITY IS REQUIRED ON LARGE FLOOR AREAS DUE TO FREQUENT OFFICE CHANGES.

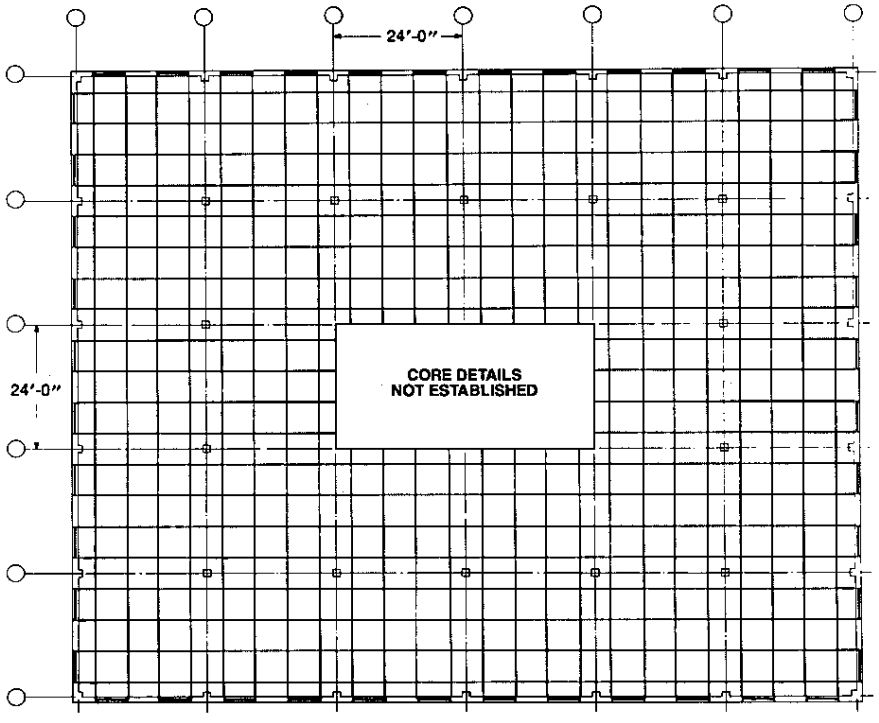
ONE METHOD IN DETERMINING A FLEXIBLE DISTRIBUTION SYSTEM IS AS FOLLOWS:

OBJECTIVE — Design an adequate distribution system, utilizing SQUARE-Duct wireway to provide power and communications for all away-from-wall work stations.

DESIGN CRITERIA FOR FEEDING CAPACITIES

TELEPHONE — One square inch of wireway capacity for every 90 to 100 square feet of usable office area.

POWER — One square inch of wireway capacity for every 500 to 1,000 square feet of usable office area.



BUILDING FLOOR PLAN

SQUARE Duct is a Registered Trademark of Square D Company.

WIREWAY

In designing an overhead distribution system, the first consideration is to determine the usable office area:

Floor Dimension = 120 Ft. x 144 Ft. = 17,280 Ft.²

Deduct
Core Dimension = 24 Ft. x 48 Ft. = 1,152 Ft.²

Usable Office Area 16,128 Ft.²

The next step is to determine the number and sizes of feeder wireway required to meet the building's design criteria:

Telephone Capacity Req'd. = 16,128 Ft.²/100 Ft.² = 161 In.²

4 - 6"x6" Wireways @ 36"² each= 144"²
2 - 4"x4" Wireways @ 16"² each= 32"²

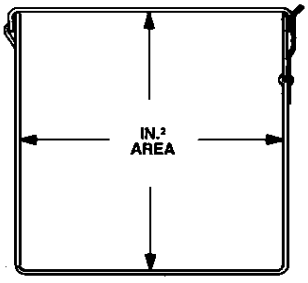
Total Telephone Capacity = 176"²

Or One Square Inch Per Each 92 Ft.²

Power Capacity Required = 16, 128 Ft.²/800 Ft.² = 20 In.²

4 - 2½"x2½" Wireways @ 6.25 in.² each = 25 In.²

Or One Square Inch Per Each 645 Ft.²



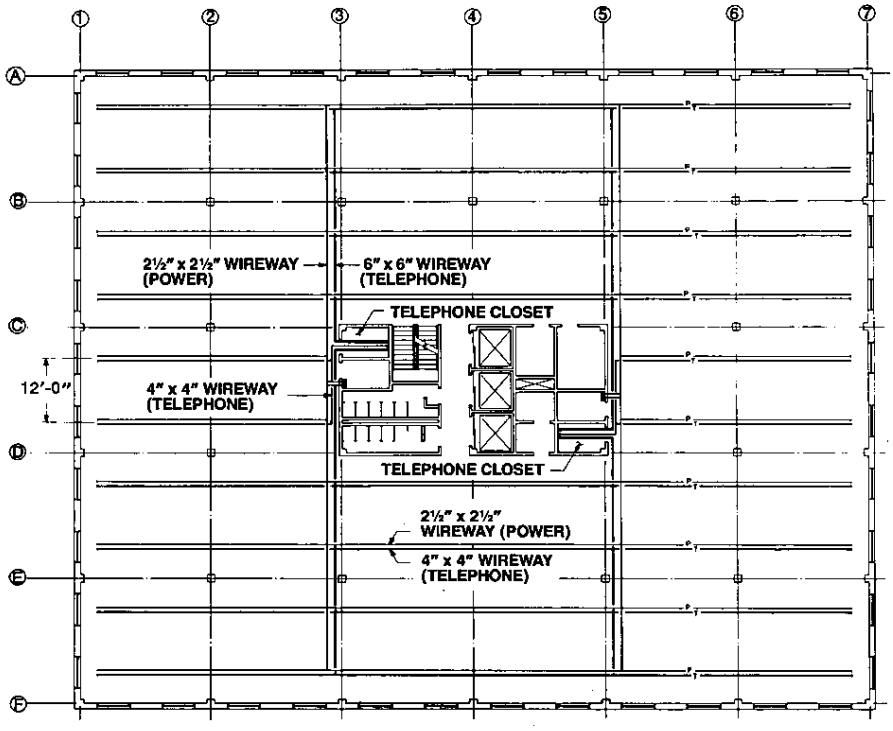
WIREWAY CAPACITIES

SIZE	AREA - IN.²
2½"x2½"	6.25
4"x4"	16.00
6"x6"	36.00

In laying out the wireway system, full advantage should be taken from telephone and power closet locations to provide equal distribution of feeder wireways.

Distribution (or branch) wireway runs can usually be reduced in size and still maintain sufficient capacity.

Centerline dimensions between runs may vary depending on ceiling construction and available space. Special consideration should also be given if the space over the hung ceiling is to be used for environmental air per 1987 NEC Article 300-22(C).



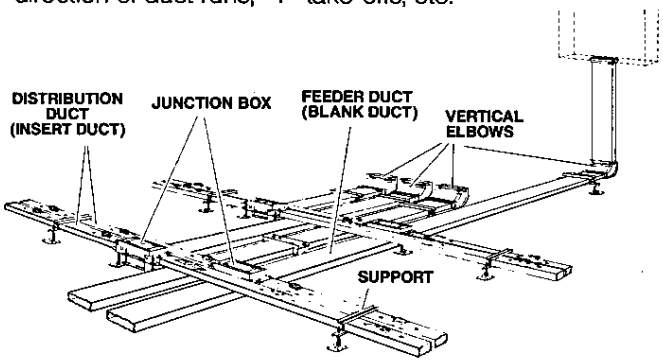
WIREWAY SYSTEM FLOOR PLAN

NEC is a Registered Trademark of the National Fire Protection Association.

9.0 UNDERFLOOR DUCT

Underfloor duct is a raceway system designed to be imbedded in the concrete floor of offices, classrooms, laboratories, manufacturing areas, supermarkets, etc., for the purpose of providing an enclosed raceway for wires and cables from their originating panel or closest to their point of use.

An underfloor raceway system is composed of two types of ducts: feeder ducts and distribution ducts. Complimenting these two types of ducts are junction boxes, support couplers and supports, horizontal and vertical elbows, power and telephone outlets and numerous cast and sheet metal fittings used as conduit adapters, change of direction of duct runs, "Y" take-offs, etc.



Underfloor duct is one of the many members of the family of "Conduit and Raceways" and as such, must conform to all of the requirements of the National Electrical Code governing this family. In addition, it must conform specifically to the requirements of Article 354 of the NEC.

9.1 FEEDER DUCTS

Feeder ducts are those ducts which provide the "feed" from the service terminal points (lighting panelboards, telephone closet or cabinet, signal cabinet, etc.) to the duct that distributes the system to its point of use.

Feeder duct is referred to as "blank duct" because it has no "inserts" as does distribution duct. Feeder ducts are available in two sizes: STANDARD BLANK, 1⅜" x 3⅛" and SUPER BLANK, 1⅜" x 7¼". Feeder ducts are available in 10 ft. lengths.

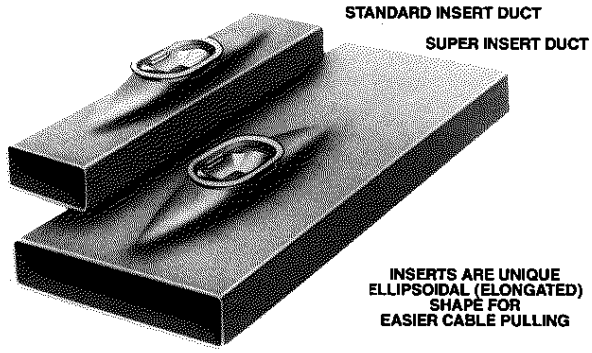
9.2 DISTRIBUTION DUCTS

Distribution ducts are those ducts that serve as the "distribution" raceway from the point of junction with the "feeder" raceway to the point where the service becomes usable.

Distribution duct, in general, comes with formed inserts or openings, circular in shape, on 24" centers along its length for convenient cable access. Distribution duct from Square D, however, has a uniquely designed insert, also on 24" centers, which is ellipsoidal (elongated) in shape for easier cable pulling with less chance of damage to the conductors, For unusual job applications, duct can also be ordered with other insert spacings.

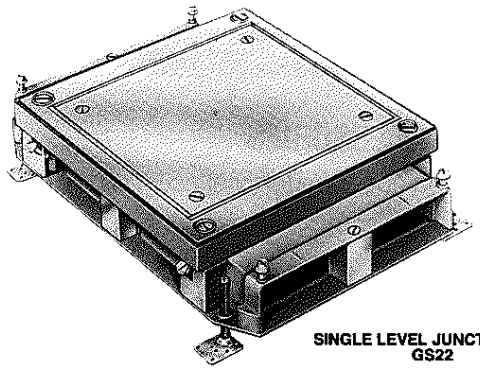
Distribution ducts are available in two sizes: STANDARD INSERT DUCT, 1⅜"H x 3⅛"W and SUPER INSERT DUCT, 1⅜"H x 7¼"W. The ducts are made in 10 ft. lengths.

SQUARE D DISTRIBUTION DUCTS



9.3 JUNCTION BOXES

Junction boxes are used at the point of juncture of the feeder raceways and the distribution raceways. Junction boxes, by the use of interior partitions (or tunnels), also maintain the separation of services where two or more non-compatible services form a junction. For instance, in a two-duct system, where one raceway is for telephone cables and one raceway is for branch circuit wiring, the junction box provides a separate raceway for each system, both through the box and at right angles to it.



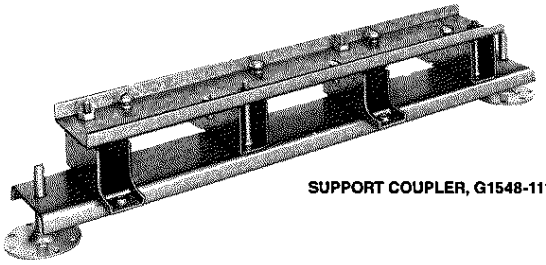
SINGLE LEVEL JUNCTION BOX GS22

All Square D junction boxes have **two** means of leveling. The first adjustment is made by using the threaded leveling legs. These legs adjust the top of the box to the screed line of the concrete. The second method of leveling is a fine adjustment composed of four screws in the corners of the boxes. By using these screws, the box can be adjusted **after** the concrete is poured.

All Square D junction boxes have ⅛" tile stops and holders built into the cover ring and plate assembly so that no additional "pan" or "ring" is needed for a floor tile installation. This is an exclusive Square D feature.

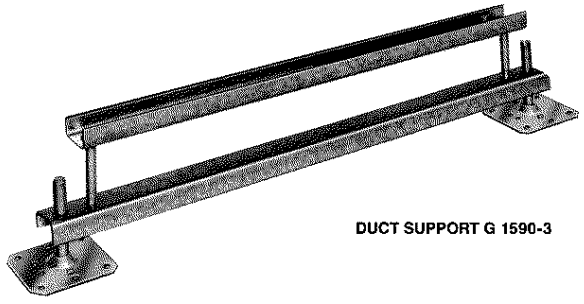
9.4 SUPPORT COUPLERS AND SUPPORTS

Square D manufactures two types of supports. One is a combination support and duct coupler (support coupler) which is used to couple lengths of ducts together, either in single duct runs or in combinations of multi-duct runs. Support couplers are also used to support ducts at the extreme ends of duct runs and to provide for the desired 1" spacing between runs.



SUPPORT COUPLER, G1548-111

Duct supports are used at the mid-point of 10 ft. spans. For additional strength, the combination of support couplers and supports provides system support for the duct every five feet.



DUCT SUPPORT G 1590-3

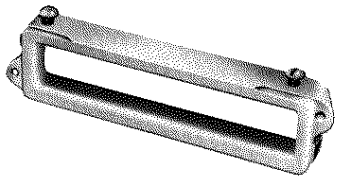
9.5 DUCT ACCESSORIES

There are a number of additional accessories of various uses that complete the duct system.

VERTICAL ELBOWS

Vertical elbows are used to "ell" into panelboards, telephone cabinets, etc. Usually, a short piece of blank duct provides the "riser" from the duct elbow to the bottom of the cabinet.

90° VERTICAL ELBOW



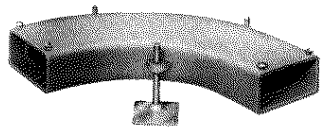
CABINET CONNECTOR

CABINET CONNECTORS

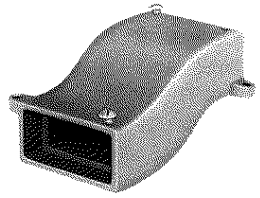
Cabinet connectors are used as a means of attaching the "riser" to the bottom of the cabinet, to "bush" the opening, and to provide the continuity of ground from the panel to the duct system.

HORIZONTAL ELBOWS

Horizontal elbows are used to change the direction of duct run in the horizontal plane. There are 90°, 45° and adjustable 15° and 30° horizontal elbows.



90° HORIZONTAL ELBOW



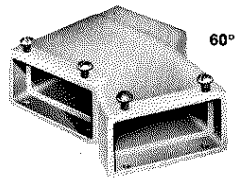
OFFSET ELBOW

OFFSET ELBOWS

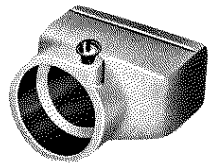
Offset elbows are used when it is necessary to change the elevation of a duct run. They are only used where absolutely necessary to avoid some obstruction (such as structural steel) in the concrete slab.

"Y" FITTINGS

"Y" fittings provide a take-off for duct or conduit to serve an outlet in an area remote from the area served by the distribution duct runs. These fittings can also be used to add a supplementary duct or conduit feed into the system.



60° "Y" FITTING



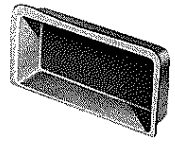
CONDUIT ADAPTER

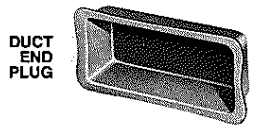
CONDUIT ADAPTERS

Conduit adapters are available in various sizes to allow a conduit take-off from the end of a duct run or from a box opening.

BOX OPENING PLUGS

Box opening plugs close up the unused duct openings in junction boxes to keep concrete out of the system.





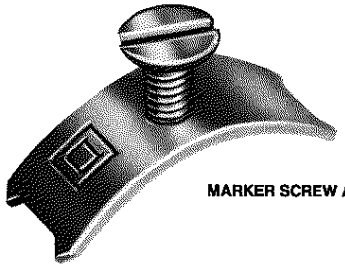
DUCT END PLUG

DUCT END PLUGS

Duct end plugs cap the ends of duct runs to keep concrete from running into the raceway. These plugs are smaller than the box opening plugs.

MARKER SCREWS

Marker screws are used to mark an insert location for future opening. Since the inserts are on 24" centers, it is only necessary to mark a few inserts. Others can be found by using the marked insert as a beginning point. Usually, only the first insert on either side of a junction box and the last insert in a duct run are marked. It is also good practice to mark the first insert on either side of a permanent partition.



MARKER SCREW ASSEMBLY

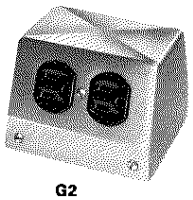
SEALING COMPOUND

Sealing compound is used wherever necessary to assure that no concrete leaks into the raceway system. It is available in tubes for use with a standard applicator.

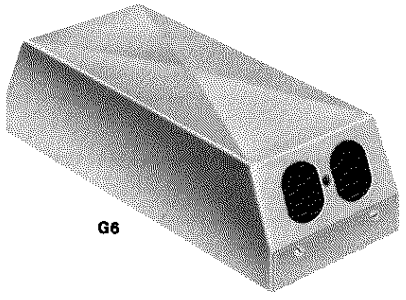
SERVICE FITTINGS

Service fittings are those fittings above the concrete, that are installed to the duct insert, which provide the service from the raceway system to the point of use. Service fittings of various types, styles and sizes serve different functions. Some are listed below:

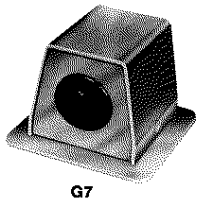
Standard duplex and single receptacles 15A, 20A, 30A or 50A
One, two, three, four and five plug amphenol connections (telephone).
Fittings for signal applications.
Standpipe fittings.
Flush telephone and power fittings.
Combination power and telephone fittings.



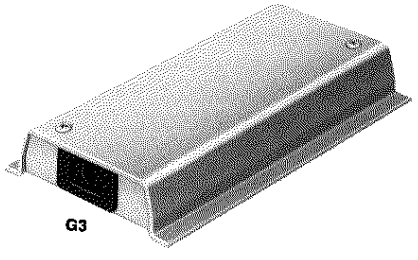
G2



G6



G7



G3

NOTES

10.0 BUSWAY

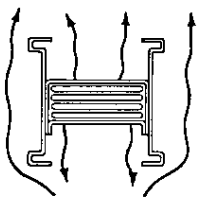
Square D offers a complete selection of advanced design I-LINE feeder and plug-in busway in ratings from 225 amperes through 5000 amperes (through 4000 amperes maximum in aluminum) to satisfy a wide range of power distribution requirements. Superior operating characteristics, flexibility and ease of installation have made I-LINE busway by Square D the popular choice since it was first introduced more than two decades ago.

The original I-LINE busway is available in ratings of 225, 400 and 600 amperes. For ratings of 800 amperes and above, the new I-LINE II busway offers many attractive features, including standard Integral Ground Bus (IGB) while retaining all of the time proven original I-LINE busway design advantages. Both are available in 3-pole and 4-pole full neutral construction for system voltages up to 600 volts ac. Both may carry 2-pole ratings with a UL listing up to 8650 amperes (dc or single phase ac).

The I-LINE busway concept has been proven in many thousands of installations in the United States and throughout the world.

10.1 TOTALLY ENCLOSED

I-LINE feeder busway, and also plug-in busway is totally enclosed. Neither requries ventilation openings in the housing for cooling. I-LINE busway is cooled by radiation from the housing surface and by convection currents outside the housing. This method of cooling offers these advantages:



TOTALLY ENCLOSED
I-LINE FEEDER BUSWAY
(FROM SQUARE D)

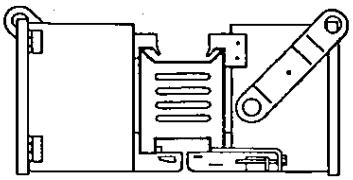
HEAT IS CONDUCTED TO SURFACES
NO DEAD AIR SPACE

I-LINE BUSWAY IS FULLY RATED
IN ALL MOUNTING POSITIONS

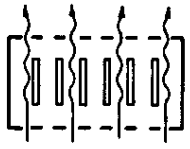
1. I-LINE busway needs no derating for different mounting positions because it cools as efficiently in one position as another. But ventilated busway, unlike I-LINE busway, maintains its maximum operating temperature within allowable limits by utilizing convection currents of air which pass through the housing itself to carry off excess heat. When ventilated busway is mounted so that the perforated housing allows these convection currents to pass freely through the housing and between the conductors, this method of cooling is fairly efficient. However, if the busway is mounted in any position other than this "preferred position", the bus bars themselves interfere with the free passage of cooling air, efficiency is decreased, and the operating temperature rises.

TOTALLY ENCLOSED
I-LINE PLUG-IN BUSWAY
(FROM SQUARE D)

CONVENTIONAL
VENTILATED BUSWAY,
IF INSTALLED IN THIS POSITION
MUST BE DERATED



Under these conditions, ventilated busway must be "derated" to a substantially lower current carrying capability. Or, if derating is unacceptable, oversized bus bars must be used to reduce overall heating to an acceptable level.



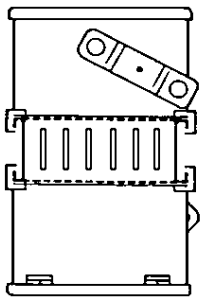
VENTILATED BUSWAY
(NOT A SQUARE D PRODUCT)

FULLY RATED ONLY
WHEN MOUNTED IN THIS POSITION

BUS BARS COOL ONLY BY AIR MOVEMENT THROUGH PERFORATED HOUSING

Where totally enclosed construction is used on busway that is normally ventilated, even more stringent derating is required.

2. Plug-in switches or circuit breakers can be side-mounted for maximum utilization. The "preferred" mounting position of most ventilated busway requires the plug-in units to be mounted on the top and bottom of the run; making those on top hard to get at, and making those on the bottom protrude into available headroom. I-LINE busway plug-in units may be side-mounted for maximum utilization, without "derating" the busway.



VENTILATED BUSWAY
(NOT A SQUARE D PRODUCT)

IN ITS "PREFERRED POSITION

FULL RATING CAN BE APPLIED ONLY
IN THIS MOUNTING POSITION

3. The National Electrical Code (Paragraph 364-6) states that busways may extend "vertically through dry floors if totally enclosed (unventilated) where passing through and for a minimum distance of 6 feet (1.83m) above the floor to provide adequate protection from physical damage."

I-LINE busway satisfies the NEC requirement with no modification. In the case of the ventilated busway, however, if the enclosure is not provided by a busway manufacturer his busway may meet requirements of NEC Paragraph 364-6, but void the UL manifest, since UL cannot sanction modifications made to a product

in the field. Ventilated busway requires expensive modification to satisfy both UL and NEC requirements. I-LINE busway requires no modification.

4. The safety precaution embodied in the NEC requirement mentioned above is obvious. Totally enclosed construction affords much greater protection from mechanical damage to the bus bars and insulation. It also gives much better protection from dust and dirt accumulation in the housing than does ventilated duct.
5. Because I-LINE busway construction does not require that bus bars be spaced apart for air flow between them, the physical size of the housing can, with proper design, be smaller, rating for rating. Weight also is lower in I-LINE busway than in other types. These two factors help reduce installation cost and makes I-LINE busway fit where other busways do not.
6. The close spacing of bus bars in I-LINE busway gives it exceptionally low reactance. This helps reduce voltage dips during the instant of a change in load, such as motor starting. Under such conditions, the high inrush current (up to 600% of load) is at a very low power factor so, the reactive component of voltage drop assumes greater importance. I-LINE busway's extremely low reactance reduces voltage dips (instantaneous voltage drop changes.) This is extremely important where voltage sensitive equipment (X-ray machines, electronic computers) is in use, or where lamp flicker is objectionable.

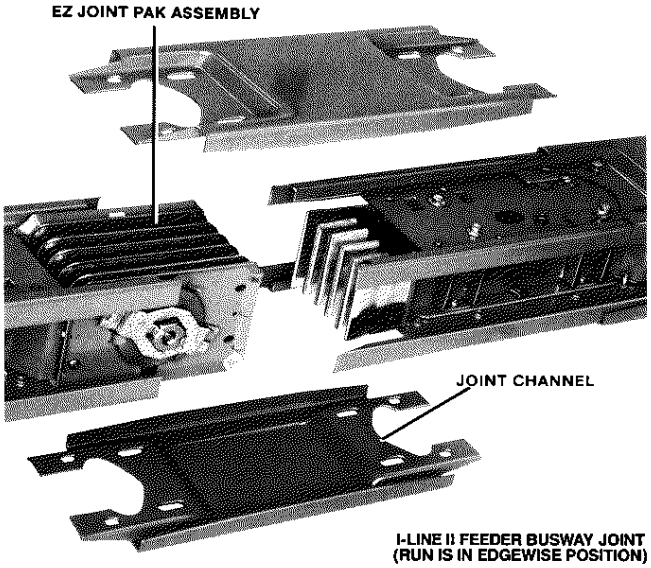
   I-LINE busway is designed to operate within satisfactory temperature rise limitations without relying on air convection currents through housing perforations, and all the described advantages are gained. Ventilation is something one puts up with only when satisfactory operation cannot be achieved through more sophisticated design considerations. The temperature rise of I-LINE busway is well below UL standards (55°) in all ratings.

10.2 ONE-BOLT JOINT

All I-LINE busway is built with "one-bolt" joints.

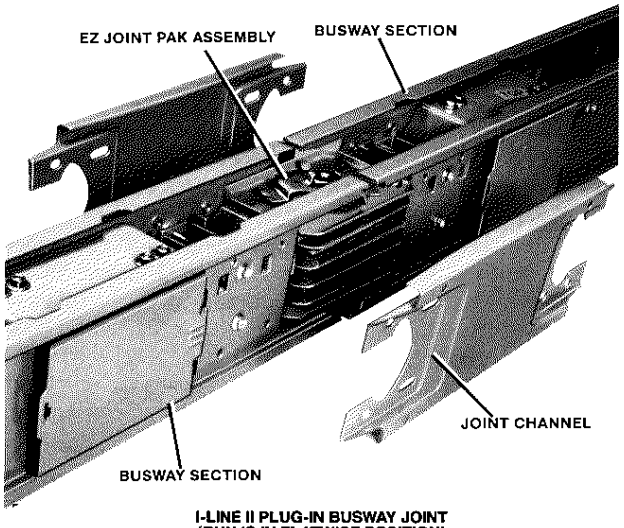
Older designs of busway used several current carrying bolts to connect the individual bus bars. This was a natural consequence of the open bus bar systems, out of which pre-fabricated busways grew. One of the most noticeable changes in recent designs is the elimination of this older joint in favor of a interleaved joint between sections, commonly called the one-bolt joint.

With the I-LINE busway design, this joint uses a single high-strength (Grade 5) torque indicating bolt to provide a clamping pressure of over 4000 pounds to the bus bar contact surfaces. This force is distributed over the contact area by a 3" spring steel cup (Belleville) washer. Where two or three parallel conducting paths are provided, two or three similar bolts are used at each joint, but this arrangement is still referred to in most industry literature, as a "one-bolt" type joint. The one-bolt principle has won an extremely favorable position with contractors, because one captive bolt replaces as many as 32 bolts, washers, lock washers and nuts, as required by some manufacturers.



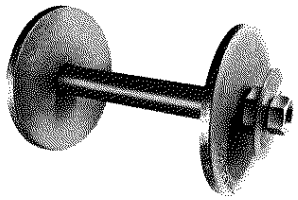
I-LINE II FEEDER BUSWAY JOINT
(RUN IS IN EDGEWISE POSITION)

The Grade 5 joint bolt used in I-LINE busway is of a unique "double-headed" design. This VISI-TITE joint bolt, as it is called, eliminates the need for special torque wrenches and their associated time consuming torque readings. For proper tightening, the installer need only twist off the outer head to produce the correct joint bolt torque. A fluorescent red indicator disc attached between the two heads, serves as a highly visible indicator of the joint bolt condition . . . when the outer head of the VISI-TITE joint bolt has been properly twisted off, the indicator disc falls away.



I-LINE II PLUG-IN BUSWAY JOINT
(RUN IS IN FLATWISE POSITION)

Labor studies have shown that an 80% saving in installation time is not uncommon when comparing I-LINE busway with older multi-bolt types of feeder or plug-in busway. Similar savings are realized when installing I-LINE busway in the place of wire and conduit. Both I-LINE feeder and I-LINE plug-in busway use the same joint which allows maximum flexibility. Plug-in sections can be inserted in feeder runs where power tap-off is required. Or feeder sections may be interspersed in runs consisting predominantly of plug-in busway. The tremendous labor savings realized when installing I-LINE busway rather than conventional busway or wire and conduit installations is, from the contractors' viewpoint, one of its most important advantages.



All I-LINE busway is UL listed for hanging on 10'0" horizontal centers or 16'0" vertical centers. This eliminates half the hangers required by some competitive makes.

10.3 SHORT CIRCUIT BRACING

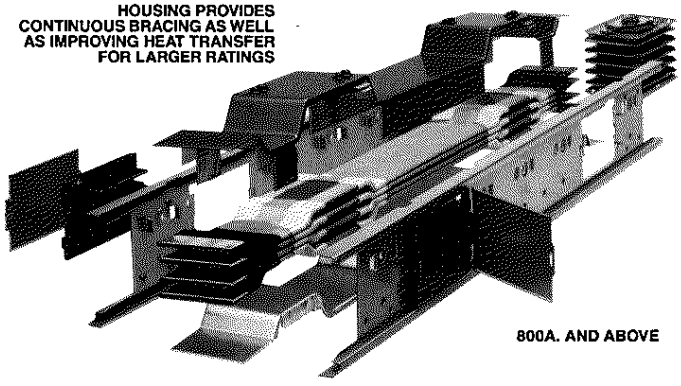
During a surge of current resulting from a low resistance fault either in the busway or in the equipment fed by the busway, the conductors carrying the fault current are subjected to extremely large physical forces. These forces are the result of the interaction of the lines of magnetic flux which surround any current flow. For currents in the range that might be encountered during a bolted fault on a large busway system, these forces may reach values of several tons per lineal foot of conductor. For a 3 phase system, there is always one conductor which is being forced away from the other two by these fault current forces, just as two magnets are repelled by each other when poles of like polarity are adjacent. To prevent physical damage to the busway, some means of restraining these forces must be provided.

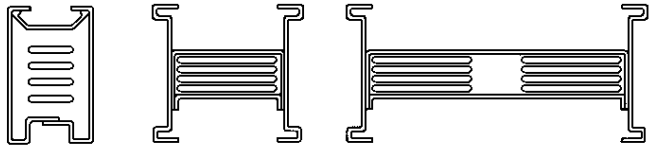
All I-LINE busway is built with special attention to the physical bracing needs which high level short circuit currents demand.

In I-LINE plug-in busway, special molded support insulators are located at every plug-in opening (10 per 10'0" length). It is significant that this support insulator is located at the most critical area—the plug-in opening. Without it, movement of the bus bars might damage plug-in units installed on the busway, even though the busway itself is able to withstand the fault and may show no apparent damage. This is why UL 857 "Standard for Busway and Associated Fittings" requires that the short circuit rating of any plug-in busway be determined by testing two lengths of busway in series: one of which must have plug-in units installed on it.

I-LINE II busway (800 amperes and above) also includes special housing details which provide even higher short circuit bracing throughout the entire length of each piece of busway (both feeder and plug-in).

For 225 ampere through 600 ampere busway, short circuit ratings of 22,000 amperes are standard. Optional construction offers a 42,000 ampere short circuit rating for 400 ampere and 600 ampere plug-in busway. Busway rated 800 amperes and above offers standard short circuit ratings of from 50,000 amperes to 200,000 amperes (depending on the specific busway rating selected). An optional high short circuit busway is also offered, which differs from the standard design only in the bracing details and in the material used to mold the support insulator at the plug-in opening. This high short circuit busway (cataloged APH and CPH) increases the standard short circuit ratings by 25,000-50,000 amperes in the majority of busway ampere ratings.



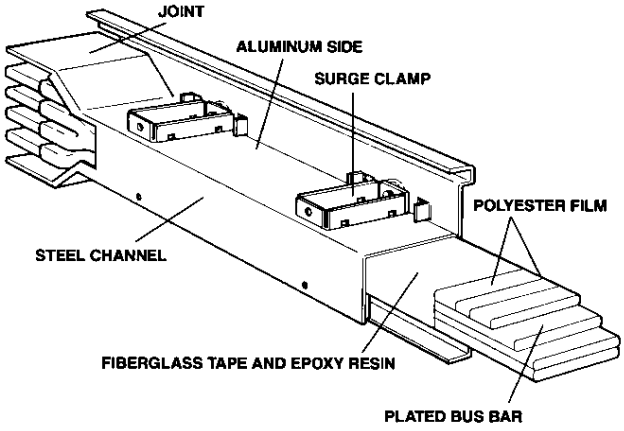


I-LINE BUSWAY HOUSING DESIGN IS COMPACT FOR ALL RATINGS (225 AMPERES THRU 5000 AMPERES)

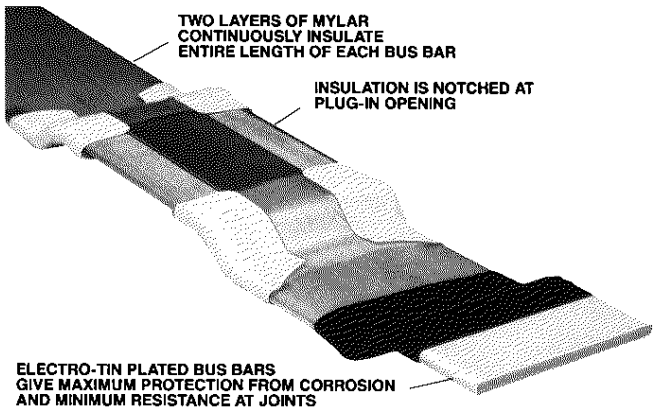
10.4 INSULATION

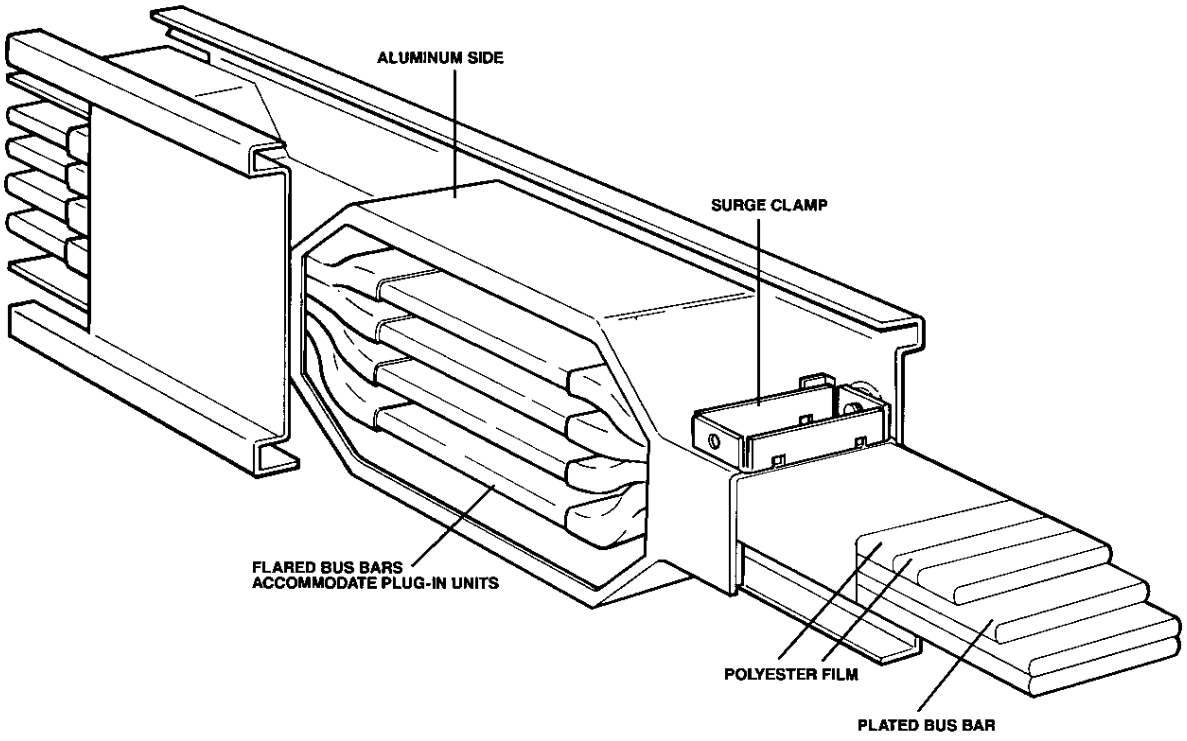
All primary insulation in I-LINE busway is Class B material, capable of satisfactory operation at temperatures up to 130°C. In both feeder busway and plug-in busway, double layers of MYLAR* polyester film are used. The use of Class B insulation is intended primarily as a means of extending insulation life under normal operating conditions. Nearly all insulating materials age more quickly when the operating temperature at which they are used approaches the allowed maximum. Most other busway designs use PVC (polyvinyl chloride), butyl rubber, plastic tape or some other Class A (105°C material. Because of this, I-LINE busway can be used in many areas of higher than normal ambient temperature without the derating required for other makes.

Bus bars on both feeder and plug-in busway are insulated over the entire length of the bar. This is necessary to prevent the propagation of traveling arcs. Should there be, by some mischance, an arc formed between bus bars in I-LINE busway, it would be confined to one length and would not damge adjacent lengths. Furthermore, the fault would be a low impedance path because of the ionized air created at the arc. This would allow the overcurrent device protecting the run to operate rapidly, clearing the fault. Traveling arcs, common to non-insulated bus bars, create extensive damage because they run down the length of a busway and are a high impedance path for the fault current.



I-LINE II FEEDER BUSWAY CONSTRUCTION





I-LINE II PLUG-IN BUSWAY CONSTRUCTION

I-LINE is a Registered Trademark of Square D Company.
MYLAR is a Registered Trademark of DuPont.

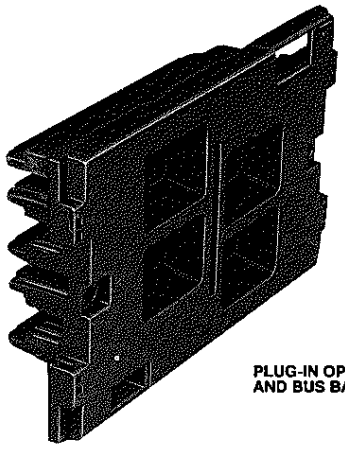
10.5 PLATING

Bus bars for I-LINE busway are plated with heavy electrotin plate. On aluminum bus, the patented ALSTAN 70 process is used to prepare the bus bar for this plating. Extensive load cycling tests, corrosive atmosphere tests and abrasion resistance tests prove the Square D Company's tin plating process results in the following advantages over conventional silver plate:

1. Lower surface-to-surface contact resistance. This is due to the greater malleability of tin and the resultant increase in effective conduction area. It means a cooler running joint.
2. Greatly improved corrosion resistance for aluminum bus bars. This is due to a reduction in galvanic action between the base metal and the plated surface, and to the better preparation for plating afforded by the ALSTAN 70 treatment.

10.6 PLUG-IN BUSWAY

I-LINE plug-in busway provides a tap-off every 2'0" along both sides of the length - 10 openings per 10 foot length. Plug-in opening spacing is not disturbed by joint location on lengths of even footage. All openings are usable. Note also, in connection with plug-in mounting, that the standard horizontal flatwise hanger in no way interferes with the plug-in units. Hanger location need not be considered when planning plug-in location or joint location. The one-bolt joint, continuous insulation and plug-in opening insulator have already been discussed. This plug-in opening insulator, in addition to its function as a support for the bus bars, also isolates each phase jaw from the others, where a plug-in unit is attached.



PLUG-IN OPENING INSULATOR AND BUS BAR SUPPORT

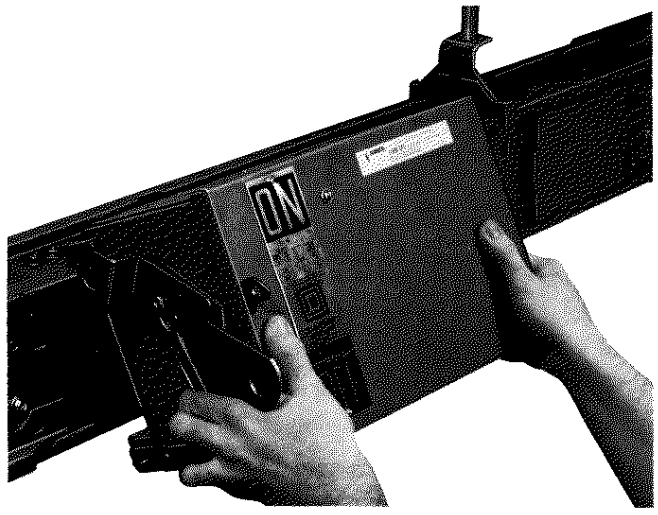
This effectively prevents accidental phase-to-phase or phase-to-housing shorts. The insulator and plug-in openings are covered by a hinged door held closed with a spring catch. With a screwdriver, this door may be opened prior to inserting the plug-in device, so that the condition of the plug-in opening can be inspected. The hinged door has proven less susceptible to jamming and being "painted shut" than sliding or pivoting covers. Also, being able to open it prior to positioning the plug-in unit is a definite safety feature. A fouled opening would be detected ***before*** the plug-in unit was in place, not after it was partially installed. Nothing enters the busway housing but the plug-in jaws. No stab or probe is required. There is no chance of some steel part coming in contact with live parts. The conductors are set well back from the surface of the molded insulator to prevent accidental contact with them.

Plug-in busway ratings 800 amperes and larger employ a "swing away" base feature which allows bolt-on style units up to 1600 ampere capacity to be connected at any plug-in opening. Instead of opening the plug-in door, two screws are removed and the entire door assembly and plug-in opening insulator swing away, exposing a much wider bus bar contact area. The connection for this type unit is of a bolted design similar to the standard I-LINE busway joint. It uses Belleville washers and a Grade 5 steel VISI-TITE bolt to insure proper operation on high ampere loads.

PLUG-IN UNITS

The plug-in units for I-LINE busway incorporate refinements in mounting, interlocking and operation which make them the most convenient of all plug-in units. The unit is positioned along the busway by hooks on the top which drop into notches in the busway's top rail. This aligns the plug-in jaws with the openings in the molded insulator without any jockeying for position by the installer. Then the unit is allowed to swing down into the plug-in opening where the plug-in jaws make contact with the bus bars.

This is accomplished in a "hook-swing" sequence of motions. As the plug swings into position, the weight of the unit and the leverage afforded by pivoting around the mounting hooks assist the installer in slipping the jaws on to the bus bars, one at at time.



I-LINE and VISI-TITE are Registered Trademarks of Square D Company.
ALSTAN 70 is a Registered Trademark of M & T Chemical Company.

In the normal plugging in of the unit, most of the weight of the plug is transferred from the installer to the plug-in busway in the first operation. The installer can then check the "feel of the alignment" before rotating the unit into the seated position.

All plug-in units are provided with a saw tooth grounding spring which makes a positive 'static' ground connection between the plug body and the busway housing prior to jaw contact with the bus bars. An optional 'blow-on' style high ampere ground jaw is also available. To complete the installation on most units, it is only necessary to tighten a single clamping screw, which rigidly fastens the plug enclosure to the busway housing. Tightening this clamping screw also releases the interlock so that the switching mechanism may be operated.

The manner in which plug-in units are mounted polarizes the units so that the neutral is always the bottom conductor. High ampere bolt-on units are available for use with 800 ampere through 5000 ampere I-LINE plug-in busway. These units include most of the plug-in unit features listed above with the addition of the bolted type connection for high ampere or severe duty loads.

A full line of plug-in and bolt-on units is available, including:

1. Fusible units from 30 to 1600 amperes.
2. Circuit breaker units from 15 to 1600 amperes.
3. Combination starter and contactor units through NEMA size 3.
4. Transformer units through 10kVA.
5. Capacitor units through 30 kvar.
6. Ground detector units.

SWITCH INTERLOCK MECHANISM SHOWING CLAMPING SCREW BACKED OUT. PLUG-IN UNIT IS READY TO MOUNT

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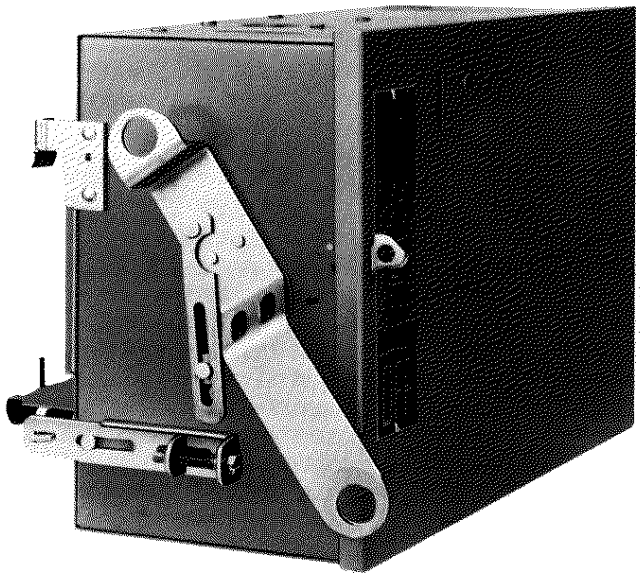
NEMA is a Registered Trademark of the National Electrical Manufacturers Association.
UL is a Registered Trademark of Underwriters Laboratories, Inc.

FUSIBLE UNITS

Fusible units through 400 amperes use the heavy duty safety switch mechanism. This switch mechanism is quick-make, quick-break, independent of the operating handle and incorporates visible blades, plated parts, arc suppressors and a one-piece crossbar.

Operation of this mechanism is such that it is not possible to restrain the main contacts once the operating handle has started the closing action. The switch has positive action, and may be opened or closed even if the main operating spring should be broken. All phase jaws are operated by the same solid one-piece crossbar.



FUSIBLE PLUG-IN UNIT

When the cover of the plug-in unit is open, the position and condition of the switch blades can be seen. There is no question as to whether the switch is "ON" or "OFF". Units may be positively padlocked in the "OFF" position. No live parts are exposed when the switch is off. The molded arc chamber barrier completely covers the line side terminals. Heavy duty switches equipped with UL Class RK9 (400 amperes and below) fuses have been tested satisfactorily on systems capable of delivering up to 100,000 symmetrical RMS amperes short circuit current. All switches withstood the tests without any signs of failure.

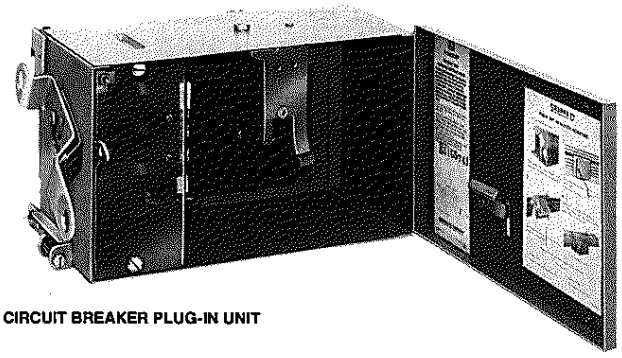
The operating handle is mounted on the end of the plug-in box, not on the cover, and is always in control of the switch (400 amperes and below). All plug-in units have interlocked doors. The door interlock can be overridden by use of a screwdriver so that the door can be opened while the switch is in the "ON" position.

Note that to remove the switch from the busway, the clamping screw must first be backed out. This insures that the unit is in the "OFF" position before being removed from the busway.

All parts of the interlock mechanism are external and require no stab or probe to enter the busway housing. Since the interlock functions to prevent certain operations, the cause of interference and method of interlocking can be easily seen without opening the plug-in unit.

CIRCUIT BREAKER UNITS

Circuit breaker plug-in units use molded case breakers in frame sizes from 100 amperes through 1600 amperes in either standard or high interrupting capacities. Both standard and high interrupting type breakers are in the same size enclosure. Current limiting circuit breaker plug-in units are also available.



CIRCUIT BREAKER PLUG-IN UNIT

The operating and interlocking mechanism is mounted on the end of the box as is true of the fusible units, and provides visual "TRIPPED" indication as well as "ON", "OFF" and "RESET" positions. All line-side live parts are protected with a transparent polycarbonate shield. Auxiliary contacts are available on breaker units on special order. Breaker plug-in units in 225, 400, 1000 and 1600 ampere frame size can be ordered for use as lug-to-bus main disconnect devices.

All switch and breaker plugs are equipped with an operator suitable for chain-pull or hook-stick operation from the floor (except 200A type PS vertical riser plug-in unit).

10.7 OUTDOOR FEEDER BUSWAY

I-LINE feeder busway is manufactured in outdoor as well as indoor construction. The outdoor design incorporates gasketed covers for joint parts, vapor barriers and other features which make it possible to install outdoor busway in exposed locations. Outdoor busway can be connected to indoor feeder or plug-in busway with the standard joint.

Plug-in busway is manufactured only in an indoor style and should not be used outdoors.

No feeder or plug-in busway is suitable for extremely dusty or hazardous locations, or in extremely corrosive atmospheres. However, I-LINE busway, because of its totally enclosed housing, full insulation and corrosive resistant tin plate, is often more suitable for borderline cases than other types of busway.

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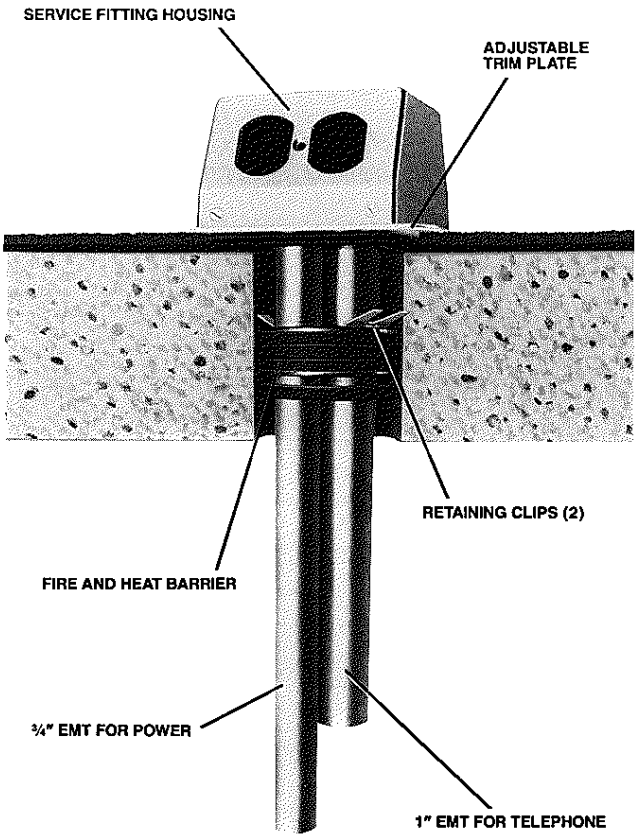
NOTES

11.0 FIRE-GARD THRU-FLOOR SERVICE FITTINGS

FIRE-GARD thru-floor fittings are classified by Underwriters Laboratories for fire resistance of up to and including a four hour rating. All fittings for power receptacles are also listed by UL as to electrical safety.

Fittings requires either a 2" or 3" diameter core drilled hole through the concrete slab for installation. The fittings are designed for use in slab depths of from 2¼" through 8" thick. They can be removed and reused at another location if desired.

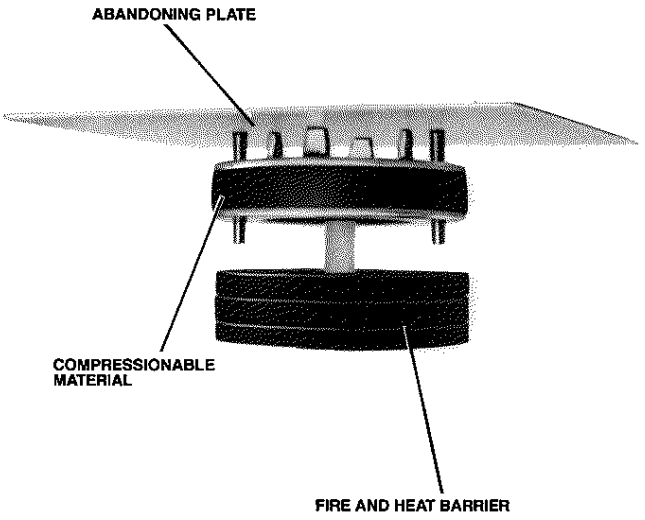


All fittings are furnished with both a ¾" and a 1" EMT conduit for use with standard and commonly available hardware to complete the raceway system in the ceiling below. When, as for instance, using the G2BA-TF fitting (power only) the extra conduit is ignored. No "plugging" of an unused conduit is necessary as the fire barrier material expands and plugs the conduit in the event of a fire.

This fitting is available for combinations of one, two and three service applications.

11.1 FIRE-GARD ABANDONING OUTLET PLATE

Designed to close any 2" or 3" diameter thru-floor hole, restoring the UL fire resistance classification of that floor up to and including a four hour rating. Available in satin aluminum or bronze finish. Both the fittings and the abandoning plates are removable and reusable.



NOTES

12.0 WALL TRENCH DUCT

Wall trench duct is a steel enclosed raceway, UL approved for enclosure of wiring of X-ray machines. The system has a complete lay-in feature. Cables can be installed by removing all covers and laying in the cables. This is an important feature due to the large diameter connectors that will be used on the high voltage cables. Whether these connectors are installed on the cable after fishing and pulling or factory assembled into one customized unit, a lay-in system is necessary. Branch connection from the system is by pipe-nippling out of the covers or sides of the tubs or by removing sections of covers.

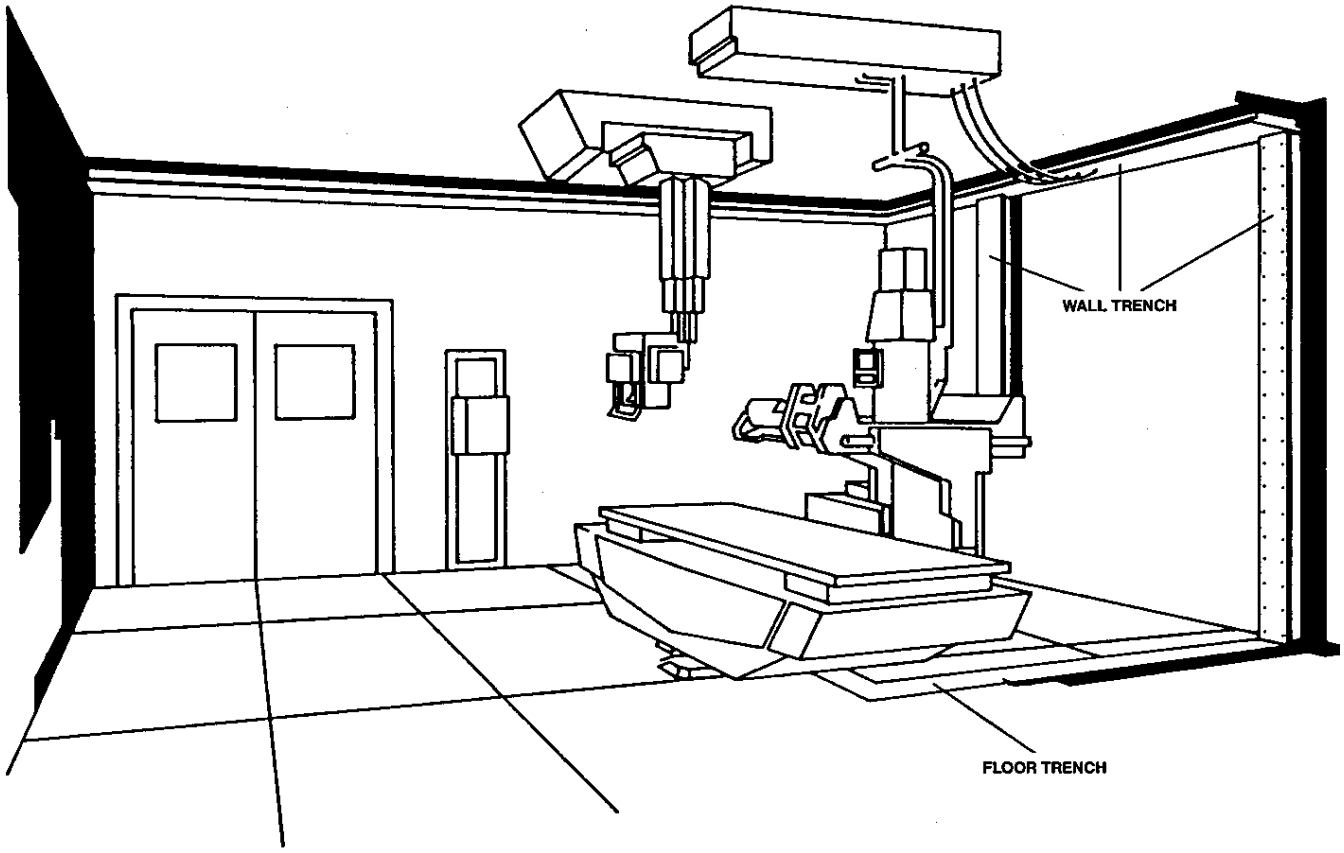
Economy and flexibility are the keys to comparison between wall trench and conduit systems. Conduit installations are fixed location systems. Wall trench with its continuous covers provide continuous points of access. Changes can be made to the room and equipment layout utilizing the existing wall trench location. Wall trench is more flexible than conduit. With the ever-advancing state of the art X-ray technology, wall trench installations provide for economical future changes.

WALL TRENCH

Wall trench is used in combination with floor trench to complete a raceway system from the power and control consoles to the table of the floor. Access to the X-ray table from the floor trench is by nippling out of the floor trench cover plates or removing sections of cover. (Floor trench covers are fabricated from ¼" nominal thickness steel.)

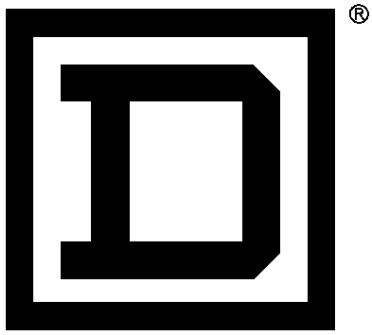
WALL TRENCH COVERS

Wall trench covers are available for either flush or surface mounting. Most applications will require a combination of both. The transition from one to the other is accomplished by the use of a flush to surface device. The normal application has flush mounted vertical duct tying into horizontally mounted surface duct in the control rooms.



WALL TRENCH IS SHOWN SURFACE MOUNTED ON WALLS AND CEILING. FLOOR TRENCH IS INSTALLED FLUSH WITH FINISHED FLOOR

NOTES



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