Hospital Isolated Power Systems

Class 4800

Catalog
4800CT9801R4/08

08

CONTENTS

a brand of Schneider Electric

SQUARE D

Overview

This catalog has three purposes:

- To demonstrate to hospitals the need for isolated systems
- To guide the engineer in the application of hospital ungrounded systems
- To describe in detail the Square D® brand equipment used to design effective and economical isolated ungrounded systems

Schneider Electric has been building isolating transformers for hospital use since the first equipment standards appeared in 1944. We have built an enviable reputation for reliability, low sound levels, and minimum inherent leakage.

Proof of the engineered superiority of Square D brand products is found throughout the country in numerous installations, many dating to the earliest applications of isolating transformers.

This bulletin is not intended as a “do it yourself” manual for installation of hospital isolated systems. The information contained here regarding codes and standards is current as of this writing. However, these codes and standards are continually changing and are also subject to local changes and interpretations.

Any hospital considering design changes to electrical systems in critical care patient areas should obtain the services of an electrical consulting engineer. The technical complexities of today’s hospitals require all involved parties to have a thorough understanding of the hospital’s objectives. This is the only way to avoid purchasing unnecessary equipment.

Time spent planning the changes will result in large dividends, provided the following parties are involved:

- Consulting engineer
- Hospital administrator
- Hospital engineer
- Chief of surgery
- Chief of anesthesiology
- Cardiologist
- Manufacturer’s representative

History

During the 1920s and ‘30s, the number of fires and explosions in operating rooms grew at an alarming rate. Authorities determined the major causes of these accidents fell into two categories:

- Man-made electricity
- Static electricity (75% of recorded incidents)

In 1939, experts began studying these conditions in an attempt to produce a safety standard. The advent of World War II delayed the study’s results until 1944, when the National Fire Protection Agency (NFPA) published “Safe Practices in Hospital Operating Rooms.”

The early standards were not generally adopted in new hospital construction until 1947. It soon became apparent these initial standards fell short of providing the necessary guidelines for construction of rooms in which combustible agents would be used.

NFPA appointed a committee to revise the 1944 standards. In 1949, this committee published a new standard, NFPA No. 56, the basis for our current standards.

The National Electrical Code (NEC) of 1959 firmly established the need for ungrounded isolated distribution systems in areas where combustible gases are used.

In the same year, the NEC incorporated the NFPA standards into the code. The NFPA No. 56A–Standard for the Use of Inhalation Anesthetics, received major revisions in 1970, 1971, 1973, and 1978.

In 1982, NFPA No. 56A was incorporated into a new standard, NFPA No. 99—Health Care Facilities. The new document includes the text of several other documents, such as:

- NFPA-3M
- 56K
- 76A
- 76B
- 76
- 56HM
- 56B
- 56C
- 56D
- 56G

The material originally covered by NFPA 56A is now located in Chapter 3 of NFPA No. 99, which was updated in 1984, 1987, 1990, 1993, 1996, and 1999, and in Chapter 4, which was updated in 2002.

The increased use of electronic diagnostic and treatment equipment, and the corresponding increase in electrical hazards, has resulted in the use of isolated ungrounded systems in new areas of the hospital since 1971. These new hazards were first recognized in NFPA bulletin No. 76BM, published in 1971. Isolating systems are now commonly used for protection against electrical shock in many areas, among them:

- Intensive care units (ICUs)
- Coronary care units (CCUs)
- Emergency departments
- Special procedure rooms
- Cardiovascular laboratories
- Dialysis units
- Various wet locations

Electrical Hazards In Hospitals

The major contributors to hospital electrical accidents are faulty equipment and wiring. Electrical accidents fall into three categories:

- Fires
- Burns
- Shock

This section covers the subject of electrical shock.

Electrical shock is produced by current, not voltage. It is not the amount of voltage a person is exposed to, but rather the amount of current transmitted through the person's body that determines the intensity of a shock. The human body acts as a large resistor to current flow. The average adult exhibits a resistance between 100,000 ohms (Ω) and 1,000,000 Ω, measured hand to hand. The resistance depends on the body mass and moisture content.

The threshold of perception for an average adult is 1 milliampere (mA). This amount of current will produce a slight tingling feeling through the fingertips.

Between 10 and 20 mA, the person experiences muscle contractions and finds it more difficult to release his or her hand from an electrode.

An externally applied current of 50 mA causes pain, possibly fainting, and exhaustion.

An increase to 100 mA will cause ventricular fibrillation.

The hazardous levels of current for many patients are amazingly smaller. The most susceptible patient is the one exposed to externalized conductors, diagnostic catheters, or other electric contact to or near the heart.

Surgical techniques bypass the patient's body resistance and expose the patient to electrical current from surrounding equipment. The highest risk is to patients undergoing surgery within the thoracic cavity. Increased use of such equipment as heart monitors, dye injectors, and cardiac catheters increases the threat of electrocution when used within the circulatory system.

Other factors contributing to electrical susceptibility are patients with hypokalemia, acidosis, elevated catecholamine levels, hypoxemia, and the presence of digitalis. Adult patients with cardiac arrhythmias can be electrocuted through the misuse of pacemakers connected directly to the myocardium.

Infants are more susceptible to electric shock because of their smaller mass, and thus lower body resistance. Much has been written about current levels considered lethal for catheterized and surgical patients. Considerable controversy exists about the actual danger level for a patient who has a direct electrical connection to his or her heart. The minimum claimed hazard level seems to be 10 microamperes (µA) with a maximum level given at 180 µA. Whatever the correct level, between 10 and 180 µA, it is still only a fraction of the level hazardous to medical attendants serving the patient.

It is believed that approximately 1,000 Ω of resistance lies between the patient's heart and external body parts.

All of this information leads us to the conclusion that the patient environment is a prime target for electrical accidents. Nowhere else can one find these elements: lowered body resistance, more electrical equipment, and conductors such as blood, urine, saline, and water. The combination of these elements presents a challenge to increase electrical safety.

Leakage Currents

Electric equipment operating in the patient vicinity, even though operating perfectly, may still be hazardous to the patient. This is because every piece of electrical equipment produces a leakage current. The leakage consists of any current, including capacitively coupled current, not intended to be applied to a patient, but which may pass from exposed metal parts of an appliance to ground or to other accessible parts of an appliance.

Normally, this current is shunted around the patient via the ground conductor in the power cord. However, as this current increases, it can become a hazard to the patient.

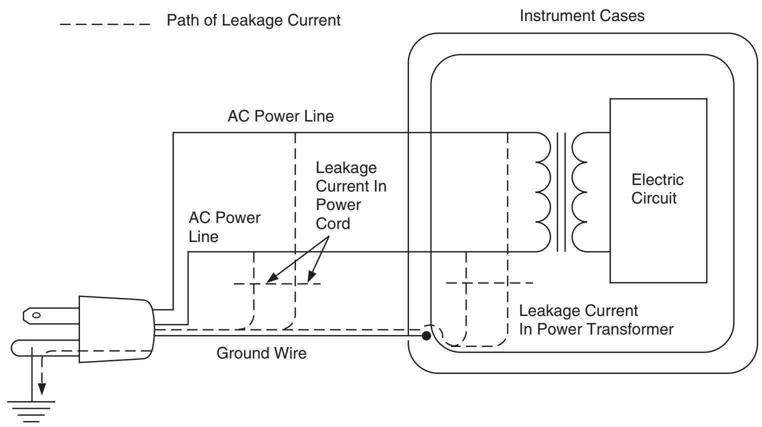
Isolated systems are now commonly used to protect against electrical shock in many areas, among them:

- Intensive care units (ICUs)
- Coronary care units (CCUs)
- Emergency departments
- Special procedure rooms
- Cardiovascular laboratories
- Dialysis units
- Various wet locations

Without proper use of grounding, leakage currents could reach values of 1,000 µA before the problem is perceived. On the other hand, a leakage current of 10 to 180 µA can injure the patient. Ventricular fibrillation can occur from exposure to this leakage current.

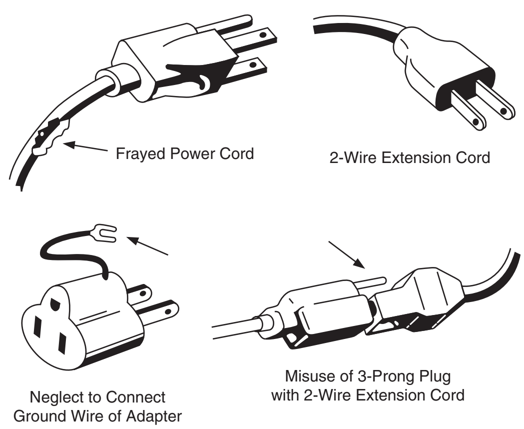
The following figure illustrates the origin and path of leakage current.

Origin of Leakage Current



Failure to use the grounding conductor in power cords causes a dangerous electrical hazard. This commonly results from using two-prong plugs and receptacles, improper use of adapters, use of two-wire extension cords, and the use of damaged electrical cords or plugs. The following figure illustrates these hazards.

Electrical Hazards



Answers

There are no perfect electrical systems or infallible equipment to eliminate hospital electrical accidents. However, careful planning on the part of the consulting engineer, architect, contractor, and hospital personnel can reduce electrical hazards to nearly zero. Hospital electrical equipment receives much physical abuse; therefore, it must be properly maintained to provide electrical safety for patients and staff.

Procedures for electrical safety should include the following:

- Check all wall power receptacles and their polarities regularly.
- Routinely verify that conductive surfaces are grounded in all patient areas.
- Request that patient electrical devices such as toothbrushes and shavers be battery powered.
- Use completely sealed and insulated remote controls for use in patient beds.
- Use bedrails made of plastic or covered in insulating material.

Codes and Standards

It would not be practical to attempt to reproduce the codes and standards that affect the application of isolated distribution systems in hospitals. As was previously mentioned, codes are continually refined and updated, with frequent amendments between major publications. All hospitals should have copies of the current standards for reference; the design engineer **must** have this information available. Obtain copies of all standards referenced in this bulletin from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

This chapter briefly covers the sections of codes and standards that apply to hospital isolated ungrounded distribution systems. This chapter only covers a few of the important points within these standards. A thorough study of applicable codes and standards is required to effectively design a project.

NFPA No. 99

History

Published by the NFPA, this code is included as a reference in the NEC Article 517.

NFPA No. 99 addresses fire, explosion, and electrical safety in hospitals. It consolidates 12 individual NFPA documents or standards into one document.

Many hospitals and consulting engineers are unaware of this document and its requirements. Square D recommends all consulting engineers who design hospitals have the hardcover “handbook” version of this document available.

Anesthetizing Location Classifications

The first type of location is one which is flammable because explosive anesthesia is used. This location must be designed to comply with NEC Article 501.

There are many other requirements for the flammable anesthetizing locations; these requirements are discussed in NFPA No. 99. Explosive anesthesia is now virtually non-existent in the United States. Therefore, this handbook does not cover the flammable location in any detail.

Non-flammable anesthetizing location requirements are also covered in NFPA No. 99. A permanent sign must be displayed at the entrance to all flammable locations. It must state that only non-flammable anesthetics can be used in the room.

Non-flammable anesthetizing locations can be further divided into locations that are subject to becoming wet and those that are not. A wet location requires special protection against electrical shock. The allowable protection is as follows:

- Ground-fault circuit interrupter if first-fault conditions are to be allowed to interrupt power
- Isolated power system if first-fault conditions are not to be allowed to interrupt power

The governing body of the hospital will make the determination of a “wet location,” using the following definition:

> A patient care area that is normally subject to wet conditions while patients are present. This includes standing fluids on the floor or drenching of the work area, either of which condition is intimate to the patient or staff. Routine housekeeping procedures and incidental spillage of liquids do not define a wet location.

NFPA No. 99 defines the items in an anesthetizing location, which must be powered from the isolated ungrounded system. Because this section is subject to individual interpretation by local Code authorities, work closely with these authorities before selecting the equipment to be powered from standard grounded systems. This is especially important when ordering permanently installed equipment, such as X-ray apparatus. NFPA No. 99 and the NEC Article 517 allow the grounded circuit providing power to an isolated system to enter the non-hazardous area of an anesthetizing location. However, ungrounded wiring and grounded service wiring cannot occupy the same conduit or raceway.

The primary and secondary of the isolation transformer cannot exceed 600 volts in any isolation system supplying power to an anesthetizing area or other critical care patient area. The secondary circuit conductors must be provided with an approved overcurrent protective device in both conductors of each branch circuit.

NFPA No. 99 sets the limits of impedance to ground of the isolated system and the instructions for testing to determine compliance with the standards. The size of the isolation transformer should be limited to 10 kVA or less.

Even in the most sophisticated operating rooms, the equipment load rarely exceeds 5 kVA. When writing specifications, we suggest choosing an isolated transformer rated at 5 kVA, having a continuous overload capability of 25 to 50%. The transformer will thus be designed to operate at a relatively cool normal temperature, but will still be able to handle future demands which exceed today's norm.

Conductors for the isolated ungrounded system must be color-coded:

- Orange for conductor #1
- Brown for conductor #2
- Green for the grounding conductor
- Where three-phase isolated systems are used, yellow for conductor #3

NFPA No. 99 describes the line isolation monitor (ground detector) required to monitor the isolated system. The limitation for total system hazard is set at 5 mA.

NFPA No. 99 specifies the "Grounding System." This subject is also discussed in detail in "grounding" on page 16 of this handbook.

Article 517, National Electrical Code—NFPA No. 70

Article 517-3 specifies the legal minimum requirements in most states. It is the document used by most inspectors. When designing the system, use it in conjunction with NFPA No. 99, which is included as a reference in Article 517. Other NFPA standards are also referenced in Article 517, such as NFPA-101 and NFPA-20.

Patient Care Areas

Article 517 defines three types of patient care areas:

- **General Care Areas:** patient bedrooms, examining rooms, treatment rooms, clinics, and similar areas. In these areas, the patient may come in contact with ordinary appliances, such as nurse call systems, electrical beds, examining lamps, telephones, and entertainment devices. Patients may also be connected to electro-medical devices, such as heating pads, EKGs, drainage pumps, monitors, otoscopes, ophthalmoscopes, and IV lines.
- **Critical Care Areas:** special care units, intensive care units, coronary care units, angiography laboratories, cardiac catheterization laboratories, delivery rooms, operating rooms, and similar areas. In these areas, patients are subjected to invasive procedures and connected to line-operated, electro-medical devices.
- **Wet Locations:** patient care areas normally subject to wet conditions while patients are present. This includes standing fluids on the floor or drenching of the work area, either of which condition is intimate to the patient or staff. Routine housekeeping procedures and incidental spillage of liquids do not define a wet location. Critical care and general care areas can also be considered wet areas. The governing body of the hospital determines whether a location is to be considered "wet."

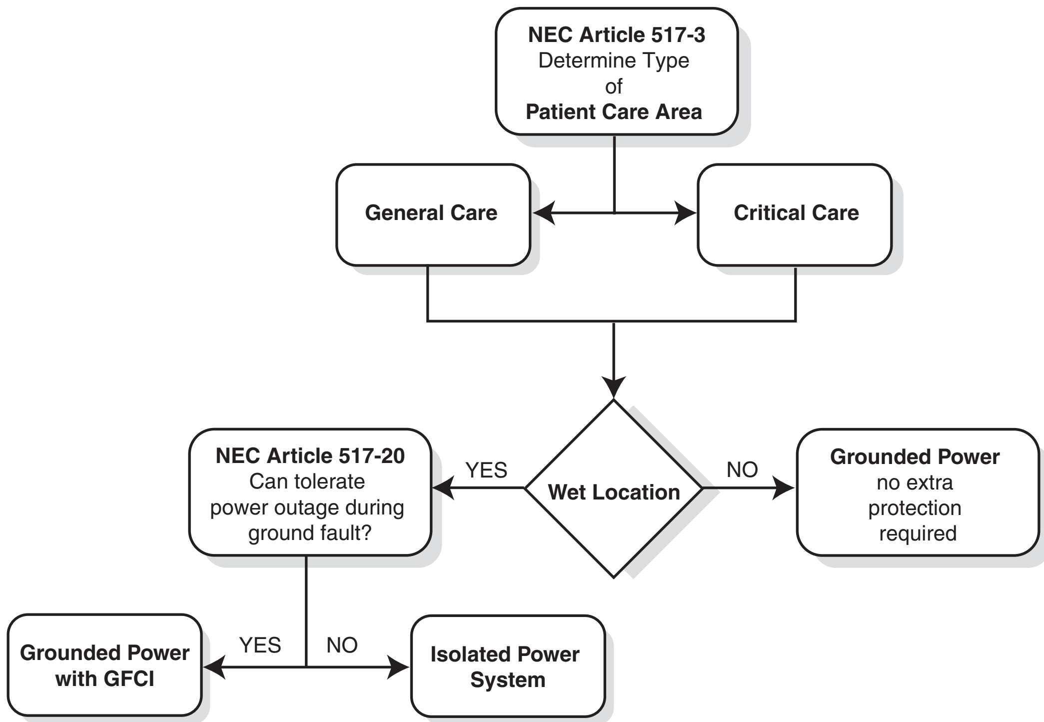
Anesthetizing Location Classifications

As with NFPA No. 99, anesthetizing locations are classified as:

- Hazardous locations which use flammable anesthetics. These locations must meet class I division requirements and must have isolated power systems.
- Other-than-hazardous locations, allowing the use of grounded power systems.

Both types of anesthetizing locations must be further classified as “wet” or “not wet” areas. If designated as a wet location, extra electrical protection is required. The acceptable protection is the same as that defined for NFPA No. 99.

The designation of all of the above-mentioned areas in the health care facility is the responsibility of the facility’s governing body. Before a designer can choose the proper electrical distribution system for a hospital, the governing body of the hospital must inform the designer about the location’s use. This requires close coordination with the medical staff of the facility, to ensure the designer understands current medical procedures as well as possible future procedures.



The NEC recognizes that hospital patients are more susceptible to electrical shock than are normally healthy individuals. Consequently, patients must be protected through use of special procedures. The special procedures and equipment required become more complicated with the degree of electrical susceptibility of the patient.

The hospital administration and designer are responsible for determining the degree of patient susceptibility and selecting the correct equipment. This selection process requires close communication between the hospital administration, medical staff, and the consulting electrical engineer.

It is generally accepted that any time the normal body resistance of a patient is bypassed, the body becomes electrically susceptible. Degree of susceptibility varies from having an electrical probe or catheter connected to the heart muscle, to having electrodes attached to the outer skin after conductive paste is applied. Patients who are anesthetized, or are demobilized through illness, restraints, or drug therapy, also have a higher degree of electrical susceptibility than normal individuals. Such patients cannot avoid or disconnect themselves from an electrical hazard that would be relatively harmless to a normal person.

For example, a patient who has impaired nerve sensitivity cannot detect heat. A cup of very hot coffee would not be a hazard for a normal person; however, it is a potential disaster for the nerve-impaired individual.

Certain medical conditions may render a patient particularly vulnerable to electrical shock. These patients may require special protection even though their normal body resistance has not been intentionally bypassed.

Give special consideration to the following potential electrically susceptible patient areas:

- Acute care beds
- Angiographic labs
- Cardiac catheterization labs
- Coronary care units
- Delivery rooms
- Dialysis units
- Emergency room treatment areas
- Human physiology labs
- Intensive care units
- Operating rooms
- Post-operative recovery rooms

UL 2601-1

This is the UL Standard against which all medical and dental equipment is tested by the Underwriters' Laboratories. UL derives its standards for performance requirements from the applicable NFPA standards and the NEC. Demand that any appliance purchased for use in patient care areas be labeled under this UL Standard for use in the specific area designated.

UL 1022

Line isolation monitors are measured against this UL Standard. Insist that any line isolation monitor installed in the facility have a UL component recognition under this standard.

UL 1047

This is the UL Standard for hospital isolating equipment. Do not accept any hospital isolation equipment unless it is listed and labeled as a complete system under this standard. This assures the hospital and consulting engineer that the equipment meets all existing codes and standards.

Isolated Systems

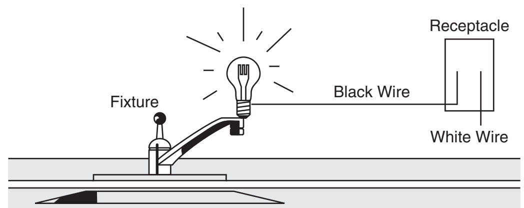
The term "isolated system" can apply to many systems in a hospital, such as the management of patients having a communicable disease. However, it is unlikely that any of the other systems is as widely used, yet as poorly understood, as the system discussed in this catalog.

The isolating system covered in this manual is really an "isolated ungrounded electrical distribution system." Although these isolated systems are very important to hospital operations, many hospital staff lack even a basic understanding of how isolating systems work. This includes the technicians responsible for maintaining the systems.

Consulting engineers and plant operating engineers who specify and apply these isolating systems usually understand them; but they have difficulty passing this knowledge to laymen. Hopefully, this section will help them fill this communication gap. The following simple analogy should help the layman understand isolated systems.

In this example, consider an electrical receptacle in the counter area of a household kitchen. The ground in this case is the kitchen plumbing fixture. The following figure illustrates this example.

Kitchen Plumbing as a Ground



Electrical current comes to the receptacle via two insulated conductors. One of them is usually black, the other white. Many people feel they can safely touch either one of these conductors, but this oversimplification could result in a dangerous shock.

When the two conductors touch each other, a violent arc results, part of the conductor melts, and the fuse opens or the circuit breaker trips. This demonstrates the energy used when any household appliance is run. Because the household appliance does not open a fuse or trip a circuit breaker the appliance places resistance between the two conductors. In placing resistance, the appliance limits the amount of current that can flow. However, the amount of current that can flow must always be less than the current rating of the fuse or circuit breaker.

When a light bulb touches both wires, it illuminates. If one of its terminals touches the white conductor in the receptacle, nothing happens. If the other terminal of the light bulb touches the kitchen plumbing, nothing happens. If the white wire touches the plumbing, nothing happens. The conclusion must be that the white wire is safe to handle as long as the black conductor is not handled at the same time.

Using the example as above, but with the black wire, the connections cause different results. When one terminal of the light bulb touches the black conductor, nothing happens. However, when the other terminal of the light bulb touches the kitchen plumbing, the bulb illuminates as it did when it touched both wires. When the black wire touches the kitchen plumbing, there is a violent arc, much as if both conductors had touched each other.

The conclusion from the above paragraph is that it is safe to handle the black conductor only if you do not simultaneously touch the white conductor, kitchen plumbing, or any other grounded item.

Obviously, the white conductor and the kitchen plumbing have something in common. That is that they are *grounded*. A wire becomes grounded when it is attached to a copper rod driven into the ground or to a convenient piece of conductive plumbing pipe, which ultimately runs into the ground. The white conductor (known as the *neutral*) is grounded when it is installed by the utility company.

The conclusion from the previous paragraph is that current flows from the black wire to *any* grounded conductive surface, of which there are many. The black conductor is safe to handle as long as you do not simultaneously touch the white conductor or any grounded item.

This type of electrical system is commonly called a “grounded electrical distribution system.”

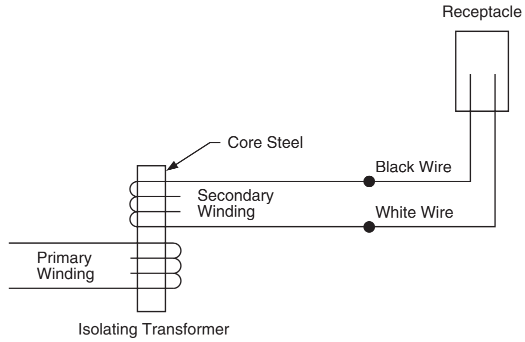
Ungrounded System

To convert available power from a receptacle into an *ungrounded service* is possible. The first step is to *isolate* the receptacle from the grounded service. There are several ways to isolate power, but the most common and economical is to use an isolating transformer.

The available grounded electrical power energizes a coil in the isolating transformer; this coil is called the *primary winding*. This induces a current in the *secondary winding*, which is completely insulated from the primary winding by electromagnetic induction. No direct electrical connection exists between the primary and secondary coils.

The following illustration shows how a transformer is constructed and connected to a receptacle.

Transformer Construction



When electrical devices are connected across two conductors on the transformer, they work as if they were connected directly to a grounded system. The conclusion to be drawn is the isolating transformer provides the same usable electrical energy as the grounded power circuit.

Repeating the experiments with the light bulb, we find current will not flow if a single terminal of the light touches either secondary conductor of the isolating transformer. No current flows if either secondary conductor of the transformer touches the plumbing (ground). Furthermore, no sparking occurs when either conductor touches the plumbing; the fuse or circuit breaker maintains the connection.

The conclusion is current does not flow from either conductor of the isolated system to ground. In more technical terms, **no hazardous potential to ground exists from either conductor of an isolated electrical system**.

System Comparison

The previous section illustrates that conductors of an isolated system are safer to handle than are the conductors of a grounded system. Now let’s use the same kitchen receptacle to show a comparison between a grounded system and an isolated system.

When installing a new curtain rod at the window over the kitchen sink, one would probably use a small electric drill. If the residence was built within the last 30 years, the receptacle most likely has three openings, not two. The third opening is shaped to receive a pin (U slot) rather than a blade-shaped prong. The portable electric drill probably has a three-prong plug. This third point of contact simply connects the metal case of the drill to ground. The connection to ground from the pin on the receptacle is often made by a third wire run with the power conductors, or by a metal pipe (conduit) which encloses the two conductors serving the receptacle.

The electric drill has an electric motor which is completely enclosed in a conductive housing. The housing is connected to a third wire in the power cord, which in turn connects to ground.

The electrical portion of the motor must be completely insulated from the conductive enclosure. If it were not, arcing would result when the black conductor of the grounded system touched the plumbing. This “short circuit” would disengage the circuit breaker or blow the fuse as it did when the live conductor touched the plumbing.

Consider this scenario: The person using the drill touches his or her opposite hand on the plumbing fixture for support. If the drill is in good repair and the enclosure is properly grounded through the power plug, the procedure is safe.

However, what if the insulation around the drill motor is defective, allowing the live conductor of the grounded system to contact the metal enclosure? This is a dangerous situation. If the ground wire is properly attached to the enclosure and connected to ground through the ground pin in the plug, there will be arcing in the drill where it contacts the conductive enclosure. If there is good contact between the live conductor and grounded enclosure, sufficient current will flow to disengage the circuit breaker or blow the fuse.

Two paths to ground are possible, one down the ground wire in the cord into the receptacle ground, and one through the person holding the drill (who is grounded through the plumbing). Since the resistance through the human body is much higher than the resistance through a properly connected ground wire, most of the current follows the path of least resistance (the ground wire); the person holding the drill is safe.

The key to keeping the drill safe is in the ground connection from the drill enclosure to the ground at the receptacle. If this connection is broken (for example, if an improperly connected adapter is used), the only path for current in the enclosure to go to ground is through the drill user. A hazardous level of current could be maintained since the human body has sufficient resistance to keep the current below the level required to disengage the circuit breaker or blow the fuse. The level of current would be high enough to be deadly.

If, on the other hand, the drill is powered from an isolated circuit, and the ground from the drill enclosure is disconnected, there is little potential for current to flow through the drill user. Even if the ground is intact, not enough current flows to disengage the circuit breaker or blow the fuse.

This is a very important factor: if the drill was really a piece of life support equipment, such as a respirator, it would continue to run without disengaging the circuit breaker or blowing the fuse.

Imperfect Isolating

In the previous examples, we assumed a perfect system. Unfortunately, a perfect system is impossible to attain.

Returning to the example of the isolating transformer, we can convert the isolated system back to a grounded system easily, by connecting one secondary conductor of the transformer to ground. This would create the potential for current to flow from the opposite conductor to ground, as it would in any grounded electrical distribution system.

An isolated system can be unintentionally grounded. For example, if the drill is plugged into the system with the ground intact and there is a fault in the drill to the grounded enclosure, that single fault converts the entire system into a grounded system.

Keep in mind no perfect insulators exist either. What we commonly call “insulators,” such as rubber or plastic coverings on wire, are actually just poor conductors. All materials conduct electricity to some degree. Thus, everything attached to the secondary conductors of an isolating transformer will partially ground the system. Examples of items that partially ground the system, without making direct connection to ground, include the following:

- Insulated wires enclosed in grounded metal conduit
- Electrical components within permanently installed electrical equipment
- Electrical components within portable devices housed in grounded enclosures (commonly referred to as the capacitance of the system)

Because an isolated system can easily become grounded without giving any indication to the user, a way must be found to monitor the integrity of the isolation in the system. With this monitoring, there must be some warning when the system becomes grounded. When the system becomes partially grounded, the warning is still necessary, but a limit must be set for the warning to be sounded. Limits are established by codes and standards, specifically the NEC.

See the “Codes and Standards” page 7 of this manual for additional information. Codes and standards state that an alarm must sound and display (it must be audible **and** visible). The alarm must activate when the integrity of an isolated ungrounded system degrades to the extent that 5 mA of current will flow from either secondary conductor to ground through a zero impedance fault.

Line Isolation Monitor (LIM)

Codes and standards not only specify the limits within which an isolated ungrounded system must operate, but also the method for checking system integrity. A LIM is required to continuously check the resistance (impedance) of the total isolated ungrounded system to ground. The LIM must respond audibly and visibly when the impedance of the system degrades to the extent that 5 mA of current will flow through either conductor of the system to ground in a zero impedance fault.

Several points should be considered:

1. The alarm condition does **not** mean there is imminent danger to the patient or anyone else. The alarm simply indicates the system has reverted to a grounded or partially grounded system, which is the same system contained in the rest of the hospital. Correct the problem as soon as possible; but do not interrupt procedures being conducted when the alarm sounds.
2. The LIM does not interrupt electrical service. Loss of integrity in the ungrounded system does not affect the operation of life support devices.
3. An activated alarm does not mean hazardous current is flowing. The LIM is a predictive device; by sounding an alarm, it predicts that 5 mA of current could flow from one conductor of the isolated system to ground if a path for the current is provided. This requires a **second** fault or electric failure to be present in the system before a true hazardous condition exists.

The LIM is equipped with a meter (also required by code) that gives continuous indication of the system's condition. The meter is calibrated in milliamperes (mA) of current. Its position indicates how much current could flow from either conductor of the isolated system to ground if a path was provided.

NOTE: Keep in mind that this meter merely predicts the possibility of the condition; it does not indicate that current is actually flowing.

Types of LIMs

Several types of line isolation monitors are available. Reviewing them not only helps determine requirements for a system, but helps identify the equipment currently used in the hospital.

Ground Detector. The first unit is not actually a LIM, but rather the original "ground detector," which is essentially a balanced bridge device. Ground detectors were standard equipment until about 1970, so many of these units are still in use. Inexpensive to build and reliable because of its simplicity, the ground detector is unaffected by and does not create any radio frequency (RF) interference. However, it only recognizes unbalanced resistive or capacitive faults; it cannot recognize a partially grounded system. This inability to sound an alarm (to recognized balanced fault systems) is the main reason codes and standards no longer allow its use.

Systems in the field have been observed to allow as much as 30 mA (30,000 µA) to flow from line to ground without sounding an alarm. This very hazardous condition can cause an electrical hazard to the patient or medical staff.

Ground detectors may still be used if they were installed before 1971. Even though not required by code, hospitals should consider revising these systems to match current standards.

Dynamic Ground Detector. The first dynamic ground detectors, now called line isolation monitors, were developed in Canada. They are called dynamic ground detectors, as opposed to static ground detectors, because the measuring circuit continually switches between the two isolated conductors and ground. In this way, it overcomes the greatest inadequacy of static ground detectors — the inability to recognize and sound an alarm at the occurrence of an excessive balanced fault condition.

Although this unit meets current codes and standards, it has two undesirable features:

1. This type of LIM connects to ground through a high resistance so that it can measure the impedance of the total system. This reduces the integrity of the isolated system by partially grounding it. With nothing connected to the system except the LIM, 1000 µA could flow from either line of the isolated system to ground. If the LIM is calibrated to sound an alarm when 2000 µA flow from either line to ground, approximately one-half of the capacity of the total system would be dedicated to the LIM. This limits the amount of equipment that can be connected to an isolated system, often requiring two systems in an operating room, rather than one.

2. Switching between the isolated conductors and ground causes interference on the isolated system. Sometimes, this interference can be detected on patient monitoring equipment, creating difficulty in gathering information needed by the medical staff. In extreme cases, it becomes impossible to use equipment such as an EEG without disconnecting the LIM.

The extent of difficulty encountered with these types of interference varies with the installation and design of the patient monitoring equipment.

The Square D brand, type EDD line isolation monitor is typical of the second generation of LIMs. This unit was the first of the low leakage LIMs. It contributes less leakage to the system because of its higher impedance connection ground. Rather than use half the system capacity for the LIM, this unit reduces LIM contribution to less than 25% of the system's capacity.

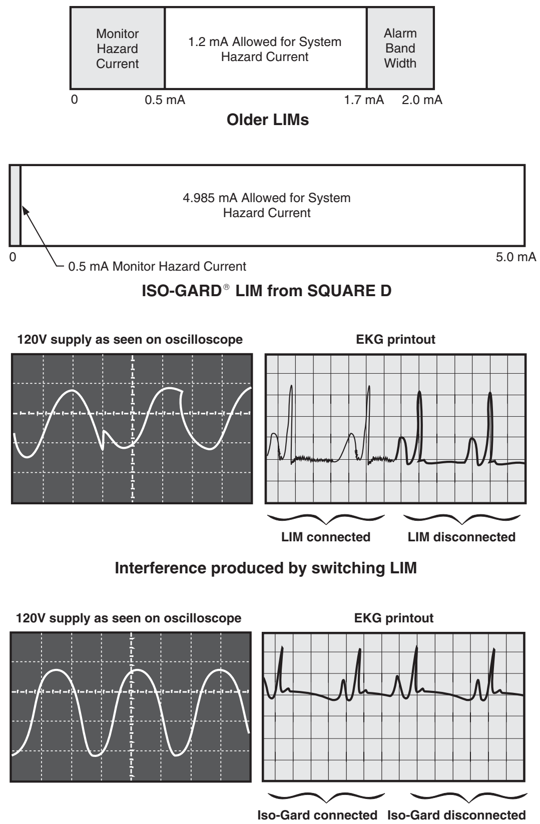
The type EDD LIM still uses a switching circuit and still causes interference with patient monitoring equipment.

IGD Iso-Gard® Line Isolation Monitor (LIM). This LIM represents the most recent generation of line isolation monitors. It virtually eliminates all of the undesirable features in the early dynamic ground detectors and line isolation monitors. It contributes only 50 µA of leakage to the system, about one percent of the system's usable capacity.

The special circuitry developed by Schneider Electric monitors both sides of the line continuously, eliminating the need for switching. It does not generate any interference that could affect patient monitoring devices. For detailed information on the Iso-Gard LIM, see page 62 of this bulletin, or request the Schneider Electric bulletin covering line isolation monitors.

Iso-Gard LIM

This figure compares the degree of interference produced by the Iso-Gard LIM with older LIMs.



Absence **of interference with ISO-GARD**

Grounding

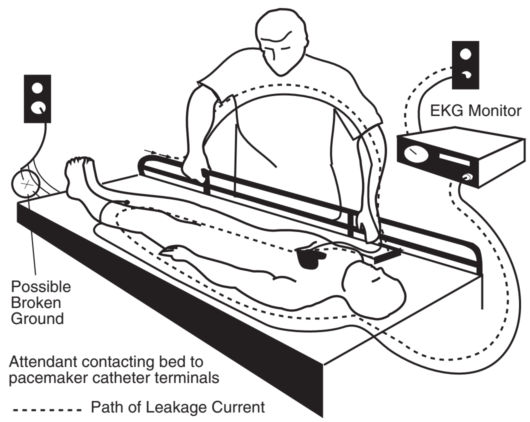
Grounding in a patient care or anesthetizing location is an important safeguard against shock and electrocution. Proper grounding dissipates static charges and shunts fault currents and normal leakage currents away from attendants. Grounding of circuits must be performed as required in Article 250 of the NEC.

Electric Equipment Power Cord Grounding

The green grounding conductor in an equipment power cord prevents static potentials from reaching dangerous values on noncurrent carrying parts such as housings, cases, and boxes of electrical appliances. If these parts are not properly grounded, a static charge could accumulate; the charge could reach a large enough value to automatically discharge as an electric static spark. This static charge could be a hazard to the patient and attendant if it ignited some flammable gas or material, or if it discharged to the patient as a shock.

This grounding conductor also provides a path for leakage current which could be conducted to an electrical appliance case. The magnitude of this leakage current depends on the characteristics of the appliance and its insulation. The leakage current could result in potential differences between pieces of equipment and could flow through vital organs of the patient, if a patient current path is established. For example, during cardiac catheterization, small amounts of current could cause ventricular fibrillation.

The following figure illustrates the current path for leakage current which could develop in an electrically operated patient bed. Since the patient provides a grounding path via the attendant and pacemaker, a current divider will result. However, the resistance through the power cord ground conductor is significantly lower, providing protection for the patient. However, if the ground wire is broken, most of the current would flow through the patient. In this example, we assume that non-isolated patient monitoring leads are used.



Because the resistance of a grounding conductor is extremely important, you must give it careful consideration. Wire resistance is inversely proportional to its cross-sectional area. The cross-sectional area is usually expressed in units of AWG (American Wire Gauge). The lower the AWG, the larger the wire. For example, the grounding conductor in a power cord is #18 AWG; it represents about 0.0064 ohms/foot. On the other hand, #10 AWG only represents 0.001 ohms/foot.

Current codes and standards for new construction of critical care areas require that no more than 40 mV exist between the reference point and exposed conductor surfaces in the patient's vicinity. This means, for a piece of electrical equipment using a #18 AWG ground wire in a 15-ft power cord, no more than 416 mA of fault current could develop without exceeding the 40 mV potential difference requirement.

These faults could develop through internal aborted components or poor power cord insulation. There is no certain way to prevent these faults; however, their magnitudes can be kept to a minimum through the use of an isolated power system. Using the isolated system, an initial line to ground fault can be kept as low as 5 mA, if the system is operating in the "safe" condition. The power cord ground wire could easily accommodate a 5 mA fault and stay well within the requirements of NFPA No. 99 and the NEC.

Permanently Installed Ground System (Hard Wiring)

Providing proper grounding for all electrical devices assumes that they connect to a sufficient ground system which interconnects to provide an equipotential ground plane for the patient. Current codes and standards require that all conductive surfaces within the patient vicinity must be properly grounded. The grounding system permits intermingling of electric appliances located near or applied to the patient without the hazard of leakage or fault current to the patient. By interconnecting all metal surfaces within the patient area, potential differences between the metal surfaces can be kept to a minimum.

Since a potential difference is required to produce a current flow, the entire ground plane can rise above ground zero as long as all metal is at the same potential. Even if a person contacts two pieces of metal, both at 10 V, a current path will not develop. This ground plane is established by the use of a properly connected ground system.

Equipotential Grounding

The NEC (1971, 1975, and 1978 editions) specified and dictated the use of an equipotential grounding system with maximum resistance for each branch of such a system. While these requirements are considerably reduced in the NEC and NFPA No. 99, grounding requirements still remain more demanding than those shown in Article 250 for other occupancies. Because of this, electrical design engineers should still plan for special grounding requirements in these areas. Carefully study the code to determine exactly what special grounding provisions must be provided in each project.

Ground Jacks

In previous codes, provisions for grounding conductive non-electrical devices were dictated. These provisions were met by supplying each critical patient care area with a specified type of ground jack. Each operating room was required to have a minimum of six ground jacks.

While this is no longer a code requirement, Schneider Electric recommends that at least one ground jack be placed in each critical care patient area. This ground jack provides connection to the grounding system for redundant grounding of exceptionally hazardous equipment. The jack also allows connection to the grounding system for testing. The cost of a single ground jack, or even several ground jacks, in a room is quite low.

Design Guide

I. System Concept

With the increased complexity of isolated systems, it is more important than ever to use a system approach in which all components work with each other to obtain a specific result. The components in an isolated power system can be purchased separately; however, it is much easier and makes more sense to purchase a complete system.

When manufacturers design and build complete systems, many factors are considered: proper and attractive packaging, convenient design, and ease of maintenance. The component system, on the other hand, invariably results in duplication of functions, high jobsite labor costs, excessive system leakages, and the lack of a dependable single vendor.

The variety of Square D brand modular system components gives the electrical consulting engineer and architect great design latitude. Consequently, a system to fit the special needs of each hospital is practical.

In spite of this great versatility, all Square D brand modules interface with each other perfectly. When designing the modules that make up its systems, the Schneider Electric engineering department considered every important requirement for isolated systems. Among these considerations are:

- Operating and panel face temperatures
- Sound levels
- Minimum leakage
- Ease of maintenance
- Interchangeability of components
- Pleasing appearance
- Ease of installation

II. Application

The design of isolated systems from Schneider Electric ensures that all pieces of a system are compatible with each other. This is the first step toward having a working system, but it is only one of four ingredients that make up a superior system. The second ingredient has been discussed but bears repeating: there must be good communication between the parties planning the system for the hospital. Poor communication causes poor planning, which will be very costly and time-consuming if the system must be modified after it is installed.

The consulting electrical engineer must be the nucleus of the team that makes the decisions. However, each team member contributes vital information to the system design.

In the past, projects run by capable consulting electrical engineers have required modifications costing several thousand dollars per operating room. This was not because of poor planning, but because the engineers did not receive the information needed to plan usable systems. This lack of information led to such errors as incorrect voltage for portable X-ray machines, insufficient receptacles, and insufficient capacity in isolating systems.

The team approach benefits all members of the hospital team, for example:

- The architect can make the proper provisions for mounting the equipment; this results in superior aesthetic quality. The architect can also specify the proper equipment, avoiding later difficulties.
- As part of the team, the hospital administrator can make informed decisions when ordering equipment for the operating room, specifying maximum leakages, and correct cords and connectors. The proper accessories are often available at no extra cost, if they are specified when the order is placed.
- The chief staff surgeon can specify a traffic flow within the operating room, allowing the engineer to provide proper receptacle placement.
- If included in the team, the hospital maintenance engineer will better understand the isolated system. This enables the engineer to perform maintenance more conveniently and efficiently.

III. General Application Criteria

A. System Size

The system must stay as small as possible to limit leakage currents. Remember that everything connected to the isolated system increases the total hazard index: LIM, transformer, circuit breakers, secondary wiring, and any peripheral equipment. The system hazard current must be kept well below maximum to allow for normal current leakage, which will come from the equipment operating on this power supply.

Additionally, the code states that the unloaded system, with the LIM disconnected, must have a minimum line-to-ground impedance of 200,000 Ω. On a 120 V system, this corresponds to 600 µA when measured through a milliammeter connected between line and ground.

When considering system size, we must include all wiring between the circuit breakers in the isolated panel and their receptacles. *Every foot of wire* contributes leakage, so we must keep the total footage to a *minimum*. This emphasizes the need to place the isolation panel as close as possible to the point of usage.

The use of a central system, containing individual distribution systems for several operating rooms or CCUs, is not practical except in rare circumstances. The only time a central system makes sense is when this location coincides with the closest placement of individual panels to each room. In other cases, the central system would result in longer runs from the panel to the receptacles and devices. This would increase system hazard current.

B. System Capacity

In selecting the capacity of an isolating transformer, remember that the patient care areas generally present an intermittent load condition and load diversity. A given area may contain equipment that requires power greater than the isolated system provides; but the hospital will not use every piece of equipment at the same time.

The isolated power requirement of the operating room is almost always under 5 kVA. However, the Square D brand, 5 kVA isolation panel incorporates a transformer built with a 220 °C insulation system, suitable for a 150 °C rise. The full load design temperature, however, is limited to an 80 °C maximum rise. Therefore, the transformer can easily provide power for loads up to 150% of its rating. This is an important feature in an isolating transformer since it provides for intermittent heavy loads, like those presented by hypothermia equipment. In critical care areas, where one transformer serves one bed, a 3 kVA transformer is recommended.

Since the amount of wire is often proportional to the number of circuit breakers, keep the number of circuit breakers to a minimum. This can be done by connecting two to four receptacles to one circuit breaker. In most cases, an operating room panel with eight or ten secondary breakers is sufficient. If additional receptacles are required, up to 16 secondary breakers can be used. Isolation panels serving a single bed in a critical care area require only eight secondary breakers.

C. System Wiring and Conduit

The selection of a proper conductor is one of the most important design criteria of an isolated power system. If improper conductor insulation is chosen, the result is the same as if the capacitive leakage is raised. A good commercially available wire insulation for this application is cross-linked polyethylene, having a mineral filler instead of a carbon black filler. A minimum wall thickness of 2/64-in. should be demanded for use in 120 V, 208 V, and 240 V applications. It is also important to specify wire with a dielectric constant of 3.5 or less, as recommended by the NEC and NFPA No. 99.

Standard Type THHN wire is definitely unsuitable. It can, however, be used for the ground conductor. The code demands that the #1 conductor in the system be color-coded orange, the #2 conductor color-coded brown, and the ground conductor color-coded green. In three-phase systems, the third conductor shall be color-coded yellow.

Schneider Electric is often asked to specify manufacturers and wire catalog numbers for the low leakage conductor. This is extremely difficult to do since the availability of these wires differs from region to region. Also, manufacturers have sometimes discontinued production of wire types that we have recommended. The most accessible XLP wire has been low leakage wire #FR-XLP (VW-1 XHHW-2).

Recently, manufactures have rescinded their notation in their specs for XHHW and XHHW-2. This note referred to the recommendation found in the NEC (517-160) concerning the 3.5 dielectric strength. The different compounds used in the manufacturing of the insulation have changed or are subject to change, and the 3.5 dielectric strength may not be obtained. The XHHW and XHHW-2 insulation is still the choice since it comes closest to meeting the recommendation. This is important to note since this could affect the overall installation of an isolated power system.

Avoid the use of wire pulling compound since it increases the capacitive coupling. The code no longer allows wire pulling compound to be used in conduits for isolated power systems. This compound is usually unnecessary, because most of the runs on an isolated system are short. Occasionally, difficulty occurs in circuits feeding portable equipment since these conductors are somewhat larger. These difficult runs can be anticipated and provided for by using oversized conduits to ease the situation.

Obviously, conduits must be dry or the leakage characteristics designed into the system will suffer. During construction, keep conduit ends capped so they remain free from moisture. The specifications should state that, if moisture accidentally enters the conduits, they must be swabbed and thoroughly dried before conductors are pulled. Use minimum fills for conduits; this results in a better random lay of the conductors within the conduit, which further reduces the capacitive coupling.

The table below shows the approximate expected hazard currents per foot of power conductor, using the various wiring schemes described in the preceding paragraphs.The consulting engineer can use this table to estimate the system hazard current at the design stages. Values given are approximate; variations in humidity, conduit moisture content, conduit fill, and wire insulation will give different results.

Hazard Current Leakage Contributed by Wiring

Materials Used	Result
TW wire, metal conduit. Wire pulling compound with ground conductor.	3 µA per ft of wire
XLP wire, metal conduit. No wire pulling compound with ground conductor.	1 µA per ft of wire

IV. System Design

A. Operating Room Layout

Before the electrical design of an operating room begins, some important information should be acquired from hospital personnel. Most hospital operating rooms have a set traffic pattern and positioning for the operating room table. This is usually restricted to the location of the overhead operating room light. However, since the position of the head of the operating room table can be varied, the hospital personnel should advise the electrical engineer of the table's standard position. The traffic pattern, along with the positioning of the surgeon and support team, should also be verified. The positioning of the electrical equipment in the operating room has a direct relationship to this information. In the following example, we will use the configuration shown on page 22.

The panel is located behind the support team, near the head of the operating room table. The location of this panel is important; correct placement will keep electrical and ground cords out of the traffic area.

A 5 kVA isolation panel is recommended for operating room use. Be sure to determine the load of secondary equipment being used; very few cases will require a 7.5 kVA transformer. The 5 kVA isolation transformer from Schneider Electric is capable of a 150% continuous overload within its maximum designed temperature. It is important to remember that an increased number of circuits will also increase the total hazard current.

Ten secondary circuit breakers are recommended for the panel in this example. Each circuit breaker should supply two duplex receptacles, or four outlets per circuit. The table below shows the recommended breaker-to-load schedule.

Secondary Circuit Breaker Schedule

Number of Breakers	Load
4	8 receptacles in panel (2 per breaker)
2	4 receptacles in anesthetist's module (2 per breaker)
2	4 receptacles in surgeon's module (2 per breaker)
1	Surgical light
1	Clocks

Square D brand isolation power panels use the QO snap-in breaker as standard. The snap-in breaker is recommended because of its ability to grab the bus and clamp down under heaver loads. Whether snap-in or bolt-on breakers are used, it is extremely important that the dead front for the panel be properly installed. It is recommended that bolt-on breaker bus connections be checked for tightness no less then once every 12 months.

Additional circuits should be added with caution, as this will increase the leakage. Schneider Electric recommends that no more then four outlets (2 duplex receptacles) be fed from one circuit. If an optional power ground module is used, two circuits should be used. If more circuits are required, consider the use of a second or even a third isolation power panel. If the state or local authority having jurisdiction (AHJ) allows the use of grounded power, this should be considered for non-life support, non-life-sustaining equipment such as film viewers and blanket warmers. Countertop areas may be served with grounded power when the power used is restricted to this area. All fluorescent lighting should be on grounded power.

When laying out the operating room electrical system, the location of power and ground receptacles is significant. Power and ground cords can be dangerous to circulating personnel; so, whenever possible, locate receptacles so cords do not lie within the major traffic area. Since the operating room support team uses most of the electrical outlets, the majority of the services should be placed behind them, near the head of the table.

Little traffic occurs between the support team and the anesthetist. Locate a power and ground module at the head of the table so the anesthetist can easily connect equipment.

Locate an additional module behind the surgeon, near the head of the table. This gives the surgeon easy access to power for surgical equipment.

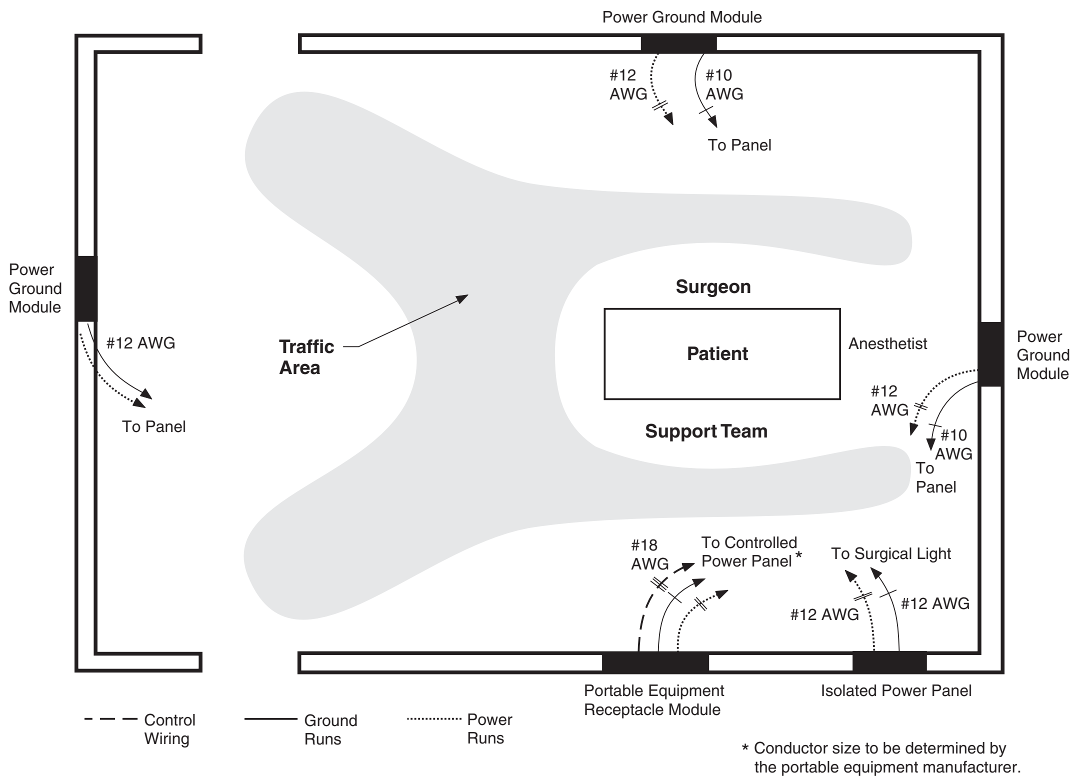
Proper location of the receptacles on these two panels, plus receptacles in the isolation panel, should eliminate tripping hazards in the traffic flow area.

There are distinct advantages to integrating power ground receptacles into one enclosure, rather than in individual power receptacles scattered around the room. The single enclosure places the receptacles at the point of usage and provides a lower resistance ground path between electrical appliances. Standard straight blade receptacles, NEMA Configuration #5-20R, are now acceptable in operating rooms.

A clock and elapsed-time indicator are required for most operating rooms, enabling the surgeon and anesthetist to easily see clock time and elapsed time. It also gives the support team easy access to the controls. Mount the control panel for the timer at the five foot level with the timer mounted at the seven foot level. Some OR teams prefer to place the control panel within reach of the anesthetist.

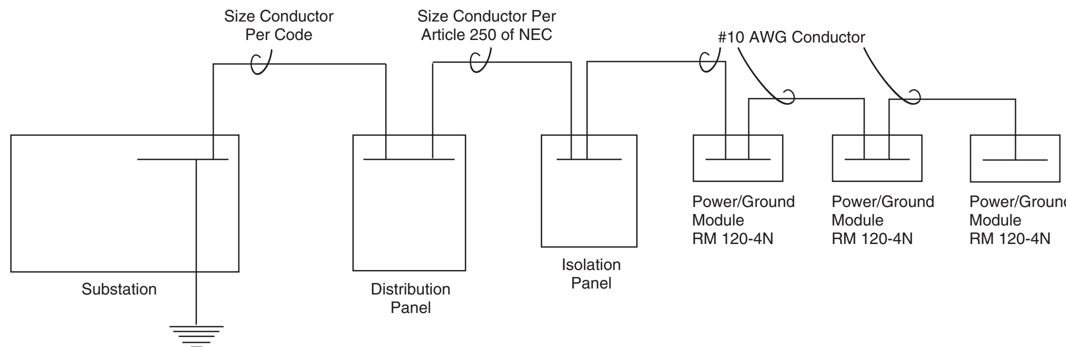
The use of articulating arms (booms) is commonplace and must be considered when they are installed in a procedure room using isolated power. Booms are typically wired with a cord that has PVC insulation and a PVC jacket. This causes a higher than desired leakage and can cause the total resistance to be below what is required by NFPA-99.

The following figure illustrates the size of power and ground conductors and their correct routing in a typical operating room.



Conductive flooring is still required by code in all flammable and mixed facilities. Conductive flooring is not required for rooms that are designed as nonflammable anesthetizing areas.

Typical Operating Room Ground System



B. Controlled Power Panels for portable Laser and X-Ray System

In operating rooms or critical care areas, the portable equipment outlets may require 208 V or 240 V, and will need a separate isolated distribution system (when isolated power is being used in that room). It is a common procedure to use a single isolated system to supply these circuits for more than one operating room. These circuits interlock so that only the required circuits can be energized at a given time. Leakage and capacity determine the number of circuits energized at one time allowing the panel to operate safely.

The circuit is selected by means of a switch located in the receptacle module or at a push button station in the panel or located in a secure area. The isolating transformer, circuit breakers, LIM, and control equipment are all mounted in an attractive flush-mounted enclosure.

When a Square D brand controlled power panel is used, locate it as centrally as possible in the area it will serve. Lay out circuit feeders for minimum length, as in the case of operating room 120 V circuits.

The system provides for a remote indicator alarm at each circuit outlet. The only indicator alarm operating is the energized circuit. When the circuit is energized, a green light on the remote indicator illuminates, telling operating room personnel that the circuit is energized and safe to use. Since the LIM is responding to total hazard current (THC), any energized remote will respond to an alarm. One advantage to turning the circuits and remote indicators on and off is the elimination of alarms where the power is not being used.

Be careful when connecting the ground terminal of the equipment receptacle to the grounding system; the ground terminal must connect to the ground system serving the patient who is served by the equipment receptacle. Connect the ground terminal of the LIM, which monitors the controlled power panel, to the equipment ground bus in the emergency distribution panel serving the 120 V isolated systems within these areas. In addition, connect a minimum #10 AWG ground wire between the controlled power panel and the equipment receptacle.

C. Interlocking Methods

There have been several different methods of controlling the interlocking system for equipment receptacles.

The method to be used is a matter of personal choice. Discuss the methods with the electrical consultant, hospital administration, and hospital radiology staff. Make the final selection after weighing the pros and cons of each method.

The most generally acceptable method is a PLC controlled system using the switch in the receptacle module. In the past, the common control system was a series of selector push buttons, located in the panel, which controlled the receptacle-energizing mode. If the panel was not accessible, the push button station was located in a separate module, built in a convenient location, or added to the operating room nurse's console. The push button control is still used, but it limits the number of circuits on at one time to one, and takes control of the circuit out of the room. This also allows someone to change circuits at will. The PLC controlled power panel puts control of the circuit in the rooms and can be programmed to allow more then one circuits to be energized at a time.

Schneider Electric supplies a variety of interlocking type panels and schemes; do not hesitate to ask us for the special system your hospital requires.

D. Surgical Facility Panels (SFP)

The surgical facility panel offers another method of providing isolated power in an operating room. This large panel condenses many of the electrical accessories normally found in an operating room into one unit.

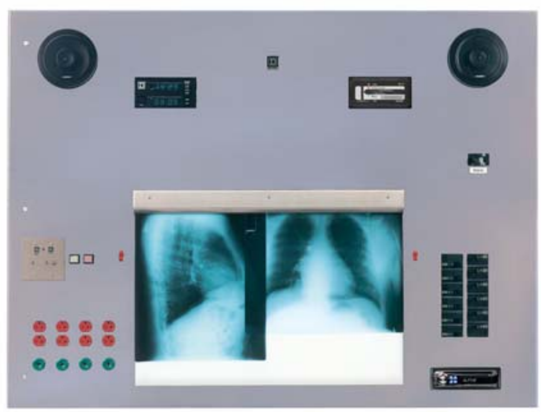
Components normally included in the surgical facility panel are:

- Isolation transformer
- Surgical clocks and timers
- Line isolation monitor (LIM)
- AM/FM, CD stereo system
- Audible indicator alarm
- Ground jacks
- Circuit breaker panel
- Double-size film illuminators
- Ground bus
- Power receptacles

Because all of these components are in the same panel, location of this panel within the operating room is critical. When specifying a surgical facility panel, consider which location is best for all concerned personnel.

Surgical facility panels are custom designed and assembled; this allows each hospital to specify the individual components needed in that hospital.

Typical Surgical Facility Panel



V. Field Test and Inspection

Because of the complexity of isolated power and the ground system, the manufacturer should field test the system before use. This is the only way to ensure the system is properly installed. The services of a factory technician are available from Schneider Electric. The factory trained technician performs the following on-site testing:

- All tests on the isolated system, ground network, and LIM are in accordance with Article 517 of the National Electrical Code and with NFPA No. 99.
- The ground test for power and ground receptacles is performed by applying a constant current between the room reference grounding bus and each ground contact of each receptacle, measuring the resulting voltage. The calculated resistance should be below 0.1 Ω. The potential difference between exposed conductive surfaces in the patient vicinity is checked; the difference cannot exceed 20 mV across a 1000 Ω resistor under normal operation.

- The LIM is tested as installed in the complete isolated system. Combinations of resistive and capacitive faults are placed on the isolated power system. The proper response of the line isolation monitor and its associated alarm device(s) is observed. Corrective steps are taken if improper operation is observed. The completed system is retested to ensure proper operation.
- The impedance of the isolated system (impedance to ground of either conductor) is tested. Impedance must exceed 200,000 Ω to conform with NFPA No. 99. The entire installation of the isolated equipment is inspected for conformance with applicable codes to ensure no code is violated.
- The technician gives a logbook to the hospital staff. The staff uses the book to record maintenance and periodic test data. The technician provides orientation to the system, and its maintenance and testing. During this orientation, the technician will answer any questions the hospital staff has about the system. Later, the hospital receives a letter containing the test results.

The above testing procedures are based on those required for isolated power systems in NFPA-99.

Electrical Maintenance

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Use extreme caution, some of the following procedures are performed when circuits are energized.
- Only trained personnel should perform these procedures.
- Use electrically insulated tools.

Failure to follow this instruction will result in death or serious injury.

A periodic maintenance program is essential to the safety of hospital patients and personnel. The services of a factory technician are available from Schneider Electric. Following a rigid maintenance program can reduce electrical hazards significantly.

Because of the size of hospital electrical systems, it is difficult to establish and follow a maintenance program which includes the entire hospital. However, checking anesthetizing and critical care areas more frequently than general patient areas is recommended.

Periodic testing for isolated power systems is required in NFPA-99.

Isolated Power System

Before using an isolated power system, conduct certain tests required in NFPA-99 to verify proper installation of the equipment and wiring. To conduct these tests, disconnect all secondary equipment from the secondary circuits. Conduct these tests before patient occupation. Follow the test procedures listed below:

LIM Test

1. Energize the isolation panel by closing the primary circuit breaker. Leave the secondary circuit breakers in the off position. Verify the LIM is operating. You should observe a slight meter deflection, indicating the monitor hazard current plus the hazard current for the isolation panel.
2. Press the push-to-test button on the LIM to ensure its test capability. Also check for audible and visible alarms attached to the LIM. The alarms should operate in the safe condition and in the alarm condition. Ensure the alarm will silence when the silence button is pressed.
3. Record the hazard current reading for the LIM with only the primary circuit breaker closed. Then close one secondary circuit breaker at a time, recording the hazard current reading for that circuit only. Close only one circuit breaker at a time; otherwise, the reading cannot be attributed to a specific circuit. If any circuit shows an unusually high hazard current compared to other circuits, investigate it immediately.
4. Determine the line-to-ground impedance between each of the power conductors and ground. Conduct this test at any of the receptacles; be sure all the secondary breakers are in the “on” position. Disconnect the LIM from the circuit during this test. To conduct this test, place a 0–1 milliammeter between either line to ground and measure the current. The value of current divided into the system voltage determines the system impedance. This impedance must be greater than 200 kilohm (kΩ) for either line to ground. For a 120 V system, this compares to 600 µA. Conduct this system impedance test without any secondary equipment connected to the circuits. If the impedance is less than that required by NFPA No. 99, investigate the system and correct the problem.

5. Test the LIM to ensure the proper alarm trip point. To perform this test, place a value of resistance between one line and ground to act as the fault impedance. The fault impedance should be inserted directly into the LIM with all secondary wiring disconnected. Use the following equation for fault impedance:

   E = System Voltage

   R = Fault Impedance in Ohms

   I = Alarm Trip Current-Monitor Hazard Current at Trip Point in Amperes

$$R = \frac{E}{I}$$

For a capacitive fault, use the following equation:

E = System Voltage

R = Fault Impedance as Calculated Above in Ohms

C = Capacitance in Farads

$$C = \frac{1}{0.377R}$$

The LIM should alarm for an impedance of 10% of this value; if it does not alarm, contact the manufacturer.

NFPA No. 99 recommends the following formula be used to fault the LIM:

R = 200 X System Voltage

For example, if a system measures 120 V, the fault impedance would be:

R = 200 X 120

= 24 K ohms

Ground Test

6. For proper continuity, test the ground system associated with the isolated power system before its initial use. To perform the test, inject 20 A between the ground bus in the isolation panel and the grounded points on receptacles and ground jacks. The potential difference measured between these two points should not exceed 2 V. If it does exceed 2 V, inspect the ground for proper connection and properly sized wire. The 20 A ground test can also verify that all metal within the room is properly grounded. To perform this test, attach probes between metal surfaces and the room ground bus; verify the ground connection. This test can also be conducted with an 0–0.1 ohm meter.
7. Perform periodic testing, according to this schedule:

Test the LIM push-to-test button monthly. Check the associated alarms and silence functions.

Calculate an external fault impedance once every six months. At this time, take LIM readings with all circuit breakers closed and with all circuit breakers open. This provides a running history for the permanently installed wired system. If these values significantly increase, inspect the system and take corrective action.

Adapters and Extension Cords

The use of extension cords in patient areas and anesthetizing locations often presents an electrical hazard. Although extension cords offer flexibility, they are often abused. These cords may lie in traffic areas where people step on them and roll equipment over them. They may also lie in pools of fluid. It is safer to install a sufficient number of accessible receptacles than to use extension cords.

NFPA-99 prohibits the use of extension cords and multiple outlet devices in operating rooms except under certain conditions. Use of the cords can also allow higher than desired current leakage, causing the IPS to go into alarm. The equipment should be spread out through the system to avoid unnecessary alarms.

Medical Equipment Maintenance

The increased use of biomedical instruments presents another maintenance responsibility. Hospitals should establish routine programs to test and maintain such equipment as required in NFPA-99.

The maintenance program should apply to all patient care areas; but it is of greatest importance for special care units where the most seriously ill patients and the most complex equipment co-exist. The amount of equipment present varies by hospital, affecting the complexity of the program. However, the following items should be found in every medical equipment testing program:

- An established procedure ensuring that equipment serves the purpose for which it is intended, and that it is safe, reliable, and the best choice for its purpose
- Specifications that must be adhered to by manufacturers before lease/purchase of equipment
- Adequate customer support from the manufacturer, ensuring technical assistance, repair, and consultation as needed
- Periodic inspections, calibration, and preventive maintenance
- Immediate, thorough inspections when equipment malfunction or shock is considered a possibility
- Close monitoring of services provided by outside vendors
- A logging/reporting system that provides effective control and record keeping
- In-service training to ensure safe, effective use of medical equipment

Testing Personnel. Hospitals may choose to employ their own medical engineering personnel, share this personnel with other hospitals, or contract with an outside vendor to service medical equipment. Each hospital must choose the best option for its purposes.

The size of the hospital, presence of other hospitals in the area, and regional demographics will help each hospital make the appropriate decisions about testing personnel.

Leakage Current. All portable equipment has the potential for leakage current. Periodically test these pieces of equipment and tag the equipment, showing leakage current readings. Equipment that connects directly to patients should have its patient leads checked for leakage current. Each hospital should maintain the necessary testing equipment to conduct these testing procedures.

Testing Programs. Planning and implementing a medical equipment control program should include the following factors:

- The hospital should obtain competent, objective biomedical engineering assistance when planning and developing the program.
- A committee must be formed, which meets for the sole purpose of medical equipment control.
- All medical equipment must be defined and inventoried.
- The hospital should appraise several options for its equipment control, rather than choose the easiest or most available program.
- The appropriate medical engineering services must be obtained.
- The necessary test equipment must be leased/purchased, and be kept on site.
- The hospital must develop procedures, specifications, and additional program components to meet its needs.

Surgical Facility Panels (SFP)

The surgical facility panel offers another method of providing isolated power in an operating room. This large panel condenses many of the electrical accessories normally found in an operating room into one unit.

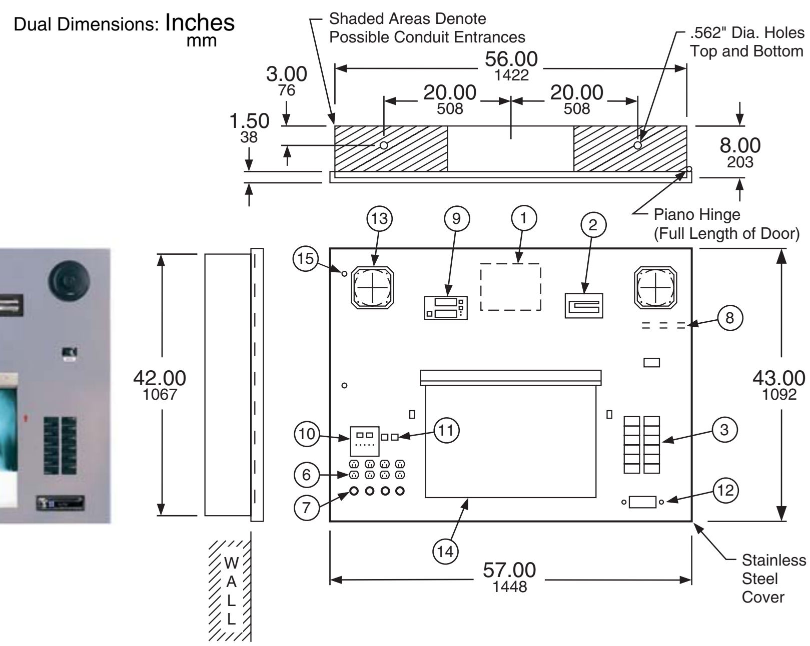
Components normally included in the surgical facility panel are:

- Isolation transformer
- Surgical clocks and timers
- Line isolation monitor (LIM)
- AM/FM, CD stereo system
- Audible indicator alarm
- Ground jacks
- Circuit breaker panel
- Double-size film illuminators
- Ground bus
- Power receptacles

Because all of these components are in the same panel, location of this panel within the operating room is critical. When specifying a surgical facility panel, consider which location is best for all concerned personnel.

Surgical facility panels are custom designed and assembled; this allows each hospital to specify the individual components needed in that hospital.

For more information, contact your local Schneider Electric representative.



Item	Description	Item	Description
1	Isolation Transformer 3 kVA 120-120	8	Ground Bus Bar
2	Iso-Gard Line Isolation Monitor	9	Digital Elapsed Timer/Clock
3	Circuit Breaker Panel with:	10	Control for Digital Elapse Timer/Clock
	1 — Primary Circuit Breaker – 30A, 2 Pole	11	Hazard Indicator with Push-to-Test
	8 — Secondary Branch Circuit Breakers – 20A, 2 Pole	12	AM/FM, CD Stereo System
4■	Power Lock Receptacle	13	Speaker for Stereo System
5■	Single Receptacle, 20A, Hospital Grade	14	X-Ray Film Illuminator
6	Duplex Receptacle, 20A, Hospital Grade	15	Trim Lock
7	Ground Jack, 30A, Green		

■ Available, but not shown in illustration.

Isolation Panel Components

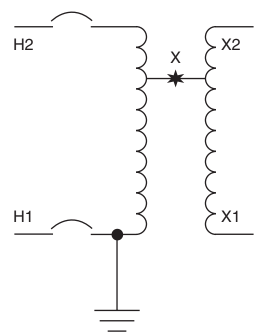
Square D brand hospital isolation panel components eliminate the difficulty in coordinating an effective isolated power distribution system for hospital anesthetizing locations and electrically susceptible patient areas.

The components are factory engineered, wired, and thoroughly tested to provide the ultimate in protection, reliability, and ease of installation.

Isolation Transformer

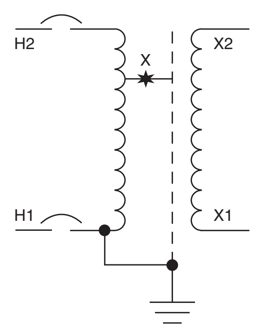
The heart of the system is the Square D brand isolation transformer. Since quiet operation is important in hospital applications, Schneider Electric followed rigid design criteria to provide a virtually inaudible transformer core and coil unit. Sound ratings of 30 dB or less are guaranteed on units 5.0 kVA and below, and 35 dB for units 7.5 kVA and above.

Unshielded Transformer



Because secondary windings of isolating transformers are ungrounded, a primary to secondary failure may not trip the circuit breaker. The result is a dangerously high secondary voltage (primary + secondary) because of auto-transformer action.

Shielded Transformer



Failures in the primary, which normally cause a dangerous secondary voltage condition, are shorted through the shield, thus activating the primary protective device.

The standard transformer uses a 220 °C rated insulation system. This insulation system allows, by NEMA–ANSI standards, a temperature rise of 150 °C above a 40 °C ambient. However, Schneider Electric limits the temperature rise of the isolation transformer to 80 °C maximum, further ensuring system reliability on all standard transformers.

Isolating the operating room system from normal building service is important. Take all possible safeguards to guarantee the transformer's isolating properties. To accomplish this, Schneider Electric provides an electrostatic shield between the primary and secondary windings as standard equipment in all transformers used in hospital isolated systems. Though not an NFPA code requirement, the shield is highly recommended by leading engineers.

Whether an electrostatic shield is necessary in a transformer used in a hospital isolation system has been widely discussed. Although the shield makes the electrical design of the coil more difficult, these two features make it desirable:

1. The shield establishes a ground plane between the primary and secondary. In an unshielded transformer, a potentially hazardous condition exists if the insulation between the primary and secondary fails for any reason. When this happens, a low resistance path would electrically connect one turn of the primary winding with one turn of the secondary winding. The transformer would function electrically with no indication of this failure. Only a LIM connected to the secondary would indicate the problem.

   In the unshielded transformer in the figure above, this failure occurred at "X." This, in effect, grounds the secondary through the primary. The secondary line-to-ground potential depends upon the portion of the primary winding between the ground and the fault, plus or minus the portion of the secondary winding. It could be from 1 V to approximately 240 V in a 120–120 V transformer.

 SQUARE D 04/2008

Individuals coming in contact with a secondary lead and ground would complete the circuit and current would flow through their bodies.

The same failure occurring in a shielded transformer, as shown in the shielded transformer illustration on the preceding page, causes a high current flow in the primary. This causes the primary circuit breaker to open, removing the unit from service.

2. The shield attenuates common-made noise or disturbances that are frequently generated by equipment used in other locations such as Diathermy and X-ray equipment.

   The shield's attenuating characteristics prevent most of the signal from feeding into the distribution system and through it into other treatment or monitoring equipment.

Circuit Breaker Protection

All Schneider Electric hospital isolated systems include a primary circuit breaker and 2-pole secondary circuit breakers. All panels are designed to accept up to 16 secondary breakers per UL. The dual output voltage panel has space for two secondary breakers for the 208 V or 240 V side of the panel. Schneider Electric recommends using the QO® (snap-in) circuit breaker in isolated power panels because of the ability of the breaker to grab the bus. There is no maintenance recommendation for the QO circuit breaker. For the QOB™ (bolt-on) circuit breaker, Schneider Electric recommends checking the tightness of the bolted bus connection at least once each year.

Enclosures

Enclosure back boxes are constructed of cold-rolled steel that is degreased, phosphatized, and finished in gray baked enamel. The boxes are designed for flush mounting, but are available for surface mounting on request. The front trim is #304 stainless steel with a brushed finish, ensuring corrosion resistance and ease of cleaning.

Square D brand isolation panels use a non-ventilated enclosure for most panel designs. The trim has no louvers or grilles for air circulation, which contributes to safe and easy cleaning. More important, no room air circulates through the transformer compartment, removing the danger of bacteria growth in the warm compartment. The hinged access door to the dead front circuit breaker and the LIM compartment has a lock to prevent unauthorized entry. The design prevents accidental entry into the transformer section when operating the circuit breakers or LIM test circuit.

While there are some panels designed to accept a ventilated trim, Schneider Electric recommends that these panels be placed in areas that are not required to maintain a sterile atmosphere, such as a non-sterile corridor.

Installation Convenience

The Square D brand hospital isolated power system was designed for convenient and economical installation by electrical contractors. The units are completely factory wired and tested. Field wiring simply involves the connection of the primary feeders and secondary circuits to clearly marked terminals. Back boxes for isolation panels and other modules can be shipped to the job site for "roughing-in" ahead of the interiors. The interiors, trims, and transformers can be shipped later.

Operating Room Panels

First introduced in the 1960s, this standard unit is most often used to supply 120 V service to the receptacles in an operating room. However, its use is not restricted to that application; it can also be used in critical care areas. This panel incorporates:

- The isolation transformer, which is a standard low-leakage, electrostatically shielded, 220 °C insulation system—80 °C temperature rise, 30 dB sound level isolating transformer
- A primary circuit breaker
- Eight secondary 2-pole circuit breakers
- A Square D brand Iso-Gard LIM

The panel is non-ventilated and has a #304 stainless steel trim with a brushed finish. Under continuous full load and normal hospital ambient conditions, the front trim panel's total temperature will be no greater than 50 °C.

See page 54 for panel-mounted indicator alarms which can be added to this panel.

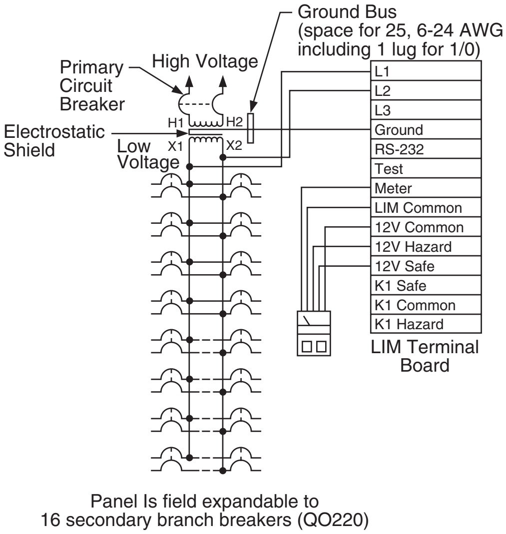
These panels are UL Listed under Section 1047 Isolated Power Systems Equipment. Schneider Electric also has a line of 3-phase isolation panels to provide power in operating rooms for specialized equipment such as operating room tables and electrosurgical laser machines.The 3-phase panel should be used for 3-phase applications only.

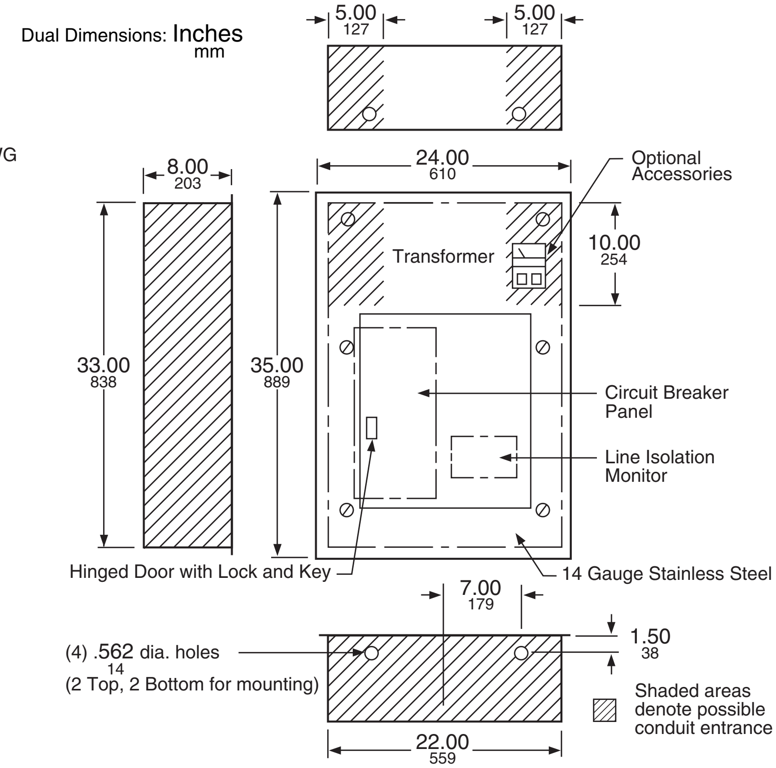
Interior						Trim Catalog Number	Back Box		Transformer Catalog Number
Catalog Number	kVA	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker[1]		Flush Catalog Number	Surface Catalog Number	
3H5S11DDI	3	120	120	30A	8-20 A	OR 24350	53013BB	53017BB	See note 2
3H5S21DDI		208		20A					
3H5S31DDI		240		20A					
3H5S41DDI		277		15A					
5H5S11DDI	5	120		60A					
5H5S21DDI		208		30A					
5H5S31DDI		240		30A					
5H5S41DDI		277		25A					
5H5S51DDI		480		15A					
7H5S11DDI	7.5	120		80A		XR 29420	53015BB	53019BB	7XR11
7H5S21DDI		208		45A					7XR21
7H5S31DDI		240		40A					7XR31
7H5S41DDI		277		35A					7XR41
7H5S51DDI		480		20A					7XR51
10H5S11DDI	10	120		100A					10XR11
10H5S21DDI		208		60A					10XR21
10H5S31DDI		240		60A					10XR31
10H5S41DDI		277		45A					10XR41
10H5S51DDI		480		30A					10XR51

1 All panels contain 8-20/2 branch breakers and are field convertible to 16-20/2 branch circuit breakers. Order the appropriate number of circuit breakers #QO220.

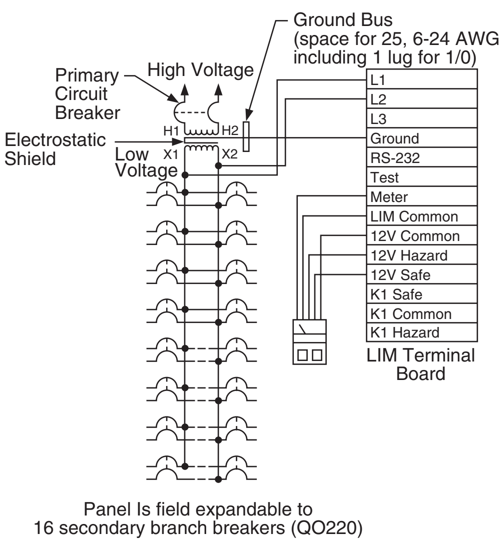
2 Transformer included for 3 kVA and 5 kVA when interior is ordered.

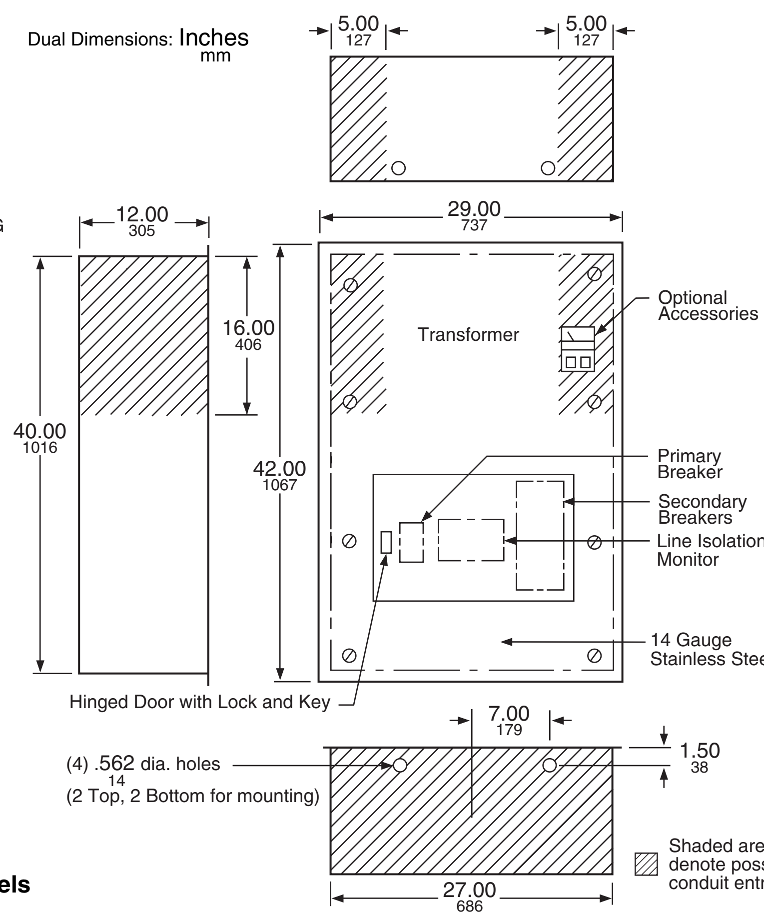
Wiring Diagrams and Dimensions





3 kVA and 5 kVA Operating Room Panels





7.5 kVA and 10 kVA Operating Room Panels

Low Profile Operating Room Panels

When isolated power system panels were introduced in the 1960's, Schneider Electric offered panels from 5 to 16 in. deep, depending on the application. The 5 in. panel eventually evolved into medical headwalls with isolated power. Designs for 6 and 8 in. panels were put aside in favor of the standard panels previously mentioned. The 6 in. low profile panel is available from 3 to 10 kVA and includes a NQOD type interior, accepting snap-in or bolt-on breakers. The low profile panel uses a common backbox for all voltages.

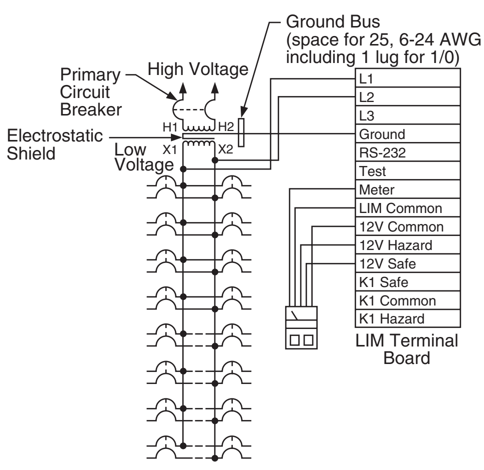
Interior						Trim Catalog Number	Back Box		Transformer Catalog Number
Catalog Number	kVA	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker[1, 2]		Flush Catalog Number	Surface Catalog Number	
3H5S11DDIL	3	120		30A					3SLP116
3H5S21DDIL		208		20A					3SLP216
3H5S31DDIL		240		20A					3SLP316
3H5S41DDIL		277		15A					3SLP416
5H5S11DDIL	5	120		60A					5SLP116
5H5S21DDIL		208		30A					5SLP216
5H5S31DDIL		240		30A			OR 29540	OR 27520	5SLP316
5H5S41DDIL		277		25A					5SLP416
5H5S51DDIL		480		15A					5SLP516
6H5S11DDIL	6.5	120		80A					6SLP116
6H5S21DDIL		208		45A					6SLP216
6H5S31DDIL		240	120	40A	8-20 A	53020BB			6SLP316
6H5S41DDIL		277		35A					6SLP416
6H5S51DDIL		480		20A					6SLP516
7H5S11DDIL	7.5	120		80A					7SLP116
7H5S21DDIL		208		45A					7SLP216
7H5S31DDIL		240		40A					7SLP316
7H5S41DDIL		277		35A					7SLP416
7H5S51DDIL		480		20A			OR 29540V[3]	OR 27520V[3]	7SLP516
10H5S11DDIL	10	120		100A					10SLP116
10H5S21DDIL		208		60A					10SLP216
10H5S31DDIL		240		60A					10SLP316
10H5S41DDIL		277		45A					10SLP416
10H5S51DDIL		480		30A					10SLP516

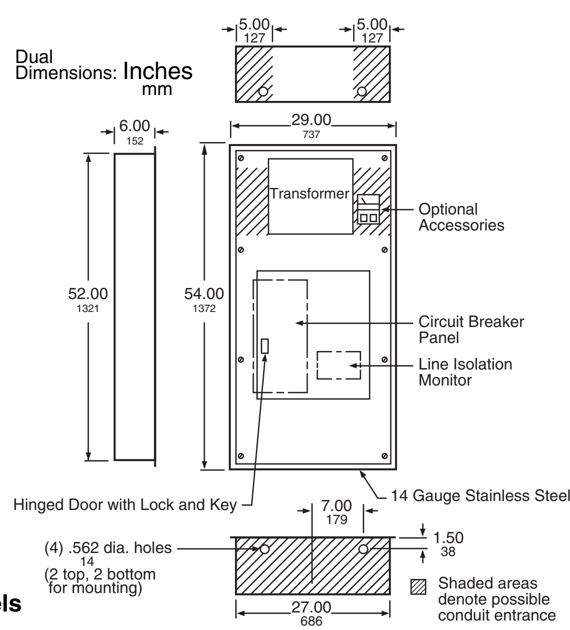
1 All panels contain 8-20/2 branch breakers and are field convertible to 16-20/2 branch circuit breakers. Order the appropriate number of QO or QOB circuit breakers.

2 For bolt-on, secondary circuit breakers, add a "B" to the end of the catalog number.

3 Vented trim. The 7.5 kVA panel is available with non-vented trim by using a 10 kVA transformer.

Wiring Diagram and Dimensions





3–10 kVA Low Profile Operating Room Panels

Intensive Care/Coronary Care Panels

These panels incorporate the same components and features as the operating room panels, but have the added feature of eight power receptacles and six approved grounding jacks which connect to a ground bus for attaching fixed equipment and building structural grounds. The power receptacles are "hospital only" locking-type receptacles. Duplex or single receptacles are available on request.

Although the panel is designed to serve the needs of a coronary care or intensive care bed, it has been widely applied to provide power within special procedure rooms, cardiovascular laboratories, and general operating rooms.

See page 54 for panel-mounted indicator alarms which you can add to this panel.

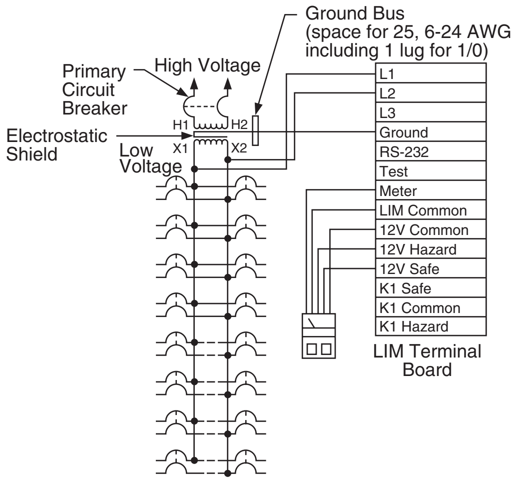
Interior						Trim Catalog Number	Back Box		Transformer Catalog Number
Catalog Number	kVA	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker[1]		Flush Catalog Number	Surface Catalog Number	
3H5S11CDDI 3H5S21CDDI 3H5S31CDDI 3H5S41CDDI	3	120 208 240 277	120	30A 20A 20A 15A	8-20A	IC24440	53014BB	53018BB	See note 2
5H5S11CDDI 5H5S21CDDI 5H5S31CDDI 5H5S41CDDI 5H5S51CDDI	5	120 208 240 277 480	120	60A 30A 30A 25A 15A	8-20A	IC24440	53014BB	53018BB	See note 2
7H5S11CDDI 7H5S21CDDI 7H5S31CDDI 7H5S41CDDI 7H5S51CDDI	7.5	120 208 240 277 480	120	80A 45A 40A 35A 20A	8-20A	IC29510	53029BB	53037BB	7XR11 7XR21 7XR31 7XR41 7XR51
10H5S11CDDI 10H5S21CDDI 10H5S31CDDI 10H5S41CDDI 10H5S51CDDI	10	120 208 240 277 480	120	100A 60A 60A 45A 30A	8-20A	IC29510	53029BB	53037BB	10XR11 10XR21 10XR31 10XR41 10XR51

[1] All Panels contain 8-20/2 branch breakers and are field convertible to 16-20/2 branch breakers. Order the appropriate number of circuit breakers #QO220.

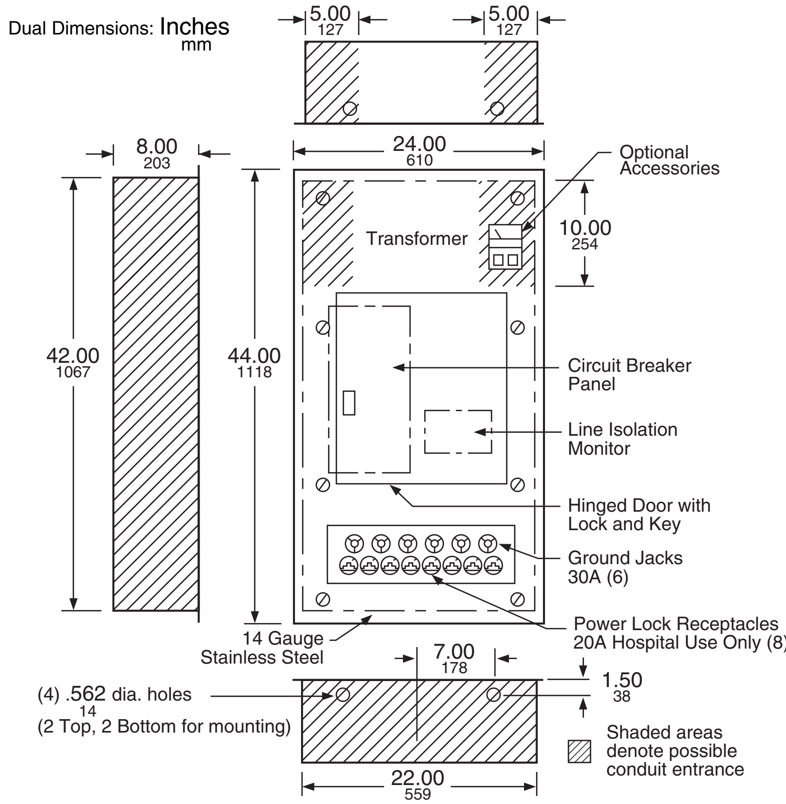
[2] Transformer included for 3 kVA and 5 kVA when interior is ordered.

[3] Panels available with red hospital-grade duplex receptacles. Change letter "C" to letter "D", e.g. 3H5S11CDDI to 3H5S11DDDI.

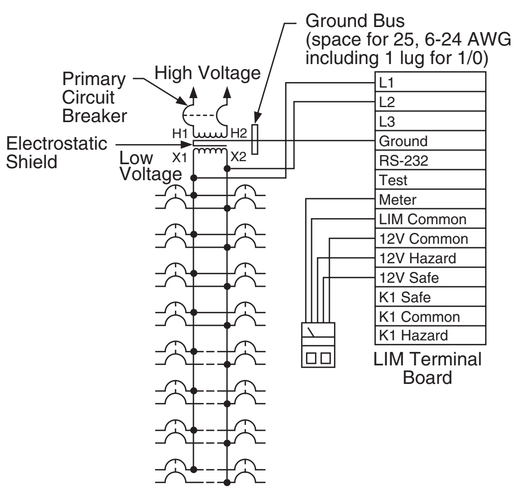
Wiring Diagrams and Dimensions



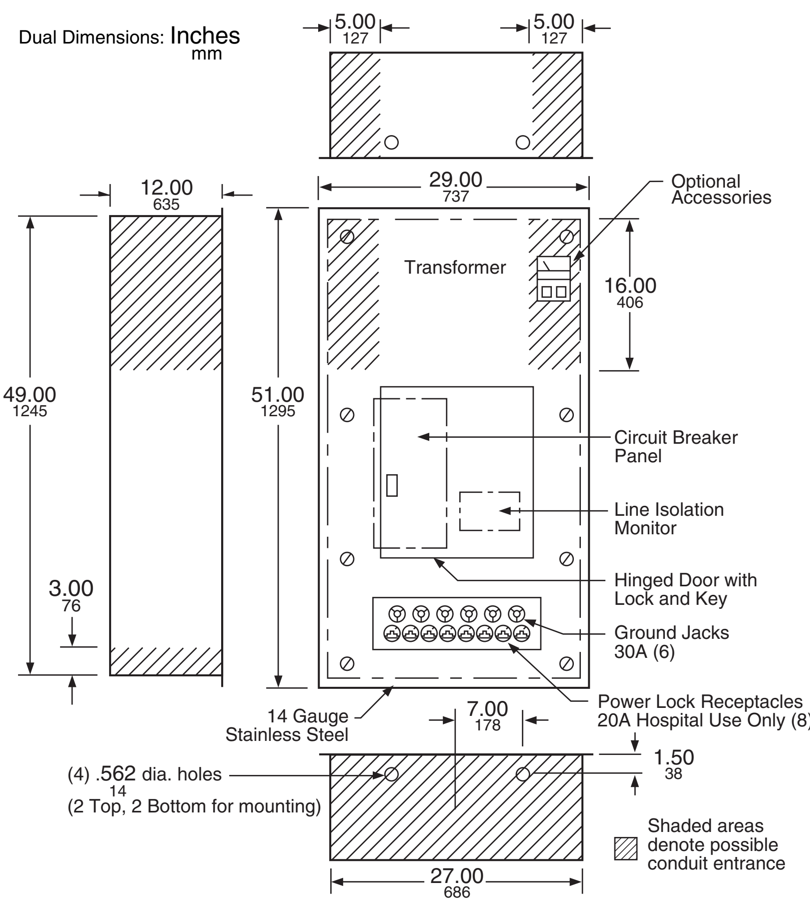
Panel Is field expandable to
16 secondary branch breakers (QO220)



3 kVA and 5 kVA ICU/CCU Panels



Panel Is field expandable to
16 secondary branch breakers (QO220)



7.5 kVA and 10 kVA ICU/CCU Panels

Dual Output Voltage Isolation Panels

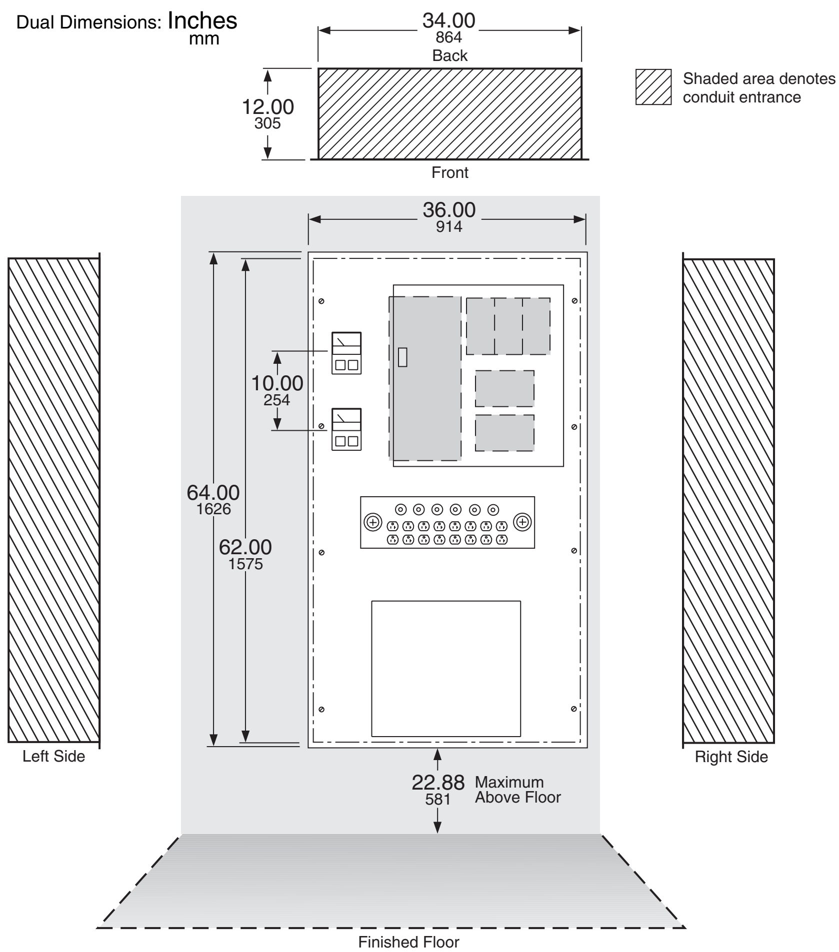
The dual output voltage hospital isolation panel is a single, ungrounded hospital isolation panel that can supply two different output voltages simultaneously. Similar to a standard distribution panel or load center, it can supply both 120/208 V or 120/240 V of ungrounded, isolated, single-phase power using only one isolation transformer. Other hospital isolation panels can supply only one output voltage.

Typically, the 208 or 240 V circuits of the dual output voltage panel supply power to operating room equipment such as mobile X-ray machines or surgical lasers. At the same time, the panel's 120 V circuits can supply power to convenience receptacles, surgical lights, X-ray film illuminators, sterilizers, and other 120 V appliances commonly found in operating rooms. This panel is ideally suited as a power supply to power/ground modules and X-ray indicator/receptacle modules, also manufactured by Schneider Electric.

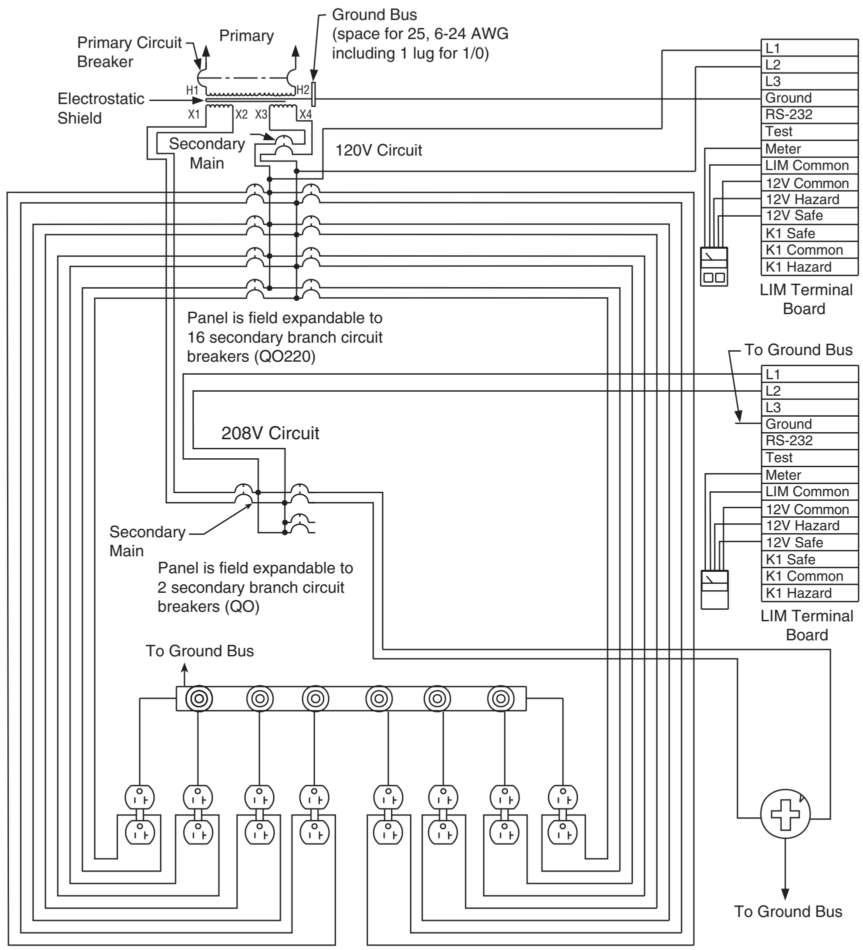
Transformers

All transformers for the dual output voltage isolation panels are single-phase only.

Dimensions



Wiring Diagram



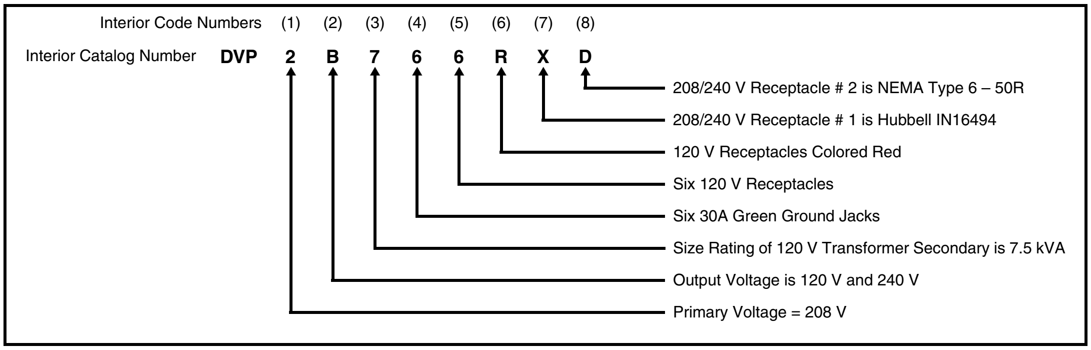
Catalog Numbers

To order dual output voltage hospital isolation panels, specify the correct catalog number for the following items:

- Interior
- Trim
- Transformer
- Back box

NOTE: The interior, trim, transformer, back box, and optional panel mounted accessories for the LIM must be ordered separately. Only the accessories are optional.

The interior catalog number is a combination of codes, which are described in the “Interior Catalog Number Selections” table that follows the example below.



Interior Catalog Number Selections

Selection Number	Options
(1) Primary voltage of dual output voltage isolation panel	2 = 208 V 3 = 240 V 4 = 277 V 5 = 480 V
(2) Output voltages	A = 120/208 V B = 120/240 V
(3) Size rating of 120 V secondary winding (kVA) Eight 20/2 branch circuit breakers are installed at the factory in the 120 V section of panel’s interior. The section is field expandable to 16 branch circuit breakers by ordering additional circuit breakers, Schneider Electric catalog no. QO220.	5 = 5.0 kVA 7 = 7.5 kVA 1 = 10.0 kVA
(4) Number of 30A green ground jacks	1 = one 5 = five 2 = two 6 = six 3 = three 0 = none 4 = four
(5) Number of 120 V power receptacles	1 = one 6 = six 2 = two 7 = seven 3 = three 8 = eight 4 = four 0 = none 5 = five
(6) Type of 120 V power receptacles	R = 20A, **red** hospital-grade duplex (NEMA 5–20R) I = 20A, **ivory** hospital-grade duplex (NEMA 5–20R) B = 20A, **black** hospital-grade duplex (NEMA 5–20R) T = 20A, **brown** hospital-grade duplex (NEMA 5–20R) L = 20A, **black** hospital only, locking-type receptacle (Hubbell #23000HG or equivalent) 0 = No 120 V receptacles

(7) Configuration of 208 or 240 V receptacle #1
The circuit breaker matching the selected receptacle is installed at the factory in the 208 V or 240 V section of the panel’s interior. If no receptacle is selected, the section is field expandable to two branch circuit breakers by ordering additional circuit breakers, Schneider Electric catalog no. QO210 through QO260. *Installation of circuit breakers rated higher than 60A voids the UL Listing.*
	X = Hubbell #IN16494 (equivalent to Hubbell #25603)
	A = NEMA #6-15R
	B = NEMA #6-20R
	C = NEMA #6-30R
	D = NEMA #6-50R
	E = NEMA #L6-15R
	F = NEMA #L6-20R
	G = NEMA #L6-30R
	0 = No 208 V or 240 V receptacle

(8) Configuration of 208 or 240 V receptacle #2
The circuit breaker matching the selected receptacle is installed at the factory in the 208 V or 240 V section of panel’s interior. If no receptacle is selected, the section is field expandable to two branch circuit breakers by ordering Schneider Electric catalog no. QO210 through QO260. *Installation of circuit breakers rated higher than 60A avoids UL Listing.*
	X = Hubbell #IN16494 (equivalent to Hubbell #25603)
	A = NEMA #6-15R
	B = NEMA #6-20R
	C = NEMA #6-30R
	D = NEMA #6-50R
	E = NEMA #L6-15R
	F = NEMA #L6-20R
	G = NEMA #L6-30R
	0 = No 208 V or 240 V receptacle

Transformer Catalog Numbers

120 V Winding Rating (in kVA)	Primary Voltage	Secondary Voltages	Catalog Number
5.0	208	208/120	DVT522
5.0	208	240/120	DVT523
5.0	240	208/120	DVT532
5.0	240	240/120	DVT533
5.0	277	208/120	DVT542
5.0	277	240/120	DVT543
5.0	480	208/120	DVT552
5.0	480	240/120	DVT553
7.5	208	208/120	DVT722
7.5	208	240/120	DVT723
7.5	240	208/120	DVT732
7.5	240	240/120	DVT733
7.5	277	208/120	DVT742
7.5	277	240/120	DVT743
7.5	480	208/120	DVT752
7.5	480	240/120	DVT753
10.0	208	208/120	DVT122
10.0	208	240/120	DVT123
10.0	240	208/120	DVT132
10.0	240	240/120	DVT133
10.0	277	208/120	DVT142
10.0	277	240/120	DVT143
10.0	480	208/120	DVT152
10.0	480	240/120	DVT153

Primary Circuit Breaker Information

Dual Voltage Panel Catalog Number	Dual Voltage Transformer Catalog Number	Primary Circuit Breaker		
		Voltage	Total kVA	Current
DVP2A5●	DVT522/DVT523	208	20	125
DVP3A5●	DVT532/DVT533	240		100
DVP4A5●	DVT542/DVT543	277		90
DVP5A5●	DVT552/DVT553	480		50
DVP2A7●	DVT722/DVT723	208	22.5	150
DVP3A7●	DVT732/DVT733	240		125
DVP4A7●	DVT742/DVT743	277		100
DVP5A7●	DVT752/DVT753	480		60
DVP2A1●	DVT122/DVT123	208	25	150
DVP3A1●	DVT132/DVT133	240		125
DVP4A1●	DVT142/DVT143	277		110
DVP5A1●	DVT152/DVT153	480		60

Trim

The trim catalog number is **DVC**.

Back Box

The back box catalog number selections include:

Flush back box = **DVBF**

Surface back box = **DVBS**

NOTE: Other receptacles are available. Please contact your Schneider Electric representative for details.

Duplex Isolation Panels

The duplex hospital isolation panel is a single enclosure containing two complete 120 V secondary hospital isolation systems. A divider in the unit's backbox separates the systems from top to bottom and front to back.

Each system has its own set of equipment:

- Primary circuit breaker
- Square D brand isolation transformer
- Reference ground bus bar
- Iso-Gard LIM
- Load center

The compact duplex design minimizes the width of the panel, which uses less horizontal wall space than two conventional isolation panels mounted side by side. This slim design is of particular benefit when the isolation panel is mounted in an operating room where wall space is limited.

The unit is available in 5 or 10 kVA ratings and includes a stainless steel cover. Because the panels provide power to life support equipment, a lockable door is included on all units. The door covers the branch circuit breakers and line isolation monitors to help restrict unauthorized access.

The unit is totally enclosed and non-ventilated to help keep out dust, dirt, recirculating air, and cleaning solutions. An optional surface mount backbox is available for remodeling applications. The entire panel assembly is listed under UL Standard 1047, Hospital Isolated Power Systems.

Duplex hospital isolation panels are ideally suited for large operating rooms where more than 14 circuits are required. The branch circuits can be divided between the two systems to keep branch circuit leakage current from exceeding the limits set by the National Fire Protection Association (NFPA) 99 Standard for Health Care Facilities.

For isolation systems with a 120 V secondary, the hazard current limit is 600 µA for the fixed wiring on the secondary of the isolation transformer. The limit is usually reached when 12 to 14 branch circuits are connected. The duplex hospital isolation panel accommodates 16 branch circuit breakers for each of its two systems.

The duplex hospital isolation panel can also be used to satisfy requirements of NFPA 70, the National Electrical Code® (NEC) Article 517-19(a), Critical Care Areas. The panel can be applied to both critical systems and normal system power. One half of the panel can be used to supply critical system power, while the other half supplies normal system power.

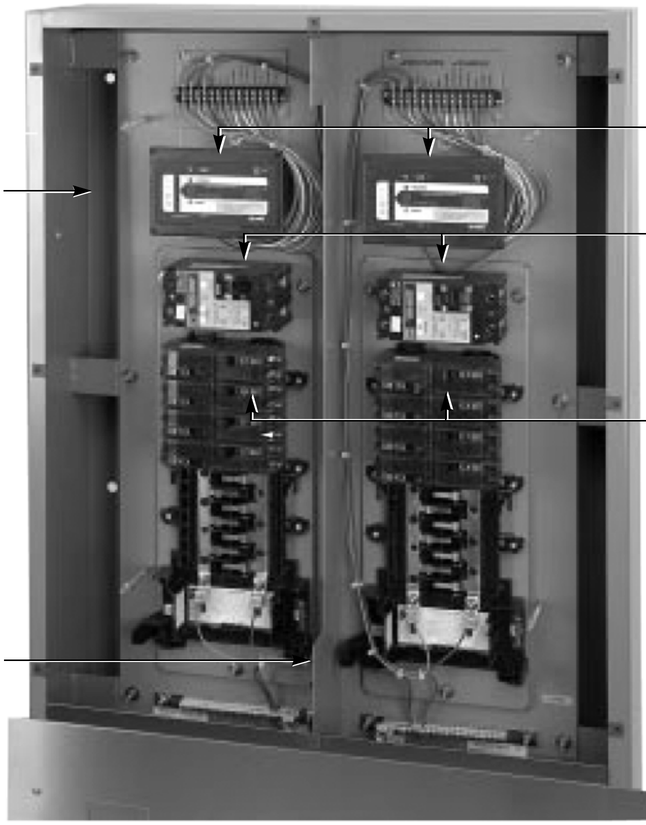
NOTE: Hospital operating rooms have been classified as Critical Care Areas since the 1993 issue of the NEC.

Features

Features of the duplex hospital isolation panel include:

- Two complete isolated power systems in one enclosure.
- Available in either 5 or 10 kVA ratings.
- Each system is capable of accepting up to 16 branch circuit breakers.
- Each panel includes two Iso-Gard Series D microprocessor-controlled line isolation monitors.
- Stainless steel trim with lockable door to restrict unauthorized access to circuit breakers and line isolation monitors.

Detailed Features of the Duplex Isolation Panel



Optional Accessories

Optional accessories for the duplex hospital isolation panel include:

- Surface mount backbox for remodeling applications.
- Panel-mounted indicator alarm and microammeter for operating room applications.
- Additional QO220 circuit breakers to increase panel from 8 to 16 branch circuits.

Advantages

The duplex hospital isolation panel provides the following advantages:

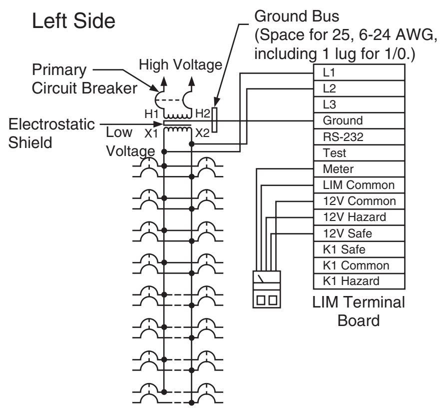
- Slim design to minimize the amount of horizontal wall space used in the operating room.
- Less installation labor than two panels.
- Ability to divide branch circuits between two isolation panels and still meet leakage current limits for branch circuit wiring as required in NFPA 99.
- Ability to provide both critical service and normal service power from one isolation panel.
- All branch circuits are located in one panel. This can be important when maintenance electricians are searching for a tripped circuit breaker in an emergency.
- Totally enclosed, non-ventilated design helps prevent air-borne dust, lint, or germs from recirculating through the panel. The design also helps keep cleaning solutions out of the panel when the walls are scrubbed down by housekeeping staff.

Catalog Numbers

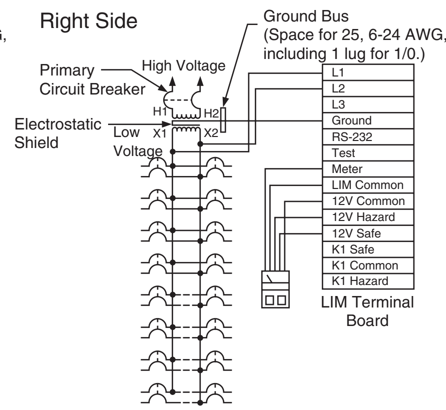
Interior						Trim Catalog Number	Backbox		Transformer Catalog Number
Catalog Number	kVA (each side)	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker▲		Flush Catalog Number	Surface Catalog Number	
5/5H5S11DDI		120		60A					5/5XR11
5/5H5S21DDI		208		30A					5/5XR21
5/5H5S31DDI	5 + 5	240	120	30A	8 (20A)	OR32730	53047BB	53053BB	5/5XR31
5/5H5S41DDI		277		25A					5/5XR41
5/5H5S51DDI		480		15A					5/5XR51
7/7H5S11DDI		120		80A					7/7XR11
7/7H5S21DDI		208		45A					7/7XR21
7/7H5S31DDI	7.5 + 7.5	240	120	40A	8 (20A)	OR32730	53048BB	53052BB	7/7XR31
7/7H5S41DDI		277		35A					7/7XR41
7/7H5S51DDI		480		20A					7/7XR51

▲ Panels are field expandable to 16 branch circuit breakers. Order circuit breaker catalog number QO220.

Wiring Diagrams and Dimensions

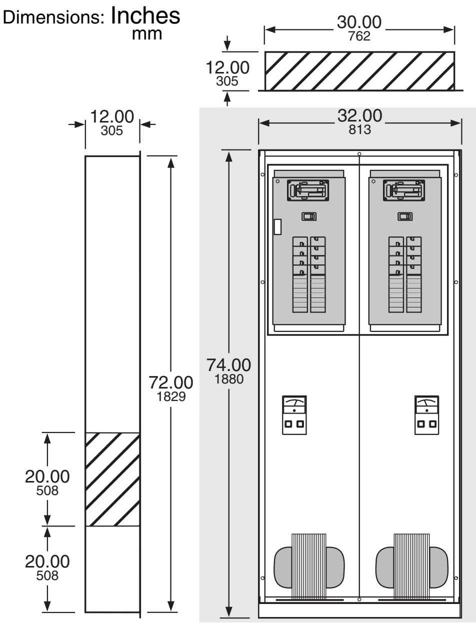


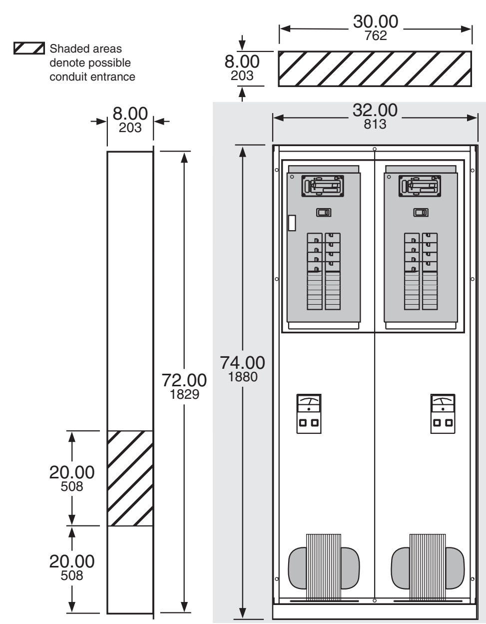
Panel is field expandable to 16 secondary branch breakers (QO220).



Panel is field expandable to 16 secondary branch breakers (QO220).

Dual Dimensions: Inches
mm





Three-Phase Isolation Panels

Three-phase hospital isolation panels are intended for use as a power supply for equipment such as surgical lasers, laminar airflow systems, and other three-phase specialty equipment used in hospital operating rooms. Three-phase isolation panels can range in size from 3.0 kVA to 25.0 kVA. Primary voltage to these panels can be either 208 or 480 V delta; the secondary voltage is usually 208 V. Use these panels for three-phase loads only; they cannot be used to supply power to 120 V single-phase loads. Under some types of ground faults, 120 V equipment can be subjected to higher than anticipated line-to-ground voltages.

Three-phase isolation panels can be supplied with up to four secondary branch breakers, which are rated from 10 through 60 amperes and are the 2-pole or 3-pole type. To comply with National Fire Protection Association (NFPA) 99 requirements for the maximum hazard current contributed by the branch circuit conductors (impedance of isolated wiring) on isolated power systems, the number of branch circuit breakers should be limited to four. Circuit runs must be kept to the shortest length possible.

Standard Features

All Square D brand, three-phase hospital isolation panels include the following components:

- Hospital isolation transformer from 3.0–25.0 kVA copper wound, low leakage, with electrostatic shield.
- Primary main circuit breaker sized in accordance with Article 450-3(b)(1) of the National Electrical Code (NEC).
- Iso-Gard Series D microprocessor-controlled line isolation monitor (LIM) manufactured by Schneider Electric.
- Maximum of four secondary branch circuit breakers.
- Totally enclosed, non-ventilated, flush enclosure with stainless steel trim.
- Ground bus bar with 25 terminals.

Optional Accessories

Optional items available with these panels are:

- Panel- or remote-mounted indicator alarms with or without analog LIM meter.
- Surface mount backbox.
- Combination 3-pole, 4-wire receptacle and indicator alarm module similar to the Square D brand X-Ray Indicator/Receptacle Module #XR-IAI.

  NOTE: Note: Customer must specify NEMA configuration of receptacle when ordering module

Optional accessories that can be included with the 3-phase isolation panel follow:

Item	Catalog Number	Description
Panel Mounted Indicator Alarms	ORIC-A	Green, amber, and red indicating lights and audible alarm mounted on front trim
	ORIC-A5C	Green, amber, and red indicating lights, audible alarm, and microammeter mounted on front trim
X-Ray/Laser Indicator and Receptacle Module	XRT30-IAI	X-ray receptacle with remote indicator alarm, Hubbell receptacle #2720, 30 A
	XRT60-IAI	X-ray receptacle with remote indicator alarm, Hubbell receptacle #8460, 60 A
	53007BB	Backbox for x-ray receptacle and indicator module[1]

1 Backbox dimensions: 12 in. H x 8 in. W x 4 in. D

Catalog Numbers

To order three-phase hospital isolation panels, specify the correct catalog number for the following items:

- Interior
- Trim
- Backbox
- Transformer

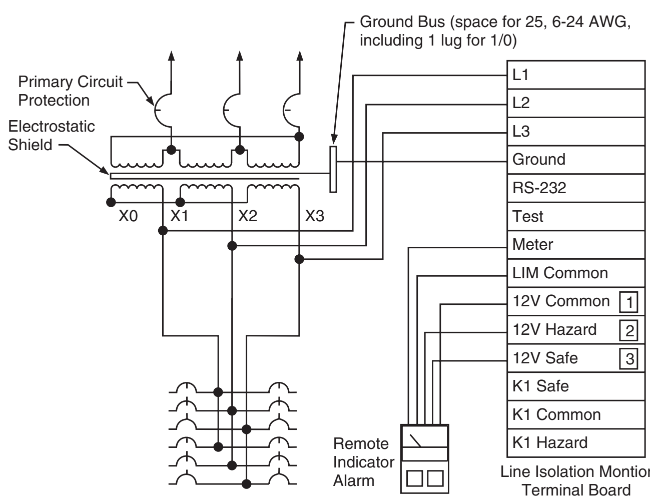
NOTE: The interior, trim, backbox, transformer, and optional panel mounted accessories for the LIM must each be ordered separately. Only the accessories are optional.

Panel interiors include one 3-pole secondary branch circuit breaker (Type QO). Contact Medical Products Marketing when multiple secondary circuits are necessary or for the availability of UL Listing.

Catalog Numbers

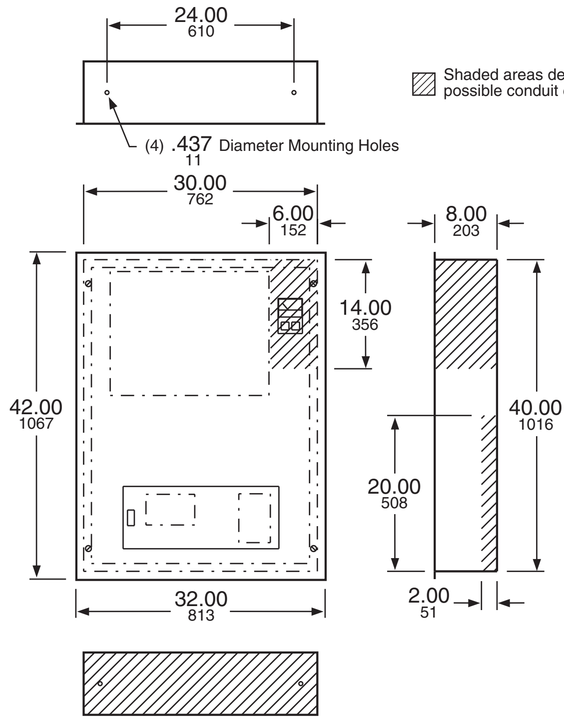
Interior						Trim Catalog Number	Backbox		Transformer Catalog Number
Catalog Number	Primary kVA	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker		Flush Catalog Number	Surface Catalog Number	
3H5ST22DDI	3	208	208	15A	(1) 15A	ORT32420	53042BB	53050BB	3XRT22
3H5ST52DDI		480		6A					3XRT52
6H5ST22DDI	6	208	208	20A	(1) 15A	ORT32420	53043BB	53051BB	6XRT22
6H5ST52DDI		480		10A					6XRT52
9H5ST22DDI	9	208	208	35A	(1) 30A	ORT32420	53043BB	53051BB	9XRT22
9H5ST52DDI		480		15A					9XRT52
15H5ST22DDI	15	208	208	60A	(1) 60A	ORT42600	53045BB	53046BB	15XRT22
15H5ST52DDI		480		25A					15XRT52
25H5ST22DDI	25	208	208	90A	(1) 60A	ORT42600	53045BB	53046BB	25XRT22
25H5ST52DDI		480		40A					25XRT52

Wiring Diagram

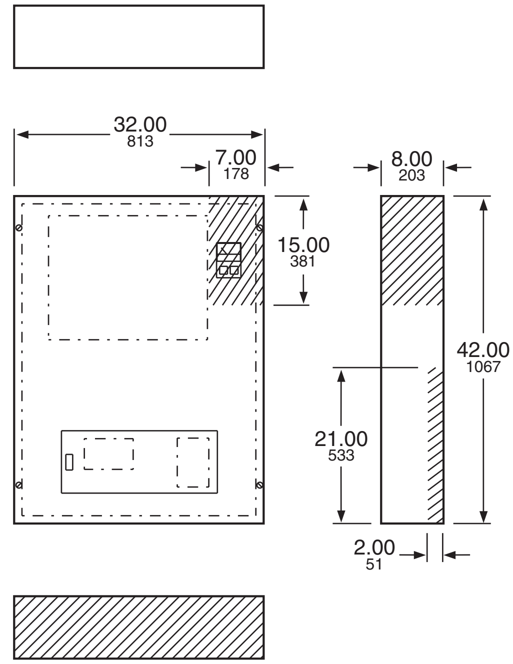


Dimensions

Shaded areas denote possible conduit entrance



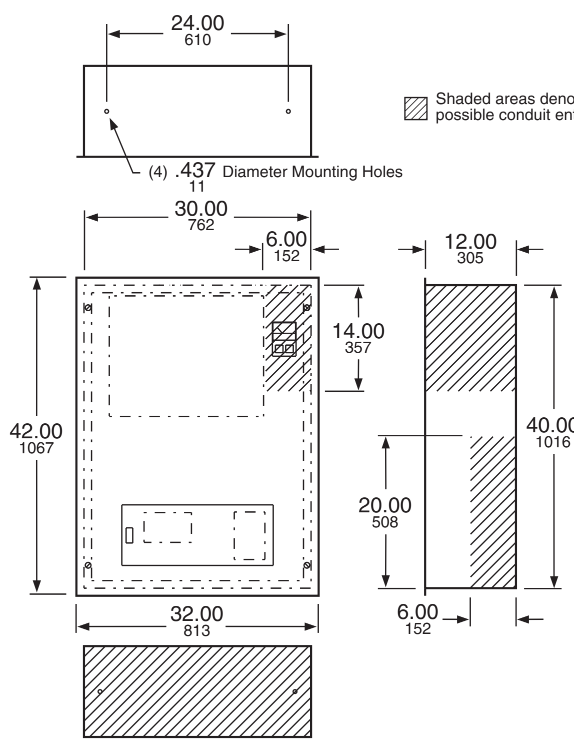
3 kVA, 3-Phase Flush Panel



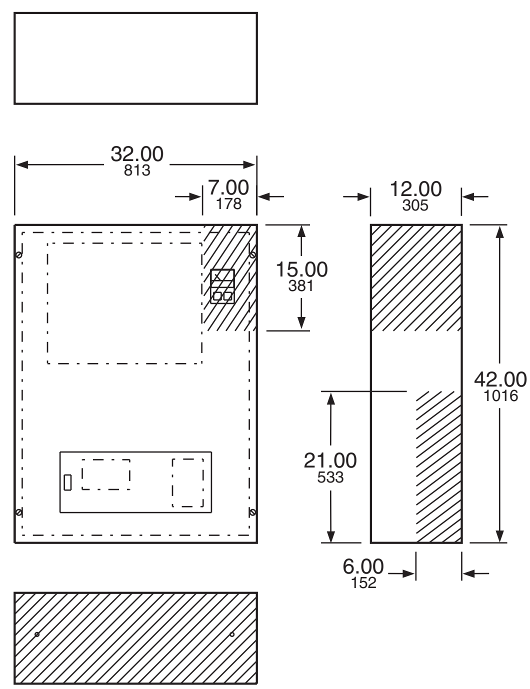
3 kVA, 3-Phase Surface Panel

Dual Dimensions: Inches / mm

Shaded areas denote possible conduit entrance



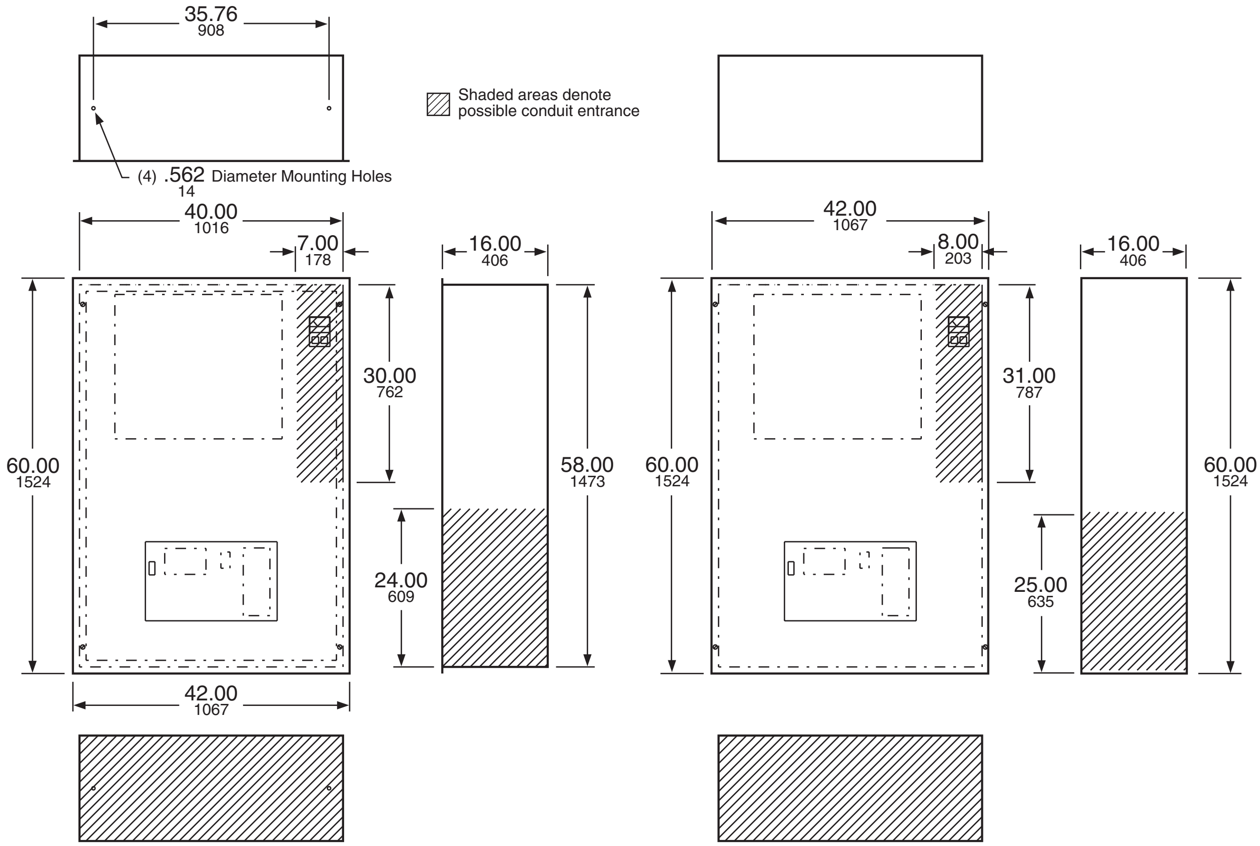
6 and 9 kVA, 3-Phase Flush Panel



6 and 9 kVA, 3-Phase Surface Panel

Dual Dimensions: Inches / mm

Dimensions (cont.)



15 and 25 kVA, 3-Phase
Flush Panel

15 and 25 kVA, 3-Phase
Surface Panel

Dual Dimensions: Inches
mm

Controlled Power Panels

Square D brand controlled power isolation power panels are designed to provide power for portable equipment outlets. In the past, most equipment operated on 60 A circuits. Today, these loads vary from 20 to 60 A and multiple pieces of equipment are being used. By applying the proper kVA loading, a panel can now provide power to multiple rooms and maintain safe operating conditions. All of these panels are available in both one-phase and three-phase configurations with 5 to 25 kVA ratings.

The type of controls applied depends on the need. Schneider Electric has a variety of control schemes from push button to switches located in the operating room. The NEC requires that an audible and visual indication of alarm be available wherever isolated power is used. We use a receptacle module with a remote alarm indicator built into it for this purpose. A receptacle module without a remote alarm indicator is also available. The control of these circuits is important not only for the safety of turning them on and off, but they also turn the remote alarm indicators on and off at the same time. This reduces any confusion caused by an alarm going off in the operating room from circuits that don’t need to be energized.

The basic control scheme is the mechanical interlock panel. The panel will serve various locations within the hospital. Interlocking circuitry allows predetermined locations to be used at any given time. Consequently, the line isolation monitor (LIM) monitors only the wiring and its inherent leakage to that single receptacle. Remote indicator alarm stations must be located at the receptacle location. A push button station located in the panel controls the interlocking system. If the panel location is inaccessible or inconvenient for operating personnel, the push button station is available in a separate module that can be installed at the nurses' station or any other convenient location. This can be an inconvenience since this type of control system requires someone to select which room will be turned on. It also poses a potential problem in that someone could easily push a button to turn the power on in another room, thus turning off the power in a room that may actually be using a piece of equipment.

The newer and more popular control scheme is the PLC controlled panel. Like the mechanical interlock panel, this panel will serve various locations. Because of the PLC, multiple locations can be served at one time. This panel is operated from the receptacle module in the room. The receptacle module contains a switch that sends a signal to the panel that power is required at the receptacle. The PLC is programmed to operate a predetermined number of circuits at one time. Once the predetermined number is achieved, the rest of the circuits are locked out. This also gives the control of the receptacle to the room. Push button control can be substituted for the switch in the receptacle module.

The interposing contact controlled panel is a panel with a maximum of four circuits available. This panel works like the PLC panel, but limits the output to only one circuit at a time. This panel is perfect for smaller applications where the facility has up to four operating rooms. The switch at the receptacle module energizes the appropriate contactor when activated, while locking out the remaining contactors. Push button control can be substituted for the switch in the receptacle module.

For facilities with limited equipment, a contactor control panel can be designed to fit individual needs. This panel would contain the secondary breakers needed and use either the receptacle module switch or push button control. The panel does not have lock-out features, but does have the ability to turn receptacles on and off where needed.

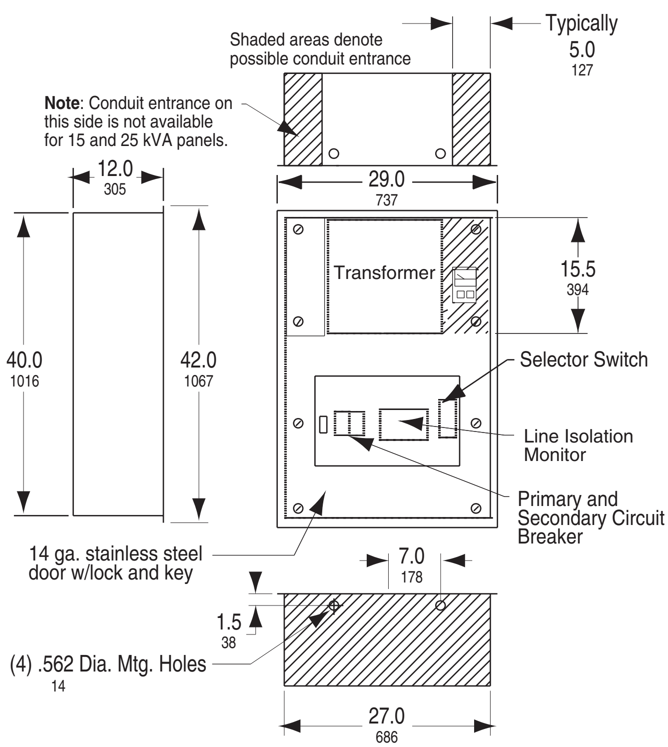
Mechanical Interlock Panels[1]

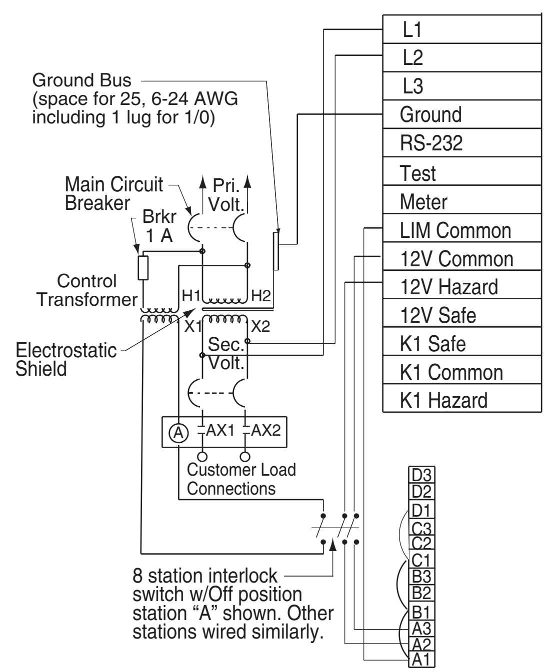
Interior						Trim	Back Box		Transformer
Interior Catalog Number	kVA	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker [2]	Trim Catalog Number	Flush Catalog Number	Surface Catalog Number	Transformer Catalog Number
15H5S22DDI	15	208	208	90A	1-60 AMP Secondary Circuit Breaker	XR29420	53015BB	53019BB	15XR22
15H5S23DDI		208	240	90A					15XR23
15H5S32DDI		240	208	90A					15XR32
15H5S33DDI		240	240	90A					15XR33
15H5S42DDI		277	208	90A					15XR42
15H5S43DDI		277	240	90A					15XR43
15H5S52DDI		480	208	40A					15XR52
15H5S53DDI		480	240	40A					15XR53
25H5S22DDI	25	208	208	125A	1-60 AMP Secondary Circuit Breaker	XR29420	53015BB	53019BB	25XR22
25H5S23DDI		208	240	125A					25XR23
25H5S32DDI		240	208	125A					25XR32
25H5S33DDI		240	240	125A					25XR33
25H5S42DDI		277	208	125A					25XR42
25H5S43DDI		277	240	125A					25XR43
25H5S52DDI		480	208	65A					25XR52
25H5S53DDI		480	240	65A					25XR53

1 Up to 8 outlets can be controlled from these panels. No branch circuit should be longer than 150 ft. For more than 8 circuits, contact Schneider Electric Medical Products.

2 Any secondary circuit breaker can be used. Contact Schneider Electric Medical Products for more information.

Wiring Diagram and Dimensions





Dual Dimensions: Inches / mm

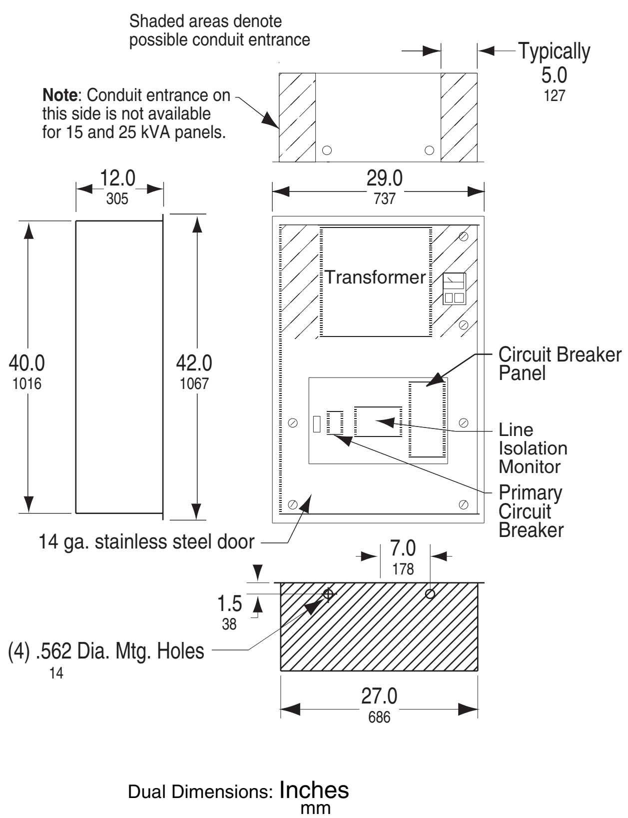
Hospital Isolated Power Systems
Controlled Power Panels

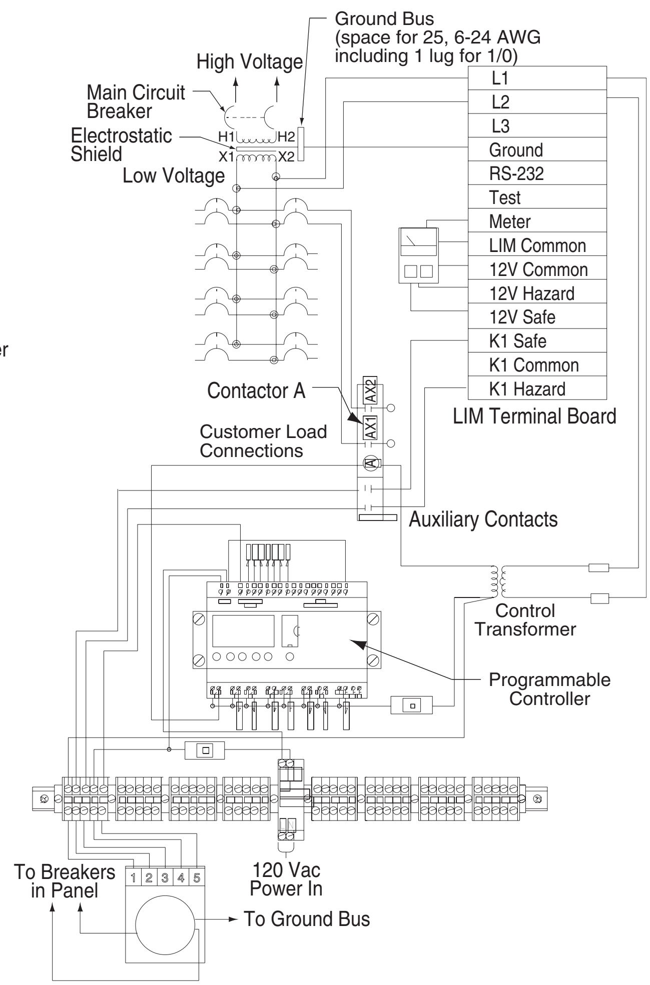
PLC Controlled Panels[1]

Interior						Trim Catalog Number	Back Box		Transformer Catalog Number
Interior Catalog Number	kVA	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker		Flush Catalog Number	Surface Catalog Number	
15H5S22PLCIR	15	208	208	90A	8–20, 30 or 60 A Secondary Circuit Breaker or a combination thereof.	XR29420	53015BB	53019BB	15XR22
15H5S23PLCIR		208	240	90A					15XR23
15H5S32PLCIR		240	208	90A					15XR32
15H5S33PLCIR		240	240	90A					15XR33
15H5S42PLCIR		277	208	90A					15XR42
15H5S43PLCIR		277	240	90A					15XR43
15H5S52PLCIR		480	208	40A					15XR52
15H5S53PLCIR		480	240	40A					15XR53
25H5S22PLCIR	25	208	208	125A	8–20, 30 or 60 A Secondary Circuit Breaker or a combination thereof.	XR29420	53015BB	53019BB	25XR22
25H5S23PLCIR		208	240	125A					25XR23
25H5S32PLCIR		240	208	125A					25XR32
25H5S33PLCIR		240	240	125A					25XR33
25H5S42PLCIR		277	208	125A					25XR42
25H5S43PLCIR		277	240	125A					25XR43
25H5S52PLCIR		480	208	65A					25XR52
25H5S53PLCIR		480	240	65A					25XR53

1 Up to 8 outlets can be controlled from these panels. No branch circuit should be longer than 150 ft. For more than 8 circuits, contact Schneider Electric Medical Products.

Wiring Diagram and Dimensions





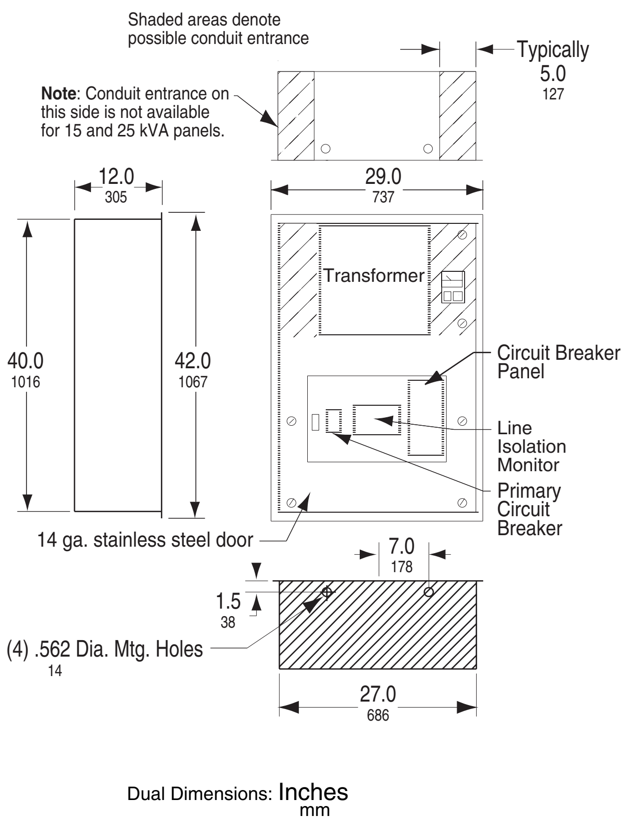
 SQUARE D 04/2008

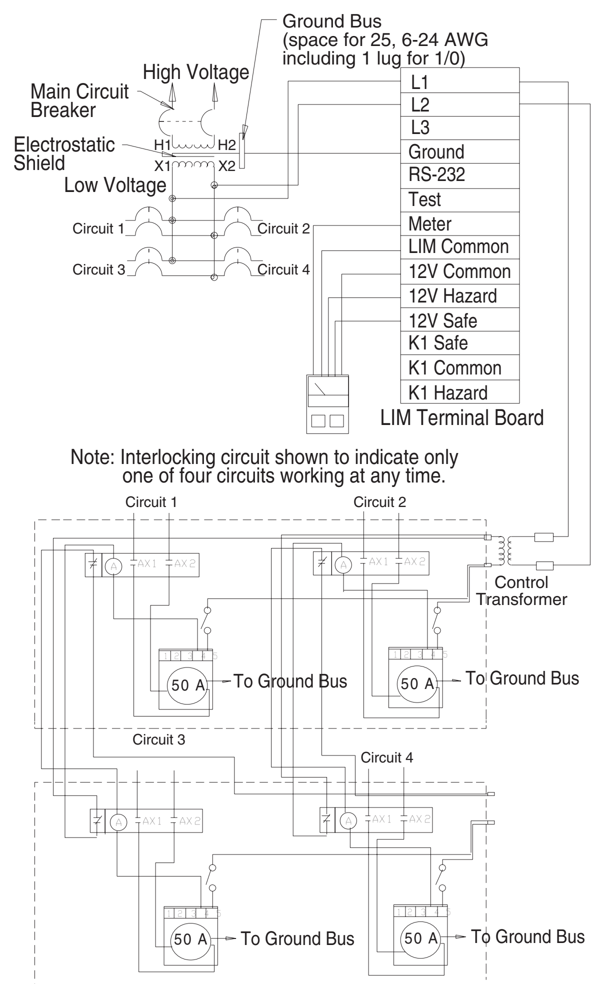
Interposing Contact Controlled Panels[1]

Interior						Trim Catalog Number	Back Box		Transformer Catalog Number
Interior Catalog Number	kVA	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker		Flush Catalog Number	Surface Catalog Number	
15H5S22DDIC	15	208	208	90A	8–20, 30 or 60 A Secondary Circuit Breaker or a combination thereof.	XR29420	53015BB	53019BB	15XR22
15H5S23DDIC		208	240	90A					15XR23
15H5S32DDIC		240	208	90A					15XR32
15H5S33DDIC		240	240	90A					15XR33
15H5S42DDIC		277	208	90A					15XR42
15H5S43DDIC		277	240	90A					15XR43
15H5S52DDIC		480	208	40A					15XR52
15H5S53DDIC		480	240	40A					15XR53
25H5S22DDIC	25	208	208	125A	8–20, 30 or 60 A Secondary Circuit Breaker or a combination thereof.	XR29420	53015BB	53019BB	25XR22
25H5S23DDIC		208	240	125A					25XR23
25H5S32DDIC		240	208	125A					25XR32
25H5S33DDIC		240	240	125A					25XR33
25H5S42DDIC		277	208	125A					25XR42
25H5S43DDIC		277	240	125A					25XR43
25H5S52DDIC		480	208	65A					25XR52
25H5S53DDIC		480	240	65A					25XR53

[1] Up to 4 outlets can be controlled from these panels. No branch circuit should be longer than 150 ft. For more than 4 circuits, contact Schneider Electric Medical Products.

Wiring Diagram and Dimensions





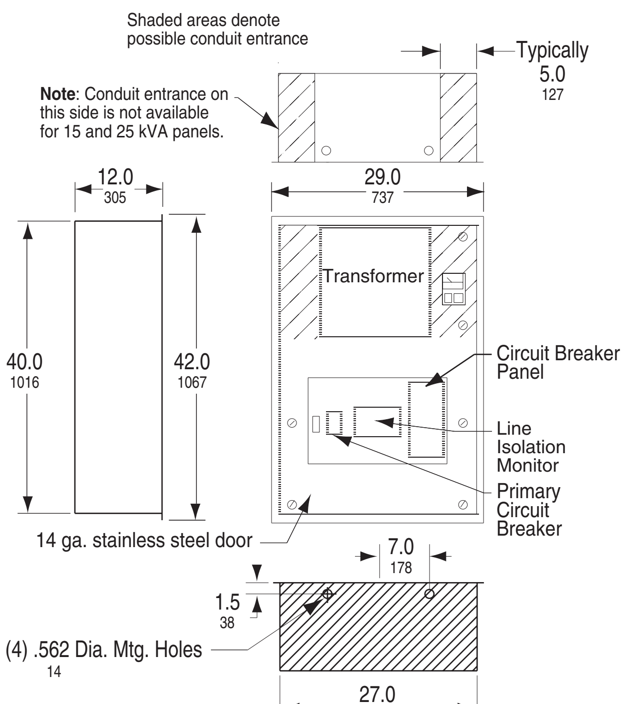
Contactor Controlled Panels[1]

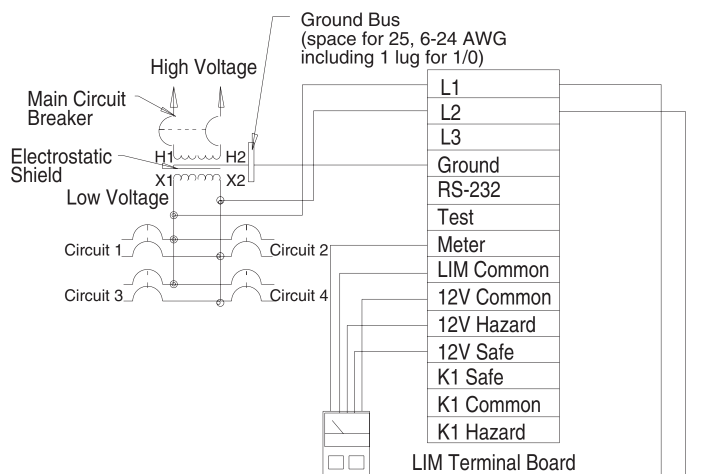
Interior						Trim Catalog Number	Back Box		Transformer Catalog Number
Interior Catalog Number	kVA	Primary Voltage	Secondary Voltage	Primary Circuit Breaker	Secondary Circuit Breaker [2]		Flush Catalog Number	Surface Catalog Number	
15H5S22DDCI	15	208	208	90A	8–20, 30 or 60 A Secondary Circuit Breaker or a combination thereof.	XR29420	53015BB	53019BB	15XR22
15H5S23DDCI		208	240	90A					15XR23
15H5S32DDCI		240	208	90A					15XR32
15H5S33DDCI		240	240	90A					15XR33
15H5S42DDCI		277	208	90A					15XR42
15H5S43DDCI		277	240	90A					15XR43
15H5S52DDCI		480	208	40A					15XR52
15H5S53DDCI		480	240	40A					15XR53
25H5S22DDCI	25	208	208	125A	8–20, 30 or 60 A Secondary Circuit Breaker or a combination thereof.	XR29420	53015BB	53019BB	25XR22
25H5S23DDCI		208	240	125A					25XR23
25H5S32DDCI		240	208	125A					25XR32
25H5S33DDCI		240	240	125A					25XR33
25H5S42DDCI		277	208	125A					25XR42
25H5S43DDCI		277	240	125A					25XR43
25H5S52DDCI		480	208	65A					25XR52
25H5S53DDCI		480	240	65A					25XR53

1 Up to 8 outlets can be controlled from these panels. No branch circuit should be longer than 150 ft. For more than 8 circuits, contact Schneider Electric Medical Products.

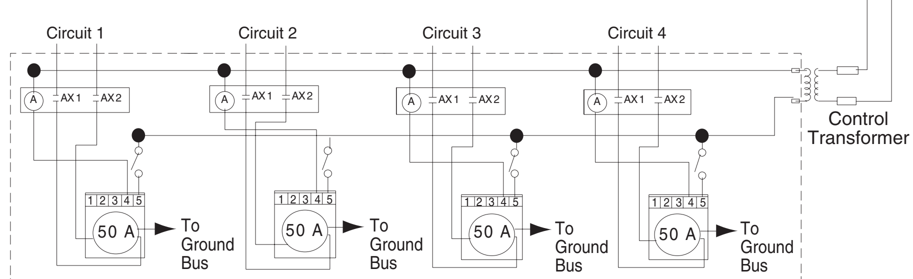
2 Any secondary circuit breaker can be used. Contact Schneider Electric Medical Products for more information.

Wiring Diagram and Dimensions





Typical of 4 Circuits



Dual Dimensions: Inches
mm

 SQUARE D 04/2008

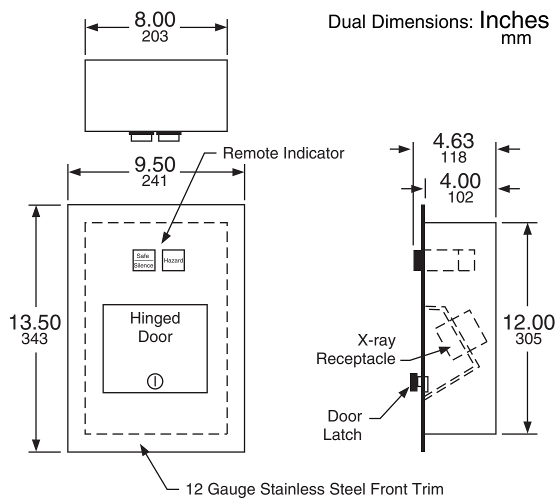
Combination X-Ray Receptacle (XRIAI–XRIADI Series) With Indicator Module

XRIAI

This unit contains a 60 A, 240 V single-phase approved X-ray receptacle plus a remote alarm indicator (described on page 54).

NOTE: Mount unit at least 48 in. above finished floor.

Dimensions



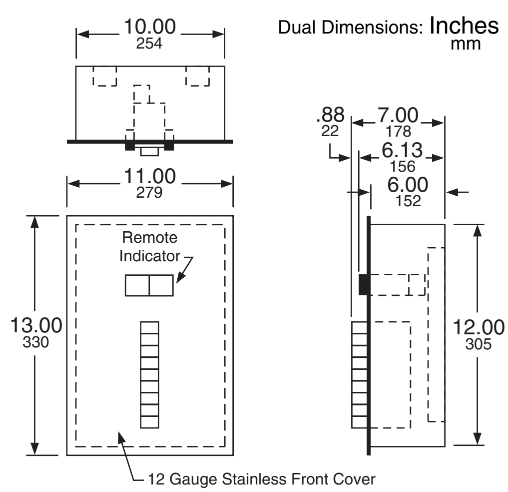
Supervisory Module For Mechanical Interlock Panel (8CIIAI)

8CIIAI

This unit is a remote push button station for control of power to a portable X-ray receptacle.

NOTE: When ordering the 8CIIAI, modify the x-ray panel interior number by changing the second ‘D’ to ‘N’. For example, change 15H5S22DDI to 15H5S22DNI. See the table on page 39.

Dimensions



Remote Alarm Indicators

Panel-Mounted Indicators

Panel-mounted indicator alarms are designed for use with Square D brand isolated power panels. The alarms indicate the condition of the LIM. Available as optional accessories, these alarms include various combinations of indicating lights (green = safe, yellow = silence, red = hazard), audible alarms, and milliammeters. They are furnished with stainless steel trim plates. Mounting space is provided within each Square D brand isolated power panel for easy installation.

RA1PM

RA1PM (Panel Mount)

The RA1 is the newest addition to the remote alarm indicators series. It comes complete with SILENCE, HAZARD, and SAFE indicators, a PUSH-TO-TEST button, and an LED light bar for metering. It is selectable for either 5mA or 2mA. The RA1PM model consists of the RA1 remote alarm indicator and a stainless steel mounting bracket (RA1PMB).

ORICA

ORICA

The ORICA model is complete with green, yellow, and red indicating lights. It is mounted on a stainless steel trim plate, and includes an audible alarm.

ORICAC and ORICA5C

ORICA5C

Both of these models are furnished with green, yellow, and red indicator lights, plus a milliammeter. The ORICAC has a 2 mA milliammeter, while the ORICA5C has a 5 mA milliammeter.

Wall-Mounted Indicators

When the flow to ground is within the predetermined limits for the circuits being monitored, a constant green light remains illuminated. When this predetermined limit is exceeded, the green light goes out, the red indicator illuminates, and an audible signal sounds. Pressing the silencing switch disconnects the audible signal. The yellow indicator illuminates, reminding personnel that the audible signal is disconnected. When the predicted leakage current to ground returns to an acceptable level, the unit automatically resets.

NOTE: Install indicator alarms above the five foot level in each operating room or anesthetizing location. Be sure they are clearly visible to personnel.

RA1WM

RA1WM (Wall Mount)

The RA1WM consists of the RA1 remote alarm indicator and a stainless steel, decorator-style cover plate. Designed to fit virtually anywhere a single-gang wiring device can be mounted, the RA1WM is complete with SILENCE, HAZARD, and SAFE indicators, a push-to-test button, and an LED light bar for metering. It is selectable for either 5mA or 2mA.

IA1C and IA1C-PTT


IA1C

The IA1C is the first in the series of low voltage remote alarm indicators. Designed to fit into a 2-gang, 3 1/2 in. deep (minimum) outlet box, this remote has SAFE/SILENCE and HAZARD indicators. In addition to these features, model IA1C-PTT provides push-to-test functionality.

M5IAI and M5IAI50

Some physicians prefer to monitor the hazard current of the isolated system as devices are energized during surgery. This M5IAI and M5IAI50 remote indicator alarms contain a milliammeter like the one found in the panel, as well as a complete test switch facility. (The RA1 remote is also acceptable for this purpose.)

The M5IAI is the original remote indicator with a meter. It mounts in a 53008BB backbox (ordered separately). The M5IAI50 is a smaller version. It has the same features as the M5IAI, but mounts in a 4-gang, 3 1/2 in. deep (minimum) outlet box. A 2 mA meter is available for either style by changing the “M5” in the catalog number to “MM.”


M5IAI


M5IAI50

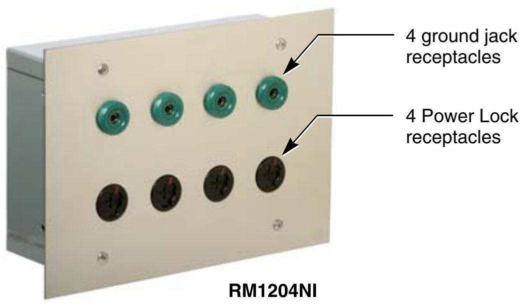
Power/Ground Modules

Power/Ground Modules—120 Series

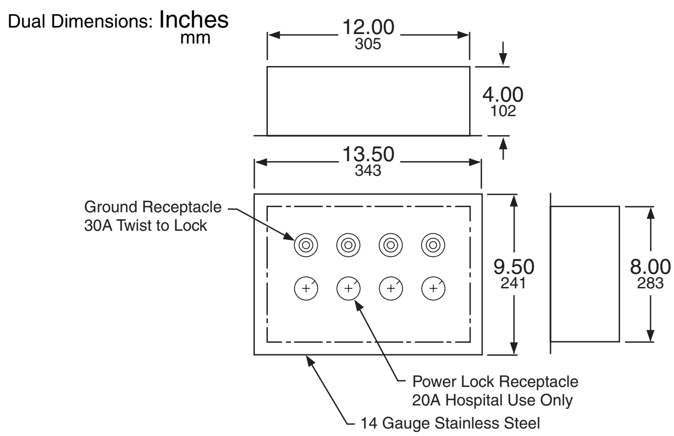
Where room ground extensions and power receptacles are both required, this module offers convenience and saves much labor in field wiring. The unit includes four power receptacles, four twist-to-lock ground jacks, and a ground bus with a generous number of lugs for external ground connections.

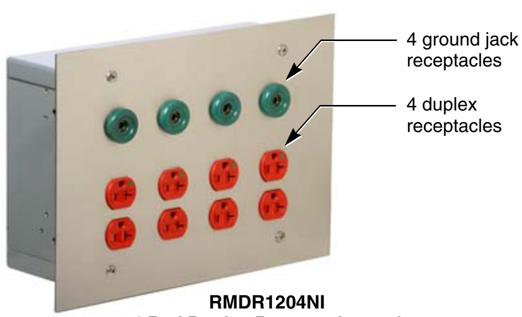
The main ground connection in the module accommodates up to a #1/0 cable. The unit is completely factory wired; only field power connections and ground connections are necessary. The front trim is #304 stainless steel with a #4 brushed finish.

Back boxes for the 120 Series are ordered separately. The size of the back box will depend on the outlet options for the overall device.

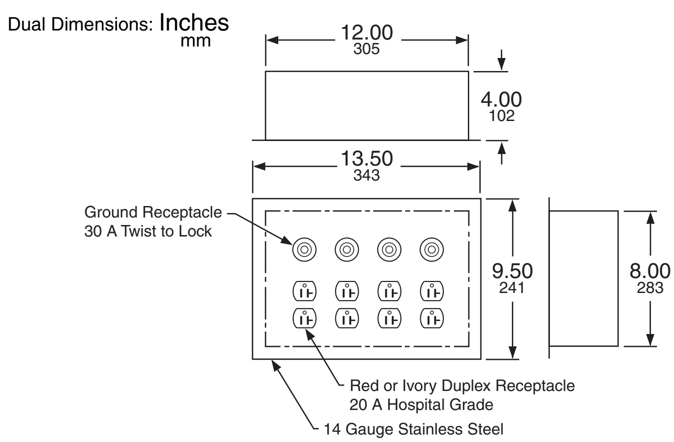


RM1204NI
4 Power Lock Receptacles and 4 Ground Jack Receptacles





RMDR1204NI
4 Red Duplex Receptacles and 4 Ground Jack Receptacles



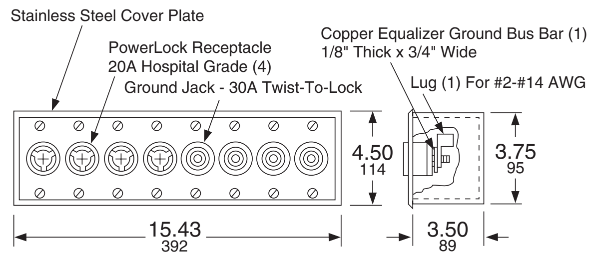
Power/Ground Modules—50 Series (To Fit Gang Boxes

These modules contain both ground jack receptacles and power lock receptacles, but do not contain a ground bar with lugs. A single lug for #2 through #14 AWG wire is included for the incoming ground. These modules use standard electrical gang boxes, therefore back boxes are not included.

These modules can be used where additional ground jack receptacles and power lock receptacles are needed, but where lugs for hard grounding of non-electrical items are not required.

Back boxes for the 50 Series are customer provided. Suggested boxes are gangable outlet boxes.

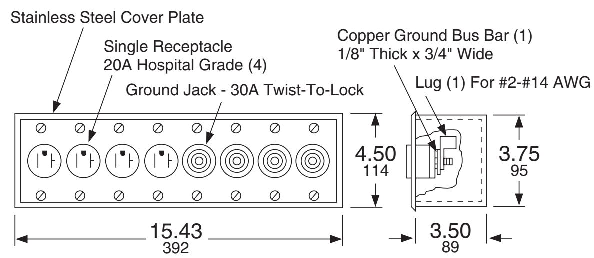
RM504NI
4 Power Lock Receptacles and 4 Ground Jack Receptacles



Note: 8-gang back box not supplied.

Dual Dimensions: Inches
mm

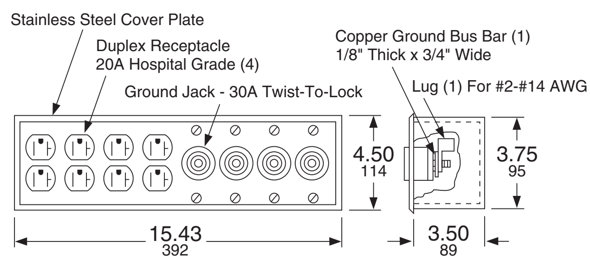
RMSI504NI
4 Ivory Single Receptacles and 4 Ground Jack Receptacles



Note: 8-gang back box not supplied.

Dual Dimensions: Inches
mm

RMDR504NI
4 Red Duplex Receptacles and 4 Ground Jack Receptacles



Note: 8-gang back box not supplied.

Dual Dimensions: Inches
mm

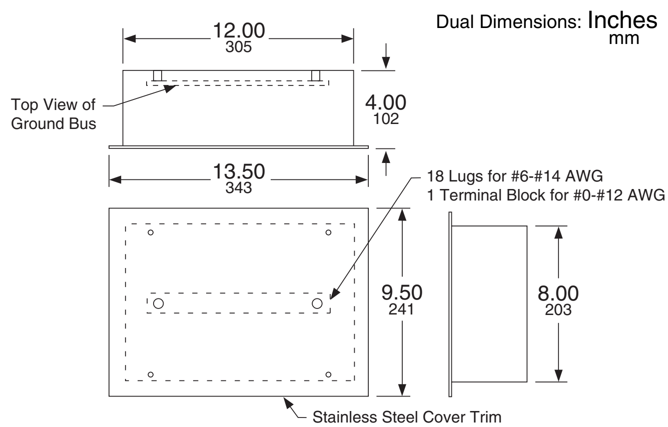
Master Grounding Station Module—120 Series

This unit can be used as a collection point for grounds in a large area such as a coronary care or intensive care ward. Primary application is where the equipment ground bus in the emergency distribution panel is not conveniently located or cannot accept the large number of connections, which may be required for the area.

This unit can connect to that point by a single conductor. However, it can be located in a more convenient location. The unit contains a bus bar with 18 lugs for field connections and has a Type #304 brushed stainless steel cover plate.

Back boxes for the 120 Series are ordered separately. The size of the back box will depend on the outlet options for the overall device.

GS1200I



 04/2008

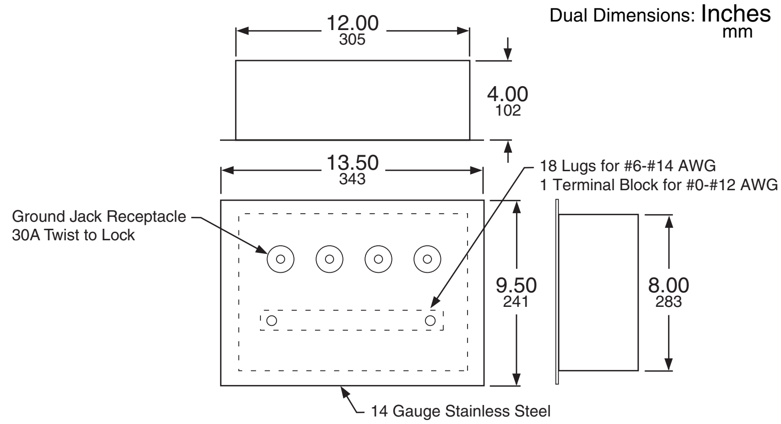
Ground Modules—120 and 50 Series

Ideal for room ground bus extensions to make ground connections in large operating rooms convenient. These units contain four ground jack receptacles and a ground bus. They are furnished with Type #304 brushed stainless trim.

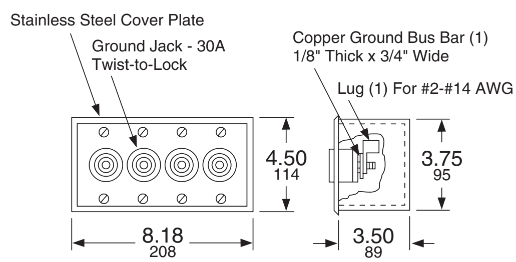
Back boxes for the 120 Series are ordered separately. The size of the back box will depend on the outlet options for the overall device. Back boxes for the 50 Series are customer provided. Suggested boxes are gangable outlet boxes.

GS1204NI

Dual Dimensions: Inches / mm



GS504NI

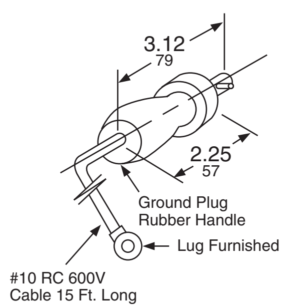


Note: 4-gang back box not supplied.

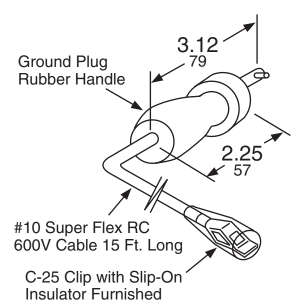
Ground Cord Assemblies

Schneider Electric offers various types of ground cord assemblies. The cord is an extra flexible #10 copper conductor with a green neoprene jacket. The cord's overall diameter is 5/16 in. The cords are designed to withstand hard usage. The cord is crimped to both the conductor and the insulation, providing maximum strain relief. The plug has a large rubber handle.

P753N



P751N



P753N

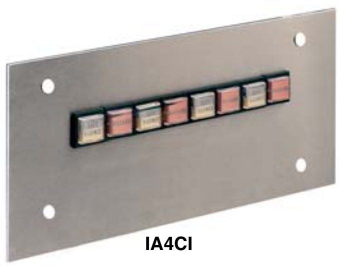
Dual Dimensions: Inches / mm

 SQUARE D

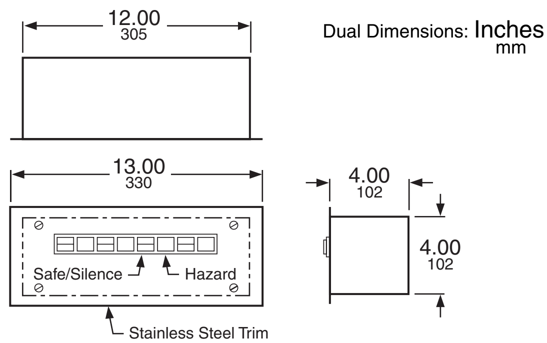
Remote Annunciator Panels

Annunciator Panel for 1 to 4 Circuits

Square D brand remote indicator alarms are available in an annunciator panel for monitoring from a single central location. Codes require an indicator alarm in each operating room. Many hospitals feel it necessary to monitor each operating room at a central location. These combined annunciator panel units meet this need.



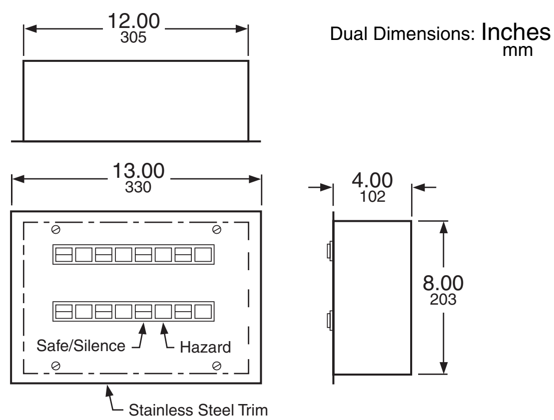
IA4CI



Annunciator Panel for 5 to 8 Circuits

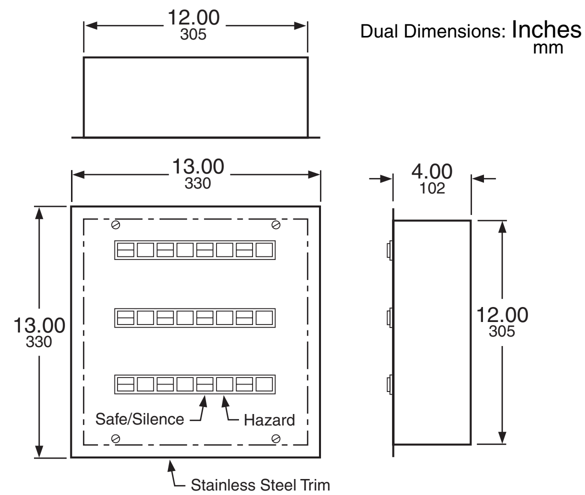
This unit is available either surface or flush-mounted for use with a total quantity of 5 to 8 circuits.

IA8CI



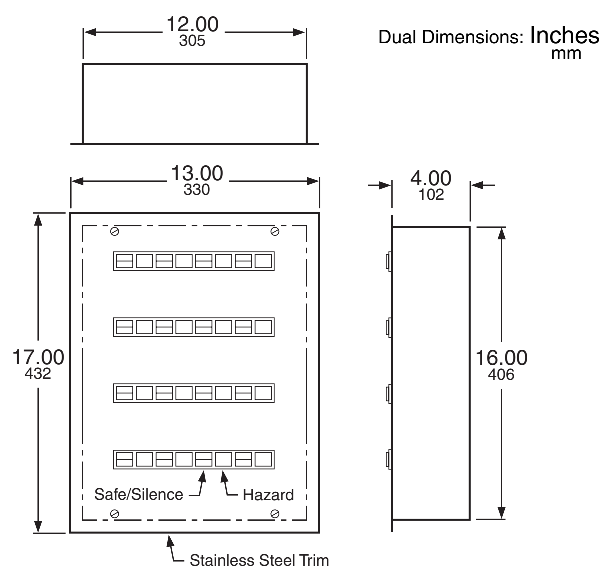
Annunciator Panel for 9 to 12 Circuits

This unit is available either surface or flush-mounted for use with a total quantity of 9 to 12 circuits.



Annunciator Panel for 13 to 16 Circuits

This unit is available either surface or flush-mounted for use with a total quantity of 13 to 16 circuits. If you need annunciator panels with a greater number of circuits, contact your local Schneider Electric representative for dimensions and cost.



The Iso-Gard LIM has the following capabilities:

- Operating voltages of 85 through 265 Vac.
- Hazard current alarm levels of 2.0 or 5.0 mA.
- Operation at either 50 or 60 Hz.
- Operation either as a single-phase or three-phase unit.

With this selection of capabilities, the Iso-Gard LIM can meet the requirement of any application. External features of the Iso-Gard LIM include:

- Easily readable and understandable faceplate with a smooth surface for cleaning ease and pleasing appearance.
- Both analog and digital hazard current indication.
- Unique audible tone to avoid confusion with other equipment sounds in the operating room.

Iso-Gard® Line Isolation Monitor (LIM)

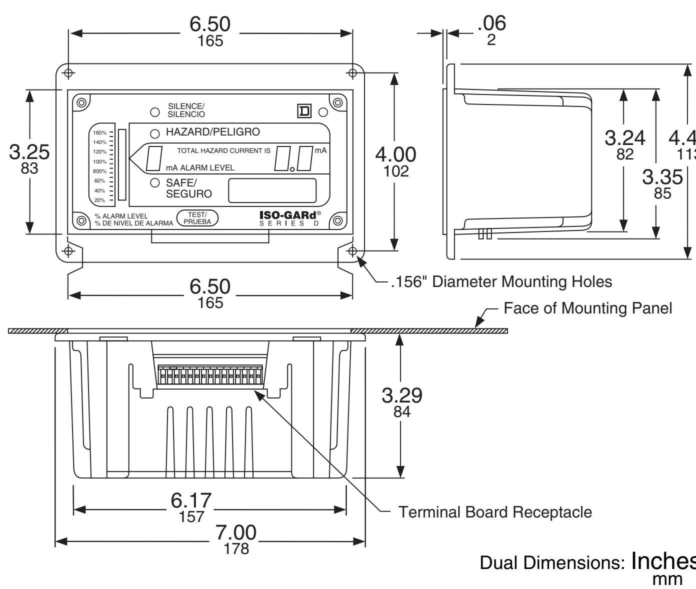
The Iso-Gard LIM is a distinct fifth-generation line isolation monitor. It uses microprocessor technology to improve the performance, versatility, and reliability of this unit over **any** previous LIMs. This monitor is included as a standard component of all Square D brand hospital isolation panels. The Iso-Gard LIM can also be purchased separately and installed as a replacement for any outdated line isolation monitor.

The Iso-Gard LIM exhibits a 50 µA monitor hazard current and an alarm band width of zero enabling the unit to sound an alarm at 5.0 mA of hazard current. This is significantly better than the other brands on the market which sound between 4.75 and 5.0 mA. The Iso-Gard LIM also self tests and self calibrates once every 65 minutes eliminating the need to manually test the unit periodically.

The Iso-Gard LIM, with its microprocessor-based technology, is impervious to all types of electrical noise interference found in hospital operating rooms. At the same time, the Iso-Gard LIM uses an advanced methodology to monitor hazard current without interfering with other sensitive patient monitoring equipment.

The unit has an extra set of normally opened and closed dry contacts for use with other external alarm systems. The Square D brand remote alarms for the Iso-Gard LIM operate at 12 Vac and do not add any additional hazard current to the isolated power system being monitored. The unit can also drive external analog meters as found in many remote alarm units such as the Square D brand remote alarm with ammeter.

The Iso-Gard LIM is component recognized by UL under UL1022 Standards for Line Isolation Monitors. The unit is compatible with all hospital isolation transformers and hospital isolation systems. The Iso-Gard LIM is manufactured in the United States by Schneider Electric.



Digital Clocks, Timers, and Accessories

MCT Series

Schneider Electric offers a line of digital clocks and elapsed time indicators uniquely adaptable to the hospital environment. The timepieces are designed for areas requiring rapid and precise time measurements. They are compact, solid state, and easily readable from 30 ft away. They operate in either the 12- or 24-hour time mode, depending on how the hospital wishes to use them. Since they are digital, they instantly reset, which eliminates annoying time delays for mechanical resets.

The elapsed time indicators can interface with a patient monitor, code blue alarm, or other equipment. An optional rechargeable battery pack can be purchased to prevent loss of time information during a power interruption. See page 66.

The MCT series of clocks/timers is designed for component mounting in various pieces of equipment such as modular walls, consoles, surgical facility panels, or building walls. This series is packaged in a durable flush mounting phenolic case. See Schneider Electric brochure No. 4890BR9201 for more complete information and specifications.

Accessory Control Panels

These control panels give hospitals the flexibility to mount digital time devices in a desired location. The MCT4RC control panel comes self-contained in a flush mounting back box with stainless steel trim. Both the MCT4RC and the MCTCT control units include a 15-foot wiring harness for connection to the clock/timer.

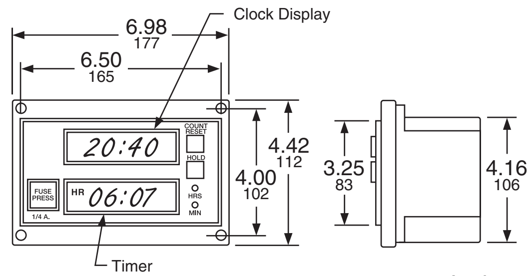
Description	Catalog Number	Dimensions (in.)				
		Trim		Backbox		
		H	W	H	W	D
Dual Display Clock/Timer[1]						
Clock/Timer with separate displays	MCT12B	4.25	11	8	12	4
Stainless steel trim plate	MCTS95135	9.5	13.5	—	—	—
Backbox to be used with MCT95135	53007BB	—	—	8	12	4
Remote control unit (optional)	MCTCT	4.5	4.5	—	—	—
Rechargeable battery pack (optional)	MCTBP	—	—	—	—	—
Surgical Chronometer						
Clock and three timers	MCT14B	16.5	13.5	15	12	4
Backbox	53006BB	—	—	15	12	4
Auxiliary control	MCT4RC	13.5	5.5	12	4	4
Backbox	53008BB	—	—	12	4	4

1 MCTS-95135 trim and 53007BB backbox must be ordered when installing clock/timers in building walls

Dual Display Clock/Timer (MCT12B)

This dual display timepiece is designed for surgical or patient care areas where simultaneous clock/timer displays are needed. The upper display is a time clock and the lower display is an elapsed timer. Controls for both displays are on the face of the unit. The displays can also be remotely controlled by the MCTCT remote control panel.

MCT12B



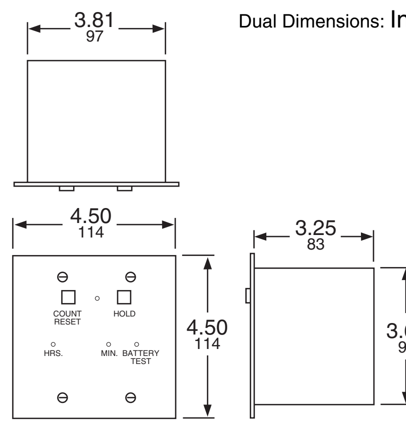
Dual Dimensions: Inches / mm

Control Panel (MCTCT)

Designed to operate with the MCT12B digital clock (see above). This control panel contains a set of controls for the timer and two push buttons to set the clock time display. Includes the MCTBP battery pack, see page 66.

NOTE: 2-gang back box not supplied.

MCTCT



Dual Dimensions: Inches / mm

Note: 2-gang back box not supplied.

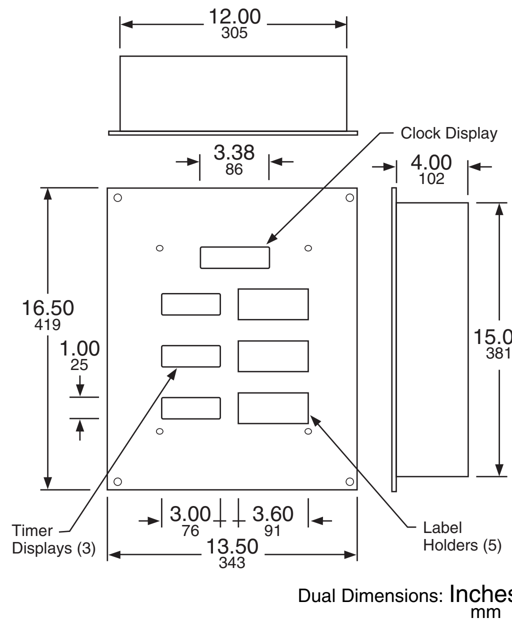
 SQUARE D 04/2008

Surgical Chronometer (MCT14B)

Today's modern surgical techniques require the most up-to-date support equipment. This equipment includes elapsed time indicators for the operating room. Doctors will commonly require simultaneous timing of surgical procedures; the Square D brand surgical chronometer fills this need. This unit has three elapsed-time indicators and one clock integrated into a single, compact enclosure. The MCT4RC remote control panel can be mounted in a location selected for accessibility.

MCT14B (Front View)

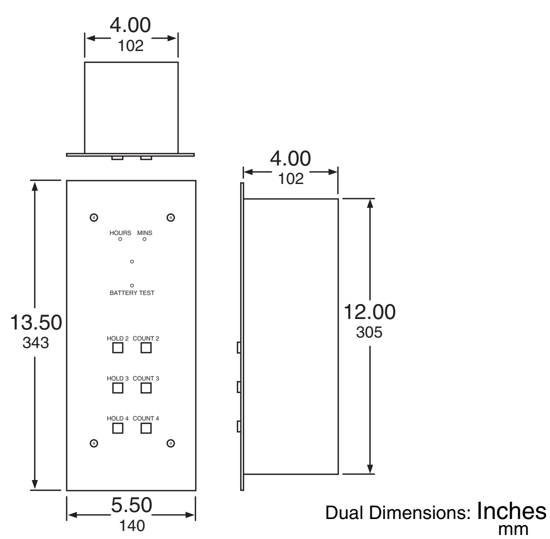
MCT14B (Bottom View)



Control Panel (MCT4RC)

Designed to operate with the MCT14B surgical chronometer. This panel arrangement consists of three groups of timer controls and one group of push buttons to set the time for the 12/24 hour clock. Includes the MCTBP battery pack, see page 66.

MCT4RC



Accessory Equipment

Battery Pack (MCTBP)

This optional battery pack is designed for use in conjunction with the model MCT12B digital clock. It powers the “memory mode,” which prevents loss of time information on the digital clocks during a power interruption. The batteries are rechargeable, which eliminates the need to replace dead batteries.

Trim Plate (MCTS95135) and Back Box (53007BB)

These accessories, when ordered with the MCT12B digital clock, allow the timepiece to be wall-mounted. The MCTS95135 is a stainless steel trim panel with holes and studs for mounting the digital clock. 53007BB is the standard Square D brand back box (4 in. by 8 in. by 12 in.) for mounting the stainless steel trim.

Schneider Electric USA

1010 Airpark Center Drive
Nashville, TN 37217 USA
1-888-Square D
1-888-778-2733
www.us.SquareD.com

4800CT9801R4/08
Replaces 4800CT9801 dated 02/1998

04/2008