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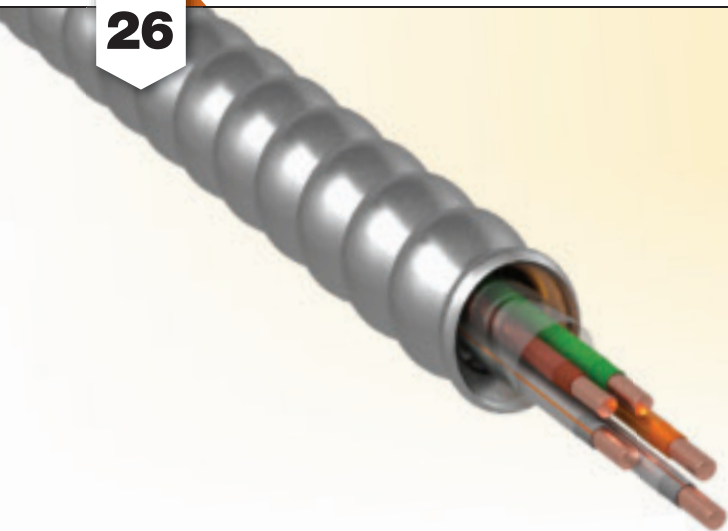


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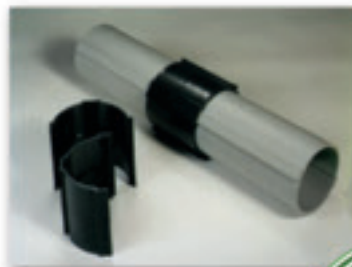


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# Upgrading Legacy Backup Power Systems with a Modern High Efficiency UPS

A WHITE PAPER BY MITSUBISHI ELECTRIC



## INTRODUCTION

There is a growing trend in the UPS industry to create a highly efficient, more lightweight and smaller UPS system. Data centers across the world are constantly searching for new ways to maximize reliable UPS power while minimizing the UPS and associated equipment footprint. In addition, operating costs for large data centers always will be a priority.

In applications that require a smaller capacity UPS (less than 200 kW), true on-line double conversion transformerless UPS systems have emerged as the topology of choice since the early 2000's. In larger applications, most legacy UPS systems consisted of a UPS with a transformer, or multiple smaller UPS power modules paralleled together to achieve the required capacity. Most UPS manufacturers were finding it difficult to create a true on-line double conversion transformerless UPS system larger than 200 kW due to factors such as ground faults, high frequency noise and efficiency.

Transformerless UPS systems utilize Insulated Gate Bipolar Transistor (IGBT) for all power conversion processes (AC/DC converter, DC/DC chopper and the DC/AC inverter). IGBTs are much faster than the traditional thyristor and can be controlled by simply toggling an on/off gate signal using a digital signal processor and a field programmable gate array as opposed to waiting for a zero crossing. When the gate signal is removed,

the IGBT turns off. The combination creates a series of pulses to re-shape existing voltages (conversion from AC to DC and from DC back to AC).

As with any switching power electronic, the device itself has power losses. For the IGBT, the two primary losses are the conduction losses and the switching losses. Since the IGBTs are being turned on and turned off much faster, the switching losses will increase creating a less efficient system. This is a challenge most manufacturers were unable to overcome in larger capacity UPS systems up until just a few years ago.

For this reason, many UPS manufacturers remained using thyristors as opposed to IGBTs in the converter section of the UPS (rectifier section) for many years. Although there are many benefits in using IGBTs in the converter section, a decrease in efficiency prevented them from being a preferred option for most in larger UPS kW rated systems (above 200 kW) for quite some time. In the UPS inverter, the benefits of the IGBT switching speed have far outweighed the decrease in efficiency.

It is important to note that a transformer serves many purposes in the UPS system. Even if the UPS utilizes IGBTs for switching, a transformer would still have a purpose. Other technologies such as the IGBT switching controls and fault detection still need to be considered.

This paper will discuss the new technologies used in transformerless UPS systems and the advances in the Mitsubishi 9900 series UPS systems.

## Background

Before the advances in UPS controls and the benefits of the IGBT in the converter and inverter

(CONTINUED ON PAGE 8)



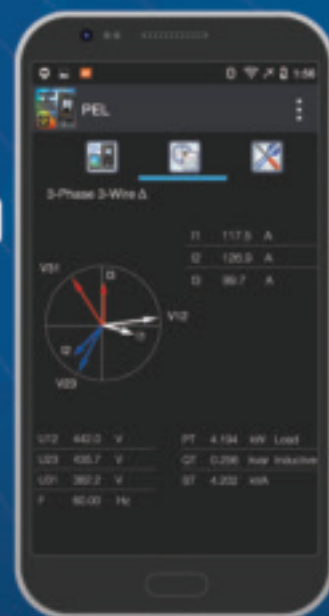
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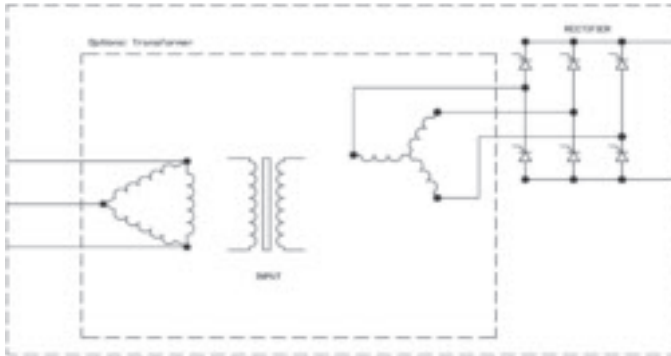


Figure 1: 6 pulse rectifier with optional transformer

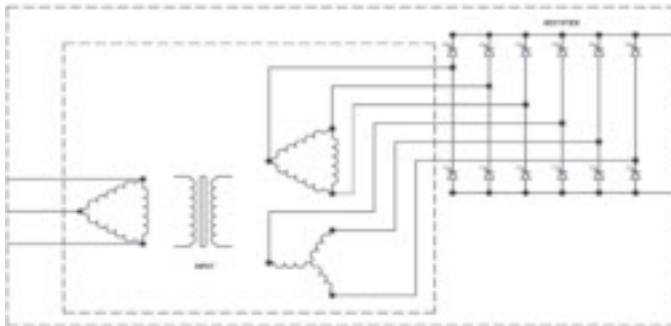


Figure 2: 12 pulse rectifier with optional transformer

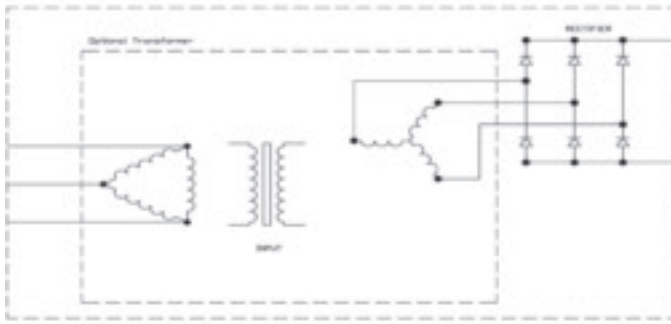


Figure 3: Diode Bridge rectifier with optional transformer

can start to be appreciated, the primary and secondary purposes of the transformer in traditional UPS systems must first be discussed.

#### CONVERTER SECTION:

The main purpose of the converter section of the UPS is to convert the AC utility power to DC power. The most popular power electronics used for this process are the Diode (6 pulse), the thyristor (SCR 6 pulse and SCR 12 pulse) and the IGBT. Until recently, the 6 pulse and the 12 pulse SCR rectifier had been the most popular.

As shown in figure 2, the 12 pulse SCR rectifier uses an isolation transformer in combination with two 6 pulse SCR rectifiers (figure 1 shows a 6 pulse SCR rectifier). The 30 degree phase shift provided by the transformer is the main purpose of the isolation transformer. The two 6 pulse SCR rectifiers will alternate to create twice as many pulses. The 12 pulse SCR rectifier will produce fewer harmonics than the single 6 pulse SCR rectifier allowing for a smaller harmonic filter.

The diode bridge converter (figure 3) is similar to the 6 pulse SCR rectifier, except the diodes are natural commutation (natural on and natural off). The benefits of the diode bridge are better efficiencies and lower harmonics compared to a traditional SCR rectifier.

Every rectifier, regardless of the technology or power electronics used, will produce harmonics. For all technologies but the IGBT (figure 4), these harmonics are greater than desired for most electrical systems, including the backup generator. Therefore, an input filter is required to reduce the harmonics to less than 10% iTHD. As shown in Figure 5, the input filter is comprised of an inductor with a parallel capacitor. The transformer, in this case, helps add inductance to the line to further reduce the harmonics. Figure 6 shows reflected harmonic distortion on input current waveforms from their respective rectifier or converter technology.

Finally, the isolation transformer used in the converter section of the UPS system will provide isolation between the UPS module and the utility. This isolation helps protect against DC ground faults caused by the batteries and will minimize damage to the upstream distribution system due to a separation in the transformer input and output windings.

Although some manufacturers have started using IGBTs in the converter section, most vary in the switching speed of the IGBTs. The benefit of using a slower switching speed for the IGBT converter is a higher efficiency (less switching means less switching losses). In this case, the IGBT converter will still produce larger amounts of harmonics, which will require a lower frequency input harmonic filter (similar to the harmonic filter for the SCR rectifiers).

The problem with lower frequency input harmonic filters on the UPS converter is the leading power factor at small loads. When the UPS system is operating at a reduced load, the ratio of capacitance in the input filter to the load becomes very large and will produce a leading power factor from the UPS. This leading power factor can result in generator compatibility issues. To eliminate these issues, an active input filter (switching harmonic filter capacitors in and out of the circuit depending on the load) will need to be used or the input filter would need to be disconnected both resulting in an increased harmonic content.

#### DIGITALLY CONTROLLED IGBT CONVERTERS:

IGBT converters offer many benefits over SCR type rectifiers if applied correctly (see figure 4). The IGBT converter can switch at speeds in the kilo-hertz range as opposed to the slower SCR rectifier, which fires pulses in the hundreds-hertz range.

The reason the SCR rectifiers can not be switched faster is because the thyristors are turned on by a gate signal, but turned off by natural commutation (zero crossing of the AC input sine wave) or by a snubber circuit. If used properly with a digital signal processor and a Field Programmable Gate Array, the IGBT switching can be controlled to minimize the harmonics normally produced by a converter, thus eliminating the input harmonic filter.

As stated above, the problem exists with the UPS efficiency. If the IGBT converter is turning on and off in the kilo-hertz range, and the IGBT inverter is turning (CONTINUED ON PAGE 12)



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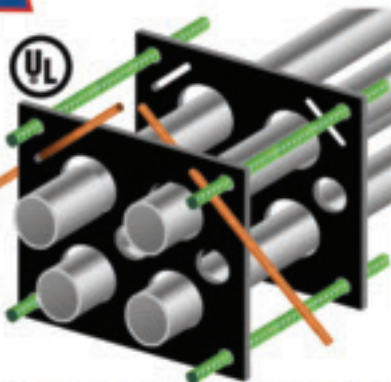
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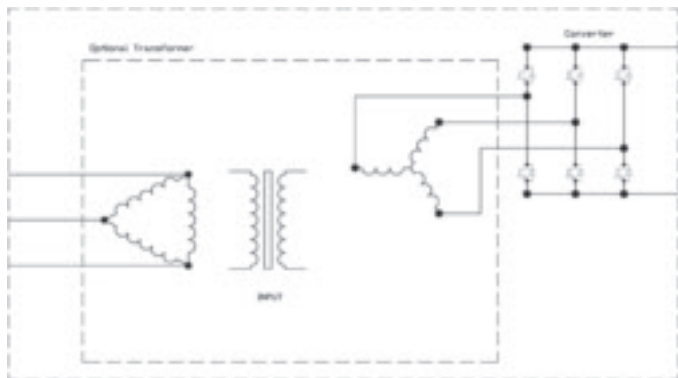


Figure 4: IGBT converter with optional transformer

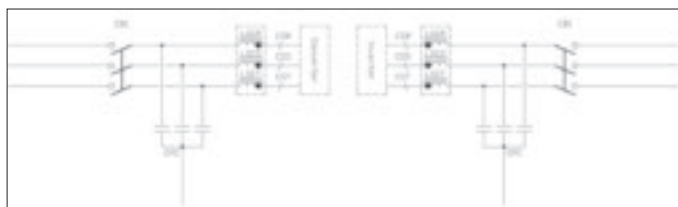


Figure 5: Filters for the rectifier section (left) and inverter section (right)

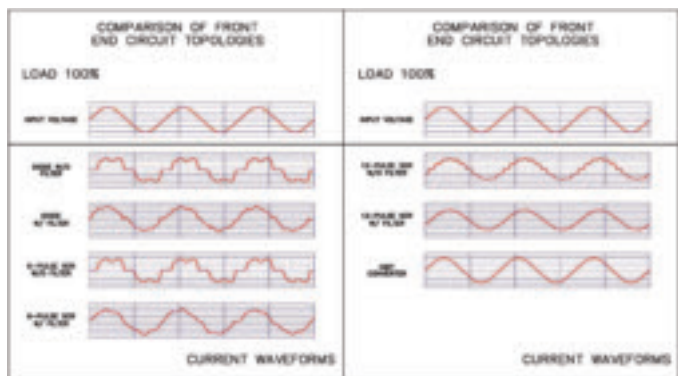


Figure 6: Input current harmonic comparison

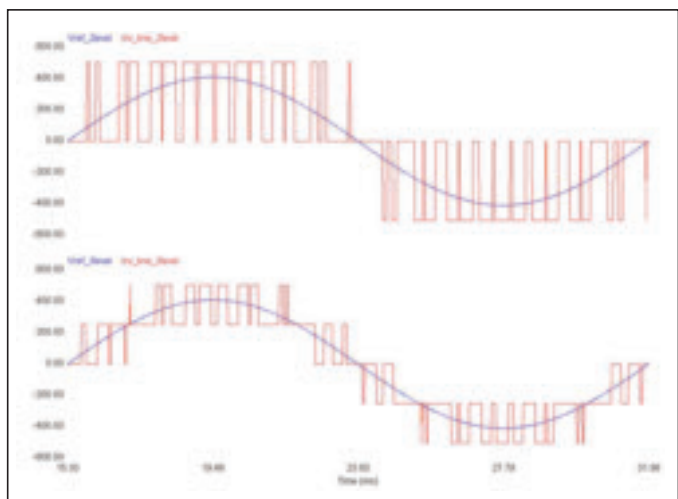


Figure 7: IGBT switching 2-level (top) and 3-level (bottom)

on and off in the kilo-hertz range, the switching losses will quickly add up creating a less efficient UPS.

#### INVERTER SECTION:

Most manufacturers have recognized the importance of using IGBTs in the UPS inverter. The faster switching capabilities of the IGBT, if controlled properly, will result in a less distorted sine wave and will offer better response to various steps in the output loads and improved compatibility with downstream static transfer switches.

The IGBTs are fired in a series of pulses, which are used to invert the DC from the converter (or batteries) into a clean sine wave (refer to figure 7). Since the pulses are not continuous, high frequency noise is generated from the inverter. The high frequency noise and harmonic content on the output side of the UPS is filtered using an output filter and an output isolation transformer.

In addition, the isolation transformer on the output of the UPS provides a means to re-establish a neutral ground bond for the downstream distribution.

#### The Mitsubishi 9900 Series Transformerless UPS Systems

As mentioned earlier, there are many different factors that need to be considered when designing a transformerless UPS system. Ideally, the UPS should be designed with minimal losses throughout the conversion processes (high efficient UPS). This was one of the design goals for the 9900 series UPS. After researching the available power conversion technologies, it was concluded that the three-level topology offered the most benefits while improving the reliability of the system.

The three-level topology reduces the switching losses associated with IGBTs. The result is a more efficient True On-Line Double Conversion UPS system that maintains this higher level of efficiency at loads as low as 10% on the UPS system (reference "The Power of Green: Mitsubishi 9900A Series High Efficiency True On-Line Double Conversion Uninterruptible Power Supply (UPS)").

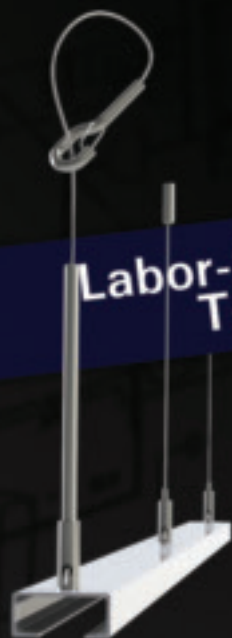
Adding to the efficiency improvements of the 9900 series is the reduction of the filtering requirements. The input current harmonics of the 9900 is controlled to less than 3% at 100% load without the use of a low frequency harmonic filter. Only a small high frequency filter is required for the input of the UPS. Generator compatibility issues due to harmonics and leading power factor are eliminated by reducing the overall input capacitance by eliminating the low frequency harmonic filter.

On the output, since the Three-Level Topology generates pulses that more closely resemble a sine-wave (see figure 7), the output filter is also minimized. The combination creates a highly reliable and efficient True On-Line Double Conversion UPS system. Reducing the size of the UPS filters and eliminating the transformer will also reduce the size and weight of the UPS system and increase the efficiency.

To further enhance the improvements in technology, the 9900 series UPS systems are designed with the newest, most advanced generation of Mitsubishi designed IGBTs. Mitsubishi UPS systems are using fifth and seventh generation IGBTs which offer better efficiencies, improved reliability and a lower gate voltage.

Although these are all great benefits for (CONTINUED ON PAGE 14)





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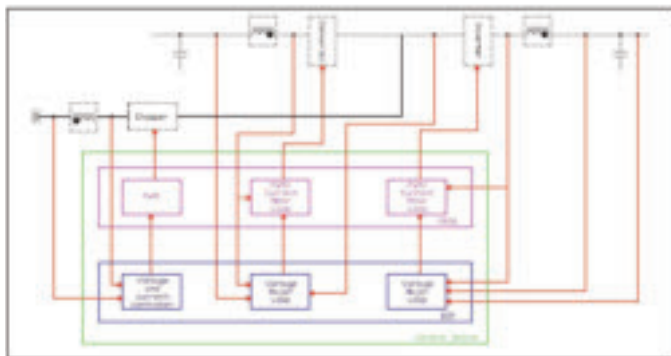
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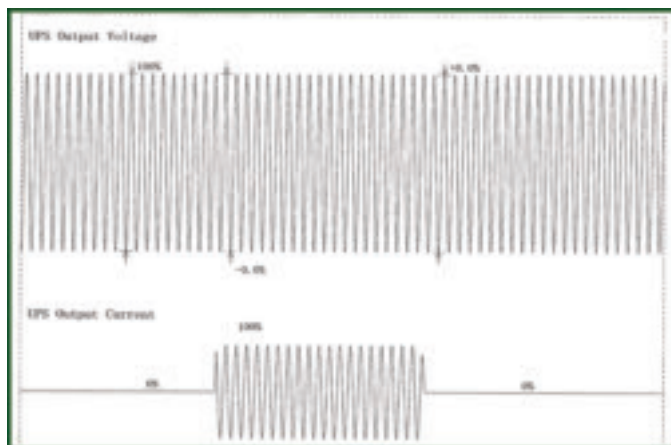
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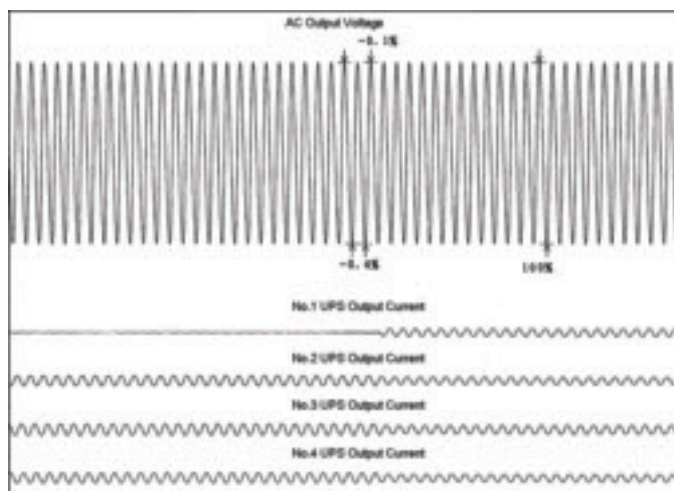
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**Figure 8:** Block diagram of the Mitsubishi Control circuit for a UPS



**Figure 9:** 100% step load on a 9900 series UPS without batteries



**Figure 10:** MMS system with (1) module added to the parallel bus

the customer, the UPS control techniques and the UPS response to different types of faults that can occur must now be considered.

### Control System

Switching the IGBTs faster is of great benefit, but more important are the control techniques used for the gate signal. The Mitsubishi 9900 series UPS utilizes a high speed Digital Signal Processor (DSP), Application Specific Integrated Circuit (ASIC)

and Field Programmable Gate Array (FPGA) for control.

As shown in the block diagram of the control circuit, Figure 8, the 9900 series UPS uses a minor current control loop with a major voltage control loop to provide a precise response to various conditions imposed on the UPS.

Data from the voltage major control loop is collected and evaluated in the digital signal processor (DSP). The field programmable gate array (FPGA) is used to collect information provided by the DSP in addition to comparing the currents from the current minor control loops. Application specific programming in the FPGA processes the information and provides a switching sequence to compensate for the specific scenarios the load presents.

The multiple feedback control loop allows the UPS logic to quickly detect changes in current in addition to detecting deviations to the voltage allowing for more precise control of the IGBT switching. By using the DSP and the FPGA, which have samplings rate greater than 100kHz (1,667 times per cycle), the switching sequence of the IGBTs can be manipulated to provide complete control of the power conversion processes.

In the event a fault occurs (including short circuits) which produces currents exceeding the current limits of the UPS (input or output), the control circuit will immediately stop firing the IGBTs and initiate the opening and closing of the contactors. On the converter section, the input contactor will open and the UPS will operate from the battery source. On the inverter, the UPS will initiate a transfer to bypass to allow the bypass current protection to clear the fault.

With minimal voltage distortion, the UPS will support any currents that do not exceed the limits of the system, including downstream inrush currents. For example, the UPS inverter can support 0% to 100% step loads on the UPS output while maintaining a voltage with less than 2% deviation (See Figure 9). Since the converter section is also controlled using the same logic, the converter can support the same step loads to the input of the inverter. Therefore, the UPS does not require power from the battery system to perform this step load.

### Control in Multi-Module Applications

The 9900 series UPS is capable of multiple module configurations (MMS), up to eight kVA matched units in parallel. For all multi-module 9900 series UPS systems, single modules are used without any changes. The same logic is used in each UPS in the multi-module configuration. For a multi-module system, redundant Cat 5e cables are used to connect the DSP and the FPGA of each UPS together. Therefore, the control logic will be looking at its own minor and major control loops, and also the information from the other UPS control loops, to match the output of each UPS on the critical bus. The result is a multi-module system which can instantaneously share load while maintaining clean, reliable, regulated and uninterrupted voltage on the critical bus (refer to figure 10). Since the 9900 series multi-module configuration is used with individual single module UPS systems, the control logic is completely redundant.

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Line-to-line noise produced by the high frequency switching inside the UPS system is easily filtered (CONTINUED ON PAGE 16)



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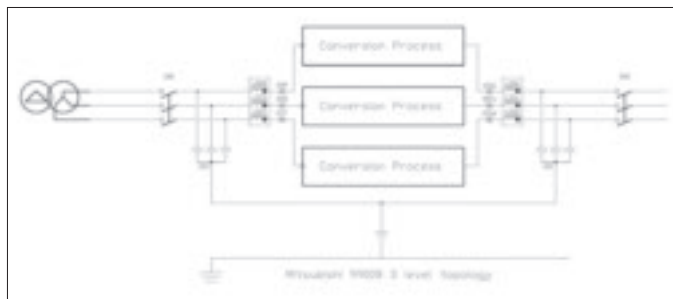


Figure 11: The 9900 series Virtual Neutral

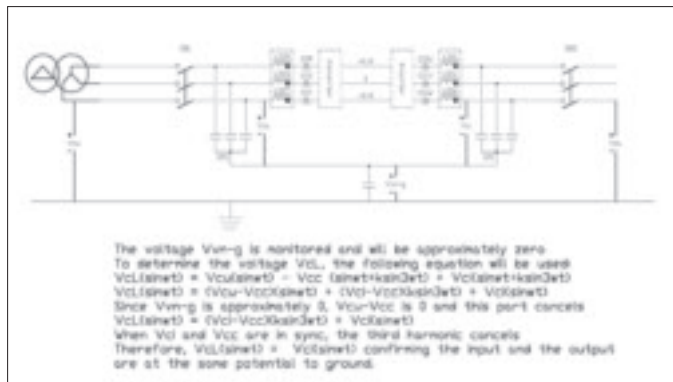


Figure 12: Virtual Neutral with the output voltage to ground reference calculations

using the small input and output filter of the UPS. However, high frequency line-to-neutral components are not suppressed due to an absence of a common connection between the three phases (neutral connection).

To filter these components, the 9900 series UPS uses a virtual neutral as shown in figure 11, which is created by connecting the common point of each of the filter capacitors to a common point. By virtue of this connection, the common mode harmonics are passed through the virtual neutral of the UPS system.

In addition to the input connection, the virtual neutral is also tied to the common point of the output filter, where the common mode harmonics are cancelled by the output of the inverter, as shown in Figure 11. During battery operation, the input contactor for the UPS system (CB1) is opened and the common mode harmonics are eliminated from the equation.

The potential of the Virtual Neutral is derived from the three phases on the input. A capacitor is added between the system ground and the virtual neutral. This capacitor, under normal conditions, will have minimal potential across the terminals and minimal current, as the potential of the virtual neutral and the system ground is the same.

As shown in Figure 12 (including the following calculations), confirmation can be made that the output phase voltage referenced to ground will be the same as the output phase voltage referenced to the virtual neutral. The input common mode harmonics are introduced through the Virtual Neutral, but cancelled by the output common mode harmonics.

## Fault Conditions

The 9900 UPS system is monitoring fault conditions in multi-

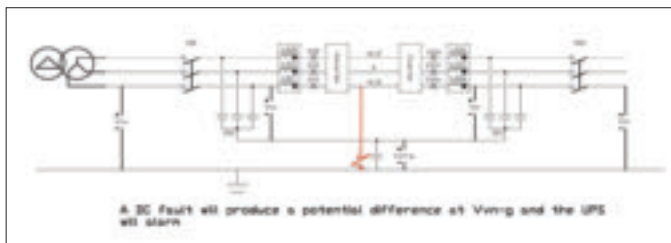


Figure 13: DC Ground Fault

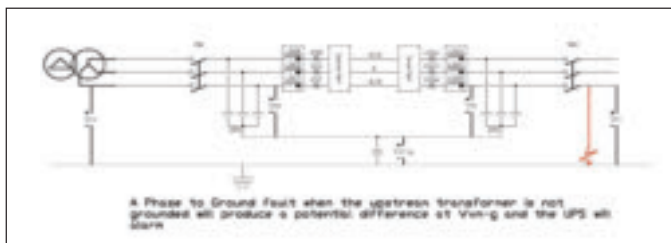


Figure 14: Ungrounded Phase-to-Ground Fault

ple ways (voltage differences, current flow and current limiters) and will detect these faults depending on the installation of the system, the configuration of the distribution system and the conditions of the fault.

As mentioned above, if a fault condition occurs on the output of the UPS which produces a large amount of current, the UPS system current minor loop, current limiter and the FPGA will detect the instantaneous over-current. The PWM will then stop firing the IGBTs in the inverter and transfer the system to bypass so the bypass over-current protection can clear the fault (Figure 16). In addition, during an output short circuit, the output voltage will try to collapse. The voltage major control loop with the DSP along with the FPGA will maintain the voltage at first. If the current from the short circuit extends beyond the capabilities of the inverter logic to maintain proper voltage regulation, the DSP and the major control loop will sense a collapse in the output voltage and the system will detect an instantaneous overload.

The same would apply to a fault on the utility side of the UPS system. The converter logic will sense an immediate drop in voltage and the FPGA will stop firing the IGBTs in the UPS converter going immediately to battery operation.

## DC Ground Fault Conditions:

If a DC Ground fault occurs as in Figure 13, the potential of the system ground will be different than the potential of the Virtual Neutral. This potential difference will be detected by the UPS system and viewed as a safety hazard. The UPS will alarm on a DC Ground Fault condition. The circuit is also being monitored by the chopper circuit logic to detect improper voltages and current levels.

## Ground Fault Detection

As shown in Figure 14, if the utility source for the UPS is not grounded (no neutral-to-ground bond), the presence of a ground fault will present a potential difference between the UPS Virtual Neutral and the system ground. Therefore, the fault will be detected by the UPS.

(CONTINUED ON PAGE 18)



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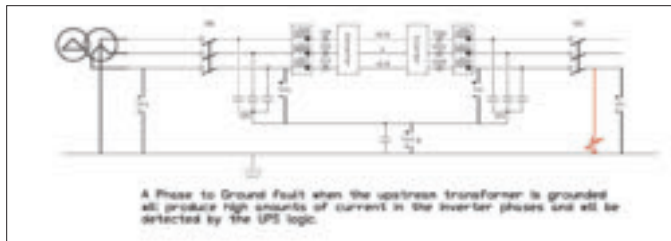


Figure 15: Grounded Phase-to-Ground Faults

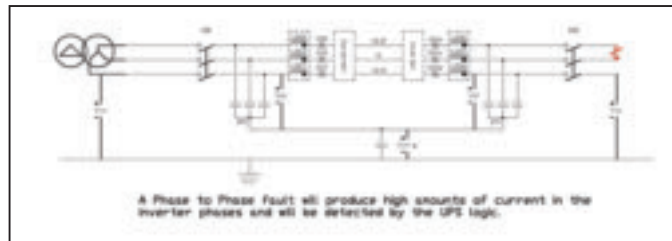


Figure 16: Phase-to-Phase Faults

As shown in Figure 15, if the utility source for the UPS is grounded (neutral-to-ground bond is installed), the presence of a ground fault will result in a second connection to ground and will produce zero sequence currents. These zero sequence currents will be detected by the UPS.

### Summary

The 9900 series UPS is a high efficiency True On-Line Double Conversion transformerless UPS designed specifically for large power applications. It uses an IGBT converter section with advanced control circuitry to eliminate common mode harmonics and leading power factor issues with the upstream generators. The minor and major control loop used with the Digital Signal Processor and the Field Programmable Gate Array for the

IGBT inverter results in precise control of the output voltage for maximum coordination with downstream Power Distribution Units and Static Transfer Switches. The Virtual Neutral allows the UPS logic to monitor all types of faults including system ground faults to offer maximum protection for critical loads.

The result is a UPS which can deliver reliable output power to your critical load with minimal footprint while saving the customer money through an efficiency of greater than 97% at 100% load. The 9900 is available in sizes ranging from 72 kW to 2000 kW (SMS) and up to 12,000 kW (MMS). □

References: "The Power of Green: Mitsubishi 9900A Series High Efficiency True On-Line Double Conversion Uninterruptible Power Supply (UPS)" by Dean Richards and Junichiro Onishi.

Residential application

Commercial application

Commercial Daisy Chain

Residential application

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Residential application

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# Protect Yourself

## Miller Safety Consultants — A Leader in Arc Flash Protection

**VINCE MILLER STARTED MILLER SAFETY CONSULTANTS,** veteran owned business in 1999. The goal of the business was to provide cost effective safety consulting, employee training such as: confined space entry, fall protection, electrical safety and provide sales of electrical shock and flash protective equipment and fall protection equipment to businesses in the Washington DC area.

Reliance Industries provided fall protection products and much of the sales and training was on behalf of the supplier. In 2000, the owner decided to retire from his business, and Vince decided to discontinue the fall protection line of his business and concentrate more in the electrical training and products.

Vince had been a distributor for Certified Insulated Products (CIP), a manufacturer of electrical insulated tools and electrical arc flash clothing manufactured by Otex in Rochester, New York. As a distributor, Vince provided sales through his internet website and much through relationships with electrical contractors. His training was a classroom environment and was provided directly to customers but he also taught as a sub-contractor for other safety consult-

ing companies and the Chesapeake Safety Council in Baltimore, Maryland. In 2005, Vince partnered with Vivid Learning Systems in Cascades, Washington to provide on-line training in safe work practices.

Training in electrical safe work practices is still provided locally in the Washington DC area and as a partner with an electrical engineering firm and online. The training is based on the Occupational Health and Safety Administration (OSHA) standards and the National Fire Protection Association (NFPA) 70E standard.

Miller Safety Consultants is now a distributor for Cementex USA, Burlington, New Jersey, for insulated tools and equipment and clothing from OTEX Protective, Rochester, New York.

The majority of his sales of products

are from the web-based store. Cementex is nationally known for their quality equipment. Otex Protective is becoming more known for their quality clothing. For years, they have manufactured their products under other provider labels. Vince chose to not create his clothing line, but to sell the manufacturer product.

Vince has worked with many electrical company employees to fine-tune the clothing to be more comfortable for the user. Working closely with the manufacturer, they have made slight changes in how the cloth pattern was modified to meet final production. An example is the lightweight 40 Calorie vented hood offered by Otex.

The material is of the latest technology. The vented assembly is constructed for balance on the back of the hardhat and the airflow is 27 CFM to prevent fogging of the face shield and provide cooling to the worker. It took over a year to develop the product with the user prior to having the hood "flash tested". This product is now standard issue with many electrical contractors.

Being a small business and having quality providers has resulted in satisfied customers for Miller Safety Consultants. Being a direct supplier for OTEX Protective, another small business means customized customer needs can be met. □

*For more information, visit  
Miller Safety Consultants at:  
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# Generator InterLock Technologies, LLC

**GENERATOR INTERLOCK TECHNOLOGIES, LLC**, is a small-based company that manufacturers and sells its products across the country. The company was founded after Hurricane Isabel hit the east coast in 2003. The product was developed to meet the need for a safe way to use portable generators to power homes in the event of power loss.

The initial inspiration for the product came from a persistent friend of an electrician working for Master Electrical Services. As electrical contractors, they had seen various unsafe and illegal methods that people had used to try to power their houses with their portable genera-

tors. The electrician set out to develop a product that would meet National Electrical Code requirements and at the same time be cost effective and convenient for the homeowner. From that original inspiration came a new company: Generator Interlock Technologies or GIT.

The Interlock Kit is a simple safety product that locks out the Main breaker in the existing home panel and allows for the portable generator to power the home through a back feed generator breaker. While many electrical inspectors liked the product; they all agreed that the product would have to be listed to UL standards. After thousands of dollars in fees, rigorous tests, a year of changes and modifications, the Interlock Kit was finally approved for production to be used with panels listed under UL Standard 67.

The company started filling orders in early 2005, using Master Electrical Services as its basis for customer awareness. Starting with a few kits that fit the most recent Square-D and Cutler Hammer panels, the offerings grew to over 30 different models in less than one year. Generator Interlock Technologies now has kits for panels from 30 years ago to the most current and they continue to add new kits to meet their customer's

needs. While contractors in Florida and the North East are the biggest customers, Interlock Kits have been sent throughout the United States and parts of Canada. Whether the power loss is due to costal hurricanes or from crippling ice storms in the northern , GIT has a kit that will allow customers to keep the power on in their homes.

The Interlock Kits are designed to be installed by licensed electricians and are cost effective for both the customer and the installer. Other products on the market such as generator sub-panels and transfer switches require extensive rewiring of the home panel, often taking the electrical contractor 6 to 8 hours to install. With the Interlock Kit, a qualified electrician can install a complete system in 2 hours or less by simply mounting the correct kit to the face of the panel and wiring a generator convenience outlet to a breaker installed in the panel.

To use their portable generator, a homeowner plugs an extension cord from their generator to the new generator convenience outlet. He then starts the generator, turns off the main breaker, slides the Interlock Kit, turns on the generator breaker and selects the circuits for use up to the capacity of the generator.

Generator Interlock Technologies' Kit is a defining safety product that has been recognized as a Innovation Award Winner by *Electrical Contracting Products* magazine and one of the Top Products by *Electrical Products and Solutions* magazine.

Generator Interlock Technologies, LLC, has taken a problem of safety and convenience and developed a system to keep danger and expenses to a minimum. Starting with an idea of helping a friend in need, to helping thousands across the country, GIT continues to grow due to its commitment to deliver a quality product. Visit [www.interlockkit.com](http://www.interlockkit.com) for a complete list of products and details. □



**With the Interlock Kit, a qualified electrician can install a complete system in 2 hours or less by simply mounting the correct kit to the face of the panel and wiring a generator convenience outlet to a breaker installed in the panel.**



# INTERLOCKKIT

A Generator InterLock Technologies Product



## Generator InterLock Technologies

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# Gardner Bender Portable Cyclone® Powered Conduit Bender

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It is compatible with most pipe threaders on the market. The Portable Cyclone® is designed with portability in mind. Weighing in at just 35 lbs (about 53 lbs with a pipe threader attached), this bender is easy to carry around on a jobsite or up and down stairs. Reduce the risk of injury by removing the need to bend larger sizes of conduit using a hand bender or lugging around heavy equipment and conduit. Make work more efficient by saving time on the jobsite.

Performing precise bends with repeatability has never been this quick and easy, especially for early stage apprentices. It takes the guess work out of bending to specific angles and gives you the correct bend every time. This is great for larger jobs that require many bends. Doing continuous bends with a traditional hand bender or mechanical bender would typically become tiring over time and make it more difficult to consistently bend to the correct angle. But using the Portable Cyclone® eliminates this problem. It saves time on the job site and is more efficient than using a hand bender. It can make a 90° bend in as little as 10 seconds.

It is especially handy for doing specialty bends like offsets and saddles quickly. There are markings on the bending shoe to help do these bends easily.

The markings include deduct arrows, rim notches, and back of 90° bend stars similar to what's seen on a hand bender. Additionally, the Portable Cyclone® has a bend radius to NEC requirements.

Setup is easy; just use the lever adjustment on the back of the bender to

adjust the level of the conduit, attach the threader to the bender, and you can begin bending. The bender can be positioned in either the vertical orientation or placed on its side to bend in the horizontal orientation. The 3/4" threaded legs can also be removed to create a longer stand when it is placed on its side. The bender is not only compatible with the Gardner Bender Power Driver, but also many common 11-R and 12-R threaders on the market.

The Portable Cyclone® is the perfect replacement for large and clunky mechanical benders that take up more room in a service van or truck. Because there is only one shoe for all sizes there are no additional spare parts to carry around and keep track of. It is small and lightweight, making it easy to move around. Rather than having to run bent conduit through a jobsite, easily take the Portable Cyclone® to bend in any location.

All this is available at a competitive price versus similar benders on the market. The Portable Cyclone® is first option for bending 1/2" to 1" conduit that doesn't break your back or wallet! □





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# Eliminating Shared Neutrals to Increase Efficiency and Safety

BY PETER LAFRENIERE, PRODUCT MANAGER

## THE DEMANDS WE PUT ON ELECTRICITY

have grown over the past decade. Critical business functions are becoming more reliant on continuously supplied electrical power and technological advances have only heightened this. To address technician safety and industry demand, there have been modifications and changes made to the National Electrical Code (NEC) regulations. As a result, it can be tricky to navigate the changing regulations that ensure that the circuits supplying critical loads are safe, stable, and efficient. This article will address the cost effective, NEC compliant options for branch circuit wiring for a variety of power distribution systems.

### What is a multiwire branch circuit?

A multiwire branch circuit is a branch circuit with a shared neutral. This means there are two or more ungrounded (hot) phase or system conductors with a voltage between them and a shared neutral.

Multiwire branch circuits are used in offices, hospitals, hotels, high-rise residential buildings, or similar facilities for a variety of power distribution systems including lighting, devices, and receptacles.

### What are the requirements for multiwire branch circuits?

The National Electrical Code (NEC) mandates the simultaneous disconnect of multiwire branch circuits that supply electricity to more than one device on the same circuit. To be more specific, NEC® 210.4(B) Disconnecting Means states, “Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates.”

To put it simply, the “simultaneous disconnection rule” means that all circuit conductors, on a multiwire branch circuit, regardless of whether they are

being worked, must be disconnected when work is performed on them. As a consequence, there is the inconvenience of disrupted service in unaffected areas supplied by associated branch circuits.

### The purpose of simultaneous disconnects

Multiwire branch circuits can be dangerous when all the ungrounded circuit conductors are not de-energized and the equipment supplied from a multiwire circuit is being worked on. Electricians run the risk of electrocution and injury while working on the equipment supplied by a multiwire branch circuit. The circuit can still be energized while work is being conducted or the proper protocol might not have been followed to disconnect the system. Simultaneous disconnects reduce the risk and takes the guess work out of ensuring safe conditions for maintenance.

Over the past decade, however, the electrical industry has been moving away from multiwire branch circuits to avoid the indiscriminate disconnection of power. It is simply not feasible for certain business operations to have an outage necessary for safe maintenance. For instance, consider the case of dis-

necting power within a centralized location in a hospital and the power to lights at patients’ beds goes out across the facility. Service cannot be interrupted for circuits supplying critical loads.

As an alternative, the use of individual branch circuits with dedicated neutrals for each ungrounded circuit conductor ensures that each circuit can be independently disconnected. A failure in one circuit will not adversely affect another.

### How?

An option is to install a neutral for each ungrounded branch circuit conductor. Once this is done, the branch circuit is no longer “multiwire” and simultaneous disconnection is not required. By replacing a home run cable, a neutral per phase Type MC cable eliminates shared neutrals and allows electrical systems to continue to operate while repair or maintenance is performed on one circuit without affecting other branch circuits within the cable. A dedicated neutral for each phase conductor allows electricians to have greater flexibility in their work because only the affected single-phase breaker will trip. Additional benefits include:

### Improved Safety

Safety is at the forefront of the NEC’s requirements on simultaneous disconnects. The risk of injury and shock is high for electricians servicing equipment when neutral wires may still be energized even after the proper lockout/tagout procedures have been implemented or when they mistakenly think both phase and neutral are shut off.

While there are various modifications that electricians can make to avoid the hazards of shared (CONTINUED ON PAGE 8)





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neutrals, including training and warning signs on electric panels, neutral per phase cables will substantially reduce this risk.

### Easy to Use

Because only the affected single-phase breaker will trip, neutral per phase Type MC cables not only decrease the time it takes electricians to identify and trace a faulty circuit, but also reduce the length of unnecessary outages. The benefit to this is two-fold. Building operators can have confidence that their facilities will continue to function with reduced risk of outages while maintenance is being performed, and electricians increase their efficiency and reduce labor charges.

### Reduced Cost

Neutral per phase cables offer both installation time savings and maintenance time savings. Instead of running two separate circuits, technicians are now required to only run one multiple circuit cable—and terminate, fit, and

secure one cable versus two.

Certain manufacturers offer neutral per phase cables made out of aluminum armor. Aluminum armor offers its own advantages by being lighter weight than steel, the material more commonly found in cables. Technicians can more easily move and position the lighter weight aluminum cables, increasing their efficiency on the job. Aluminum is also inherently RoHS compliant. RoHS, the Restriction of Hazardous Substances, also known as Directive 2002/95/EC, originated in the European Union and restricts the use of specific hazardous materials found in electrical and electronic products.

### Reduced Harmonic Distortions

Neutral per phase Type MC cables are also ideal for applications where harmonic distortion is a concern due to shared neutrals. Prime examples are computers, variable frequency drives, electrical test equipment, and office equipment. Branch circuit wiring to computers and

other electronic equipment may present additive harmonic currents from nonlinear switching loads.

When a current builds up on the neutral, the neutral can overheat. The additional current will cause the problem to be compounded when multiple circuits are connected to the shared neutral and buildup will occur. This buildup damages the conductor, which will have adverse effects on equipment, degrade the quality of the power, and ultimately require replacement.

Neutral per phase cables can mitigate this harmonic distortion by reducing currents in the neutral conductor.

Regardless of whether your installation uses multiwire branch circuits or neutral per phase, care must be taken to avoid risks and on-the-job injuries. Consider the cost-benefit of labor and supplies. Ensure you're following code and complying with industry regulations. Consult a manufacturer for the best recommendation that suits your needs. □

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# Megger Raises \$17,800 for Phoenix Children's Hospital Foundation

19th annual Megger Distributor Golf Outing also Supports HopeKids of Arizona and 4 Paws for Ability

**M**EGGER held its 19th annual Distributor Golf Outing on Saturday, January 25, raising \$19,600. \$17,800 was donated to Phoenix Children's Hospital Foundation; \$1,000 went to HopeKids of Arizona, an organization that provides ongoing events, activities and a powerful, unique support community for families who have a child with cancer or some other life-threatening medical condition; and \$800 was donated to 4 Paws for Ability, an organization that provides service dogs for children with disabilities worldwide.

This year's event was held once again at Ahwatukee Country Club in Phoenix, Arizona. "It was a fantastic day in the Phoenix sun with 145 golfers, six of which were kids from HopeKids, all out to support important organizations and families," said David Danner, director of USA distribution for Megger, founder and co-coordinator of the event.

"We always look forward to hosting this event each year. It is great to see the children and their families having a fun day, as well as the amount of support for the event year after year. We are so appreciative that Megger helps us give back to a community that provides hope and healing to those who need it the most," said Mike Palmer, co-coordinator of the event and Western regional sales manager of US Distribution, Megger.

## Working Together to Make a Difference

Each year this philanthropic event is hosted by not only Megger's US distribution team, but also by authorized distributors, customers, employees, as well as doctors, nurses and representatives from Phoenix Children's Hospital. This year, in addition to the \$10,000 Megger donated, \$3,420 was raised in the 50/50 raffle, with winner Aaron Tanquary giv-



Pictured left to right: Francisco Aguiar, vice president finance, North America, Megger; Graeme Thomson, vice president, Americas distribution, Megger; Tyler Danner, daughter of David Danner; David Danner, director US distribution sales, Megger; Diane Meehl, Phoenix Children's Hospital representative

Photo credit: Gwendolyn Hanlon, Radia LLC, [www.radiaphotography.com](http://www.radiaphotography.com)

ing back his portion of the prize. Otis Elevator also made a generous monetary donation to the event. Generous company and individual donations helped raise the \$19,600 that was donated.

Several other items and prizes for raffles were donated by various organizations, including Chandler Harley Davidson, who offered a chance to win a 2020 Harley Davidson Street Glide valued at close to \$30K if a hole in one was made at the 12th hole. The bike and Chandler Harley Davidson staff were at the hole, plus they provided several Harley Davidson items for raffles. Electrical Contractor magazine supplied tool bags, backpacks, and thermal lunch bags; T'Equipment supplied cart stickers; Transcat donated golf towels; Mitchell

Instrument supplied pin flags; Megger's office in Germany donated an electric scooter; Hob Knob, a sports bar in Chandler, donated cases of water, snacks, as well as a generous monetary donation; and My Popcorn Kitchen donated a popcorn tin.

"Raffle winners included Mariel Aguilar who won a golf bag; Mark Shoemaker who won the Razor scooter and John Rubalcaba who was the winner of the popcorn tin. Alan Goggin of Megger Dover UK received an award for longest distance traveled to participate in this wonderful event," said Danner.

This year's event winners include:

First place went to Jim Cooke, Andy Augustyniak, Andrew Augustyniak and Jamie Braley. □



# RedBird LED

## **NEW** High Output Stripit Kit®



**17,000 to 34,000 Lumens**  
**Made-in-USA**      **BAA Compliant**  
**190 lumens/Watt**   **DLC Premium**  
**10 year warranty**   **100,000 hour life**

## **Best Linear High Bay Retrofit**



Patents Pending Design embeds LED board in aluminum extrusion. Exceptional thermal management, mechanical toughness, flexible mounting options

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Model #	Description	Lumens
S4-1-95W-50K	1-4' Strip, 95 Watts	17,000
S4-2-190W-50K	2-4' Strips, 190 Watts	34,000

## **LightFair Booth 7099**

As the RedBird says,  
"Our Stripit Kits® are  
**OUT OF THIS WORLD**"



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4020 Steve Reynolds Blvd, Duluth, GA 30093

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# Mobile Desk Wins Altec Consistency Award

**SO PROUD OF OUR TEAM** to have won the Altec Consistency Award, it was a total shock and surprise! We always try to do the best job we can, but it's nice to be recognized by one of our best partners. **Thank you, Altec!**

*Mobile Desk / Mobile Office Solutions has been manufacturing innovative Mobile Office Solutions for over 20 years.*

*Our unique product line includes Medical Laptop Carts, Computers on Wheels, Work Stations on Wheels, Tough Desk Laptop Mounts and Laptop Desks, Console-X Truck Consoles, Truck Organizers and Screen Out Laptop Screen Blanking Technologies.*

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**Doug Mayer**

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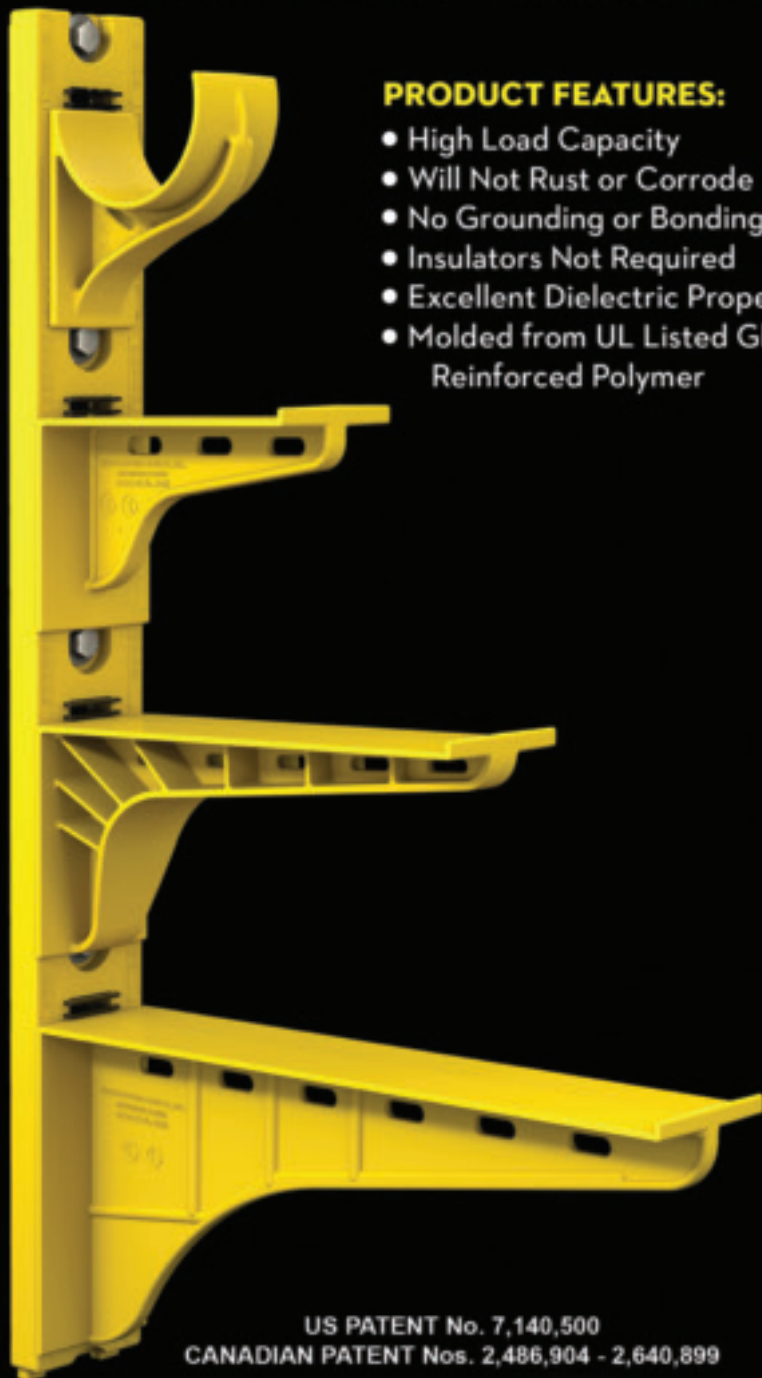

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# The Heavy Duty Nonmetallic CABLE RACK



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- Insulators Not Required
- Excellent Dielectric Properties
- Molded from UL Listed Glass Reinforced Polymer



HDL Arm Lock shown with  
RA04 Arm and CR36-B Stanchion



3HDS - 3" throat saddle shown with  
a cable secured by cable ties.



RA08 - 8" arm shown with three  
cables secured by cable ties.

US PATENT No. 7,140,500  
CANADIAN PATENT Nos. 2,486,904 - 2,640,899

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INCORPORATED



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Website: [www.udevices.com](http://www.udevices.com)

## Condux Tesmec Introduces New Electric Puller

Condux Tesmec, Inc. recently introduced a new all-electric puller. The new Condux Tesmec PE1250 all-electric puller is the industry exclusive. With an electric motor, the PE1250 eliminates the need for hydraulic components such as hydraulic motors, pump and valves, and requires no oil. The unit's silent operation makes it ideal for almost any location, while the electric power system generates zero emissions.

The PE1250 delivers a maximum pull force of 11,240 lbf (50 kN) and offers an advanced user interface and remote control.



### PERFORMANCE

- Max pull 11,240 lbf (50 kN)
- Speed at max pull 33 ft/min (10 m/min)
- Max speed 230 ft/min (70 m/min)
- Pull at max speed 1,124 lbf (5 kN)
- Free wheel max speed 230 ft/min (70 m/min)

### CHARACTERISTICS

- Bull-wheel diameter 12 in (300 mm)
- Max rope diameter 1/2 in (13 mm)
- Weight (without rope) 5,181 lbs (2,350 kg)
- Number of grooves 8
- Suitable for 1 rope

*Note: the basic machine performance is calculated at 68°F (20°C) and at sea level.*

**For more information, visit  
[conduxtesmec.com](http://conduxtesmec.com)**

## DEWALT® Announces POWER DETECT™ Technology

*Maximizing performance with high-capacity XR® Batteries*

DEWALT announces POWER DETECT™ Technology included exclusively on four new 20V MAX\* XR® Brushless Tools. These include a 7-1/4-In. Circular Saw (DCS574), Reciprocating Saw (DCS368), 5-In. Angle Grinder (DCG415), and Hammer Drill (DCD998).

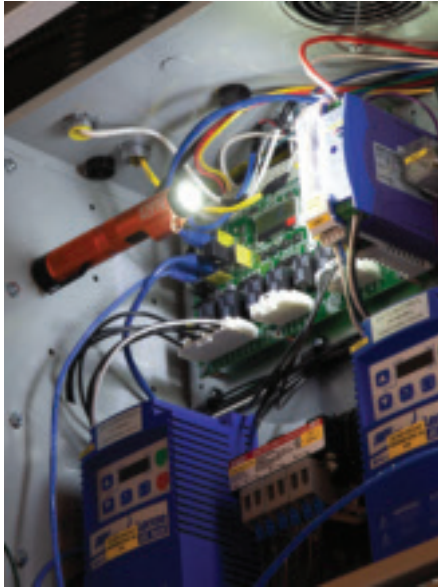
Newly developed electronics in tools with POWER DETECT™ Technology can identify the battery the tool is paired with and adjust power output accordingly. This is ideal for commercial contractor applications where premium power, performance, runtime, and productivity are required. The new tools also feature upgraded motors and components compared to their predecessors and durable housings. This combined with battery pack identification included in POWER DETECT™ Technology, provide premium capability for the professional user and continue the expansion of the cordless jobsite.

In addition to updates offered within the tools themselves, they are also paired (in kitted units only) with the newly available 20V MAX\* 8.0Ah battery (DCB208). Tools with POWER DETECT™ Technology add to the over 200 20V MAX\* products offered by DEWALT that help users reach the goal of a cordless jobsite, providing a wide variety of solutions for professional applications.



**For more information, visit  
[www.DEWALT.com](http://www.DEWALT.com)**





- Strong magnetic end cap for hands-free use
- 12-hour all day runtime on low of 125 lumens
- 6-hour runtime on high of 350 lumens
- Battery gauge notifies when the battery is low
- Rechargeable via included micro-USB cord
- Removable pocket clip with an integrated lanyard hole
- 10-foot (3 m) drop test rating and is IP54 water & dust resistant



"This flashlight was designed to give users a light that is bright, long lasting, easily adjustable, and improves communication across any jobsite," says Klein Tools' senior product manager Laura Ranieri. "The flashlight features a built-in class IIIa laser making it easy to pinpoint objects at a distance when communicating to supervisors, inspectors, etc. It offers a strong magnetic end cap for hands free use, and has a 12-hour runtime, meaning trade professionals can count on it to last through an entire day of work without needing a charge. Additionally, the focusable bezel lets users concentrate the light where they need it most."

**For more information, visit  
[www.kleintools.com](http://www.kleintools.com)**

## Klein Tools'® New Rechargeable Focus Flashlight with Laser Solves Multiple Jobsite Problems

Klein Tools, for professionals since 1857, introduces the Rechargeable Focus Flashlight with Laser, a durable and rechargeable LED flashlight with onboard Class IIIa laser and a battery that lasts all day.

Rechargeable Focus Flashlight with Laser (Cat. No. 56040)

- Equipped with a Class IIIa red laser to pinpoint out-of-reach objects
- Twist focus bezel concentrates the light beam where it's needed

## 4 Reasons Why Building Pros Love **Light All**

**Experience** - *Light All* is a suite of expert services and custom solutions from TCP, longtime designers and manufacturers of top-awarded LED lighting and fixtures.

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TCP reserves the right to change, modify or cancel these programs at any time with or without notice. All pricing is valid in the US only through December 31, 2020 at a TCP certified electrical distributor. Please contact TCP for full details.

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## Lind Equipment's All-In-One Beacon LED Tower Wins Two Innovative Product Awards

The All-In-One Beacon LED Tower by Lind Equipment won two innovation awards in two separate industries in its first month on the market. Rental Equipment Register (RER) magazine announced the All-In-One Beacon LED Tower as a winner of the Innovative Product Award in the light tower category. Soon after that, the All-In-One achieved its second victory from the World of Concrete, winning the Experts Choice Most Innovative Product Award.

An All-In-One Beacon LED Tower alleviates the need to own three separate lighting assets and combines them all into a single, compact unit. Both innovation awards celebrate this paradigm changing design of the light tower. The All-In-One works as a generator powered light tower, a diffused no-glare light tower and an electric powered light tower – all in one.

The rental market's innovative product award recognizes how this tower can be rented out for more applications than any other tower light in existence. Instead of owning a generator light tower, a small indoor electric tower and a balloon light: you can now own one unit that works in multiple applications. Equipment rental companies' return on investment will triple with a tower that can be rented out throughout the year. Similarly, the construction market is amazed with the All-In-One Beacon LED Tower as a heavy-duty, full-brightness light tower that has the ability to also be a diffused no-glare light tower. If a job requires half diffused light and half full-brightness light, the All-In-One can do just that with the adjustable and movable no-glare diffuser frames. The Experts at the World of Concrete recognize this feature as innovative and deemed it as award winning.

"It is truly amazing to see the tower continuously grow and with it achieve all these awards," said Sean Vandoorselear, CEO of Lind Equipment. "The Beacon LED Tower series has received an astonishing seven award wins in a few short years - and we are just getting started."



**For more information, visit  
[www.LindEquipment.net](http://www.LindEquipment.net)**



## SAKOR Technologies Announces Dynamometer Line for Testing Electric Motor Efficiency to Meet International Environmental Standards

*New models can test wide range of motor sizes on a single system*

SAKOR Technologies Inc., a recognized leader in the area of high-performance dynamometer systems, announces that it has developed a series of dynamometer systems ideal for customers required to test and verify the level of efficiency of electric motors in accordance with a variety of national and international standards, including IEC 60034-2-1; IEEE 112B; and Canadian standard C390-93. The SAKOR units can be used test from two to eight pole motors ranging from 10 watts to more than 3 megawatts.

As part of the global effort to reduce the use of fossil fuels and greenhouse gas emissions, regulators are developing energy efficiency standards for the billions of small, medium, and large electric motors used around the world. These regulations specify how to ensure motors are meeting the efficiency standards that have come into effect or are being phased in. First in line for regulation are induction motors; it is likely that permanent magnet motors will be regulated in the coming years, followed later by inverter driven motors.

The new line of SAKOR motor testing dynamometers offers high-accuracy testing for designers and manufacturers of electric motors of any size, for use in applications ranging from large industrial equipment to consumer appliances, including fans, refrigerators, and washing machines. They have been optimized so that individual machines can test the widest possible range of motor sizes and still maintain necessary accuracy tolerances. SAKOR systems meet the standards' tight tolerances and exacting requirements regarding data precision and accuracy.

Capable of precisely measuring motor efficiency, these dynamometers provide an essential tool to engineers seeking to reduce fossil fuel consumption and enhance energy efficiency to meet strict environmental standards and regulations.

"We have worked hard to define this line of systems to give the maximum utility per machine and make it most cost-effective for the customer," said Randal Beattie, president of SAKOR. "By optimizing equipment to test the widest range of motor sizes with one system while staying within required accuracy levels, customers will need to buy the fewest number of machines at the lowest total cost."

**For more information, visit  
[www.sakor.com](http://www.sakor.com)**



## No Housing Needed for Nora Lighting® M2 Mini 2" LED Recessed Downlight

Nora Lighting's discrete M2 Mini LED Downlight installs in new construction or re-modeling applications without requiring a recessed housing, saving time and labor.

With a small 2" aperture, the M2 offers a clean, contemporary appearance, suited for today's residential and commercial applications.

The M2 installs in three steps: cut the ceiling, wire the junction box and insert the luminaire in the ceiling cavity. Quick disconnect cables allow for extended lengths.



IC and air-tight rated, the M2 is offered in a wide selection of downlight or adjustable gimbal trims to complement any interior. These include round and square trims, pinhole, wall wash, baffle and shower (wet) with finishes in matte powder white or black. Field changeable reflectors are also available for downlight models.

The M2 Series delivers up to 600 lumens with 2700K or 3000K at 90+ CRI. The dimmable fixture is ENERGY STAR® certified and can be used to comply with 2016 Title 24 Part 6 high efficacy LED light source requirements.

Nora Lighting has served the lighting industry for more than 30 years and is a recognized leader in the development and introduction of LED products. Nora offers one of the industry's most comprehensive lines of LED luminaires, including: commercial, architectural and residential downlights; track and rail lighting; panels and troffers; MLS (multi-lighting systems); linear and under cabinet lighting; RLM, pendants and cylinders; tape lights; step lights; and emergency/exit signs.

**For more information, visit  
[www.noralighting.com](http://www.noralighting.com)**

A photograph of two grey, weatherproof double gang device covers lying on a snowy surface. The covers are shaped like snow angels, with their arms and legs spread out. The background is a snowy, outdoor setting with small evergreen trees. The text "Corrosion Resistant Weatherproof Double Gang Device Covers Playing in the Snow" is printed at the bottom of the image. Below the image, a dark blue banner contains the text "WHEN LIFE THROWS YOU SNOW... MAKE SNOW ANGELS". To the right of the banner, the text "Topaz's Friendly Tip #26" is visible.

Corrosion Resistant Weatherproof Double Gang Device Covers Playing in the Snow

**WHEN LIFE THROWS YOU SNOW...  
MAKE SNOW ANGELS**

Topaz's Friendly Tip #26

Topaz is not only the easiest company to do business with, but the friendliest too. Our dedicated sales and customer service teams are always on stand-by to offer friendly tips and warm advice for your lighting and electrical fitting needs.

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## A.L.P. Introduces LENA 16™, a Cost-Effective, High Performing, Low Profile Reflector

A.L.P. Lighting Components, a leading global manufacturer of lighting components and kits, has added the LENA 16™ shallow prismatic reflector to the “S Series” of optics. Designed for low-, mid- and high-bay LED fixtures, it offers superior glare control and an elegant aesthetic, combined with the versatility to accommodate a variety of light sources without expensive modifications.

The LENA 16 has a shallow design, optimizing cost without sacrificing high angle brightness control. The 10.36” flat top allows it to be easily adapted and directly attached to many fixtures. The lower flange works with a wide range of bottom lenses and standard clamp bands. The top can be cut to order with an opening of up to 10.66 inches.

Like their HID predecessors, today’s LED low-, mid- and high-bay fixtures should always be installed with optical or refractive control. Without this control, they emit high angle glare, causing a reduction in contrast and negatively affecting color and focus. By reducing high angle glare, LENA 16 improves visual comfort, provides even illumination, and can also increase worker efficiency in some settings. It is suitable for warehouse, industrial, commercial, and retail applications.

LENA 16 is available in Clear Acrylic, Clear Polycarbonate, Interface Acrylic, and Lumieo® Acrylic. It works with a wide range of LexaLite® brand bottom lenses.

A.L.P. is a leading global supplier of lighting components, offering a diverse line of products and services for lighting OEMs and the aftermarket. From LED to legacy applications, A.L.P. offers the industry’s most comprehensive line of LED fixture kits, vapor-proof enclosures, unwired fixture bodies, louvers and reflectors. A.L.P. Brands include Steel Craft, LexaLite®, and Reflek®

**For more information, visit  
[alpadvantage.com](http://alpadvantage.com)**

## Russelectric, A Siemens Business, Offers Customized SCADA Systems

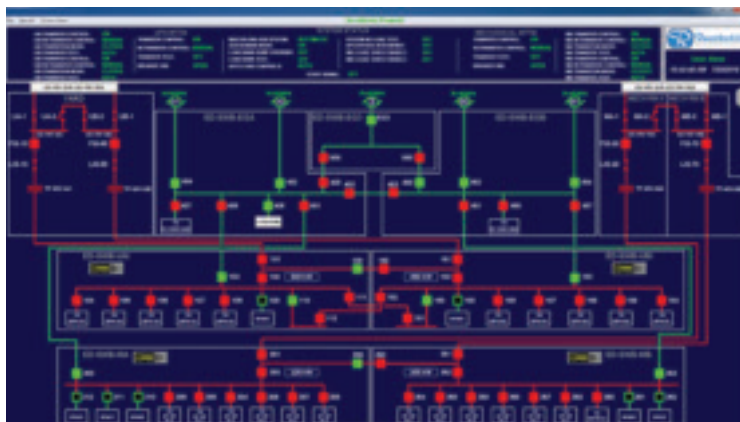
*Enables remote monitoring of all power system functions*

Russelectric, A Siemens Business, a leading manufacturer of power control systems and automatic transfer switches, announces the availability of customized Russelectric® supervisory control and data acquisition (SCADA) systems, enabling users to monitor system operation, acknowledge alarms, and review PLC setpoints and alarm history. All screens are custom-designed for each power control system, providing the most realistic, accurate display possible.

The basic SCADA system includes a dynamic one-line display with changing color codes to indicate real-time power switching device status and power source connection to the loads. Event logging, alarm logging, and help screens are also included.

Optional enhancements are available to provide added functionality. Included are highly detailed graphic displays of the physical arrangement of equipment, control panel close-ups, instrument displays indicating actual values, and the ability to initiate control functions.

Also available is an optional simulation system. Based on SCADA system graphics, the simulation system enables off-line operator training without affecting any operating system parameters.



**For more information, visit  
[www.russelectric.com](http://www.russelectric.com)**



## Klein Tools® Introduces Tone & Probe Test and Trace Kit

Klein Tools, for professionals since 1857, introduces the VDV500-705 Tone & Probe Test and Trace Kit, designed to give users an opening price point solution for simple toning and tracing as well as wire map testing of non-energized wire.

### Tone & Probe Test and Trace Kit (Cat. No. VDV500-705)

- Easy-to-use tone generator traces wire when used with the included probe
- Responsive probe with durable, non-metallic, conductive tip
- Alligator clips for unterminated wires
- RJ45 to RJ45 test cable included
- Toner and probe together perform pin to pin wire map test on RJ45 terminated cables
- Work light on probe tip for use in dark spaces
- Adjustable volume control dial
- Headphone jack for noisy environments (headphones not included)
- Replacement test cables available (Cat. No. VDV770-855)



"In creating this kit, we wanted to provide a simple-to-use device that was also multi-functional," says Karen Alpan, product manager with Klein Tools. "This kit functions not only as a tone generator and wire tracing probe for non-active wire runs, but also performs pin-to-pin wire mapping testing."

**For more information, visit  
[www.kleintools.com](http://www.kleintools.com)**

## KOHLER Extends Fully Integrated Gas-Powered Generator Line

*New 100kW, 125kW models feature powerful and compact KOHLER 6.2-liter V8 engines*

KOHLER is extending its gaseous-powered industrial generator lineup featuring the company's 6.2-liter V8 turbocharged engine with new models at 100kW and 125kW. The generators' turbocharged engines are optimized for applications and integrate durable aluminum cylinder heads with heavy-duty valves and valve seats.



With the launch of these new generators, KOHLER now offers fully integrated gas-powered models ranging between 40kW and 125kW – all powered by KOHLER engines. These generators provide users with the flexibility to select the appropriate gas fuel source for a specific application – natural gas, LP, or patent-pending dual fuel – and are ideally suited to a variety of settings, such as commercial and municipal buildings, educational facilities, apartment complexes, health clinics and nursing homes.

"Our gas generators are suited for a wide array of industrial settings and, because they're fully-integrated units, KOHLER provides one-source responsibility for the generating system and accessories – including fast and easy access to our genuine aftermarket parts and service," said Amy Haese, associate product manager for KOHLER industrial generators.

The KG100 and KG125 generators feature Kohler's Fast Response X excitation system that delivers excellent voltage response and short-circuit capability using a rare-earth, permanent magnet-excited alternator.

They are available as open or closed units and can be ordered with KOHLER's recently launched sound-attenuated, hurricane-rated enclosure. This durable aluminum enclosure meets the most stringent and widely recognized Testing Application Standards (TAS) within the Florida Building Code for wind load and projectile impact.

The KG100 and KG125 gensets also feature the KOHLER APM402 controller, which offers a digital display and menu control for easy access to local data as well as seamless remote communication through standard protocol support for remote annunciator and building management system integration.

The KG100 and KG125 generators are now exclusively available through KOHLER's extensive network of dealers/distributors throughout the United States. A Distributor Locator can be found online here: <https://kohlerpower.com/en/generators/industrial/distributor-locator>.

**For more information, visit  
[www.KohlerPower.com](http://www.KohlerPower.com)**

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sole mate**



## MIT400/2 Series

After 100 years, let Megger introduce you to the only 1-kV insulation tester you'll need for your low voltage installation tests. There are four models in the MIT400/2 Series of 1-kV insulation resistance testers. Some of the features include:

- CAT IV 600 V safety rating
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- Single range, faster continuity testing from 0.01  $\Omega$  to 1 M $\Omega$
- Adjustable insulation test voltage from 10 V to 1000 V
- Rechargeable options for ac power and car charging

Meet your match ... the MIT400/2 Series from Megger.



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A Stitch in Time,  
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**Megger**

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