



NAVIGATING THE ADVANTAGES OF NEC CLASS 2 CONTROL CIRCUIT DESIGN





Advantages of NEC Class 2 Control Circuit Design

For many automation installations in North America, Class 2 power distribution devices and designs provide performance, cost, and safety benefits.

Designers of machinery and equipment systems typically rely on proven materials and methods to ensure consistent delivery of the most reliable and effective end results. Especially when it comes to power branch circuit distribution and control circuits, the products available on the market are fairly mature and design practices are largely guided by codes. But every once in a while, a new option becomes available to improve performance, reduce cost, increase safety—or in rare cases all three.

This is the case now with respect to a relatively new type of power distribution device. For low voltage control circuits commonly used in automated equipment, products destined for the North American market can take advantage of a special National Electrical Code (NEC) classification called a 'Class 2' circuit.

Traditional control circuit power distribution designs use properly sized fuses, circuit breakers, and conductors to meet standards and requirements. In some ways, these properly designed circuits were overkill for the relatively small power involved. Class 2 recognizes the low energy levels associated with many control and signaling applications, and provides an improved option for designers to use specific materials and methods for these situations.

This white paper describes some details of products and practices associated with Class 2 designs, and it shows why implementing Class 2 principles with the right devices can provide functional benefits, lower the total installed cost, and maximize safety for users and equipment.

Understanding Requirements

Different global regions have specific directives, codes, and standards which must be observed for electrical design, products, and installations. Products are typically made to comply with one or more of these codes and standards. Following are some relevant documents for power supplies within industrial equipment:

Europe and International

- International Electrotechnical Commission (IEC)
- European Standards (EN)
- IEC/EN 61204-1: Low-voltage power supply devices
- IEC/EN 61439-1: Low-voltage switchgear and controlgear assemblies

North America (USA, Canada)

- National Fire Protection Association (NFPA)
- NFPA 70: National Electrical Code (NEC)
- NFPA 79: Electrical Standard for Industrial Machinery
- Underwriters Laboratories (UL)
- UL 508A: Standard for Industrial Control Panels
- UL 1077: Std. for Supplementary Protectors for Use in Electrical Equipment
- UL 1310: Standard for Class 2 Power Units
- UL 2367: Standard for Solid State Overcurrent Protectors

Designers and engineers must be familiar with applicable guidance for the final location where equipment will be installed and inspected. European and North American standards are not necessarily harmonized, adding to the complication.



Figure 1: Control circuit power distribution is a relatively mature field, but new devices and installation practices can provide many advantages.

Standards related to power supply and distribution are generally intended to protect personnel, and to prevent fires or any potentially unsafe or damaging conditions. The design principles and applicable products are well understood, but sometimes the standards change or newer products become available, providing options for improvement (Figure 1).

For instance, through an understanding of and compliance with NEC Class 2, designers can save money and provide safer equipment, with a secondary benefit of realizing some relief from UL508A inspections.

Class 2 Considerations

In simplest terms, a Class 2 circuit is of such low voltage and current, and therefore low power, that it does not present a shock hazard to personnel or a fire hazard. Ensuring available energy is limited provides many design, regulatory, installation, and operational benefits.

Traditional hardwired devices like motor starters often draw too much power for Class 2 circuits to be a practical option. But the increasing prevalence of low-power digital devices like programmable logic controllers (PLCs), human-machine interfaces (HMIs), and other intelligent components work well when powered by Class 2 circuits. Also, much of the communication, networking, and input/output (I/O) signaling can be supplied by Class 2 circuits.

In North America, the NEC is the primary standard for electrical installations. UL 508A addresses control panels and the control

circuits within them, while UL 1077 and 2367 address branch circuit protection.

The NEC defines Class 2 energy limited control circuits in article 725-121 as:

- Not to exceed 60V DC (although they are most commonly operated at 24V DC or 24V AC for industrial and commercial purposes).
- Load side power potential must be limited to less than 100VA (although adhering to these limits with standard fuses or circuit breakers is not acceptable).
- Therefore, Class 2 power source devices must be specifically UL listed as such.
- These conditions must be maintained even in the event of a short circuit or during fault conditions.
- There are also restrictions on what classes of circuits may be routed together. Generally, Class 2 circuits must be routed separately from other classes of circuits in control panels and raceways.
- Note that Class 2 is only applicable within North America.

When product suppliers and designers comply with Class 2 requirements, many benefits are realized.

Class 2 Advantages

Circuits and downstream devices operating under Class 2 require no further protection from shock or fire hazards. From a practical standpoint, this means Class 2 devices and conductors can be smaller, and circuitry is often simplified for these reasons. Field wiring methods are less demanding because the materials are easier to procure, install, and maintain. These benefits combine to reduce the expense of design, materials, installation, and support.

Manufacturers submit their devices to UL for investigation in order to receive NEC Class 2 certification. Once a device is Class 2 certified, it simplifies design efforts compared with using most other types of electrical components. For example, within UL 508A listed control panels, any Class 2 circuits and the components connected to them need not be evaluated for UL compliance, greatly minimizing the panel design effort.

There are a few points to be aware of for properly implementing Class 2 designs. Some downstream devices may be certified as requiring a Class 2 power source, so designers must be aware of this and ensure the proper Class 2 source is provided. Also, while Class

greater amount of control circuit current, which therefore required multiple power supplies and eroded some of the expected benefits.

Some suppliers responded to customer needs for a better way to deploy Class 2 designs by creating a new category of device called an electronic circuit protector (ECP) (Figure 3, 4). ECPs are a newer and smarter family of Class 2 devices. Using intelligent power distribution, ECPs take advantage of all the Class 2 benefits, while providing many standalone and modular options for distributing bulk 24VDC power from standard power supplies. Using ECPs, it is possible to distribute up to 40A of bulk upstream power to individual Class 2 downstream circuits. Designers can therefore choose fewer, but larger, upstream power supplies as needed, perhaps even incorporating redundancy. ECPs also provide many other benefits.

More Intelligent Power Distribution Benefits

Because intelligent power distribution devices perform their ECP function using digital methods, the protection actually reacts faster than other physical methods such as fuses or traditional circuit breakers. The response is more reliable than the trip curve of a



Figure 2: Suppliers like Murrelektronik created power supplies like the Emparro67 Model shown here to meet Class 2 requirements, although this approach is typically limited to less than about 4A power supply.

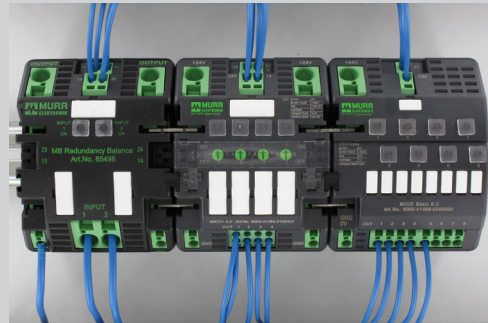


Figure 3: Individual ECP modules, like the three devices from the Murrelektronik MICO line shown here, enable bulk 24VDC control panel power to be distributed to 1, 2, 4 or even 8 individual Class 2 circuits.

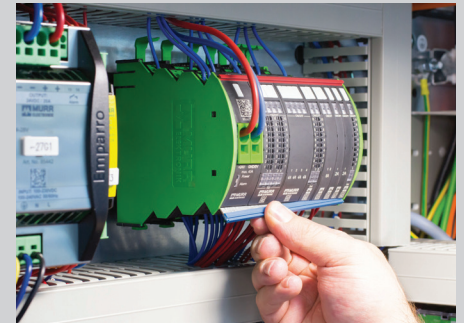


Figure 4: Other Murrelektronik MICO ECPs are available in an expandable form factor with convenient bussing, making it easier to design and fabricate control panels with many Class 2 circuits.

2 wiring methods are generally easier to use, the Class 2 circuits must be routed independently of other circuits both within a control enclosure and in field raceways.

Perhaps the biggest concern with Class 2 designs is the limited power available, and consequently ensuring there is enough to properly operate downstream devices. There are a few options for implementing Class 2 power sources.

Class 2 Implementations

Small transformers can be designed to convert 120VAC to 24V AC in a current-limited manner to meet Class 2 requirements, and these are often used for residential and commercial signaling such as for heater and air conditioner thermostats. However, typical industrial control systems commonly use 24V DC.

Some component suppliers originally developed power supplies specifically for this application, which were designed, tested, and certified to meet Class 2 requirements (Figure 2). This is a workable approach, but these power supplies were often limited to a nominal 4A or less output current at 24V DC. Many control panels needed a

standard breaker or fuse and much closer to the desired protection level selected. For example, if 2A protection is desired, the ECP trip curve is nearly 2.1-2.2A, but may be as high as 6A for a breaker. This responsiveness provides accurate overcurrent selectivity with other circuits, and it helps prevent voltage drops, and even cable fires.

An ECP monitors the current on each individual output channel, providing users with the ability to turn each output channel on and off individually, sometimes via remote signaling from control systems. Upon startup, the output channels are automatically started in a cascade manner to reduce the system inrush and minimize the chance of upstream overcurrent trips.

Note that ECPs are not only for Class 2 installations. Some general ECP models may allow adjustable current limits per channel, while specific Class 2 models are necessary for true Class 2 installations.

Some ECPs offer visual indication of channel loading, such as a steady green LED for <90%, blinking green for 90% to 100%, and red for >100%. Also, a group alarm contact allows the ECP to be monitored by supervisory PLCs so control actions can be taken if necessary, or HMI alarms can be triggered.



Many ECPs offer compact form factors, and versions supporting higher channel numbers can take up less DIN rail space than fuses or circuit breakers. A line-side bridging system facilitates bulk power distribution, while compact form factors and clear labelling make it easier to design, fabricate, and maintain control panels. Modern ECPs are the best choice for distributing bulk 24V DC control panel to Class 2 circuits in control panels, and also provide substantial benefits for distributing standard 24V DC circuits. Implementing ECPs allows for proactive monitoring, requires no replacements like fuses do, and often precludes any need for personnel to open electrical cabinets.

Conclusion

Class 2 circuits are a very specific configuration, unique to the North American market and defined by the NEC. There are many safety, performance, regulatory, and economic benefits associated with implementing Class 2 control circuits.

Certain power supplies are rated to provide Class 2 circuits, but there are power constraints, so sometimes many such devices would be needed. ECPs, such as the Murrelektronik MICO product family, are the best and most flexible way to distribute multiple Class 2 circuits from the bulk 24V DC power supplies typically used in control panels. ECPs also provide many benefits for distributing general power circuits.

For projects and equipment destined for North America, designers should familiarize themselves with the requirements, products, design methods, and installation practices associated with Class 2 control circuits so they can take advantage of this compact, economical, and feature-rich solution.



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