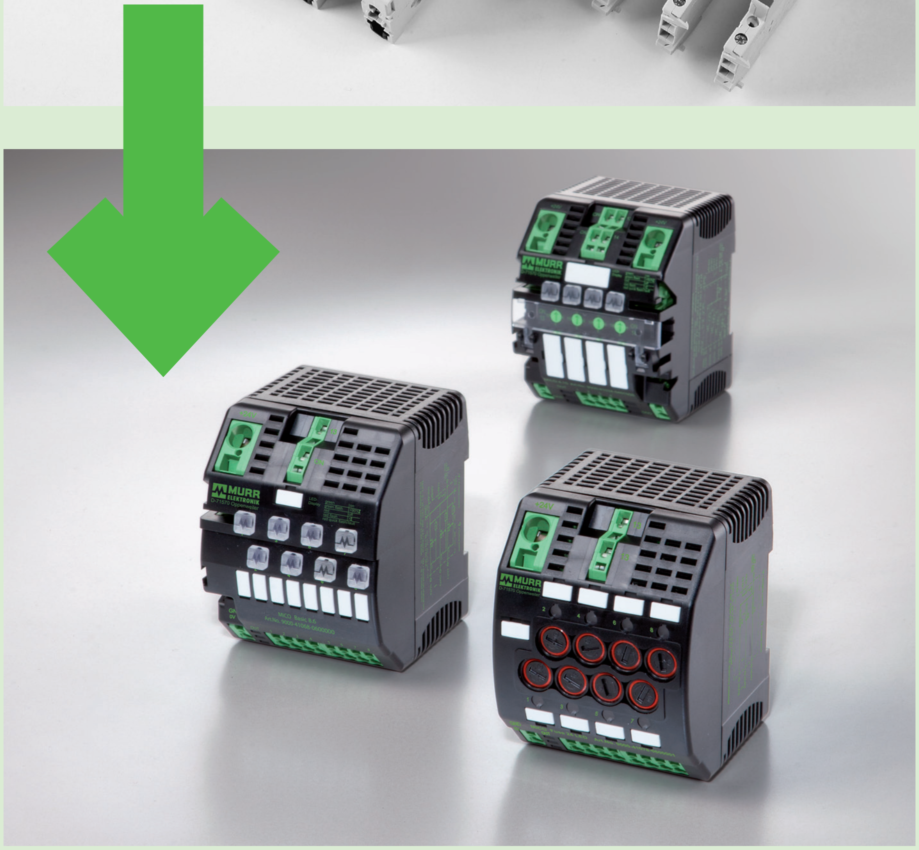
| GIVE BREAKERS A BREAK:

How to Protect Your 24V DC Control Circuits Better

A Special Report for Control Engineers



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Do you recognize any of these 24V DC control circuit problems?

- Sensor and valve cables get very hot, melt or catch fire without the breaker reacting
- We have to shut down the machine to reset a breaker, repair sensor cables or replace a fuse
- We have to open the control cabinet to see which breaker or fuse failed, and keep the cabinet open to troubleshoot a circuit
- The power supply shuts down during a short circuit or overload
- We oversize our power supply to prevent it drawing down before our breakers trip
- We oversize our breaker or fuse to avoid them blowing during machine start-up
- We have to keep many different breakers and fuses in stock

| DRAWBACKS OF TRADITIONAL BREAKERS & FUSES

If you experience any of these problems, you are feeling the pain of using traditional circuit breakers and fuses to protect 24V DC control circuits.

When you look in a typical control cabinet, you spot glass fuses, cartridge fuses or circuit breakers. These devices have been wired and sized the same way since they first became commercially available in the 1930s. Over the years, control engineers have learned to live with the way these devices operate.

You expect them to react when a cable is cut or damaged. You expect to replace or reset them whenever this happens. You expect them to react faster than your power supply.

But despite their familiarity, traditional breakers and fuses have some distinct drawbacks, such as slow reaction time, limited sensitivity, and no help in troubleshooting. As you know, it can be time-consuming and costly for personnel to open a control cabinet—or even worse, shut down a whole production line—while technicians strive to troubleshoot a circuit.

Sometimes you can't afford to live with these limitations. Sometimes you replace an installed breaker or fuse with a higher-current version to prevent nuisance tripping. Sometimes you replace a power supply with a larger model with a higher protection point so you won't lose an entire control circuit if the breaker fails to react. And sometimes you worry if your cables and devices are properly protected.

| TODAY'S SOLID-STATE CIRCUIT PROTECTION

Control engineers have an alternative: a more modern form of circuit protection and monitoring device based on solid-state electronics (microchips). "Electronic fuses" have proven themselves in the field for more than 10 years, in many applications. For example, similar technology is now routinely used to protect switch-mode power supplies. Engineers in many other fields have come to appreciate the benefits of solid-state electronics over electromechanical devices. These advantages include:

- Faster reaction time
- More precise operation
- Lower power consumption
- Less electrical "noise" output
- Smaller size and lighter weight
- Less sensitive to mechanical shock, vibrations, humidity or magnetic fields
- Longer life expectancy

Scan the QR to see MICO in action

These new electronic circuit-protection devices can do things that traditional breakers and fuses were never designed to do. For example, standard breakers and fuses cannot monitor and analyze circuits. Modern solid-state devices are designed to analyze any fault, or possible fault, conditions and react quickly.

When these new devices sense an overload, they can isolate that circuit to prevent any damage, then monitor it to see if the overload subsides. This enables these devices to accommodate a machine startup without any nuisance tripping. Some can even be programmed for a cascading start, with a certain time delay for each branch that eliminates startup peaks.

Another example: Some of the newer solid-state devices can monitor a circuit, and send a relay contact signal to another device like a stack light, HMI or PLC to alert an operator of a fault. LEDs on the monitoring device (or other contacts) can show the affected circuit, and help a technician trace the problem and fix the cable. Once the repair is complete, a quick and easy remote reset can be done to clear the fault—without ever needing to open the control cabinet. This saves a tremendous amount of time and labor.

| COMPARE THE PERFORMANCE OF BREAKERS TO SOLID-STATE PROTECTION

Perhaps you are not sure how reliable an electronic circuit-protection device can really be? To compare performance of older and newer devices, look closely at the trip curves shown in Figure 1. Notice how a traditional 24V DC thermal breaker compares to a 2A electronic device. Look at the reaction times in the accompanying table. While waiting for the bi-metal components of a thermal breaker to react to a short, cables and devices can be exposed to massive over-current. While 8A of current takes 9 seconds to trip the 2A breaker, the same current will trip the electronic device in only 10ms—900 times faster.

The same occurs with the 6A devices shown in Figure 2. In this case, 12.5A will take 50 seconds to trip the breaker, but only 10ms to trip the electronic device—5,000 times faster!

How can we explain such dramatic improvement in reaction times? Electronic protection devices use a precise set point as a reference, and react as soon as the current goes beyond that set point. This protects all cables,

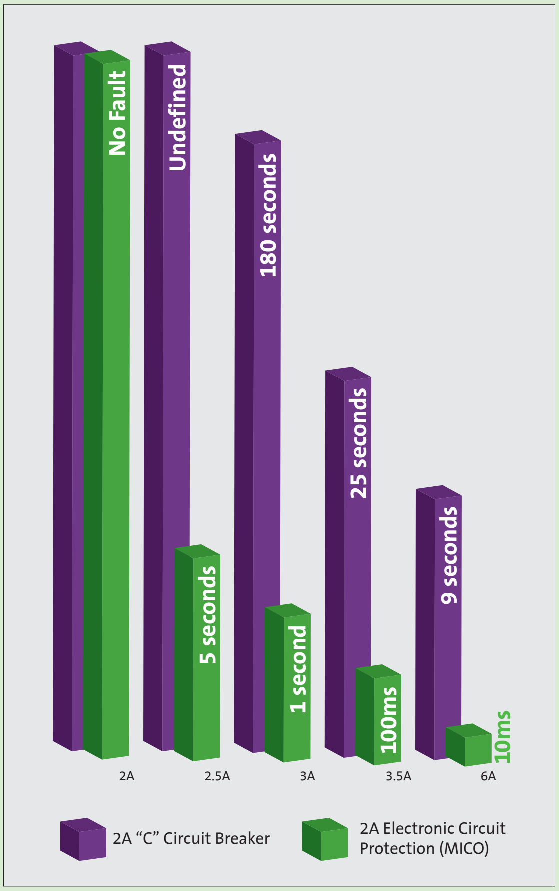

Figure 1: Circuit Breakers vs. Electronic Circuit Protection in a 2A Circuit

Reaction Time and Over-Current in a 2A Circuit		
Switch Off Time (t_{max})	Circuit Breaker	MICO
∞	≤ 2A	≤ 2A
undefined	2 - 2.5A	
180 sec	3A	
25 sec	5A	
9 sec	8A	
5 sec		2.5A
1 sec		3A
100ms		5A
10ms		8A

conductors, and devices from exposure to unnecessary current, hundreds or thousands of times faster than a traditional breaker. Imagine how much damage you could avoid by cutting almost a minute of over-current stress from your sensitive loads.

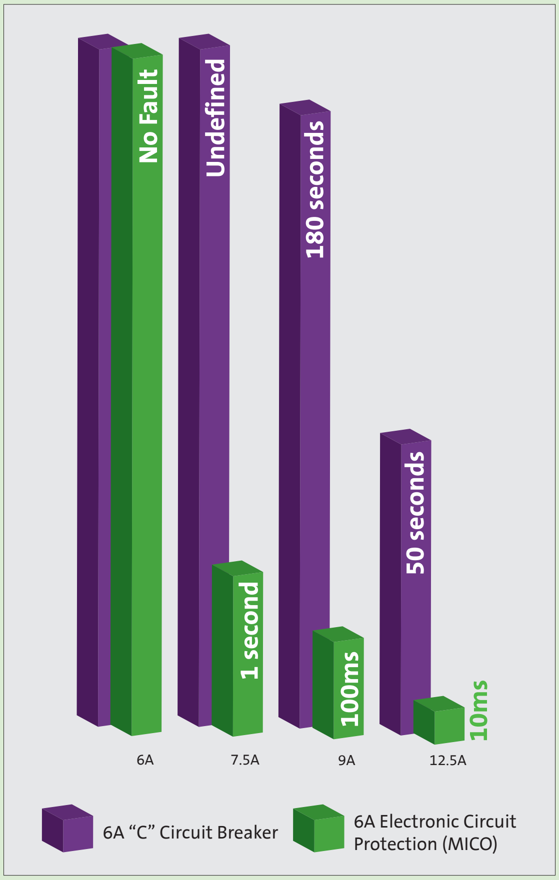

Figure 2: Circuit Breakers vs. Electronic Circuit Protection in a 6A Circuit

Reaction Time and Over-Current in a 6A Circuit		
Switch Off Time (t_{max})	Circuit Breaker	MICO
∞	≤ 6A	≤ 6A
undefined	6 - 7.5A	
180 sec	9A	
50 sec	12.5A	
1 sec		7.5A
100ms		9A
10ms		12.5A

Source: Murrelektronik

| NEWER DEVICES PAY FOR THEMSELVES IN A SINGLE INCIDENT

Since solid-state devices provide more "smarts" you might expect them to be much more expensive. While these devices may cost more per protected channel, many engineers find they pay for themselves in a single incident.

How? Electronic circuit protection can eliminate the wait for a technician to open control cabinets. They shorten troubleshooting time by showing a LED or alert to the exact branch in question. Since they react much faster to faults, they spare your cables and components from over-current stress and heat, and reduce the risk of fire. They provide for remote reset, saving many more steps. Best of all, they help avoid any costly shutdown of production equipment during troubleshooting, reset or restart.

By saving time and trouble at every step—installation, monitoring, fault detection, troubleshooting, and reset—solid-state circuit protection devices pay for themselves in both hard costs and peace of mind.

| SMOOTH DESIGN AND INSTALLATION

Electronic circuit-protection is still new to some engineers. Is there a big learning curve in starting to use them? Not at all. In fact, you can size these electronic devices exactly the same as a traditional breaker, using a simple formula. Many engineers find the newer devices make installation faster and easier. They install just like a breaker, but with less wiring. Some of the newer devices provide current-selection switches for each branch, which makes any future adjustments quick and easy.

UL and CSA have categories for testing and use of electronic circuit protectors, removing any questions about where to use them safely. And once they're installed, you can count on stable and predictable operations for years to come.

| A REAL WORLD EXAMPLE

As you know, every item in an electrical circuit has resistance, including the power supply, terminal blocks, switches, devices and wires.

Considering we have constant 24V power, the higher the resistance, the lower the current, according to Ohm's Law: $E = R \times I$

As resistance (R) increases, current (I) decreases. Likewise, as resistance (R) decreases, current (I) increases.

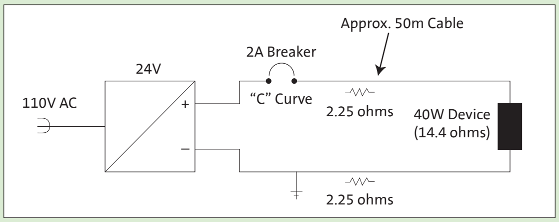

Figure 3: Typical 2A Circuit in Normal Condition

Consider the circuit shown in Figure 3, with a 24V power supply, a 2 Amp "C" curve circuit breaker and a 40 Watt (14.4 ohms) device with a cable run of approximately 50m that totals 4.5 ohms resistance. Under normal conditions, the current going through the circuit is:

$$I = \frac{E}{R} = \frac{24}{14.4 + (2.25 \times 2)} = 1.27A$$

Now assume there is a short between point A and point B, as shown in Figure 4.

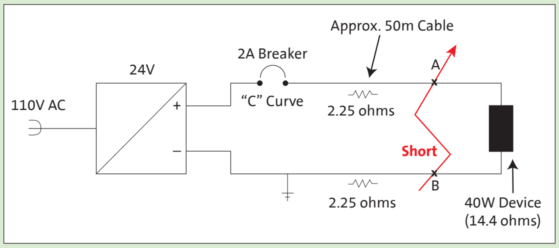

Figure 4: Typical 2A Circuit with Short at the Device

What happens? The current will find the path of least resistance, flowing from A to B and bypassing the device. The total resistance of the short circuit is now only 4.5 ohms. The current going through the cable thus increases:

$$I = \frac{E}{R} = \frac{24}{0 + (2.25 \times 2)} = 5.33A$$

This is far more than the 2A rating of the breaker. But look at the table under Figure 1 and note how long a 2A breaker can take to react to 5.33A: 25 seconds. During that time, the power supply may draw down, cutting power to a number of mission-critical circuits. But a 2A electronic circuit-protection device like MICO would trip in only 100ms—250 times as fast—sparing the circuit device and the power supply from any undue stress, and preventing any interruption to the overall production of the facility. This shows the serious drawbacks of a traditional circuit breaker in real-world conditions.

| HOW TO SELECT THE IDEAL SOLID-STATE CIRCUIT PROTECTION DEVICES

Any electronic monitoring and protection device for 24V DC circuits should meet all the following criteria:

- Multiple independent 24V DC channels
- Switch-selected current range from 1A to 10A per channel
- LED status indicator for each channel
- Current monitoring with warning before failure
- Integrated floating alarm output
- Memory system for fault recognition after power loss
- Remote reset with 24V DC signal
- High-capacitive loads up to 20,000 µF
- Spring clamp terminals for quick, sure contacts that resist vibration
- Bridge multiple units together to save wiring
- UL-listed as industrial control equipment under UL 508 for U.S.A.
- CSA-listed as industrial control equipment under CSA 22.2, no. 14 for Canada
- Proven effective with 500,000+ units installed in the field

stay connected

Figure 5: MICO Electronic Circuit Protection Unit

| THE IDEAL SOLUTION

Murrelektronik has been pioneering this new approach to circuit protection for years. As shown in Figure 5 the MICO family of electronic circuit-protection devices features current selection, overload monitoring, remote reset, fault notification, remote on/off for energy savings, and more. Inventory is also streamlined. While fuses may blow, solid-state devices don't, so they never need to be replaced. Very little spare inventory is needed. Already a massive success in Europe, the complete family of MICO devices is now available in North America.

| ABOUT MURRELEKTRONIK, INC.

Murrelektronik, Inc. is the North American arm of Murrelektronik GmbH, a worldwide leader in the manufacture of state-of-the-art technology and made-to-measure solutions for complex automated industrial systems, network protocols and machine connectivity. For more information on the company's products and services, contact:

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