Electrical and Motor Controls Training Series

Get everyone skills improved on electrical maintenance troubleshooting

Modules

-Understanding 3Ø Power and Plant Distribution
-Electrical Switching, Timing, and Control
-DevicesInstrumentation: Discrete and Sensory
-Understanding Electrical Diagrams and Control Circuits
-Preventive Maintenance and Troubleshooting Control Circuits
-Introduction to Motor Control Operations and Protection
-Sizing the Protection of Motors and Control Circuits
-AC Motor Controls and Troubleshooting
-DC Motor Controls and Troubleshooting
-Understanding and Applying PLCs in Electrical Controls

Ten Programs to Get Everyone Up to Speed

A very complete system. It's exactly what I expected.
Dale Frazier, Electronic Systems Technician, City of Columbus, OH

You Need Skilled Technicians

We Can Help You

Why waste time and money suffering through long downtimes, improper troubleshooting, and quick fixes that don't last—solve the problem right the first time.

- A Great Source for Proven Training Content

The EMC Series offers proven, readily available, properly formatted, syndicated training content, which is familiar and currently in use by maintenance, engineering, operations and plant personnel. Finally, manufacturers are able to incorporate this comprehensive content to satisfy their particular needs using a highly customizable and formal curriculum to build internal apprentice programs for critical needed skills.

The EMC series offers a dynamic, interactive combination of multimedia and human touch to provide the right training, in the right way, at the right time and place.

This EMC Training Series provides along with the instructional lessons, assessment and testing, certificates, and access to course handbooks to empower technical workers and management in their efforts to rapidly train and maintain a skilled technical workforce.

You're Not Buying More Work!

You already have enough to do. You may not have the time to set up a training program. With our programs, we've done all the work for you.

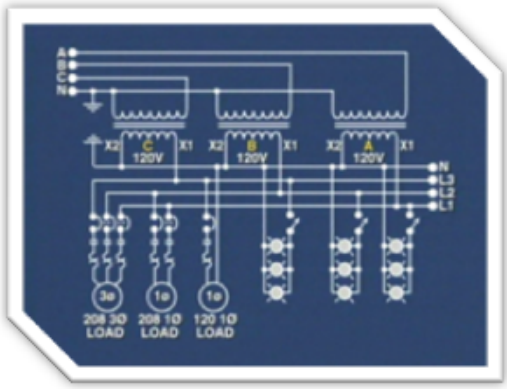
Your technicians only have to View-It-And-Do-It[sm].

UNDERSTANDING 3Ø POWER AND PLANT DISTRIBUTION

> *I really like your training programs. My staff basically trains themselves.*
>
> —Dale Lancaster, Maintenance Manager, Color Box, Inc.

This program will give everyone in your plant a solid understanding of the basics of power generation and distribution. Everyone who works with, or around, electrical equipment needs to know the basics as well as how to protect themselves and your equipment.

Use this program to cross train your mechanics in the basics of electricity and cut your power bills at the same time.



Now Everyone Will Understand the Basics of Power in the Plant

- ✓ Cut your power bills and extend the life of your equipment by using power factor correction
- ✓ Choose the safest methods for power distribution
- ✓ Understand why motors and their voltages are designed the way they are
- ✓ Configure wye and delta branch and feeder circuits to provide a balanced power system
- ✓ Learn which voltage connection to avoid to prevent equipment damage
- ✓ Determine phase-to-phase and phase-to-neutral voltages and currents
- ✓ Before you can protect your circuits everyone has to understand them
- ✓ Distribute power through your plant via switchgear and busways
- ✓ Rectify AC power into DC power
- ✓ Make sure you place correction capacitors in the right place or else your motor overload heaters won't work right and you'll burn out your motors
- ✓ Provide a safe ground bus—for safety and proper equipment operation

CONTENTS:

Program provides approximately 4 hours of instructional material (equivalent to a 1-day course).

- Bringing power inside the plant
- Power generation
- Wye & delta power systems
- Balanced power circuits
- Phase-to-neutral & phase-to-phase voltages and currents in wye & delta systems
- Transformers
- Wye & delta transformers and connections
- Plant power distribution
- Switchgear, busways, motor control centers
- Rectification of 3Ø power into DC power
- Power factor and correction
- Areas of proper power factor correction in a motor circuit

TECH TIPS

Did you know that you must compensate for power factor when using an AC squirrel-cage motor?

POWER DISTRIBUTION

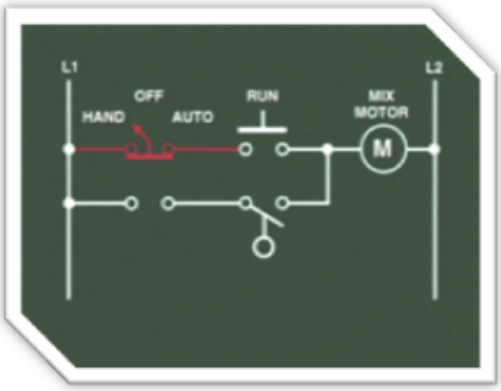
ELECTRICAL SWITCHING, TIMING, AND CONTROL DEVICES

"You've made my job much easier, helped our electrical department, and lowered the overall machine downtime in our facilities."

—Nick Meheula, Plant Maintenance, Oahu Transit Services

This program covers the most common switches, timers, and control devices found in your plant. You have hundreds (probably thousands) of these devices in your plant. At a cost of $25 to $250 per component, this program will quickly pay for itself.

We show how these devices work, how they are wired, and how to troubleshoot them. This program also provides the first step in learning ladder diagrams.



Solve Even the Trickiest Component Failures

- ✓ Poles, throws, breaks—there are dozens of different combinations—pick the right one for yourapplication and know how to wire it
- ✓ Avoid costly wiring mistakes—read multiposition selector switches in ladder diagrams
- ✓ Troubleshoot tricky pushbutton problems—don't replace the whole thing when it might just be the contact blocks
- ✓ Read the action and timing diagrams of ON-delay and OFF-delay timers so that when something goes wrong, you'll know exactly which component to replace
- ✓ Use time-delayed and instantaneous timer contacts—know the difference and protect your equipment
- ✓ Avoid intermittent problems—make sure control relays are receiving the proper steady voltage
- ✓ Troubleshooting relays can be a nightmare—follow our detailed troubleshooting method and save time
- ✓ Many control devices share components—learn how to cut your spare parts inventory to a minimum

CONTENTS:

Program provides approximately 4 hours of instructional material (equivalent to a 1-day course).

- Basic ladder diagrams
- Information provider switches
- SPST, SPDT, DPST, and DPDT switches
- Proper component wiring connections
- Control device troubleshooting: static & dynamic checks
- Static and dynamic component checks
- Understanding drum switch operation & its use in the reversal of motors
- Use and application of control relays (standard & latching)
- Troubleshooting delay circuits
- ON-delay & OFF-delay timer action, timing control & troubleshooting

TECH TIPS

Did you know that incorrect reference wiring and connections cause most of the problems in troubleshooting timer circuits?

INSTRUMENTATION DISCRETE AND SENSORY

"Your programs have not only given my staff a better understanding of electrical controls, but also reduced our troubleshooting time. I would recommend them to other companies."

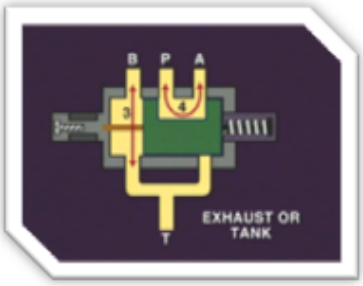
—Rodney Nylin, Technical Training Coord., Abbott Laboratories

This program shows how to calibrate and bench test the most common components found in your plant. You can be sure that your people will know how to test and calibrate these components before installation to avoid costly mistakes and delays.

This program also explains how valves operate, how to wire them, and how they work. Now everyone will be able to quickly identify the real problem and avoid wasting time replacing unnecessary components.

Bench Test & Calibrate Components—Cut Installation Time & Costs

- ✓ Similar devices share components—cut your spare parts inventory to a minimum
- ✓ Choose the correct photoelectric sensor for your application
- ✓ Apply, install, and troubleshoot limit, photoelectric, and proximity switches
- ✓ Should you use an inductive or capacitive prox—they look the same, but if you pick the wrong one it won't detect
- ✓ Wire and understand the inner workings of 2, 3, and 4-way valves
- ✓ Cut your installation time—bench test and calibrate pressure devices before installation
- ✓ Clogged ports or a bad solenoid—learn to spot the difference and avoid replacing unnecessary components
- ✓ Intermittent malfunctions in limit switches can take forever to track down—earn a step-by-step method for identifying and solving the problem quickly



CONTENTS: Program provides approximately 4 hours of instructional material (equivalent to a 1-day course).

- Limit switches
  -use, application, installation, and wiring
- Proximity sensors
  -operation and use
  -inductive and capacitive
- Photoelectric sensors
  -selection, installation, wiring, and troubleshooting
- Discrete process-sensing control devices: pressure, flow, level & temperature sensors: wiring connections, set-up (bench test), installation, circuit troubleshooting
- Discrete solenoid-operated control valve operation & application: 2-way, 3-way & 4-way—4 and 5 ports
- How to properly read solenoid valve schematics
- Troubleshooting solenoid control valves

TECH TIPS

Did you know that a 25% reduction in target size will reduce the effective sensing distance of a proximity switch by almost 50%?

SENSORS & COMPONENTS

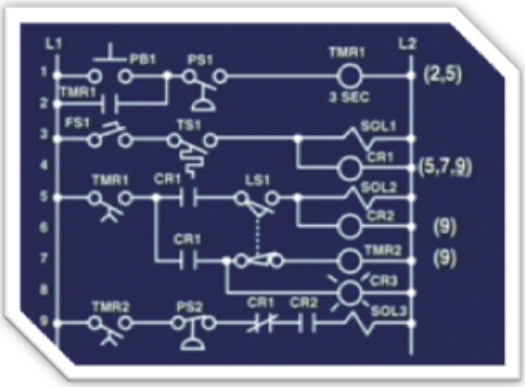
UNDERSTANDING ELECTRICAL DIAGRAMS & CONTROL CIRCUITS

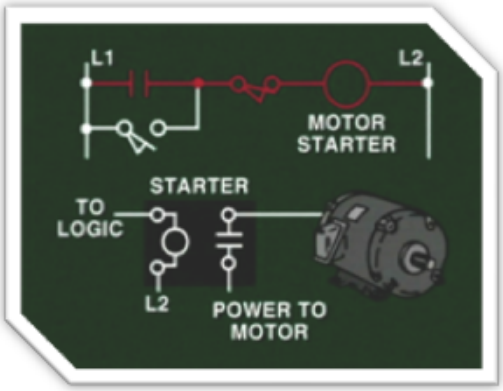
"The information in these training programs is accurate, to the point, and easy to understand."
—Jerry Roshong, Project Engineer, J.M. Smucker Company

All maintenance personnel must know how to read and write ladder diagrams—it's an essential skill. Plus, it's a prerequisite to using PLCs (programmable controllers).

This program explains the components of a control circuit and moves on to more complex circuits. Use this program to learn the fundamentals of control circuits and then go on to Preventive Maintenance & Troubleshooting Control Circuits on the following page to learn troubleshooting. These two video programs

Save Time During Troubleshooting—Learn to Read Layout, Wiring, and Ladder Diagrams





- ✓ Protect your people—follow our four basic rules of ladder diagrams to implement a safe circuit
- ✓ Add interlocking, memory, and cross-referencing to complex control circuits
- ✓ Layout a control panel—from scratch to finish—just by following the wiring and layout diagrams
- ✓ Implement motor control and magnetic starter circuit diagrams
- ✓ Prevent faulty operation and equipment damage—use mechanical, push button, and electrical interlocks
- ✓ Design and read ladder, wiring, and layout diagrams
- ✓ Save installation time—follow our method to layout a control system using proper component placement and wiring guidelines
- ✓ Avoid confusion—document and cross-reference devices properly so that everyone will understand the ladder diagram and know how to troubleshoot it

CONTENTS:

Program provides approximately 4 hours of instructional material (equivalent to a 1-day course).

- Control circuit components & representation
- Power continuity
- AND-OR-NOT circuit logic: understanding & application
- Electrical diagrams: ladder, wiring (motor circuits) & layout
- Proper reading, referencing, interpretation, design & implementation of electrical control diagrams
- Control circuit examples & implementation
- Adding interlocking memory to a control circuit
- Types of control circuit interlocking: mechanical, push button & electrical
- Magnetic starter wiring diagrams
- Interpretation of more complex ladder diagrams
- Layout & connection diagrams
- Component placement & wiring

TECH TIPS

Did you know that reading ladder diagrams incorrectly is one of the biggest causes of troubleshooting delays?

ELECTRICAL CONTROL LADDER DIAGRAMS

PREVENTIVE MAINTENANCE & TROUBLESHOOTING CONTROL CIRCUITS

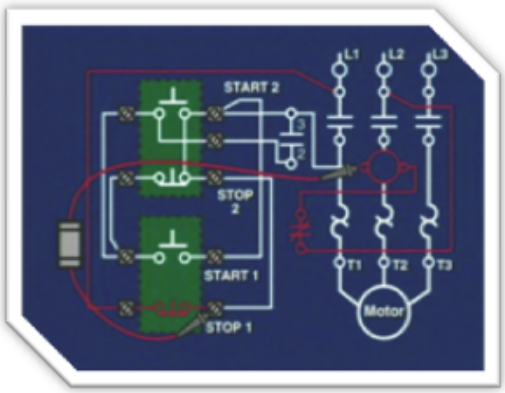
> *Your programs are convenient to schedule. We can train all three of our shifts in a very convenient and economical way.*
>
> —Rick Pruden, Electrical Engineer, Bundy Corporation

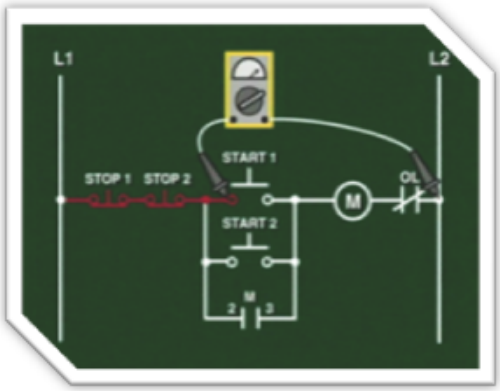
This program covers the most basic, fundamental, and important troubleshooting skills needed in the plant. It's not enough to know what the different components do—your people need a quick way of identifying and solving control circuit problems. For example, the main problem with a short circuit isn't the short itself—it's the fact that things aren't running.

Combine this program with the one on the previous page for a complete control circuit toolkit. Use both programs to make sure everyone understands control circuits and can troubleshoot them.

Get Back On-Line Fast— Cut Production Losses

- ✓ Follow our systematic approach to troubleshooting electrical systems both at the power source and the control circuit
- ✓ Find short circuits and faulty components quickly—get back up and running fast
- ✓ Install power and phase monitors to detect dangerous conditions before causing costly motor damage
- ✓ Use our four fundamental guidelines to implement an effective preventive maintenance program
- ✓ Perform dynamic and static preventive maintenance inspections
- ✓ Troubleshoot control circuit logic using ladder and wiring diagrams
- ✓ Learn how a phase imbalance will make your motors run hot—solve the problem and prevent insulation breakdown
- ✓ Learn why thermal overloads aren't enough to protect your equipment against damage from phase loss





CONTENTS:

Program provides approximately 2 hours of instructional material (equivalent to a 1/2-day course).

- Preventive maintenance: approaches, guidelines & scheduling
- Preventive maintenance checks: dynamic & static inspections
- Engineering preventive maintenance into control circuits & into the plant's electrical power distribution with power & phase monitors
- Preventing & detecting phase imbalance, phase loss & phase reversal
- Troubleshooting electrical systems at the power source & at the control circuit
- Troubleshooting using ladder diagrams & wiring diagrams (motor circuits)
- Troubleshooting the logic section & the power section of the control circuit
- Finding faulty components
- Finding a short circuit

TECH TIPS

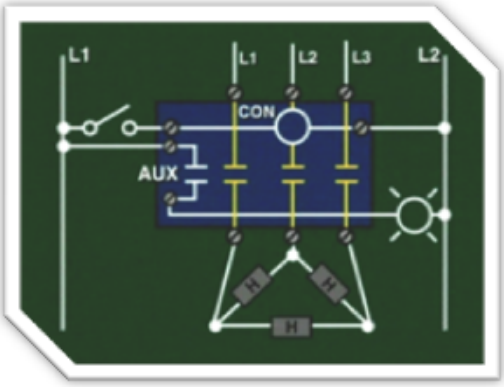
Did you know that a cross-firing problem in a double pole–double break contact component is often overlooked during troubleshooting?

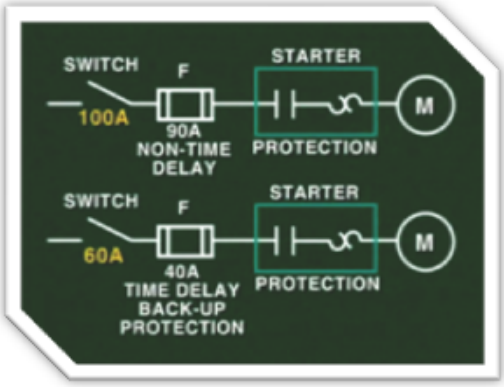
INTRODUCTION TO MOTOR CONTROL OPERATIONS & PROTECTION

"These troubleshooting programs are essential not only to electricians, but also to our mechanics." —Joe Meccia, Production Maintenance, Current, Inc.

This program gives everyone the practical motor control knowledge they need as well as explains the different causes of motor failures and the ways to prevent them.

Whether you're using AC or DC motors, this program will give everyone in your plant the skills to protect your equipment. This program, combined with Sizing the Protection of Motors & Control Circuits, provides the best reference for safe motor operation in your plant.





A Must-Have for All Your Motors

- ✓ Learn to prevent the seven most common causes of heat-related motor failure
- ✓ Hundreds of different starter configurations are available—identify and learn to quickly replace and rewire the ones used in your facility
- ✓ Avoid safety hazards—choose the right contactors and starters for your application
- ✓ Class 10, 20, 30 heaters—which one offers the right protection for your motor application
- ✓ Learn why and when troubleshooting 2-wire control can be dangerous
- ✓ When a starter is wired incorrectly anything can happen—make sure it's done right the first time
- ✓ Implement proper arc suppression to protect against shorts and fire hazards
- ✓ Make sense out of NEMA standards
- ✓ Fuses, breakers, and overloads look simple, but they each offer a different type of protection—make sure everyone understands their function and uses them properly
- ✓ Learn how spending a few extra dollars can add invaluable backup motor protection

CONTENTS:

Program provides approximately 4 hours of instructional material (equivalent to a 1-day course).

- Understanding, application, installation & wiring of contactors, and manual & magnetic motor starters
- Types of motor starters: full-voltage, combination, reversing, two-speed & reduced-voltage
- Arc suppression & protection in contactors & starters
- Motor & circuit protection: fuses (single & double element), circuit breakers (magnetic & thermal), & overloads (eutectic, bimetal & solid-state)
- Understanding motor protection curves, overload conditions & proper sizing of heater elements
- Use of double-element fuses as motor backup protection
- Controlling motor operations & plugging
- Understanding electrical & wiring control diagrams
- 2-wire & 3-wire control: application & uses
- Low-voltage release & low-voltage protection
- Causes of motor failure: symptoms & prevention

TECH TIPS

Did you know that thermal overloads can be affected by ambient temperature?

SIZING THE PROTECTION OF MOTORS & CONTROL CIRCUITS

"I have passed your info on to other companies and friends. I was happy to find Industrial Text & Video—it's hard to find good quality products."

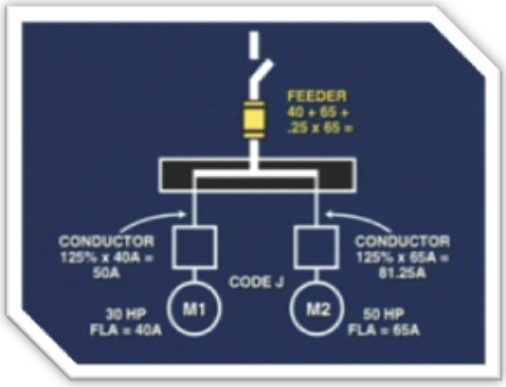
—Ed Godin, VP Manufacturing, Falcon Plastics, Inc.

Some skills, such as reading motor nameplates, may be basic but are still important. The information in this program is extremely important because if someone makes a mistake, not only will you not be up to code, but a dangerous situation could occur.

After watching this program, you'll not only be able to prevent future problems, but also spot and solve problems that may have been lurking in your plant for years.

Keep Everything Up to Code—Prevent Electrical Fires

- ✓ Use our six-step method to implement and maintain a safe motor branch circuit
- ✓ Time-delay or non time-delay fuses—which one should you use to provide the best protection
- ✓ When it comes to nameplates, reading them isn't enough—everyone needs to understand what they mean and know how to use this valuable information
- ✓ The motor dictates circuit design, protection, and components—know how to get the requirements from Article 430 and make your job easier
- ✓ Select proper circuit protection components according to code
- ✓ Choose safe conductors and protection devices
- ✓ Overloads and short circuits—are you protected against both
- ✓ Select the right size fuse to protect a branch circuit—we'll show you how
- ✓ Choose the right NEMA starter for your motor
- ✓ Finally, a clear explanation of Article 430 and what it means to your motor control operations



CONTENTS: Program provides approximately 2 hours of instructional material (equivalent to a 1/2-day course).

- Introduction to the National Electric Code (NEC)
- Article 430 of the NEC: motor, motor controller & motor circuit protection
- Safety & Article 430
- Sizing the proper protection for feeder & branch circuits
- Choosing proper conductors for feeder & branch circuits
- Understanding & protection of locked-rotor amperage in motor circuits & overload situations
- Understanding motor nameplate information according to code

TECH TIPS

Did you know that according to code, an overload heater must be rated at 125% of the motor's full-load amperage (FLA)?

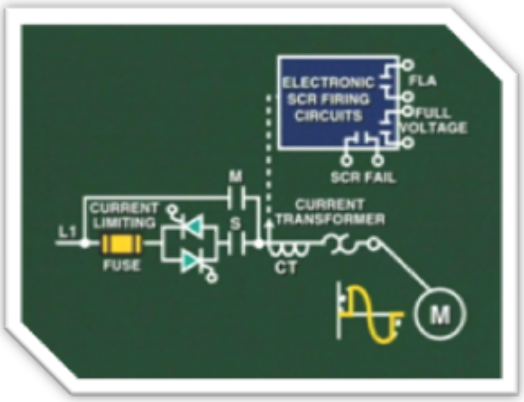
AC MOTOR CONTROLS & TROUBLESHOOTING

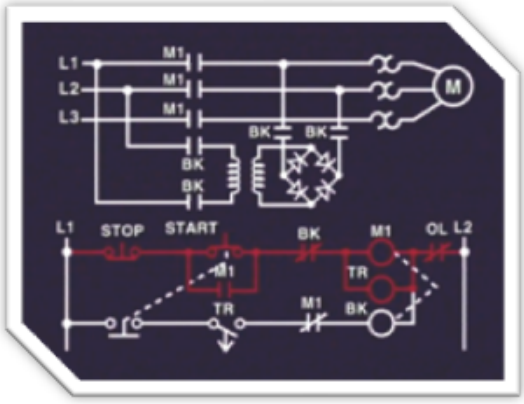
"I've had the opportunity to evaluate many training materials and I've found Industrial Text & Video's programs to be the best I've seen."

—Bob Desoto, Continuing Education Professor, University of California-Fullerton

Everyone needs to know the basics when it comes to AC motor controls. This program teaches you the basics. More importantly, it shows you how to quickly identify the root cause of a problem.

Our View-It-and-Do-It℠ method will show you how to check the windings for open conditions, isolate a problem to either the circuit or the motor, and much more. We even cover the telltale symptoms of premature motor failure.





Cut AC Motor Troubleshooting Time in Half

- ✓ Troubleshoot solid-state starters by quickly detecting misfirings of SCRs
- ✓ Before someone can troubleshoot a 1Ø or 3Ø motor they need to understand how they operate—we'll show you how
- ✓ Troubleshoot the different reversing methods and circuits used with AC motors
- ✓ The motor may be working, but is it working properly—learn to identify the hidden problems that can cause your motor to fail
- ✓ Troubleshoot across-the-line start motors as well as the 5 types of reduced-voltage start motors
- ✓ Is the fault at the motor or is it the circuit—learn how to quickly troubleshoot using the ladder diagram
- ✓ Solve the trickiest reduced-voltage start problem
- ✓ Understand how variable speed drives work and where to look to solve problems
- ✓ Quickly troubleshoot multispeed motors and their circuits—learn how to double check the connections
- ✓ Cut troubleshooting time by looking for the most likely causes of motor failure first

CONTENTS:

Program provides approximately 4 hours of instructional material (equivalent to a 1-day course).

- 1Ø & 3Ø AC motor components & operation
- Types of 1Ø motors: split-phase & capacitor motors
- Starting & accelerating 1Ø & 3Ø AC motors
- Selecting motor starters: across-the-line & reduced-voltage
- Types of reduced-voltage starts: primary resistor, auto-transformer, part winding, wye-delta & solid-state
- Operation of all reduced-voltage, wiring & connections
- Reversing circuits for 1Ø & 3Ø AC motors
- Speed control: multispeed motors & variable frequency
- Introduction to AC drive speed control (inverters)
- Braking circuits using plugging (zero-speed) switches
- Troubleshooting at the power section (branch circuit) & wiring circuit
- Finding open & short circuits
- Detection of serious AC motor symptoms

TECH TIPS

Did you know that if you're using friction brakes to decelerate a motor, you need to calculate the required braking torque?

DC MOTOR CONTROLS & TROUBLESHOOTING

"You covered a huge amount of detail well. It was very easy to understand."

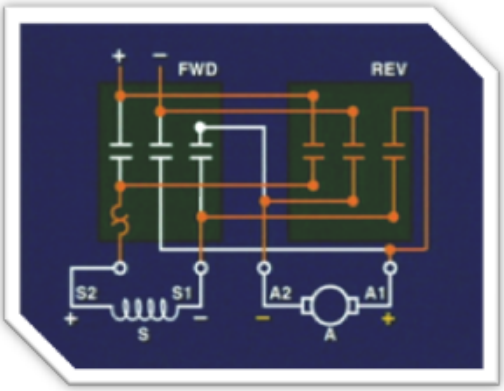
—Jeff Camp, Senior Systems Engineer, United Control

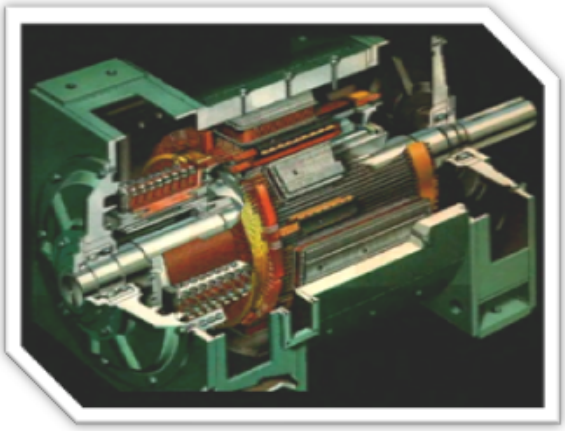
Just like our program on AC motors (AC Motor Controls and Troubleshooting), this program explains the basics of DC motor controls. However, we don't just cover the basics. We also show you how to look for the signs and symptoms of a failing motor.

We show you how to troubleshoot all of the DC motors found in your plant as well as how to prevent a motor from failing and shutting down a production line.

Troubleshoot and Avoid DC Motor Failure

- ✓ Keep the production line running—learn to troubleshoot and control the speed of DC motors
- ✓ Avoid the most common mistakes made during the installation and maintenance of brushes
- ✓ Learn how to detect an SCR fault in the power bridge of a DC drive
- ✓ See how noise can affect the operation of a DC drive and learn to correct it
- ✓ Series, shunt, and compound motors require different troubleshooting techniques—we'll show you the quickest ways to find faults
- ✓ Troubleshoot both the circuits and components used in the three most common methods of decelerating a DC motor
- ✓ Bring full-voltage and reduced-voltage DC motors back on-line fast
- ✓ Understand how DC motors are reversed so you'll be better prepared to troubleshoot them
- ✓ Use our proven techniques for detecting problems in a series, shunt, and compound DC motor before they break





CONTENTS: Program provides approximately 4 hours of instructional material (equivalent to a 1-day course).

- Components & operation of DC motor types: series, shunt & compound
- Application, characteristics & uses of series, shunt & compound DC motors & their wiring connections
- Field winding & armature winding circuit representation
- Starting DC motors using drum switches and manual & magnetic starters
- Speed control of DC motors
- Acceleration of DC motors using variable resistance & solid-state controls
- SCR operation & basic troubleshooting
- Introduction to DC drive speed control
- Deceleration circuits & methods used with DC motors: plugging, regenerative braking & friction brakes
- Troubleshooting series, shunt & compound DC motors
- Checking for open & short circuits in DC motors

TECH TIPS

Did you know that a series DC motor without a load can gain enough speed to cause a dangerous runaway condition?

UNDERSTANDING & APPLYING PLCS IN ELECTRICAL CONTROLS

"We looked at training from several different companies. We liked Industrial Text & Video's program so much. They cover everything that we really need to know."

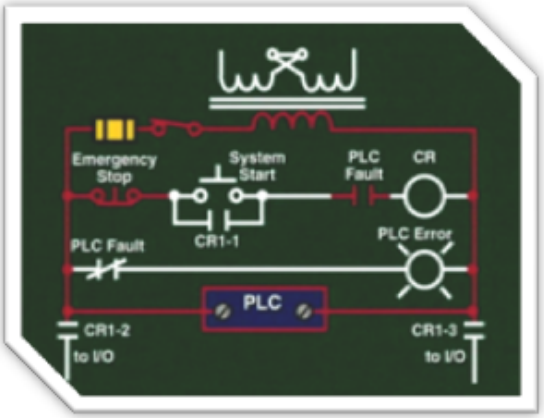
—George Cooros, PLC Training Instructor, US Steel Co.

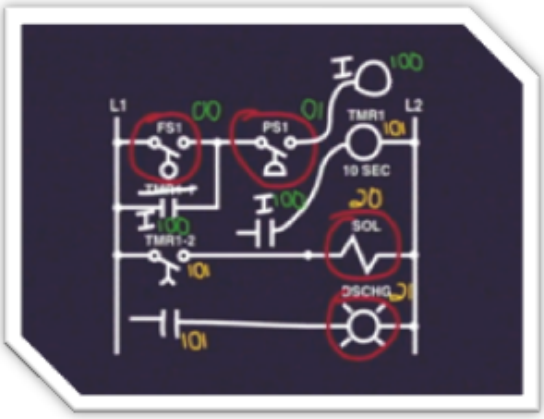
This program covers it all from number systems to general operation to introductory programming. You'll learn how to convert an electromechanical (hardwired) system to a PLC-based system, troubleshoot the I/O system, and much more.

It's packed full of industry secrets, installation hints, and maintenance how-tos—all to make your job easier. This program gives maintenance personnel the skills necessary to troubleshoot the controller and determine whether the problem is with the controller, the wiring, or a field device.

PLCs—What Everyone Needs to Kno

- ✓ If you're using PLCs to control motors, make sure you're implementing low-voltage protection—we'll show you how and help you avoid potential injury to personnel and equipment
- ✓ Is your PLC system safely and properly installed—learn which sections of the control circuit must be left hardwired for safety reasons
- ✓ One small wiring mistake during trouble-shooting will make things worse—we'll show you the right way to do it
- ✓ Follow our step-by-step method of converting a hardwired relay system to a PLC-based system—do it quickly and do it right!
- ✓ Troubleshoot the complete discrete I/O system—see it graphically—from power line problems to wiring connections to I/O modules to the detection of a bad field device
- ✓ Does everybody on your staff know how to troubleshoot PLCs and I/O—learn how to use the power of the PLC and its monitoring capabilities to help you





CONTENTS:

Program provides approximately 4 hours of instructional material (equivalent to a 1-day course).

- PLC principles of operation
- Ladder diagrams and the PLC
- Ladder symbology & power flow: continuity & logic
- Binary concepts & number systems used in PLCs
- Input and output (I/O) system addressing & structure
- Discrete I/O modules: interface installation & wiring
- Basic relay instructions
- Timer control: ON-delay & OFF-delay timers
- PLC control circuit examples & implementations: start/stop motor circuit (2-wire & 3-wire control), wiring & interfacing to magnetic starters, reversing motor control & interlocking
- Troubleshooting the CPU & I/O system
- Isolating faults
- Sections to leave hardwired for safety reasons
- PLC preventive maintenance

TECH TIPS

Did you know that you should never use normally open devices programmed as normally closed devices in safety situations?