Industrial Maintenance

Troubleshooting
Industrial Controls Training System

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Safety and Common Symbols

The following safety and common symbols may be used in this manual and on the equipment:

Symbol	Description
⚠ DANGER	**DANGER** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
⚠ WARNING	**WARNING** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
CAUTION	**CAUTION** used without the *Caution, risk of danger* sign ⚠, indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.
	Caution, risk of electric shock
	Caution, hot surface
	Caution, risk of danger
	Caution, lifting hazard
	Caution, hand entanglement hazard
	Notice, non-ionizing radiation
	Direct current
	Alternating current
	Both direct and alternating current
	Three-phase alternating current
	Earth (ground) terminal

Safety and Common Symbols

Symbol	Description
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position of a bi-stable push control
	Out position of a bi-stable push control

We invite readers of this manual to send us their tips, feedback, and suggestions for improving the book.

Please send these to did@de.festo.com.

The authors and Festo Didactic look forward to your comments.

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Preface

The Lab-Volt Troubleshooting manual, p/n 85082, introduces methods to develop skills in troubleshooting.

This manual applies to the following systems:

- Fundamental Controls
- Basic Controls
- Programmable Logic Controller
- Motor Drives

About This Manual

The exercises in this manual, *Troubleshooting*, complement the exercises contained in the manuals *Basic Controls*, *Programmable Logic Controller*, and *Motor Drives*.

The present manual is divided into four units:

- Unit 1 introduces troubleshooting methods;
- Unit 2 introduces the troubleshooting methods that apply to basic motor control circuits. The equipment supplied with the Fundamental Controls system, Model 8036-0 or Basic Controls system, Model 8036-1 (or 8036-E), is required to perform this unit;
- Unit 3 introduces the troubleshooting methods that apply to circuits where a PLC is used. The equipment supplied with the Programmable Logic Controller system, Model 8036-2, is required to perform this unit;
- Unit 4 introduces the troubleshooting methods that apply to AC and DC drive circuits. The equipment supplied with the Motor Drives system, Model 8036-3 (or 8036-B), is required to perform this unit.

Each exercise is divided into the following sections:

- A clearly defined Exercise Objective;
- A Discussion of the theory involved in the exercise;
- A Procedure Summary which provides a bridge between the theoretical Discussion and the laboratory Procedure;
- A step-by-step laboratory Procedure.

Safety Considerations

Make sure that you are wearing appropriate protective equipment before performing any of the exercises in this manual. Remember that you should never perform an exercise if you have any reason to think that a manipulation could be dangerous to you or your teammates.

Reference Material

Refer to the component data sheets for detailed information about the devices. These data sheets are included on the CD supplied with the manual *Basic Controls*, Lab-Volt p/n 39163 (or 87774).

Prerequisite

To perform the exercises in this manual, you should have completed the following manuals:

- Units 1 and 2: *Basic Controls*, p/n 39163 (or 87774);
- Unit 3: *Basic Controls*, p/n 39163 (or 87774), and *Programmable Logic Controller*, p/n 39436;
- Unit 4: *Basic Controls*, p/n 39163 (or 87774), and *Motor Drives*, p/n 39653 (or one of 85626, 85725, 87667, 87668, 87669).

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Sample Exercise

Extracted from

Student Manual

Voltmeter Method of Troubleshooting

EXERCISE OBJECTIVE

- To become familiar with the voltmeter method of troubleshooting.

DISCUSSION

Voltmeter method of troubleshooting

The voltmeter method of troubleshooting consists in measuring the voltage supplied to each component to detect an abnormal level.

Figure 1-1 illustrates an example of how this method can be used to locate a problem at component C. The dotted lines show where voltages are checked and the circled numbers indicate the steps in sequential order.

The supply voltage is checked first. With the power supply turned on, the + probe of the voltmeter is connected to the + side of the first input device (component A), while the – probe is connected to the – side of the output device (component E). The voltmeter should indicate the supply voltage. If not, the leads connecting the + and – terminals of the power supply to components A and E may be damaged or open.

In this example, all input devices are in the closed condition so as to allow the current to flow through the circuit. Industrial components are often equipped with override push buttons that allow the operator to manually operate the actuators to place the switches in the closed condition during troubleshooting.

If the supply voltage is correct, the + probe of the voltmeter is moved to the + side of component B, while the – probe is left connected to the – side of component E. The voltmeter should indicate the supply voltage. If not, component A or the lead connecting components A and B may be damaged or open.

If the voltage at the + side of component B is correct, the + probe of the voltmeter is moved to the + side of component C, and the voltage is again checked. This approach is repeated until the defective component or lead is located.

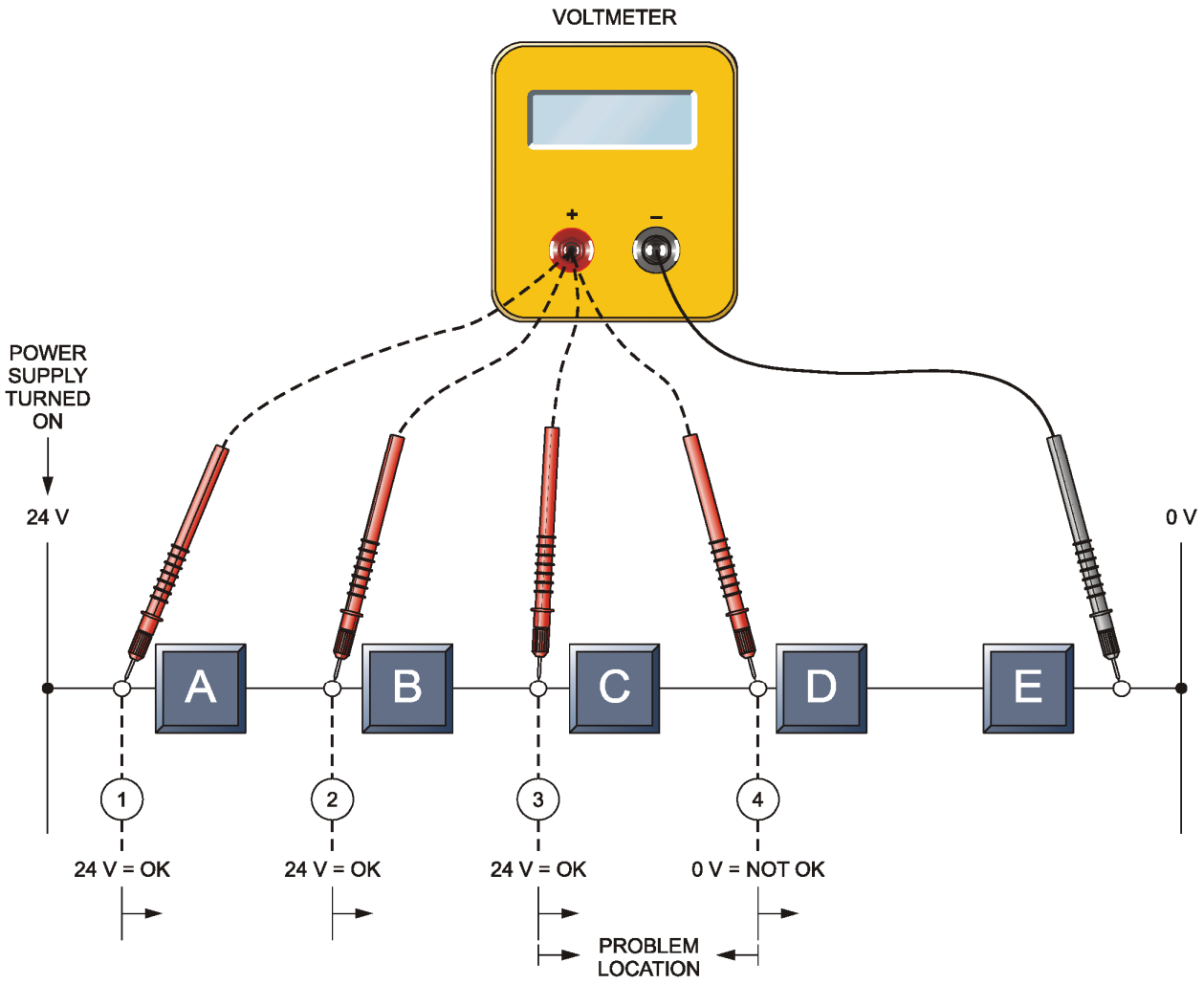


Figure 1-1. The voltmeter method of troubleshooting.

Procedure summary

In this exercise, you will locate the four faults of the Push Buttons module, Model 3110-2. To do so, you will estimate the voltage values at each terminal of the module for both positions of the push buttons. Then, you will power the circuit, insert the faults one at time, and measure the voltage values to find where the values are abnormal and locate the faults.

EQUIPMENT REQUIRED

Refer to the Equipment Utilization Chart, in Appendix A of this manual, to obtain the list of equipment required to perform this exercise.

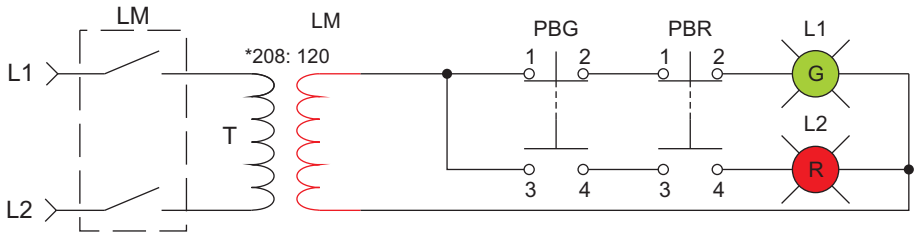
PROCEDURE

Basic setup

☐ 1. Perform the Basic Setup and Lockout Tagout procedures shown in Appendix C.

☐ 2. Set up the circuit shown in Figure 1-2.

Note: *In order to locate the faults of the Push Buttons module, both positions of each push button must be checked.*



*208:120 FOR 120 V - 60 Hz NETWORK
380:110 FOR 220 V - 50 Hz NETWORK
415:110 FOR 240 V - 50 Hz NETWORK
380:120 FOR 220 V - 60 Hz NETWORK

LEGEND

LM = LOCKOUT MODULE
PBG = GREEN PUSH BUTTON
PBR = RED PUSH BUTTON
L1 = GREEN PILOT LIGHT
L2 = RED PILOT LIGHT
T = CONTROL VOLTAGE TRANSFORMER

Figure 1-2. Circuit used to locate the faults of the Push Buttons module.

☐ 3. Referring to the four configurations shown in Figure 1-3, indicate in Table 1-1, the voltages that you should measure between the push button terminals and the neutral terminal of the Lockout Module when no fault is present in the circuit.

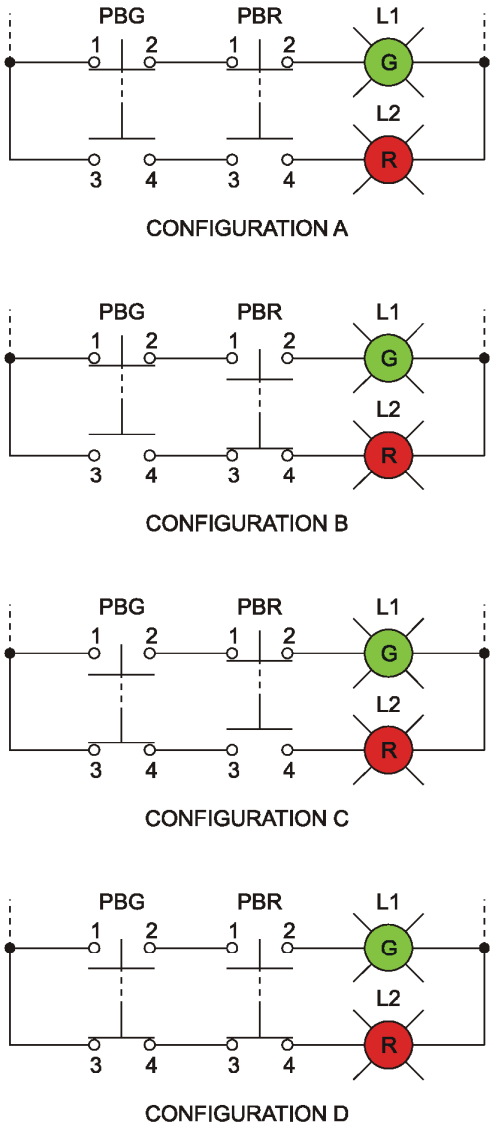


Figure 1-3. Push button configurations.

CONFIGURATION	PBG TERMINAL NUMBER				PBR TERMINAL NUMBER			
	1	2	3	4	1	2	3	4
A								
B								
C								
D								

Table 1-1. Voltage values without inserted faults.

☐ 4. On the Push Buttons module, set fault switch 1 to the I position and fault switches 2, 3, and 4, to the O position.

Perform the energizing procedure.

☐ 5. Does the circuit operate normally for each configuration?

☐ Yes ☐ No

☐ 6. Which configuration does not operate normally?

☐ A ☐ B ☐ C ☐ D

☐ 7. Measure the voltage at the push button terminals and compare your measured voltage values to the values you predicted in Table 1-1 for that configuration.

Indicate where fault 1 is located in Table 1-2.

FAULT SWITCH	PBG		PBR	
	BETWEEN TERMINALS 1 AND 2	BETWEEN TERMINALS 3 AND 4	BETWEEN TERMINALS 1 AND 2	BETWEEN TERMINALS 3 AND 4
1				
2				
3				
4				

Table 1-2. Location of the faults.

☐ 8. Repeat the previous steps to locate the other faults of the Push Buttons module. Make sure you do not set two fault switches to the I position at the same time.

Note: *Fault 2 simulates a dirty contact.*

☐ 9. Do your observations confirm that the voltmeter method of troubleshooting permits the locating of faults in a circuit?

☐ Yes ☐ No

☐ 10. Turn the individual power switch of the AC Power Supply off, disconnect the circuit, and return the equipment to the storage location.

CONCLUSION

In this exercise, you applied the voltmeter method of troubleshooting to locate the faults of the Push Buttons module.

This exercise has allowed you to observe that a good knowledge of system operation and voltage levels is essential when troubleshooting an electrical circuit.

Sample

Extracted from

Instructor Guide

Voltmeter Method of Troubleshooting

ANSWERS TO PROCEDURE STEP QUESTIONS

☐ 3.

CONFIGURATION	PUSH BUTTON GREEN TERMINAL NUMBER				PUSH BUTTON RED TERMINAL NUMBER			
	1	2	3	4	1	2	3	4
A	(1)	(1)	(1)	(3)	(1)	(1)	(3)	(2)
B	(1)	(1)	(1)	(2)	(1)	(2)	(2)	(2)
C	(1)	(2)	(1)	(1)	(2)	(2)	(1)	(2)
D	(1)	(3)	(1)	(1)	(3)	(2)	(1)	(1)
(1) AC line voltage								
(2) ≈0 V								
(3) Induced electrical noise								

Table 1-1. Voltage values without faults.

☐ 5. No.

☐ 6. A.

☐ 7.

FAULT SWITCH	PUSH BUTTON GREEN		PUSH BUTTON RED	
	BETWEEN TERMINALS 1 AND 2	BETWEEN TERMINALS 3 AND 4	BETWEEN TERMINALS 1 AND 2	BETWEEN TERMINALS 3 AND 4
1	✔			
2		✔		
3			✔	
4				✔

Table 1-2. Location of the faults.

To the instructor:

The following tables show the voltages that should be observed when the fault switches are actuated.

CONFIGURATION	PUSH BUTTON GREEN TERMINAL NUMBER				PUSH BUTTON RED TERMINAL NUMBER			
	1	2	3	4	1	2	3	4
A	(1)	(2)	(1)	(3)	(2)	(2)	(3)	(2)
B	(1)	(3)	(1)	(2)	(3)	(2)	(2)	(2)
C	(1)	(2)	(1)	(1)	(2)	(2)	(1)	(2)
D	(1)	(3)	(1)	(1)	(3)	(2)	(1)	(1)
(1) AC line voltage								
(2) ≈0 V								
(3) Induced electrical noise								

Voltage values when fault switch 1 is actuated (I position).

CONFIGURATION	PUSH BUTTON GREEN TERMINAL NUMBER				PUSH BUTTON RED TERMINAL NUMBER			
	1	2	3	4	1	2	3	4
A	(1)	(1)	(1)	(3)	(1)	(1)	(3)	(2)
B	(1)	(1)	(1)	(2)	(1)	(2)	(2)	(2)
C	(1)	(2)	(1)	(1)	(2)	(2)	(1)	(2)
D	(1)	(3)	(1)	(4)	(3)	(2)	(4)	(4)
(1) AC line voltage								
(2) ≈0 V								
(3) Induced electrical noise								
(4) AC line voltage minus ≈5 V for 120 V version (minus ≈10 V for 220 V and 240 V versions)								

Voltage values when fault switch 2 is actuated (I position).

CONFIGURATION	PUSH BUTTON GREEN TERMINAL NUMBER				PUSH BUTTON RED TERMINAL NUMBER			
	1	2	3	4	1	2	3	4
A	(1)	(1)	(1)	(3)	(1)	(2)	(3)	(2)
B	(1)	(1)	(1)	(2)	(1)	(2)	(2)	(2)
C	(1)	(3)	(1)	(1)	(3)	(2)	(1)	(2)
D	(1)	(3)	(1)	(1)	(3)	(2)	(1)	(1)
(1) AC line voltage								
(2) ≈0 V								
(3) Induced electrical noise								

Voltage values when fault switch 3 is actuated (I position).

CONFIGURATION	PUSH BUTTON GREEN TERMINAL NUMBER				PUSH BUTTON RED TERMINAL NUMBER			
	1	2	3	4	1	2	3	4
A	(1)	(1)	(1)	(3)	(1)	(1)	(3)	(2)
B	(1)	(1)	(1)	(3)	(1)	(2)	(3)	(2)
C	(1)	(2)	(1)	(1)	(2)	(2)	(1)	(2)
D	(1)	(3)	(1)	(1)	(3)	(2)	(1)	(2)
(1) AC line voltage								
(2) ≈0 V								
(3) Induced electrical noise								

Voltage values when fault switch 4 is actuated (I position).

☐ 9. Yes