



Technology Training that Works

Practical Industrial Troubleshooting of Instrumentation, Electrical and Process Control for Engineers and Technicians

Contents

1.0	Introduction and basics	1
1.1	Basic Measurements and Control Concepts	1
1.2	Measurement	2
1.3	Basic Measurement Performance Terminology and Specifications	4
1.4	Advanced Measurement Terminology and Specifications	6
1.5	Definitions of Instrumentation Terminology	9
1.6	Introduction to Industrial Troubleshooting	12
1.7	Industrial Instrumentations Basics	13
1.8	Basic Concepts of Industrial Controllers	14
1.9	Control System Basics	15
1.10	Electrical Basics	15
1.11	Meters used in Electrical Troubleshooting	30
1.12	Electrical Devices and Symbols	30
1.13	Troubleshooting Basics	33
1.14	Gaining System Familiarity	34
1.15	System Analysis	36
1.16	Diagnostic Strategies	36
1.17	Fault Diagnosis	37
1.18	Fault Validation	38
1.19	Verify Correct Operation	38
1.20	Tools Used	39
1.21	Safety Aspects	39
1.22	Conclusion	41
2.0	PLC Troubleshooting	43
2.1	Introduction to PLCs	43
2.2	PLC Basics	44
2.3	Reading and Understanding Ladder Logic	47
2.4	PLC Standards	52
2.5	Some Commercial PLCs	53
2.6	System Level Diagnostics	54
2.7	Subsystem Level Diagnostics	56



Technology Training that Works

2.8	CPU System Level Diagnostics	56
2.9	I/O System Diagnostics	58
2.10	MMI Subsystem Diagnostics	60
2.11	Software Subsystem Diagnostics	62
2.12	Software Subsystem Fault Symptoms and Diagnostic Strategies	62
2.13	CPU Subsystem Troubleshooting	63
2.14	Status Lamps Indicators	63
2.15	I/O Subsystem Troubleshooting	72
2.16	MMI Subsystem Troubleshooting	76
2.17	Software Subsystem Troubleshooting	78
2.18	Advanced Troubleshooting of CPU Subsystems	78
2.19	Advanced Troubleshooting of I/O Subsystems	83
2.20	Advanced Troubleshooting of MMI Subsystems	86
2.21	Advanced Troubleshooting of Software Subsystems	86
2.22	Summary	89
2.23	Appendix- References	89

3.0 Sensors and Measuring Devices 91

3.1	Introduction	91
3.2	Sensors Role in Process Control	91
3.3	Types of Sensor Devices	93
3.4	Diagnostic Strategies Common to all Sensor Types	94
3.5	Common Troubleshooting Methods	95
3.6	Switches	97
3.7	Position Encoder Troubleshooting	105
3.8	Optical Sensor Troubleshooting	111
3.9	Temperature Sensor Troubleshooting	118
3.10	Pressure Sensor Troubleshooting	129
3.11	Magnet Sensor Troubleshooting	136
3.12	Pressure Transmitters	139
3.13	Ultra Sonic Devices	139
3.14	Time of Flight Flow Meters	139
3.15	Doppler Flow Meters	140
3.16	Magnetic Flow Meters	140
3.17	Advanced Troubleshooting	140
3.18	Corrective/ Preventative/ Predictive Maintenance of Instruments	142
3.19	Troubleshooting	142
3.20	Conclusion	147

4.0 Actuators and Drives 149

4.1	Introduction	149
4.2	Actuators in Process Control	149



Technology Training that Works

4.3	Types of Actuators	150
4.4	Diagnostic Strategies Common to all Actuator Types	151
4.5	Common Troubleshooting Methods	156
4.6	Solenoids and Relays	159
4.7	Valve Troubleshooting	168
4.8	Motor Troubleshooting	176
4.9	Conclusion	285
5.0	Electrical Systems	187
<hr/>		
5.1	Introduction	187
5.2	Power Circuits	187
5.3	Control Circuits	188
5.4	Reading and Understanding Electrical Drawings	191
5.5	Wires and Terminal Numbering	200
5.6	Electrical Motors	202
5.7	Switchgears	217
5.8	Overloads and Fault Protection	222
5.9	Phase Failure Relays	222
5.10	Winding Protection Relays	223
5.11	Switchboards	223
5.12	Motor Control Center	224
5.13	The Need for Variable Speed Drives	224
5.14	Power Supply Connections and Earthing Requirements	228
5.15	Commissioning Variable Speed Drives	231
5.16	Conclusion	233
6.0	Communications & Network Troubleshooting	235
<hr/>		
6.1	Introduction	235
6.2	Communication System Modules	235
6.3	Types of Communication Devices	236
6.4	Diagnostics Strategies	236
6.5	Troubleshooting Methods	239
6.6	Troubleshooting Industrial Data Communications	241
6.7	Conclusion	262
7.0	Troubleshooting Tools and Instruments	263
<hr/>		
7.1	Introduction	263
7.2	Basic Principles in Using a Drawing and Meter in Troubleshooting Circuits	265
7.3	Checks for Circuit Continuity with Discarded Supply	266



Technology Training that Works

7.4	Checks for Circuit Continuity with Live Supply	269
7.5	Tests and Methods	271
7.6	Testing Devices	271
7.7	Circuits	285
7.8	Accurate Wiring of Circuits and Connects	287
7.9	Tests of Installation and Troubleshooting	293
7.10	Fault Analysis	293
7.11	Voltage/ current and Resistance Measurement	298
7.12	Common Rules	304
7.13	Analog and Digital Meters	305
7.14	Testing a Diode	316
7.15	Testing of Diodes/ DIACS/TRIACS with a Meter	316
7.16	Calibrations	320
7.17	Classification of Standards	323
7.18	Standards of Calibrations	324
7.19	Calibration in Instruments	327
7.20	Documentation of Calibration Procedures	328
7.21	Conclusion	331

Practical Exercises	333
----------------------------	------------