



IAWEA

Fall Operators Conference

September 9th-10th, 2015



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Vice-President

Jetco Inc.

PRESENTS

**Troubleshooting Control
Systems**



YESTERDAYS CONTROL SYSTEMS

- 1. No PLC's, PanelView Touch Screens, SCADA Computers**
- 2. Mercury Pressure Switches**
- 3. Hands on technology**
 - A. Local Hand, Off, Auto Switches**
 - B. Valves had to be opened/closed by hand**
 - C. You had to walk the plant to verify different pressures and levels**
- 4. Alarms notification was just a light and maybe horn/buzzer**





TRUCK PARTS
TRUCK TRAY

Various small text and diagrams, likely a technical manual or parts list.



PREVENTION OF WORKPLACE INJURY:
ACCIDENT PREVENTION AND FIRST AID TRAINING

COMPANY NURSE
Injury Hotline
1-888-770-0928

RECOMMENDED BY EMPLOYERS & OSHA

- 1** Immediate medical attention is essential. Employees should be instructed on an emergency.
- 2** Supervisors / First Aid workers immediately call injury hotline. Supervisors / First Aid workers should follow instructions of the hotline to determine care.
- 3** Employees should perform a first aid assessment until the phone call help arrives. Workers should not administer medical treatment. Personnel should receive instructions per written a course of complete first aid or location of treatment center details.

OSHA COMPLIANT WITH
EMRCA

Model by National Fire Protection Association

For more information on workplace safety, visit www.osha-slc.gov. OSHA's mission is to prevent workplace injuries and illnesses through safety and health training, research, and enforcement.





water tower
pressure gage
located at city
hall



Today's Control Systems

- Can consist of one or multiple PLC Control Panels
- Each PLC could have 10's to 100's of I/O Points depending on the size of the system.
- PLC Panels can be networked together via Ethernet Networking with CAT5 (copper) and Fiber Optic Cabling.
- Systems can also incorporate radio telemetry communication links to various remote sites.
- All these factors contribute to the complexity of troubleshooting the system.

Before you troubleshoot your system

Have complete documentation for your system.

This would include:

- ✓ **Operation and Maintenance Manuals**
- ✓ **Sequence of Operations or Functional Description**
- ✓ **Wiring Diagrams and Network Layouts for each PLC Control Panel.**
- ✓ **Detailed Bill of Materials that include manufacturer and part numbers.**
- ✓ **Manuals for each piece major piece of equipment or instruments. Level Sensors, Flow Meters, Chlorine Analyzers, VFD's, etc.**



If you intend to perform electrical troubleshooting of your control system and control panels you need to have proper training and have the proper tools, test equipment and safety equipment.

- ✓ **Multi-Meter (Fluke) with the ability to read Volts AC, Volts DC, DC Milli-Amps at a minimum.**
- ✓ **Laptop Computer with proper software and interface modules to connect to your PLC's and Network.**
- ✓ **Arc-Flash Protection Gear**



Main Parts of a PLC System:

Processor

Power Supply

Rack with I/O Modules

Or

Modular I/O Cards

Operator Interface

Rack with I/O



Modular I/O



PLC Processors

SLC 500 Series CompactLogix

Micrologix



Type of I/O Modules:

Digital Input:

- On/Off Signals to PLC such as:
float switches, pressure switches,
selector switches flow pulse
signals, pushbuttons, etc.
- Typically 120Vac or 24Vdc



Type of I/O Modules:

Digital Output:

On/Off Signals that the PLC controls with the programming logic. Used to start/stop pumps/motors, control valve actuators, energize alarms lights/horn, or energize indicating lights.



Type of I/O Modules:

Analog Input:

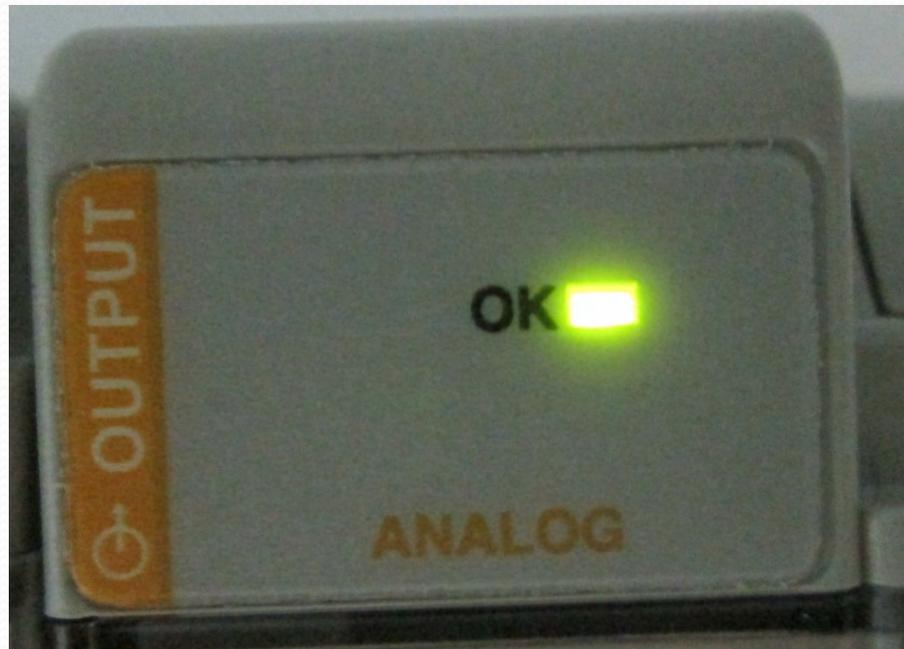
Signals that vary typically a flow rate, tank level, or pressure signal, etc. Types of signals are usually milli-amp or dc voltage (1-5vdc, 0-10vdc)



Type of I/O Modules:

Analog Output:

Signals that vary and are controlled by the PLC programming logic. Used to vary the speed of a VFD, modulate a valve actuator, or provide signal to digital display, etc.



Initial steps in troubleshooting a control panel:

Does the Control Panel have power?

Are any PLC LED's on?

Yes – Main Power is usually ok

No – The first thing will be to get power back on.

Check circuit breakers, fuses, DC Power Supplies and UPS units.



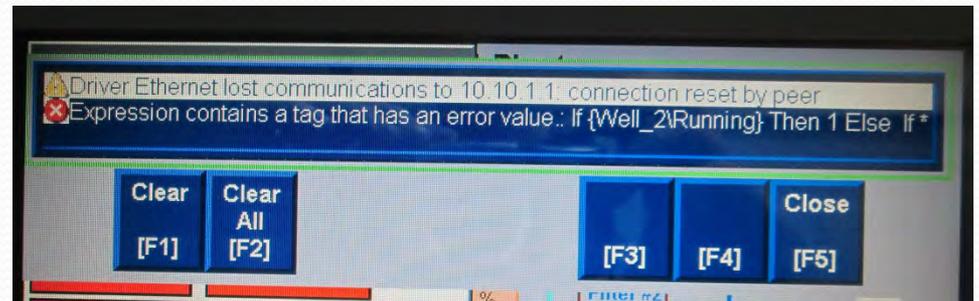
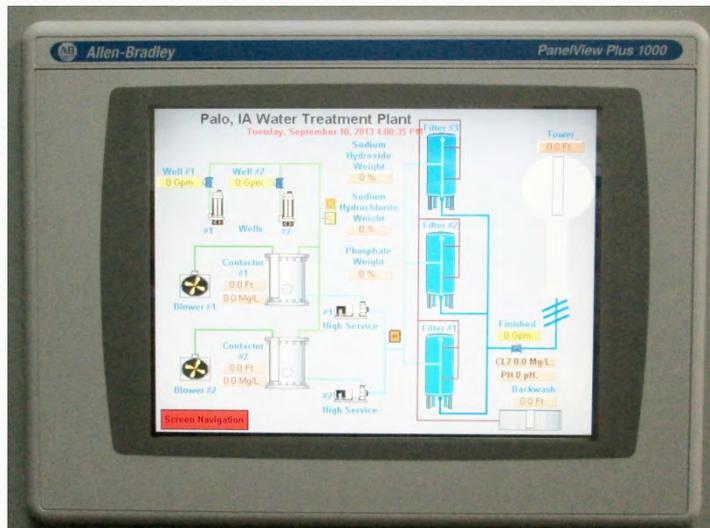
Faulted PLC:

- will not have any Output Module Lights on.
- Processor will have LED indicating a fault.



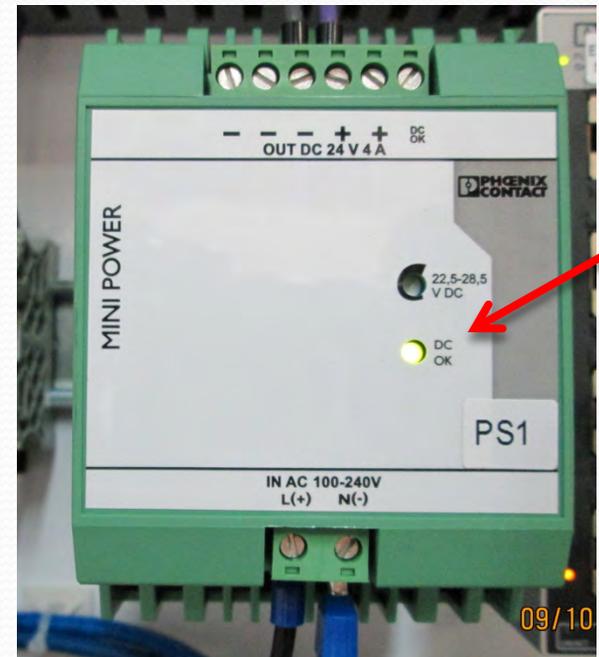
Panelview Operator Interfaces:

- Very minimal troubleshooting
- Verify Power
- Verify Network Connection
- All other issues would most likely be programming issues with Panelview Application or PLC.



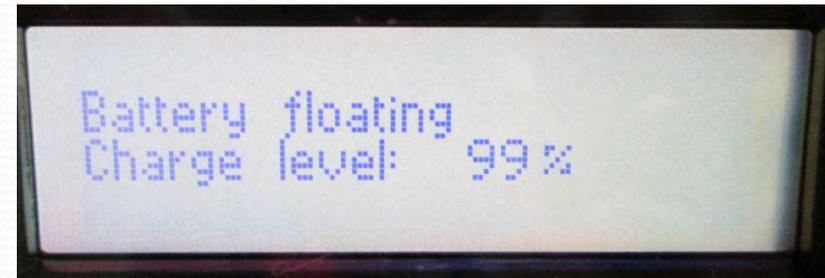
DC Power Supplies:

- Almost all PLC Control Panels will have at least one DC Power Supply.
- LED that will indicate operating status.
- Provide power to DC Inputs, Ethernet Network Switches, Panelviews, PLC's, loop powered instruments, radios.
- They can be a very integral part of the system.



Uninterruptible Power Supplies (UPS):

- 120vac back up power supply.
- Typically wired to provide power for all critical control panel components.
- Most units have a LCD displays for status and alarms.
- Some units have status outputs that can be monitored by the PLC System for alarming.





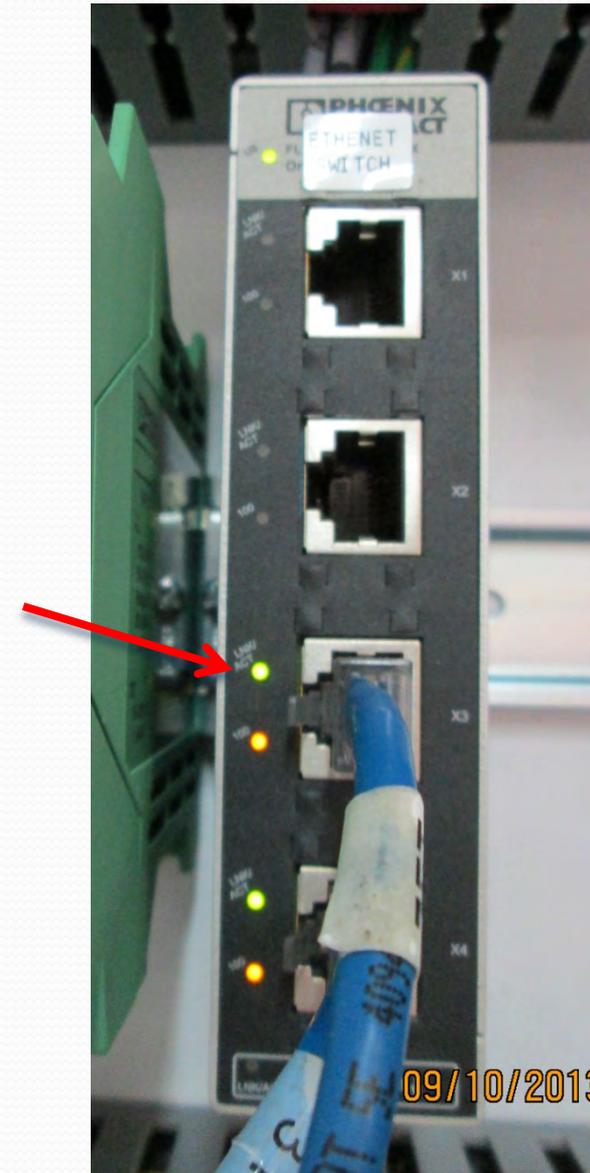
Ethernet Network Troubleshooting

Typical issues:

- **Bad cables or connections on CAT5 (copper) or Fiber Optic Cables.**
- **Failed Hardware such as Network Switches or Fiber Optic Converters**
- **Duplicate IP Address on Network Devices**

Network Switches:

- Each port will have link/status LED's.
- LED's will be flashing if network activity is present.
- 24vdc or 120vac power.





Radio Telemetry Systems

Typical system architectures:

- **Point to Point (one-way)**
- **Point to Point (two-way)**
- **Point to Multi-point**
 - ✓ **Master Site**
 - ✓ **Slave Site(s)**
 - ✓ **Repeater Site(s)**

Radio Telemetry Systems

Troubleshooting typical issues:

- **Loose connections, bad cables or connections on antenna coax cables.**
 - Check connections, check for center coax connection short to ground.**
- **Bad Surge Arrestor**
 - Remove Surge Arrestor from line.**
- **Failed Hardware**
 - Swap radios around in system.**
- **Interference from other radio systems**
 - Requires additional test equipment**

Radio Telemetry Systems

Most radios transceivers will have status LED's that will aid in troubleshooting. Instruction manual from the manufacture will aid in the troubleshooting.



Alarm Dialers

Types:

- Land Line/Dial
- Cellular
- Satellite
- Hardware Type
- Software on a Computer Workstation

Sensaphone
Software

Omni-Site

Win-911



WIN-911

Alarm Dialers

Troubleshooting

Land-line type:

- ✓ Verify Phone line has dial tone
- ✓ Verify Phone numbers are entered correctly
- ✓ Cause and alarm and monitor indicating lights on dialer.

Cellular:

- ✓ Verify Cellular Service is activated
- ✓ Check Signal Strength via LCD Display on Dialer
- ✓ Cause and alarm and monitor indicating lights on dialer.

SCADA Computer Workstation

- Typically a Workstation Operating on a Microsoft Windows Operations.
- System could have multiple computer and servers depending on size
- SCADA Software could be Wonderware, Allen Bradley Factory Talk or several other.

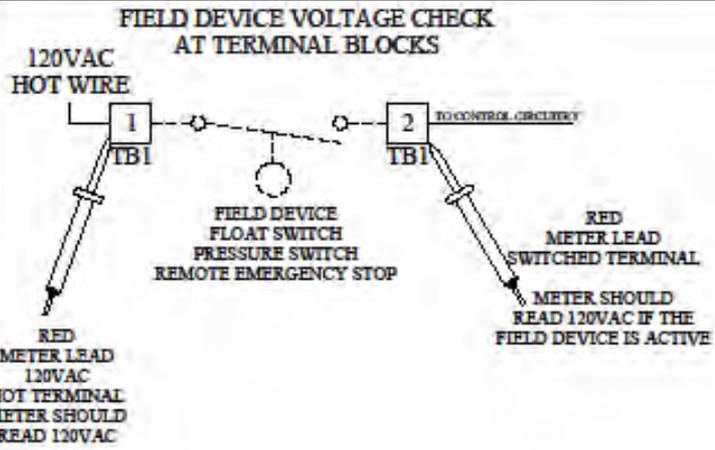
Troubleshooting:

Depending on the issue extensive training in the set-up and configuration of the software is required for troubleshooting.

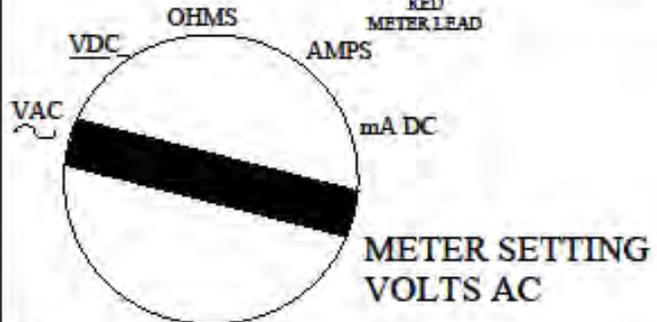
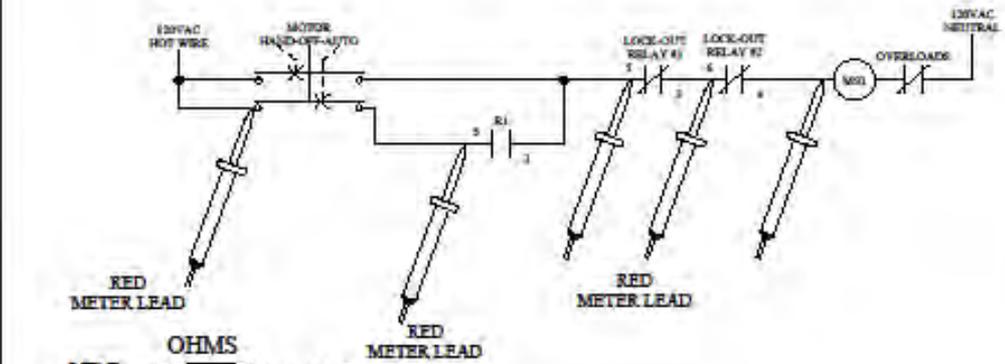
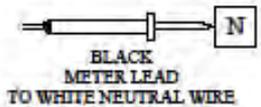


Instrumentation and Field Devices

- **Failure of instrumentation or a field device will be the most common issue for a control system.**
- **Documentation on all your instrumentation and knowledge of it's function/operation will aide in troubleshooting.**
- **If you are trained and knowledgeable with the use of a multi-meter to check digital and analog signals narrowing down the source of your malfunction is fairly simple task.**

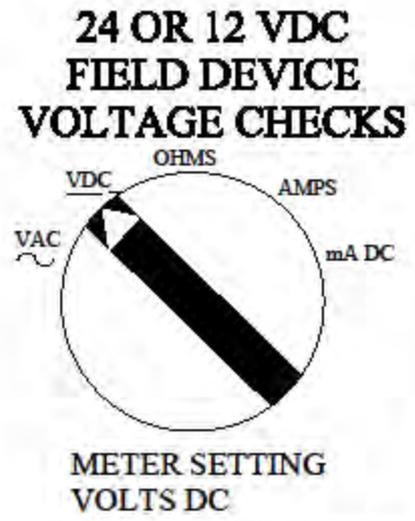
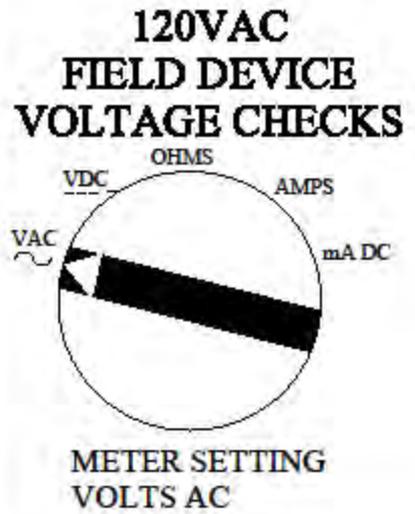
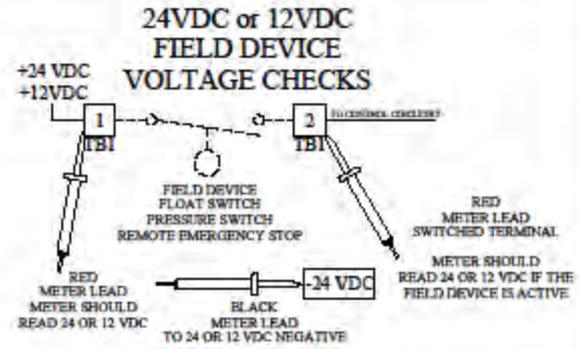
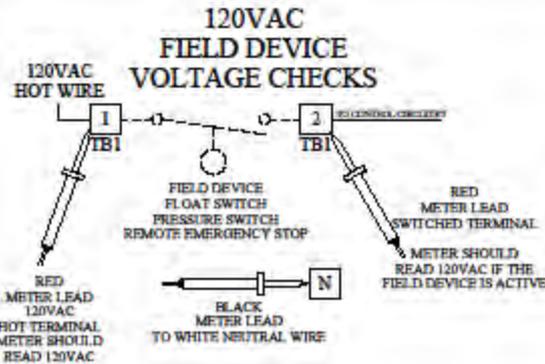


120VAC CONTROL POWER CHECKS



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 208 1ST AVE. S.
 ALTOONA, IA 50009
 PH. 515.967.5874
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 EMAIL:
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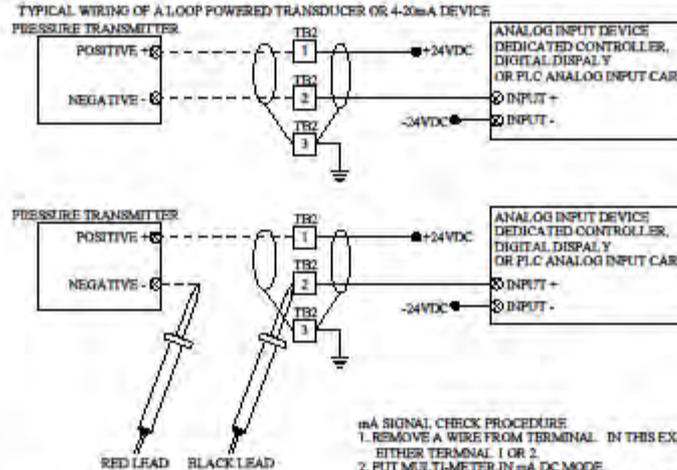
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DESIGNER	DATE
CONTRACT NUMBER	
PROJECT	
LOCATION	
PROJECT NO.	
DATE	
BY	
NO.	



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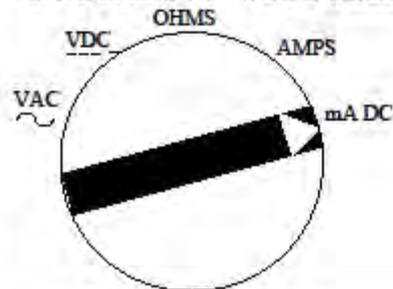
JOB INFORMATION	
DESIGNER	J. D. ...
CHECKED	...
DATE	...
PROJECT NO.	...
PROJECT	...
DATE	...

4-20mA ANALOG FIELD DEVICE CURRENT CHECKS



- mA SIGNAL CHECK PROCEDURE
1. REMOVE A WIRE FROM TERMINAL. IN THIS EXAMPLE CAN BE EITHER TERMINAL 1 OR 2.
 2. PUT MULTI-METER IN mA DC MODE.
 3. PLACE THE RED METER LEAD ON THE WIRE THAT WAS REMOVED.
 4. PLACE THE BLACK METER LEAD ON THE TERMINAL IT WAS REMOVED FROM.
 5. METER SHOULD DISPLAY THE mA READING.

4-20mA FIELD DEVICE CURRENT CHECKS



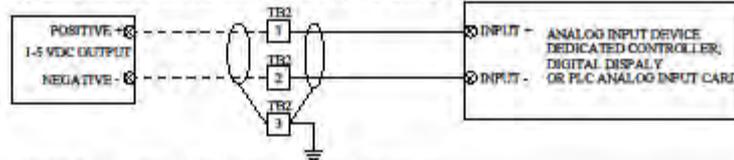
METER SETTING
VOLTS AC

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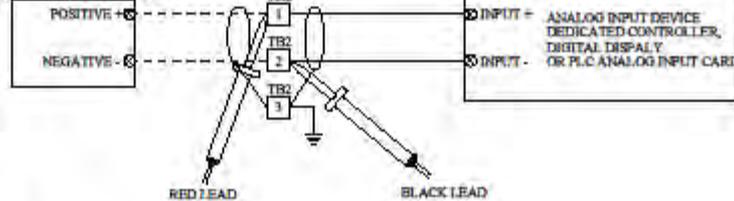
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DESIGN NO.	DATE
CONTRACT NO.	PROJECT NO.
CLIENT	LOCATION
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PROJECT	BY
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ANALOG FIELD DEVICE VOLTAGE CHECKS

TYPICAL WIRING OF A DEVICE WITH A 1-10VDC ANALOG OUTPUT

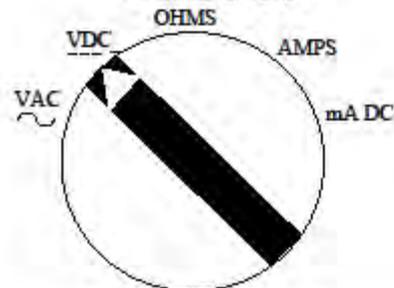


TYPICAL WIRING OF A DEVICE WITH A 1-10VDC ANALOG OUTPUT
PRESSURE TRANSMITTER



- VOLTAGE ANALOG SIGNAL CHECK PROCEDURE
1. PLACE THE MULTI-METER ON VDC.
 2. PLACE RED LEAD ON THE SIGNAL POSITIVE
 3. PLACE THE BLACK LEAD ON THE SIGNAL NEGATIVE.

VOLTAGE ANALOG FIELD DEVICE CHECKS

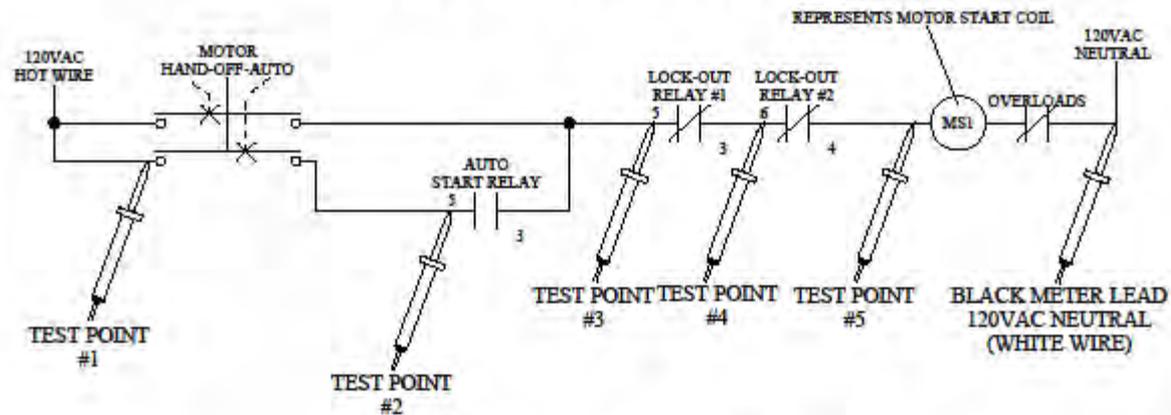


**METER SETTING
VOLTS AC**

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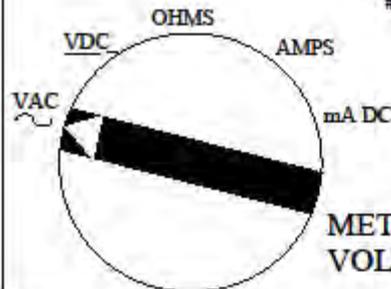
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DESIGNER	DATE
CHECKED	BY
DATE	BY

120VAC HAND-OFF-AUTO CONTROL TROUBLE SHOOTING



TEST POINTS FOR RED METER LEAD

1. SHOULD ALWAYS READ 120VAC IF 120VAC CONTROL POWER IS AVAILABLE.
2. SHOULD READ 120VAC IF SELECTOR SWITCH IS IN AUTO.
3. SHOULD READ 120VAC IF SELECTOR SWITCH IS IN HAND OR AUTO AND AUTO START RELAY IS ENERGIZED.
4. SHOULD READ 120VAC IF THE PUMP IS REQUIRED TO RUN IN HAND OR AUTO AND LOCK OUT #1 IS NOT ACTIVE.
5. SHOULD READ 120VAC IF MOTOR IS REQUIRED AND LOCK OUT #1 AND LOCK OUT #2 ARE NOT ACTIVE.



METER SETTING
VOLTS AC

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JOB INFORMATION

DATE	10/10/2010
TIME	
BY	W. B. L.
PROJECT	100
NO.	100



Preventative Maintenance

- Keeping field instruments such as transducers and floats clear of debris, grease, rust or scaling build up.
- Periodic flushing of dead end pressure lines on transducers and pressure switches.
- Periodic checks and tightening of wiring connections.
- Prevent condensation and other sources of moisture from entering control panels and junction boxes.
- Test your Alarm Notification System(s) to ensure proper operation.
- Test your battery back-up power systems or UPS.

Preventative Maintenance: What Happened Here?





Summary

- **Keeping System Documentation is a key in being able to safely and efficiently troubleshoot your controls system.**
- **Field Device, Instrument or PLC Hardware Failure is the main cause of system malfunction.**
- **The PLC is the device that has the programmed logic to control your system. Once your system has been installed, tested and operational the PLC logic will not change.**
- **For your safety do not enter or attempt to troubleshoot an energized control panel without the proper training or knowledge of the system. If you are at all uncomfortable troubleshooting electrical systems call your Systems Integrator.**
- **Questions?**