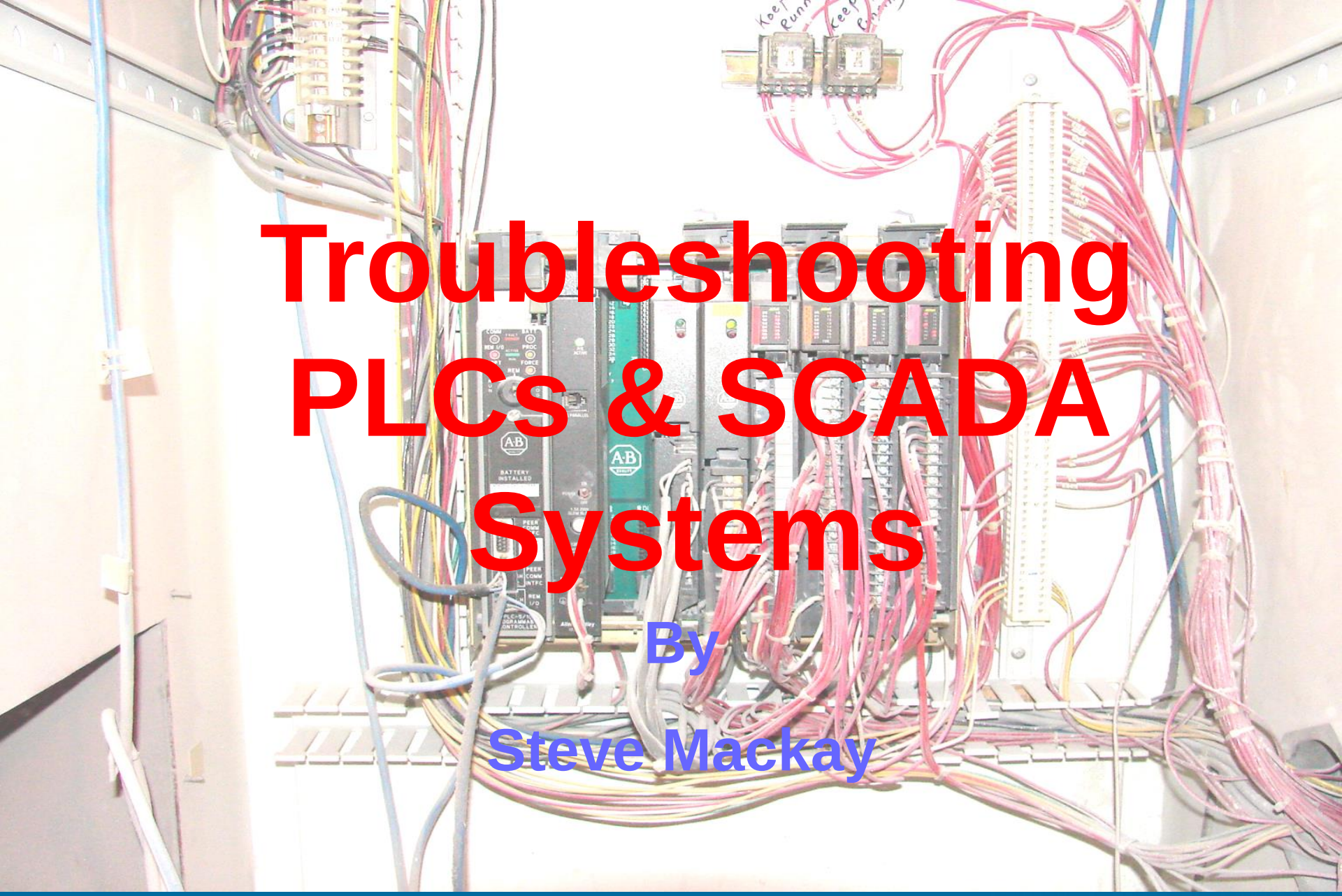
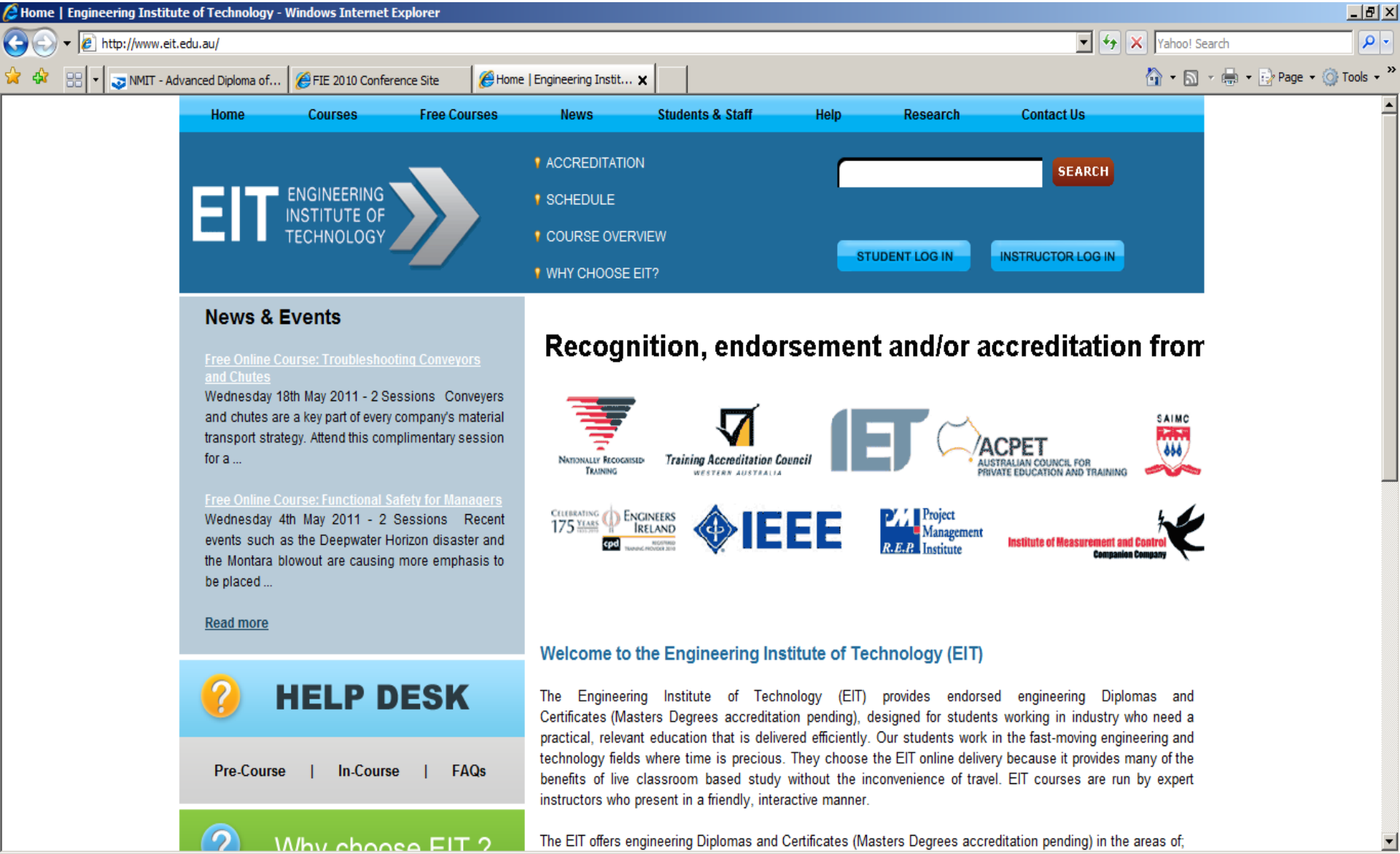


Troubleshooting PLCs & SCADA Systems

By

Steve Mackay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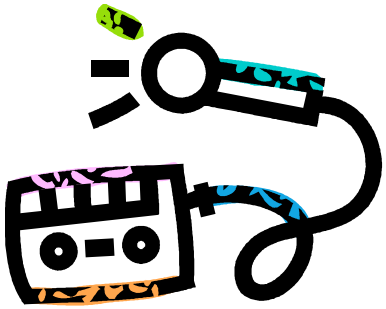

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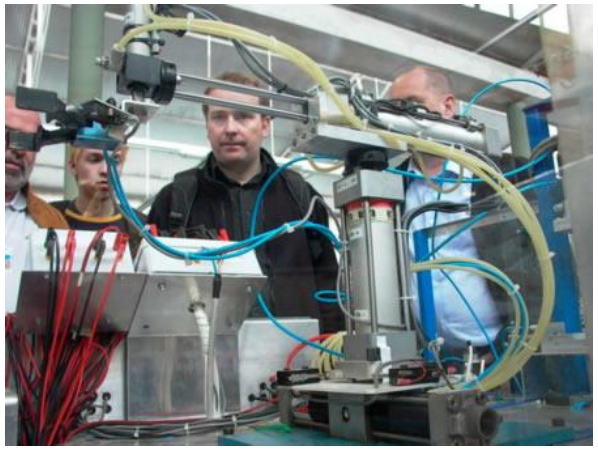
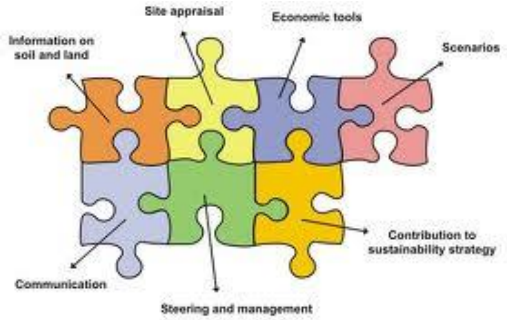
Objectives

- Quickly interpret, isolate and fix common hardware problems related to PLC input/outputs
- Troubleshoot PLC software
- Identify data communications problems

Topics



- Introduction to PLC
- Internal or External Problem
- Internal Problems
- External Problems - I/O and Comms
- Applications
- SCADA Troubleshooting
- Conclusion



Industrial Automation Skills

"Today's Industrial Automation engineer and technician should be able to troubleshoot, identify, prevent and fix common PLC and SCADA problems.

If you have worked in industry, you are probably familiar with PLCs and SCADA systems and understand their basic operation.

You want to be able to quickly diagnose problems using your PLC software; know how to connect to the right PLC processor online, make minor changes to get the machine running and have the know-how to test new ideas and hardware components. In addition, you want to be able to do troubleshooting and problem solving of your associated SCADA system".

Introduction to the PLC

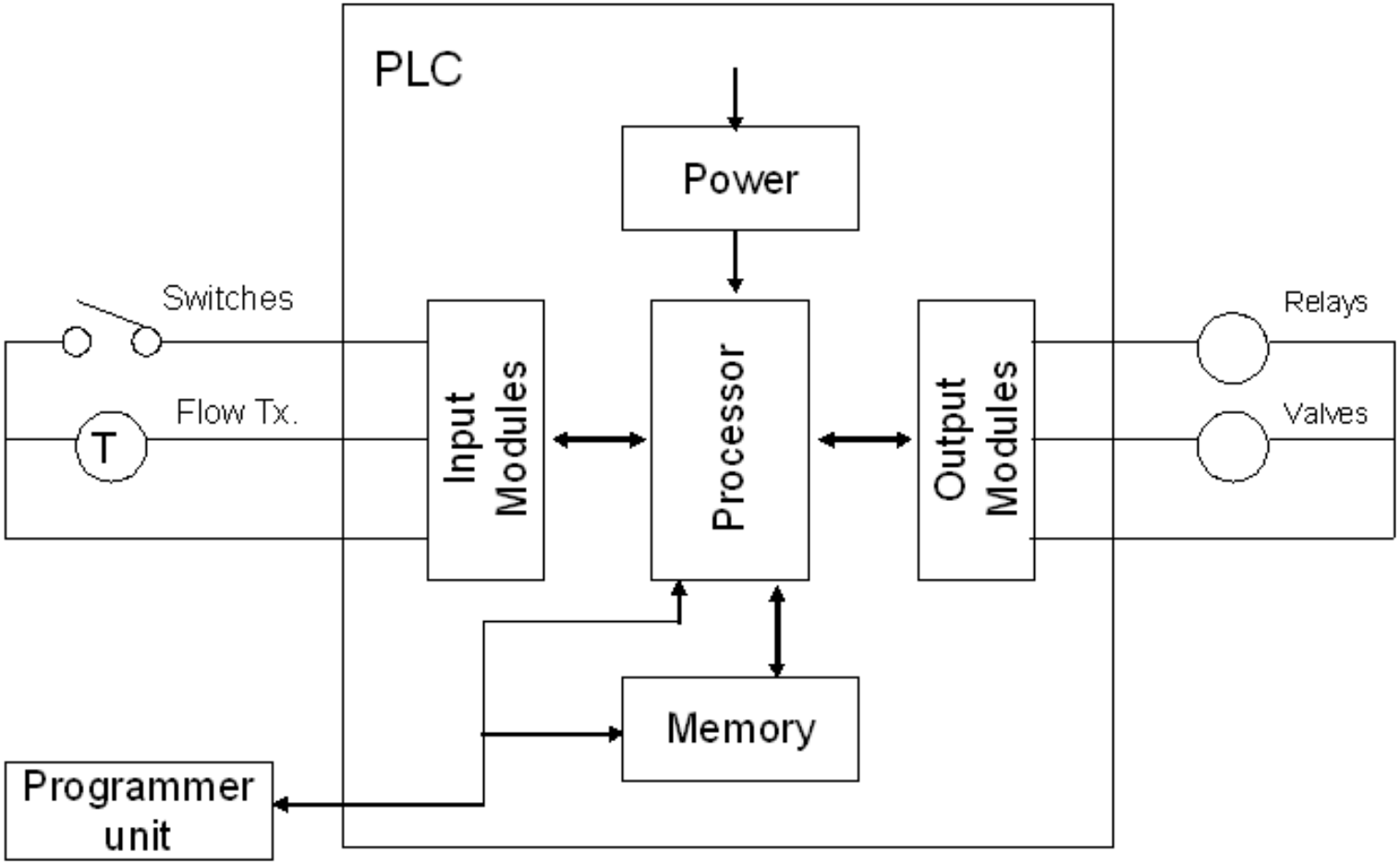
Introduction to the PLC

- “PLC” means “Programmable Logic Controller”. The word “Programmable” differentiates it from the conventional hard-wired relay logic
- The PLC as a unit consists of a processor to execute the control action on the field data provided by input and output modules
- In a programming device, the PLC control logic is first developed and then transferred to the PLC
- PAC or Programmable Automation Controller

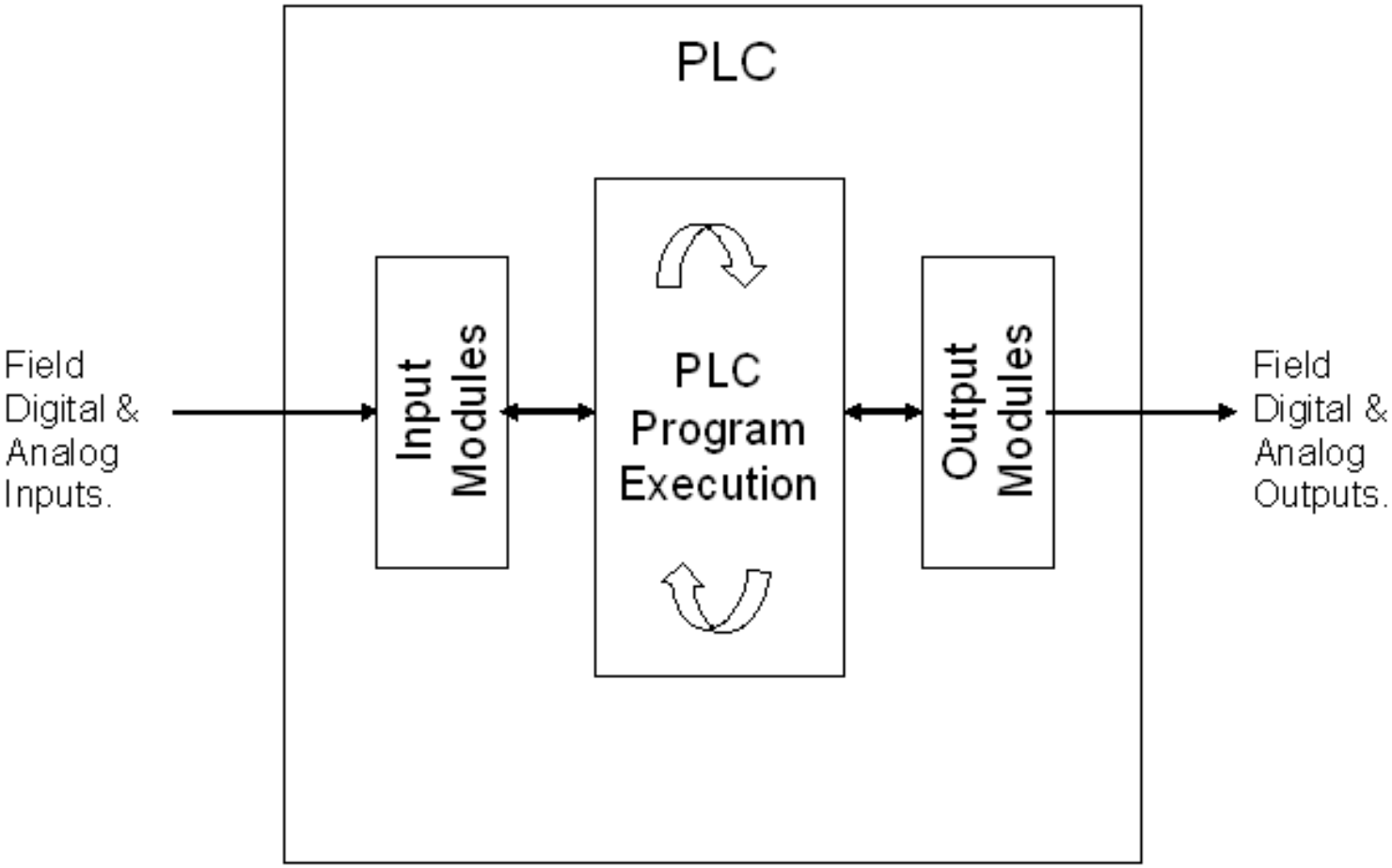
What can a PLC do?

- It can perform relay-switching tasks.
- It can conduct counting, calculation and comparison of analog process values.
- It offers flexibility to modify the control logic, whenever required, in the shortest time.
- It responds to the changes in process parameters within fraction of seconds.
- It improves the overall control system reliability.
- It is cost effective for controlling complex systems.
- Trouble-shooting becomes simpler and faster.
- An operator can easily interact with the process with the help of the HMI (Human-Machine Interface) computer.

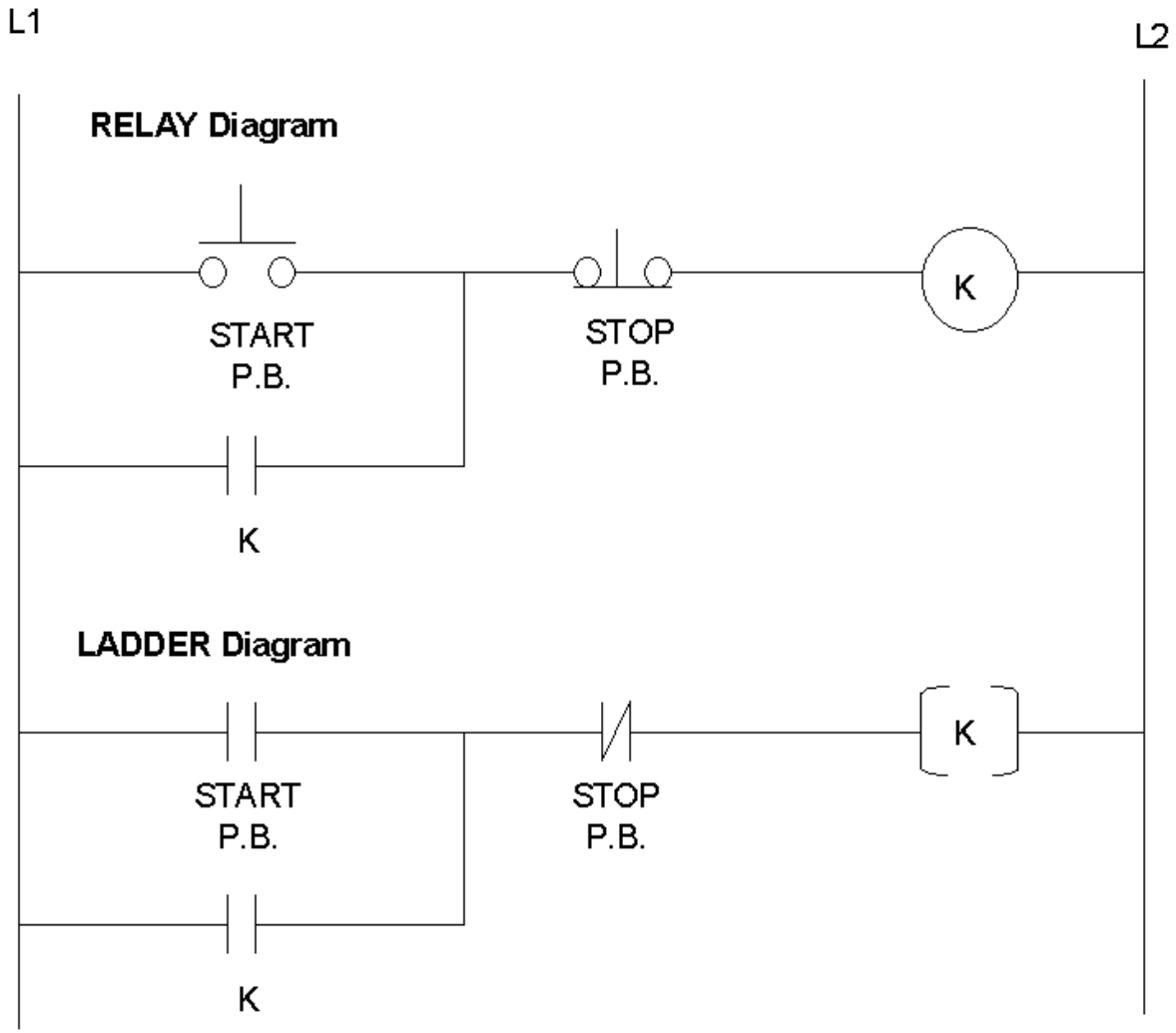
Basic block diagram of the PLC



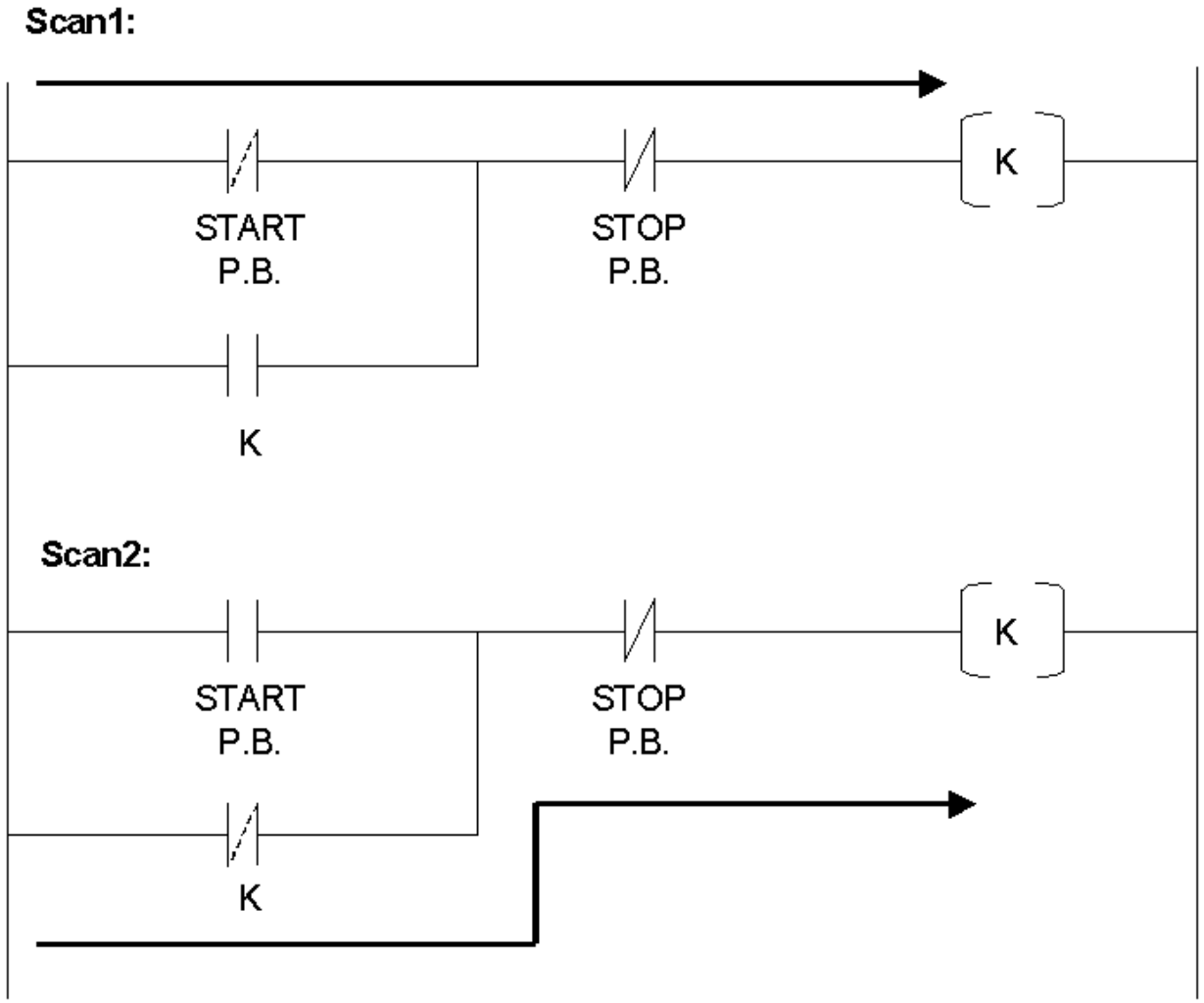
Working of a PLC CPU

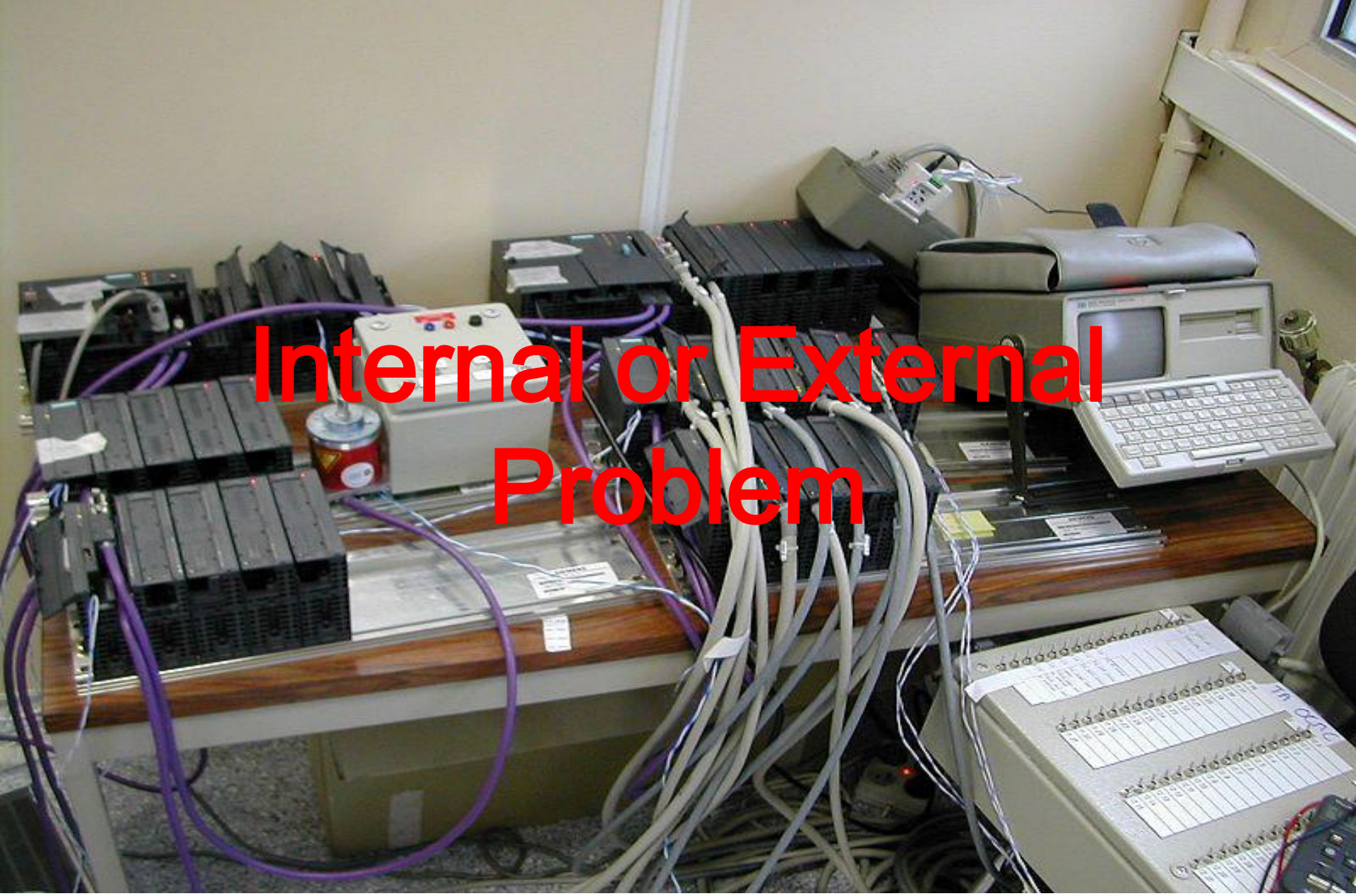


Ladder diagram



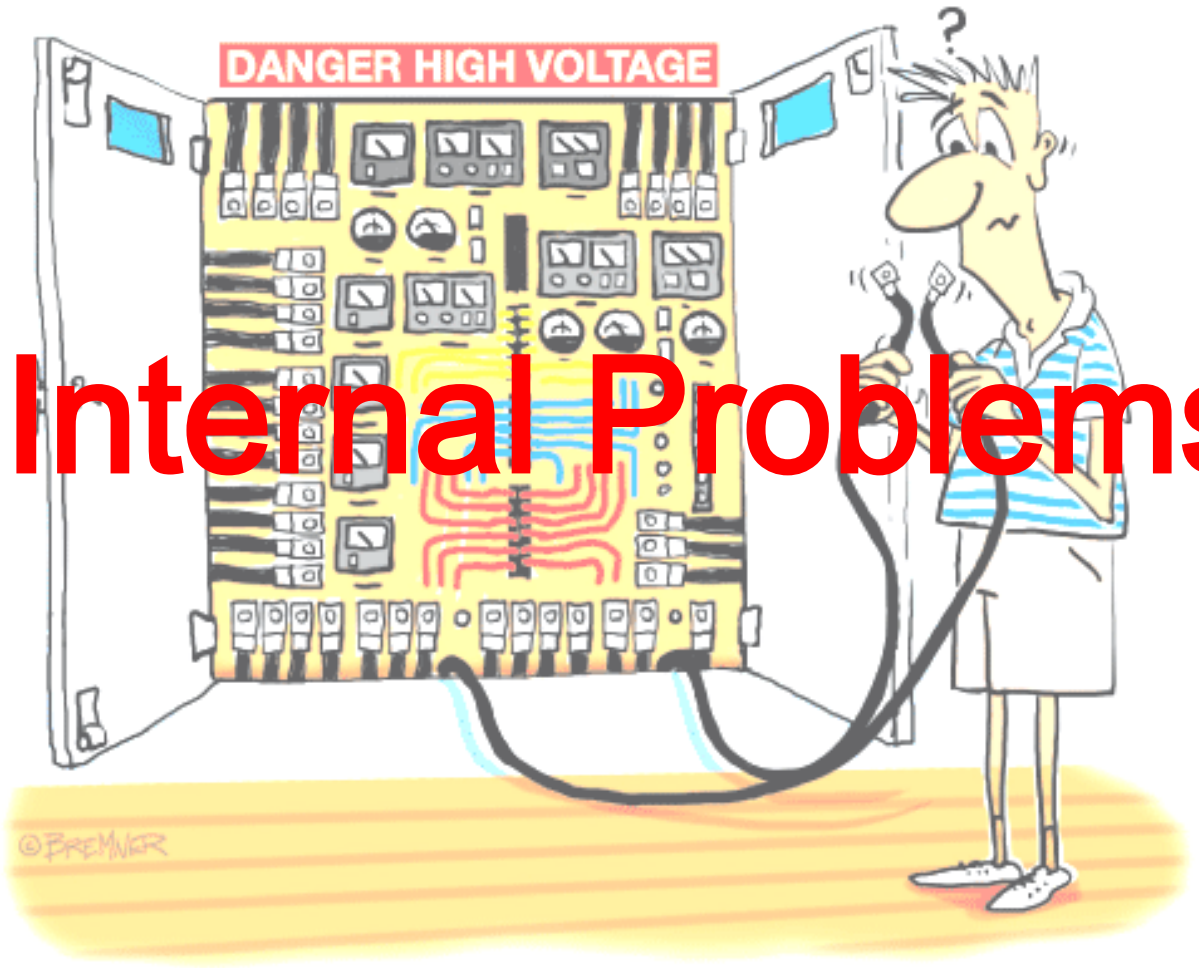
Ladder program execution




Internal or External Problem

Internal or External Problem ?

- Over 80% of malfunctions are with I/O modules and field equipment
- Problems related to specific I/O module or I/O device are external problems
- Large groups of failures – internals of PLC

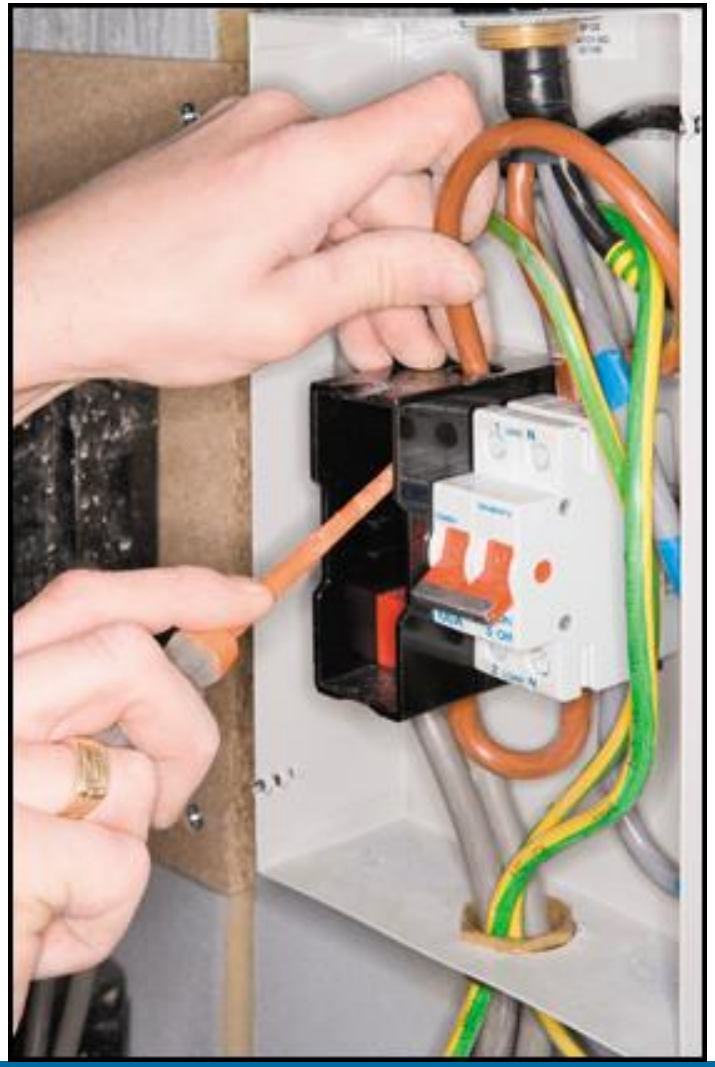


Internal Problems

Internal Problems

- Check earthing/grounding is correct
- Check power supply to PLC is within correct range and ac ripple on dc supplies is not excessive
- Batteries on PLC are OK
- PLC program hasn't been corrupted
- Examine internal diagnostics for a crash of PLC program

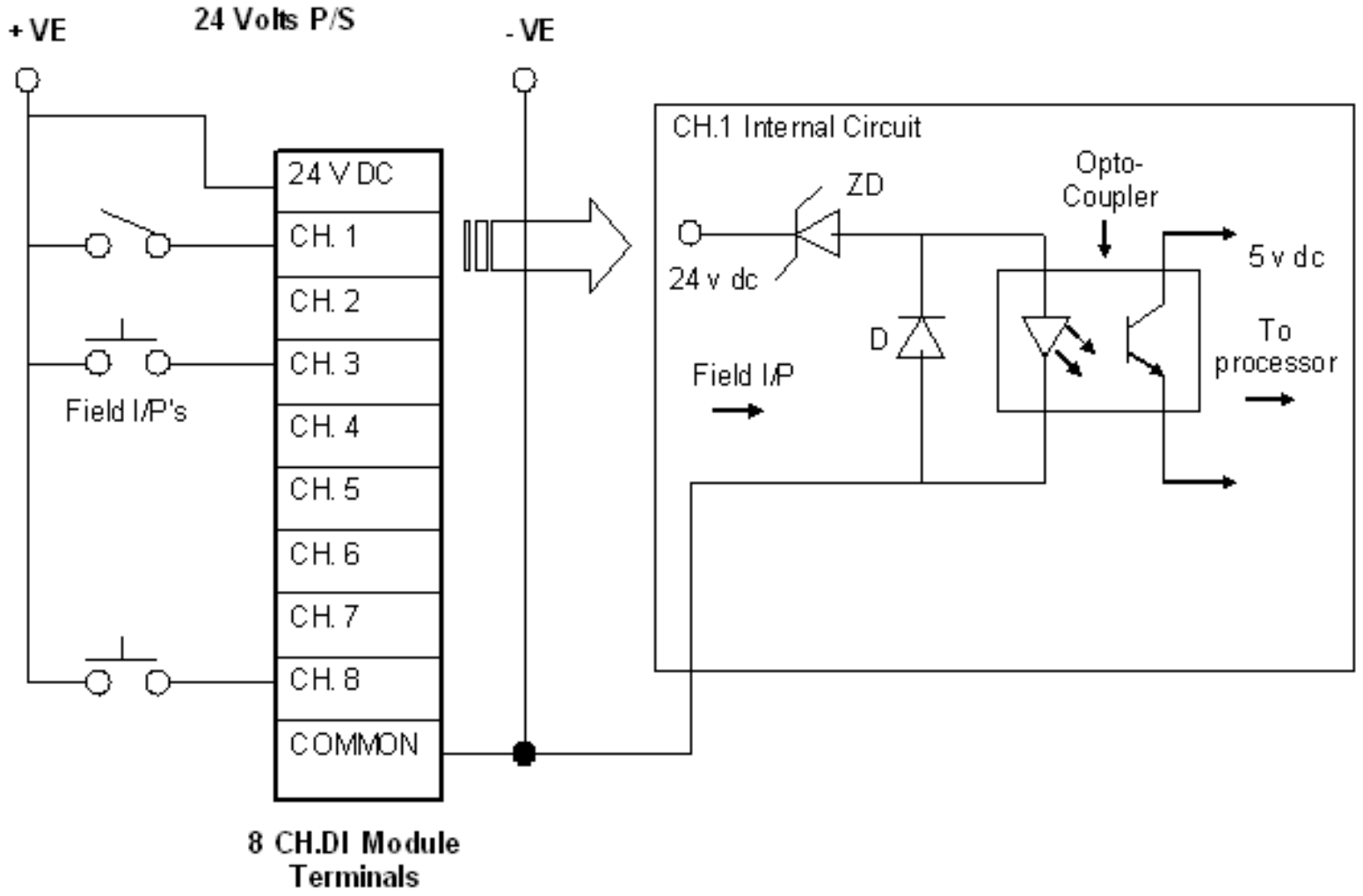
External Problems



External Problems – digital Inputs

- Check Power supply to module
- Look for where power to digital Input comes from
- Check fuses/breakers
- Adequate changes of voltage to Input
- Digital input fine ===> PLC program problem

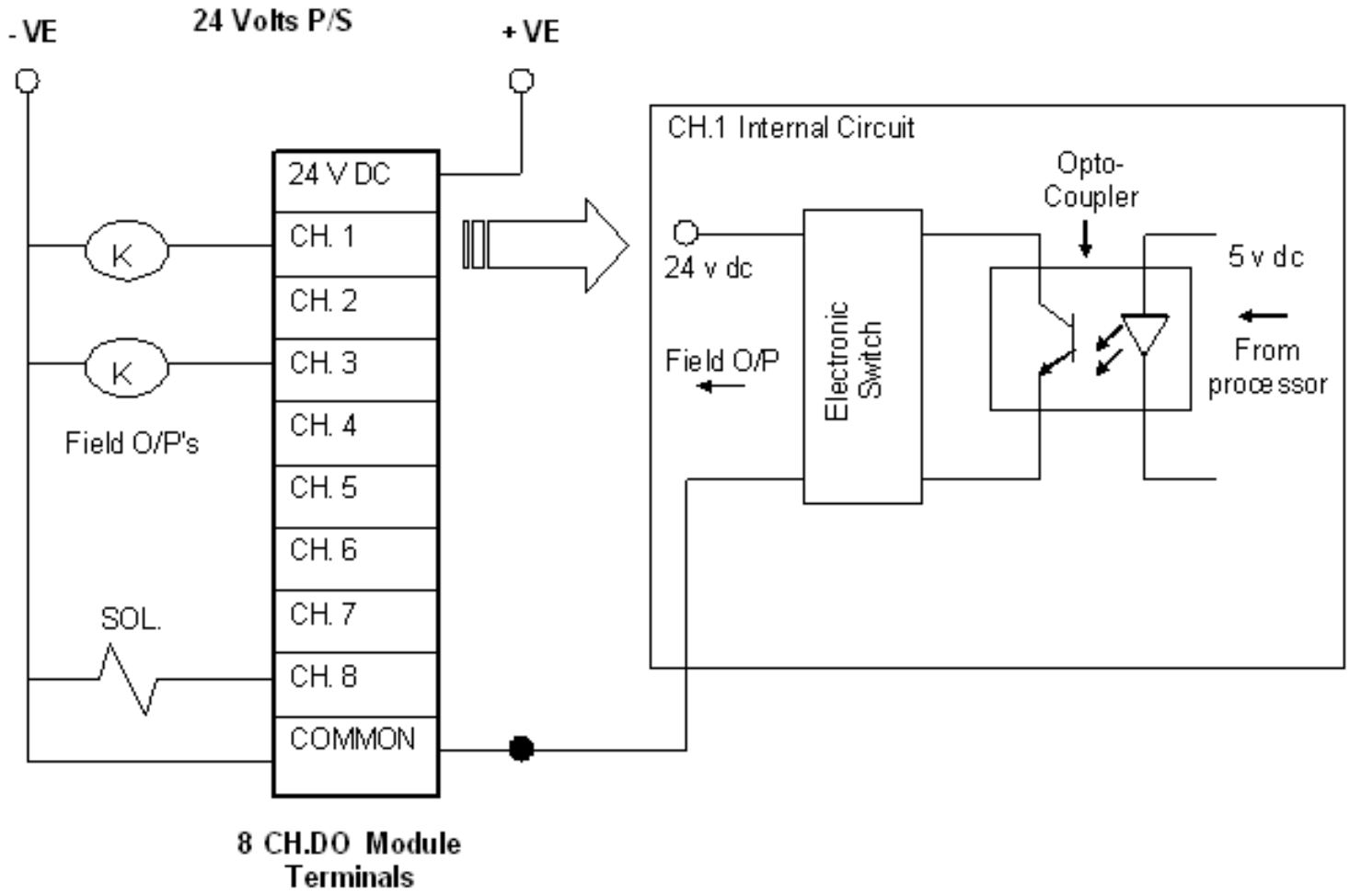
Discrete DC input module



External Problems – digital outputs

- Check Power supply to module
- Check power output from PLC
- Check fuses
- Force digital outputs on and off
- Use test load rather than open circuit – why ?

Discrete DC output module

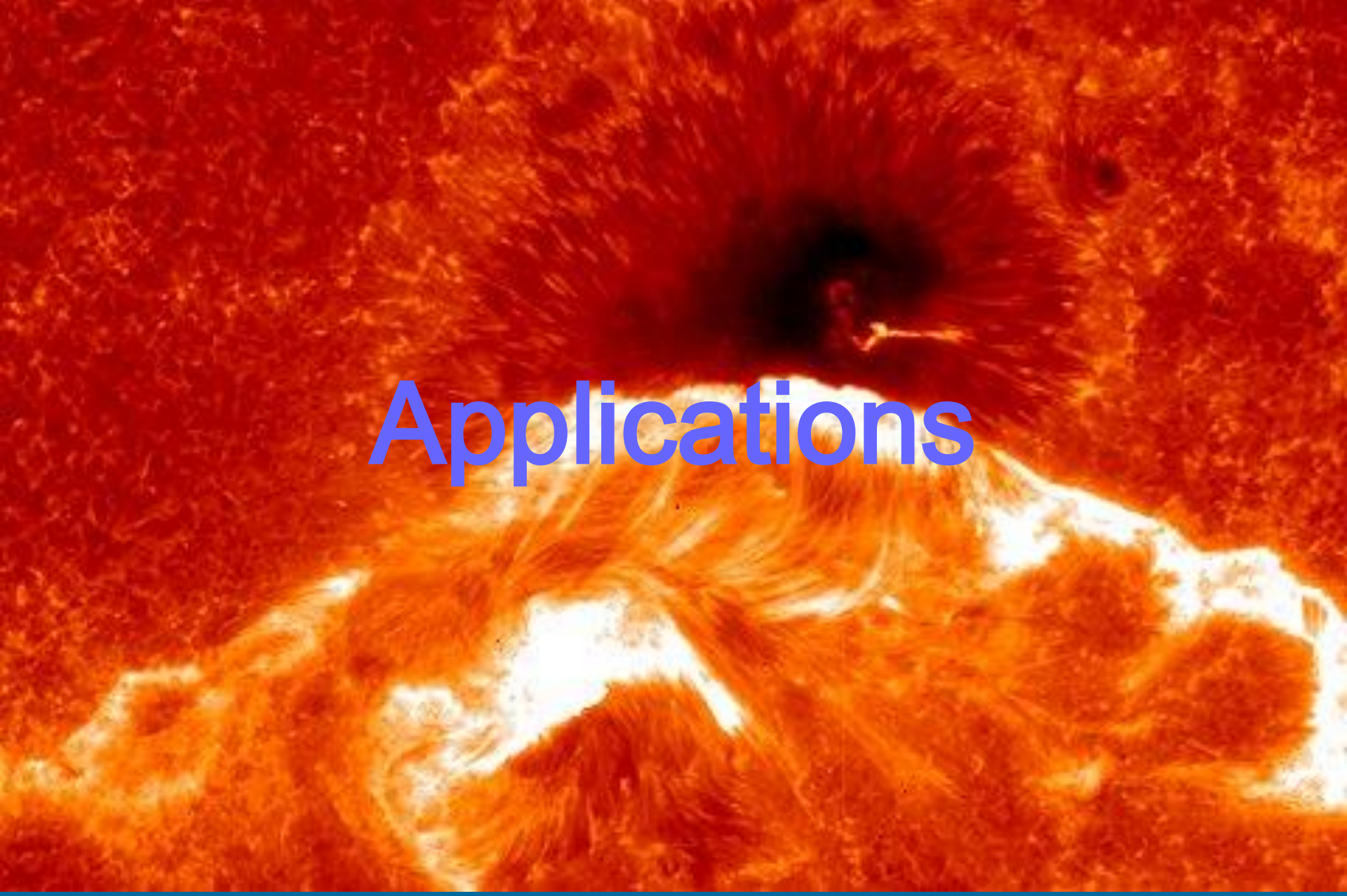


External Problems – analog inputs

- Move field device through full range of current – 4-20mA
- Hook up signal transmitter if you need to be absolutely sure.

External Problems – analog outputs

- Force output to specific value and observe
- Check external wiring


Applications

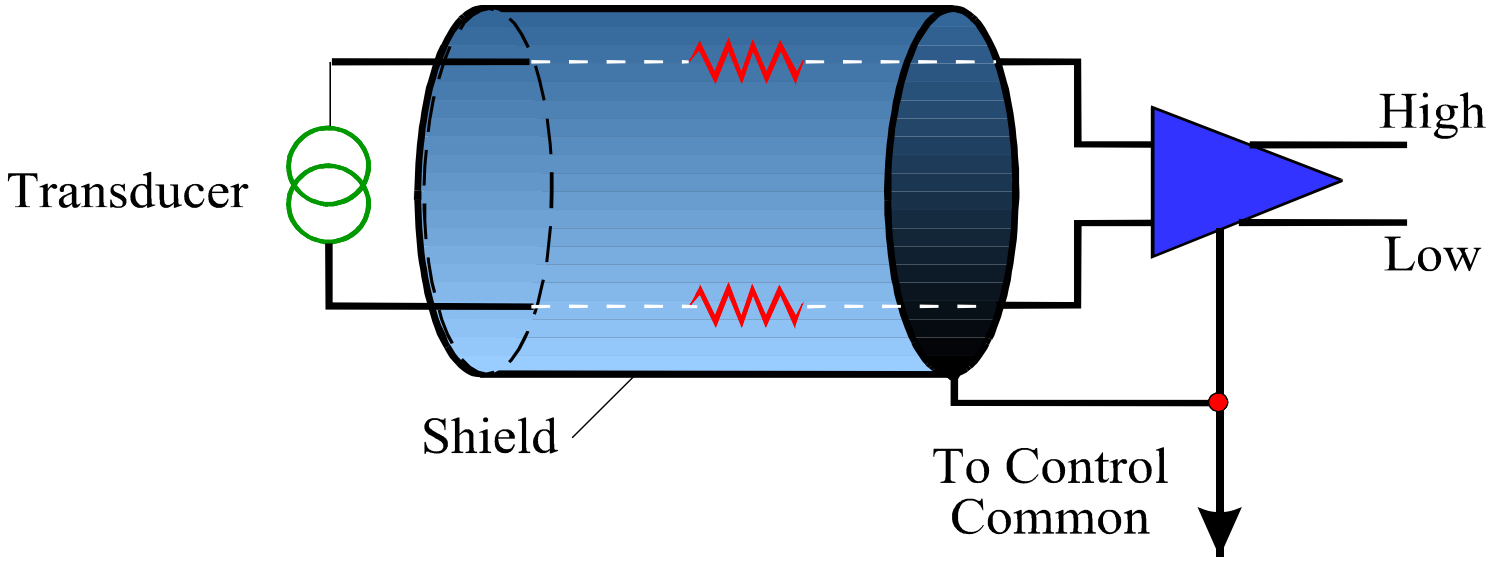
Remote troubleshooting

- Be careful with remote troubleshooting about industrial network security
- Hackers are about 24x7

Thorny transients

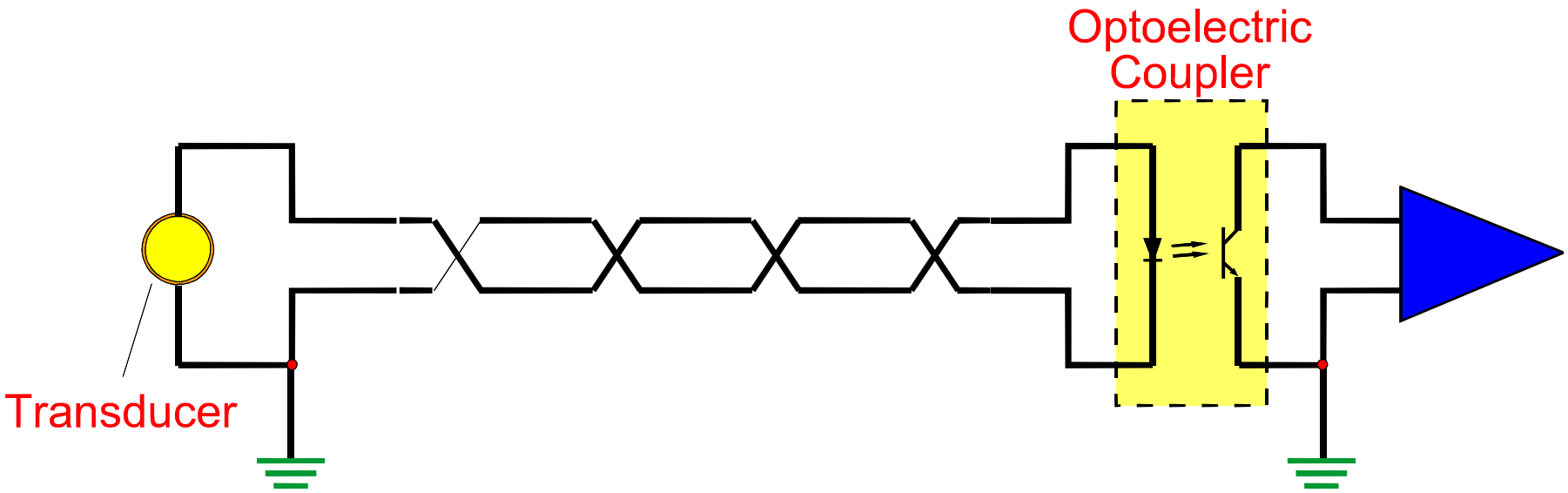
- Fiber Optics where possible
- Good earthing/grounding for data comms

A typical shield



The purpose of the shield is to reduce the magnitude of the noise coupled into the low-level signal circuits by electrostatic or magnetic coupling. This has brushed up the above-mentioned concepts up to some extent

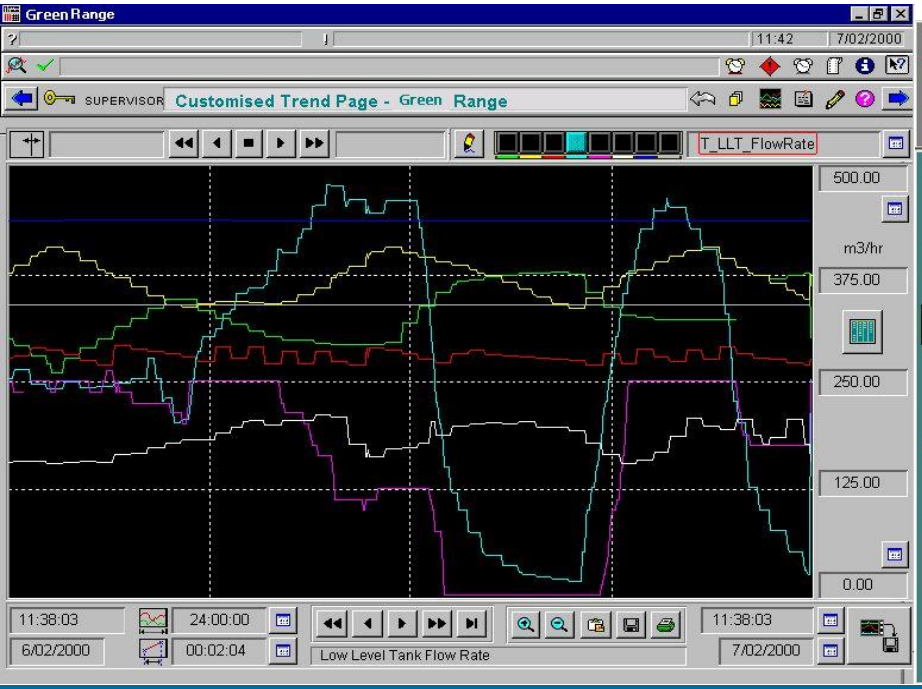
Opto-electric coupler circuit

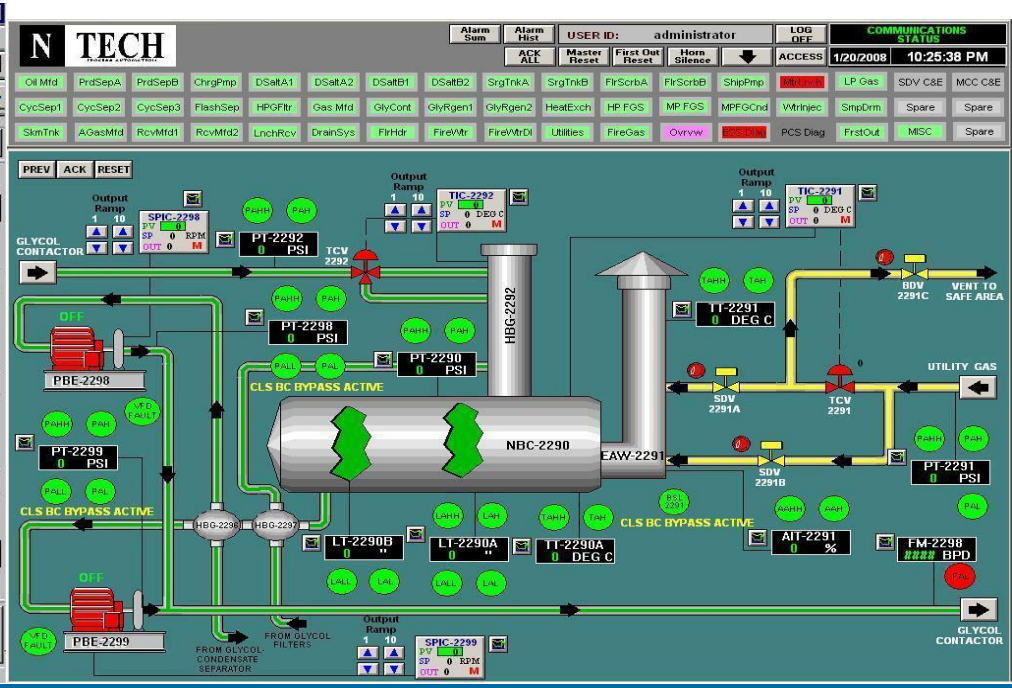


When in doubt -disconnect

- Test with dummy equipment not 1MW ball mills

Troubleshooting of SCADA Systems





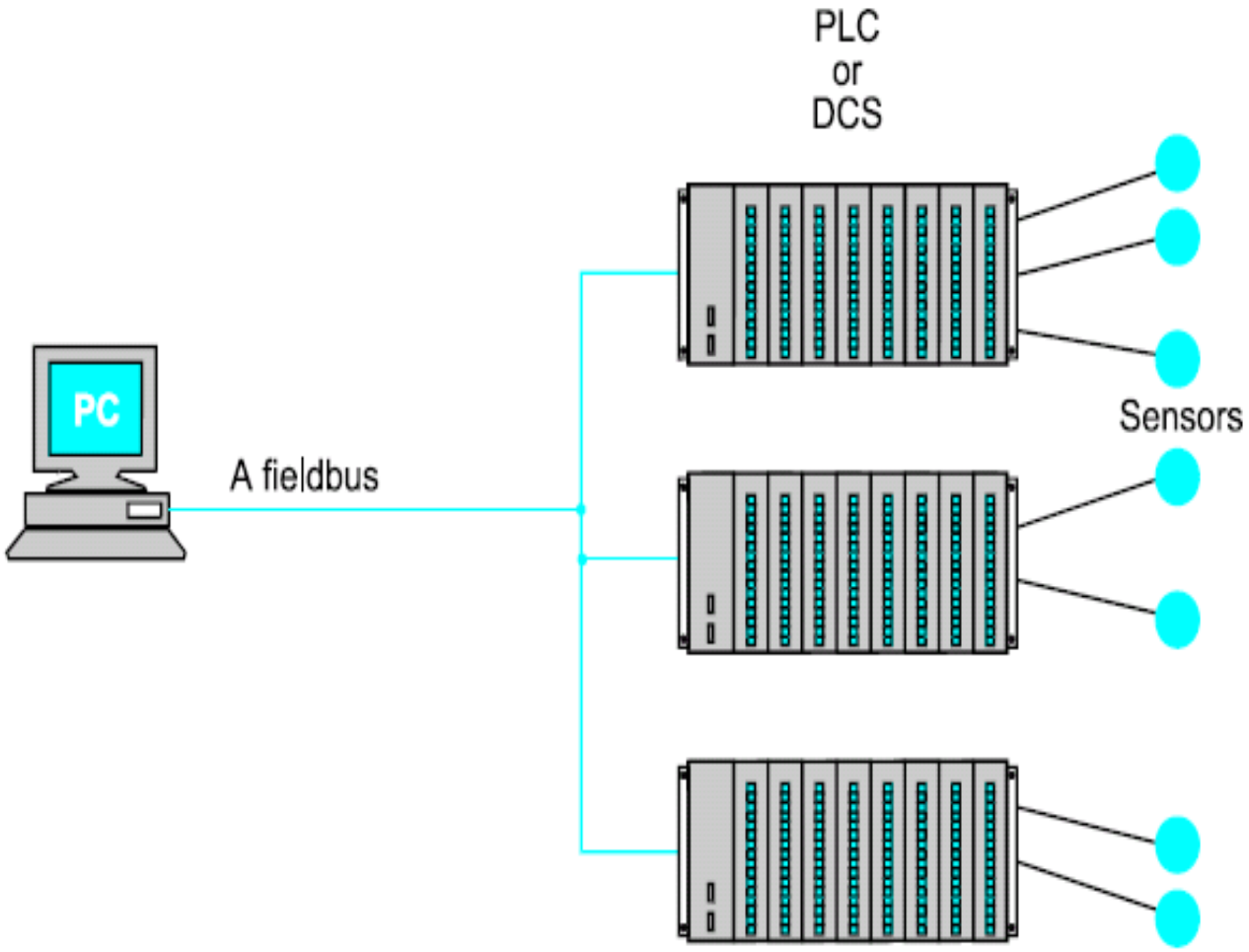
SCADA

Supervisory Control And Data Acquisition

- SCADA is not just Software or Hardware
- But a **complete control system** including communications systems

SCADA

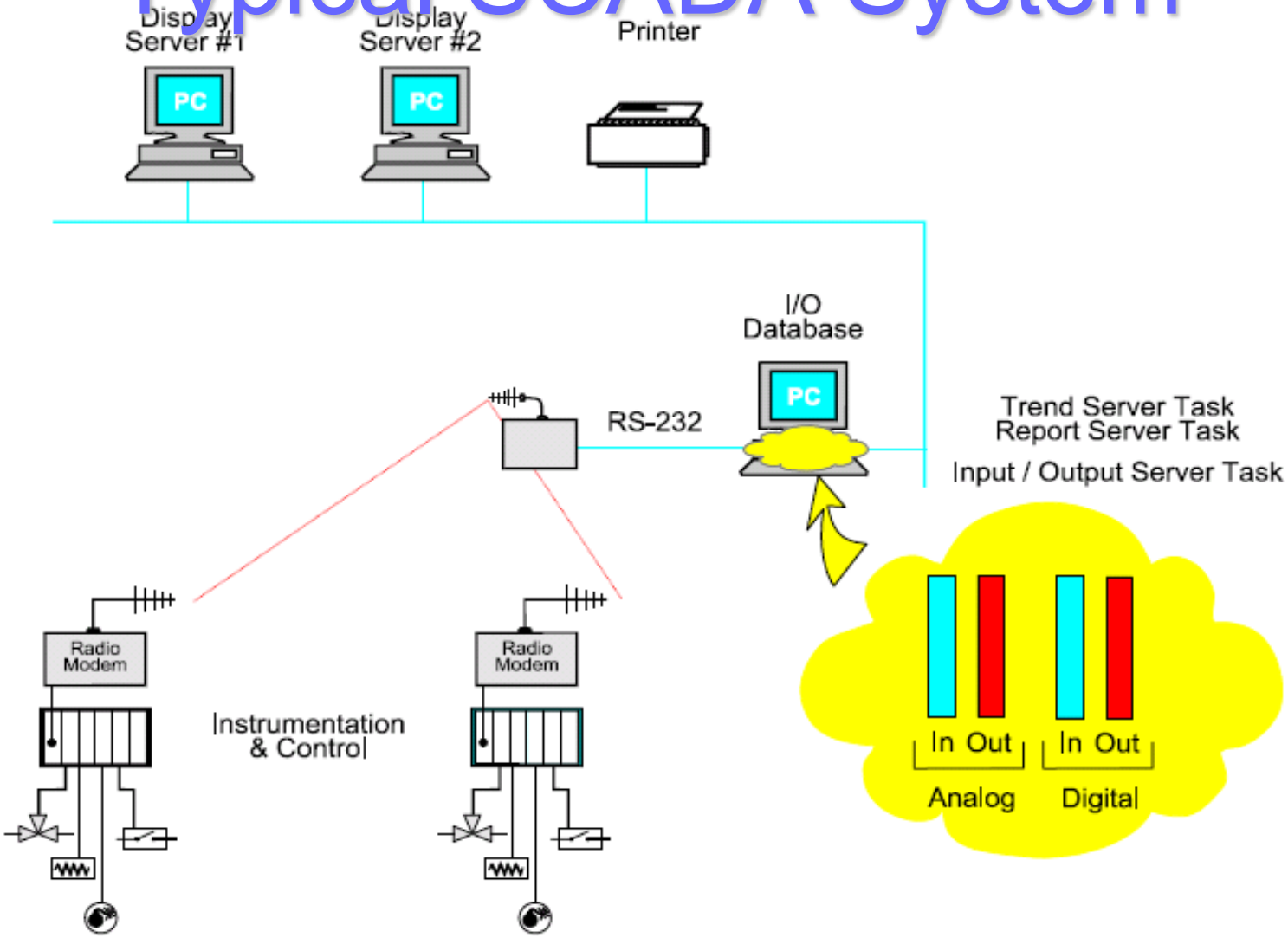
Supervisory Control and Data Acquisition



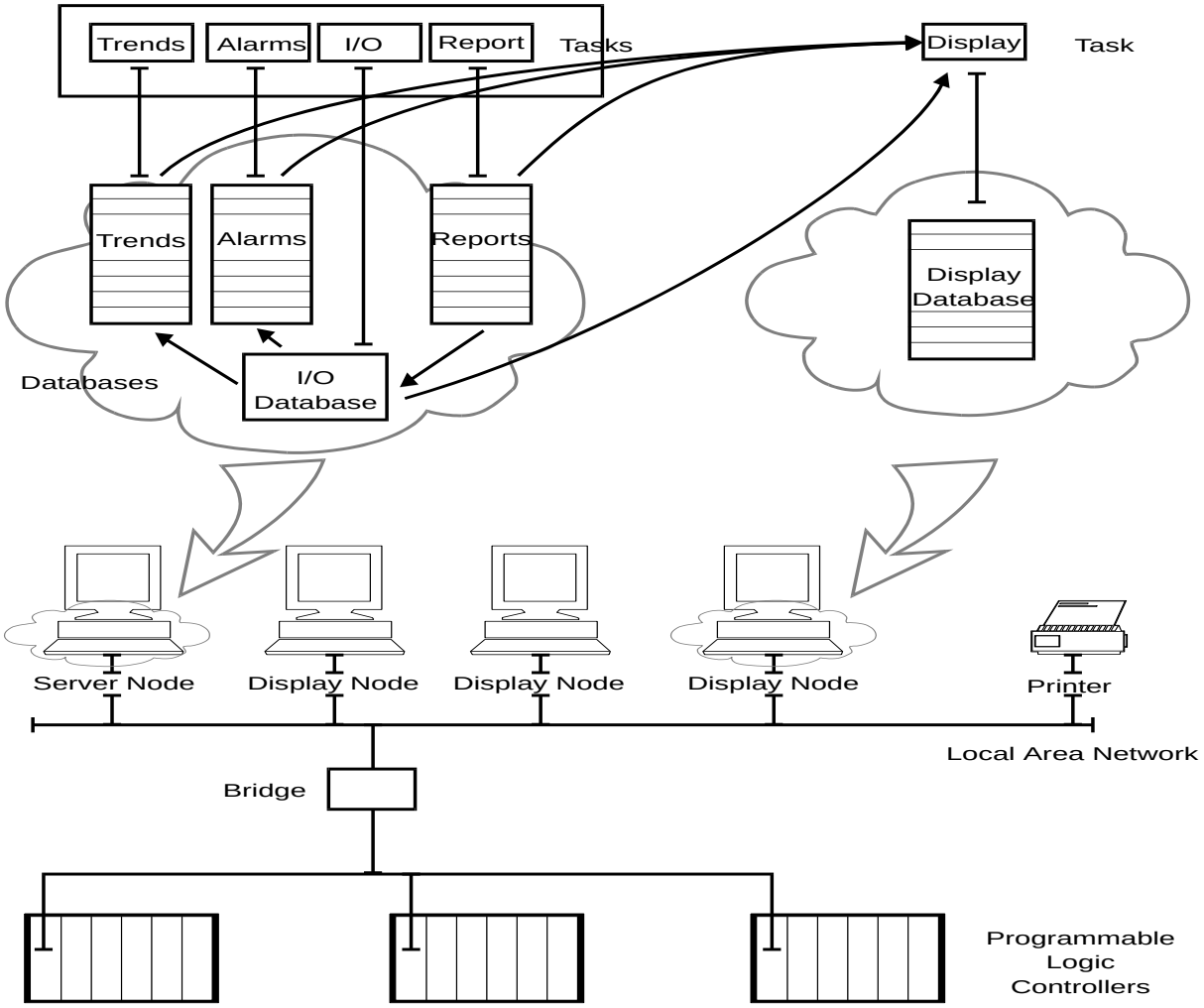
Remote Terminal Unit

- The complete assembly of equipment at an end point of the control system in the field, factory or industrial site.
- This can be a Programmable Logic Controller (PLC).

Typical SCADA System

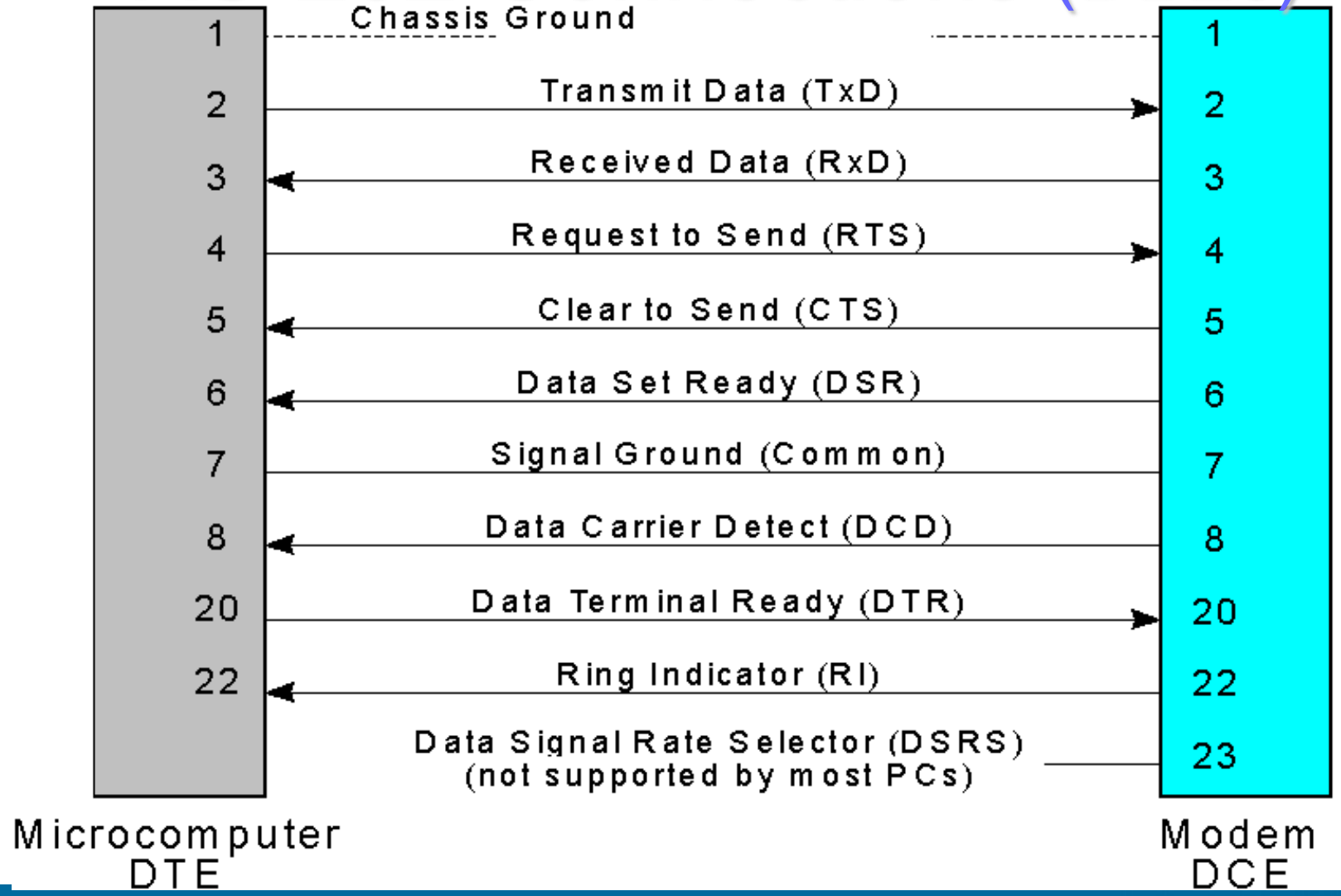


Client Server for SCADA Systems



Industrial Communications Protocols

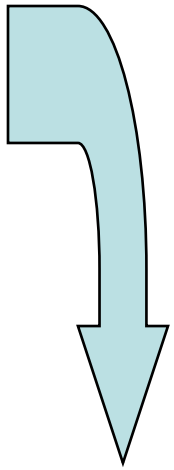
RS-232 Connections (DB25)



RS-485 Review

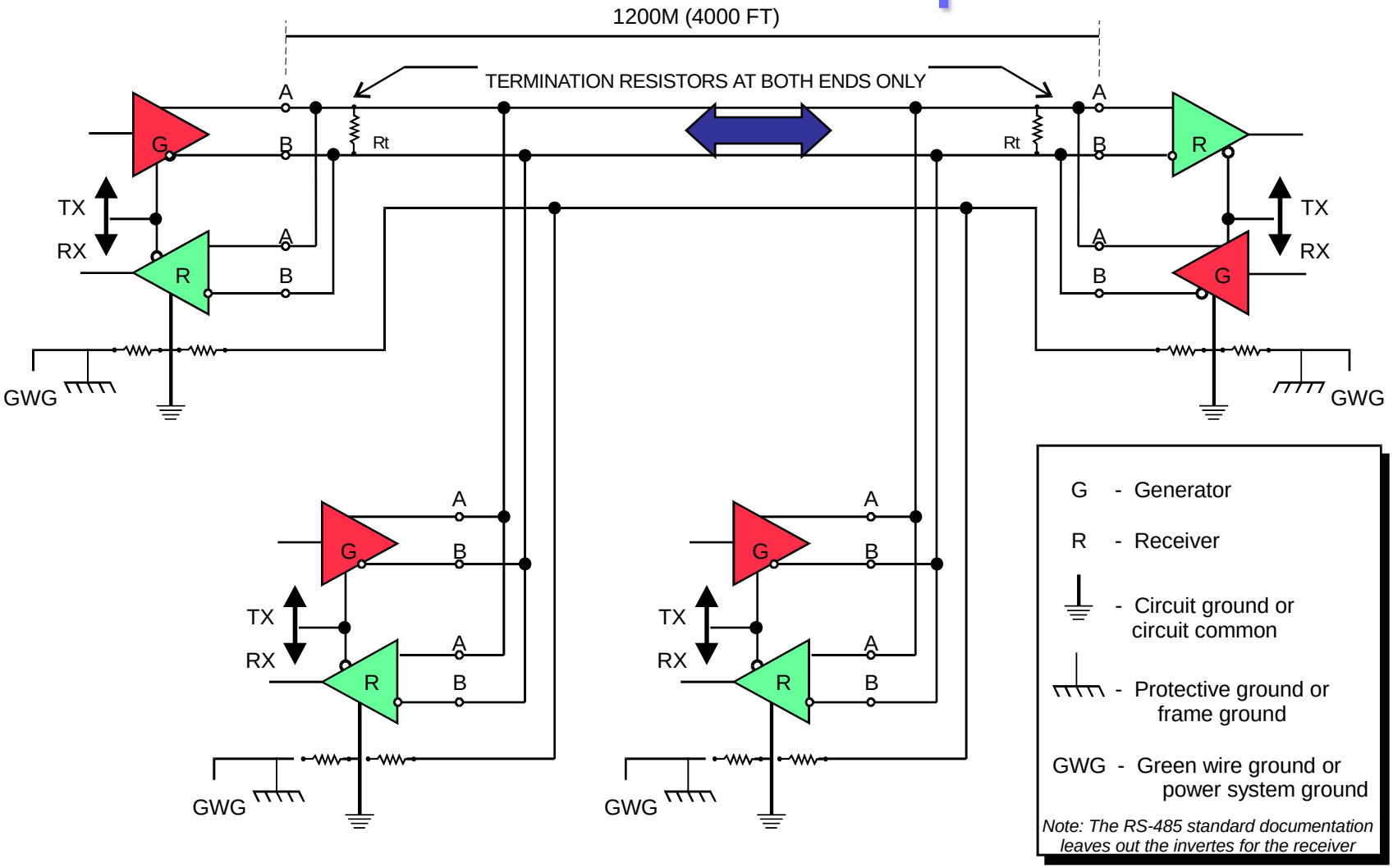
EIA-485 interface standard

- Distances of up to 1200m
- Data Rates of up to 10Mbps
- 32 Line Drivers
- 32 Line Receivers

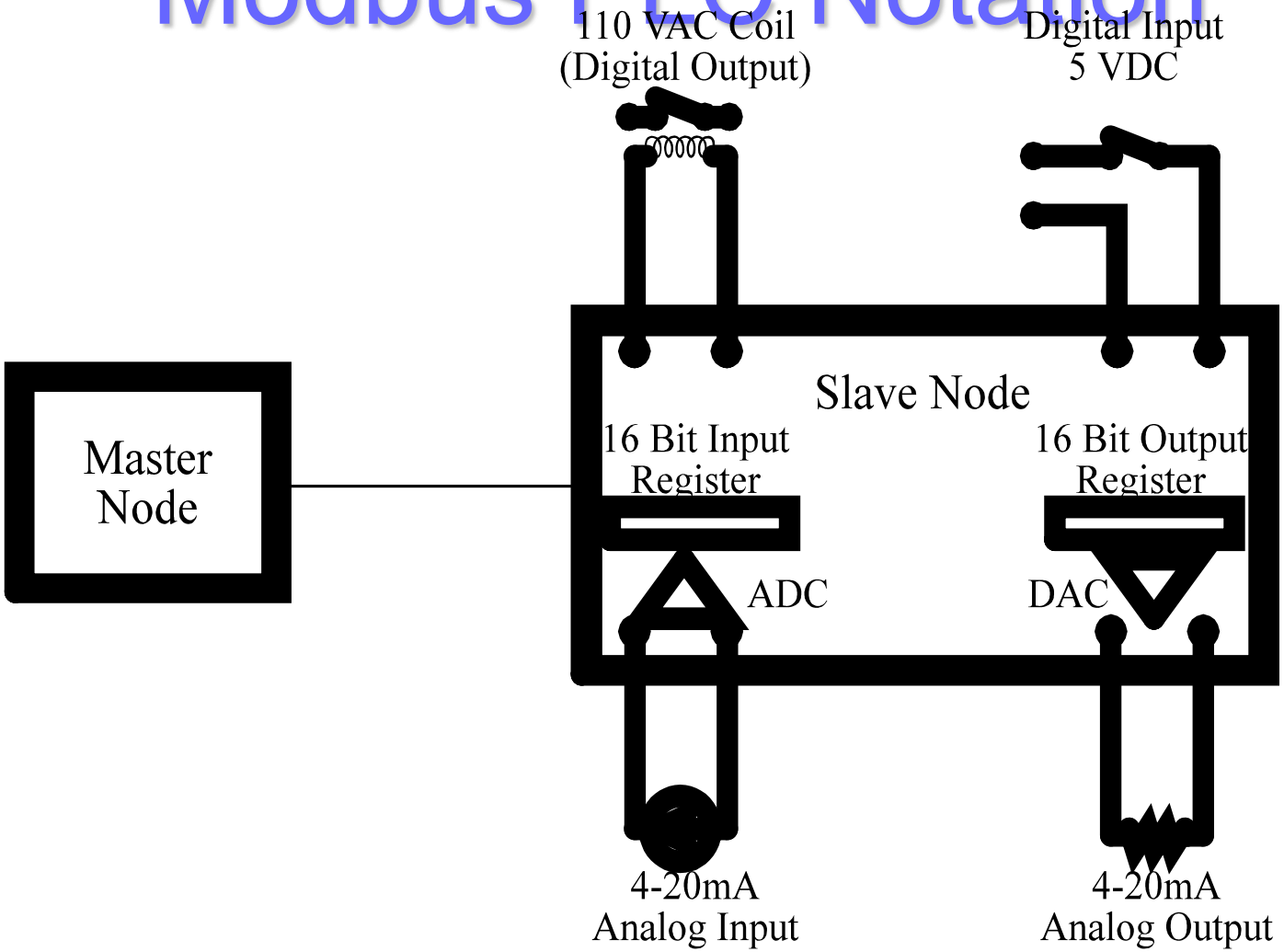


NOTE : Total of 32 devices on same line

Two Wire Multidrop RS-485



Modbus PLC Notation



Troubleshooting and Maintenance

Troubleshooting the telemetry system

- Ensure that components are not removed on line whilst the system is powered up unless the manufacturer specifically indicates that this is permissible.
- Damage to components and modules can occur when removing whilst the system is still powered up.
- Ensure that the antenna system is not disconnected from the system unless a dummy load has been installed, otherwise the radio power amplifier may be damaged.

The RTU and component modules

Check:

- Analog input modules
- Digital input module
- Interface from RTU to PLC (RS-232 / RS-485)
- Privately owned cable
- Switched telephone line
- Analog or digital data links

The master sites

- The master sites will generally consist of a more complete telemetry unit and higher quality radio equipment.
- The same troubleshooting techniques can be applied to the master site as are used at the RTUs.
- Additional equipment would include links to other master sites, to the central site and computer control facilities

The operator station and software

There is not much that can be done here if a system fails or has intermittent problems except to systematically replace each connected unit to identify the faulty module

- Operator terminal (normally a personal computer)
- Local area network card(s)
- Bridge unit to radio, microwave or landline system
- Printer connected to operator terminal

There are however a few problems which can be examined:

- **Operator terminal locks up intermittently**
- **Throughput of the operator station and associated system drops off dramatically**


Q&A

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