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Master Diagnostic Philosophy

Every troubleshooting process should follow this order:

1. Verify the complaint
2. Verify machine configuration
3. Verify power and ground
4. Verify communication
5. Verify control logic
6. Verify commanded outputs
7. Verify mechanical/hydraulic response
8. Verify feedback confirmation
9. Repair root cause
10. Validate full system operation

Troubleshooting Mindset

Elite technicians troubleshoot in this order:

1. Power

Is the component powered correctly?

2. Ground

Can current return properly?

3. Communication

Can modules talk?

4. Logic

Is the machine allowing operation?

5. Mechanical/Hydraulic

Can the commanded action physically occur?

The best technicians do not chase symptoms.

They identify:

1. What the system needs to operate
2. What the system is missing
3. Why it is missing
4. What upstream condition caused it
5. What downstream effects resulted

That process produces reliable root-cause diagnostics instead of repeated part replacement.

Field Technician Quick Rules

Voltage Rules

- Never trust unloaded voltage readings alone
- Test under load whenever possible
- Low voltage creates false diagnostics
- Ground problems mimic component failures

CAN Network Rules

- One failed node can crash the network
- Poor grounds create communication noise
- Shield drains matter
- Termination resistance is critical

Hydraulic/Electrical Rules

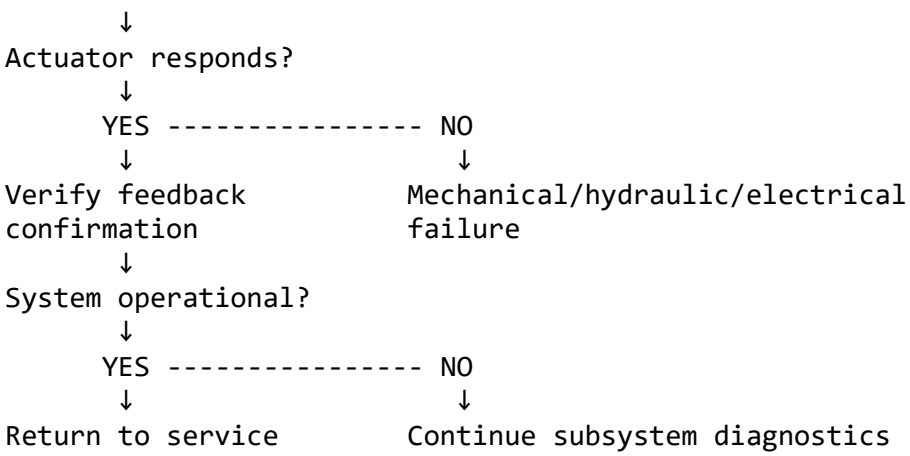
- Electrical command does NOT guarantee hydraulic movement
- Hydraulic pressure does NOT guarantee actuator motion
- Feedback confirmation matters

Vision System Rules

- Dirty lenses create false failures
- Lighting matters as much as camera quality
- Ethernet issues often appear as camera failures
- Latency can mimic logic faults

Flowchart 1 — Master Electrical Diagnostic Flow

```
MACHINE FAILURE / CUSTOMER COMPLAINT
                ↓
Verify complaint is repeatable
                ↓
Check active faults / alarms / codes
                ↓
Visual inspection
 • Loose connectors
 • Burnt wiring
 • Damaged harnesses
 • Water intrusion
 • Blown fuses
                ↓
Battery voltage within specification?
                ↓
      YES ---------------- NO
       ↓                    ↓
Check main grounds       Repair charging/
and power distribution   battery system
       ↓
Main control voltage present?
       ↓
      YES ---------------- NO
       ↓                    ↓
Check communication      Trace power path:
(CAN/Ethernet/PLC)       Fuse → Relay → Harness
       ↓                    ↓
Communication healthy?   Repair open/short/high resistance
       ↓
      YES ---------------- NO
       ↓                    ↓
Verify input conditions  Diagnose network:
(interlocks/sensors)     CAN termination
       ↓                 Shielding
Inputs valid?            Node power
       ↓
      YES ---------------- NO
       ↓                    ↓
Verify controller output Diagnose sensor/input issue
       ↓
Output energized?
       ↓
      YES ---------------- NO
       ↓                    ↓
Verify actuator          Diagnose logic/output stage
operation                Relay/transistor/PLC output
```


↓
Actuator responds?
↓
YES ---------- NO
↓ ↓
Verify feedback Mechanical/hydraulic/electrical
confirmation failure
↓
System operational?
↓
YES ---------- NO
↓ ↓
Return to service Continue subsystem diagnostics

Flowchart 2 — Power Distribution Diagnostic

Purpose: Used for no-power, intermittent power, low-voltage, or random reset conditions.

```
START
 ↓
Verify battery voltage
 ↓
Battery voltage within spec?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check disconnect switch    Charge/test/replace battery
 ↓
Voltage through disconnect?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check main breaker/fuse    Repair disconnect circuit
 ↓
Power leaving breaker/fuse?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check relay activation     Replace fuse/reset breaker
 ↓
Relay functioning properly?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check downstream voltage   Diagnose relay control circuit
 ↓
Voltage stable under load?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check grounds              High resistance connection
 ↓                           Corrosion
Ground resistance OK?       Undersized wiring
 ↓                           Weak power source
YES ---------------------- NO
 ↓                          ↓
Power system healthy       Repair grounding system
```

Flowchart 3 — Control System Diagnostic

Purpose: Used for PLC, ECU, HMI, or machine logic failures.

```
CONTROL SYSTEM FAILURE
 ↓
Controller powered?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check controller status    Restore controller power
LEDs/diagnostics
 ↓
Internal controller fault?
 ↓
YES ---------------------- NO
 ↓                          ↓
Replace/reprogram         Verify communications
controller                CAN/Ethernet/Serial
                             ↓
Communication active?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify inputs              Diagnose network
Interlocks/safety          wiring/node power
 ↓
Required inputs present?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify logic state         Repair failed input device
 ↓
Controller commanding outputs?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check output hardware      Diagnose logic conditions
 ↓
Output voltage/current correct?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check actuator/load        Repair output stage
 ↓
System operates correctly?
 ↓
YES ---------------------- NO
 ↓                          ↓
Return to service          Continue subsystem diagnostics
```

Flowchart 4 — Sensor Diagnostic Flow

Purpose: Used for analog sensors, switches, transducers, proximity sensors, encoders, and feedback devices.

```
SENSOR FAILURE SUSPECTED
 ↓
Verify sensor supply voltage
 ↓
Supply voltage within specification?
 ↓
YES ---------------------- NO
 ↓                           ↓
Verify sensor ground       Repair supply circuit
 ↓
Ground integrity good?
 ↓
YES ---------------------- NO
 ↓                           ↓
Measure sensor output      Repair grounding issue
 ↓
Output changing correctly?
 ↓
YES ---------------------- NO
 ↓                           ↓
Verify controller input    Inspect:
 ↓                         Wiring
Controller reading valid?  Connector pins
 ↓                         Contamination
YES ---------------------- Signal drift
 ↓                           ↓
Sensor system healthy      Replace sensor
```

Flowchart 5 — Can Bus / Network Diagnostic

Purpose: Used for communication loss, intermittent nodes, or network instability.

```
NETWORK COMMUNICATION FAILURE
 ↓
Verify all network nodes powered
 ↓
All nodes powered?
 ↓
YES ---------------------- NO
 ↓                          ↓
Measure CAN resistance     Restore node power
(typically 60 ohms total)
 ↓
Resistance correct?
 ↓
YES ---------------------- NO
 ↓                          ↓
Check CAN High/Low voltage Diagnose:
 ↓                         Missing terminator
Voltage normal?            Short/open
 ↓                         Harness damage
YES ---------------------- Node failure
 ↓                          ↓
Check shielding/grounding  Repair network wiring
 ↓
Verify node communication
 ↓
Missing/offline node?
 ↓
YES ---------------------- NO
 ↓                          ↓
Disconnect suspect node    Check controller software
one at a time              configuration
 ↓
Network restored?
 ↓
YES ---------------------- NO
 ↓                          ↓
Replace failed node        Continue advanced diagnostics
```

Flowchart 6 — Hydraulic Electro-Control Diagnostic

Purpose: Used when electrical controls command hydraulic functions.

```
HYDRAULIC FUNCTION FAILURE
 ↓
Operator command received?
 ↓
YES ---------------------- NO
 ↓                           ↓
PLC/output active?          Diagnose operator input
 ↓
Voltage reaching solenoid?
 ↓
YES ---------------------- NO
 ↓                           ↓
Solenoid coil resistance    Diagnose electrical output
within specification?
 ↓
YES ---------------------- NO
 ↓                           ↓
Check valve movement        Replace solenoid coil
 ↓
Valve shifting correctly?
 ↓
YES ---------------------- NO
 ↓                           ↓
Verify hydraulic pressure   Repair valve issue
 ↓
Pressure available?
 ↓
YES ---------------------- NO
 ↓                           ↓
Check actuator              Diagnose pump/filter/
operation                   relief valve issue
 ↓
Actuator moving correctly?
 ↓
YES ---------------------- NO
 ↓                           ↓
Verify feedback sensor      Mechanical/hydraulic failure
 ↓
Function restored?
 ↓
YES ---------------------- NO
 ↓                           ↓
Return to service           Continue diagnostics
```

Flowchart 7 — Safety Interlock Diagnostic

Purpose: Used for machines inhibited by safety logic.

```
SAFETY INTERLOCK ACTIVE
 ↓
Identify active safety fault
 ↓
Emergency stop active?
 ↓
YES ---------------------- NO
 ↓                          ↓
Reset E-stop circuit       Check guard switches
 ↓
Guard switch closed?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify safety relay        Repair guard circuit
 ↓
Safety relay energized?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify safety PLC          Diagnose relay/input issue
 ↓
All safe conditions met?
 ↓
YES ---------------------- NO
 ↓                          ↓
Enable machine operation   Correct unsafe condition
```

Flowchart 8 — Camera / Vision System Diagnostic

Purpose: Used for machine vision, guidance systems, object detection, or operator camera systems.

```
VISION SYSTEM FAILURE
 ↓
Camera powered?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify Ethernet/network    Restore camera power
connection
 ↓
Camera communicating?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify image quality       Diagnose network issue
 ↓
Image clear and stable?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify lighting            Clean lens/check vibration
 ↓
Lighting adequate?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify processor logic     Repair lighting system
 ↓
Target/object detected?
 ↓
YES ---------------------- NO
 ↓                          ↓
Verify PLC integration     Recalibrate vision system
 ↓
Machine responding correctly?
 ↓
YES ---------------------- NO
 ↓                          ↓
Return to service          Diagnose integration logic
```

Flowchart 9 — Intermittent Failure Diagnostic

Purpose: Used for difficult, random, or vibration-related faults.

```
INTERMITTENT FAILURE
 ↓
Attempt to reproduce failure
 ↓
Failure repeatable?
 ↓
YES ---------------------- NO
 ↓                          ↓
Monitor live data          Install data logger
 ↓
Check for:
 • Voltage drops
 • Ground instability
 • CAN errors
 • Temperature changes
 • Vibration sensitivity
 ↓
Perform harness wiggle test
 ↓
Failure triggered?
 ↓
YES ---------------------- NO
 ↓                          ↓
Repair affected harness    Continue monitoring
 ↓
Verify environmental conditions
 ↓
Heat/moisture/vibration related?
 ↓
YES ---------------------- NO
 ↓                          ↓
Repair environmental       Suspect controller/software
failure source             issue
```