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Variable Frequency Drives Troubleshooting

Safety First!

Adhere and comply with NFPA70E

- Service by qualified person only:
 - **Qualified person:** One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.
- Procedural steps:
 - Disconnect all power sources.
 - Visually verify disconnection (when possible).
 - **Implement approved lock out / tag out procedure.**
 - Identify power sources (e.g., review drawings / documentation).
 - Confirm electrically safe status (e.g., voltmeter measurement).
 - Ground equipment as needed (e.g., capacitive energy storage).

Safety First!

Remember:

An open disconnect, circuit breaker or fuses is **NOT** a true indication that the DC bus is not charged!

As well, A DC bus indication lamp should be verified. If the light is off, consider the light to be in a failed state and verify the bus.

Gather the Facts First

- **VFD Fault / Trip**

- Be reassured: The VFD is protecting itself and the equipment.
- Often the person reporting the condition has limited technical expertise and this person is reporting what they see, hear or even smell. They are not typically reporting the “problem.”

Gather the Facts First

Ask Leading Questions and Listen

- **Questions**

- How long has it been installed and functional?
- Environment around the drive?
- Centrifugal or PD pump? Heavy duty or normal duty VFD? Part number?
- What is the drive reporting in the form of fault messages?
- What time did this occur, has it previously tripped at this time or process point?
- Did anything else trip?
- What other heavy load are you aware of starting?
- Any recording meters on the distribution or branch power?

Hardware Troubleshooting

Proper Grounding

- Do **NOT** daisy chain grounding!

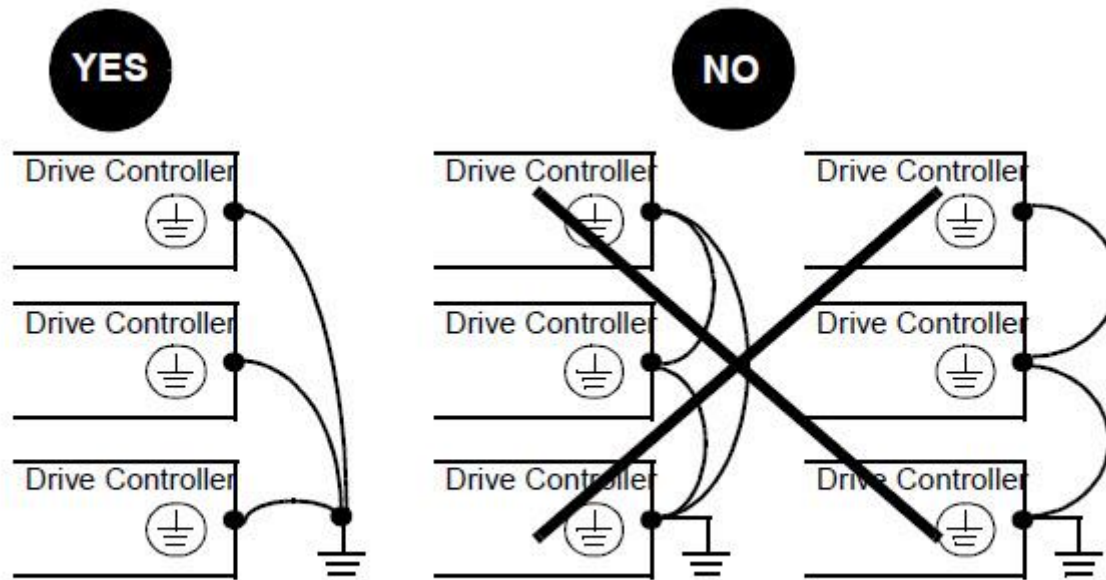


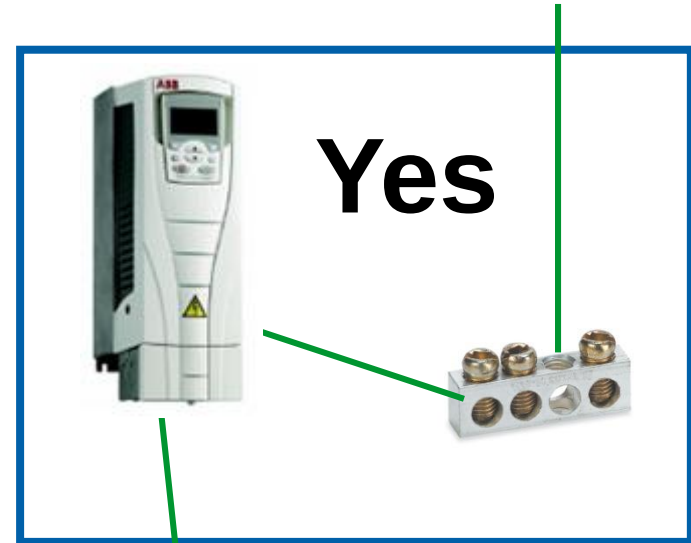
Figure 20: Grounding Multiple Drive Controllers

Hardware Troubleshooting

Proper Grounding Termination



Enclosure back
panel



Enclosure back
panel



Hardware Troubleshooting

Proper Cable Routing

- Verify per installation manuals.
- For loose cables such as ones in a cable tray maintain a minimum of 6 inches between input power, output power and the controls, unless they have their own grounding shield such a metal conduit.
- **NEVER mix control and power.**
- Issue – Electro Magnetic Interference (EMI).
- Problems that could happen:
 - Control and or communication signals may not communicate properly or inadvertently triggered signals.
- It is okay for cables to cross perpendicular to each other.
- Reference: IEEE 110-1999 Emerald Book; *“IEEE Recommend Practice for Powering and Grounding Electronic Equipment.”*

Troubleshooting Output Cable Length

- Follow the VFD manual regarding cable length.
 - Reflected Wave, First turn failure
- Line and load reactors vs. DV/DT filters.
 - Impedance Values
- Issue: Ground fault tripping of the VFD.
- Motor ground.

Troubleshooting

Will Not Start, Stop, Follow an Analog Signal or Pilots

- Verify that the E-Stop safety input is high (SIL2).
- Does the VFD have an enable input and a run directional input?
- 2 or 3 wire control enabled?
- Rising edge on start command (has start command been cycled?).
- Is the NC **stop** contact wired correctly?
- Have you verified with a meter the polarity of your analog signal and where it is landed?
- Are you on the right set of contacts? – Form C.

Troubleshooting Cooling Issues

- Possible causes:
 - #1 - - Dirty Filters or VFD heatsink.
 - VFD cooling fans not working.
 - Enclosure stirring fans not working.
 - Enclosure cooling fan filters are clogged.
 - Ambient temperature is above the rating of the VFD.
 - Top Vents.
 - Do not use compressed air to blow out the VFD.
 - Low Pressure air may be used to blow out some heat sinks
- Note that some VFD cooling fans:
 - Only run when the VFD is running.
 - A specific time or temperature after the VFD has stopped.

Troubleshooting

VFD Faults: Input Phase Loss or Under-Voltage

- Verify phase-to-phase voltage.
- Verify input current in all 3 phases
- If permissible, look at voltage drop across each pole of the breaker or fuse. You must follow company procedures!
- Look at the connection points for the breaker or fuse – are they discolored?
- Compare your meter readings to the VFD display – do they agree? (Know how to use your meter and verify, measure and re-verify.)
- Be aware – some VFDs monitor ripple current on DC bus to indicate input phase loss / undervoltage.
- Management of DC bus without mains?
- Where's the squirrel?

Troubleshooting

VFD Faults: Output Phase Loss

- Verify balanced phase-to-phase output with your meter.
 - Know that the reading may not be what you expect as your meter may “ring” on the drive waveform.
 - Balance is important . Best to drop the motor leads when practical.
- Is there a bypass? Have you validated the isolation contactor and it's control?
- VFD configured for bypass?
- Verify the motor lead connections.
- Is there a line of sight disconnect?
- Drive type and motor control algorithm will effect how a VFD trips on OPL (ACS550 only trips in vector mode)

Troubleshooting

VFD Faults: Instantaneous Overcurrent

- Start up problem or has VFD been running for some period?
- Balanced input and output voltage?

Check input current in each leg, as this verifies the rectifier.
Check output currents in each leg to verify the motor.

- Motor ramping up in speed or only when approaching full speed
- Motor cables together or smoking insulation? All 3 motor leads must be run together.
- Mechanical problem
- Bypass? Isolation contactor chattering? or pilot relay?
- Conduit box: taping inspected? Have leads rubbed together?
- Motor : location – wet, hot, ultra high efficiency

Troubleshooting VFD: Overload

- Initial Start-Up – Verify Parameter sets
- Measure DC bus – do you have a solid bus
- Has it ever run? What changed?
- Balanced output voltage? Phase-to-phase – check for balance – not level.
- Balanced output currents?
- Set up issue: Acceleration too short, gains too high, PID
- Multiple motors in a common conduit? Tray? – What is the Mfg. recommendation?
- Scope Available? Look at incoming waveforms – especially if tripping at a higher speed (may be IOC)

Troubleshooting

VFD Faults: Ground Fault

- Motor leads up or down?
- Condition inside conduit?
- Most common is moisture in conduit or motor
- Corner Grounded Delta input?
- Subsidence?
- Multiple motor leads in conduit?
- Long motor leads – over 100'?
- How much ground current do you measure?
 - What kind of conductor was used?
 - Has it been ohmed out?
 - Do you have a ground plane?

Troubleshooting

VFD Faults: Unbalanced Currents

- Drop motor leads and verify output voltage phase-to-phase.
- Roll motor leads (be particularly concerned about reversing the motor). Does the issue follow the motor lead or stay in the same phase?
- Conduit box: Taping, connections, and skinned wires/connection.
- Grounding.
- Motor: If output voltages are balanced, then direct attention to motor.
- Lugs discolored
- Motor integrity

Troubleshooting

VFD Faults: DC Bus Overvoltage

- Mains Overvoltage
 - Possible spike or change in the line voltage.
 - PFCC (notice time of day).
 - Lightning.
 - Line strike (power pole strike).
 - Line reactor.
 - DB resistors.
- Regenerative Overvoltage
 - Has application worked in past?
 - Overhauling Loads.
 - Deceleration ramp.
 - DB resistor: Installed, OL tripped.
 - Decel ramp adaptation: automatic extension of ramps.

Troubleshooting Fault History

- Many VFDs have a fault history.
- Review for multiple faults. If time stamped note time.
- More then one fault may have happened at the same time.
- Self test ?
- Reference the VFD manual.

Troubleshooting Fault Resetting

- **SAFETY FIRST** – if fuses have cleared – make sure to do a thorough electrical and physical check of the product!
- After a fault issue has been resolved and it is okay to reset, there are several ways to accomplish the reset:
 - Digital input via an operator, if configured.
 - Network communications.
 - VFD keypad (for many VFDs).
 - Power cycle.
 - Automatic fault reset.
 - Good for remote applications.
 - But be cautious as to what and how you configure!
 - Think of how the operation will function under this occurrence and the people around it.

System problems

Vibration

- Issue: Heavy vibration at one or more particular operating speeds.
- Fix: Skip speeds / frequencies.
- Most all VFDs allow you to program a window of operating speed that is not to be used.
- Vibration may also occur at the motor rated / nominal speed.
- Physically check the motor and motor current.

System problems

Water Hammer

- Maybe a simple fix.
 - During acceleration: Increase the accel rate.
 - During deceleration: Increase the decel rate.
 - Soft pipe fill.

Troubleshooting

Factory Default – “Danger Will Robinson”

- Possible Un-assignment of required I/O
- Why is the VFD / system not working as it use to?
- Everything mechanically is fine but the operation is not?
- How could the parameters in the VFD have changed?
- Factory default might be the answer ? **CAUTION!**
 - Controls, communications, motor parameters, etc...
- Make sure that you have your original parameter list.
 - Some VFDs allow you to store a parameter set in memory.
 - Most all VFDs have programming software, which is a good way to backup.

Other Helpful tips

- Make sure that the VFD has been programmed with the correct motor nameplate information.
- Does the motor nameplate FLA exceed the VFD amperage rating?
- Has the proper VFD been selected? Variable or Constant Torque?
- Some VFDs have an auto diagnostics function.
- If you have access to the VFD keypad confirm that it is showing the proper status (run and speed command).
- If the VFD system has bypass, there will be an overload device for the bypass circuit, but if tripped, will also prevent the VFD connect to the motor.
- Make sure if you have a bypass function that both the VFD and bypass mode operate the motor in the same direction.
- Test the VFD without a motor to possibly isolate a problem (V/Hz).

Maintenance

- Clean equipment a must
 - Keep your VFD clean.
 - Heat sinks.
 - Vacuum away dust (do NOT use compressed air!).
- Enclosure air filters
 - For Type 12 enclosures with cooling fans, replace the air filters, as necessary.
- Thermal Scan
 - Especially connections.
- Megger
 - Leads and motor but not the VFD.

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