

# 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!

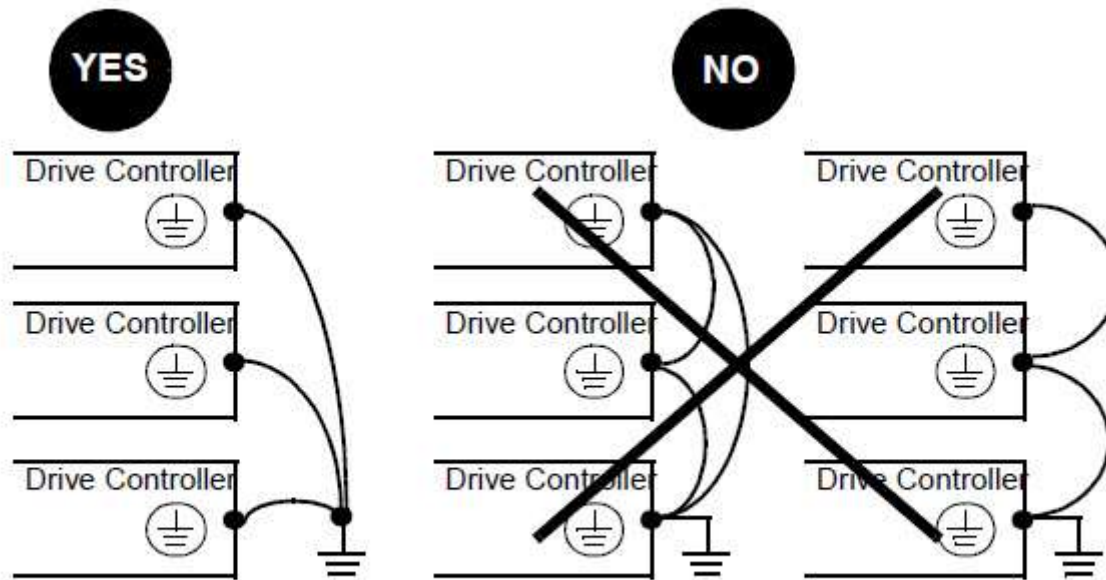


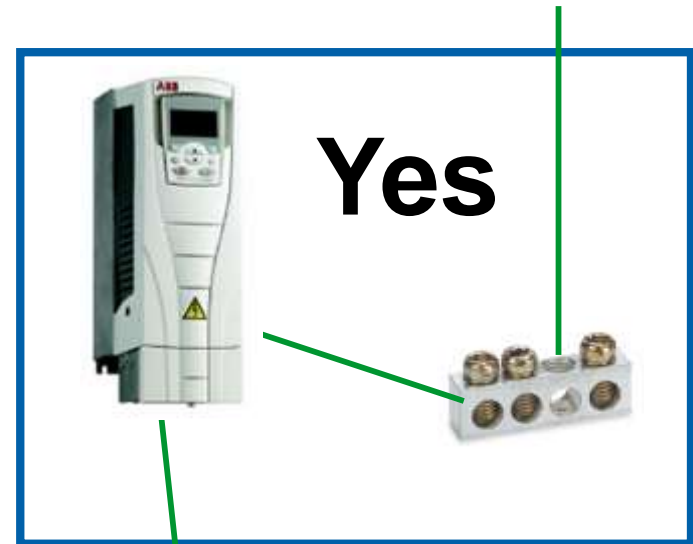
Figure 20: Grounding Multiple Drive Controllers

# 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).
  - Lightening.
  - 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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