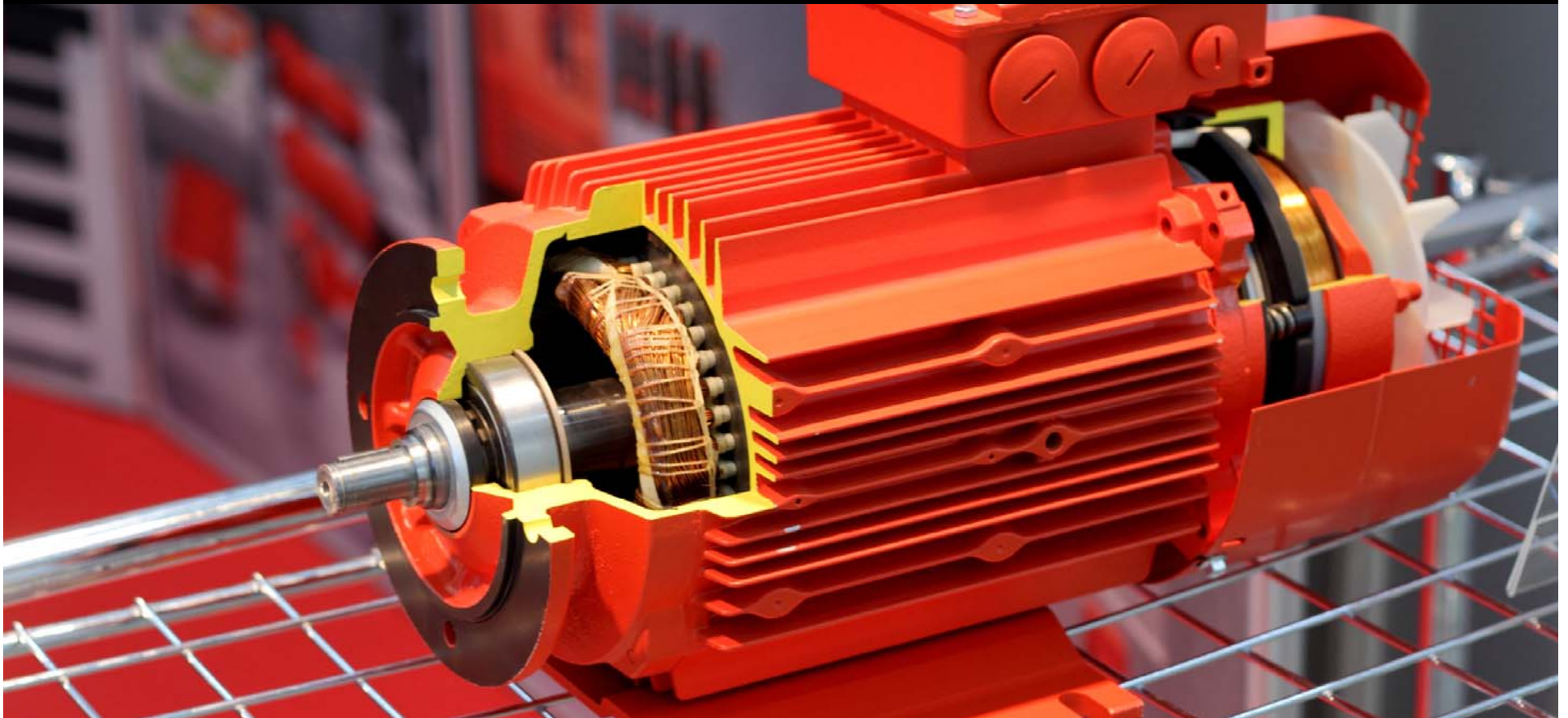


Understanding VFD (Variable Frequency Drive) Cables

By: Isaac Müller, P.Eng.



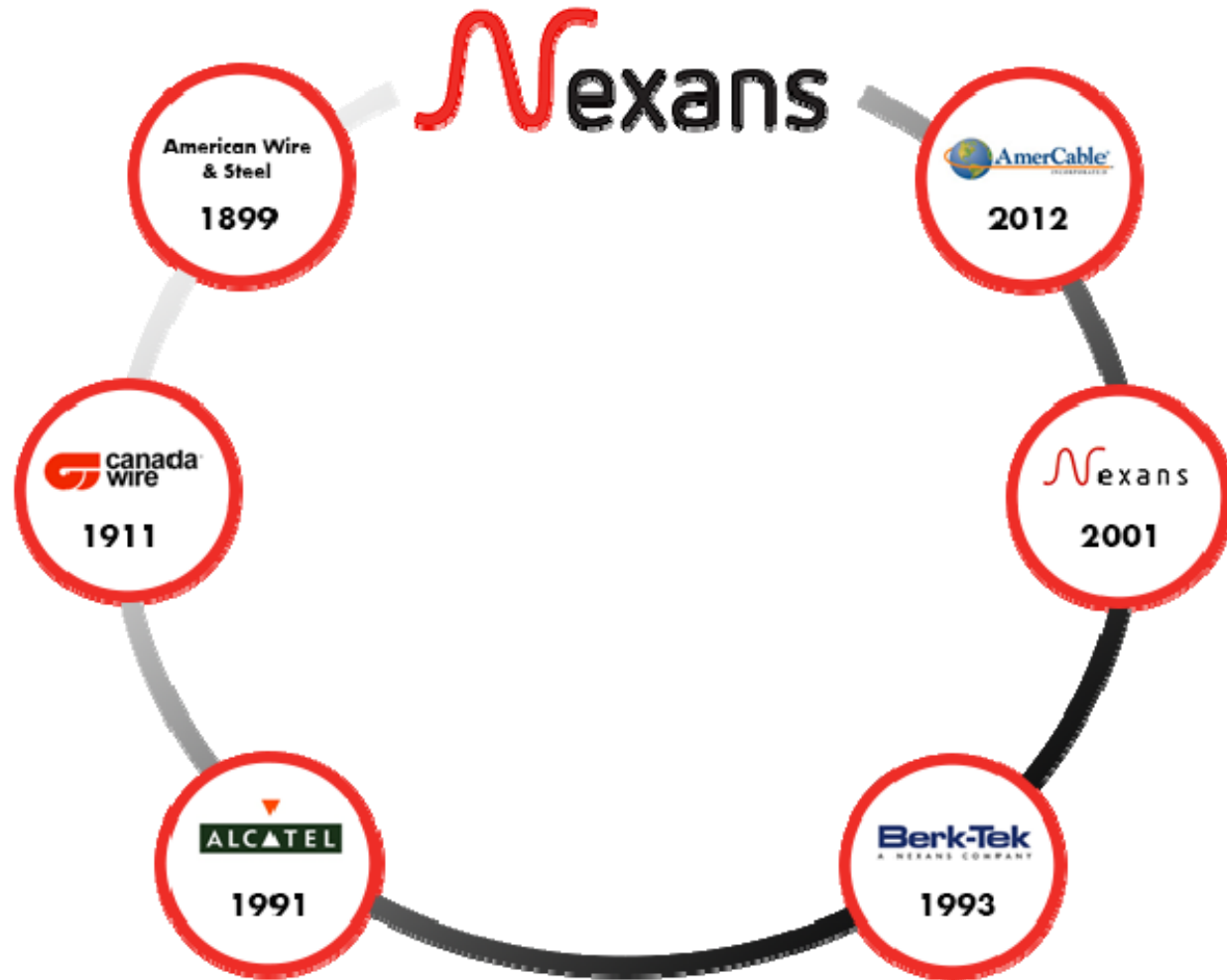
INTRODUCTION



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Agenda

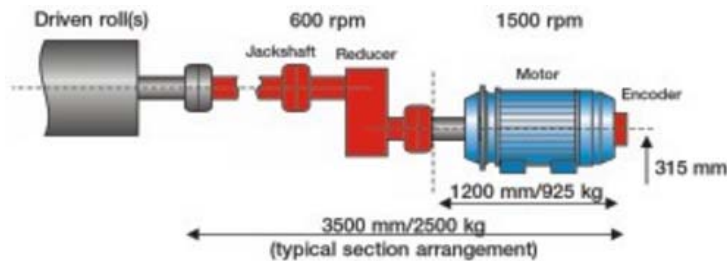
- 1 What is a VFD?
- 2 VFD Applications
- 3 Advantages and Complications
- 4 VFD System
- 5 Why use VFD Cables?
- 6 VFD cable designs
- 7 Installation tips
- 8 Summary
- 9 Q & A



1 What is a VFD?

Old Way:

- Single-speed drive
- Mechanical speed control
- Electrical or mechanical direction control

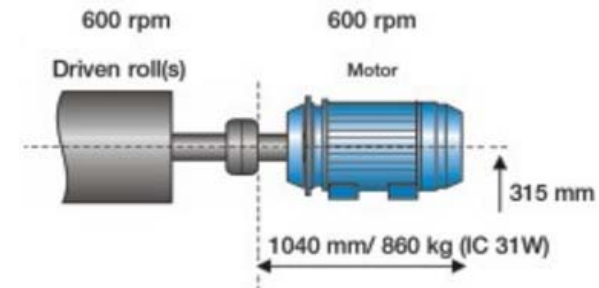


Removable parts



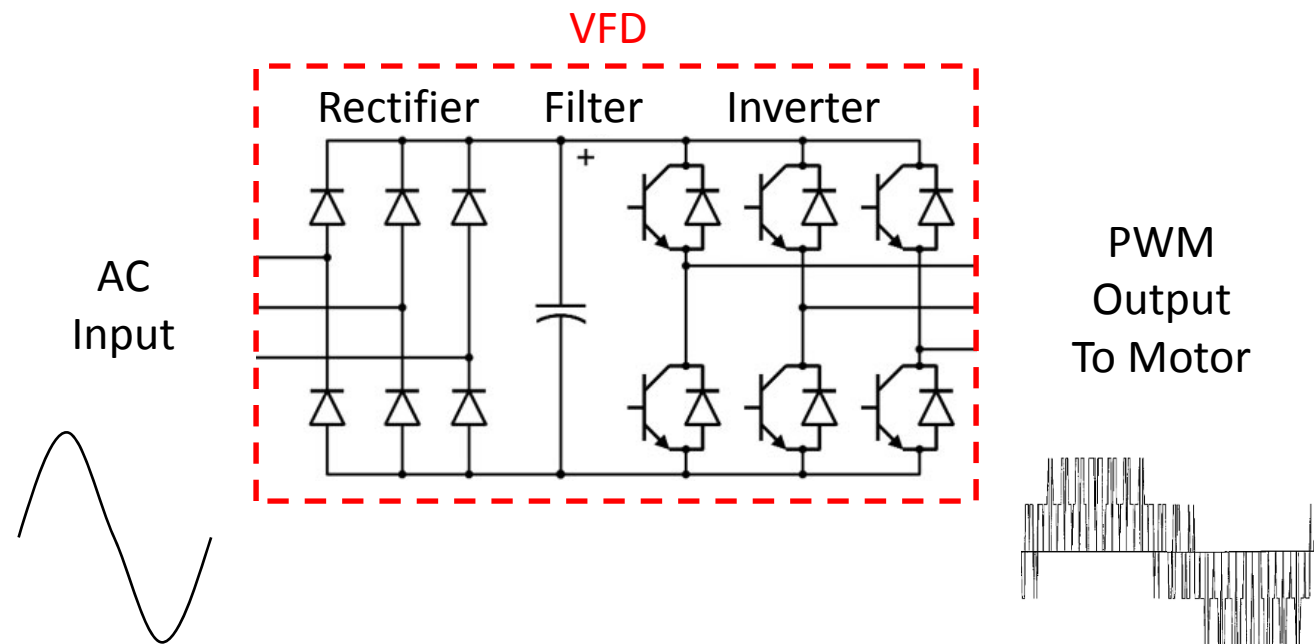
New Way:

- Variable Frequency Drive
- Electrical speed control, plus torque and direction



A typical VFD is made of 3 key components:

1. Rectifier – Transforms Alternating Current (AC) current into Direct Current (DC);
2. Filter – Creates a constant DC power source; and
3. Inverter – Transforms DC into a Pulse Width Modulated (PWM) waveform.



2 VFD Applications

Material Processing & Handling

- **Industrial:**

- Wood processing
- Automotive
- Pulp, paper, and printing
- Food and beverage
- Power plants
- Mining
- Metal industry
- Machine shop
- Plastics
- Textiles



- **Non-Industrial:**

- Water and Sewage Treatment
- Heating, Ventilation, and Air Conditioning (HVAC)

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VFD Manufacturers

ABB

TOSHIBA

**Rockwell
Automation**

**Schneider
Electric**

 **Allen-Bradley**

EATON


EMERSON™

BALDOR®

HITACHI

YASKAWA

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3

Advantages and Complications

Advantages

- Lower maintenance cost
- Increased productivity
- Energy savings
- Smooth start and stop
- Higher quality

Complications

- Electromagnetic Interference (EMI)
- Repetitive high voltage spikes
- Corona discharge
- Reflected wave and standing waves
- Possibility of motor bearing failures
- Limited motor cable length



These complications are significantly reduced in severity when proper VFD cable is installed!

IEEE Study on VFD Cables

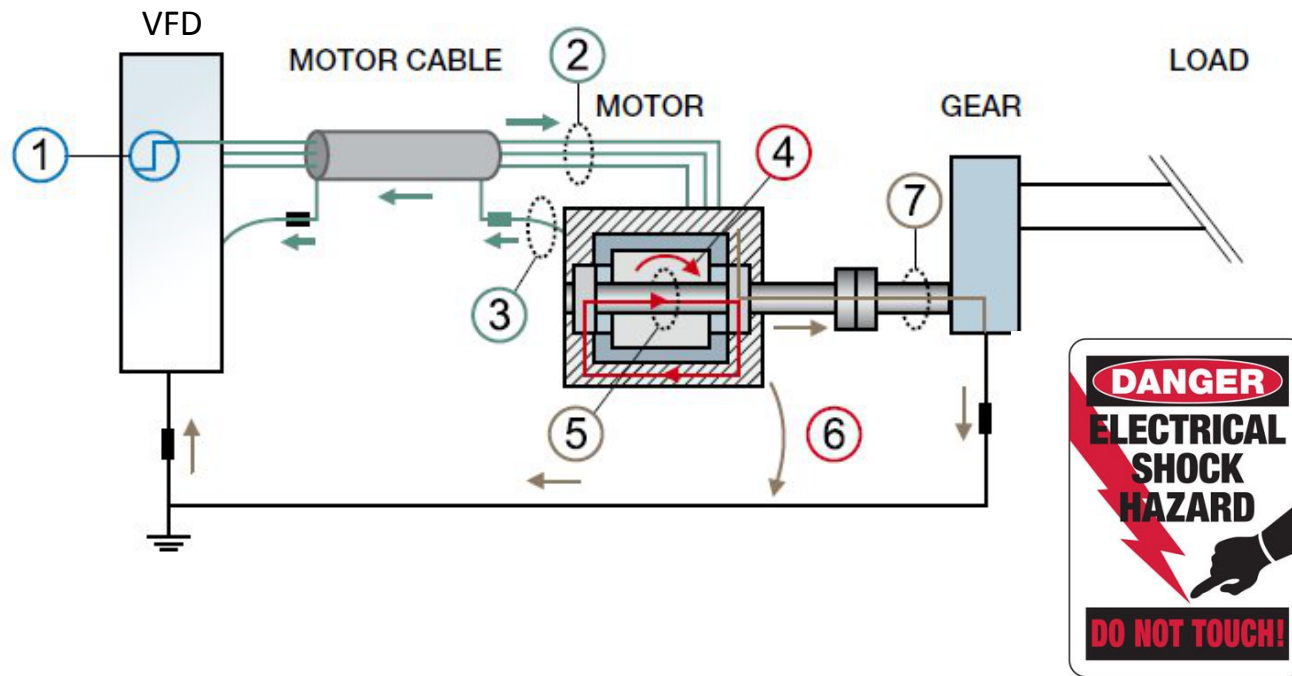
5 performance concerns were addressed in an IEEE paper titled “Evaluation of Motor Power Cables for PWM AC Drives”.

1. Minimize net injected ground current into drive system ground bus
2. Minimize common mode currents
3. Minimize motor frame standing voltage
4. Best possible cable shielding
5. Best possible ground path in cable



4 VFD System

Bearing Currents



Source: TDM001 EN Rev B 2007 "Bearing currents in AC drive systems", ABB, 2007

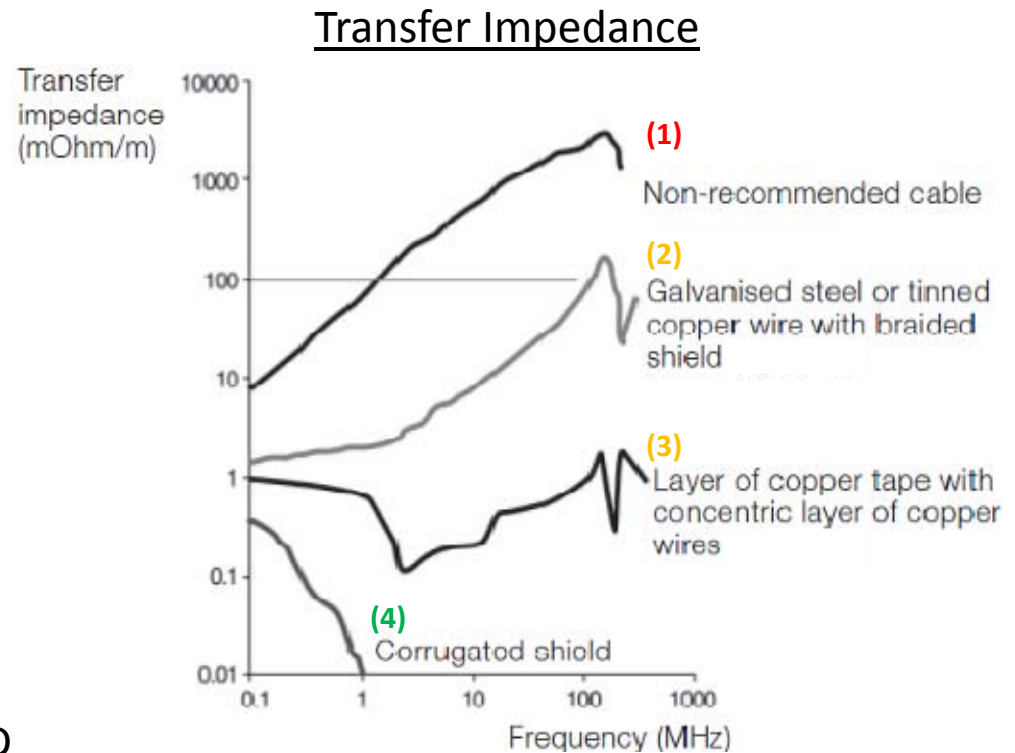


- VFDs have been used for HVAC systems in buildings for more than 40 years!
- About 5% of all motors are controlled by VFD!
- Sales of VFD technology is growing at a rate of more than 5% per year!

5 Why Use VFD Cables?

Cable Comparison

1. Building Wire or Cable in Conduit
 - TECK90 or MC
 - RW90 or XHHW-2 in EMT
2. Tinned Copper Braid
 - Very flexible VFD cable
3. Copper Tape with Wires
 - Flexible VFD cable
4. Corrugated Aluminum Sheath
 - Trainable, self supporting VFD cable



Source: "Technical guide No. 3 EMC compliant installation and configuration for a power drive system", ABB, 2012





6 VFD Cable Designs

Key Characteristics

- XLPE insulated conductors
- Three symmetrically placed grounding conductors
- Continuous Al sheath, Cu tape, or braided wire
- PVC jacket



VFD Cable Designs

Characteristic	Aluminum Sheath, with XLPE Conductors	Copper Tape, with XLPE Conductors	Braided Wire, with XLPE Conductors	Typical Wire or Cable, with XLPE Conductors
				
High Frequency Bonding	Best	Better	Good	Poor
Flexibility	Good	Better	Best	Varies
Self-Supporting	Best	Good	Poor	Varies
Mechanical Protection	Best	Good	Good	Varies
Suitable as a VFD Cable	✓	✓	✓	✗

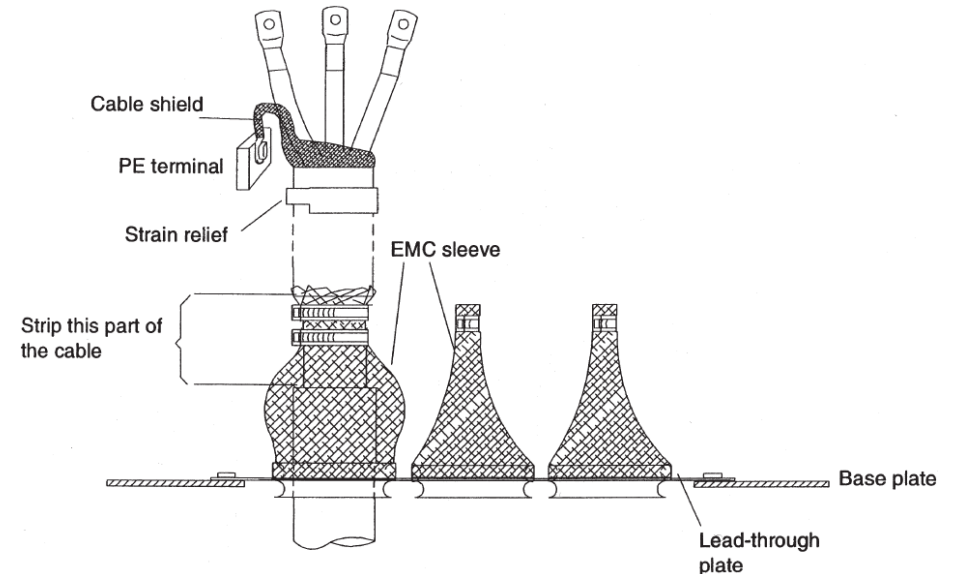
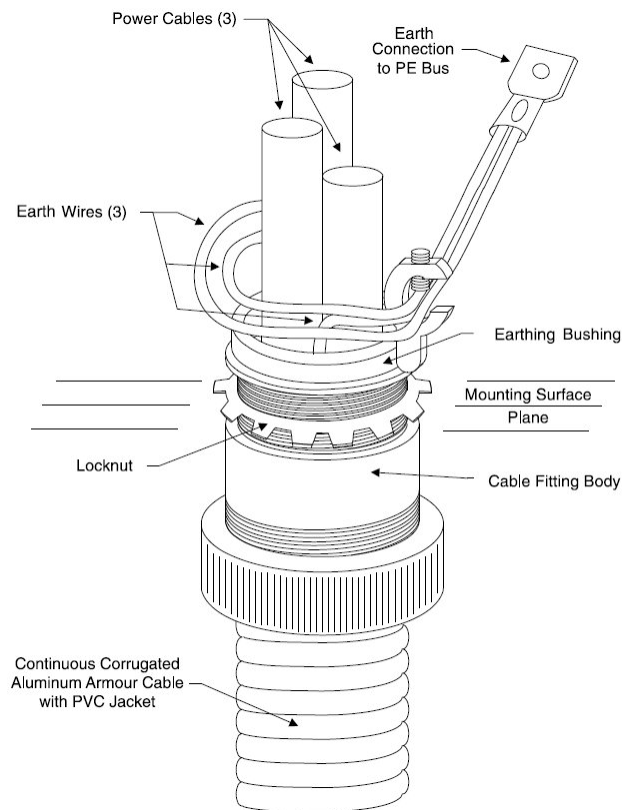
Note that these cables are CSA certified or UL listed for installation and use in Canada and the U.S.

7 Installation Tips

- Use only symmetrical 3 conductor shielded VFD cables.
- Do not break the cable shield except where terminating in a shielded environment (enclosure).
- Cable shield should be connected to ground by a short pigtail.
- Use twisted pairs for communications cables to avoid crosstalk.
- Route power and control cables separately.
- Follow VFD manufacturer's instructions!

Installation Tips

- Use cable connectors that maintain 360° contact with the cable shield and the shielded enclosure.



Source: "Technical guide No. 5 – Bearing currents in modern AC drive systems", ABB, 2011

8 Summary

- **What: VFD** controls a motor's **speed, torque, and direction**, resulting in improved system efficiency.
- **Where: VFD applications** include **Material Processing & Handling**
- **Why: Advantages:** Lower maintenance cost, Increased productivity, Energy savings
- **Why: Complications:** EMI, Repetitive high voltage spikes, corona discharge
- **VFD cable designs** – key characteristics
- **Installation tips**

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QUESTIONS?



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