Motor Inverter Compatibility Topics

- ❖ Reflected Wave Theory
- ❖ Waveform Analysis with output reactors & filters
- ❖ Long Motor Leads
- ❖ Drive Solutions
- ❖ Motor Solutions

Reflected Wave Theory

Mismatch between surge impedance of:

Drive-to-motor cable & Motor winding

- ❖ Cable surge impedance fairly constant through hp range
- ❖ Motor surge impedance inversely proportional to hp
- ❖ 2 per unit voltage evident on motors up to 500 hp
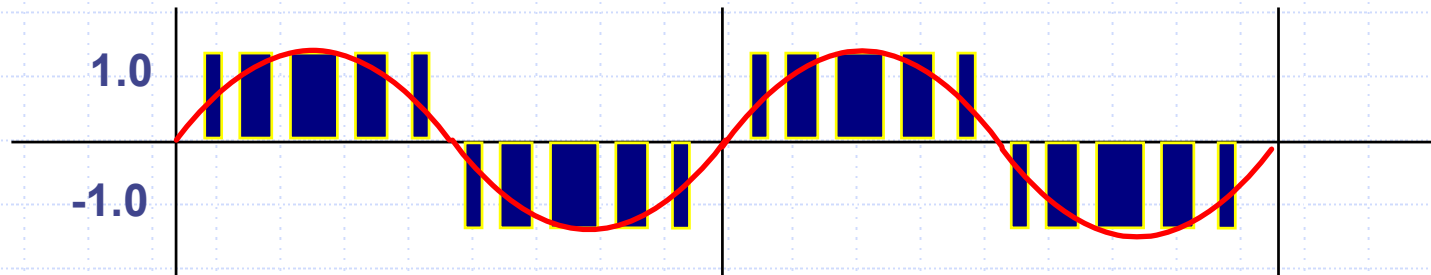- ❖ Motor terminal voltage doubling on leads over 15 feet

PWM Waveform

Full Voltage, 60 Hz PWM Waveform
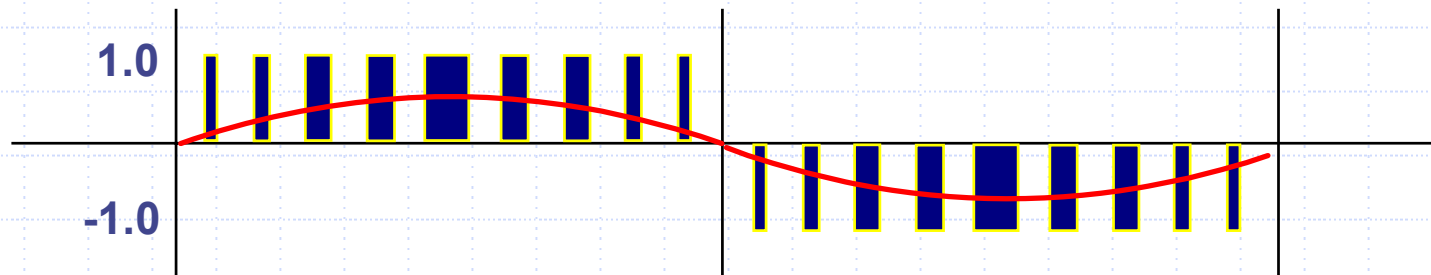
Half Voltage, 30 Hz PWM Waveform

VFD Output & Motor Terminal Voltage, Reflected Waves
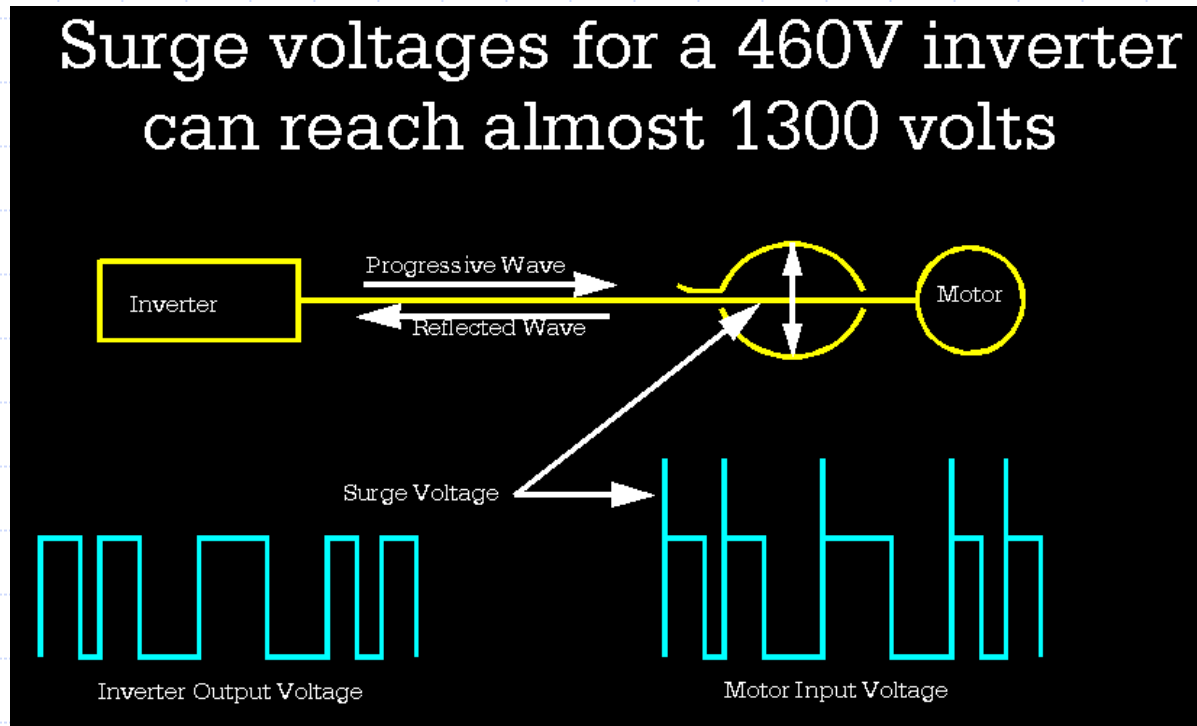
Surge voltages for a 460V inverter can reach almost 1300 volts

Inverter — Progressive Wave → ← Reflected Wave — Motor

Surge Voltage

Inverter Output Voltage

Motor Input Voltage

IGBT VFD, Motor Terminal Peak Voltage & Rise Time Characteristics

Peak voltage = twice DC Bus voltage at critical cable length and longer. DC bus voltage = AC input voltage * 1.414.

e.g. 600 VAC * 1.414 = 850 * 2 =1,700 V Peak.

Rise time = 0.25uS to 1uS Depending on IGBT Current Rating

Critical cable length = speed of propagation * rise time.

e.g. 150meters/uS * 0.25uS = 37.5 meters

NEMA Minimum Design Standards For 3 Phase Induction Motors

MG1 part 30

As a minimum
   motor insulation
   must withstand

1000 volt peak @
2uS rise time

MG1 part 31

As a minimum
   motor insulation
   must withstand

1600 volt peak @
0.1uS rise time

VFD Solutions

For NEMA MG1 part 30 Motors

- ❖ No output reactor or filter required for 208/240Volt applications
- ❖ Use output reactor for 460 volt applications
- ❖ Use output dv/dt filters for 600 volt applications
- ❖ Keep motor leads short
- ❖ Keep carrier frequency low
- ❖ Keep motor cool

Motor Solutions

For NEMA MG1 part 31 Motors

- ❖ No output reactor or filter required for 208/240 volt applications
- ❖ No reactor or output filter required for 460 or 600 volt applications unless cable length is extreme