



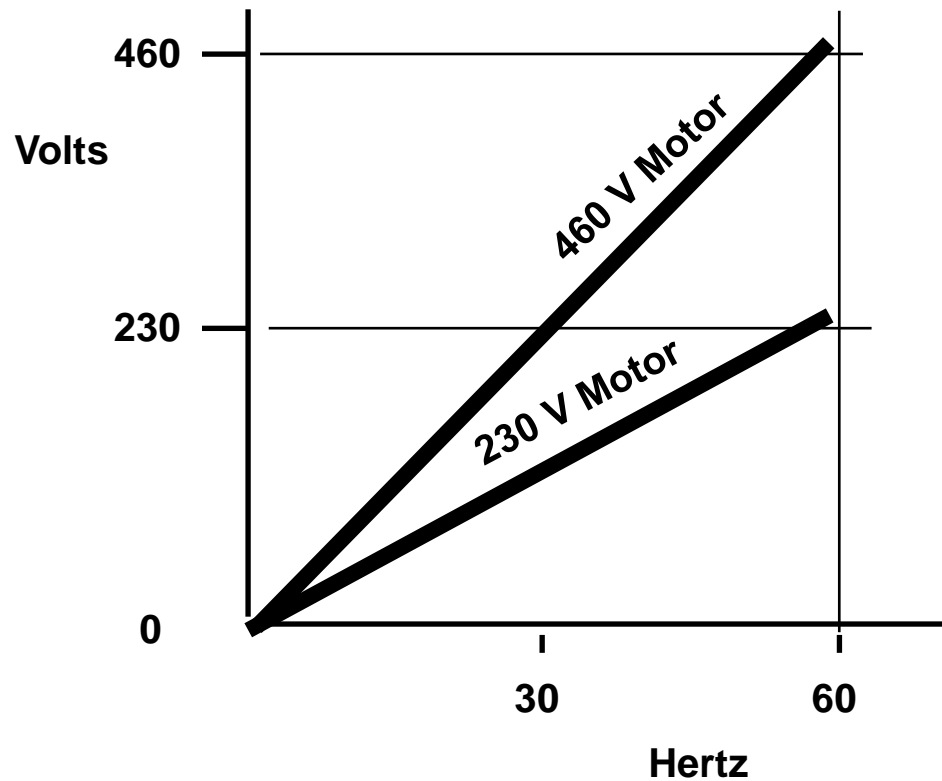
VFD Education

Jeff Miller – JMB & Associates

Introduction

- Jeff Miller, President and Owner of JMB & Associates
- Been in the VFD industry over 30 years
- Have worked for multiple manufacturers
- Enjoy engaging with the engineering community on the proper selection and application of VFDs in multiple industries
- Always willing to take tech support calls and make site visits

What is a Drive / VFD/ AFD?

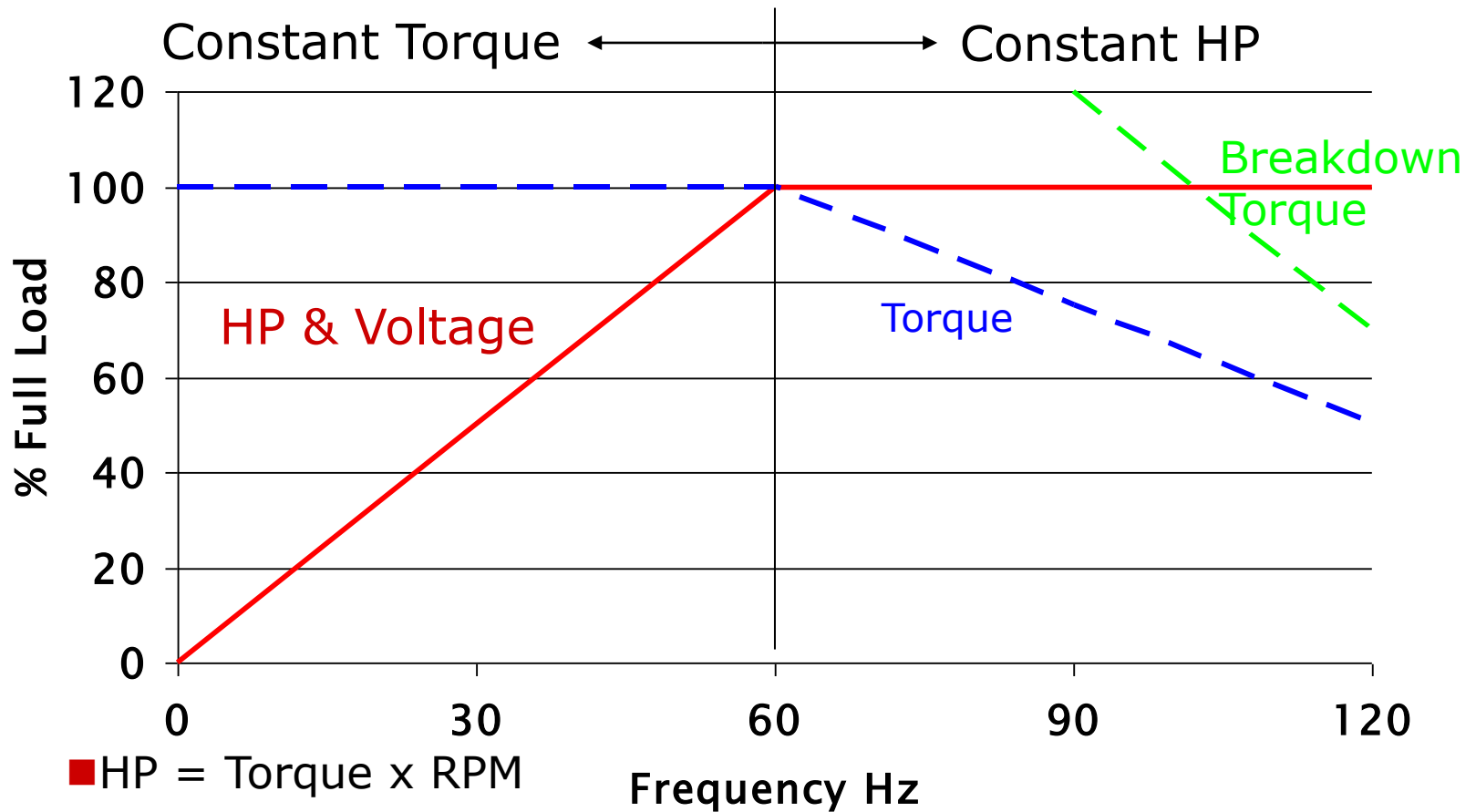


$$\frac{460 \text{ V}}{60 \text{ Hz}} = 7.67 \frac{\text{V}}{\text{Hz}}$$

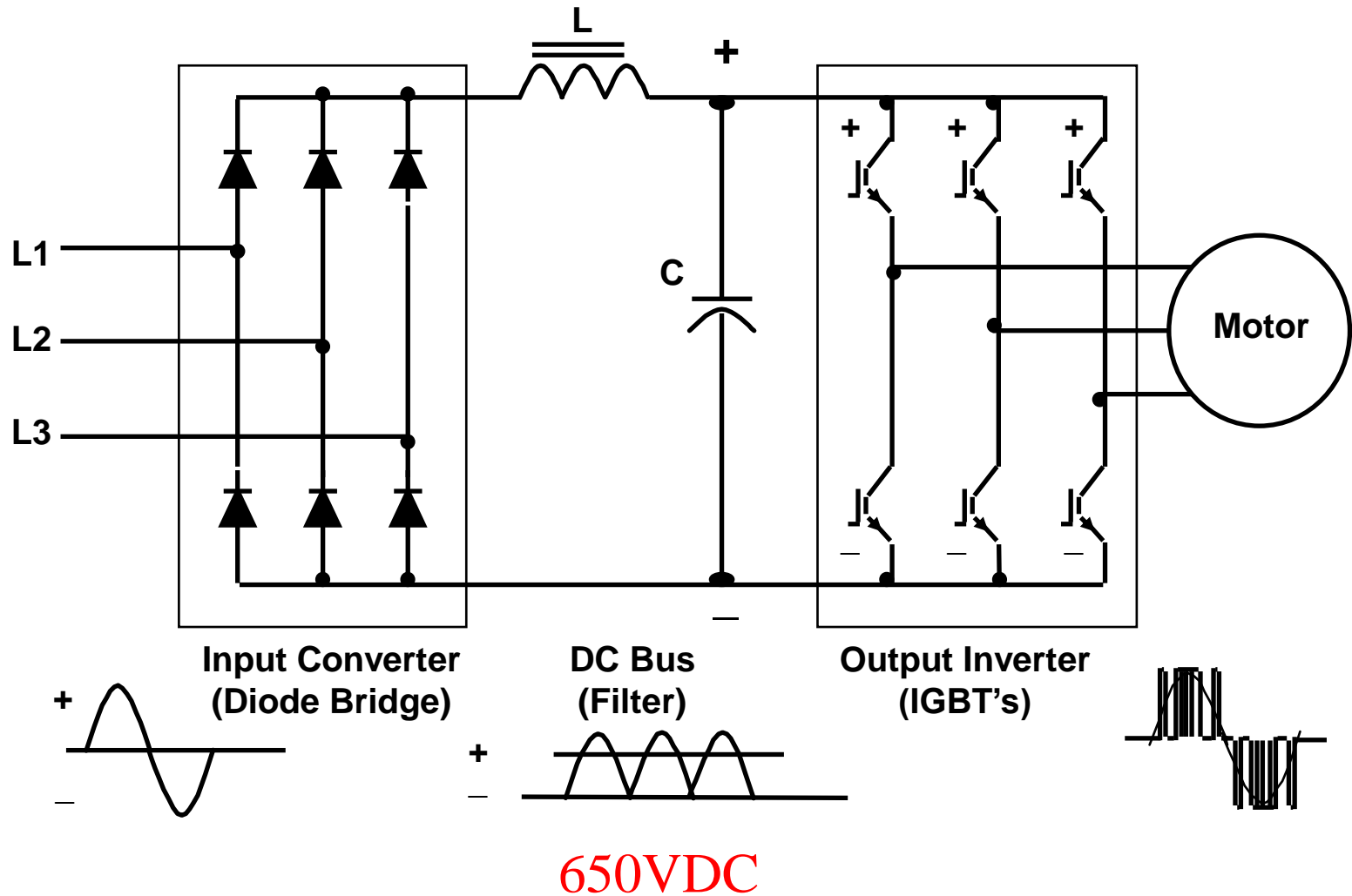
If 230 VAC Power Line:

$$\frac{230 \text{ V}}{60 \text{ Hz}} = 3.83 \frac{\text{V}}{\text{Hz}}$$

Motor Response to Frequency



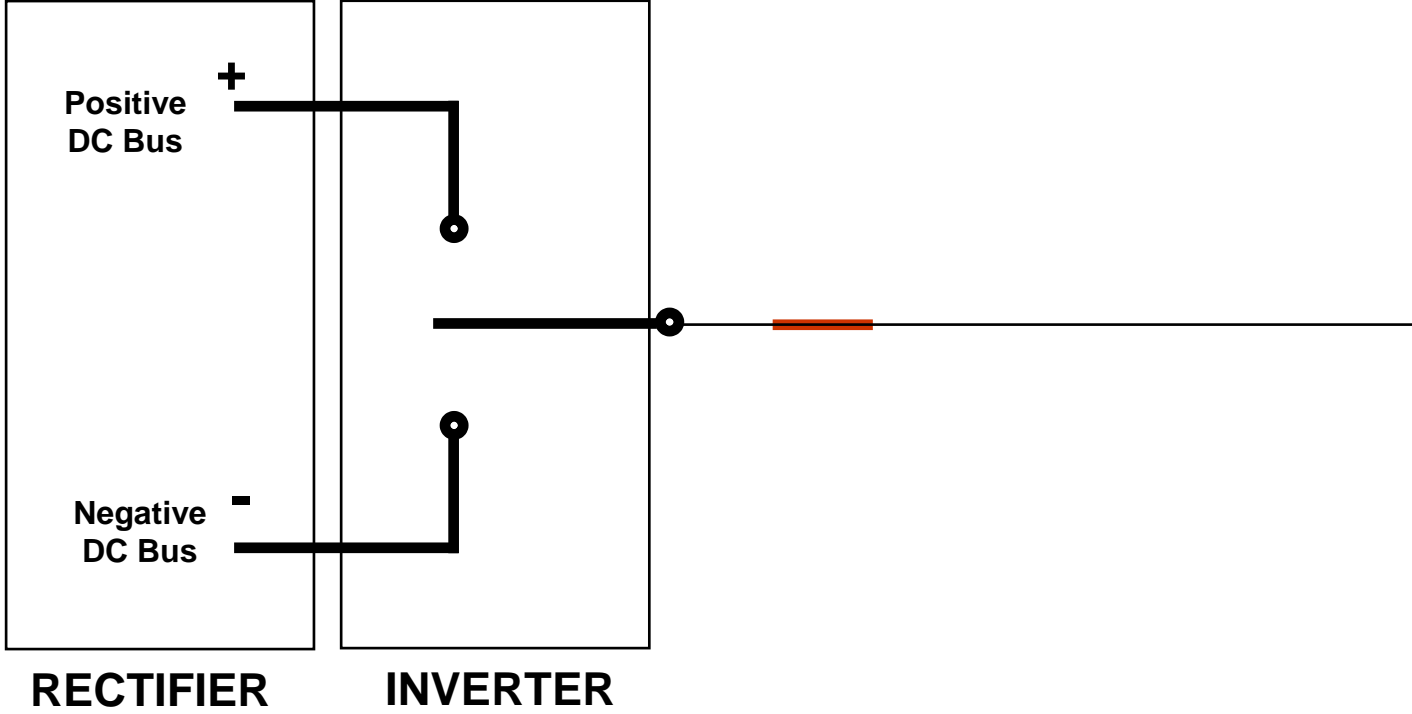
What is a Drive?

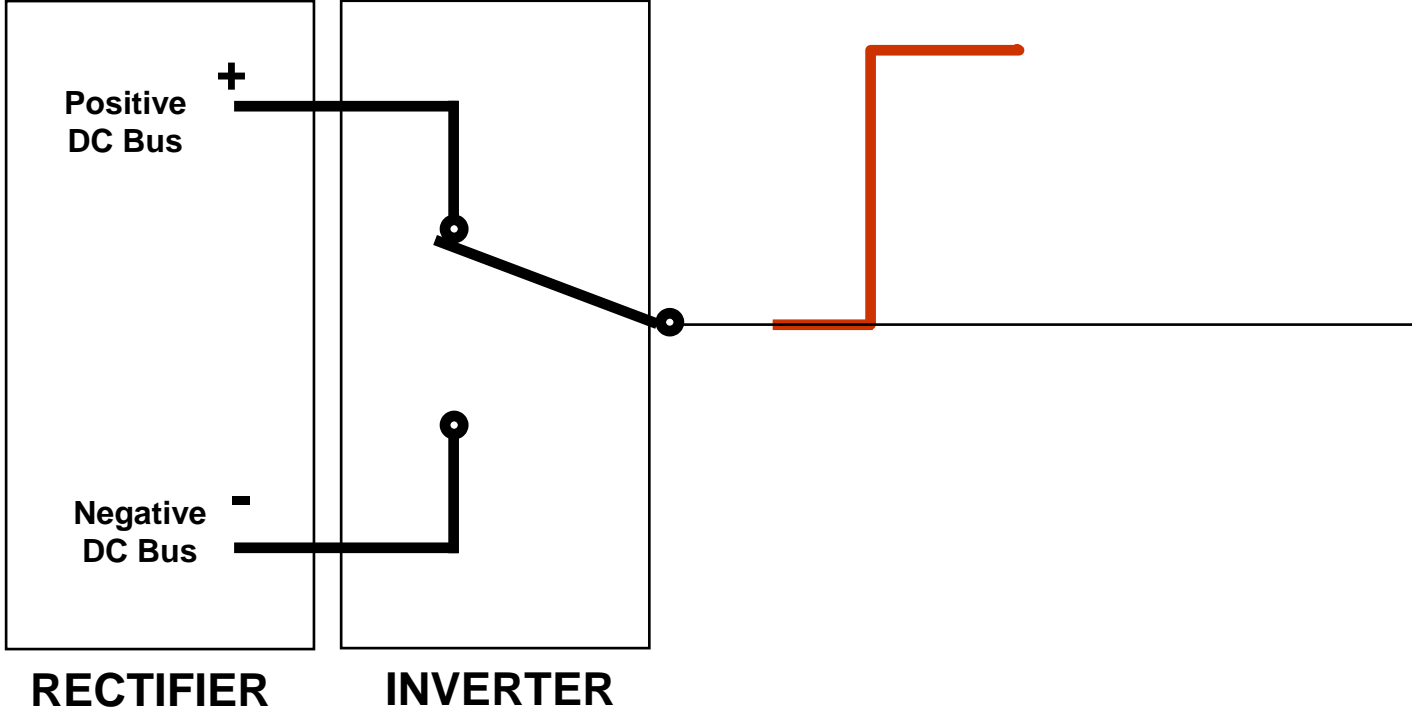


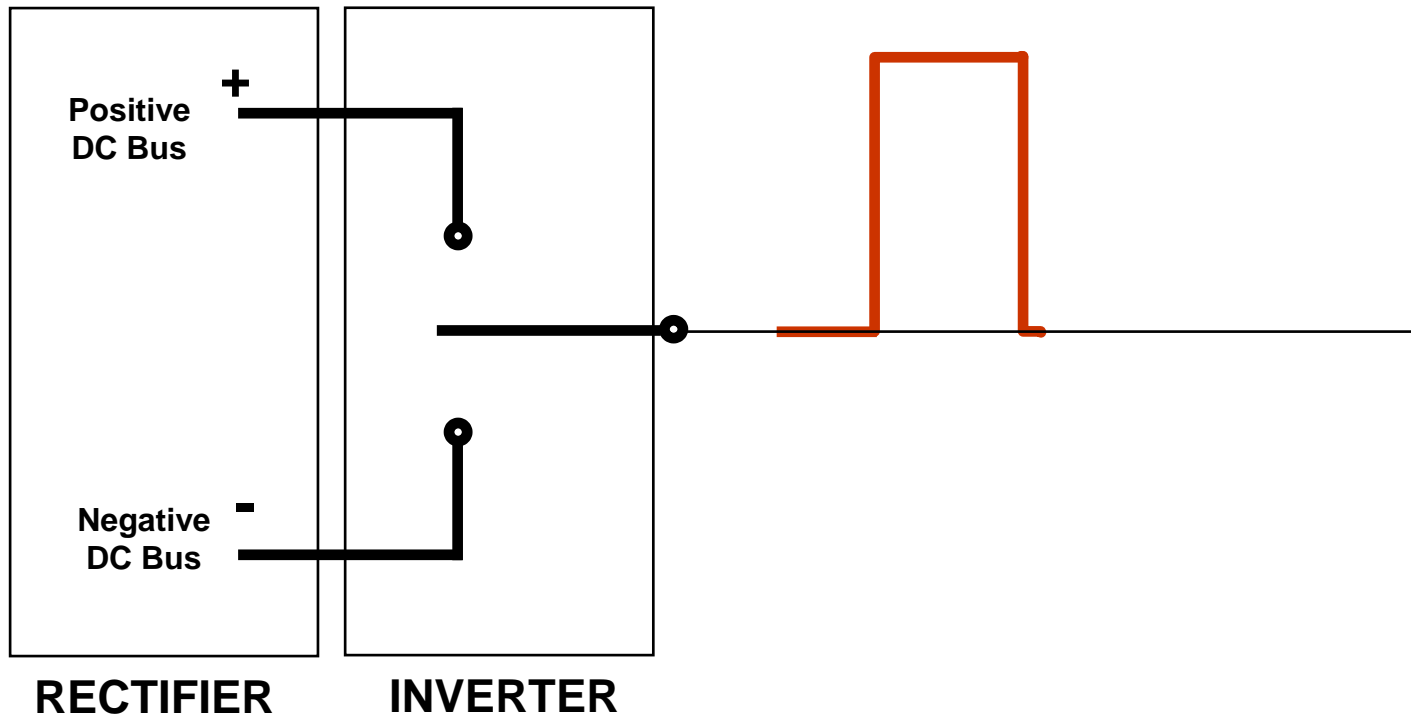
Safety First

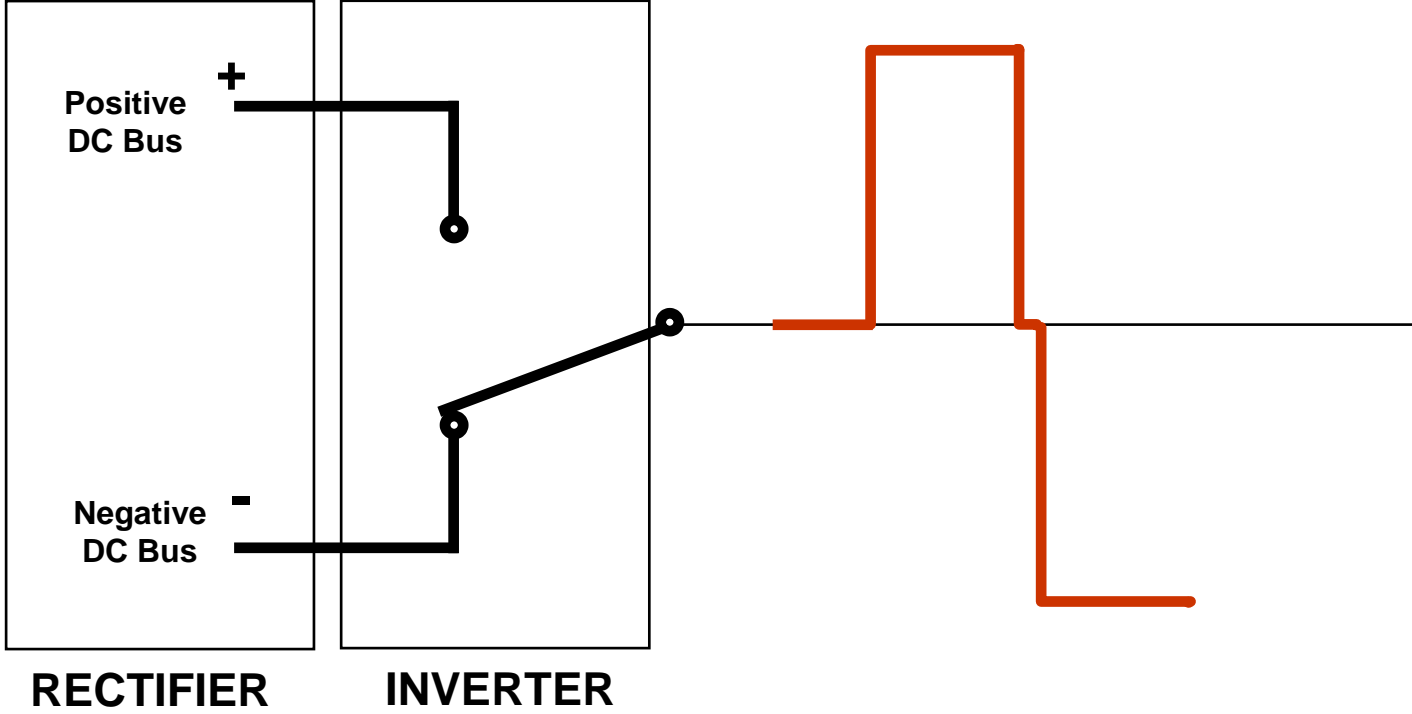
- Electrical safety training required to remove covers with power applied
- Wait until display/s are blank and all LEDS are off
- External power sources are on relays
- Verify all power is off using AC & DC meter ranges and probes rated for CATIV

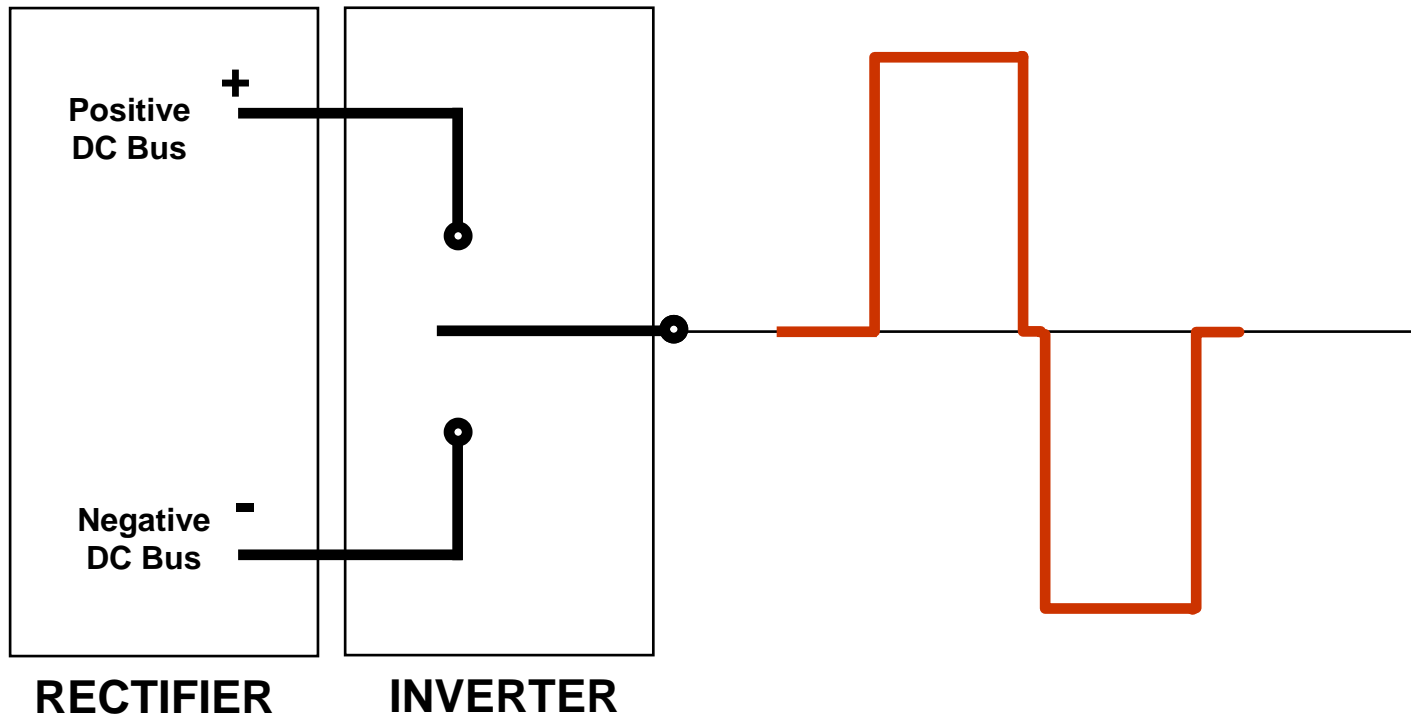


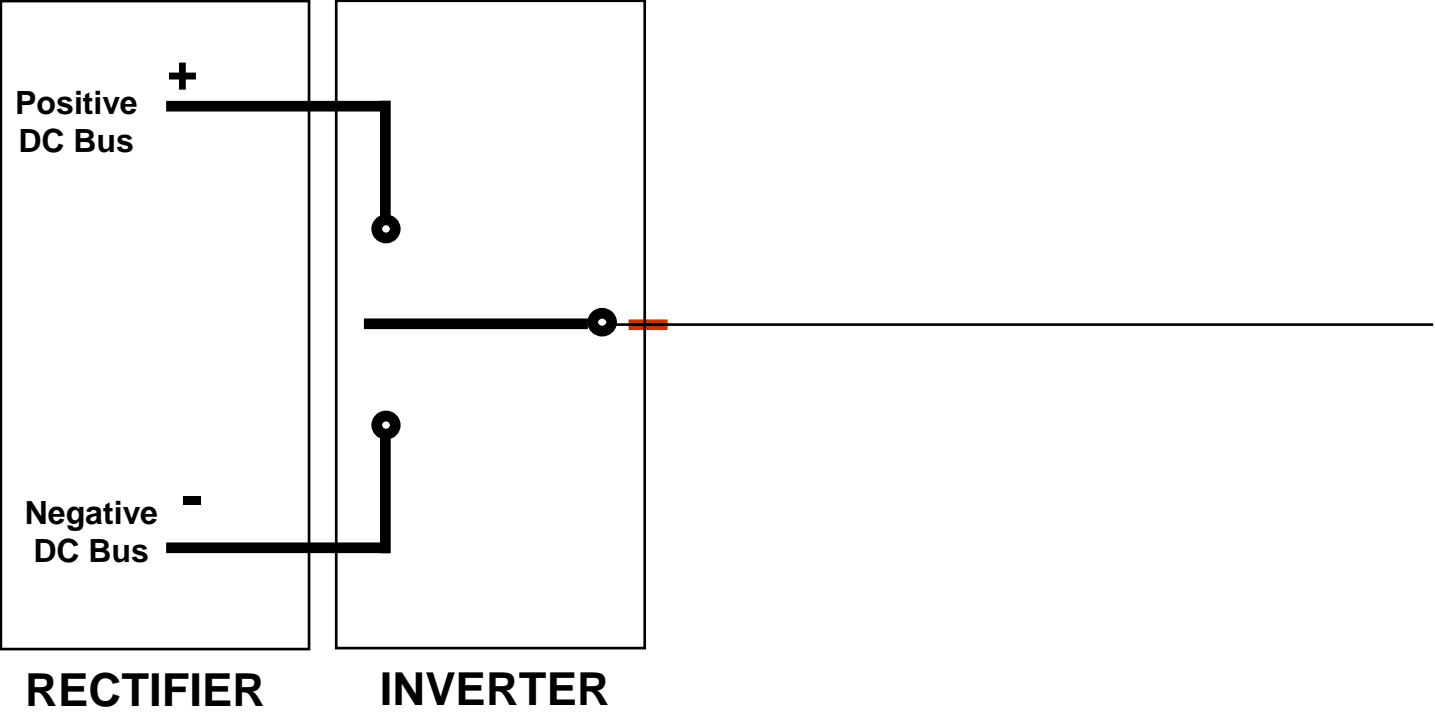


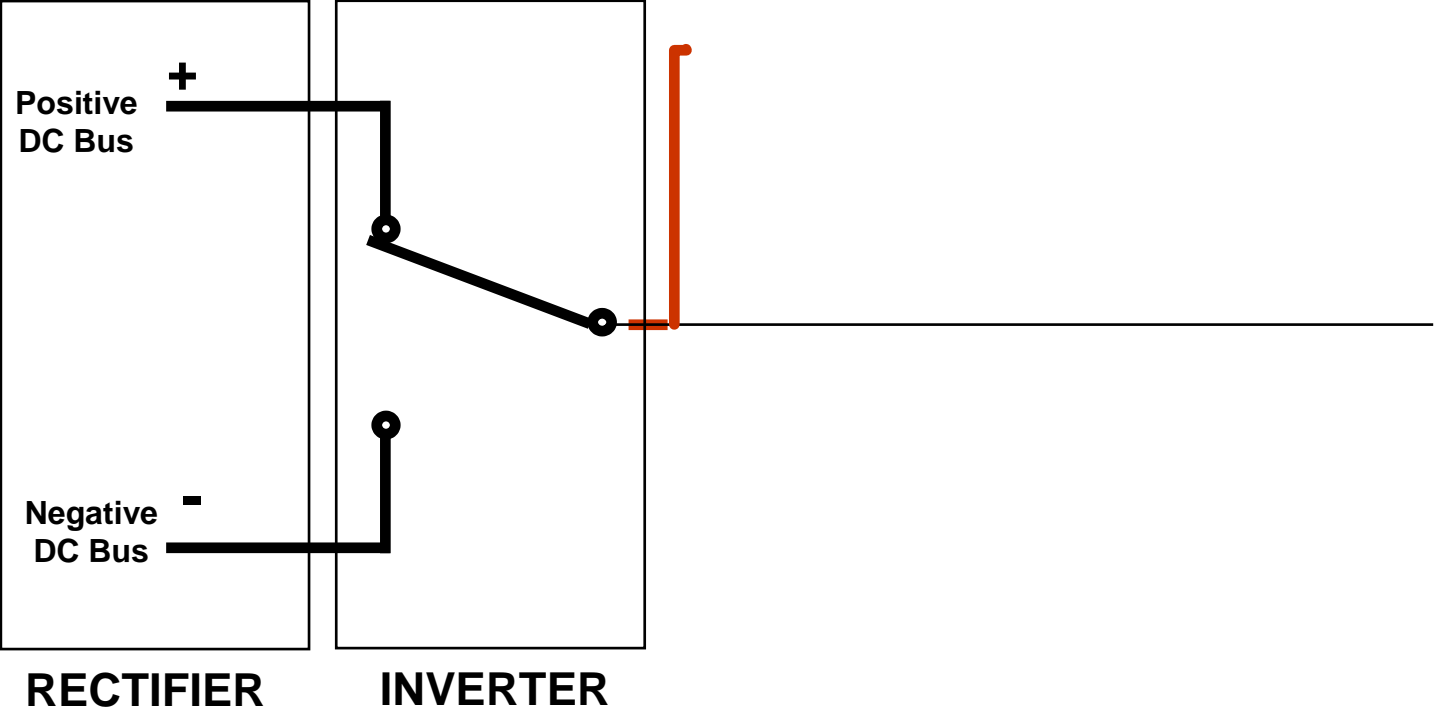


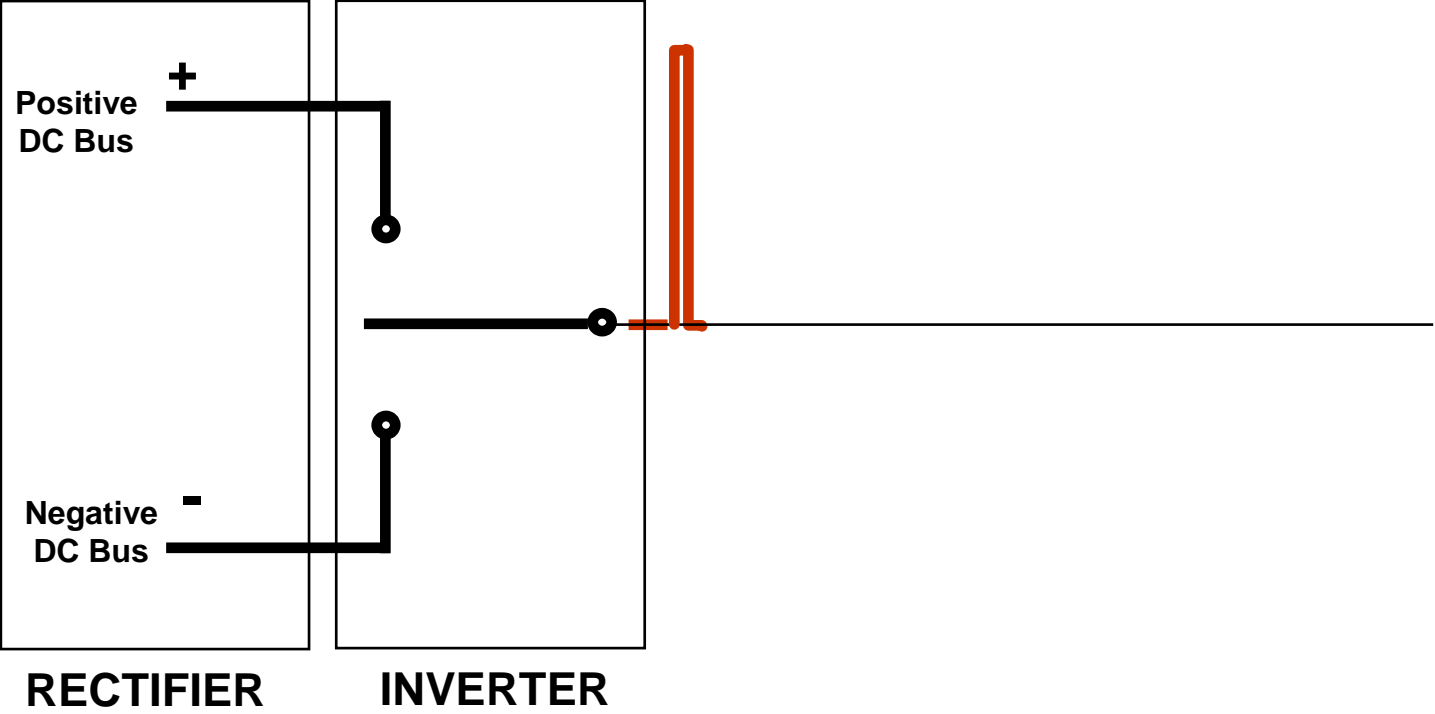


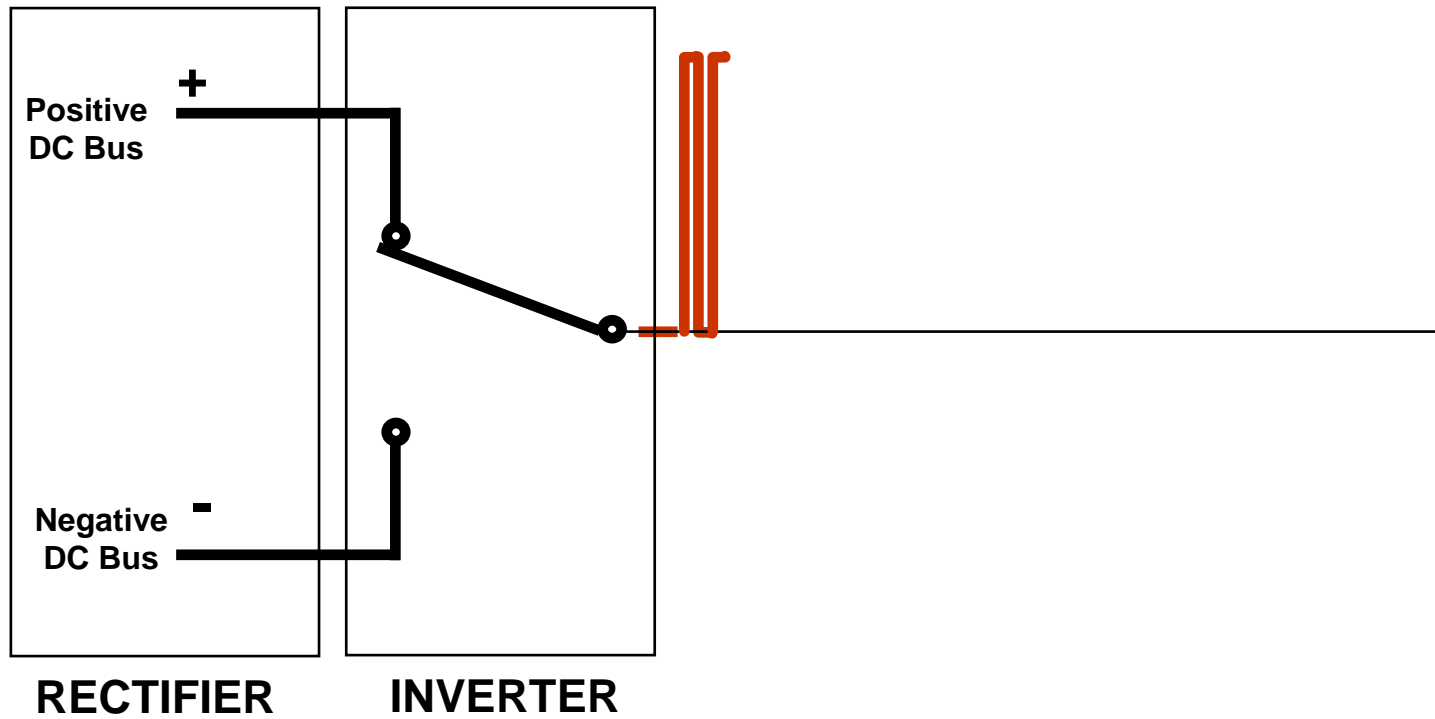


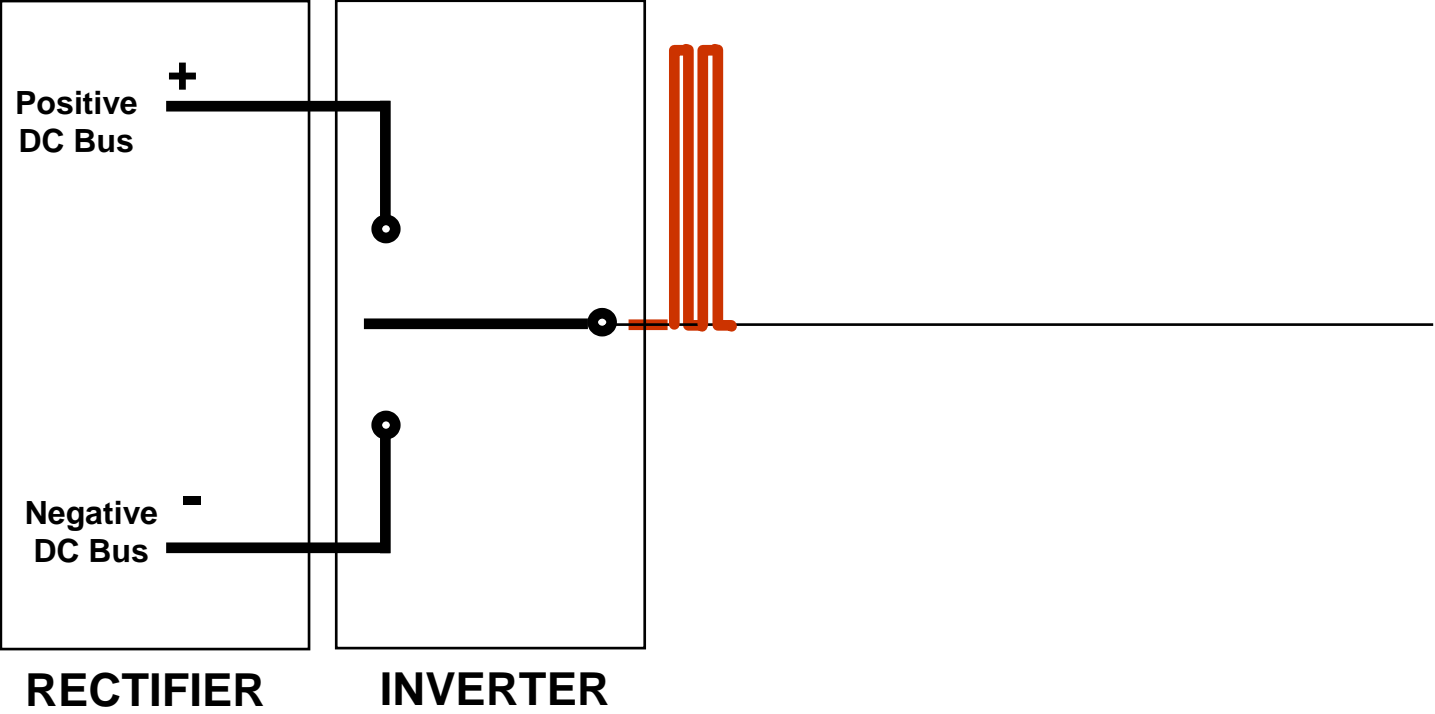


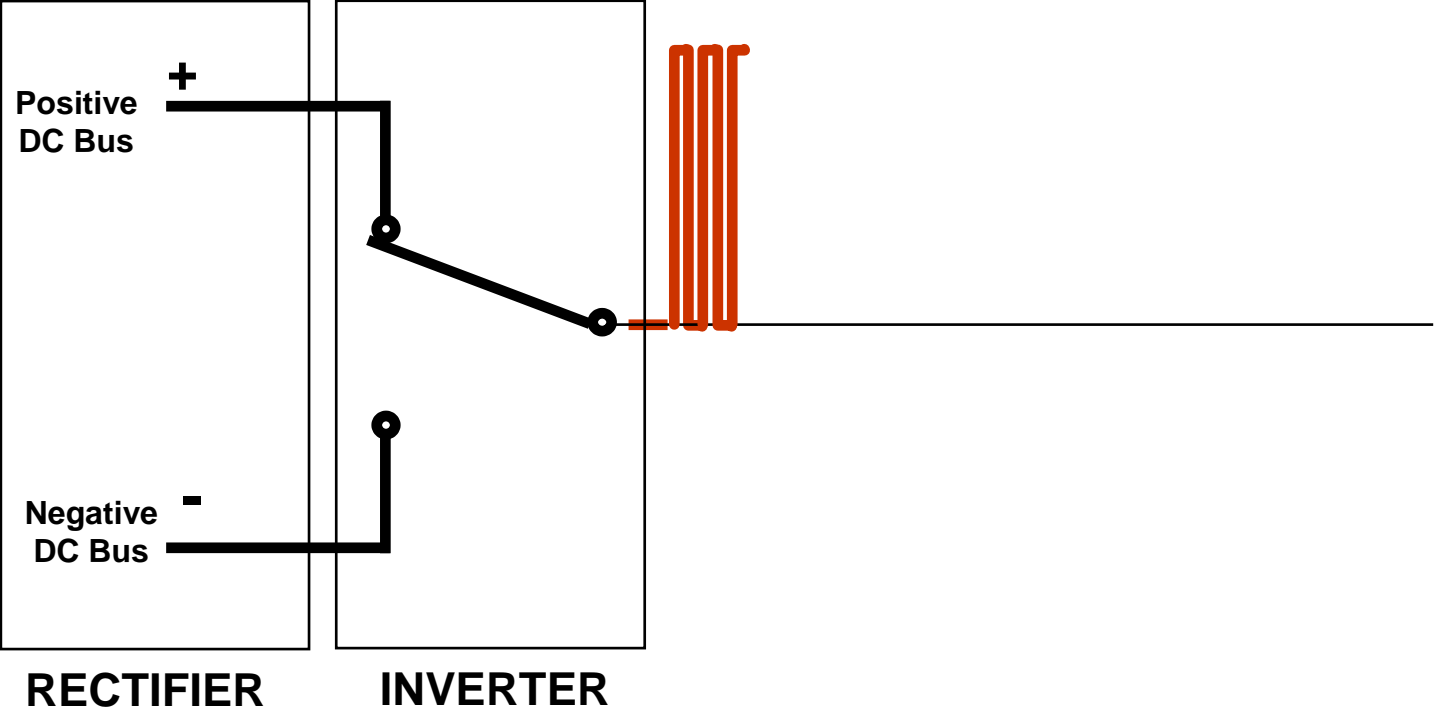


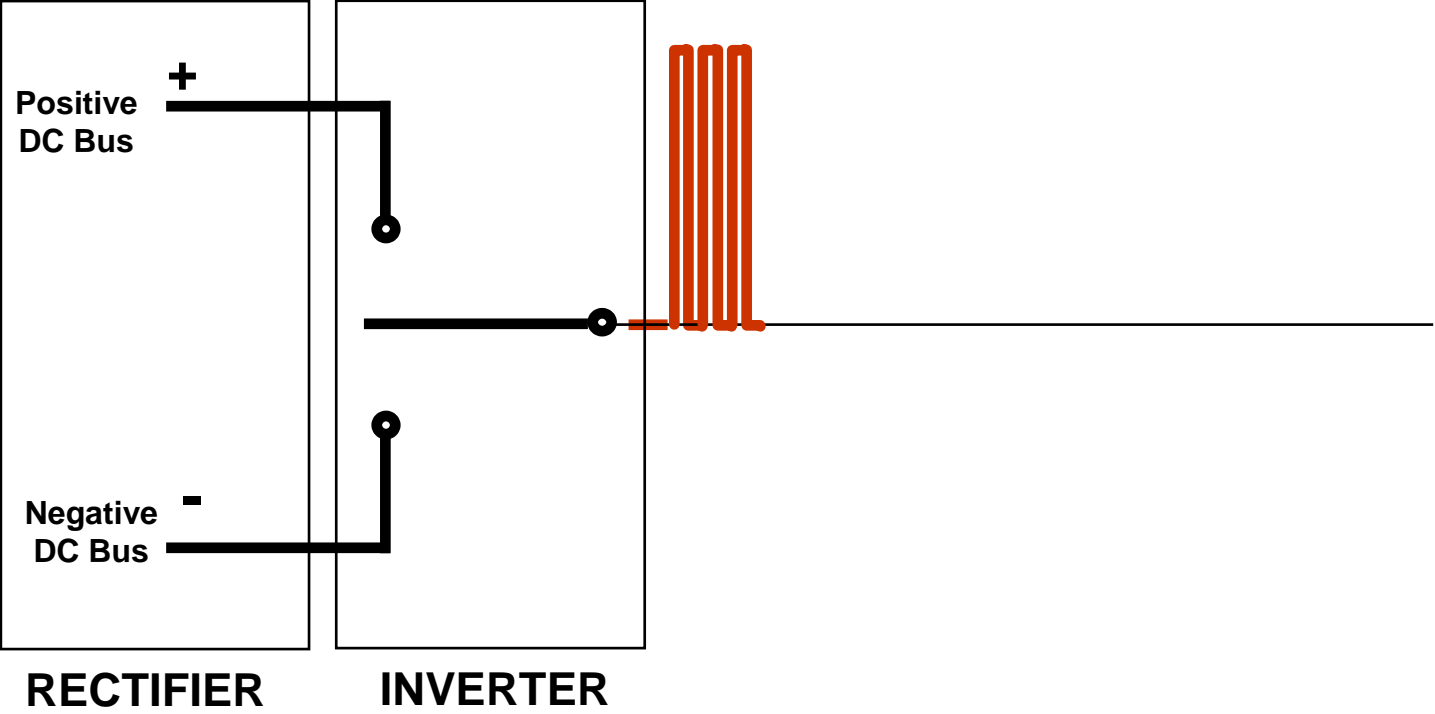


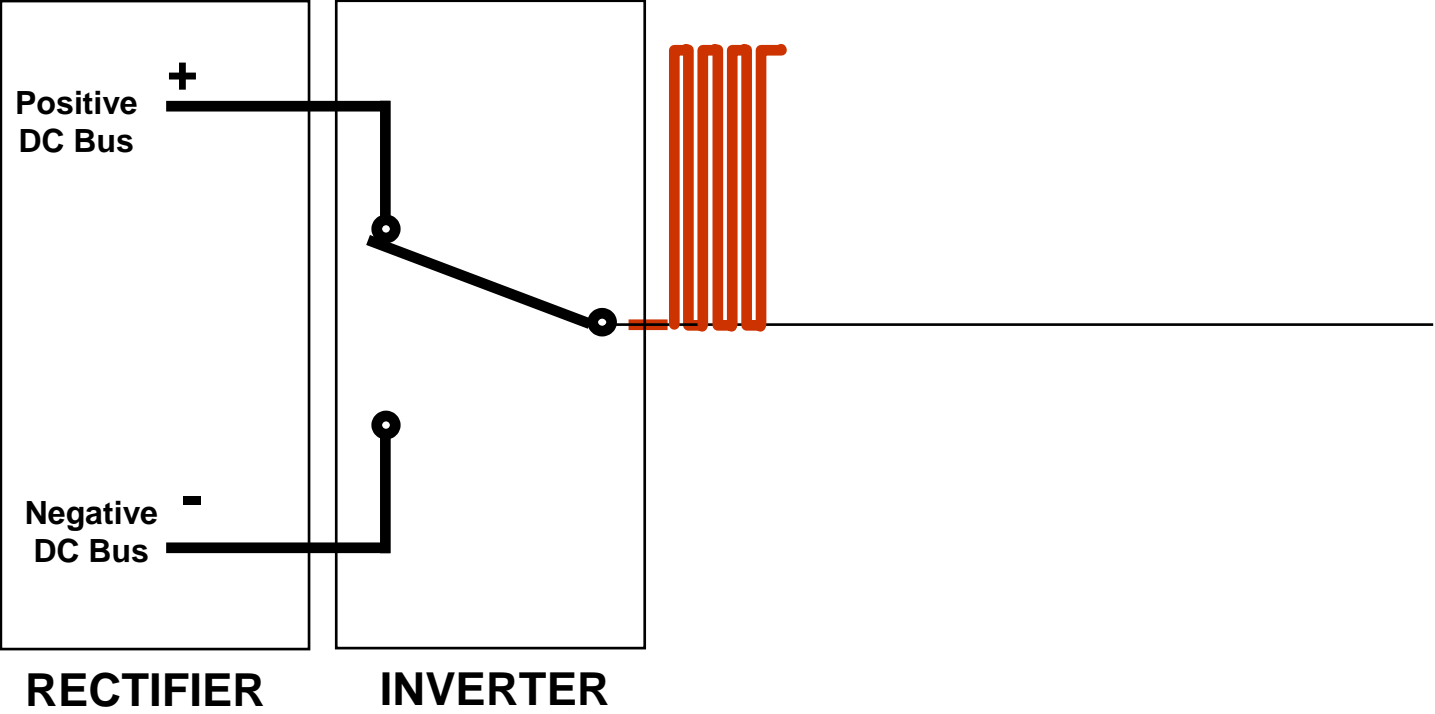


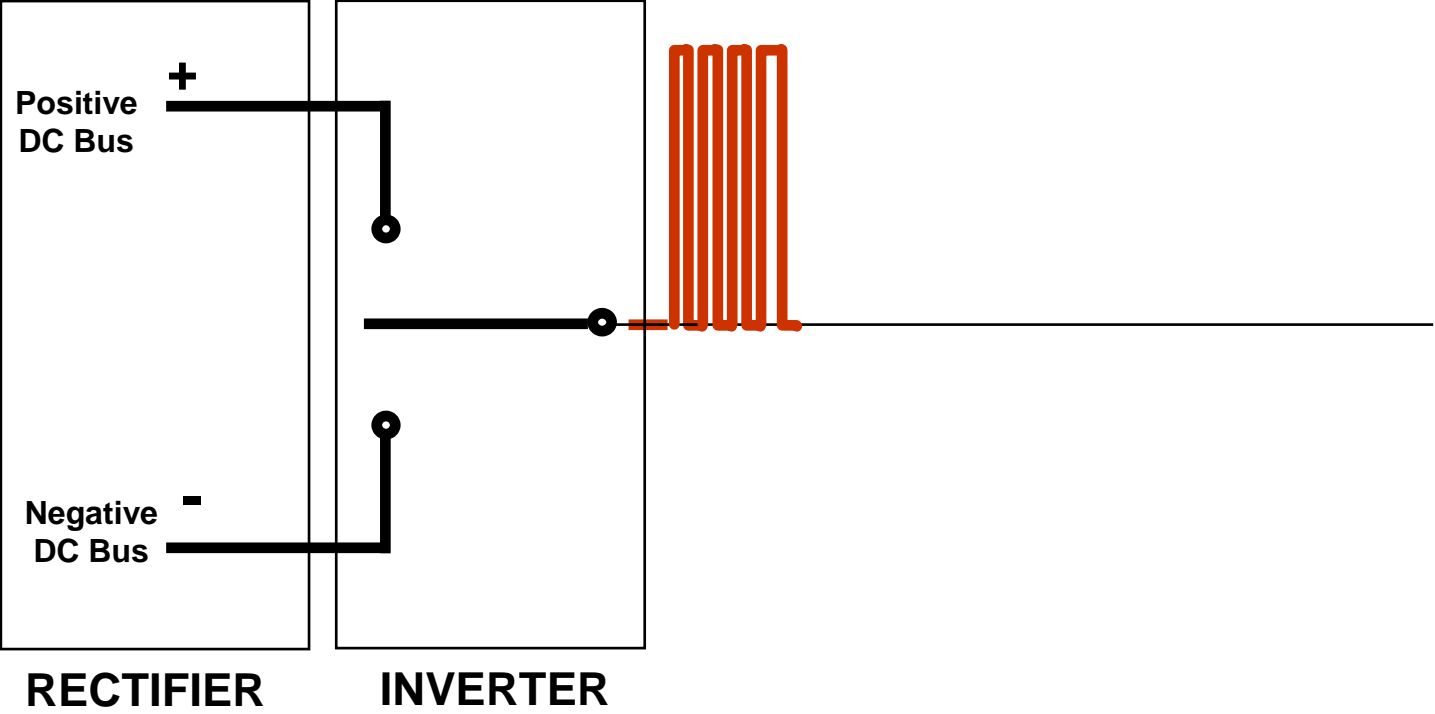


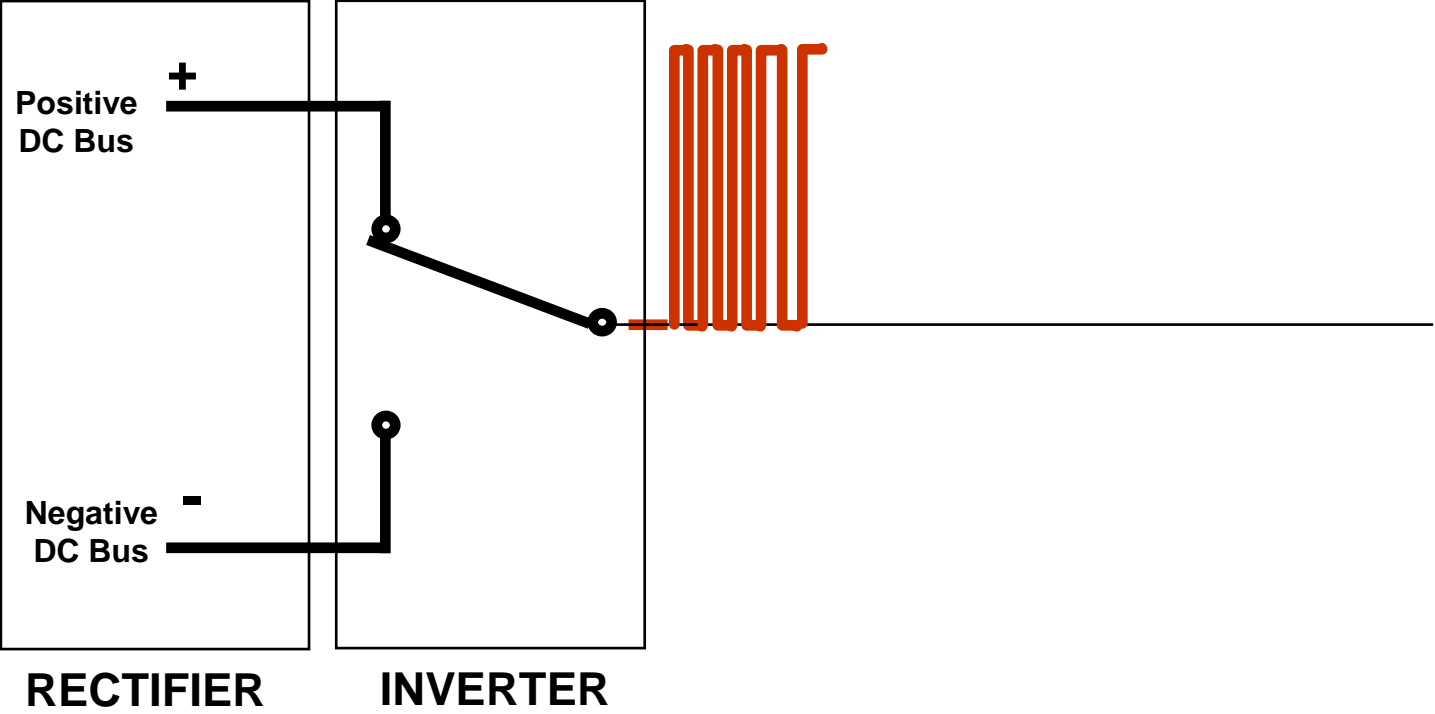


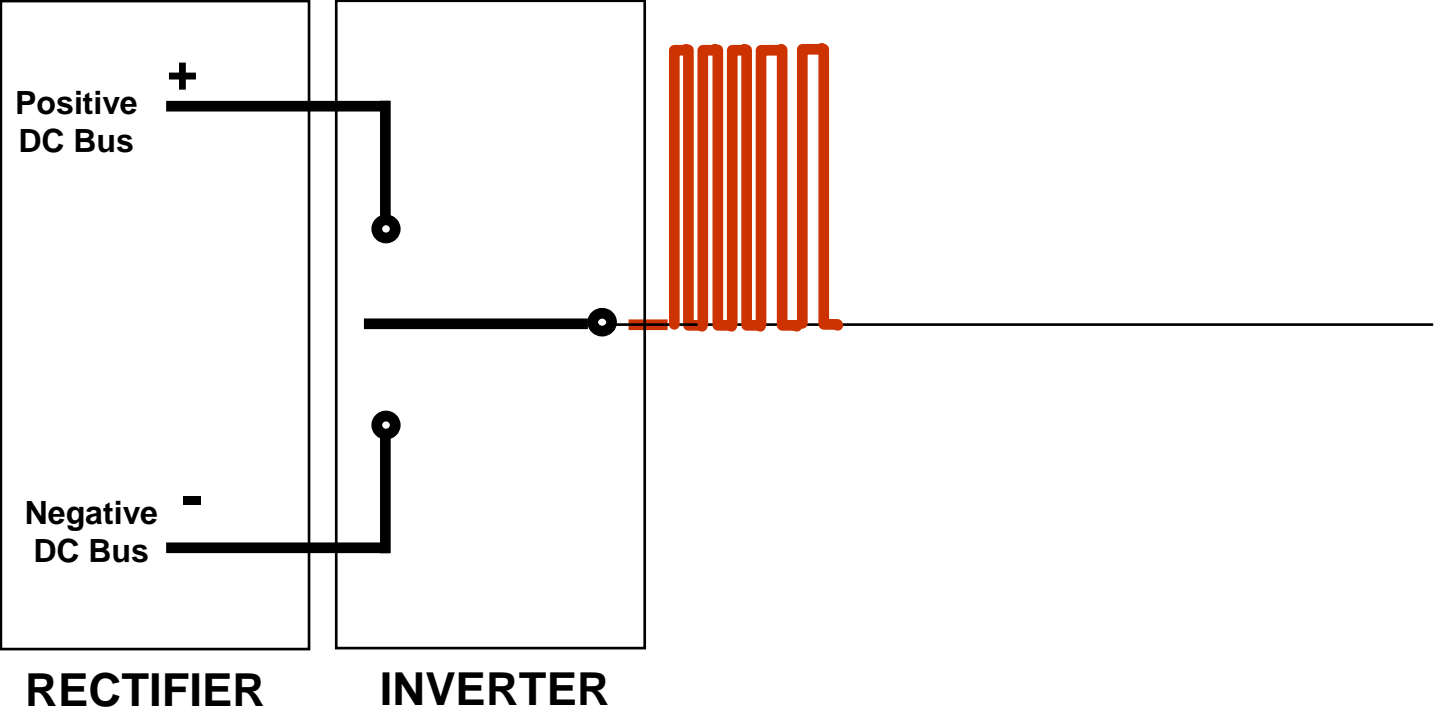


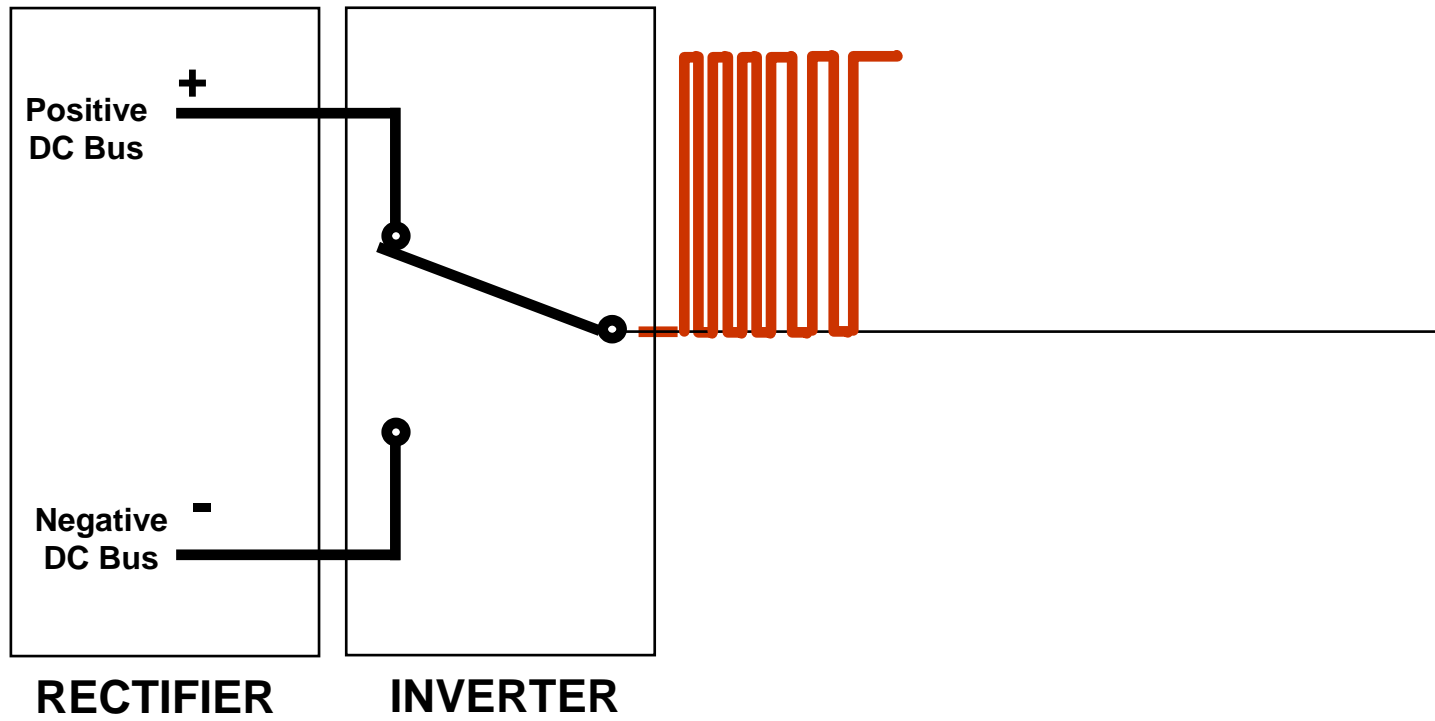


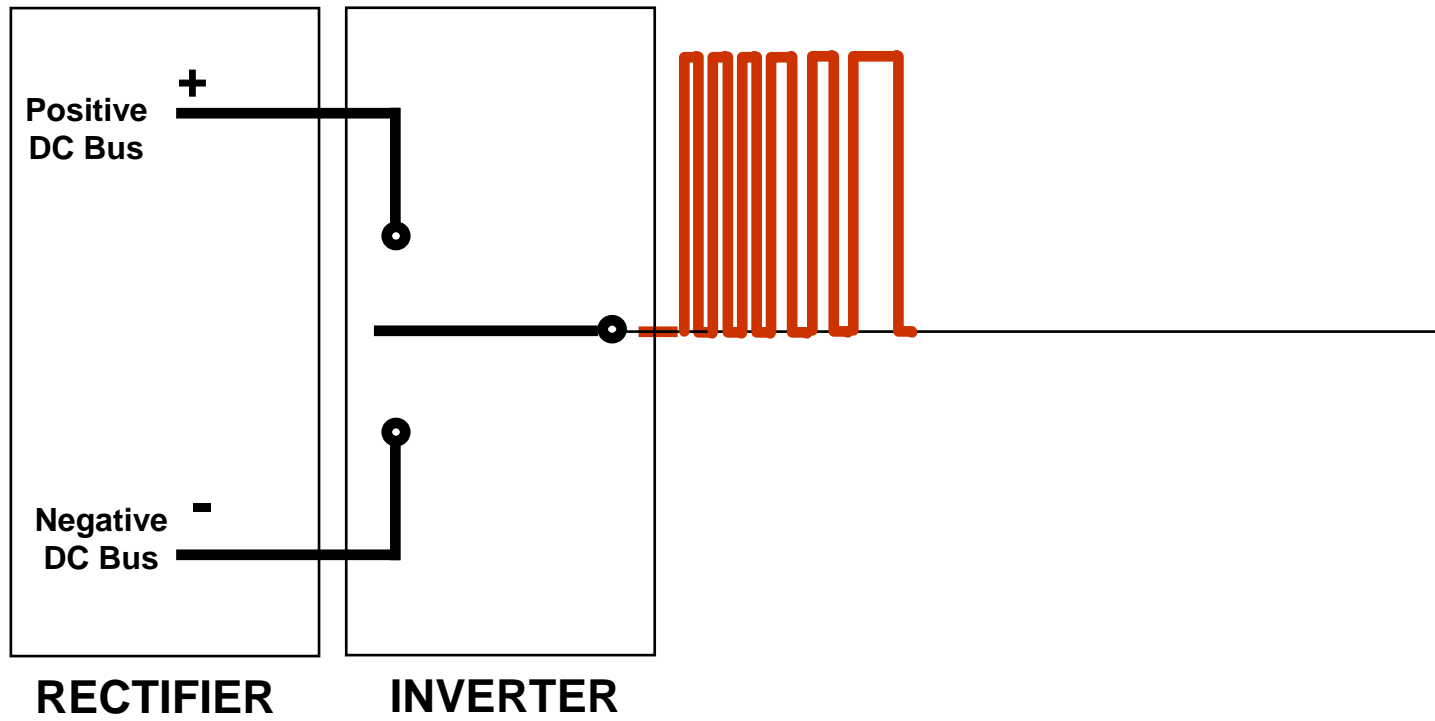


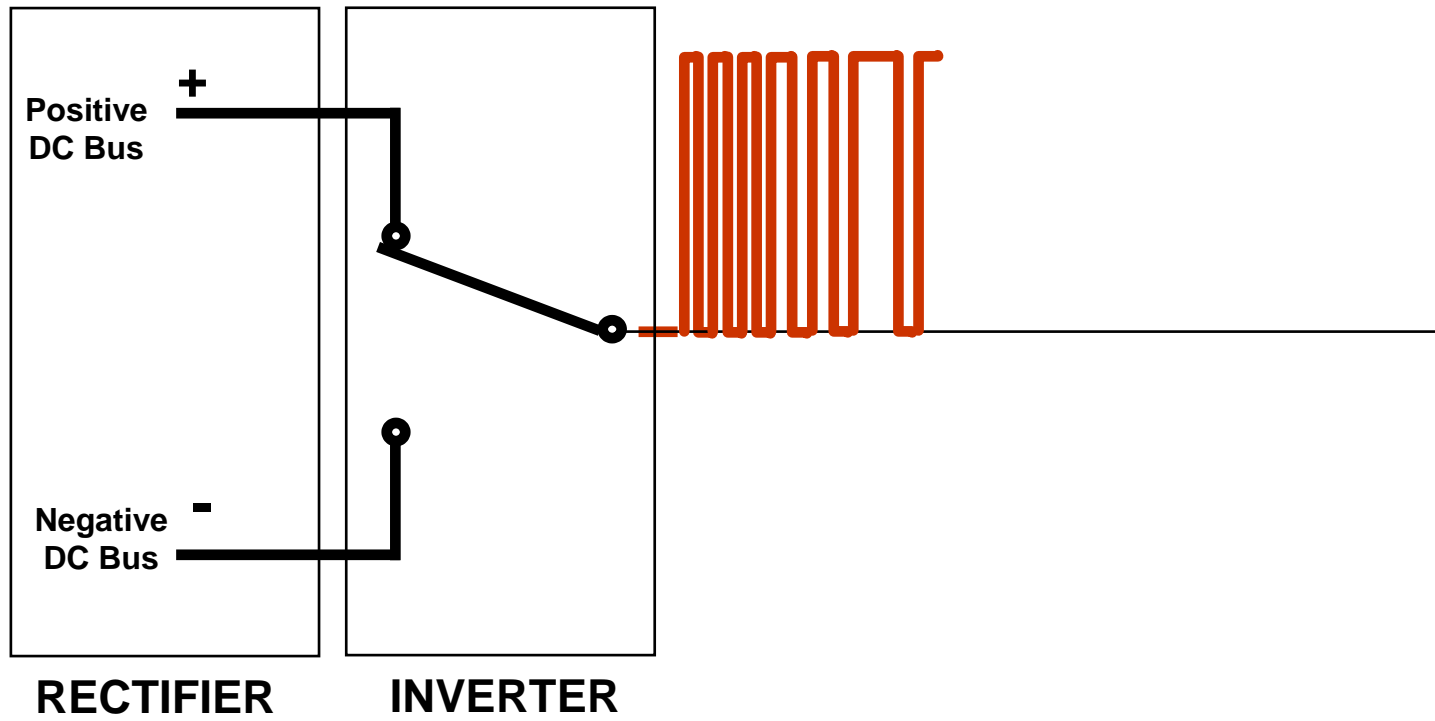


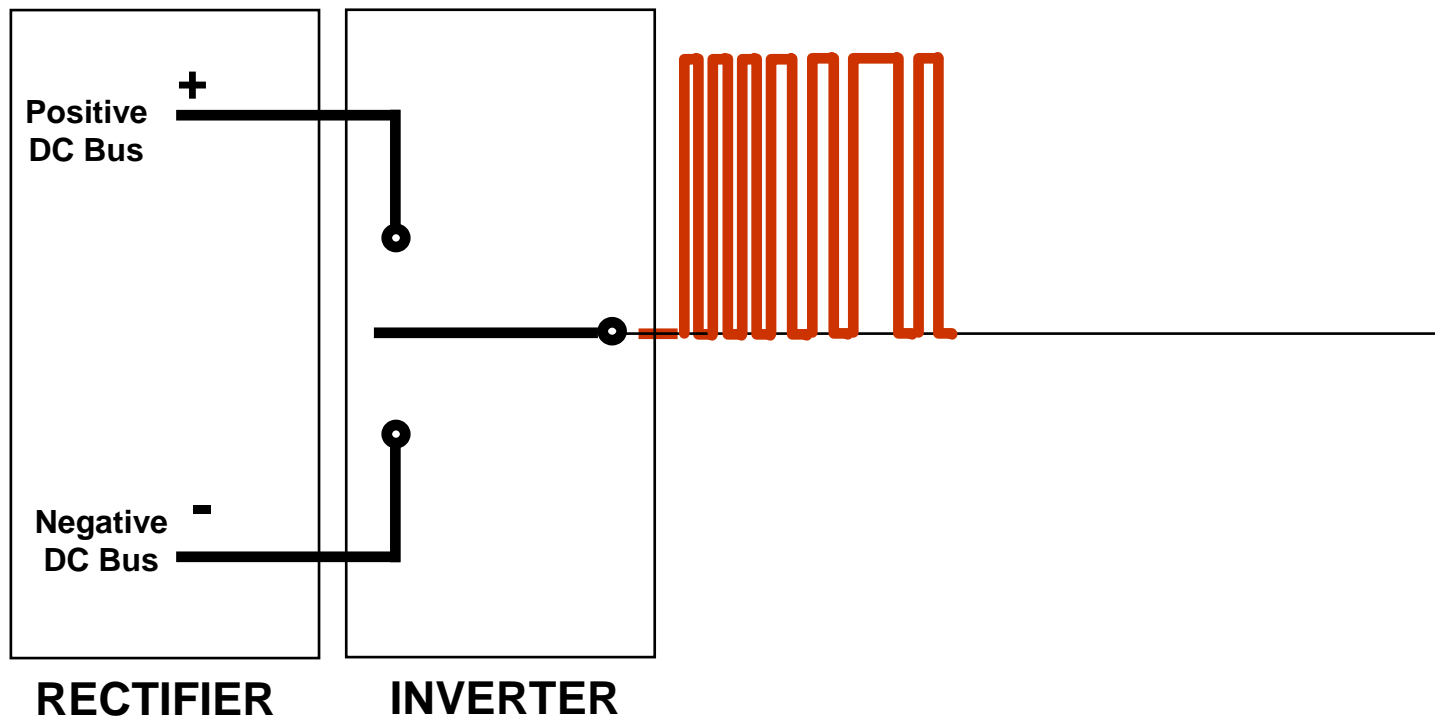


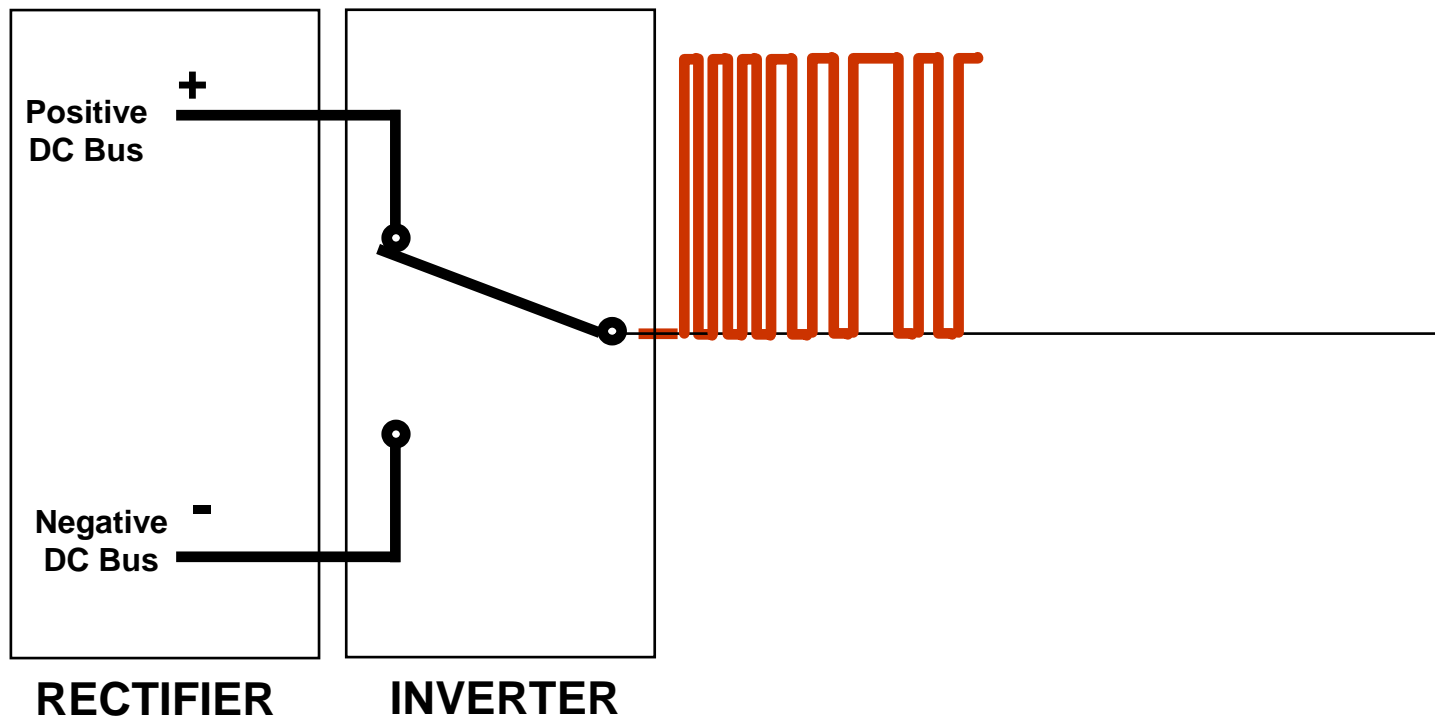


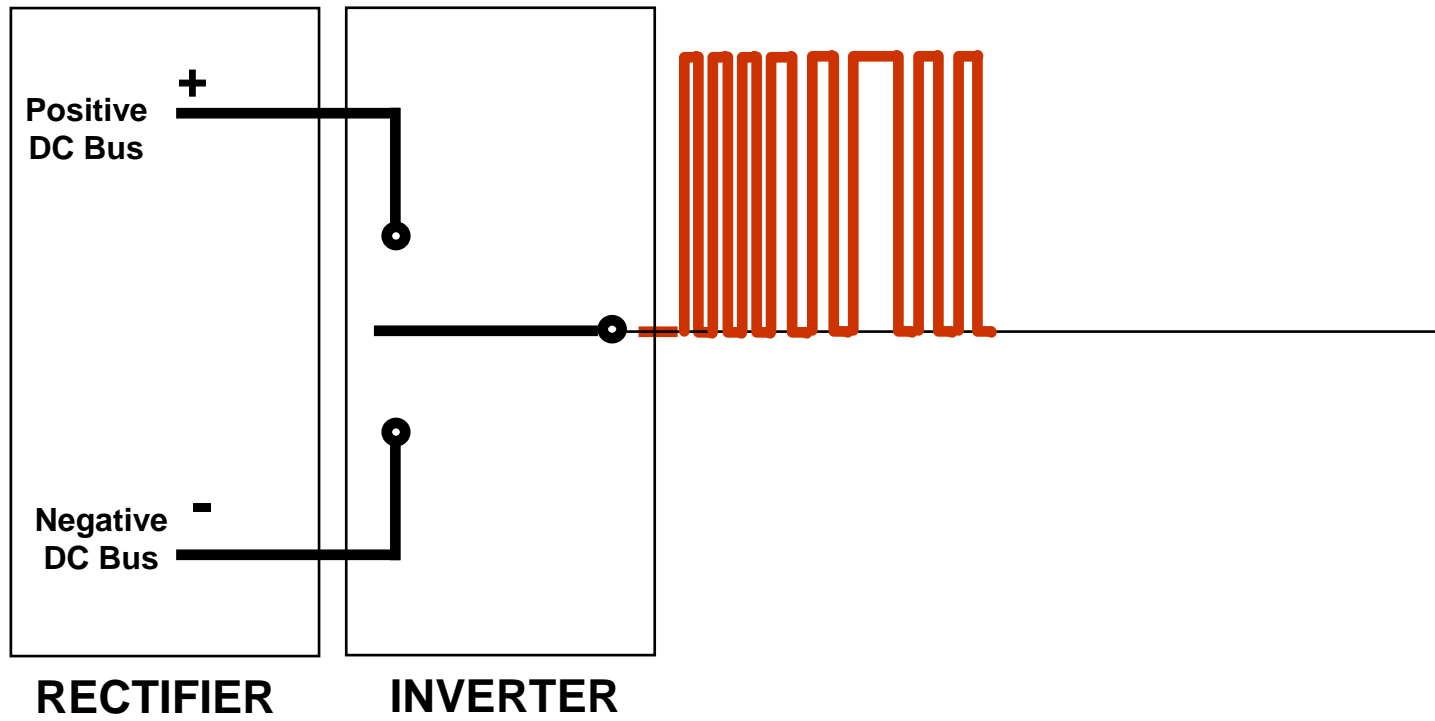


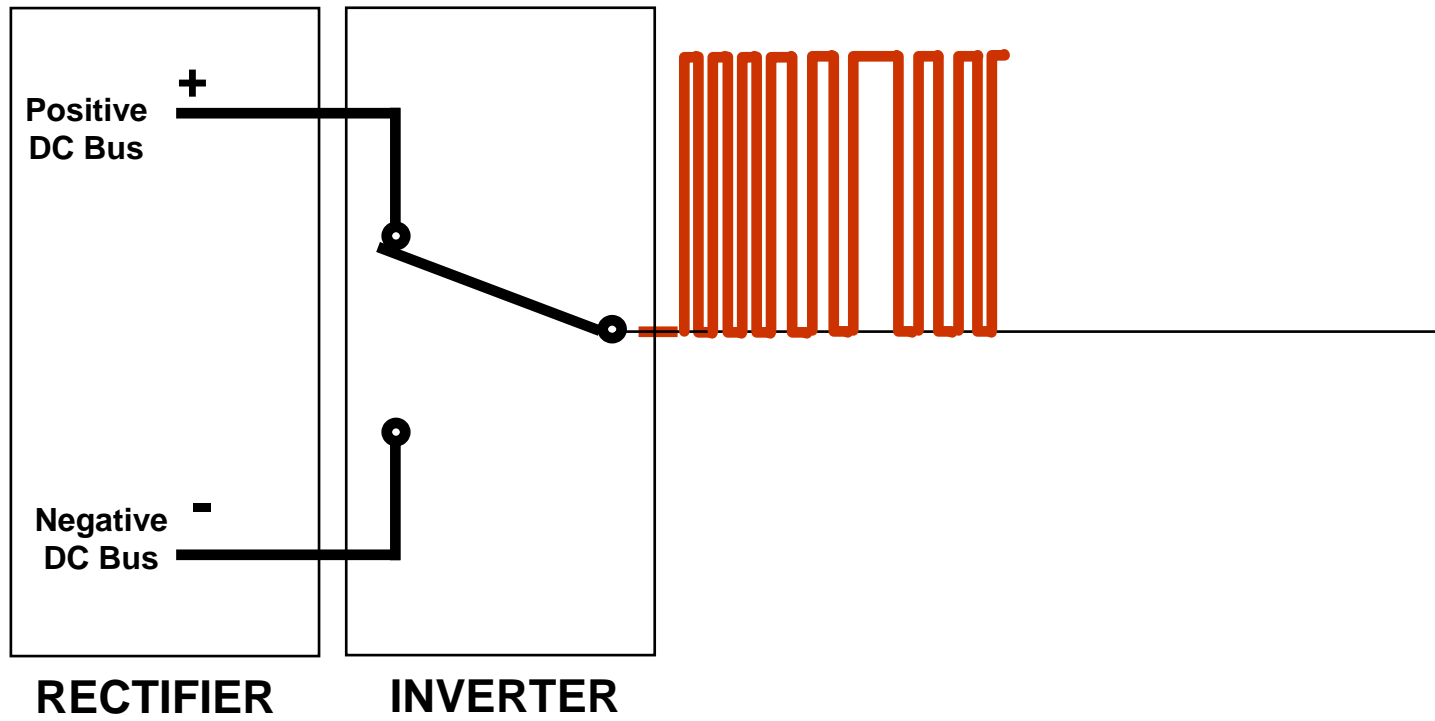


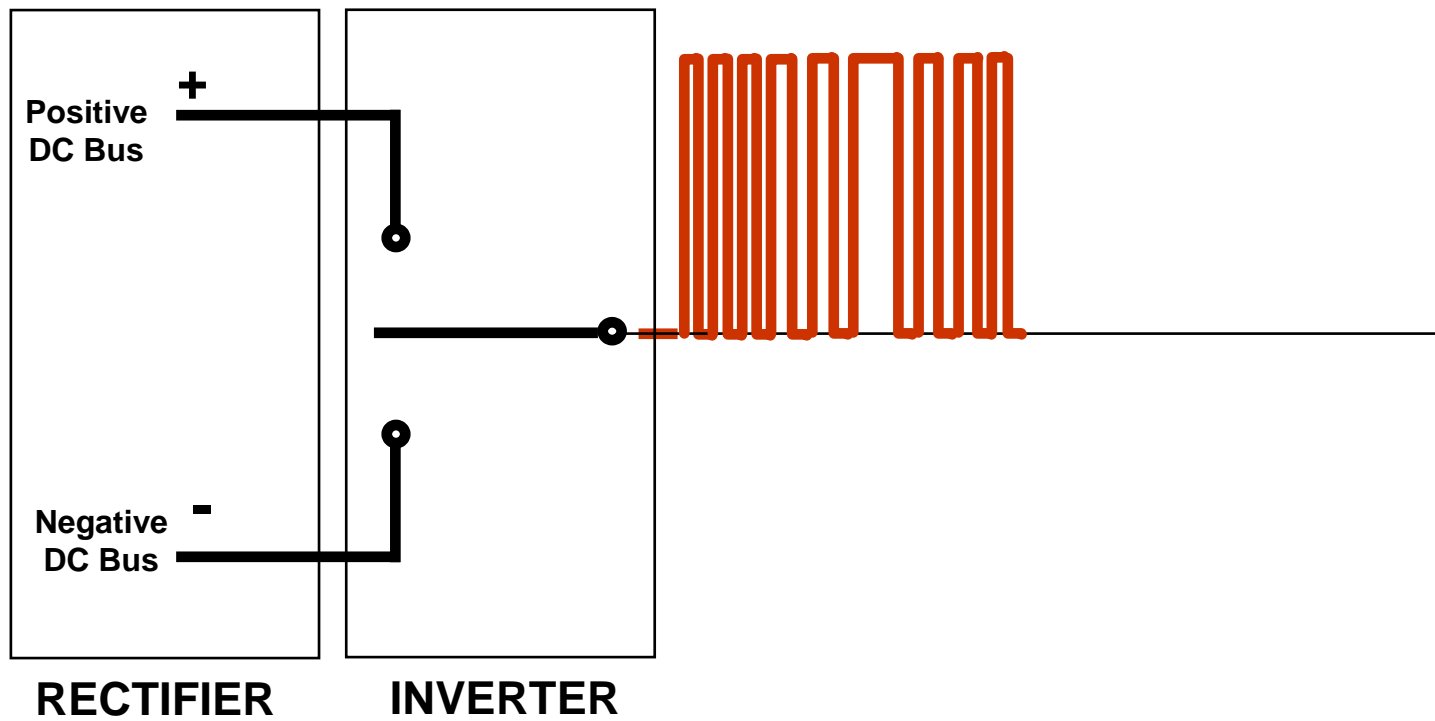


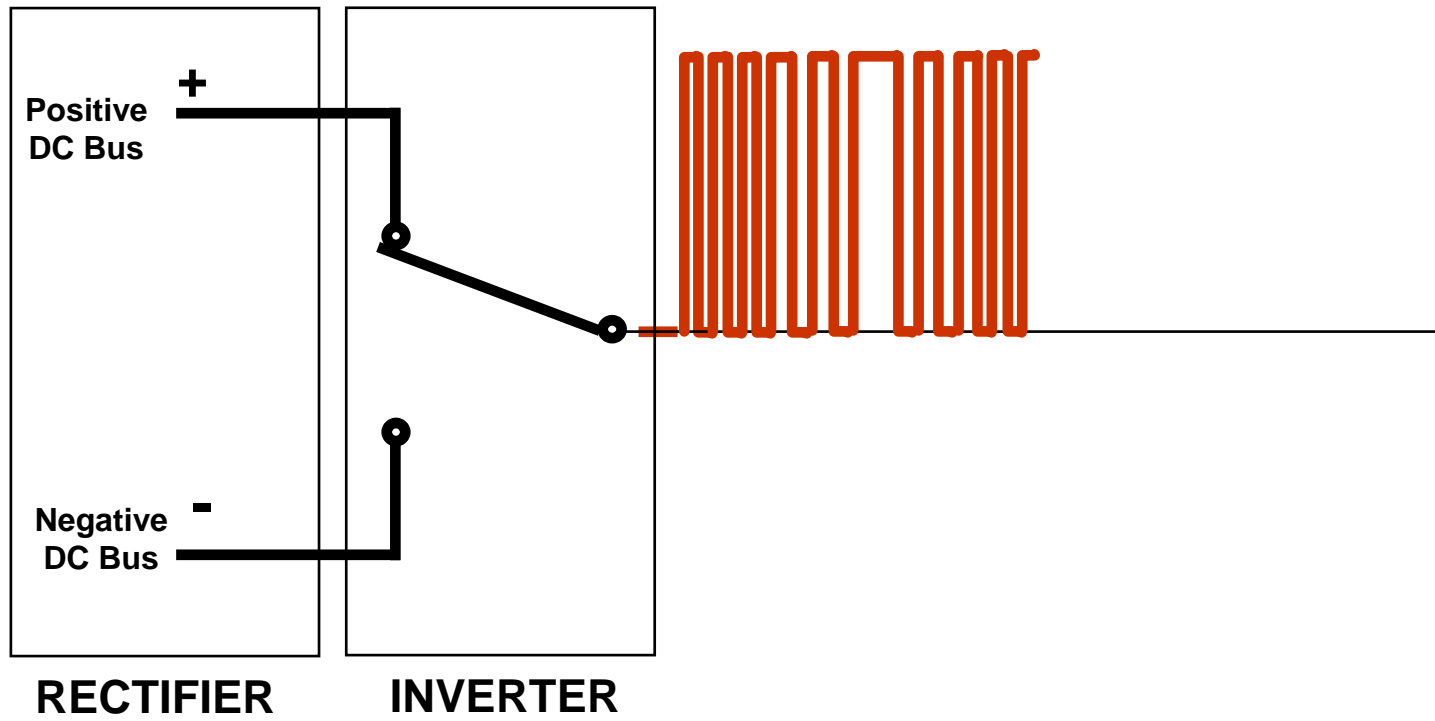


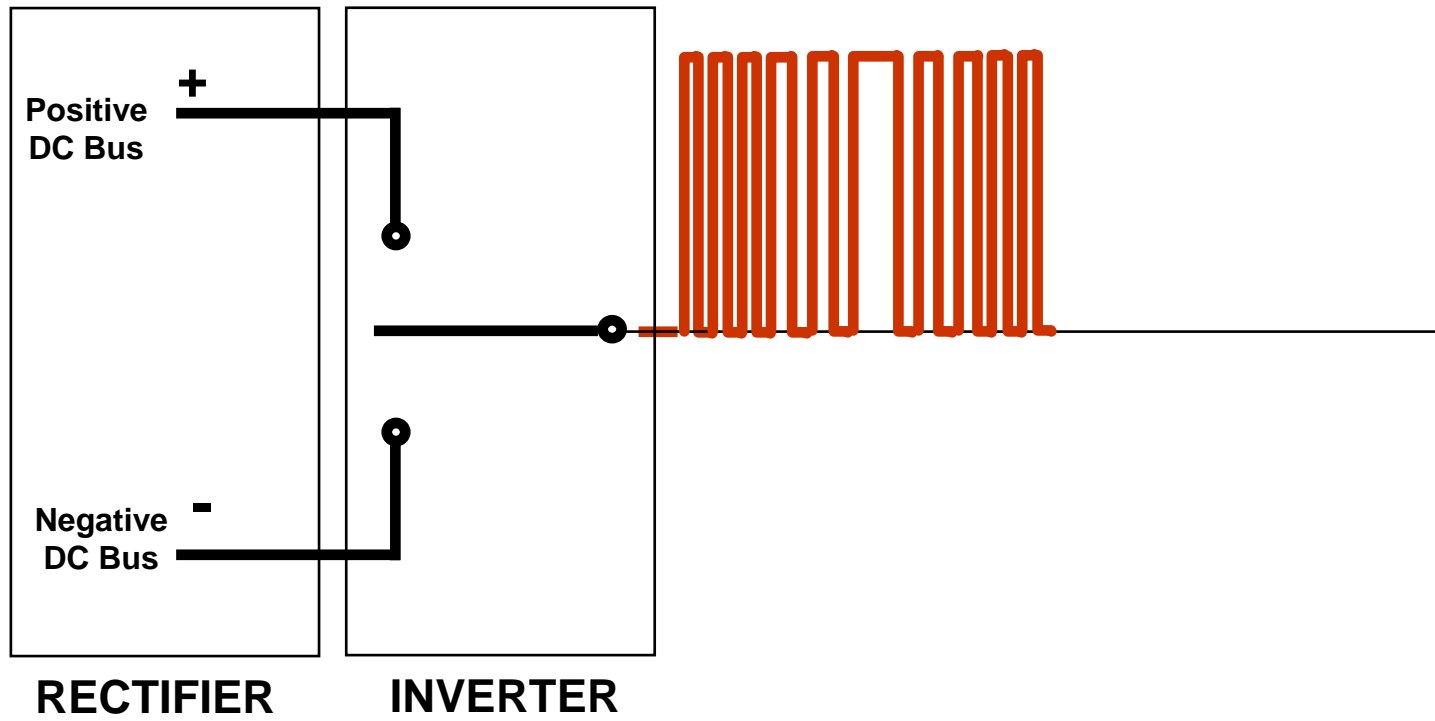


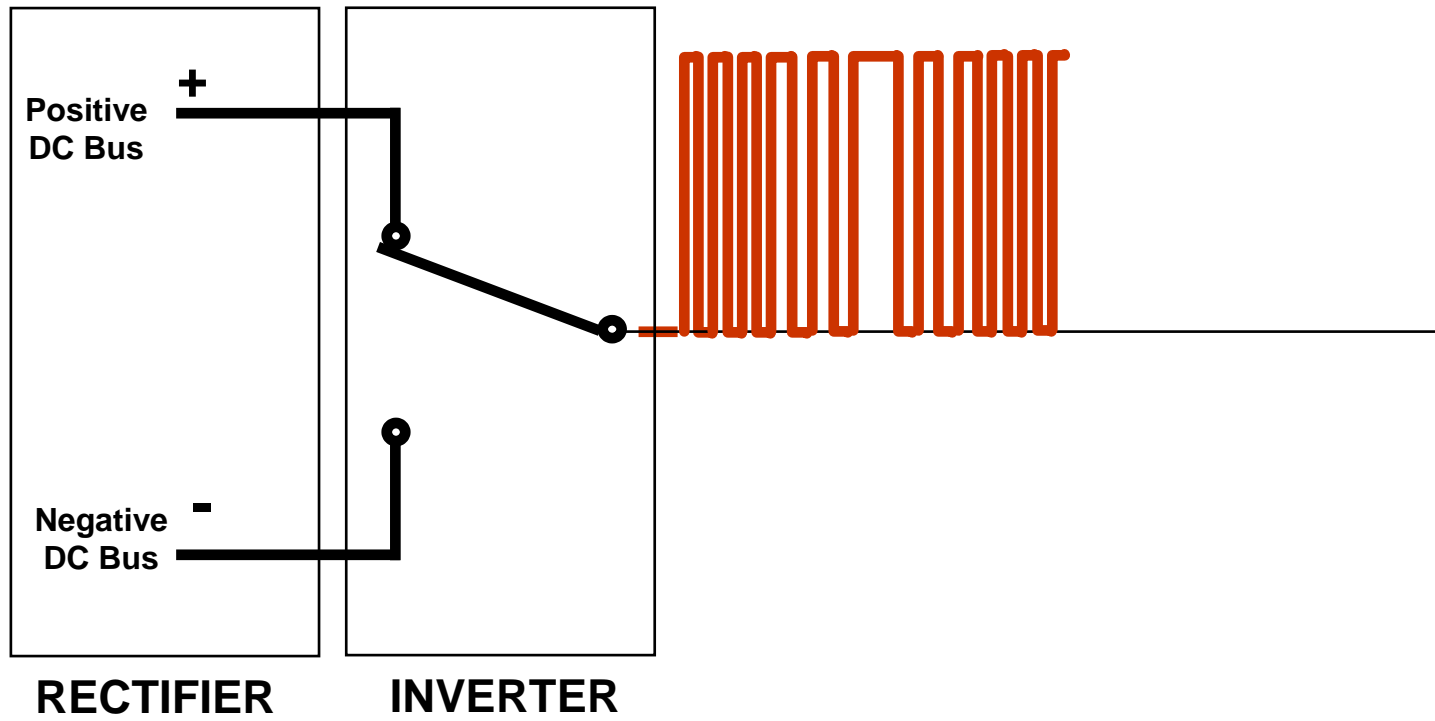


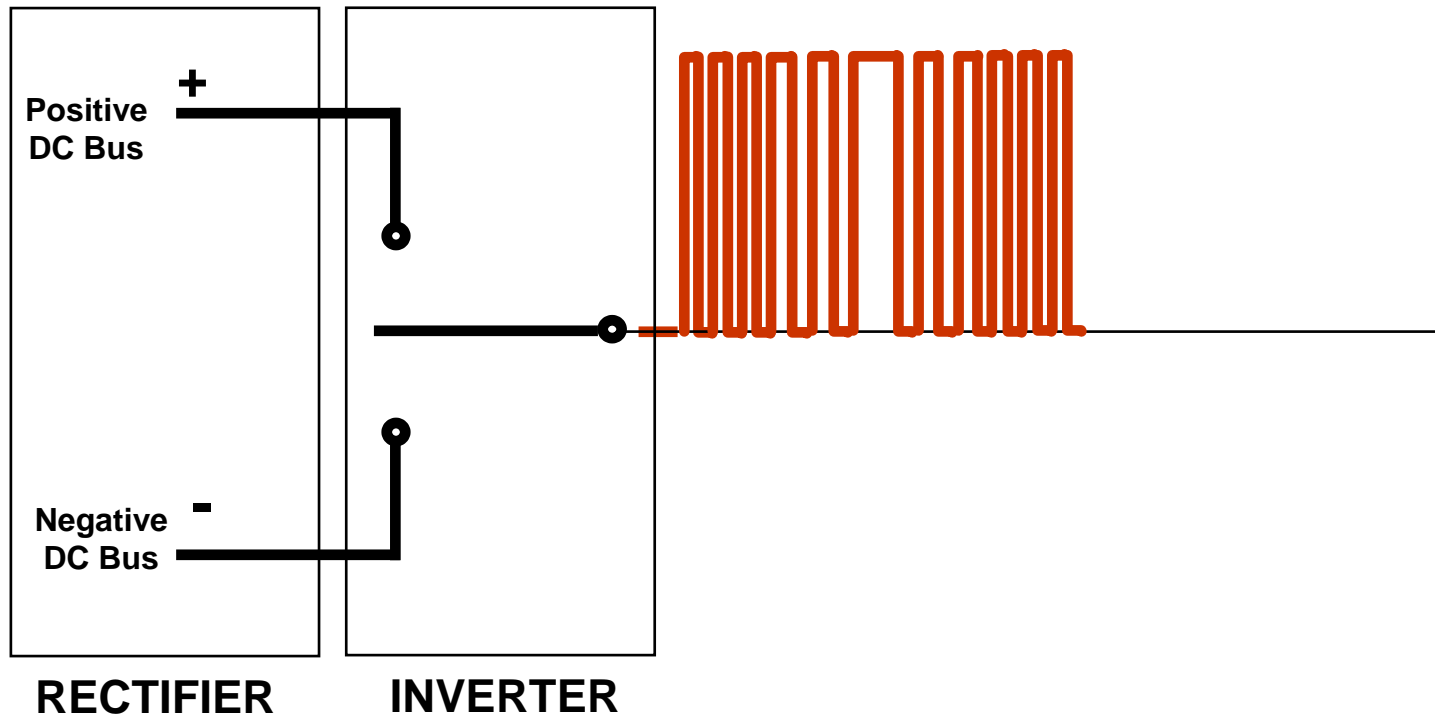


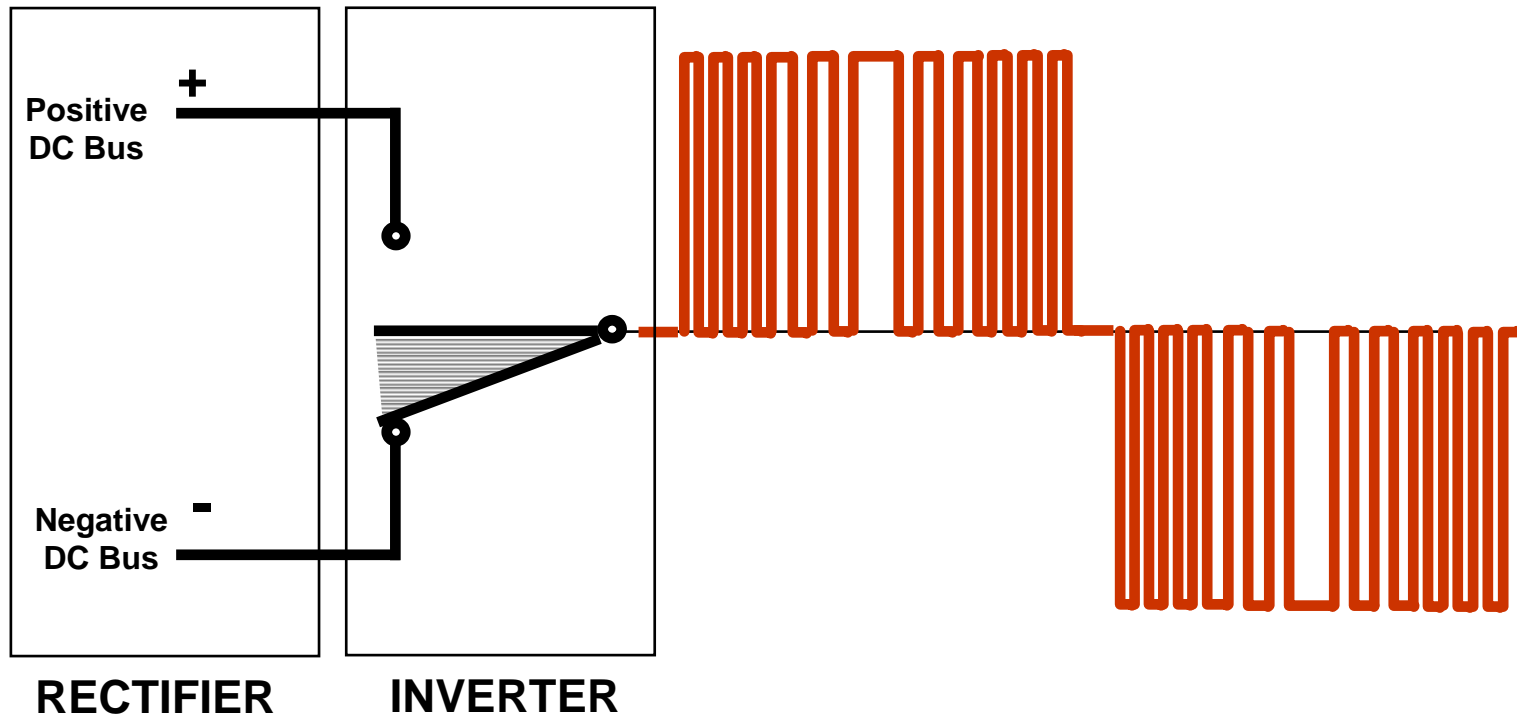


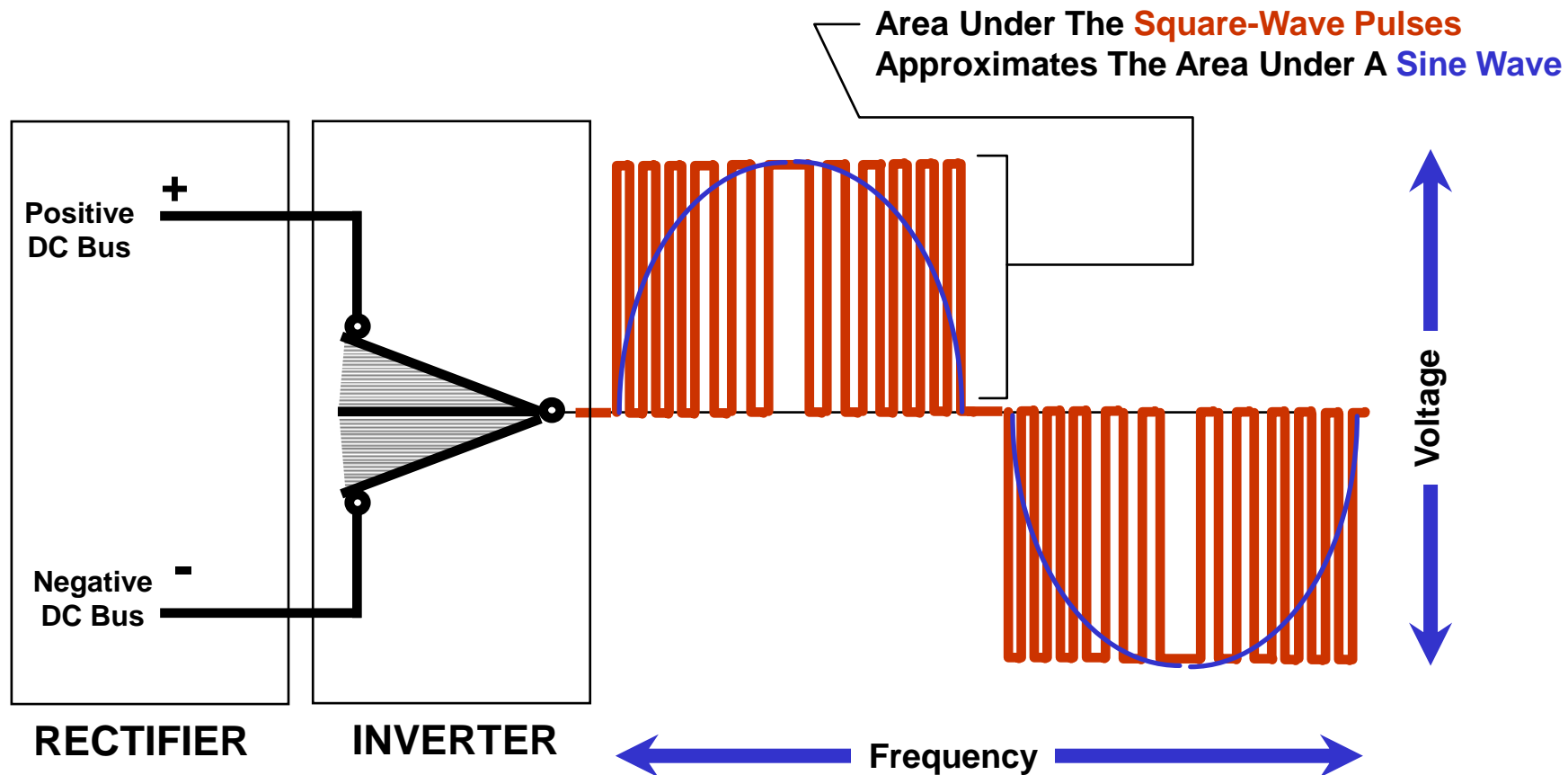






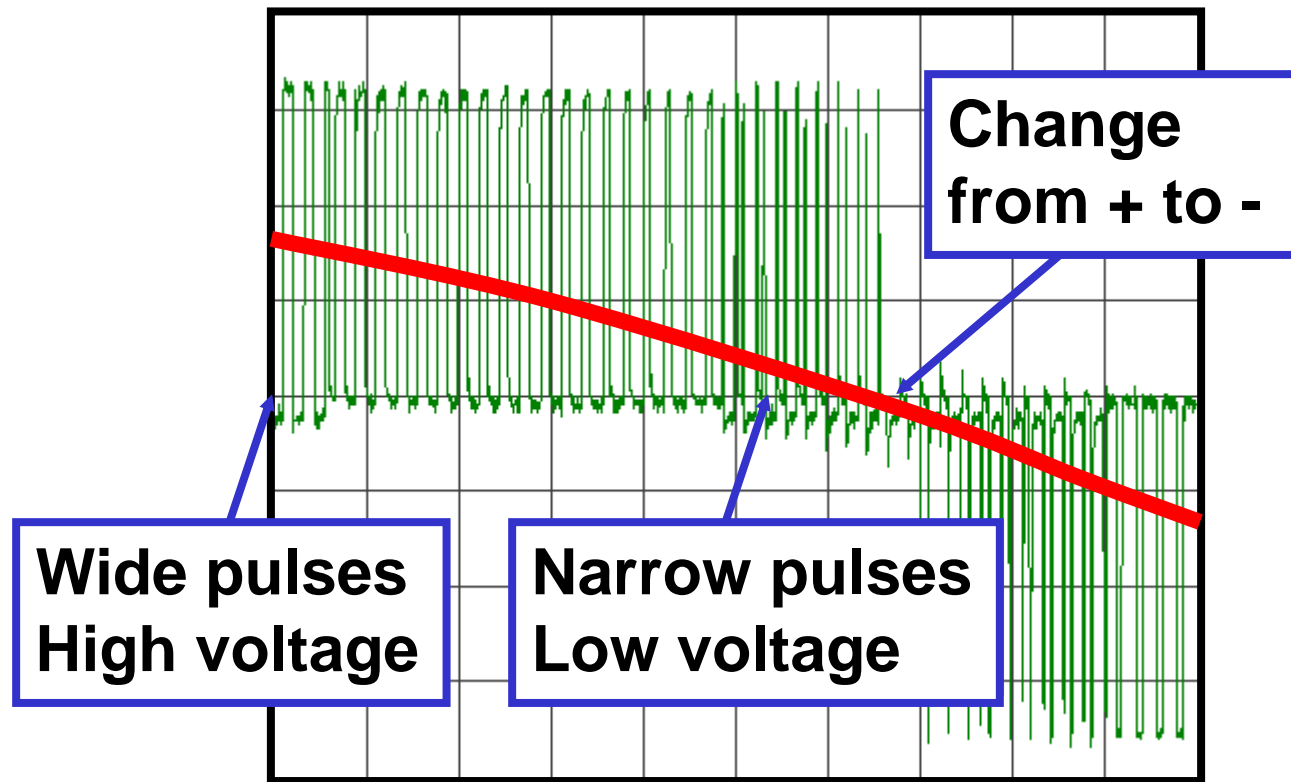






Fundamentals of Variable Frequency Drives

Pulse Width Modulation (PWM) to control



Pulse width controls the effective voltage.

VFD Installation

- Three separate metallic conduits
 - Control, input power and motor wiring
- Should not be the ground source
- Be cautious of buried conduit for EMC issues!
- OEM mounted drives too!

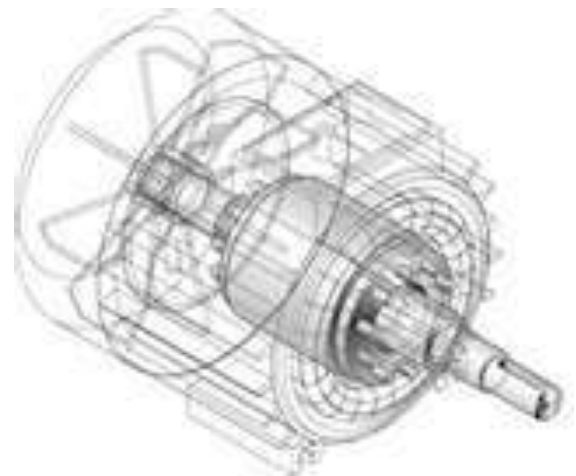






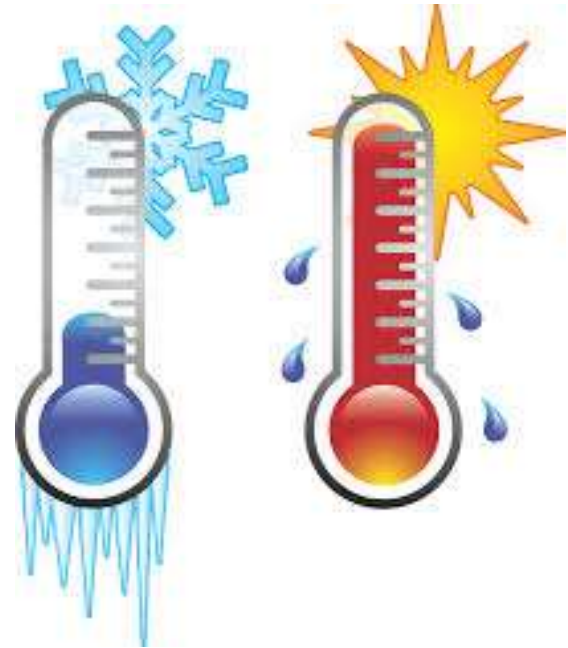
VFD Installation

- Branch circuit sizes to the VFD input current, not motor FLA (NEC 430)
- Observe fuse requirements and short circuit rating requirements for base drive and combination drive and bypass (drive and bypass protection)
- Size the VFD by motor(s) FLA for multi-motor applications



VFD Installations - Ambient

- Most drives are rated 0-40C
 - Derating required for higher temps (for 50C). Large impact on drive lifespan.
 - Heaters required for cold temperatures

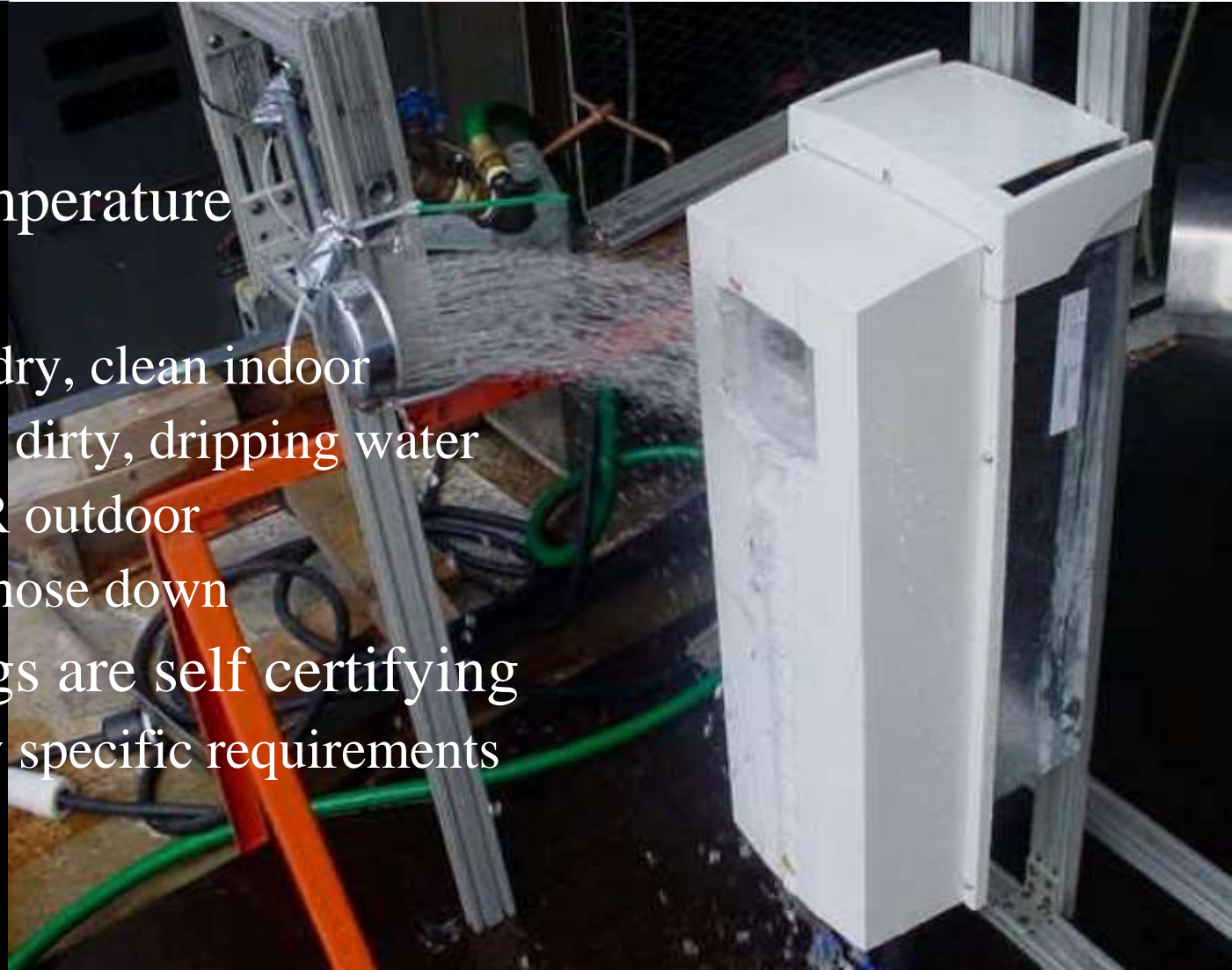


- Proper Cooling:
- Stacking drives
- Hot Spots
- Min air changes



Enclosures Types

- Ambient Temperature
- UL rated
 - UL Type 1 dry, clean indoor
 - UL Type 12 dirty, dripping water
 - UL Type 3R outdoor
 - UL Type 4 hose down
- NEMA ratings are self certifying
 - UL has very specific requirements



Proof of Flow

- For broken belt, coupling and indicated that the mover is providing flow
- Typically, someone provides a CT “doughnut” that installed cost is several hundred dollars installed
- VFD’s can provide this feature, the level of indication is adjustable.



VFD Applications - Cooling Towers



- Gear box driven fans need a minimum speed of approx. 30% speed for proper lubrication
- Check for critical frequencies and tune-out at start-up
- Good multimotor application (run cells at the same time instead of staging for enhanced energy savings)
- Limited payback with more than 4 cells

VFD Applications - Pumps



- Minimum speed at least 20-30% speed to open check-valves and provide motor cooling
- Be cautious mixing variable speed and constant speed pumps on parallel pumping systems
- Ramp times critical for most submersible pumps (thrust bearing)
- Bypass or no bypass?

VFD Applications - Features

Run Permissive Circuit

- Upon a run request (start signal) from the automation system (time clock, process control) or “Hand-Start” from the VFD H-O-A switch, or if bypass is initiated, the VFD system will provide a contact closure to activate damper or valve. When the damper is full open, a contact closure from the end switch will allow motor operation.



Fan Array Applications



Interfacing with BAS

- Monitoring / Monitoring & Control
 - Don't waste your connection!
 - S/S, Speed, Run & Fault
 - VFD temperature, trip ID, trip reset (remote), load “health” (plugged pump, stuck valve, etc), man-auto control, KWH and much more!





Micro Drives – Small, cost reduced, short lifespan

Standard Drives – Robust, high volume, long life

Performance Drives – Capable, tight motor control, PLC type functions, robust, long life

Most Common Issues

- Trips due to:
 - Safeties
 - Smoke Alarm
 - High Static
 - Over temp
 - Motor
 - VFD
 - Failed motor
 - Ground Fault
 - Short Circuitit



Maintenance Needs

- Keep them Clean!
- Interval depends on environment
- Heat sinks and PCB's
- Dry, compressed air
- Only with No power!



Maintenance Needs

- Cooling Fans
 - 6-8 years
 - Internal and door fans
- Connections
 - IR
 - Torque Wrench
- Fault Logs



Questions?

- Feel free to email me at Jeffm@jmb-assoc.com



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