

Application Note

690+ Regen Unit & Active Front End

APP-AC-04

For 690+ series drives version 5.3g or later

Introduction

On occasion, one or more drives in a system may absorb power from the machine and pump it back into the drive. This condition is called regeneration. This occurs when motors are being “overhauled” (mechanically pulled at a speed faster than their setpoint) or when the drive and motor are “holding back” their speed to provide desired tension, as in the case of unwind stands.

This regenerative energy can be absorbed by other motoring drives if the drives are connected in a common DC bus configuration. The AFE-xxx may be used as an active front end to power the common bus and to regenerate any energy back into the lines. It can also be used as a line regen unit that only regenerates excess energy back into the lines.

Used as an Active Front End, the AFE acts as a 4 quadrant power supply to one or more drives. It draws nearly pure sine wave currents at unity power factor with very low harmonic content

Using the 690+ as a 4-Quadrant power supply in common Bus schemes provides:

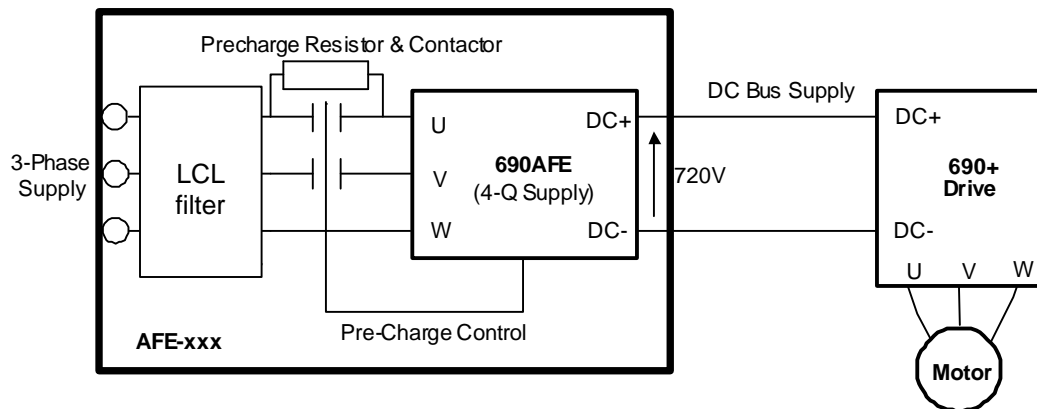
- Simplified approach to common bus systems
- Allows the AFE panel to act as 4-Quadrant DC bus power supply unit
- Near-sinusoidal supply currents (Motoring and Regenerating)
- Near-unity power factor operation (0.99 or better)
- Low supply harmonics currents
- eliminates the need for line reactors and circuit breakers for each section in the system

IMPORTANT: If drives connected to the 4-Quadrant Regen common DC Bus are being controlled in Volts/Hz motor control mode, it is essential that the VOLTAGE MODE parameter in the VOLTAGE CONTROL function block is set to FIXED. This will ensure the motor is not over fluxed by the boosted 720V DC Bus. Failure to do this may lead to motor overheating and possible burn out.

Note: If the drive is part of a common bus system set the ENABLE parameter in the SLEW RATE LIMIT function block to FALSE.

Single Motor System

The simplest configuration for 4-Quadrant Regen control is a single AFE-xxx acting as the unity power factor supply, connected via the DC bus to another 690+ driving the motor.



The AFE panel and the 690+ drive are matched in power, with the AFE supplying the full motoring and regenerating requirement of the load. No extra hardware is required to detect the rotation, frequency and phase of the mains supply. Also, no dynamic braking resistor is required.

When mains power is applied to the AFE, the DC bus slowly charges through the pre-charge circuit. The AFE's internal power supply will start in the normal way. When the AFE is healthy and the run (coast stop) signal is applied, synchronization to the mains supply (phase, rotation and frequency) begins. This process takes approximately 100ms. Once synchronized, the DC bus on the common bus is boosted to 720V (on a 460V product). This high value of DC link volts is required for successful regen operation.

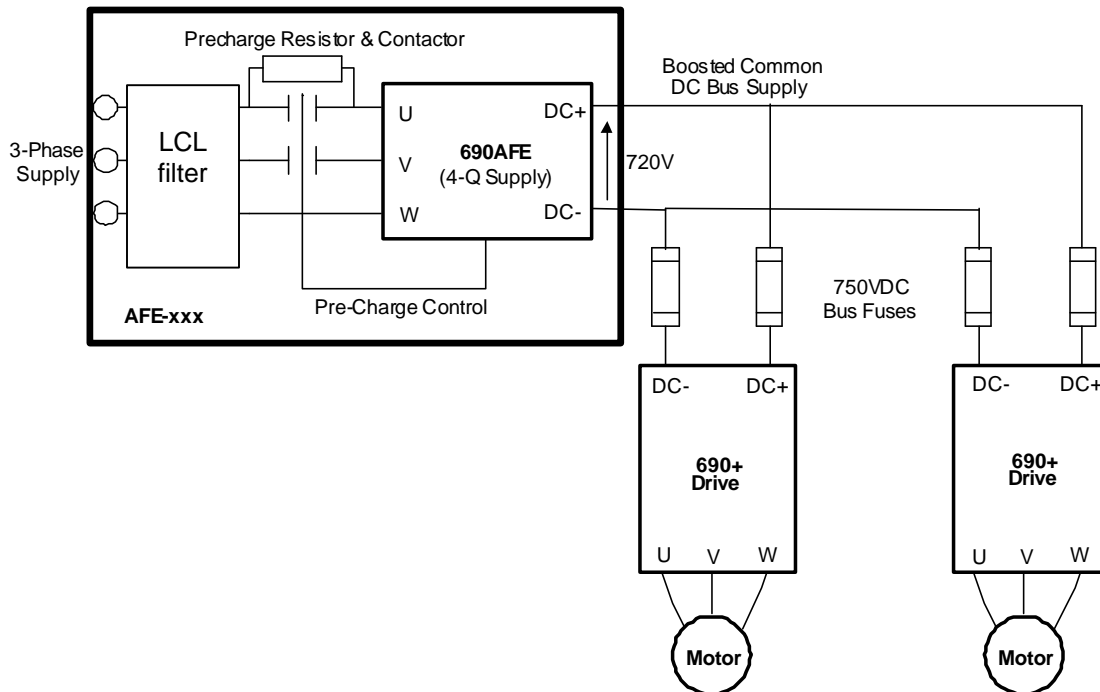
Applications of single motor 4-Quadrant Regen systems include :

- Hoists and Elevators
- Dynamometer test rigs
- Unwind Stands
- Installations that would otherwise require a Harmonic Power Filter

Multi-Motor System

In many applications, the total power consumed by the system is less than the installed power of the drives. This is because some drives are motoring (rewinds) and some are regenerating (unwinds). In these situations it is efficient to connect the drives on a common DC bus. The AFE panel simplifies the connection of common bus applications as shown below.

The 4-Q Regen drive draws sinusoidal, unity power factor current from the supply and only has to

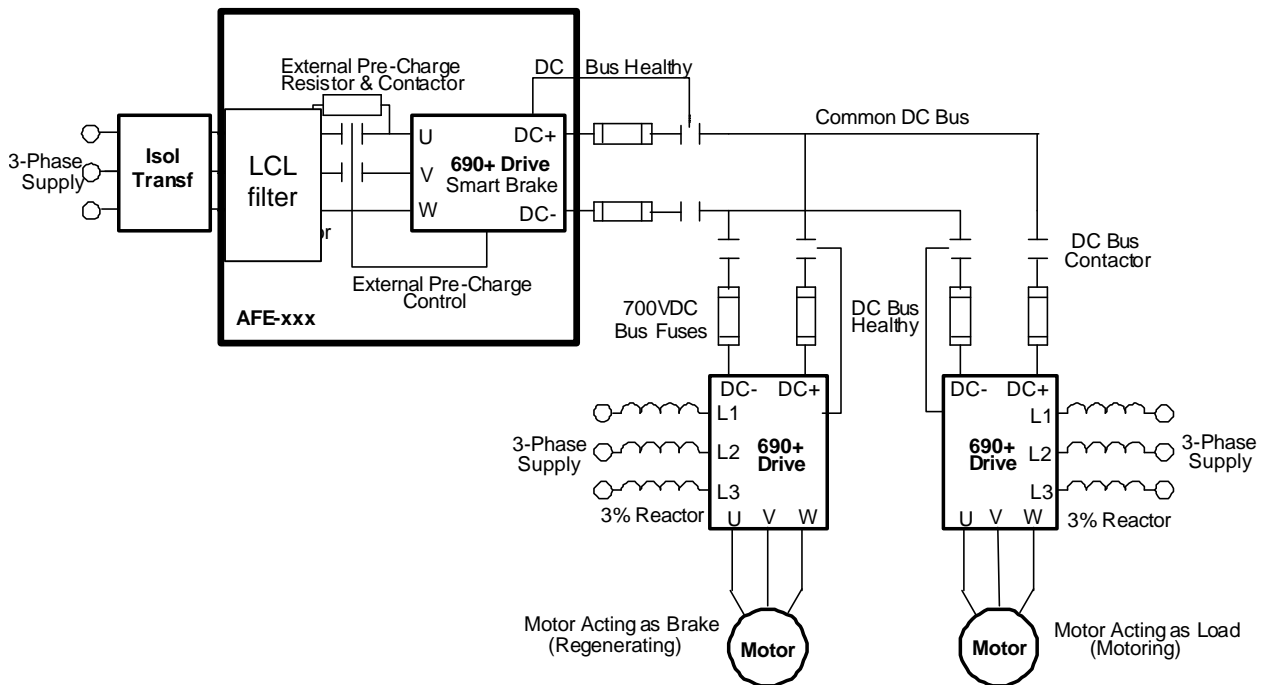


be rated for the net power consumed by the system or by the system braking requirements. Dynamic Braking (e.g. for Emergency Stopping purposes) can still be used in this control mode if required.

Feeding the 690+ drives exclusively from the AFE eliminates the need for line reactors and circuit breakers for each section in the system.

Brake Mode

The AFE can also be used as a Line Regen unit. This is selectable in software by setting the BRAKE MODE parameter in the REGEN CONTROL function block to TRUE. In this mode, the AFE is connected onto a common bus. The drives on the common bus are supplied via their own 3-phase supplies. The AFE tracks the mains supply but does not supply motoring power to the common bus. During regeneration, the DC bus will rise and trigger the AFE to return the excess power to the mains in the form of sinusoidal current at unity power factor. Thus, the AFE acts as a smart, no loss, dynamic brake. Since the AFE is not supplying power to the common bus, this mode allows the use of a much smaller AFE unit, sized only for the amount of regenerative energy expected. In this mode, an isolation transformer is required to supply power to the AFE panel and provide isolation from the line drives.



In the Brake Mode, each drive, including the AFE, is responsible for pre-charging its own DC bus. When an individual drive is pre-charged and healthy, it connects itself on to the common bus via a DC contactor. Drives disconnect from the common bus under fault conditions or loss of power.

Ordering the Product

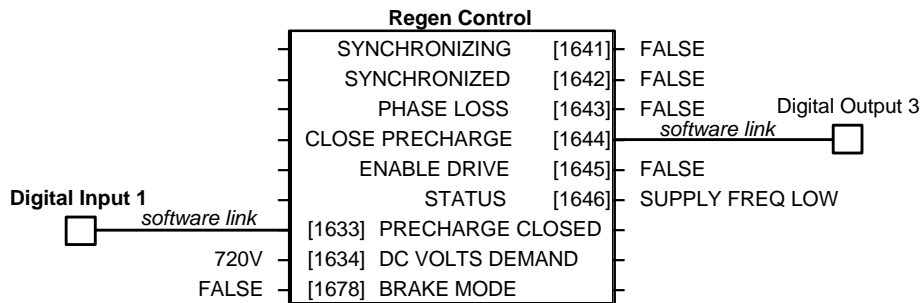
HP	Amps	Catalog #	Dimensions	
13	12	AFE-13-LCL	22 x 18	Open panel
26	25	AFE-26-LCL	28 x 22	
45	45	AFE-45-LCL	33 x 27	
85	80	AFE-85-LCL	46 x 34	
125	120	AFE-125-LCL	46 x 34	
167	160	AFE-167-LCL	46 x 34	Enclosed
200	194	AFE-200-LCL	79 x 47 x 24	
300	284	AFE-300-LCL	79 x 47 x 24	
350	325	AFE-350-LCL	79 x 47 x 24	
400	378	AFE-400-LCL	79 x 47 x 24	
500	468	AFE-500-LCL	79 x 47 x 24	

The AFE is available as an assembly, rated by HP at 460V. (AFE-xxx-LCL). For 230V ratings, consult the factory. Each panel or enclosure contains a 690+ drive configured for use as an active front end, along with the pre-charge resistor, contactor, and the LCL filter.

IMPORTANT: Every 690+ drive used as and with an AFE-xxx needs to be ordered with option 007. Please append the catalog number with /007. Example: To use a 460V 20HP drive with a AFE-xxx, order catalog number 690+0020/460/1BN/007

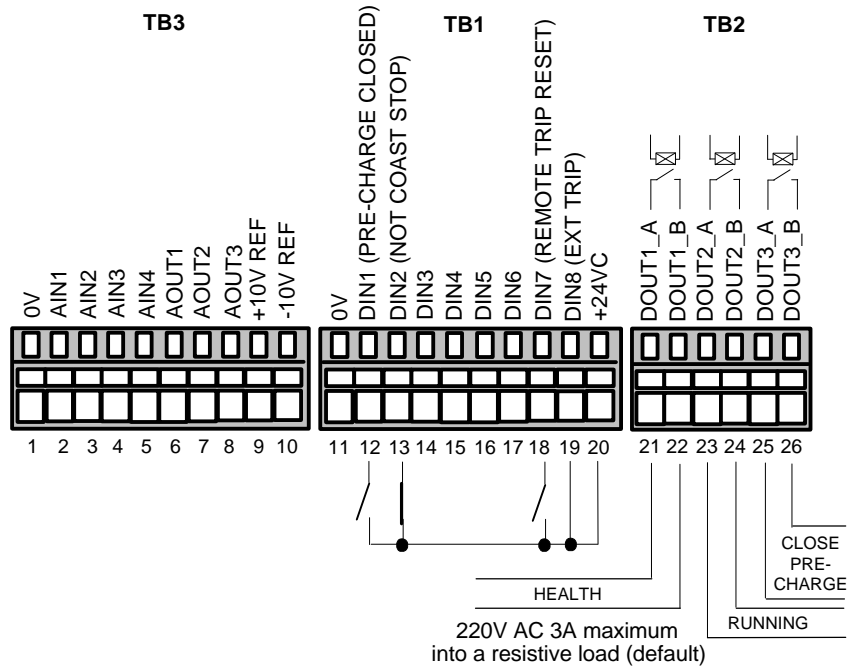
Software Function Block

Refer to the 690+ Software Manual, Chapter 1 for details on the function block parameters.



The AFE is factory configured to be an active front end and the configuration is stored as Macro 8 inside the drive, in case it needs to be restored to the "as-shipped" values. Refer to the product manual for details on restoring macros.

Control Connections



Setup

Although most parameters will be preset to the correct values, follow the steps below to set up for your application

In the Quick Setup menu:

- Control Mode should be set to 4-Q REGEN
- Leakage inductance should be set to the value of total line reactor inductance in mH.

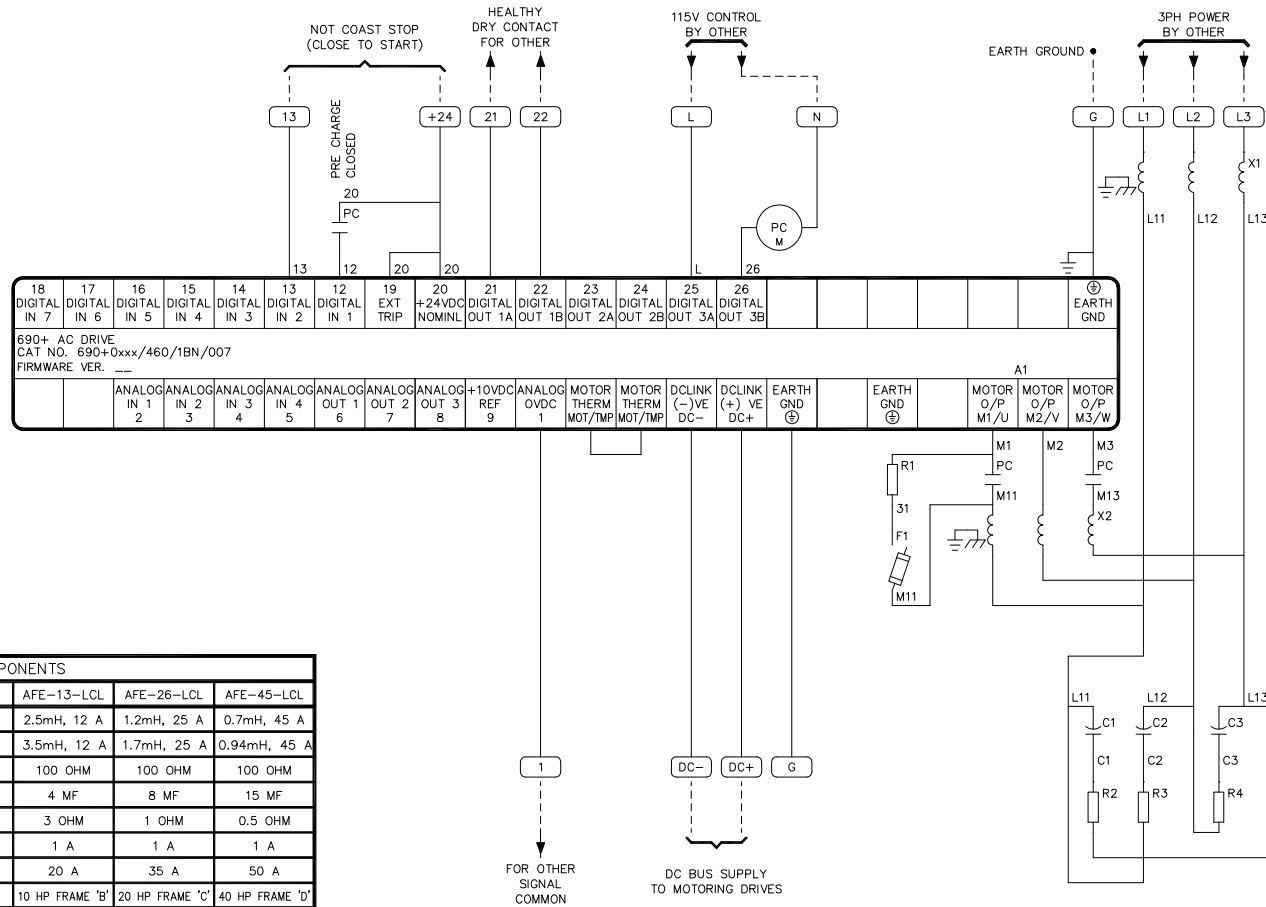
HP	Amps	Catalog #	Leakage Inductance
13	12	AFE-13-LCL	6 mH
26	25	AFE-26-LCL	2.9 mH
45	45	AFE-45-LCL	1.64 mH
85	80	AFE-85-LCL	0.93 mH
125	120	AFE-125-LCL	0.55 mH
167	160	AFE-167-LCL	0.41 mH
200	194	AFE-200-LCL	0.33 mH
300	284	AFE-300-LCL	0.225 mH
350	325	AFE-350-LCL	0.205 mH
400	378	AFE-400-LCL	0.17 mH
500	468	AFE-500-LCL	0.14 mH

- In the Regen Control menu: (*Setup/Motor Control/Regen Control*), set Brake Mode = FALSE for active front end, or TRUE for line regen mode.

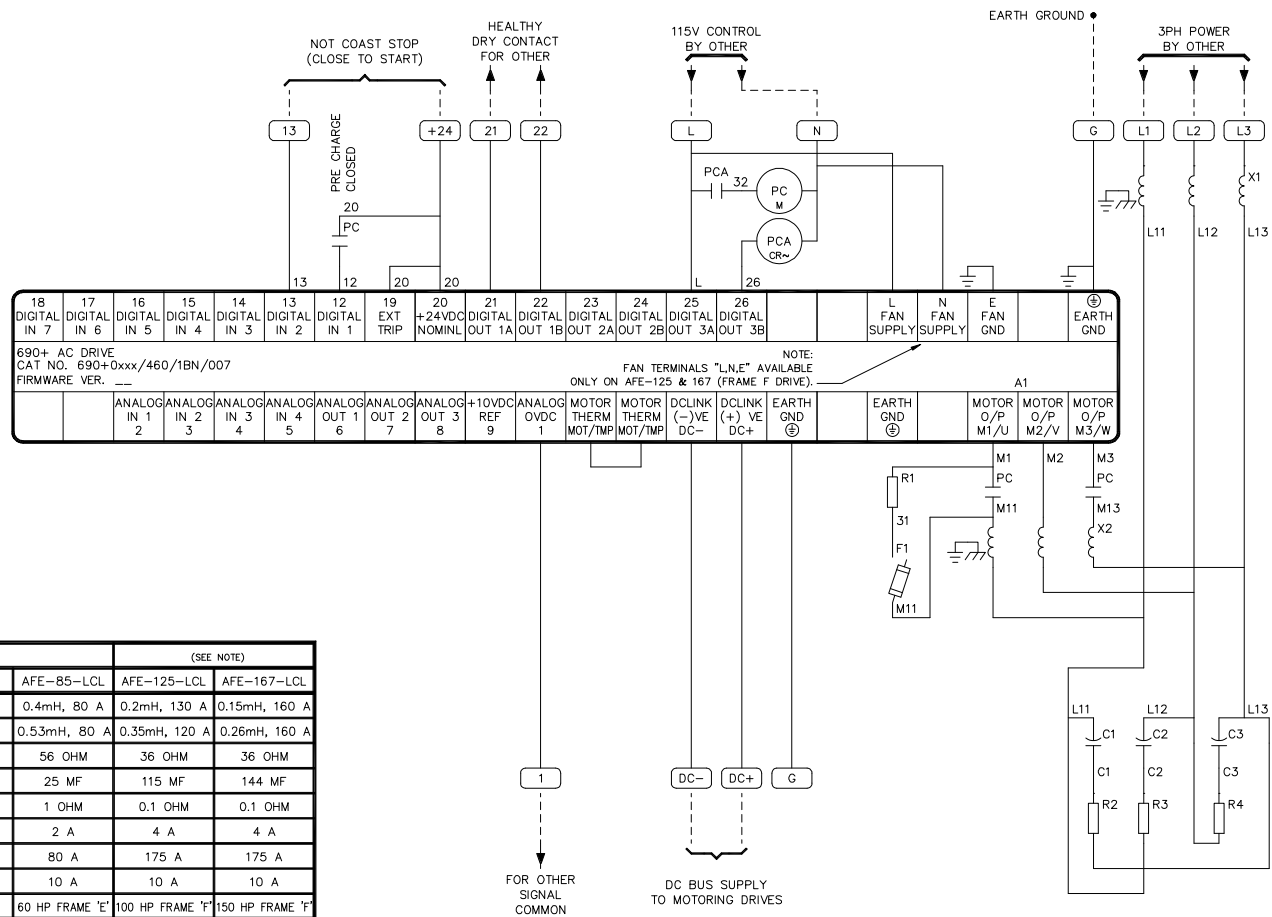
Macro 8 provides the following connections:

- Digital Output 3 (terminals 25 & 26) controls the external pre-charge circuit.
- Digital input 1 (terminal 12) is used to confirm the status of the pre-charge circuit (open or closed). The AFE will not synchronize with the 3-phase power unless the pre-charge contactor is closed.
- Digital input 2 (terminal 13) is used to run the AFE.
- Upon the introduction of the run command, the drive automatically synchronizes to the 3-phase power if the pre-charge contactor has closed.
- Digital input 2 (terminal 13) may be connected to 24V, or used to cause a coast stop in case of emergencies.

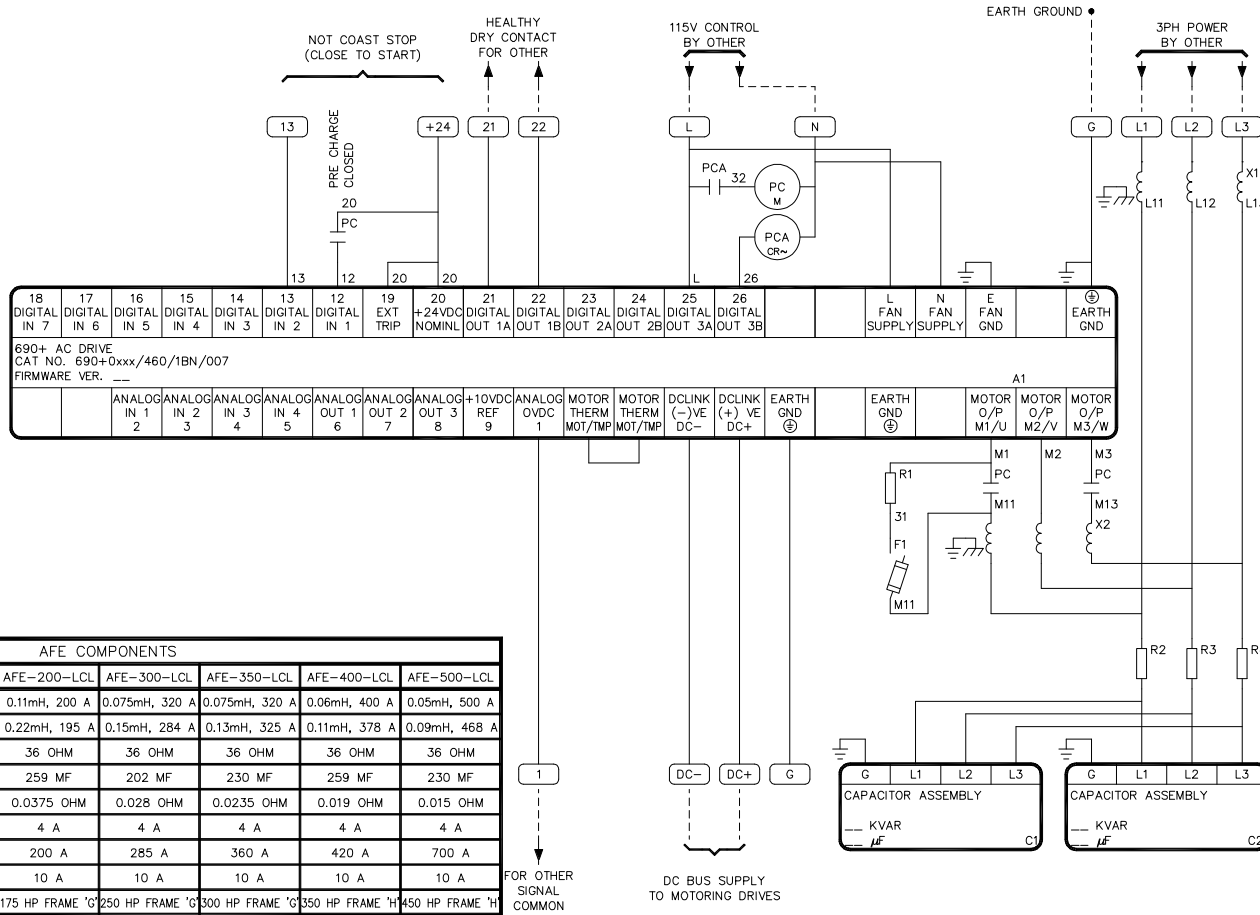
Typical Wiring Diagram – AFE-13, 26, 45-LCL



Typical Wiring Diagram – AFE-85, 125, 167-LCL (with PC pilot relay)



Typical Wiring Diagram – AFE-200 – 500-LCL (with PC pilot relay)



AFE COMPONENTS						
REF	DESCRIPTION	AFE-200-LCL	AFE-300-LCL	AFE-350-LCL	AFE-400-LCL	AFE-500-LCL
X1	LINE REACTOR 3%	0.11mH, 200 A	0.075mH, 320 A	0.075mH, 320 A	0.06mH, 400 A	0.05mH, 500 A
X2	LINE REACTOR 6%	0.22mH, 195 A	0.15mH, 284 A	0.13mH, 325 A	0.11mH, 378 A	0.09mH, 468 A
R1	PRE-CHARGE RESISTOR	36 OHM	36 OHM	36 OHM	36 OHM	36 OHM
C1,C2	FILTER CAPACITOR ASSY.	259 MF	202 MF	230 MF	259 MF	230 MF
R2,R3,R4	FILTER RESISTORS	0.0375 OHM	0.028 OHM	0.0235 OHM	0.019 OHM	0.015 OHM
F1	PRE-CHARGE FUSE	4 A	4 A	4 A	4 A	4 A
PC	PRE-CHARGE CONTACTOR	200 A	285 A	360 A	420 A	700 A
PCA	PRE-CHARGE PILOT RELAY	10 A	10 A	10 A	10 A	10 A
A1	AC DRIVE	175 HP FRAME 'G'	250 HP FRAME 'G'	300 HP FRAME 'G'	350 HP FRAME 'H'	450 HP FRAME 'H'