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## Application Note

### 890 Regen Unit & Active Front End

With Line Sync Module

**For 890 series drives version 3.3 or later**



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## 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 890 as a 4-Quadrant power supply in common Bus schemes provides:

- Simplified approach to common bus systems
- Allows the AFE 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

**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.*

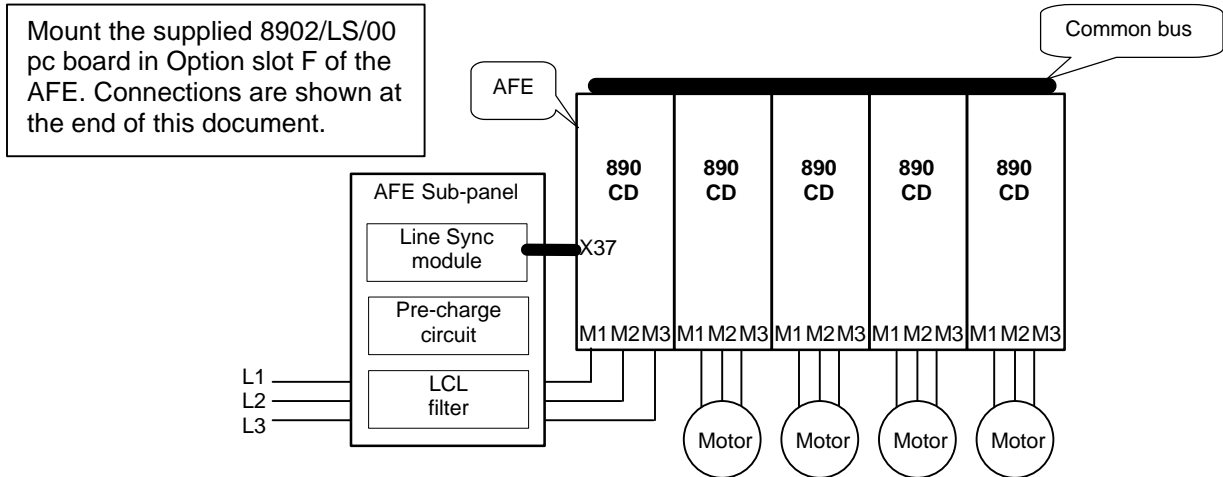
In many applications, the total power consumed by the system is less than the installed power of the drives. This is because some drives are motoring (rewinds) and some are regenerating (unwinds). In these situations it is efficient to connect the drives on a common DC bus. The AFE panel simplifies the 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 pre-charge requirements 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 890 drives exclusively from the AFE eliminates the need for line reactors and circuit breakers for each section in the system.

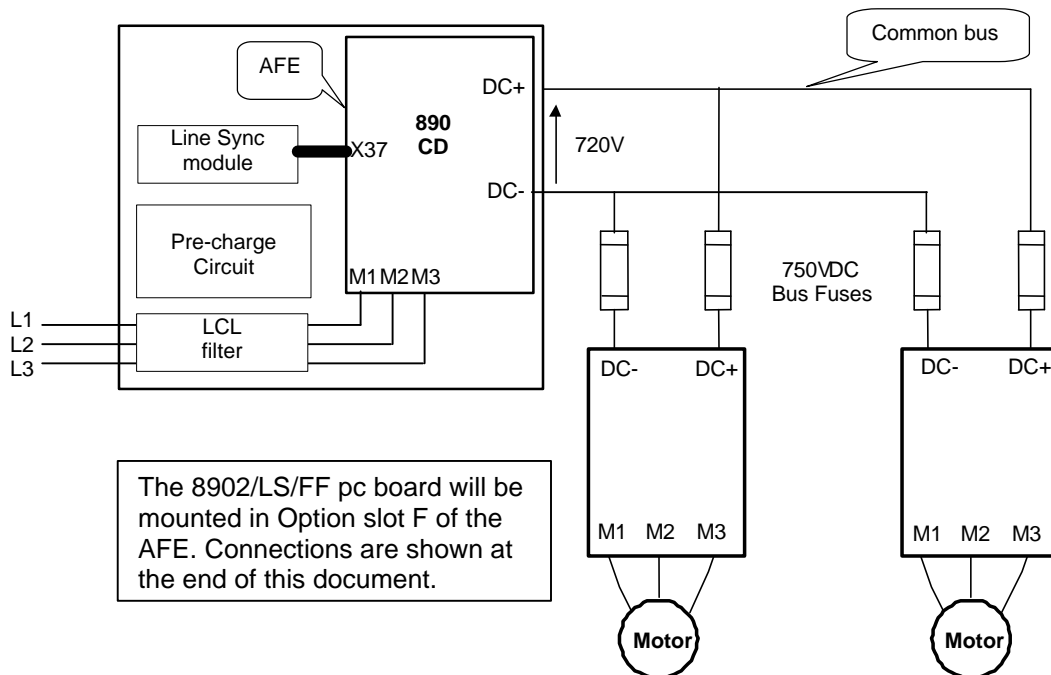
### 890 Frames B,C,D

In this case, the AFE drive is simply an 890CD drive tied to the common bus drives with the SSD Rail system. The AFE sub-panel (shipped separately) contains the line sync module, pre-charge circuitry and LCL filter that make the 890CD an AFE. See scheme below. Connection diagram can be found at the end of the document.



### 890 Frames E and up

In this case, the AFE drive is mounted on the same panel as the rest of the drives, but the common bus is wired to the other motoring drives through DC bus fuses. See scheme below. Connection diagram can be found at the end of the document.



The 890CD serving as the AFE, is supplying the full motoring and regenerating requirement of all the common bus drives. 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 signal (coast stop input) is applied, synchronization to the mains supply (phase, rotation and frequency) begins. This process takes approximately 100ms. Once synchronized, the DC voltage 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.

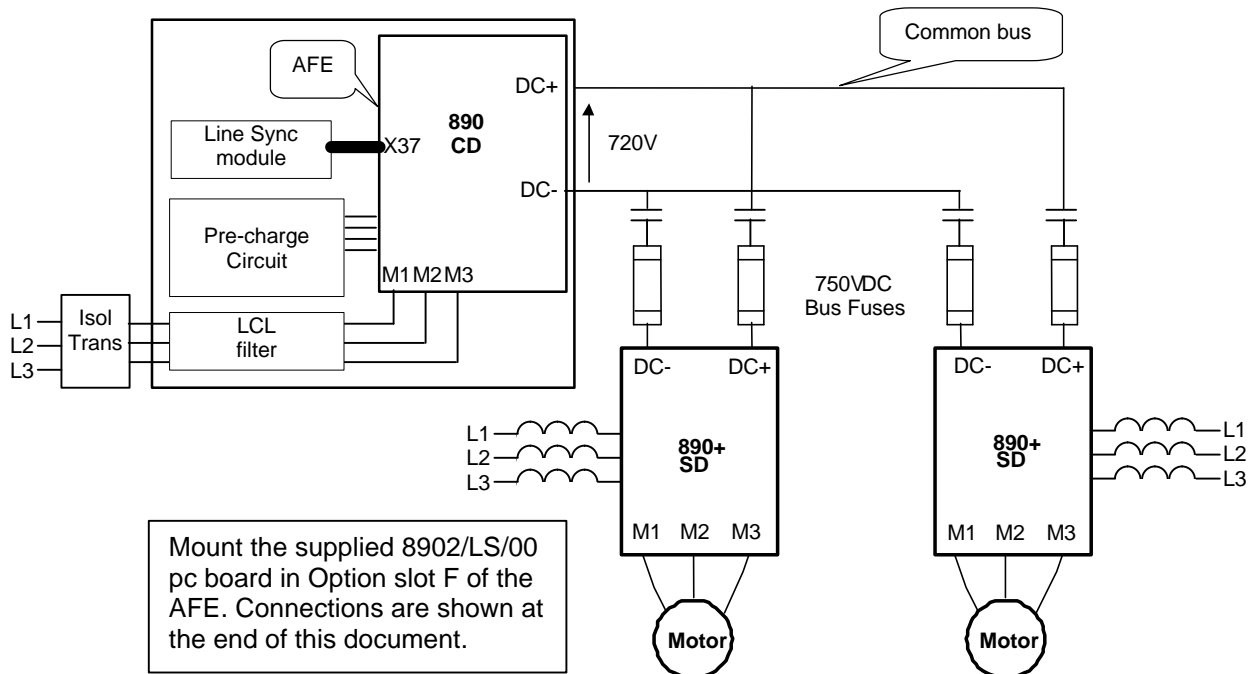
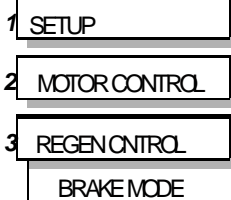
Applications of single motor 4-Quadrant Regen systems include :

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

### 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.

#### MMI Menu Map





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 (up to 45HP rated at 460V, 60Hz)**

The AFE is available as a sub-panel containing the line sync module, pre-charge circuit and the LCL filter. It is rated by HP at 460V, 60Hz. (AFE-xxx). For 230V ratings or other frequency ratings, consult the factory.

**IMPORTANT:** The drive is not included in the sub-panel. Order the correct size 890CD drive with the other motoring drives

HP	Amps	order AFE Drive	Sub-panel #	Dimensions
13	12	890CD/5/0016B/N/00/A/US	AFE-13-890	22 x 18
26	25	890CD/5/0030C/N/00/A/US	AFE-26-890	22 x 18
45	45	890CD/5/0059D/N/00/A/US	AFE-45-890	22 x 18

**Ordering the Product (85HP to 500HP rated at 460V, 60Hz)**

Each panel or enclosure contains an 890 drive configured for use as an active front end, along with the line sync module, pre-charge circuit and the LCL filter. It is rated by HP at 460V, 60Hz.

HP	Amps	Catalog #	Dimensions	
85	80	AFE-85-890	46 x 34	Open panel
125	120	AFE-125-890	46 x 34	
167	160	AFE-167-890	46 x 34	
200	194	AFE-200-890	79 x 47 x 24	Enclosed
300	284	AFE-300-890	79 x 47 x 24	
350	325	AFE-350-890	79 x 47 x 24	
400	378	AFE-400-890	79 x 47 x 24	
500	468	AFE-500-890	79 x 47 x 24	

**IMPORTANT:** Every 890 drive (frames E and higher) used as and with an AFE-xxx needs to be ordered with option 007. Please append the catalogue number with /007.

**Software**

Launch DSE Lite, the free software shipped with the drive:

1. Click on File/New and select: 'V37\_AFE.890'.
2. Install this in the drive you wish to use as an AFE.

for detailed information on the use of DSE Lite, please refer to its product manual.

**Setup**

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

**IMPORTANT:** Every 890CD drive used as and with an AFE-xxx needs to have the EMC capacitors disconnected. Frames BCD: Using the keypad, this can be found under Setup/Miscellaneous/EMC capacitors. Verify that "Disconnected" is selected.



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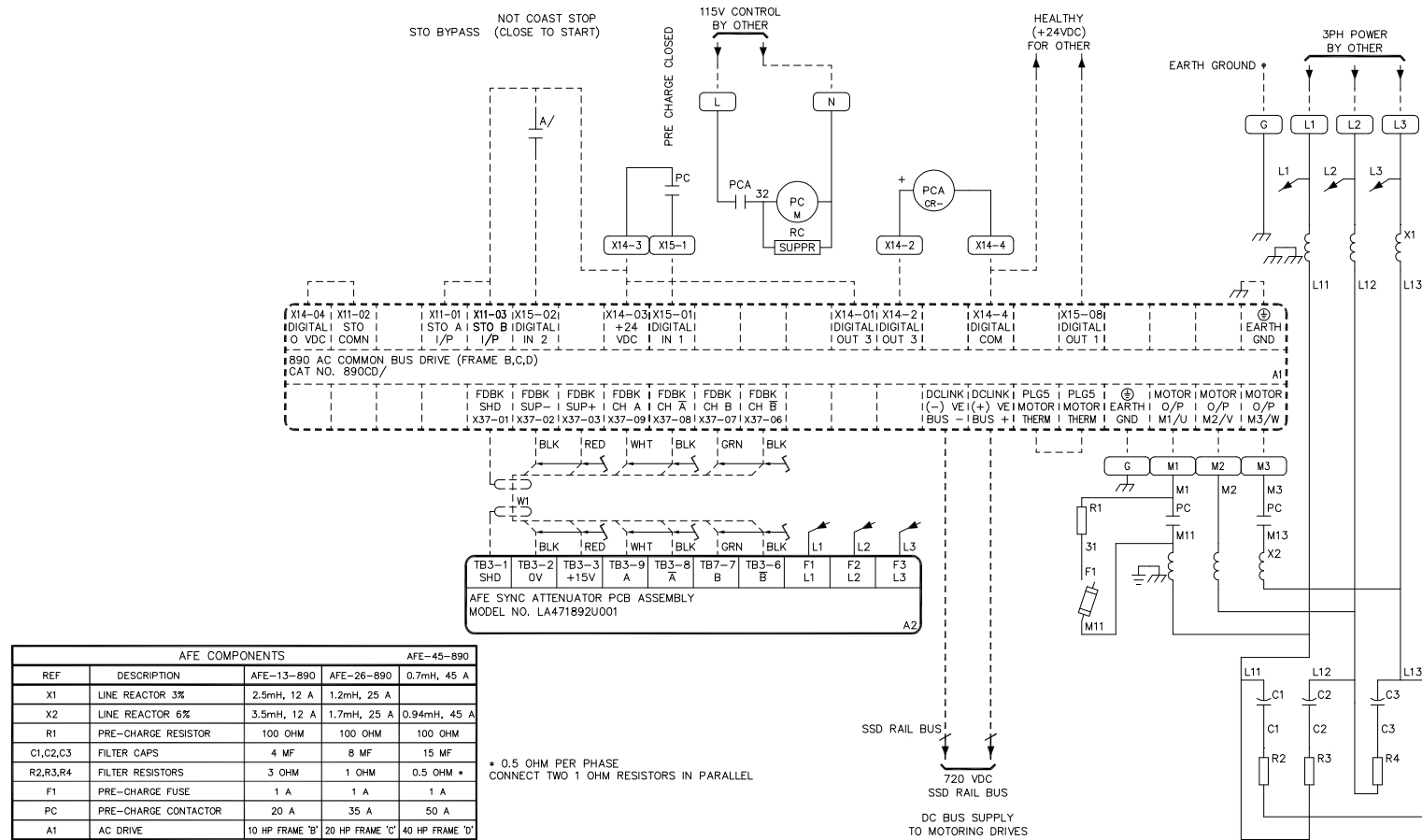
In the Quick Setup menu:

- Control Mode should be set to 4-Q REGEN
- Enter the Motor Current per the chart below.
- Leakage inductance should be set to equal the sum of the inductances of the two line reactors (in mH).

HP	Amps	Catalog #	Leakage Inductance
13	12	AFE-13-890	6 mH
26	25	AFE-26-890	2.9 mH
45	45	AFE-45-890	1.64 mH
85	80	AFE-85-890	0.93 mH
125	120	AFE-125-890	0.55 mH
167	160	AFE-167-890	0.41 mH
200	194	AFE-200-890	0.33 mH
300	284	AFE-300-890	0.225 mH
350	325	AFE-350-890	0.205 mH
400	378	AFE-400-890	0.17 mH
500	468	AFE-500-890	0.14 mH

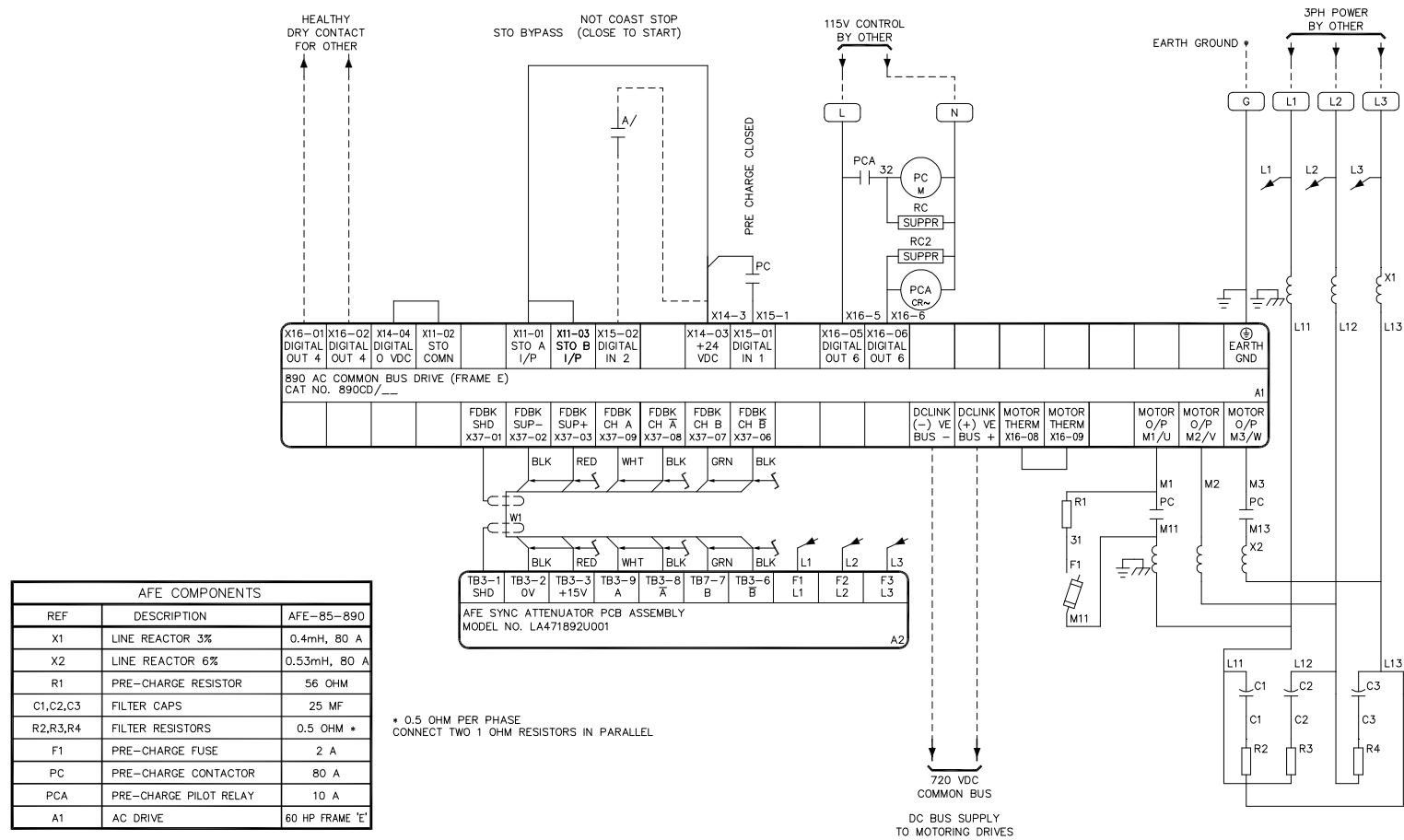
- In the Regen Control menu: (*Setup/Motor Control/Regen Control*), set Brake Mode = FALSE for active front end, or TRUE for line regen mode.

## Typical Wiring Diagram – AFE-xx-890, Frames B,C,D



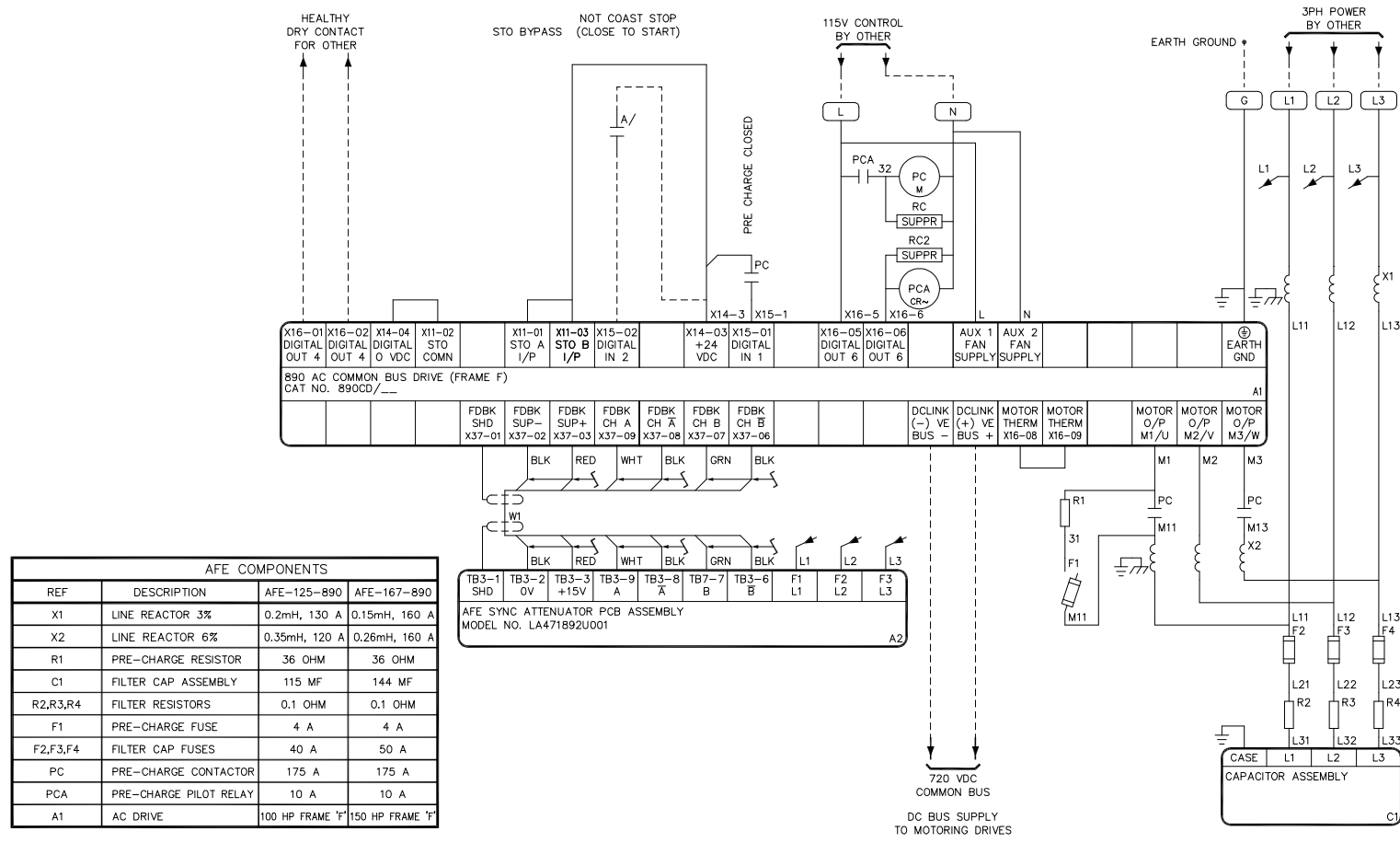


## Typical Wiring Diagram – AFE-xx-890, Frame E



**Note:** The 24V output on X14-03 is current-limited to 150ma. If more capacity is required to drive other elements, remove the jumper between X14-03 and X14-01, and supply X14-01 with an external 24V source.

## Typical Wiring Diagram – AFE-xx-890, Frames F and Higher



AFE COMPONENTS			
REF	DESCRIPTION	AFE-125-890	AFE-167-890
X1	LINE REACTOR 3%	0.2mH, 130 A	0.15mH, 160 A
X2	LINE REACTOR 6%	0.35mH, 120 A	0.26mH, 160 A
R1	PRE-CHARGE RESISTOR	36 OHM	36 OHM
C1	FILTER CAP ASSEMBLY	115 MF	144 MF
R2,R3,R4	FILTER RESISTORS	0.1 OHM	0.1 OHM
F1	PRE-CHARGE FUSE	4 A	4 A
F2,F3,F4	FILTER CAP FUSES	40 A	50 A
PC	PRE-CHARGE CONTACTOR	175 A	175 A
PCA	PRE-CHARGE PILOT RELAY	10 A	10 A
A1	AC DRIVE	100 HP FRAME 'F'	150 HP FRAME 'F'