MOTORTRONICS™

Solid State AC Motor Control

VMX2

VMX2 SERIES COMPACT SOFT STARTER

208 - 600V, 9 - 1250 Amps, 5 - 1200 HP

USER MANUAL

Table of Contents

Chapter 1 - Introduction

1.1 General Description

The *VMX2 Series* is a digitally programmable solid-state reduced voltage soft starter. Its six SCR design features a voltage/current ramp with an anti-oscillation circuit for smooth load acceleration. The SCRs are sized to withstand starting currents of 500% for 20 seconds (Standard Duty) and up to 500% for 60 seconds (Heavy Duty). The *VMX2 Series* features smooth, stepless ramp control, which reduces motor inrush current and excessive wear on the mechanical drive train components. The *VMX2 Series* includes a programming keypad for setting operating parameters for the ideal starting cycle and protection features, plus easy to understand diagnostic LEDs. Starting torque, ramp time, current limit, dual ramp, and Decel control are standard features on the *VMX2 Series*. By simply adjusting the units' starting torque, ramp time, and current limit functions, the starting electrical characteristics of the motor can be matched to the mechanical characteristics of the drive train for controlled acceleration of the load. The *VMX2 Series* includes solid-state electronic overload protection in addition to numerous other protective features. It requires 120VAC (220VAC optional) control power and uses dry contact inputs for Start / Stop control. Programmable auxiliary contacts and provisions for interlocking are also included.

1.1.1   Control Features

Acceleration Adjustments	Programmable Ramp Types: Voltage Ramp (VR) or closed loop Current Ramp (CR) Initial Values: 0 - 100% of line voltage (VR) or 0 - 600% of motor FLA (CR) Ramp Time: 1 to 120 seconds Current Limit: 200 - 600% (VR or CR)

Dual Ramp Settings	4 Options:
	    Ramps 1 & 2 = VR.
	    Ramp 1 = VR, Ramp 2 = CR.
	    Ramps 1 & 2 = CR.
	    Ramp 1 = CR, Ramp 2 = VR.
	    Dual Ramp Control:
	    Ramp #1 = Default.
	    Ramp #2 = Selectable via dry contact input.

Deceleration Adjustments	Begin Decel Level: 0 - 100% of line voltage Stop Level: 0 to 1% less than Begin Decel Level Decel Time: 1 - 60 seconds Programmable to Decel or coast to stop upon overload trip.
Jog Settings	Jog function selected via dry contact closure input. Jog Voltage: 5 - 100% Time of Jog Voltage: 1 - 20 seconds Jog Current: 100 - 500%
Kick Start Settings	Kick Voltage: 10 - 100% Kick Time: 0.1 - 2 seconds

1.1.2   Advanced Motor Protection Features

Thermal Model Electronic Overload Protection	A sophisticated Thermal Model of the motor operation is created in the microprocessor to accurately track all starting, stopping, and running conditions, thus, providing maximum motor protection.
Two Stage Overload Curves	Starting: Programmable for Class 5 through 30 Run: Programmable for Class 5 through 30 when "At-Speed" is detected.
Overload Reset	Manual (default) or automatic.
Retentive Thermal Memory	Overload circuit retains thermal condition of the motor regardless of control power status. Unit uses real time clock to adjust for off time.
Dynamic Reset Capacity	Overload will not reset until thermal capacity available in the motor is enough for a successful restart. Starter learns and retains this information by monitoring previous successful starts.
Current Imbalance Trip	Trip Level: 5 - 30% Imbalance in any two phases. Trip Delay: 1 -20 seconds.
Over Current Trip (Electronic Shear Pin)	Trip Level: 100 - 300% of FLA Trip Delay: 1 - 20 seconds
Voltage Protection	Over Voltage Trip Level: 1 - 10% of Line Voltage. Under Voltage Trip Level: 1 - 20% of Line Voltage. Separate Under Voltage levels for Start and Run modes. Voltage Imbalance Trip Level: 1 - 30% Phase Difference. Voltage Imbalance Trip Delays: 1 - 20 seconds.
Phase Loss	Phase Loss trip: Any phase current less than 12% of unit CT value. Can be disabled in programming for testing with smaller loads.
Phase Rotation	Phase Rotation Trip: ABC, ACB or insensitive. Phase Protection Trip Delays: 1 - 3 seconds.
Power Protection	Motor kW Trip Settings: Over / Under Trip. Under kW Trip Level: 20 - 100% of calculated motor kW. kW Trip Delay: 1 - 9999 minutes. PF Trip Setting: Lead, Lag or Lead/Lag. PF Trip Level: 0.01 - 1.0 (cos. θ). PF Trip Delay Time 1 - 2 seconds.
Equipment Ground Fault Protection	Type: Residual Current Method. Range: 5 - 90% of unit CT ratio. Trip Delay: 1 - 60 seconds.
Load Loss Trip	Under Current Trip Level: 10 - 90% of motor FLA. Trip Delay: 1 - 60 seconds.
Coast Down (Back Spin) Lockout Timer	Prevents restart when motor may be spinning backwards. Coast Down Time Range: 1 - 3600 seconds.
Starts-per-hour Lockout	1 - 10 successful starts per hour.
Minimum Time between Starts Lockout	Range: 1 - 60 minutes between start attempts.
Restart Delay	Sequential Start Feature for restarting delay after a power outage ends. 1-999 seconds after a power loss.
Auto Reset	Can be programmed to attempt resetting after selected faults. 0 - 10 Attempts, in 1 minute cycles.
Power Device Monitoring	Shorted SCR Lockout (1 shorted SCR) and independent Shunt Trip (multiple shorted SCRs). Can be disabled in programming.

1.1.3 Design Specifications

Type of Load:	Three - phase AC induction motors.
AC Supply Voltage:	Universal, 208 - 600VAC ±10%, 50/60 Hz.
Power Ratings:	9 - 1250 Amps, 7.5 - 1000 HP @ 460V.
Unit Capacity - Continuous	Max. Amp rating is UL Listed continuous rating.
Unit Capacity - Overload Rating (Percent of motor FLA)	500% - 60 seconds.
Power Circuit	6 SCRs, full phase angle firing using a hard fire firing circuit to avoid motor transient problems.
SCR Firing Angle Detection	6 pulse Independent Locked Phase Tracking with Auto-synchronization, prevents misfiring on unstable source frequency.
SCR PIV Ratings (Peak Inverse Voltage)	1600V
Transient Protection	RC snubber dV/dt networks on each phase.
Cooling	Fan assisted convection.
Bypass Contactor	Standard on all units.
Bypass Contactor Rating	Shunt rated or can be sized for Line start rating.
Bypass Contactor Control	Integral control is included, but contactor can be externally controlled as well.
Ambient Condition Design	0° to 40°C (32° to 122°F)
	5 - 95% relative humidity.
	0 - 3300 ft. (1000m) above sea level without derating.
Control Power	120VAC (customer supplied), 240VAC optional.
Inputs	6 Dry (voltage free) contact inputs using 24VDC from an internal power supply.
Programmable Relay Outputs	3 relays, 2 each Form C (SPDT), 1 each Form A (SPST). Can be programmed for 32 functions, with delays or flashing.
Output Relay Contact Rating	5 Amps, 240VAC max. (1200VA).
Programmable Analog Outputs	1 analog output 4-20mA Can be programmed for 12 functions with scaling.
Dedicated Fault Output	AC Triac solid state switch.
	240VAC, 50mA max.
Approvals	UL Listed, Canadian UL (cUL) Listed CE Approved. UL 60947-4-2

1.2 Sizes and Ratings

The Motortronics **VMX2 Series** starters are current rated controllers. Max. Amp ratings are for continuous duty and must not be exceeded. Always check the motor nameplate FLA and Service Factor to ensure proper sizing.

Each size has an adjustable current range of 50% to 100% of the Max Amp rating. Table 1.2 shows the Current Ratings available.

Table 1.2 VMX2 Series Range	
Model Number	**Current Range** **Min.- Max.**
VMX2-18-BP	9 - 18
VMX2-28-BP	14 - 28
VMX2-39-BP	19 - 39
VMX2-48-BP	24 - 48
VMX2-62-BP	36 - 62
VMX2-78-BP	39 - 78
VMX2-92-BP	46 - 92
VMX2-112-BP	56 - 112
VMX2-150-BP	75 - 150
VMX2-160-BP	80 - 160
VMX2-210-BP	105 - 210
VMX2-275-BP	138 - 275
VMX2-361-BP	181 - 361
VMX2-450-BP	225 - 450
VMX2-550-BP	275 - 550
VMX2-600-BP	300 - 600
VMX2-862-BP	431 - 862
VMX2-900-BP	450 - 900
VMX2-1006-BP	503 - 1006
VMX2-1250-BP	625 - 1250

1.2.1 Selecting for Service Factor Utilization

Many NEMA design motors include a design rating referred to as Service Factor (SF) that may allow continuous operation above the nameplate current rating. If using this Service Factor, the **VMX2 Series** starter must be sized for the total amps used. For proper selection of the **VMX2 Series** starter when using SF continuously, multiply the nameplate FLA by the stated Service Factor, or use stated Service Factor Amps (SFA) if listed on the nameplate. The following excerpt is from the NEMA MG-1 standards for AC Motors that describes the issues concerning the use of Service Factor ratings.

"*When an induction motor is operated at any service factor greater than 1.0, it may have efficiency, power factor and speed different than those at rated load. Locked rotor torque and current and breakdown torque will remain the same. A motor operating continuously at any service factor greater than 1.0 will have a reduced life expectancy compared to operating at its nameplate horsepower.*"

When using this feature, simply program the **VMX2 Series** Service Factor (F002) to the nameplate rating. (See section 5.6.1.) All other adjustments to the protection circuits are done automatically within the **VMX2 Series.**

1.2.2 Selecting for Across the Line Bypass

If you need to be able to start the motor Across-the-Line when the **VMX2 Series** electronics are out of service, the starter can also be selected based upon the rating of the Bypass Contactor. Some users may also elect to size their Bypass Contactors per NEMA guidelines. When doing this, please refer to the Product Selection Guide for details and notes, and see Appendix 4 for special considerations regarding Overload Protection.

1.2.3 The **VMX2…-BP Series** starters include the ability to connect a dry contact directly to the Bypass Contactor coil control circuit. These terminals are covered when shipped and should be used ONLY when necessary for Emergency Bypass operation **_and_** with an external Overload Relay. See Appendix 4 for additional information.

No field wiring to these terminals is necessary if this feature is not used.

Chapter 2 - Installation

2.1   Receiving and Unpacking

Upon receipt of the product, you should immediately do the following:

- Carefully unpack the unit from the shipping carton and inspect it for shipping damage. *If damaged, notify the freight carrier and file a claim within 15 days of receipt.*
- Verify that the model number on the unit matches your purchase order.
- Confirm that the ratings nameplate on the unit match or are greater than the motors' HP and current rating with which it is to be used.

2.2   Choosing a Location

Proper location of the *VMX2 Series* is necessary to achieve specified performance and normal operational lifetime. The *VMX2 Series* should always be installed in an area where the following conditions exist:

- Ambient operating temperature: 0 to 40°C (32 to 104°F) Protected from rain, moisture, and direct sun.
- Humidity: 5 to 95% non-condensing.
- Free from metallic particles, conductive dust, and corrosive gas.
- Free from excessive vibration. (below 0.5G)
- Open panel units must be mounted in the appropriate type of enclosure. Enclosure size and type must be suitable to dissipate heat generated by the soft starter and any other components mounted inside with it.
- Care should always be taken to maximize the available space inside of the enclosure. See section 2.5.1 or contact factory for assistance in sizing enclosures.

2.3   Initial Unit Inspection

Make a complete visual check of the unit for damage that may have occurred during shipping and handling. Do not attempt to continue installation or start up the unit if it is damaged.

- Check for loose mechanical assemblies or broken wires which may have occurred during transportation or handling. Loose electrical connections will increase resistance and cause the unit to function improperly.
- Prior to beginning the installation, verify that the motor and *VMX2 Series* unit are rated for the proper amperage and voltage.

2.4 SERVICE WARNING!

Do not service equipment with voltage applied! The unit can be the source of fatal electrical shocks! To avoid shock hazard, disconnect main power and control power before working on the unit. Warning labels must be attached to terminals, enclosure and control panel to meet local codes. Use Lockout tags such as the one shown when servicing equipment.

2.5 Mounting and Cleaning

When drilling or punching holes in the enclosure, cover the electrical assembly to prevent metal filings from becoming lodged in areas which can cause clearance reduction or actual electrical shorts. After work is complete, thoroughly clean, vacuum the area, and re-inspect the unit for foreign material.

2.5.1 Clearances

Make sure there is sufficient clearance all around the unit for cooling, wiring, and maintenance purposes. To conserve panel space, the **VMX2 Series - BP** models were designed for close clearances of only 1 inch (25mm) on either side. A minimum clearance of 4 inches (100 mm) on the top and bottom is necessary to maximize effective airflow and cooling. Also the unit must be installed with its heat sink ribs oriented vertically and running parallel to the mounting surface. Keep in mind that these are minimums. NEC or local codes may require more clearance, particularly for the power terminals.
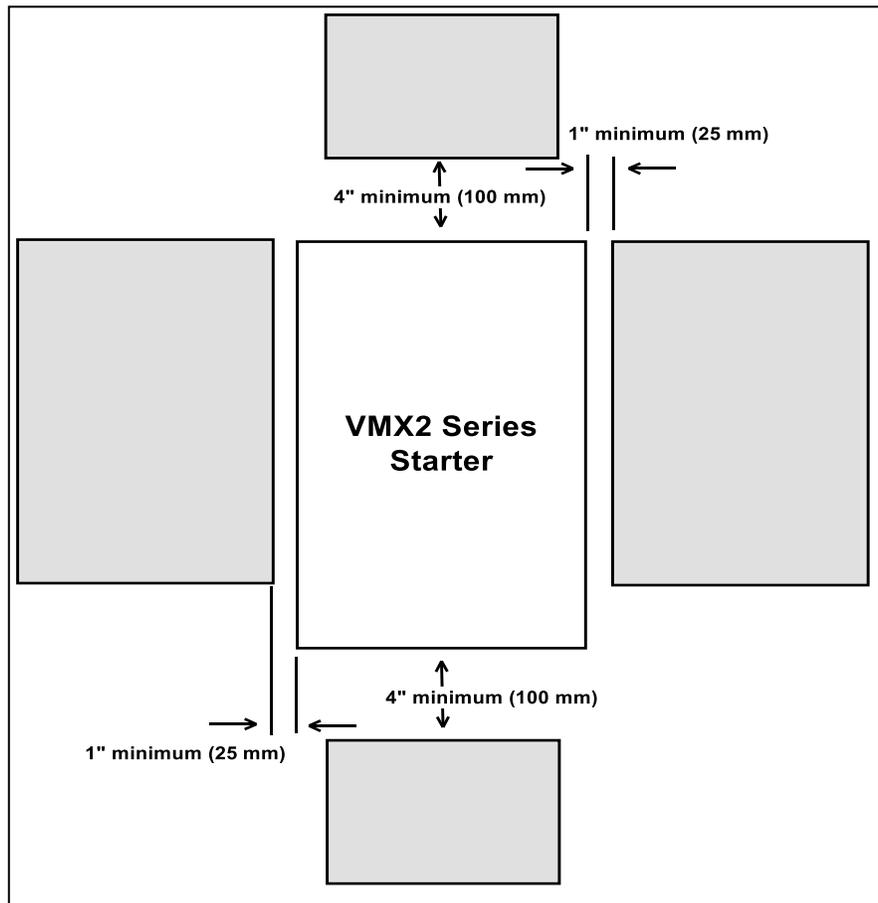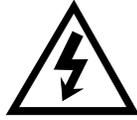

Figure 2.5: VMX2 minimum mounting clearances

WARNING!

Remove all sources of power before cleaning the unit.

In dirty or contaminated atmospheres, the unit should be cleaned on a regular basis to ensure proper cooling. Do not use any chemicals to clean the unit. To remove surface dust, use clean, dry compressed air only, 80 to 100 psi. A three-inch, high quality, dry paintbrush is helpful to loosen up the dust prior to using compressed air on the unit. Do not use wire brushes or other conductive cleaning materials

2.6   Power Terminations

All line and load power terminations are to be made to the tin plated copper Bus Tabs located on each unit. Bus tabs are pre-drilled to accept industry standard bolts. Motortronics recommends using crimp-on ring lugs, although mechanical compression lugs are suitable as well. The following diagrams show sizes of the bus tab holes and critical spacing between them for determining the size of lug that can be used.

Note: All wiring must be sized according to local and national code standards.
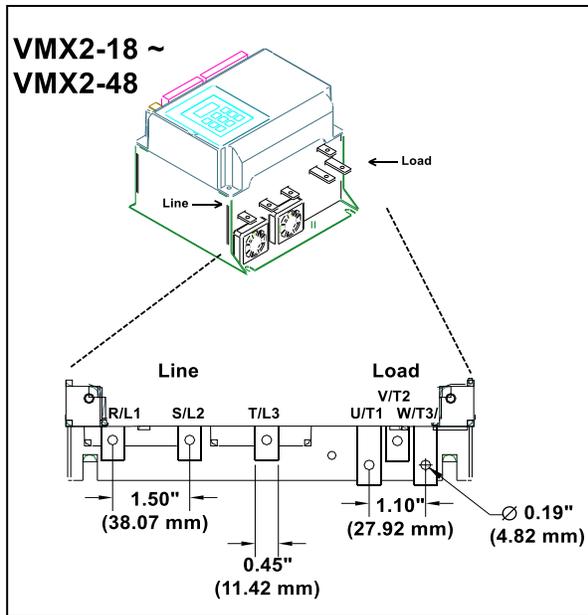

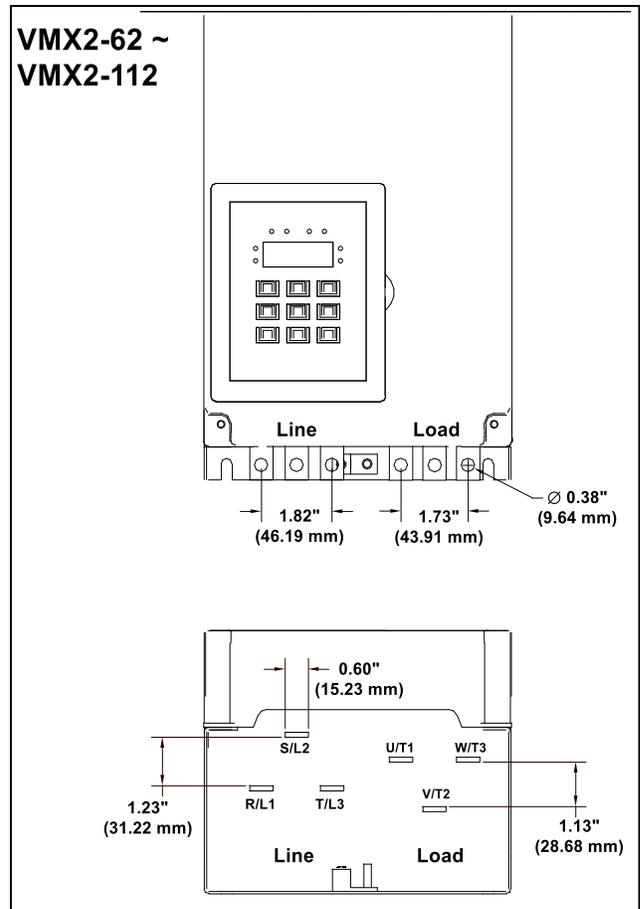Figure 2.6.1 Critical clearances for bus tab connections

Figure 2.6.2 Critical clearances for bus tab connections
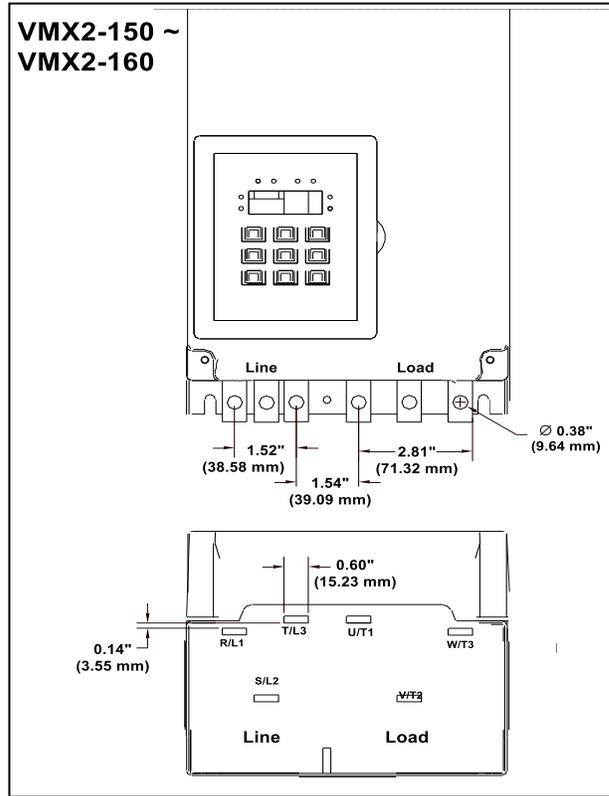
2.6 Power Connections (cont.)

VMX2-150 ~ VMX2-160

Line   Load

∅ 0.38"
(9.64 mm)

1.52"
(38.58 mm)

2.81"
(71.32 mm)

1.54"
(39.09 mm)

0.60"
(15.23 mm)

R/L1   T/L3   U/T1   W/T3

0.14"
(3.55 mm)

S/L2   V/T2

Line   Load

Figure 2.6.3 Critical clearances for bus tab connections

Note: Consult factory for bus tab critical dimensions for units 210A and above

2.6.1 Power Terminals:

Connection points are bus tabs with pre-drilled holes (see below). Suggested wire sizes and tightening torques for factory-supplied connectors using conductors rated for 75°C are shown in the chart below. Always consult local and national codes along with industry standard practices for proper wires sizes and terminations to accommodate voltage drop and ambient conditions.

Table 2.6: VMX2 Series Wire Ranges and Torque Specifications						
Model Number	Current Range Min.- Max.	Suggested Wire Size AWG	Tightening Torque in.-lbs.	Screw / Bolt Size	Tightening Torque Nm	Suggested Wire Size ISOmm²
VMX2-18-BP	9 - 18	10	35	1 x M5 (included)	4	6
VMX2-28-BP	14 - 28	8				10
VMX2-39-BP	19 - 39	8				10
VMX2-48-BP	24 - 48	6				16
VMX2-62-BP	36 - 62	4	45	1 x M8 (included)	5	25
VMX2-78-BP	39 - 78	3				35
VMX2-92-BP	46 - 92	2				35
VMX2-112-BP	56 - 112	1				50
VMX2-150-BP	75 - 150	2/0	80	1 x M8 (included)	9	70
VMX2-160-BP	80 - 160	3/0				95
VMX2-210-BP	105 - 210	250	200	1 x 0.38" hole (M10) for User supplied lugs	15	150
VMX2-275-BP	138 - 275	350 kCMIL				185
VMX2-361-BP	180 - 361	2 x 300 kCMIL				2 x 150
VMX2-450-BP	225 - 450	2 x 300 kCMIL				2 x 150
VMX2-550-BP	275 - 550	2 x 400 kCMIL				2 x 240
VMX2-600-BP	300 - 600	2 x 500 kCMIL	TBD	TBD	TBD	2 x 300
VMX2-862-BP	431 - 862	3 x 400 kCMIL	TBD	TBD	TBD	3 x 240
VMX2-900-BP	450 - 900	3 x 500 kCMIL	TBD	TBD	TBD	3 x 300
VMX2-1006-BP	503 - 1006	4 x 350 kCMIL	TBD	TBD	TBD	4 x 185
VMX2-1250-BP	625 - 1250	4 x 500 kCMIL	TBD	TBD	TBD	4 x 300

Note: TBD = To Be Determined at a later date

2.7 Remote Keypad Mounting

The keypad / operator interface unit can be remotely mounted up to 10ft (3 meters) away from the starter, i.e. on the enclosure door. A remote mounting kit is necessary, which consists of an adaptor plate, a doorframe for NEMA 1 or NEMA 12 enclosures and a pre-assembled ribbon cable available in 1-meter length increments. Detailed assembly instructions and an enclosure cutout template are included with the kit. See Product Selection Guide for part numbers of the available kits.
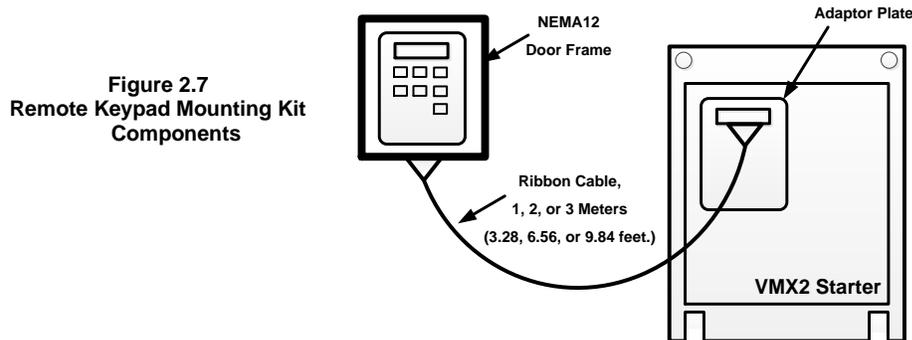

**Figure 2.7
Remote Keypad Mounting Kit
Components**

2.8   Dimensions (consult price catalog for enclosed units)

Table 2.8: VMX2 Dimensions and Weights								
		Overall			Mounting			
Enclosure	Model Number	A Inches (mm)	B Inches (mm)	C Inches (mm)	D Inches (mm)	E Inches (mm)	F Inches (mm)	Weight lbs (kg)
Panel (open) with integral bypass contactor	VMX2-18-BP through VMX2-48-BP	8.85 (230)	8.00 (203)	6.65 (169.7)	8.06 (204.7)	7.00 (177.8)	0.22 (5.6)	13 (5.9)
	VMX2-62-BP through VMX2-112-BP	14.00 (355.6)	8.00 (203)	6.65 (169.7)	13.25 (336.6)	6.75 (171.5)	0.28 (7.1)	23 (10.4)
	VMX2-150-BP and VMX2-160-BP	19.00 (487.9)	8.00 (203)	6.65 (169.7)	18.25 (463.6)	6.75 (171.5)	0.28 (7.1)	35 (15.9)
	VMX2 -210-BP and VMX2-275-BP	28.10 (723.9)	12.5 (317.5)	9.1 (229.4)	27.38 (695.5)	10.75 (273.1)	0.40 (10.2)	90 (40.9)
	VMX2-361-BP and VMX2-450-BP	29.30 (744)	12.5 (317.5)	9.1 (229.4)	27.38 (695.5)	10.75 (273.1)	0.40 (10.2)	105 (47.7)
	VMX2-550-BP through VMX2 -600-BP	29.50 (786.9)	12.5 (317.5)	9.1 (229.9)	27.38 (695.5)	10.75 (273.1)	0.40 (10.2)	120 (55)
	VMX2-862-BP through VMX2-900-BP	44.25 (1124)	25.5 (647.7)	11.86 (301.3)	43.00 (1092.2)	23.00 (584.2)	0.40 (10.2)	Contact Factory
	VMX2-1006-BP through VMX2 -1250-BP	50.77 (1182.6)	25.5 (716.3)	13.28 (332.7)	42.75 (1095.9)	23.25 (590.5)	0.40 (10.2)	Contact Factory

Figure 2.8: VMX2 Dimensions
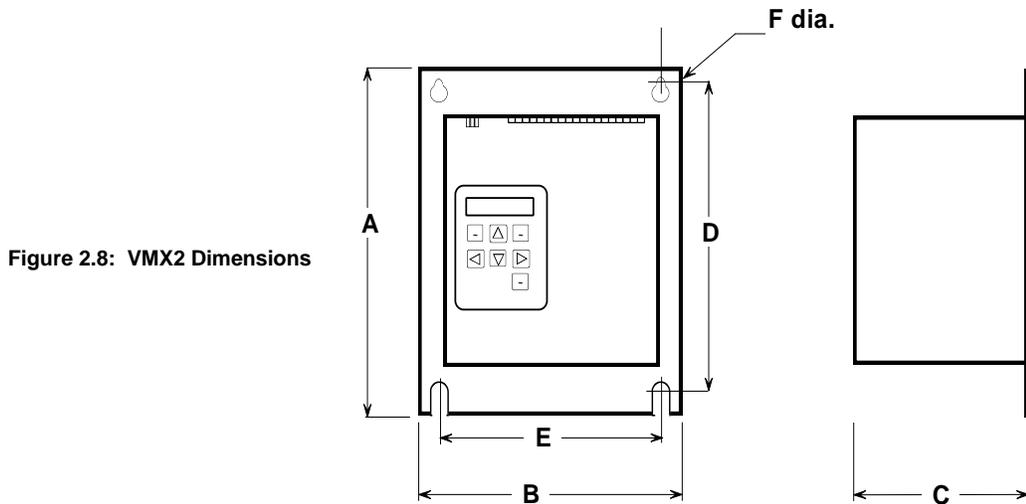
Chapter 3 - Motor Overload Protection

> **MOTOR FLA (F001) must be programmed for unit to operate!**

3.1 Solid State Overload Protection

The **VMX2 Series** Starter provides true U.L. listed I^2t Thermal Overload Protection as a built-in function of the main digital processor for maximum motor protection. It mimics the tripping action of a bi-metallic overload relay, with the accuracy and repeatability of a digital control system. It is adjustable over a wide range and can easily be programmed to different trip curves.

3.1.1 Thermal Memory

The **VMX2 Series** microprocessor uses a sophisticated "Thermal Register" in the digital memory to keep track of motor heating and cooling over time regardless of the starter's power status. By using non-volatile memory, the **VMX2 Series** does not "forget" that the motor has been running even if power to the starter is turned off and turned back on. Continuous overload protection is provided based on the true thermal condition of the motor.

3.1.2 Thermal Capacity

The Thermal Register is displayed as a percentage. This percentage is the motor's <u>remaining</u> thermal capacity. The percentage value begins at 100; showing that the motor is cool (has 100% of its capacity available). As the motor heats up or moves toward an overload condition, the percentage begins to drop. The Thermal Capacity is derived from the programmed motor nameplate Full Load Amps (FLA) in Function **F001**, the Service Factor rating in Function **F002**, and the Overload Trip Class in Functions **F003** and **F004**. Setting these functions to the proper values provides maximum protection and eliminates nuisance tripping.

Examples:

H100

100% Thermal Capacity remaining at rest

H057

57% Thermal Capacity remaining after starter (43% used)

The Remaining Thermal Capacity can be viewed by using the UP or DOWN arrow keys when in the Status Display mode. From the default Phase A Current screen (dot on right side), press the UP arrow key 4 times to display **[H100]** meaning there is 100% of the Thermal Capacity (H = Heat capacity) remaining in the motor. After starting or running, the motor will use this capacity and the display will show a lower number. For example, after a cold start, the display may read **[H065]** which indicates that the motor has 65% of its thermal capacity remaining (35% used). The Status Display screens cycle back to the beginning, so the Down arrow keys can access this display as well.

- **3.1.2.a   Motor Full Load (FLA) Setting**
  Use Function **F001** to enter motor FLA as indicated on the motor nameplate. (Do not calculate for service factor, this is programmed separately in **F002**).

- **Note:**
  All **VMX2 Series** starters are shipped from the factory with **F001** set to a default value of 0000. If **F001** is left at the factory default, the unit will not operate. If the user attempts to start the **VMX2 Series** without entering the motor nameplate FLA, the starter will Fault and the display will read "**nFLA**" (no Full Load Amps).

3.1.3 Disabling the Overload Protection

The Overload Protection feature can be disabled if necessary. When using external devices such as Motor Protection Relays or when the *VMX2 Series* is wired downstream from an existing starter, this feature can be disabled to prevent conflicts with external Overload Protection devices. When the *VMX2 Series* is controlling multiple motors, the built-in Overload Protection must be disabled and individual thermal overload relays must be installed on the motor leads going to each motor (see Appendix 4 for additional details). To disable the Overload Protection function, use **F005**.

WARNING!

Do NOT disable Overload Protection unless another Thermal Overload Protection device exists in the circuit for all three phases. Running a motor without Overload Protection presents serious risk of motor damage or fire.

- **3.1.3.a   Manual Reset**
  The factory default setting is Manual Reset. This means that when the Overload Trip is activated, the starter cannot be restarted without pressing the Reset key. The Overload Trip will not reset until the motor cools down (see 3.1.3.d). The Manual Reset function is also "trip free". Holding in the Reset key will not prevent the Overload Trip from activating and protecting the motor.

- **Note:**
  When the Overload Trip activates, the Overload LED will be on solid. When the motor cools down, the LED will begin to flash, indicating that the Overload Trip can be reset.

- **3.1.3.b   Automatic Reset**
  If Automatic Reset is necessary, change from Manual Reset to Automatic Reset by using Function **F005**. (See Section 5 for details). In this mode, a 3-wire control circuit will be capable of restart when the *VMX2 Series* has reset itself after the cool down period.

WARNING!

Two-wire control systems may restart without warning when Auto Reset of the Overload Protection is selected. Extreme caution should be exercised. To prevent automatic restarting with 2-wire control systems, use external interlocking to provide sufficient warning and safety to operators. A Warning Label similar to that shown below (and the one provided in the packet with this manual) must be located where visible (on the starter enclosure and/or the driven equipment) as required by local code.

> # WARNING: MOTOR CONNECTED TO THIS EQUIPMENT MAY START AUTOMATICALLY WITHOUT WARNING

- **3.1.3.c   Overload Protection During Bypass**
  When an integral Bypass Contactor is used to shunt power around the SCRs in the *VMX2 Series* (as in the VMX…-BP version), overload protection is maintained as long as the *VMX2 Series* is directly controlling the contactor. No additional Overload Relay is **necessary for normal operation.**

- When the Bypass Contactor on a *VMX2…-BP Series* has been selected to be used for Across-the-Line restart (reference section 1.2.3), supplemental overload protection is necessary. For this application, refer to the External Overload Relay Applications supplement and wiring diagram in Appendix 4.

- **3.1.3.d   Dynamic Reset Capacity**
  The *VMX2 Series* includes the ability to dynamically track the Thermal Capacity needed for a successful restart after an overload trip. It averages the Thermal Capacity consumed in the previous three successful starts, and calculates a Thermal Capacity to Start (viewed in Function **F059**). After tripping on Overload, the Thermal Register must have regained the amount recorded in **F059** before a Reset will be allowed. If the display reads **[Inh]** when attempting to reset an overload trip, it is indicating that the starter is **Inh**ibited from being reset.

  Refer to details of Function **F071** for information on emergency override of lockouts such as this.

3.2   NEMA Class Trip Curves

NEMA Class trip curves are based on a common tripping point of 600% of motor Full Load Amps (FLA). Curves vary by the amount of time before the unit trips. As an example, a Class 20 curve will trip in 20 seconds at 600% of FLA. The factory default setting of Class 10 will trip in 10 seconds at 600% of FLA.

3.2.1   Dual Overload Trip Curves

The *VMX2 Series* Soft Starter provides two separate Overload Trip Protection Curves, one for starting and one for running conditions. The starter's At-Speed detection circuit determines when the motor has reached full speed. When the At-Speed condition is reached, the overload trip curve will shift from the Start to the Run level, as programmed in Functions **F003** and **F004**. See Section 5.6.1 for programming details.
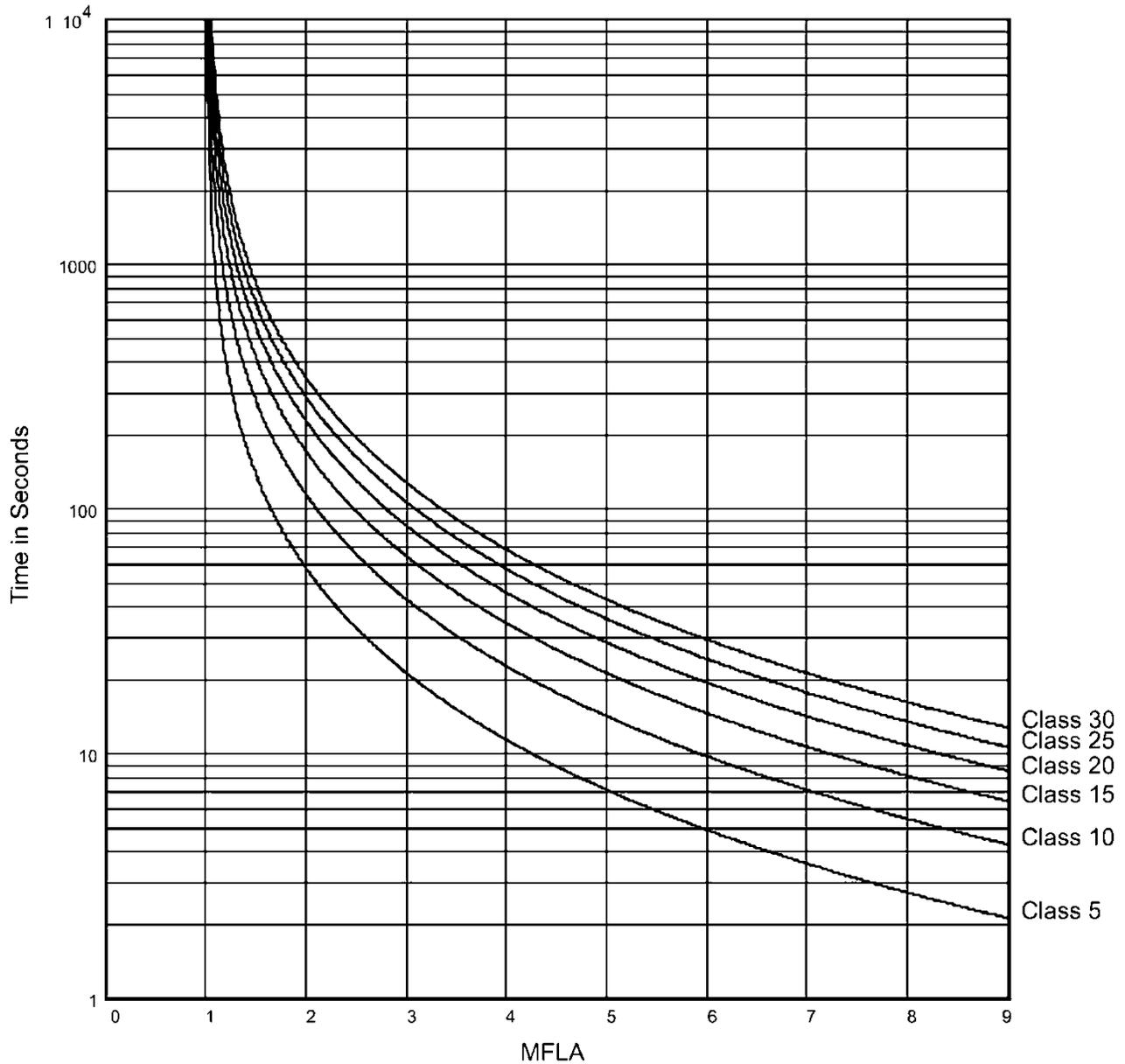
3.2.2   Starting Overload Trip Curve

During the start mode, Overload Trip Curves are selectable from NEMA Class 5 through Class 30 only. The default setting of Class 10 allows protection for the overload capacity of the soft starter as well as the motor. Use a higher Trip Class only if nuisance tripping occurs with the default setting.

3.2.3 Running Overload Curve

During the Run mode, Overload Trip curves are selectable from NEMA Class 5, 10, 15, 20, 25, and 30. Program the appropriate curve according to the characteristics of your motor and load.

3.2.4 Overload Trip Curve Chart

Note: Factory default setting is Class 10 for both Start and Run Overload Protection

Figure 3.2.4: *VMX2 Series* Overload Trip Curves
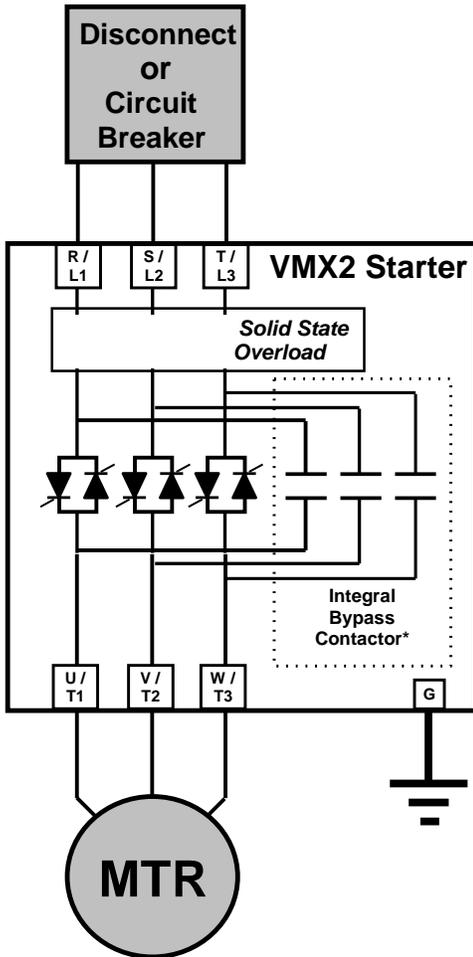
Chapter 4 - Connections

4.1 Power Connections

Refer to national and local code for wire sizing and length, connect power conductors to the unit input terminals marked L1, L2, L3 (R, S, T for IEC users). Use appropriate compression or mechanical lugs for termination to these bus tabs. Avoid routing power wires over the control board or display. Connect the motor leads to the unit terminals marked T1, T2, T3 (U, V, W for IEC users). If control power is present, but line power is disconnected from L1, L2, L3, the display will show **[n3PH]** indicating "no 3 Phase".

Caution!

⚠ **Never interchange input and output connections to the unit. This could cause excessive voltage in the control logic circuit and may damage the unit.**

4.1.1 Bypass Contactor

Bypass Contactors are integral (built-in) on all VMX2 sizes. See sections 1.2.3, 3.1.3.c, and Appendix 4 for more details on contactor control and overload protection details.

4.1.2 Power Factor Correction Capacitors

Power factor correction capacitors can be connected to motors controlled by *VMX2 Series* starters; however they must be off-line during ramping. Connect PFC capacitors to the Line side of the starter with a separate capacitor control contactor.

WARNING!

Never connect power factor correction capacitors on the load side of the unit. The SCRs will be seriously damaged if capacitors are located on the load side.

4.1.3 Grounding

Connect the ground cable to the ground terminal as labeled on the unit. Refer to the National Electrical Code or your local Code for the proper ground wire size, and be sure that the ground connector is connected to earth ground.

Figure 4.1:
VMX2 Power Connections

4.1.4 Testing

The *VMX2 Series* can be tested with a load smaller than the motor it was originally selected to control, however additional steps must be taken to avoid tripping on Phase Current Loss. See section 5.6.8.a under "Phase Loss Protection" for additional details on performing this task.

▪ **Notes:**
The unit cannot be tested without a motor or other test load connected to the load side of the unit. It may be necessary to use a load bank to test the unit without a motor.

▪ Line voltage will appear across the output terminals if there is no motor or load connected to the unit.

4.1.5 Lightning Protection

As with all electronic power controllers, protection from damage by lightning surges is recommended in areas where lightning is a significant problem. Stationary SPDs (Surge Protection Device) should be considered and utilized on the input power source. The best method of protection is to have an Isolation Contactor in front of the starter that is open when the soft starter is not in use. Enclosed versions can be ordered with an OPTIONAL surge protection device.

4.2 Control Connections

Control connections on the *VMX2 Series* starter are divided into 2 groups. With the unit oriented vertically, TB1 is a 12-point DC terminal block (on the left), and TB2 is a 10-point AC terminal block (on the right side). These are removable terminal blocks for ease of connection and servicing, and are provided with different spacing (pitch) between the header pins, so they are not interchangeable. Following are descriptions of control connection points.

▪ **Note:**
Terminal numbers are shown on the side of the first and last terminal of each block. An additional 3 point terminal on the far left side is for serial communication connections (see section 5.6.10).
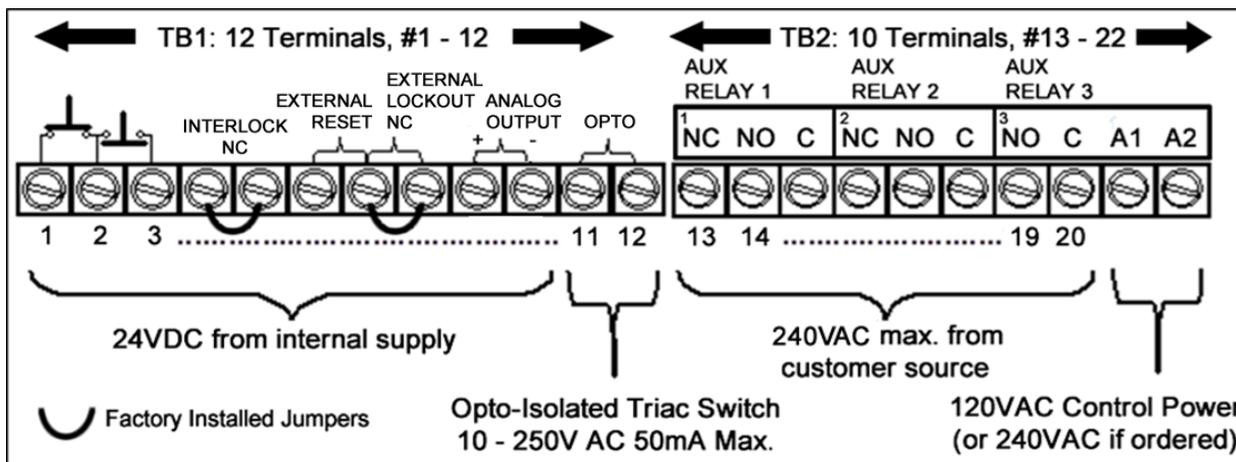

Figure 4.2: Control Terminal Blocks
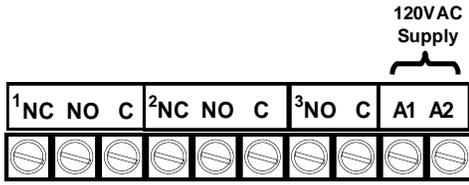
4.2.1 AC Control Power Supply Connection

120VAC Supply

¹NC	NO	C	²NC	NO	C	³NO	C	A1	A2

Figure 4.2.1
Control Power Supply Connection
TB-2

Separate AC Control Power supply is required to power the electronics of the **VMX2 Series** starter. The standard is 120VAC, but 240VAC (optional) can be ordered if necessary for your line power supply configuration. The control voltage must be connected to terminals marked A1 and A2 of TB-2 as shown in figure 4.2.1 (these are also Terminal No.'s 21 and 22). This control voltage must be customer supplied, unless an optional control power transformer (see table below) has been supplied with the unit.

Table 3: *VMX2 Series* AC Control Power VA Requirements					
VMX2…-BP Model	**PC Boards**	**Fans**	**-BP: Bypass Contactor Inrush**	**-BP: Bypass Contactor Sealed**	**Recommended minimum CPT Rating**
VMX2-18 to 48	48	(inc. in PCB)	95	9	100
VMX2-62 to 112	48	(inc. in PCB)	220	17	250
VMX2-150 to 160	48	72	298	12.3	500
VMX2-210 to 276	48	100	380	11.6	500
VMX2-360 to 450	48	150	571	14	750
VMX2-550	48	200	1000	29	1000

- **4.2.1.a   Control Power Requirements**
  When sizing a control power transformer for the **VMX2…-BP Series** starter use the above chart for minimum sizes or supply capacity. Any additional control devices powered by the same CPT must be added to the above values to ensure proper operation of the Bypass Contactor.

- **4.2.1.b   Control Fusing**
  The output relay contacts (TB2) must be protected from currents in excess of 5A by either using fuses or other suitable current protection devices.
- A dedicated fault output for use in PLC or interposing relay control is available on TB1. This opto-isolated Triac switch is rated for 50mA max., 10-250V AC. Any circuit connected to it must be fused accordingly.

4.2.2 Three-Wire Control Connection

Connect 3-wire control here as shown

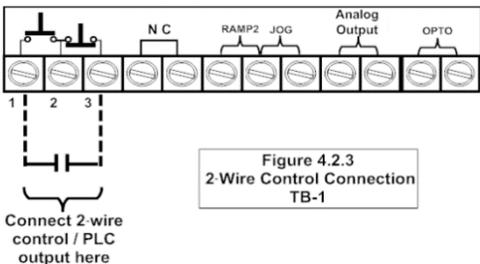Figure 4.2.2
3-Wire Control Connection
TB-1
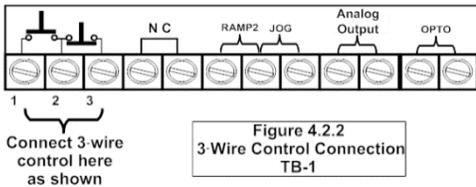
For standard 3-wire control, connect dry (voltage free) contacts for the Stop / Start buttons as shown on the diagram directly above the terminal strip. Connect the N.O. contact of the Start button to Terminal 1 (far left terminal), the common point between the Stop and Start to Terminal 2 (2nd from left) and the N.C. from the Stop button to Terminal 3 (3rd from left).

- **4.2.2.a   Seal In Contact**
  The **VMX2 Series** uses an internally pre-wired "seal-in" contact around the Start button (Terminals 1 and 2). No external relay or auxiliary output connection is necessary.

4.2.3 Two Wire Control: Relay / PLC Connection

Connect 2-wire control / PLC output here

Figure 4.2.3
2-Wire Control Connection
TB-1

An alternate connection for automated or unattended operation replaces the start/stop push buttons by connecting a dry (voltage free) maintained contact closure between terminals 1 and 3 as shown in Figure 4.2.3. When this contact is closed, the **VMX2 Series** starter will start and run. When it is opened, it is the same as a Stop command.

- **4.2.3.a   Automatic Functions and 2-Wire Control**
  When using the Auto Reset functions (**F052 - F053**), special consideration must be given to using 2-wire control. Refer to section 5.6.8 for details on using Auto-Reset functions.

- **Note:**
  When a maintained contact is used for start/stop, it is advisable to set the overload relay to the manual reset position. This will prevent the motor from restarting if the thermal overload trips and then cools down.

CAUTION!

Control Terminals 1-10 of TB1 are configured using solid state devices powered internally with a 24VDC power supply. To prevent damage to the _VMX2 Series_ control board, use dry (unpowered) contact closures only when connecting to these terminals.

If existing 120VAC or other powered control circuit must be interfaced, use isolating relays.

4.2.4 Interlock Connection

Remove factory jumper and connect external interlock device here

Figure 4.2.
External Interlock Connection
TB-1
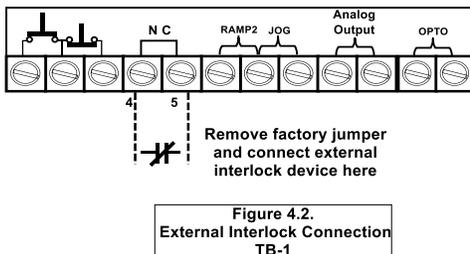
TB1 provides a connection point for an external dry (voltage free) N.C. (Normally Closed) interlock device between terminals 4 and 5. Examples where this interlock connection would be used include low oil, high temperature, or excess vibration dropout from user supplied devices. A factory-installed jumper is provided which allows the **VMX2 Series** unit to operate if external interlocks are not used. If this jumper is removed and an interlock is <u>not</u> used, the **VMX2 Series** unit will not function.

4.2.5 Enabling the Dual Ramp and Jog Features

TB1 includes provisions for enabling the Dual Ramp and Jog functions by using external contact closures. Both features use a common +24VDC from Terminal 7. However, they can be used independently of each other or together. See sections 5.6.2 and 5.6.3 for full function descriptions and setup.

Figure 4.2.5.a:
Dual Ramp Connections
TB-1
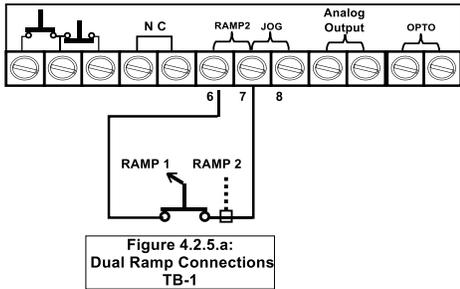
Note: Ramp 2 terminals are defaulted as "External Reset", see parameter F113 for other options.

- **4.2.5.a Dual Ramp Command**
Closing a dry (voltage free) contact between TB1, terminals 6 and 7 will enable Ramp 2, and the *VMX2 Series* starter will respond to the settings for Ramp 2 in **F015 - F018**. If no contact closure is present, the *VMX2 Series* starter defaults to the Ramp 1 parameters (**F011 - F014**). See Section 5.6.2.a for setup of the Dual Ramp Feature.

The Dual Ramp feature is useful in instances where the load changes significantly. *Example*: a loaded or unloaded conveyor belt. The characteristics for starting an unloaded conveyor can be programmed for Ramp 1. The characteristics for starting a loaded conveyor can be programmed for Ramp 2. Ramp 2 can also be programmed for Full Voltage / Across-the-Line starting by setting the ramp time to 0 and Current to 600%.

Dual Ramp is also useful in 2-speed motor applications. Simply use an auxiliary contact from one of the speed contactors to select Ramp 2 so that separate ramp profiles can be used.

Dual Ramp input can also be configured as a "Remote reset"
(See parameter F113 and associated table)
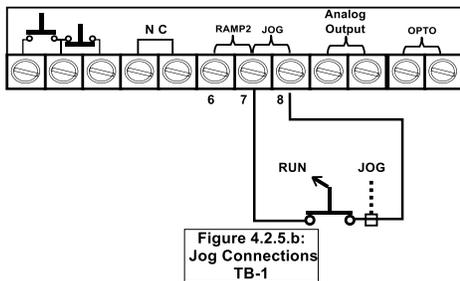
- **4.2.5.b Jog / Remote Command**
Connecting a dry (voltage free) contact between TB1, Terminals 7 and 8 will enable the Jog feature. A Start command (Run Command or Start button) is required to activate the Jog feature. See Section 5.6.3 for setup of the Jog Function.

Figure 4.2.5.b:
Jog Connections
TB-1

Note: Jog terminals are defaulted as "External Lockout, Normally Closed", see parameter F113 for other options.

The Jog feature can be used for tasks such as lining up machines for blade or bit changes, or inching belts along to check tracking.

This input is also used to change the function of the Serial Communications port control through **F068**. For additional information, see instructions of that function in **section 5.6.11**.

Jog input can be also configured as:
- "Remote" (via comm. link) / "Local" (T-strip), Start stop control.
- "External Lockout" (N.O.)
- "External Lockout" (N.C.)
  (See parameter F113 and associated table)

Figure 4.2.5.c:
Dual Ramp / Jog Connections
TB-1
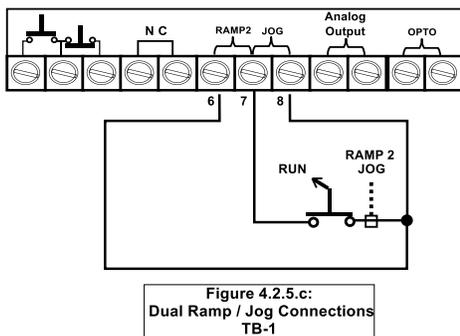
- **4.2.5.c Using Both Commands**
It may be useful to initialize the Ramp 2 and Jog command simultaneously when jogging. If this is the case, terminals 6 and 8 can be jumped together and controlled with one contact closure to Terminal 7 (the common 24VDC).

4.2.6 Analog Output (4-20mA)

Figure 4.2.6:
Analog Output Connection
TB-1

The *VMX2 Series* starter provides a 4 to 20 milliamp output signal that can be set to monitor different parameter values using F108 and scaled with parameter F109 and F110. See section 5.5.16.

Figure 4.2.6.a:
External Overload Relay(s)
and/or E-Stop PB Connection
TB-1

** Remove factory jumper
from Terminals 4 and 5

▪ **4.2.6.a   External Overload Relay Connection**
If an external Overload Relay (OLR) is used (see Section 3.1.3.c and Appendix 4), connect the N.C. aux. contact of the OLR across the Jog input (TB1 terminals 7&8), and re-program the Jog input for "External Lockout N/C", by changing F113 per table in sect 5.6.17.

When the external OLR trips, the contact will open. This indicates an immediate Overload to the starter, which trips and displays **[LcA, Lcc, or Lcd]** depending on operation mode when the overload trips. If multiple OLRs are used, i.e. multiple motors controlled by the same *VMX2 Series* starter, simply wire the Aux Contacts in series as shown in Figure 4.2.6.a. See Appendix 4 for additional information.

Note:
This feature is especially useful when using Deceleration Control because it will immediately shut off power to the motor even if Deceleration is active. If used this way, the trip indication will be **[LcA, Lcc, or Lcd]** depending on the operation mode when the trip is issued.

4.2.7 Fault Signal
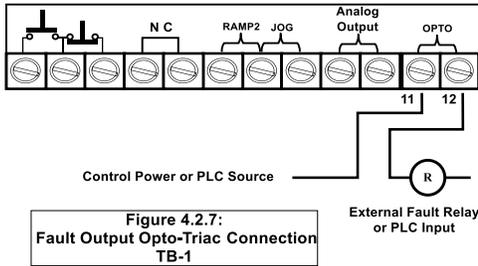
An optically isolated Triac output is dedicated as a fault indicator on TB1, terminals 11 and 12, labeled "**Opto**". The output Triac switch is rated for 10 - 250VAC, **50 mA (maximum)**. If the three programmable Output Auxiliary Relays are being used for other functions, this output can easily be hooked up to a PLC or small external relay to provide a Fault signal. This Fault Output operation is permanently fixed at "Any Trip", duplicating the relay setting 22 as shown in Table 5.6.9.

This output is permanently set to this function and is not programmable.

Figure 4.2.7:
Fault Output Opto-Triac Connection TB-1

4.2.8 Output (Auxiliary) Relay Contacts

Three programmable auxiliary relays are on TB2. The *VMX2 Series* starter comes with three programmable dry relay output contacts. Outputs 1 and 2 are Form C (SPDT), with a Common, N.O. and N.C. Output 3 is a Form A, (SPST), N.O. contact. It is not necessary to use the programmable output auxiliary relays in the Start / Stop circuit. An internal seal-in relay is provided elsewhere (see 4.2.2.a). Motortronics recommends fusing all outputs with external fuses.

The relays are rated for 240VAC, 5 A and 1200 VA.

Factory default settings for these relays are as follows:
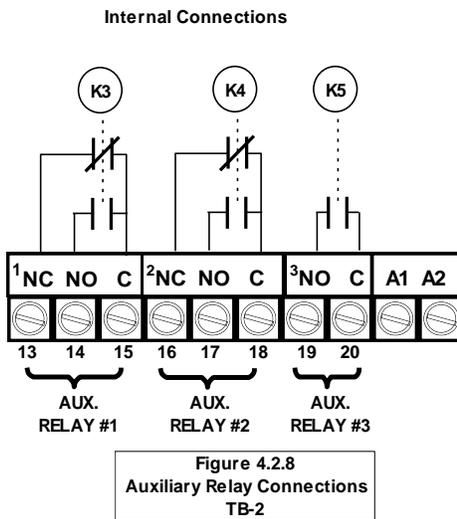
- **AUX 1** - Run / Stop (see **F060**).This contact changes state upon a Start command, returns to normal on Stop (or Begin Decel if active).

- **AUX 2** - At-Speed / Stop (see **F061**).This contact changes state upon the *VMX2 Series* detecting At-Speed, and returns to normal on Stop. At-Speed is determined by the *VMX2 Series* detecting the current dropping after reaching End-of-Ramp, or a maximum of 30 seconds after Start.

- **AUX 3** - Any Trip (see **F062**) This contact closes when any trip condition 5 - 21 (as defined in Table 5.6.9) occurs.

All relays can be reprogrammed for a wide variety of functions. See Section 5.6.9 for additional relay programming details.

Internal Connections

Figure 4.2.8
Auxiliary Relay Connections TB-2

4.2.9 Bypass Contactor Control

On **VMX2…-BP** version (and NEMA 12 enclosures) starters, an internal dedicated connection is used at the factory for automatically controlling the Bypass Contactor. Field wiring for Bypass Contactor operation is not required.

- **4.2.9.a   Independent Bypass Contactor Control**
  The *VMX2…-BP Series* starters use standard industrial contactors that can be controlled independently of the starter electronics if necessary. When doing so, it is necessary to size the starter based upon the ATL (Across-the-Line) selection chart so that the contactors are rated for ATL duty instead of normal Shunt Duty. Supplemental overload protection will be required (see section 3.1.3.c).

  Units have external terminal blocks marked for this purpose (see Appendix 4 for drawings). A dry (voltage free) contact closure between these terminals will close the bypass contactor immediately. The Bypass Contactor coil voltage is the same as the control voltage (120VAC unless the optional 240VAC control is specified), and the voltage on these terminals is the same as the coil voltage.

  No field wiring is necessary to these terminals if this feature is not used.

For all other styles of *VMX2 Series,* the At-Speed signaling can be programmed into any of the three Output relays (section 4.2.8 and Table 5.6.9).

Chapter 5 - Programming

MOTOR FLA (F001) must be programmed for unit to operate!

5.1 Introduction

It is best to operate the motor at its full load starting conditions to achieve the proper time, torque and ramp settings. Initial factory settings are set to accommodate general motor applications and provide basic motor protection. Advanced features must be enabled via programming. The only parameter that MUST be set by the user is motor FLA (**F001**).

5.2 Digital Interface

The *VMX2 Series* Soft Starter includes a digital keypad with eight LEDs, seven command keys, and an LED display with four alphanumeric digits.

Figure 5.2: Digital Interface

Table 5.2: VMX2 Series Display Features		
Keys	Reset	Clears the Trip indication and releases the Trip Relay.
	Fn	Enters or exits the Program Mode.
	Up and Down Arrows	Navigates through the Status Display Mode, scrolls up and down through the Function List, increases or decreases the value of the active (flashing) digit and scrolls through the fault history. When entering values, holding the key down for more than 2 seconds will activate Auto-step, which increases its rate the longer the key is held down.
	Right and Left Arrows	Each keypress shifts the active (flashing) digit to the right or left by one position, allowing you to change higher values of functions without waiting to Auto-step though large numbers.
Green LEDs	Power On	Control power is available at A1 and A2
	At Speed	The motor is at full power and the Bypass Contactor has been commanded to pull in. The SCRs are at full conduction and current has dropped.
Yellow LEDs	Shunt Trip	Power is flowing to the motor in the Off mode. See section 5.6.8.a for additional information.
	Shorted SCR	There is no voltage drop across at least one SCR phase assembly, indicating that at least one SCR is shorted. See section 8 for additional information.
	Over Current	Overcurrent LED lights for three sets of fault conditions: 1) During start, the unit saw current exceeded the normal rate of increase in the first 250ms. 2) During Run, current exceeded either the OC setting in **F042** for the delay set in **F043**. This LED will be accompanied by **oCA, oCC** or **oCd** on the display. 3) The unit has seen a Short Circuit exceeding 10x FLA for 12.5ms. This LED will be accompanied by **SCA, SCC** or **SCD** display.
	Phase Loss	One or more of the phase currents dropped below the threshold during starting or running.
	Over Temp	Starter has tripped due to excess heat sink temperature. This will automatically reset.
	Over Load	Starter has tripped due to the Thermal Register reaching 0000. The Overload must reset before this fault can be cleared.
Display	8888.	4 digit 7 segment display with a decimal point on the right side indicating Phase A.

5.3 Display Modes

There are three modes of display: The Status Display Mode, the Program Mode, and the Fault Mode.

5.3.1 Status Display Mode (Default Display)

The Status Display Mode displays five "screens" of information. Motor Currents (3 phases), Remaining Thermal Capacity and Ground Current. This is also the entry screen for going into the Program Mode.

Status mode:

[0000.] The initial display on power up is four digits and the decimal. This indicates the motor current for Phase A of the motor.

[0000] Scroll UP to display four digits only (no decimal). This indicates the motor current for Phase B. While viewing Phase B, press the UP arrow again to view Phase C current.

[G000] Scroll UP to display the "G". This shows the value of the current flowing to ground on the motor leads.

[H000] Scroll UP to display the "H". This indicates the value of the remaining thermal capacity percentage of the motor (i.e. H070 = 70% remaining thermal capacity).

Example: Figure 5.3.1
Reading the Status Display

[0120.] Indicates Phase A is drawing 120 amps.
Press the UP arrow

[0121] Indicates Phase B is drawing 121 amps.
NOTE: Decimal points are not present in the readouts for Phases B and C.
Press the UP arrow

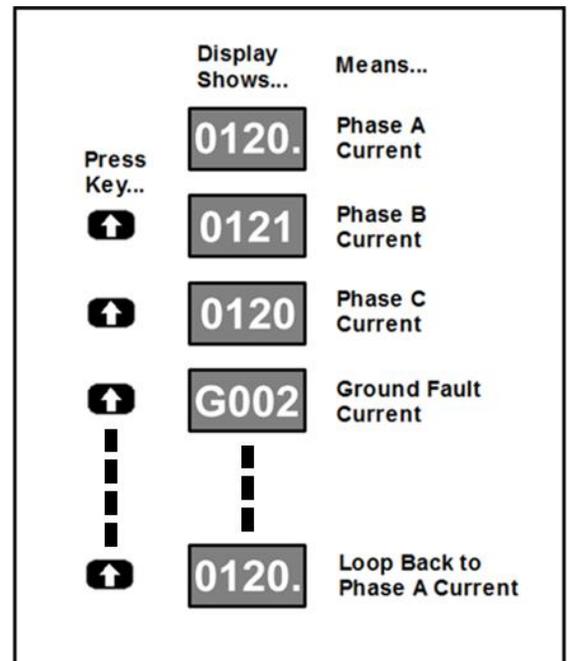**[0120]** Indicates Phase C is drawing 120 amps.
Press the UP arrow

[G002] Indicates that there are 2 amps of current flowing to ground in the motor leads or motor.
Press the UP arrow

[H083] Indicates the motor has 83% of its thermal capacity remaining (H = Heat).
Press the UP arrow

[0120.] Loop back to Phase A current indication

5.4   Program Mode

The starter must be OFF (Motor Stopped) in order to enter the Program Mode. Use the Program Mode to view or change Function (Fn) settings. To enter the Program Mode, press the **[Fn]** key once from the Status Screen described in 5.3.1 above. The first time you enter the Program Mode after power has been cycled to the starter, the initial function **[F001]** should be displayed with the selected digit flashing. If the *VMX2 Series* starter has been programmed and power to the unit has not been cycled, the readout will display the last function viewed or changed. To change to a different function, use the arrow keys.

5.4.1 Viewing Function Programming and Values

While in the RUN Mode, the programming of each individual function and metering values can be viewed, but no changes are allowed. Each Function is signified by the letter "F" at the beginning of the data. The 4-digit value of the function follows after pushing the **(READ/ENTER)** key.

• **[F001]** The "F" indicates the programmable **F**unction.

• **[0000]** This is the present setting of the applicable function. This display may include decimals between digits depending on the function setting's range and incremental steps.

Example: Figure 5.4.1
Viewing a Function's Set Value:
Motor FLA Setting

[0000.]   Indicates that Phase A is drawing no current (unit is in Off mode).

Press the Fn key

[F001]   Indicates that this is Function 001 (Motor FLA).

Press Read / Enter key
to view the F001's value

[0306]   Indicates that the programmed motor FLA is 360 Amps.

Press the Fn key
to return to the function

[F001]   Indicates that you have returned to the Function Select screen.

Press the Fn key again
to return to the Status Display Mode

[0000.]   Indicates that Phase A is drawing no current (unit is in Off mode).

Press Key...	Display Shows...	Means...
	0000.	Default Display: Phase A Current
Fn	F001	Selecting Function #1
READ ENTER	0360	Fn 1 Value: FLA = 360A
Fn	F001	Return to Function # Selection
Fn	0000.	Return to Default Display Without Change

Figure 5.4.1:
Viewing a Function's Set Value

▪   **Note:**
If password protection has been enabled, the operator will need to obtain password access before function settings can be changed. See Section 5.6.12 and Appendix 3.

5.4.2 Enabling Password Protection / Parameter Lock

The *VMX2 Series* starter is shipped with the password protection disabled (**F070 = 0**). If it becomes necessary to prevent parameters from being changed inadvertently, set the password in function **F070**. See Appendix 3 for details. If the display reads **[Loc]** when the **[READ/ENTER]** key is pressed, the parameter lock is enabled.

5.4.3 Changing a Function's Set Value

From the instructions above, after pressing the **[READ/ENTER]** key the display will show the value of that function with one digit flashing (usually the rightmost digit). Flashing indicates this is the digit to be altered (similar to cursor position). Use the UP arrow key to increment the value of the flashing digit. Use the DOWN arrow key to decrement the value of the flashing digit. Use the LEFT or RIGHT arrow to select the next digit to be altered. Values can only be changed within the Adjustment Range of the function parameter.

<table>
<tr><td colspan="2">

Example 1: Figure 5.4.3

Viewing a Function's Set Value

</td></tr>
<tr><td>**[0000.]**</td><td>Indicates Phase A is drawing no current (unit is in Off mode).</td></tr>
<tr><td colspan="2" align="center">**Press the [Fn] key**</td></tr>
<tr><td>**[F001]**</td><td>Indicates this is Function 001 (Motor FLA).</td></tr>
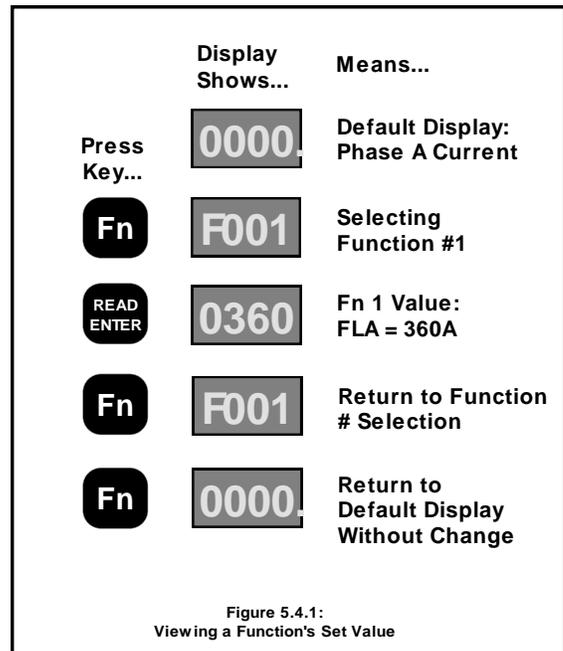<tr><td colspan="2" align="center">**Press [READ/ENTER] key
to view the F001 value**</td></tr>
<tr><td>**[0048]**</td><td>Indicates the programmed motor FLA is 48 Amps. The right most digit (8) is flashing, indicating that this is the digit that you will alter (cursor position).</td></tr>
<tr><td colspan="2" align="center">**Press the UP Arrow key
to increase this digit value**</td></tr>
<tr><td>**[0049]**</td><td>Indicates you have increased the right most digit to a value of 9**.**</td></tr>
<tr><td colspan="2" align="center">**Press the LEFT Arrow key
to shift left to the next digit**</td></tr>
<tr><td>**[0049]**</td><td>The second digit from the right is now flashing, indicating a new cursor position.</td></tr>
<tr><td colspan="2" align="center">**Press the UP Arrow key
to increase this digit value**</td></tr>
<tr><td>**[0059]**</td><td>Indicates you have increased the 2nd to right digit to a value of 5 (10's place)**.**</td></tr>
<tr><td colspan="2" align="center">**Press [READ/ENTER] key
to store the new value**</td></tr>
<tr><td>**[End]**</td><td>The word "End" will flash briefly to indicate that the new value has been entered and accepted. After flashing once, the display will revert to showing the Function number.</td></tr>
</table>

Example 1: Setting the Motor FLA

Change FLA from 48 to 59A

Press Key...	Display Shows...	Means...
	0000.	Phase A Current
Fn	**F001**	Function #1 Selected
READ ENTER	**0048.**	Previous Setting of Function #1
↑	**0049**	New Value of First Digit
←	**0049**	Cursor (flashing) Position Shift
↑	**0059**	New Value of Second Digit
READ ENTER	**End**	Value Accepted (flashes once)
	F001	Return to Function # Display

Figure 5.4.3:
Changing a Function Value
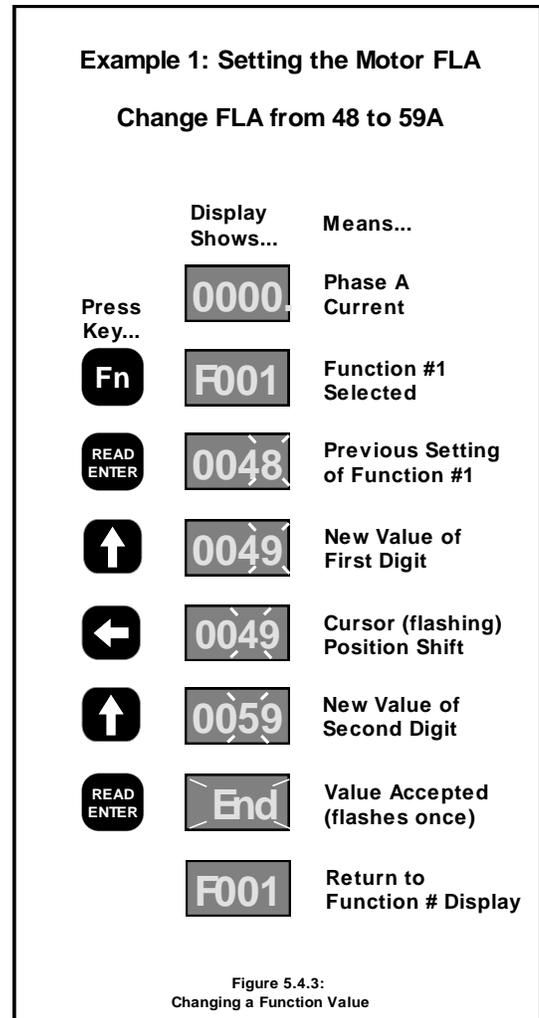
- ▪ **5.4.3.a   Changing a Value by Increments**
  Although it may be easier to shift the cursor position, it is also possible to increase or decrease values by pressing the UP or DOWN arrow keys successively. This will change the Function value by the incremental amount associated with that Function. The Function List shows increment values for each Function.

Example 2: Figure 5.4.3.a

Changing a Function's Value by Increments

[0000.] Indicates that Phase A is drawing no current (unit is in Off mode).

Press the [Fn] key

[F001] Indicates that this is Function 001 (Motor FLA). The right most digit (1) is flashing, indicating this is the digit that you will alter (cursor position).

Press the UP Arrow key twice to increase this digit value to 3

[F003] Indicates that this is Function 003 (OL Class During Start).

Press [READ/ENTER] key to view the F003 value

[0010] Indicates that the programmed OL is Class 10 during the Start Mode. Cursor flashing on right most digit.

Press the UP Arrow key to increase this digit value

[0015] Indicates that you have increased the Function value by the increment assigned to it, a value of 5 in this case**.**

Press the UP Arrow key again to increase this digit value

[0020] Indicates that you have again increased the Function value by the increment assigned to it**.**

Press [READ/ENTER] key to store the new value

[End] The word "End" will flash briefly to indicate that the new value has been entered and accepted. After flashing once, the display will revert to showing the Function number.

	Example 2: Setting the OL Curve During Start	
	Change from Class 10 to Class 20	
Press Key...	Display Shows...	Means...
	0000.	Phase A Current
Fn	**F001**	Function #1 Displayed
↑ x2	**F003**	New Value of First Digit
READ ENTER	**0010**	Previous Setting of Function #3
↑	**0015**	Value Increased by 1 Increment
↑	**0020**	Value Increased by 1 Increment
READ ENTER	**End**	Value Accepted (flashes once)
	F003	Return to Function # Display

Figure 5.4.3.a:
Changing a Function Value by Increments
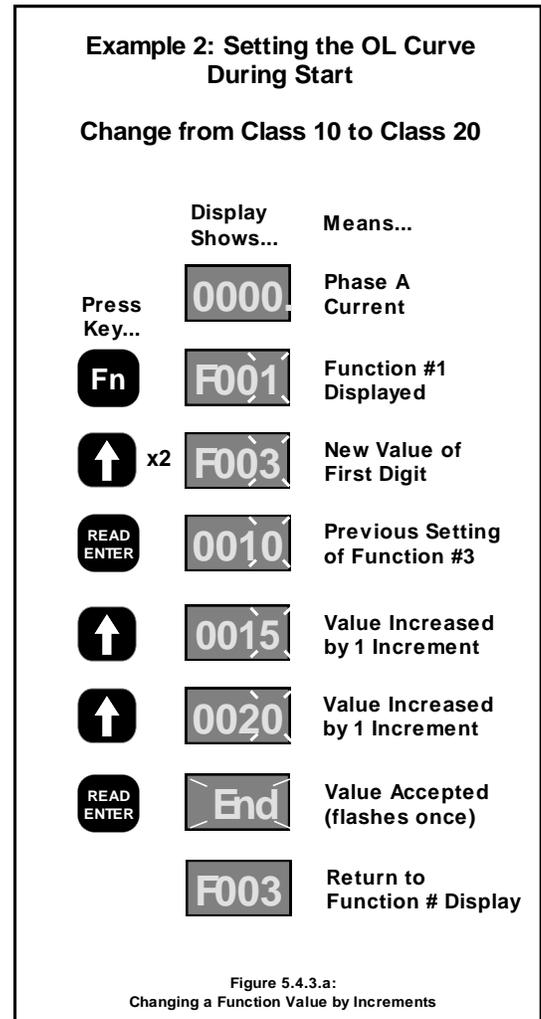
5.4.4   Storing the Altered Value of a Function

Once the desired value is displayed, press the **[READ/ENTER]** key. This *stores* the value in memory. The readout momentarily displays **[End]** and then returns to the function code.

Caution!

If the Fn key is pressed or power is lost _before_ the [READ/ENTER] key is pressed, the *VMX2 Series* Starter will not store the selected value in memory.

5.4.5 Fault Mode

The Fault Mode Display provides information to the operator when a fault occurs and allows the operator to review fault history. Refer to Section 7 for details. Fault codes are displayed by 3 alpha characters. The first and second characters (reading left to right) are the initials for the applicable English-language fault name. The third or right-most character can be either A, c, or d to denote when the fault occurred. "A" denotes Acceleration. "c" denotes Constant speed. "d" denotes Decel or Stop.

Example: Figure 5.4.5

Viewing a Fault and History

[PLA.] Indicates that there was a Phase Loss during Acceleration. The Decimal point on the right signifies that this is the current fault.

Press the UP Arrow key

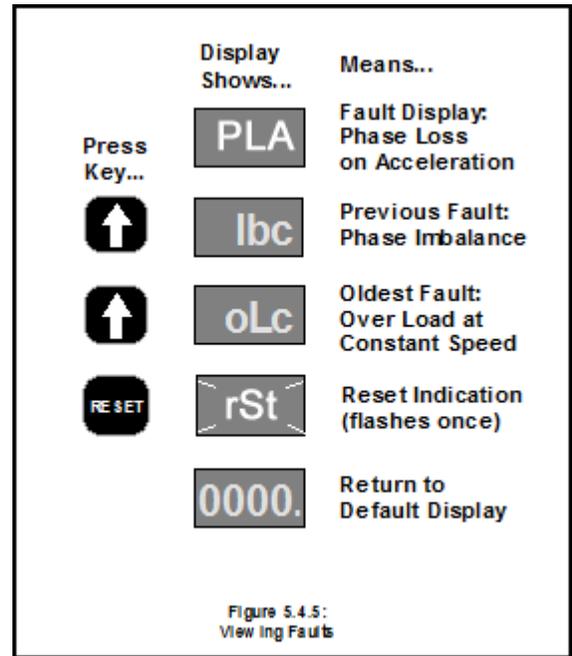**[IBc]** Displays the previous fault, a Phase Imbalance during Constant Speed (running).

Press the UP Arrow key

[oLc] Displays the oldest fault, an Overload trip during Constant speed (running).

Press [RESET] key

[rSt] Flashes once to indicate a successful Reset of the current fault. If it cannot be reset, the display will read **[inH]** for Inhibited.

[0000.] Returns to Default Display, indicating that the unit is ready to re-start.

Display Shows...	Means...
PLA	Fault Display: Phase Loss on Acceleration
↑ Ibc	Previous Fault: Phase Imbalance
↑ oLc	Oldest Fault: Over Load at Constant Speed
RESET rSt	Reset Indication (flashes once)
0000.	Return to Default Display

Figure 5.4.5:
Viewing Faults

This Fault History can only be accessed during a fault condition. While the active fault number is being displayed, use the Up and Down Arrow keys to scroll through the Fault History. An additional Fault History complete with Time and Date stamps is also available for viewing at any time in **F085** through **F093**.

▪ **5.4.5.a   Resetting Faults**
Once a fault condition has been corrected, pressing the Reset key will return the readout to the Status Display mode. To reset faults, press the **[RESET]** key on the keypad. Alternatively, most faults will reset upon removal and return of control power. Overload trips will NOT be reset in this way unless sufficient time has passed for the Thermal Register to regain sufficient capacity for a successful restart (see section 3.1).

▪ **5.4.5.b   Remote Reset**
Because most trips can be reset by removing control power, remote reset can be accomplished this way. A N.C. remote contact (or push-button) can be placed in the control power supply to A1 or A2 and opened to facilitate a trip reset. See figure 5.4.5.b for a suggested connection.

Figure 5.4.5.b
Remote Reset Connection
TB-2

¹NC NO C ²NC NO C ³NO C A1 A2

Remote Reset

Control Power Supply
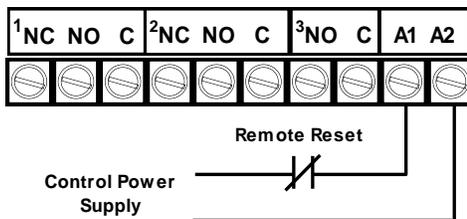
- **5.4.5.c   Automatic Reset**
  The *VMX2 Series* starter provides for automatic reset on certain non-critical faults and Overload. For non-critical fault resets, see section 5.6.9.b for program details of **F052**. For automatic Overload reset, see section 3.1.3.b and 5.6.1 for programming details.

- **5.4.5.d   Lockout Functions**
  Lockout functions such as Minimum Time Between Starts and Starts per Hour are not true fault conditions. They are based on the internal Real Time Clock (RTC). When control power is removed, the RTC value is quickly stored. Upon return of power, the timer values are updated from the RTC for elapsed time. If the Lockout Time has not expired, the *VMX2 Series* cannot be started. To reset the Lockout Times for emergency restart, see section 5.6.11, under **F071**.

- **5.4.5.e   Changing to Default Screen During Fault**
  In some cases, it may be necessary to alter programmed parameters in order to test or make changes to clear a fault (such as Phase Loss), or to view the more detailed fault history in F085 - F097. To accomplish this, you must get to the Status Screen so the Fn button becomes active. When in a Fault Screen, pressing the Right or Left Arrow buttons will take you to the Status Screen. From there, you can press the **[Fn]** key to enter the Programming Mode and move to different functions.

5.5 The VMX2 Function List

5.5.1 Motor FLA, Service Factor and Overload Protection Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F001	Motor and Overload Info.	Motor Nameplate FLA FLA must be programmed for starter to function.	50 -100% of Max Amp Rating. Upper limit of range automatically adjusts downward as Service factor is increased.	1 amp	0	1	5.6.1 and 3.2
F002		Motor Nameplate Service Factor	1.00 - 1.30 SF	0.05	1.0 SF		
F003		Overload Class During Start	NEMA / UL Class 5 -30	5	Class 10		
F004		Overload Class During Run	NEMA / UL Class 5 - 30	5	Class 10		
F005		Overload Reset	0 = Manual 1 = Auto 2 = Disabled Overload	1	0 (Manual)		
F006		Reserved for factory use				2	
F007 - F009		Reserved for factory use				Read Only	

Table 5.5.1: Motor and Overload Function Group

5.5.2 Starting Mode Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F010	Starting and Stopping Modes	Ramp Type Selection: VR = Voltage Ramp CR = Current PID Ramp 1 = Ramp 1, 2 = Ramp 2	Setting 1 = VR1 + VR2 Setting 2 = CR1 + CR2 Setting 3 = VR1 + CR2 Setting 4 = CR1 + VR2	1	1 VR1+VR2	1	5.6.2 and Append. 1
F011		Initial Torque (VR) of Ramp 1	0 - 100% Line Voltage	1%	60%		
F012		Initial Torque (CR) of Ramp 1	0 - 600% Motor Current	1%	200%		
F013		Accel Ramp Time of Ramp 1	1 - 120 seconds	1 second	10 seconds		
F014		Max Current Limit of Ramp 1	200 - 600% Motor Current	1%	350%		
F015		Initial Torque (VR) of Ramp 2	0 - 100% Line Voltage	1%	60%		5.6.2, Append. 1 and 4.2.5
F016		Initial Torque (CR) of Ramp 2	0 - 600% Motor Current	1%	200%		
F017		Accel Ramp Time of Ramp 2	1 - 120 seconds	1 second	10 seconds		
F018		Max Current Limit of Ramp 2	200 - 600% Motor Current	1%	350%		

Table 5.5.2: Starting Mode Function Group

5.5.3 Jog Mode Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F019	Jog Modes	Voltage Jog	5 - 100% Line Voltage	1%	50%	1	5.6.3 and 4.2.5.b
F020		Time of Voltage Jog	1 - 20 Seconds	1 second	10 seconds		
F021		Current Jog	100 - 500% Motor Current	1%	150%		

Table 5.5.3: Jog Mode Function Group

5.5.4 Kick Start Mode Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F022	Kick Mode	Kick Start Voltage	0 = Disabled, or 10 - 100% Line Voltage	1%	0 Disabled	1	5.6.4
F023		Kick Start Time	0.1 - 2 Seconds	0.1second	0.8 seconds		

Table 5.5.4: Kick Start Mode Function Group

5.5.5 Decel Mode Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F024	Pump Flex Decel Mode	Pump Flex Control / Deceleration Ramp	0 = Disabled (coast to stop) 1 = Enabled, Power OFF on OL trip 2 = Enabled, Decel even if there is an OL trip	1	0 Disabled	1	5.6.5 and Append. 2
F025		Begin Decel Level (BDL), Immediate Drop Down Torque	0 - 100 % of Output Voltage	1%	60%		
F026		Decel Shut Off Voltage	0 to (BDL minus 1)% Voltage	1%	30%		
F027		Decel Ramp Time	1 - 60 Seconds	1 second	10 seconds		

Table 5.5.5: Pump Flex Decel Mode Function Group

5.5.6 Restart Function

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F028	Restart	Auto Restart Delay Time (Sequential Start Delay)	0 = Disabled, or 1-999 seconds after a Power Loss (Status can be read in F054)	1 second	0 Disabled	1	5.6.6

Table 5.5.6: Restart Function Group

5.5.7   Line Voltage

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F029		Voltage Input	200 - 690 Volt	1	480		
F030		Voltage Imbalance Trip %	0, 1 - 30% [0=Disabled]	1(%)	0		
F031		Voltage Imbalance Trip Delay	1 - 20 seconds	1	10		
F032		Over Voltage Trip %	0, 1 - 10% [0=Disabled]	1(%)	0		
F033	Line Voltage	Over Voltage Trip Delay	1 - 20 seconds	1	10		
F034		Under Voltage Trip on Start %	0, 1 - 20% [0=Disabled]	1(%)	0	1	5.6.7
F035		UV Trip on Start Delay	1 - 180 seconds	1	10		
F036		Under Voltage Trip on Run %	0, 1 - 20% [0=Disabled]	1(%)	0		
F037		UV Trip Delay during Run	1 - 20 seconds	1	2		
F038		Shorted SCR and Trip Delay	0, 1-10 seconds [0=Disabled]	1 second	1 second		
F039		Shunt Trip Delay	0, 1-10 seconds [0=Disabled]	1 second	1 second		

Table 5.5.7: Line Voltage Function Group

5.5.8   Current and Ground Fault Protection Features

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F040		Current Imbalance Trip	0, 5 - 30% [0 = Disabled]	1%	0 Disabled		
F041		Current Imbalance Trip Delay	1 - 20 seconds	1 second	2 seconds		
F042		Over Current Trip	0, 100 - 300% of motor FLA [0 = Disabled]	1%	0 Disabled		
F043	Phase Current	Over Current Trip Delay	1 - 20 seconds	1 second	1 second	1	5.6.8
F044		Under Current Trip	0, 10 - 90% of motor FLA [0 = Disabled]	1%	0 Disabled		
F045		Under Current Trip Delay	1 - 60 seconds	1 second	2 seconds		
F046		Ground Fault Trip	0, 5 - 90% of CT ratio from Fn 074 [0 = Disabled]	1%	0 Disabled		
F047		Ground Fault Trip Delay	1 - 60 seconds	1 second	2 seconds		

Table 5.5.8: Current and Ground Protection Features Group

5.5.9 Lockouts, Reset and Internal Protection Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F048	Lockouts, Reset and Internal Protection	Coast Down (Back Spin) Lockout Timer	0 - 60 minutes [0 = Disabled]	1 minute	0 Disabled	1	5.6.9
F049		Maximum Starts per Hour	0 - 10 starts [0 = Disabled]	1	0 Disabled		
F050		Minimum Time Between Starts	0 - 60 minutes [0 = Disabled]	1 minute	0 Disabled		
F051		nCP Trip (No Control Power)	0, 1 [0=Disabled, 1=Enabled]	1	0	1	5.6.9.a
F052		Auto Reset on Selected Faults	Fault Preferences 1 - 17 See Table 5.6.7: "Auto-Reset Selected Faults"	1	4, Phase Loss only	1	5.6.9.b
F053		Auto Reset Attempts	0 - 10 attempts [0 = Disabled] [In 1 minute cycle]	1	0 Disabled		
F054		Restart Delay Time Value Readout (for F028)	0 - 999 Seconds	-	Read Only	Read Only	5.6.9.c
F055		Coast Down Timer Value for F048	1 - 3600 Seconds	-	Read Only		
F056		Starts Per Hour Timer Value for F049	1 - 3600 Seconds	-	Read Only		
F057		Starts Per Hour For F049	1 - 10 Starts	-	Read Only		
F058		Time Value Between Starts for F050	1 - 3600 Seconds	-	Read Only		
F059		Thermal Capacity to Start for F005	0 - 100 % Thermal Capacity	-	Read Only		

Table 5.5.9: Lockouts, Reset and Internal Protection Group

5.5.10 Output Relay Programming Features

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F060	Output Relays	Aux Relay 1 setting	Operation # 1 - 32: see "Aux. Relay Settings Chart"	1	1	1	5.6.10
F061		Aux Relay 2 setting	Operation # 1 - 32: see "Aux. Relay Settings Chart"	1	2		
F062		Aux Relay 3 setting	Operation # 1 - 32: see "Aux. Relay Settings Chart"	1	22		
F063		Aux. Relay Delay Timer (for Operations 28-31)	0 - 999 seconds [0 = Disabled]	1 second	0 No Delay		
F064		Reserved for factory use				2	

Table 5.5.10: Output Relay Function Group

Notes:
Check wiring to each relay before changing programming to ensure there are no unintended consequences.
Relays programmed to some protection features will not operate if function is disabled elsewhere.

5.5.11   Serial Communications

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F065	**Communications**	Communications	0 = Disabled 1 = Enabled (11Bit) 2 = Enabled (10Bit)	1	0	1	5.6.11
F066		Baud Rate	4.8, 9.6 and 19.2 KB	3 rates	9.6 KB		
F067		Modbus Address	1 - 247	1	1		
F068		Remote Starter Control	0 = Disabled 1 = Enabled w/ Start button 2 = Enabled w/o Start button 3 = Enabled via Jog-Remote Input **See parameter F113 as well.**	1	0		
F069		Reserved for factory use				2	

Table 5.5.11: Serial Communications Function Group

5.5.12   System Settings

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F070	**System Settings**	Parameter Lock Customer Password	0 - 999 0 = Disabled Any Other Numbers = Password	1	0 (displays encrypted code)	1	5.6.12 and Append. 3
F071		System Clear / Reset	0 = Disabled 1 = Clear THR and Lockout Timers 2 = Reset to Factory Default Settings	1	0	Any	5.6.12
F072		Reserved for Factory Use				2	
F073		Frame Rating	10 - 2000 Factory set	1	By Model (defaults to 48)	2	5.6.12
F074		CT Value	10 – 2000 Factory set	5	By Model (defaults to 40)		
F075		Year	2000 - 2047	1 year	2000	1	5.6.12.a
F076		Month	1 - 12	1 Month	1		
F077		Day	1 - 31	1 Day	1		
F078		Hour	0 - 23	1 Hour	0		
F079		Minute	0 - 59	1 Minute	0		
F080		Second	0 - 59	1 Second	0		
F081		Revision #	-	-	Factory Setting	Read Only	
F082 - F084		Reserved for factory use				2	

Table 5.5.12: System Settings Function Group

5.5.13 Fault History and Run Time

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F085	Fault History and Run Data	Fault History #1, Latest Fault	0 = No fault history, or Fault # 1 - 57: see Fault code list	N/A	Read Only	Read Only	5.6.13.a
F086		Time Stamp, Fault #1 Based on F078-80	00.0 23.59 (hh.mm) [hh = 00 - 23; mm = 00 - 59]				
F087		Date Stamp, Fault #1 Based on F076-77	01.01 - 12.31 (MM.DD) [MM = 01 - 12; DD = 01 - 31]				
F088		Fault History #2, Previous Fault	0 = No fault history, or Fault # 1 - 57: see Fault code list				
F089		Time Stamp, Fault #2	00.00 - 23.59 (hh.mm) [hh = 00 - 23; mm = 00 - 59]				
F090		Date Stamp, Fault #2	01.01 - 12.31 (MM.DD) [MM = 01 - 12; DD = 01 - 31]				
F091		Fault History #3, Oldest Fault	0 = No fault history, or Fault # 1 - 57: see Fault code list				
F092		Time Stamp, Fault #3	00.00 - 23.59 (hh.mm) [hh = 00 - 23; mm = 00 - 59]				
F093		Date Stamp, Fault #3	01.01 - 12.31 (MM.DD) [MM = 01 - 12; DD = 01 - 31]				
F094		Run Time, Hours	000.0 - 999.9 hours				5.6.13.b
F095		Run Time, 1000 Hour Overflow	0000 - 9999 thousand hours				
F096		Run Cycle Counter	0000 - 9999 times				
F097		Run Cycle Counter 10K overflow	0000 - 9999 10 thousand times				

Table 5.5.13: Fault History and Run Data Group

5.5.14 Phase Protection Settings

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F098	Phase and Frequency Protection	Phase Rotation Trip	0, 1 or 2 0=Disabled, 1=ABC, 2=ACB]	1	0	1	5.6.14
F099		Phase Rotation Trip Delay	1 - 3 seconds	1	1		
F100		Phase Loss Trip Delay during Stop	0 - 20 seconds [0 = Disabled]	1	1		
F101		Phase Loss Trip Delay during Running	0 - 20 seconds [0 = Disabled]	1	3		

Table 5.5.14: Phase Protection Function Group

5.5.15 Motor Power Protection Settings

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F102	Power Protection	Motor kW Trip	0 - 2 0 = Disabled 1 = Over kW Trip 2 = Under kW Trip	1	0	1	5.6.15
F103		Motor kW Trip Point	20 - 100% of full load KW	1%	50(%)		
F104		Motor kW Trip Delay Time	1 - 999 seconds	1	1		
F105		Power Factor Trip Range	0, 1 - 3 [0=Disabled, 1=lag, 2=lead, 3= lead/lag]	1	0		
F106		Power Factor Trip Point	.01 - 1	.01	.50		
F107		Power Factor Trip Delay Time	1 - 20 seconds	1	2		

Table 5.5.15: Motor Power Protection Function Group

5.5.16 Analog Output

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F108	Power Protection	Analog Output	0 - 12 [0: OFF; 1 - 12] (See Table of Default Display)	1	OFF	1	5.6.16
F109		Analog Output 4mA	0 - 9999	1	0		
F110		Analog Output 20mA	0 - 9999	1	9999		

Table 5.5.16: Analog Output

5.5.17 Display and System Settings

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Password Level	Section
F111	System Settings	Default Display	1-12 (See Table of Default Display)	1	10	1	5.6.17
F112		System Settings	Reserved for factory use	-	-	2	
F113		Alternate functions for Ramp2/Jog inputs	See Table page 64	1	7	1	

Table 5.5.17: System Settings

5.6 Function Descriptions

Your *VMX2 Series* starter is set at the factory with typical default settings that perform well in most applications. Following are detailed descriptions of each Function and the factory default settings.

5.6.1 Motor and Overload Function Descriptions

MOTOR FLA (F001) must be programmed for unit to operate!
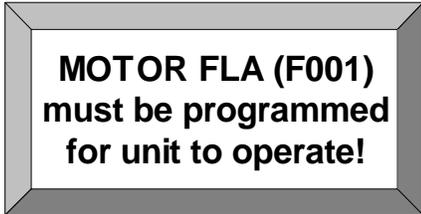
F001= Motor FLA
Factory Setting = 0
Range = 50 - 100% of Unit Max. Current
Set the value of this function to the motor nameplate Full Load Amps (FLA). Adjustments for service factor are not necessary when programming this function (See note below). If the motor nameplate FLA is not available, use typical values as shown in NEC, NEMA standard MG-1, or other reputable third party source (motor manufacturer, etc.).

▪ **Note:**
To prevent adjusting the settings beyond the starter Max Amp rating, the range of adjustment for the Motor Nameplate FLA will vary in accordance with the Service Factor as programmed into **F002**. At the default setting of 1.0SF, the full range of adjustment from 50 - 100% of the Max Amp rating is available. As the Service Factor is increased, the FLA range will drop by an equal ratio. For example if **F002 = 1.15** (a 1.15 Service Factor), the maximum FLA programmable into **F001** will be limited to 85% of the starter Max. Amp rating (100% - 15%).

F002 = Service Factor
Factory Setting = 1.0 S.F.
Range = 1.00 - 1.30
Set value according to the Service Factor (SF) data provided on the motors' nameplate. This value affects several protection features so it must be accurate. Setting the SF too high may result in motor damage in an overload condition. Setting SF too low may cause nuisance trips; however, a 1.0 SF setting is safest if SF is unknown.

▪ **Note**:
The combination of **F002** and **F001** (FLA x SF) cannot exceed the Unit Max Amp rating. If when programming **F002** you are not allowed to raise the setting, the combined total has been exceeded.

F003 = Overload Class During Start
Factory Setting = 10 (Class 10)
Range = NEMA / UL Class 5 - 30
Set value to the motor protection overload class required for the application. It is recommended that you try the factory setting first. (If possible, keep values for **F003** and **F004** the same.) Increase **F003** above **F004** only if nuisance tripping occurs during start. See Section 3.2 for details on trip curves.

F004 = Overload Class During Run
Factory Setting = 10 (Class 10)
Range = 5 - 30 NEMA / UL Class
Set value according to the instructions provided by your motor / equipment manufacturer. This trip curve will not be enabled until the motor has reached full speed.

F005 = Overload Reset
Factory Setting = 0 (Manual)
Range = 0 - 2
Set value to determine starter behavior after an overload condition has cleared.

When set to 0 = Manual, the operator must press the **[RESET]** key before restarting the motor. Once the motor windings have cooled sufficiently *AND* the **[RESET]** key is pressed, the unit will accept a restart command.

When set to 1 = Automatic mode, and once sufficient time has elapsed allowing motor windings to cool, the motor will be restarted upon a start command. If 2-wire control is used, the unit will restart immediately.

When set to 2 = Disabled Overload, the *VMX2 Series* will *NOT* trip on Motor Thermal Overload. This is provided for applications where either an external Overload Relay or Motor Protection Relay is used, or where multiple motors are connected and each one requires having an individual Overload Relay. See Appendix 4 for more details.

WARNING:

Setting F005 = 1 (Automatic) may present significant operational risk.

When F005 = 2 (Disabled Overload), a separate external thermal overload protection device must be in the circuit.

▪ **Note:**
Because of the risk of fire or equipment damage, cycling control power will NOT reset an Overload Trip. If **F005 = 2** (Automatic Reset), cycling control power will allow reset *ONLY* if the Thermal Register has determined that the motor has regained sufficient thermal capacity to allow it to restart successfully.

F006 - F009 = Reserved

5.6.2   Starting Modes

The *VMX2 Series* is capable of several different starting modes, but is set from the factory for the most common applications. A second ramp profile is available for use should it be required. Unless wired to do so, the *VMX2 Series* defaults to Ramp 1. This section describes functions for Ramp 1, with references to function numbers that do the same thing for Ramp 2 (if required). **Refer to Appendix 2 for a detailed description** of the differences in Ramp Profiles and their uses. All current percentages are based on the Motor FLA as programmed in **F001**.

F010 = Ramp Profile Selection
      Factory Setting = 1
      Range = 1 - 4
      This Function selects the type of Ramp Profile desired. Ramp profiles can be either Voltage Ramp or Current Ramp. See Appendix 2 for details. Each Ramp Profile consists of 3 settings: Initial Torque, Ramp Time, and Maximum Current Limit. Because there are two ramps available, there are 4 settings to cover the combinations of profiles possible. If you are not using the 2nd ramp, the *VMX2 Series* will ignore all settings in reference to Ramp 2.

F010 Setting	Ramp 1 (Dual Ramp Input Open) Ramp Profile	Ramp 2 (Dual Ramp Input Closed) Ramp Profile
1	Voltage	Voltage
2	Current	Current
3	Voltage	Current
4	Current	Voltage

Table 5.6.2: Ramp Type selection Settings

Select Voltage Ramp by setting **F010 = 1** (factory default)
When Voltage Ramp is selected,
Set Initial Torque (Voltage) with **F011** (see below)
Set Ramp Time with **F013** (see below)
Set Maximum Current Limit with **F014** (see below)

Or;

Select Current Ramp by setting **F010 = 2**
When Current Ramp is selected,
Set Initial Torque (Current) with **F012** (see below)
Set Ramp Time with **F013** (see below)
Set Maximum Current Limit with **F014** (see below)

▪ **Note:**
When either Ramp is set to "Voltage Ramp", the corresponding "Initial Torque (Current)" setting is ignored. Conversely, when set to "Current Ramp", the "Initial Torque (Voltage)" is ignored.

F011 = Initial Voltage of Ramp 1
Factory Setting = 60%
Range = 0 - 100%
Sets the initial voltage of Ramp 1 when **F010 = 1 or 3**. The initial voltage level should be set to provide just enough torque to make the motor shaft begin to rotate while preventing torque shock damage to mechanical components.

F012 = Initial Current of Ramp 1
Factory Setting = 200%
Range = 0 - 600%
Sets the initial current of Ramp 1 when **F010 = 2 or 4.** The initial current level should be set to provide just enough torque to make the motor shaft begin to rotate while preventing torque shock damage to mechanical components.

F013 = Accel Ramp Time of Ramp 1
Factory Setting = 10 seconds
Range = 1 - 120 seconds
Sets the time between the initial value set with **F011 or F012** and either the Max Current Limit set with **F014** or full output voltage. Set the time to enable soft starts without stalls. Also, consider the motor's application. For example, centrifugal pumps may require a shorter ramp time.

▪ **Note:**
Acceleration time is affected by the following conditions:

1. Reducing the Current Limit setting will extend the acceleration time if the motor reaches full speed prematurely.
2. The anti-oscillation circuit may shorten the ramp time if the motor reaches full speed before the programmed ramp time has expired.

F014 = Max Current Limit of Ramp 1
Factory Setting = 350%
Range = 200 - 600%
Sets the maximum motor current that the **VMX2 Series** starter will allow during Ramp 1. This limit applies to both voltage and current ramping. Current will be limited to this setting until either the motor reaches full speed or the overload protection feature trips (**F003**).

- **5.6.2.a   Ramp 2 (user-optional ramp)**

This ramp is selected by closing the input for Ramp 2, TB1 - terminals 5 & 6 (see section 4.2.5). If this input is left open, the **VMX2 Series** will respond only to Ramp 1 settings as listed above. Since ramp 2 is always used as an alternate to the default Ramp 1, different combinations of ramp profiles can be selected in **F010**. Refer to Appendix 1 for additional information on ramp profiles.

F015 = Initial Voltage of Ramp 2
Factory Setting = 60%
Range = 0 - 100%
Sets the initial voltage of Ramp 2 when **F010 = 1 or 4**. The initial voltage level should be set to provide just enough torque to make the motor shaft begin to rotate while preventing torque shock damage to mechanical components.

F016 = Initial Current of Ramp 2
Factory Setting = 200%
Range = 0 - 600%
Sets the initial current of Ramp 2 when **F010 = 2 or 3**. The initial current level should be set to provide just enough torque to make the motor shaft begin to rotate while preventing torque shock damage to mechanical components.

F017 = Accel Ramp Time of Ramp 2
Factory Setting = 10 seconds
Range = 1 - 120 seconds
Sets the time between the initial value set with **F015 or F016** and either the Max Current Limit set with **F018** or full output voltage. Also consider the motor's application. For example, centrifugal pumps may require a shorter time. See notes for **F013** for more details.

F018 = Max Current Limit of Ramp 2
Factory Setting = 350%
Range = 200 - 600%
Sets the maximum motor current that the **VMX2 Series** starter will allow during Ramp 2. (This limit applies to both voltage and current-type ramping.) The current will be limited to this setting until either the motor reaches full speed or the overload protection feature trips (**F003**).

- **Note**:
Ramp 2 is often useful as a "bump start" or as a temporary Across-the-Line start mode. Consult Appendix 1 for details.

Note: Jog terminals are defaulted as "External Lockout, Normally Closed", see parameter F113 for other options.

5.6.3 Jog Mode

The Jog Function is another user optional feature and is controlled by closing the input on TB1 Terminals 6 and 7. If this input is left open, the *VMX2 Series* will ignore all Jog settings. Engaging the Jog feature along with the Start / Run Command provides an output from the SCRs, but will not continue ramping to full acceleration. This feature can Jog the motor at either a preset Voltage (**F019 & F020**) or a preset Current (**F021**), depending upon the settings of the Ramp Type from **F010**, and can be initiated along with Ramp 1 or Ramp 2 (see Dual Ramp Select, Section 4.2.5 and 5.6.2.a). It is also sometimes useful to use Jog in combination with Ramp 2, see section 4.2.5.c.

Note: Jog functions may become disabled by COM port function F068 setting 3. See section 5.6.10 for details.

Setting from F010	Ramp 1 (Dual Ramp Input Open)			Ramp 2 (Dual Ramp Input Closed)		
	Ramp & Jog Type	Initial Torque from…	Jog Torque from…	Ramp & Jog Type	Initial Torque from…	Jog Torque from…
1	Voltage	F011	F019	Voltage	F015	F019
2	Current	F012	F021	Current	F016	F021
3	Voltage	F011	F019	Current	F016	F021
4	Current	F012	F021	Voltage	F015	F019

Table 5.6.3: Jog Settings

Caution:
Although the Thermal Register tracks all motor current use, continuous usage of the Jog feature risks thermal motor damage or nuisance tripping.
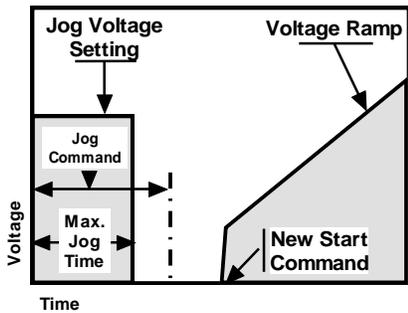
Figure 5.6.3.1: Voltage Jog and Jog Time

F019 = Voltage Jog
Factory Setting = 50%
Range = 5 - 100%
Sets the voltage level of the Jog feature and is typically used to check rotation, alignment, or to slowly move a load into position. Jogging at a set voltage has no current control so the duration of the applied voltage must be limited to prevent excessive motor heating.

F020 = Time of Voltage Jog
Factory Setting = 10 seconds
Range = 1 - 20 seconds
Set to minimize motor heating during a voltage jog. This setting is the **maximum** allowable time for jogging the motor using voltage only.
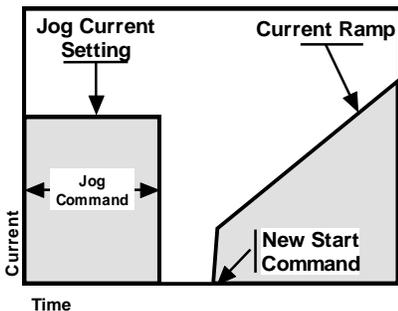
Figure 5.6.3.2: Current Jog

F021 = Current Jog
Factory Setting = 150%
Range = 100 - 500%
Sets output of a current Jog. The current jog feature is typically used to check rotation, alignment, or slowly move a load into position. This is not time-limited but should be used cautiously.

5.6.4 Kick Start Mode

Kick Start applies a pulse of voltage to the motor producing a momentary "kick" of high torque to break the motor load free from high friction or frozen components. This pulse is limited to 2 seconds.
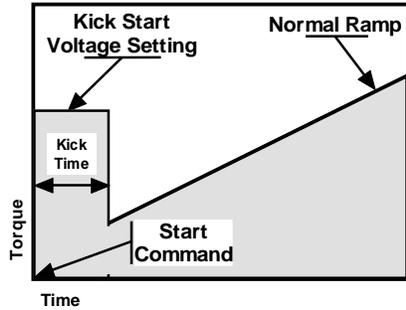
F022 = Kick Start Voltage
   Factory Setting = 0 (Disabled)
   Range = 10 - 100%
   When **F022 ≠ 0,** a voltage "pulse" is applied before the initial torque setting of **F011** (or **F012** if Current Ramp). This sets the voltage level and the duration of the pulse is set by **F023**. This setting should be higher than **F011** (except for Dwell Starting, see below) and high enough to provide a benefit in the worst starting condition.

F023 = Kick Time
   Factory Setting = 0.8 seconds
   Range = 0.1 - 2 seconds
   Sets the duration of time the Kick Start voltage is applied.

Figure 5.6.4:
Kick Start

- **5.6.4.a "Dwell" operation using Kick Start**
  In some applications such as chain drive machinery, the Kick Start feature can be used to slowly take up slack in the drive chain before applying full torque. This is referred to as "Dwell Starting" because the torque output stays low for a short time. To take advantage of this feature, simply set the Kick Start to the same level as the Initial Voltage setting. This will only work in Voltage Ramp mode.

Figure 5.6.4.a:
Dwell Start Using Kick Start

- **Note:**
  Do not use the Kick Start feature unless you determine that you need it. Using this feature may eliminate many of the mechanical and electrical benefits of using a Soft Starter.

5.6.5 Pump-Flex® Decel Mode (F025 through F028)

Pump-Flex® deceleration is a feature of the **VMX2 Series** Soft Starter that slowly decreases the applied voltage to the motor when a stop command is given, resulting in a gentle decrease in motor torque. Deceleration provides a way to extend the stopping time so that abrupt stopping does not occur. Deceleration is useful with centrifugal pumps, material handlers, and conveyors where abrupt stopping could be damaging to the equipment and/or load.

SEE APPENDIX 2 AT THE END OF THIS MANUAL for typical Pump-Flex® Decel feature applications and more detailed descriptions of the following functions.

F024 = Deceleration Ramp
Factory Setting = 0 (Disabled)
Range = 0 - 2

When F024 = 0, the deceleration feature is **disabled**.

When F024 = 1, the deceleration feature is **enabled** *AND* the overload protection feature (**F003 - F005**) remains active (power off on OL trip).

When F024 = 2, the deceleration feature is **enabled** and deceleration will **continue even when an overload condition trips**.

WARNING!
Setting F024 = 2, presents significant risk of over-heating the motor beyond its design limits which could result in motor damage and fire hazard. Do this only in circumstances where the potential for mechanical damage outweighs the risk of motor damage.

F025 = Begin Decel Level (BDL)
Factory Setting = 60%
Range = 0 - 100% of line voltage
Used to drop voltage to a level where there is a noticeable effect on motor torque during initial Decel mode.

F026 = Decel Shut Off Voltage
Factory Setting = 30%
Range = 0 to (BDL -1)%
Sets the level where the starter is turned off, corresponding to where motor torque during Decel is no longer effective.

F027 = Decel Ramp Time
Factory Setting = 10 seconds
Range = 1 - 60 seconds
Sets the maximum time for the deceleration ramp to go from the Begin Decel Level setting (**F025**) to the Decel Shut Off Voltage (**F026**).
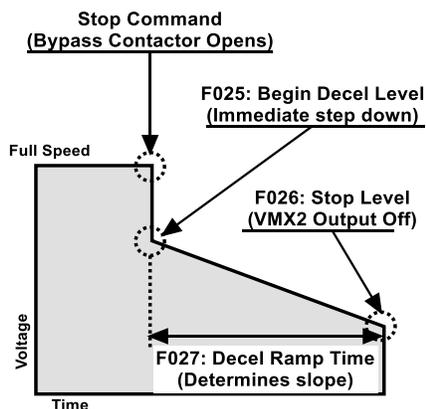
Figure 5.6.5:
Pump-Flex Decel Ramp Settings

Note:
When using the Decel function, count these cycles as additional "starts" when determining maximum starts-per-hour of the motor.

Caution!
Deceleration is THE OPPOSITE of braking. Enabling the Deceleration feature will make the motor take LONGER to stop than if it were simply turned off.

5.6.6   Restart Delay

The *VMX2 Series* can be programmed to delay restarting upon restoration of line power after an outage. This allows multiple units to be programmed to restart at staggered times in an effort to avoid causing additional problems with the power supply system. Another term for this is "**Sequential Start Delay**".

F028 = Restart Delay Time
> **Factory Setting = 0 (Disabled)**
> **Range = 0 = Disabled (no delay), or 1 - 999 seconds**
> Sets a delay time before the starter can be restarted after a complete loss of power. Use this if multiple motors are connected to a supply system that may have trouble providing adequate power to restart them all at the same time. By using different Restart Delay Times on each unit, a sequential restart can be achieved.

▪ **Note:**
This is similar to the Coast Down Lockout Timer in **F048**, however it only activates on Power Loss.

5.6.7   Voltage Protection Features

F029 - F037 set extended protection features that may be used in the *VMX2 Series* starter.

▪ **Note:**
All of these features are disabled upon shipping from the factory and must be enabled via user programming as follows:

F029 = Voltage Input (nominal line voltage)
> **Factory Setting = 480 (V)**
> **Range = 200 - 600 (V)**
> Set to the nominal line voltage supplied to the VMX2 unit. This value is used for both display and calculations of kW, PF etc.

F030 = Voltage Imbalance Trip
> **Factory Setting = 0 (Disabled)**
> **Range = 1 - 30% or 0 (Disabled)**
> Sets the trip level for percent voltage imbalance between any two phases, and the average of the phase to phase voltages.

F031 = Voltage Imbalance Trip Delay
Factory Setting = 10 seconds
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. With F030 set to 10%, and the difference in voltage between two phases being 10% or higher for more than 10 seconds, the unit will trip.
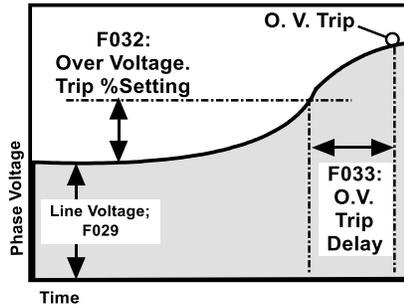
F032 = Over Voltage Trip
Factory Setting = 0 (Disabled)
Range = 1 - 10% over nominal, 0 (Disabled)
When a value other than 0 is entered in F032, the starter will trip when the voltage between any two input phases exceeds the nominal voltage set in F029 by this percentage and for the time specified in F033.

F033 = Over Voltage Trip Delay
Factory Setting = 10 seconds
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. For example, if the voltage between any two input phases exceeds the percentage set in F031 for more than 10 seconds, the starter will trip.
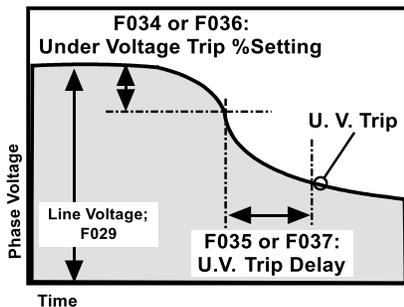
F034 = Under Voltage Trip on Start
Factory Setting = 0 (Disabled)
Range = 1 - 30% under nominal, or 0 (Disabled)
When a value other than 0 is entered in F034 and the starter is in the process of starting the motor, the starter will trip if the voltage between any two input phases drops below the nominal value of F029 by this percentage and for the time in F035. This fault detection is only active during motor starting. Once the starter reaches the "At Speed" state this function is replaced by F036.

F035 = Under Voltage on Start Trip Delay
Factory Setting = 10 seconds
Range = 1 - 180 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default setting, if the voltage between any two input phases drops by the percentage set in F034 for more than 10 seconds, the starter will trip.

F036 = Under Voltage Trip on Run
Factory Setting = 0 (Disabled)
Range = 1 - 30% under nominal, or 0 (Disabled)
When a value other than 0 is entered in F036 and the starter is in the run mode (At Speed), the starter will trip if the voltage between any two input phases drops below the nominal value of F029 by this percentage and for the time in F037. This fault detection is only active after the starter reaches the "At Speed" state during the Run mode. While in the Start mode, this function is ignored in favor of F034.

Figure 5.6.6.a:
Over Voltage Trip

Figure 5.6.6.b:
Under Voltage Trip

F037 = **Under Voltage on Run Trip Delay**
Factory Setting = 2 seconds
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default setting, if the percent difference in voltage between any two input phases equals or is greater than the value set in F036 for more than 2 seconds the starter will trip.

▪ **Note:**
Under Voltage and Over Voltage Trip settings may conflict with Voltage Imbalance Trip settings set in F030 and F031. If a voltage anomaly occurs that is out of range of any feature, the one with the lowest settings and fastest trip time will take precedence.

5.6.8 Current and Ground Fault Protection Features

F038 - F050 set extended protection features that may be used in the *VMX2 Series* starter. Percentages shown are all based automatically upon the Motor FLA setting from **F001** except Ground Fault, **F046**. No additional calculations are necessary.

▪ **Note:**
All of these features are disabled at the factory and must be enabled via user programming as follows:

F038 = **Shorted SCR Trip Delay**
Factory Setting = 1 seconds
Range = 1 - 10 seconds, 0 (Disabled)
Sets the delay time before the starter will trip after a shorted SCR is detected.

F039 = **Shunt Trip Delay**
Factory Setting = 1 seconds
Range = 1 - 10 seconds, 0 (Disabled)
Sets the delay time before starter will trip after detection of current flow through any of the phases while the starter is in Off state.

F040 = **Current Imbalance Trip**
Factory Setting = 0 (Disabled)
Range = 5 - 30% or 0 (Disabled)
Sets the percentage of current imbalance between any two phases that will cause a trip. The trip delay time is set in **F041**.

F041 = **Current Imbalance Trip Delay**
Factory Setting = 2 seconds
Range = 1 - 20 seconds
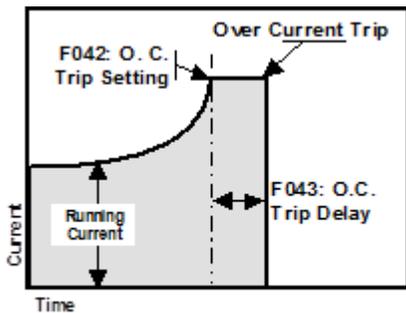Provides a time delay to prevent nuisance trips from short-duration transients.

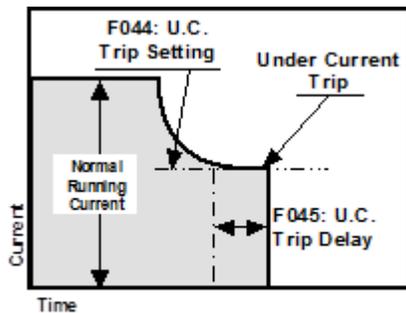Figure 5.7.8.a:
Over Current Trip

F042 = Over Current Trip / Shear Pin Trip
Factory Setting = 0 (Disabled)
Range = 100 - 300%, 0 (Disabled)
When a value other than 0 is entered in **F042**, the starter will trip when the output current of any phase exceeds the amount set and the time specified in **F043**. This is also referred to as a "Shear Pin Trip" and can be used to protect mechanical components from damage due to jammed loads.

Note: Overcurrent trip is only enabled after motor reaches "At Speed", it will not trip during acceleration".

F043 = Over Current Trip Delay
Factory Setting = 1 second
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. For example using default settings, if the output current of any phase exceeds **F042** for more than 1 second, the starter will trip.

Figure 5.7.8.b:
Under Current Trip

F044 = Under Current Trip
Factory Setting = 0 (Disabled)
Range = 10 - 90%, or 0 (Disabled)
When a value other than 0 is entered in **F044**, the starter will trip when the output current of any phase drops below the amount set, and the time specified by **F045**. This fault condition is often referred to as a "Load Loss Trip" and can be used to detect a broken shaft, V belt or other mechanical drive system component failure. In pumping applications, this can be used as a "Loss of Prime" trip.

F045 = Under Current Trip Delay
Factory Setting = 2 seconds
Range = 1 - 60 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using the default setting, if the output current of any phase drops below **F044** for more than 2 seconds, the starter will trip.

5.6.8.a Ground Fault

F046 - F047 provides Ground Fault protection for equipment only using the Residual Current method. Trip settings are based on the CT ratio as shown in **F074**. A delay time can be set by **F047** to help prevent nuisance trips. Ground current can always be viewed in the Status Display, shown with a "G" prefix (see section 5.3.1).

WARNING!

THIS IS NOT INTENDED TO BE USED AS "PERSONNEL PROTECTION" GROUND FAULT! This feature is only intended to provide a level of equipment protection against damaging ground currents. Ground faults are potentially dangerous conditions and must be corrected immediately for safety of operating personnel.

F046 = Ground Fault Trip
Factory Setting = 0 (Disabled)
Range = 5 - 90% of CT value, or 0 (Disabled)
When a value other than 0 is entered in **F046**, the starter will trip if current to ground exceeds this percentage of the unit CT value. The CT value is shown in **F074**, (see section 5.6.12). This value is different from the Unit Rating or FLA setting. Following are two examples of Ground Fault current settings.

Example:
To calculate the ground current trip value in amps, divide the setting of **F046** by the CT Value in **F074** then multiply by 100. Example using VMX2-210-BP: The value in F046 = 20, the CT value in **F074** = 250. So, 20/250 = 0.08 x 100 = 8A.

If you have a desired trip value in amps and need to determine the percentage value for **F046**, simply divide the desired trip ampere value by 100, then multiply that times the value in **F074**.

Example: 210A starter desired Ground Fault Trip Level is 8A, The CT value is **F074** is 250. Then, 8 ÷ 100 = 0.08 then x 250 = 20% in F046.

F047 = Ground Fault Trip Delay
Factory Setting = 2 seconds
Range = 1 - 60 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default setting, if the Ground Fault current exceeds the level set in **F046** for more than 2 seconds, the starter will trip.

CAUTION:
This method of Ground Fault sensing may not provide adequate equipment protection in resistance-grounded systems. We recommend providing external GF protection using a core balanced Zero Sequence CT for those types of applications. Consult factory for additional assistance.

5.6.9 Lockouts, Reset and Internal Protection Features

F048 - F050 provide lockout protection for motors and equipment that may have potentially damaging consequences from premature restart or with limited duty cycles. Time and count values for these lockouts can be viewed in **F055 - F058**. Time values are based on the Real Time Clock, and *DO NOT* reset when power is lost or disconnected. Emergency clearing of lockouts can be accomplished in **F071**.

▪ **Note:**
When **F048** through **F050** are used with 3-wire control systems, a Start command will not seal in during lockout time. When time has expired, a new Start command will be necessary.

WARNING!

When F048 through F050 are used with <u>2-wire</u> control, the starter may re-start automatically when time has expired. Adequate warnings similar to those in Section 3.1.3.b should be observed.
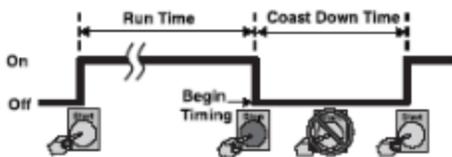

Figure 5.7.8:
Coast Down Lockout Timer

F048 = Coast Down Lockout Timer

Back Spin Timer
Factory Setting = 0 (Disabled)
Range = 1 - 60 minutes, or 0 (Disabled)
F048 = 1 - 60, sets the number of minutes that the starter must be off before a restart can be attempted. This function is useful in applications such as pump motor backspin protection (where you need to prevent the pump motor from restarting if it is spinning backwards), 2-speed operations where speed changes require a minimum disconnect (spin-down timer), or reversing applications to prevent plugging (anti-plugging timer).

F049 = Maximum Starts per Hour Lockout
Factory Setting = 0 (Disabled)
Range = 1 - 10 or 0 (Disabled)
F049 = 1 - 10, counts the number of start commands within a 1 hour period. If the setting (maximum starts per hour) is exceeded, starting is prohibited until sufficient time has expired. This timer initiates upon the first start in an hour. It resets after 1 hour from that start and waits until another subsequent start to initiate again. (Often used in conjunction with **F050**).

Notes:

▪ Consult the motor manufacturer for a "Starts-per-Hour" or "Starting Duty Cycle" rating. Larger motors tend to have lower starts-per-hour ratings.

▪ When using the Decel function (**F025**), or an external electronic braking option, count these cycles as additional "starts" when determining maximum starts-per-hour.

F050 = Minimum Time Between Starts Lockout
Factory Setting = 0 (Disabled)
Range = 1 - 60 minutes, or 0 (Disabled)
When F050 is set to 1 through 60, the motor cannot be restarted within the time specified after the first start. Time between starts is calculated from the time of the first start command to the next regardless of run time or off time.

Example:
If F050 = 15, motor will not be allowed to re-start within 15 minutes of the first start.

This function is useful as a "Short-Cycle Timer" to prevent excessive motor wear when automatic demand control may occasionally cycle on and off too quickly. e.g. compressors or sump pumps.

5.6.9.a Control Power Trip (F051)

F051 = nCP Trip
Factory Setting = 0 (Disabled)
Range = 0 (Disabled), 1 (Enabled)
When F051 is set to 1, VMX2 trips when control power is lost.

5.6.9.b Auto-Reset Programming (F052 - F054)

The *VMX2 Series* can be programmed to automatically attempt a reset based on the selected "Auto-Reset" faults (F52), provided a Start Command is present (see Section 4.2), and no fault condition is active. Function F52 selects the "Auto-Reset" faults and function F53 sets the number of reset attempts. If F053 is set to 0 (default setting), the *VMX2 Series* auto-reset function is disabled.

▪ **Note:**
When using 3-wire control:
For safety reasons, the *VMX2 Series* will not attempt restarting unless the Start Command is reinitiated and maintained during a restart attempt.

F052 = Auto-Reset Selected Faults
Factory Setting = 4 (Phase Loss)
Range = 1 - 17, or 0 (Disabled)
If F052 = 1 through 17, the **VMX2 Series** will attempt to restart after the fault(s) coded in the following table. Only one selection can be entered.

F052 Setting	Fault Condition Description	Display Readout Reference	F052 Setting	Fault Condition Description	Display Readout Reference
0	Auto Reset Disabled	---	10	Under Voltage	UE
1	Over Temperature Trip	**OT**	11	Power Factor	PF
2	Over Current (Shear Pin) Trip	**OC**	12	PoweR (KW)	PR
3	Under Current Trip	**UC**	13	Any fault #1-3 above	
4	Phase Loss Trip	**PL**	14	Any fault #4-6 above	
5	Current Unbalance Trip	**IB**	15	Any fault except #7	
6	Ground Fault Trip	**GF**	16	Any fault except #6 & #7	
7	Short Circuit Trip	**SC**	17	Any fault	
8	Voltage Imbalance	EI			

Note 1: UC, OC or UB require operation to resume before the fault can be detected.
Note 2: Cycling and / or restoration of control power will reset all of the above faults.
Note 3: Overload Trip reset function is programmed only in F005. See Section 3 for details
Note 4: Reset attempts with a fault condition present will cause a new fault. This will be logged into the fault history (F085 - F093) and may overwrite previous fault records.

Table 5.6.8.b: Faults Selected for Auto-Restart

F053 = Auto-Restart Attempts
Factory Setting = 0 (Disabled)
Range = 1 - 10 Attempts, or 0 (Disabled)
If F053 = 1 through 10, the **VMX2 Series** will attempt to restart if the Start Command is present for this number of times. If set to Zero, the starter will **NOT** attempt to reset automatically.

5.6.9.c Timer Value Readouts for Protection Features

F054 - F059 provide display of timer or register values for information only. The user cannot alter them. Upon power loss and restoration, these values are updated for time elapsed.

F054 = Restart Delay Time Readout
Factory Setting = Not Applicable
Range = 1 - 999 Seconds
Remaining time value readout of F028, the Auto-Restart Delay Timer.

F055 = Coast Down (Backspin) Timer Value
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Remaining time value readout of F048, the Coast Down Lockout Timer.

F056 = Starts per Hour Timer Value
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Remaining time value readout of F049, the Starts-per-Hour Lockout Timer.

F057 = Starts per Hour Counter Readout
Factory Setting = Not Applicable
Range = 1 - 10 Starts
Incremental counter value readout of F050, the Starts-per-Hour Lockout.

F058 = Time Value Between Starts Readout
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Remaining time value readout of F050, the Minimum Time Between Starts Timer.

F059 = Thermal Capacity to Start Readout
Factory Setting = Not Applicable
Range = 0 - 100 % Thermal Capacity
Readout only for the user's viewing of the motor Thermal Capacity percentage required to allow a Reset after an Overload Trip. Use this function in conjunction with the Remaining Thermal Capacity (in the Status Screen group) to be able to determine when a restart will be allowed. This value is automatically updated by the *VMX2 Series* CPU whenever a successful start sequence has been accomplished. The *VMX2 Series* essentially "learns" how much Thermal Capacity is needed in the motor in order to successfully restart, and stores the information in this Function. Upon power loss and restoration, this value is updated for elapsed time.

5.6.10 Output Relays

There are three programmable relays (rated 240VAC, 5A, 1200 VA) in the *VMX2 Series*. They can be programmed for change of state indication for any one of the 32 conditions identified in the following chart.

F060 = **Aux Relay 1: Form C (SPDT)**
Factory Setting = 1 (Run / Stop)
Range = 1 - 32 (See list)
Use to program the desired operation for Relay # 1.

F061 = **Aux Relay 2: Form C (SPDT)**
Factory Setting = 2 (At Speed / Stop)
Range = 1 - 32 (See list)
Use to program the desired operation for Relay # 2.

F062 = **Aux Relay 3: Form A (SPST, N.O.)**
Factory Setting = 22 (Any Trip, 5 - 15)
Range = 1 - 32 (See list)
Use to program the desired operation for Relay # 3.

F063 = **Aux Relay Delay Timer for Settings 28 - 31**
Factory Setting = 0 (Disabled)
Range = 1 - 999 seconds, or 0 (Disabled)
Use to program the desired On Delay for any Aux. Relay that has been programmed for Settings 28 through 31 from the chart below.

Setting	Relay Operation Description	Setting	Relay Operation Description
1	Run / Stop	17	Over Voltage Trip
2	At Speed / Stop	18	Under Voltage Trip During Start
3	At Speed / End of Decel	19	Under Voltage Trip During Run
4	Start / End of Decel	20	Power Factor Trip
5	Short SCR Trip	21	Power Trip
6	Phase Loss Trip	22	Any Trip
7	Shunt Trip	23	Any Trip, flashing output
8	OL Trip	24	Coast Down Time Lockout
9	OT Trip	25	Starts Per Hour Lockout
10	Short Circuit Trip	26	Time Between Starts Lockout
11	Current Imbalance Trip	27	Any Lockout
12	Over Current Trip	28	Run / Stop with On-delay from F063
13	Under Current Trip	29	At Speed / Stop with On-delay from F063
14	Ground Fault Trip	30	At Speed / End of Decel with On-delay from F063
15	Phase Rotation Trip	31	Start / End of Decel with On-delay from F063
16	Voltage Imbalance Trip	32	Power Loss (nCP No Control Power) Trip
*Note: Flash rate for Setting #23 is ½ second On and Off			

Table 5.6.9: Output Relay Programming

F064 = Reserved

5.6.11 Serial Communications

The *VMX2 Series* starter is shipped from the factory ready to accept RS-485 Serial Communications using Modbus RTU protocol.
F065 - F067 are used to set the communications parameters in the starter for use by the adaptor module. F068 determines how the Start / Stop functions work through the COM port.

F065 = Communications
Factory Setting = 0 (Disabled)
Range = 0 - 2
This enables serial communications for remote monitoring and control systems. It also sets the format for Modbus RTU protocol. Once Enabled, the local start / stop inputs are altered to avoid inadvertent starting. See F068 for details.
F065 = 0, communications are disabled.
F065 = 1, uses the std 11-bit Modbus format w/ parity bit.
F065 = 2, a non-standard 10-bit format without a parity bit is used to accommodate some systems using this method.

F066 = Baud Rate
Factory Setting = 9.6 kB
Range = 4.8 to 19.2 kB
Set value to either 4.8 kB, 9.6 kB, or 19.2 kB to match the setting of the host device.

F067 = Modbus Address
Factory Setting = 1
Range = 1 - 247
Using Modbus communications protocol, up to 247 *VMX2 Series* starters can be networked using RS485 standard communication, each having a unique address. Two devices with the same address will result in a communications error.

F068 = Remote Starter Control
Factory Setting = 0 (disabled)
Range = 0 - 3
This determines how the *VMX2 Series* starter is to be controlled when using serial communications.

When F068 = 0, the starter can be monitored by the communications. No communications based start or stop capabilities are available.

When F068 = 1, 2, the starter will be controlled by the COM port. In addition, the Start / Stop inputs are altered as follows: The hard-wired Start command is put in "**AND"** logic with the COM port; Both Start commands must be on for the VMX2 to start. The Stop function is put in "**OR"** logic; either the COM port Stop command **OR** the hard-wired Stop will cause the VMX2 to stop.

Special Note when using Serial Comm:
When F068 = 3, the function of the Jog Input on TB-1 terminals 7 and 8 must be changed to "Remote/Local" in F113. Closing the Input will cause the Comm. port control to function as per setting F068=1. Leaving the input open will cause the Comm. port to function as per setting F068=0.
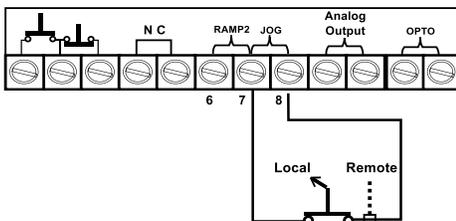

Figure 5.6.11:
Local - Remote Control Connections to TB-1
Only when F068 = 3

When F068 = 3, and the jog input is set to "Remote/Local" in F113 the VMX2 starter will change the function of the **Jog Input** to cause a switch between the functions of setting **0** and setting **1** as listed above. When the input is open, the starter will respond to the COM port as per setting F068=0. When the **Jog Input** is closed, the starter will respond as per setting F068=1. Use this function if it is necessary to have a return to local start/stop control should the communications system fail or become disconnected. **NOTE:** There is no jog function available, due to the reconfiguration of the jog input port. The jog input must be manually changed to "Remote/Local" in parameter F113.

F069= Reserved

5.6.12 System Settings

The following functions set operator interface controls and unit programming. Also contained here are the Clock settings used for history functions. Change the Clock settings to local time zone if accurate time values are needed.

F070 = Parameter Lock / User Password
Factory Setting = 0 (disabled)
Range = 0 - 999
Use only when necessary to prevent unauthorized access. Provides users with the ability to prevent unauthorized operators from making changes to the programmed functions. If you do NOT need to take advantage of this feature, do not enter anything into this function. The factory default is disabled, and no Password is necessary to make changes to the program.
See Appendix 3 at the end of this manual for detailed instructions on using and altering the Parameter Lock / User Password feature.

F071 = Emergency Clear / Reset
Factory Setting = 0 (disabled)
Range = 0 - 2
This Function serves two purposes. It can clear the memory values used for lockouts and overload protection, and it can reset all functions to the factory default settings. This is a "One-Shot" feature, so when another value is entered as shown below, this function automatically returns to the default state.

- **When F071 = 0**, the feature is disabled.
- **When F071 = 1**, the values stored in the Thermal Register and all of the Lockout Timers will be cleared. This will allow an E**mergency Restart** without having to wait for proper cool down time or lockout timers to expire.

WARNING!

Clearing the Thermal Register to allow restarting without proper cool-down time after an Overload Trip can result in motor damage and fire. Use only where emergency restart is necessary with knowledge of these potential hazards.

- **When F071 = 2,** the values of all functions will be reset to the factory default settings. Use this feature when setting conflicts have occurred or parameters have been tampered with. The Fault History is also cleared with this function.
- **Note**:
  This will not reset F070 = Parameter Lock / User Password. See Appendix 3 for resetting this feature.

F072 = Reserved

F073 = Unit Frame Rating:
Read Only. Reserved for Factory Use.

F074 = CT Ratio:
Read Only. Primary value of the *VMX2 Series* internal Current Transformers (CTs) for use in determining the GF trip settings (F046). CTs cannot be used for external metering. Alteration is reserved for factory use only.

5.6.12.a Real Time Clock Settings
Functions F075 through F080 set the system real time clock.
The time clock is used for date/time stamping of the Fault History.
The clock automatically adjusts for leap years and is backed up by a Lithium ion battery for long life.

- **Note:**
  The time clock does not automatically adjust for daylight savings time.

F075 = Year
Factory Setting = Year of manufacture
Range = 2000 to 2047

F076 = Month
Factory Setting = Month of manufacture
Range = 1 - 12

F077 = Day
Factory Setting = Day of manufacture
Range = 1 - 31

F078 = Hour
Factory Setting = Actual (EST)
Range = 0 - 23 (12:00 midnight is hour 0)

F079 = Minute
Factory Setting = Actual (EST)
Range = 0 - 59

F080 = Second
Factory Setting = Actual (EST)
Range = 0 - 59

F081 = Firmware revision number for Factory Use

F082 -F084 = Reserved

5.6.13 Fault History and Statistical Data

F085 - F097 contain the Fault History and Statistical data for the Run Mode.

5.6.13.a Fault History

Fault codes for each of the three latest events are stored with time and date stamps; see Chapter 7 for a complete list of fault codes and corresponding error displays.
Time stamps use the 24hr HH.MM format, so for example 3:19 PM would display as [15.19]
Date stamps use the MM.DD format, so for example September 3rd would display [09.03]

	Fault #1 (Latest Fault)	Fault #2 (Previous Fault)	Fault #3 (Oldest Fault)
Fault code: (See Chapter 7)	F085	F088	F091
Time Stamp (HH.mm)	F086	F089	F092
Date Stamp (MM.DD)	F087	F090	F093

Table 5.6.12.a: Fault History Configuration

F085 = **Latest Fault Code (Fault #1)**
Factory Setting = 0 (No Fault)
Range = 0 - 57
This Function displays the Fault Code of the latest fault event.

F086 = **Time Stamp of the Latest Fault**
Factory Setting = 00.00 (No Fault)
Range = 00.00 - 23.59 (24hr time format)
This Function displays the time of the latest fault event.

F087 = **Date Stamp of the Latest Fault**
Factory Setting = 00.00 (No Fault)
Range = 01.01 - 12.31
This Function displays the date of the latest fault event.

F088 = **Same as F085 except for the Previous Fault (Fault #2).**

F089 = **Same as F086 except for the Previous Fault**.

F090 = **Same as F087 except for the Previous Fault**.

F091 = **Same as F085 except for the Oldest Fault (Fault #3).**

F092 = **Same as F086 except for the Oldest Fault.**

F093 = **Same as F087 except for the Oldest Fault.**

5.6.13.b Statistical Data

F094 - F097 display information from the Run Time / Elapsed Time meter and Run-Cycle counter.

Run Time includes Accel, Run, Decel, and Jog operations.

Run Cycles are counted only when the starter reaches At-Speed mode.

F094 = Run Time, Hours
Factory Setting = 0000
Range = 000.9 - 999.9 hours
Run times in excess of 999.9 are recorded in F095.

F095 = Run Time, K Hours
Factory Setting = 0000
Range = 0000 - 9999 K hours
0001 in readout means a run time of 1,000 hours.

F096 = Run Counts
Factory Setting = 0000
Range = 0000 - 9999
Run counts in excess of 9999 are recorded in F097.

F097 = Run Counts, 10K Times
Factory Setting = 0000
Range = 0000 - 9999, 10 thousand times
0001 in readout means a run count of 10,000 operations.

Examples:	Overflow Value	Basic Value
Run Time 23,047 Hours	**F095**	**F094**
	0002	**3047**
Run Counts 18,702 Starts	**F097**	**F096**
	0001	**8702**

Table 5.5.15: Statistical Data Examples

5.6.14 Phase Protection Settings

F098 = Phase Rotation Trip

Factory Setting = 0 (Disabled)
Range = 0 (Disabled), **1 (A-B-C), or 2 (B-A-C)**

The *VMX2 Series* is set up to monitor an expected Phase Rotation and trip if it changes. Control of this is divided into two categories: Enable or Disabled and Expected Sequence. The default setting is disabled.

Setting this function to disabled (setting 0) is useful in applications where the *VMX2 Series* is going to be used downstream from an existing reversing contactor or to avoid conflicts with other protection devices.

On large motors where large multiple conductors are used, it may be easier to change the Expected Sequence in the *VMX2 Series* starter rather than swap the conductors.

F099 = Phase Rotation Trip Delay
Factory Setting = 1 second
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default settings, if the phase rotation is detected to be different for more than 1 second the starter will trip.

F100 = Phase Loss Trip Delay during Stop
Factory Setting = 1 second
Range = 0 - 20 seconds (0 = Disabled)
Provides a time delay to prevent nuisance trips from short-duration transients while stopped.

Note: Based on loss of input voltage on one phase while decelerating or stopped.

F101 = Phase Loss Trip Delay during Running
Factory Setting = 3 seconds
Range = 0 - 20 seconds (0 = Disabled)
Provides a time delay to prevent nuisance trips from short-duration transients while running.

Note: Based on current in one phase dropping below 20% of FLA (F001), while starting or running.

5.6.15 Motor Power & Power Factor Protection Settings

F102 = **Motor kW Trip Setting**
Factory Setting = 0 (Disabled)
Range = 1 - 2, or 0 (Disabled)
When a value other than 0 is entered for F102, the starter will trip according to the following settings:

1 = Over kW Trip. If the calculated motor load exceeds the trip point setting in F103 for the time set in F104, the starter will trip.

2 = Under kW Trip. If the calculated motor load falls below the trip point setting in F103 for the time set in F104, the starter will trip.

F103 = **Motor kW Trip Point**
Factory Setting = 50 %
Range = 20 - 100 % of calculated motor full load kW rating
Motor rated power (kW) is calculated based upon Voltage times Current times power factor (all of which are measured) times 1.732 (for 3 phase). Efficiency is assumed to be 100% for these purposes.

F104 = **Motor kW Trip Delay**
**Factory Setting = 1 second**
Range = 1 - 999 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default setting, if F102 is set to 1 and the motor kW rises above the value in F103, the starter will trip after 1 minute. Similarly, if F102 is set to 2 and the motor kW falls below F103, the starter will trip in one minute.

F105 = **Power Factor Trip Range**
Factory Setting = 0 (Disabled)
Range = 1 - 3
When a value other than 0 is entered for F105, the starter will trip according to the following settings:
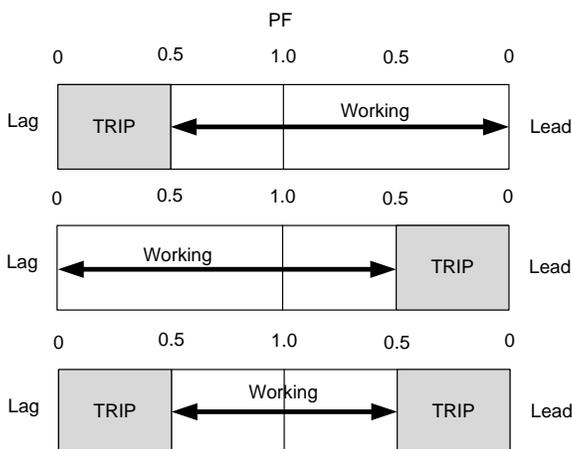
1 = Trip on Lagging power factor. If the measured motor power factor lags behind the trip point setting in F106 for the time set in F107, the starter will trip.

2 = Trip on Leading power factor. If the measured motor power factor leads beyond the trip point setting in F106 for the time set in F107, the starter will trip.

3 = Trip on Leading or Lagging power factor. If the measured motor power factor lags or leads the value in F106 for the time set in F107, the starter will trip.

F106 = Motor Power Factor Trip Point
Factory Setting = 0.50 (cosine θ)
Range = 0.01 - 1.0 measured motor Power Factor
Motor Power Factor (PF) is measured based upon measured voltage and current waveforms.

F107 = Motor Power Factor Trip Delay Time
Factory Setting = 2 seconds
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default setting, if the motor PF moves outside of the settings in F106 in the direction set in F105 for more than 2 seconds, the starter will trip.

5.6.16 Analog Output

F108 = Analog Output
Factory Setting = 0 (Off)
Range = 1 - 12
Sets analog output signal

Value	Display	Definition
1	XXXX. (A) or XX.XX. (kA)	Ia: Phase A Current (With a dot "." Shown at bottom right corner of rightmost digit.) Shows XX.XX if Iavg>9999 Amp. e.g.12.50 means12.5kA.
2	XXXX (A) or XX.XX (kA)	Ib: Phase B Current Shows XX.XX if Iavg>9999 Amp.
3	XXXX (A) or XX.XX (kA)	Ic: Phase C Current Shows XX.XX if Iavg>9999 Amp.
4	GXXX	Igf: Ground Fault Current
5	UXXX	Uab: Line Voltage AB
6	UXXX	Ubc: Line Voltage BC
7	UXXX	Uca: Line Voltage CA
8	^{L}XXX (^{L} is like superscript) or $_{L}$XXX ($_{L}$ is like subscript)	Power Factor (a superscript "L" is for Lead condition, or subscript "L" for Lag. Either of them is shown at leftmost digit)
9	PXXX	KW (w/o decimal point) or MW (w/ decimal point): Kilo-watt (range: 000 - 999); Mega-watt (range: 0.00 - 9.99)
10	XXXX (A) or XX.XX (kA)	Iavg: Average of 3 Phase Currents (It is factory default display); Shows XX.XX if Iavg>9999 Amp.
11	UXXX	Uavg: Average of 3 Line Voltages
12	HXXX	Thermal Capacity Remaining

F109 = Analog Output 4mA

　　　Factory Setting = 0

　　　Range = 0 - 9999

Enter a value that the 4mA level will represent for the selected function; typically this value should be 0.

F110 = Analog Output 20mA

　　　Factory Setting = 9999

　　　Range = 0 - 9999

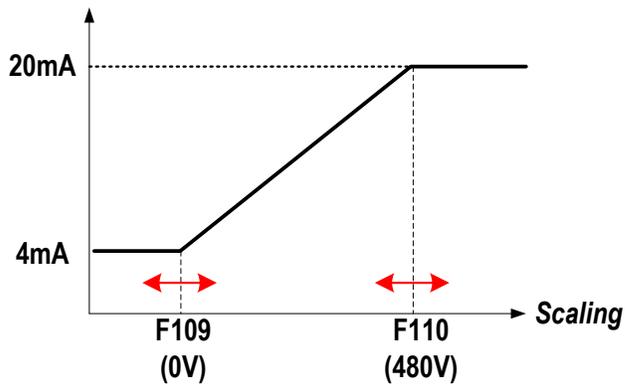Enter a value that the 20mA level will represent for the selected function.

Example: Use Analog Output to measure Line Voltage AB

Set F108 to 3 (Line Voltage AB)
Set F109 to 0
Set F110 to 480

Analog Output Level

5.6.17 Display & System Settings

F111 = Display Setting

Factory Setting = 10

Range = 1 - 12, 0 (Off)

Sets default display monitor

Value	Display	Definition
1	XXXX. (A) or XX.XX. (kA)	Ia: Phase A Current (With a dot "." Shown at bottom right corner of rightmost digit.) Shows XX.XX if Iavg>9999 Amp. e.g.12.50 means 12.5 kA.
2	XXXX (A) or XX.XX (kA)	Ib: Phase B Current Shows XX.XX if Iavg>9999 Amp.
3	XXXX (A) or XX.XX (kA)	Ic: Phase C Current Shows XX.XX if Iavg>9999 Amp.
4	GXXX	Igf: Ground Fault Current
5	UXXX	Uab: Line Voltage AB
6	UXXX	Ubc: Line Voltage BC
7	UXXX	Uca: Line Voltage CA
8	^{L}XXX (^{L} is like superscript) or $_{L}$XXX ($_{L}$ is like subscript)	Power Factor (A large L is for Lead and a small L is for lag). Either of them is shown at leftmost digit)
9	PXXX	KW (w/o decimal point) or MW (w/ decimal point): Kilo-watt (range: 000 - 999); Mega-watt (range: 0.00 - 9.99)
10	XXXX (A) or XX.XX (kA)	Iavg: Average of 3 Phase Currents (It is factory default display); Shows XX.XX if Iavg>9999 Amp.
11	UXXX	Uavg: Average of 3 Line Voltages
12	HXXX	Thermal Capacity Remaining

F112 = System Settings - Reserved

F113 = Alternate functions for Ramp2/Jog inputs

Factory Setting = 7

Range = 0 - 7

Sets system settings.

Quick Setup of F113:

Note: When Jog Input is set to "Remote/Local", "Remote" is communication as set in F068, and "Local" is normal control via the terminal strip.

Data	Dual Ramp Input	Jog Input
0	Dual Ramp	Jog
1	Dual Ramp	Remote / Local
2	Dual Ramp	Ext. Lockout N/O button
3	Dual Ramp	Ext. Lockout N/C button
4	RESET	Jog
5	RESET	Remote / Local
6	RESET	Ext. Lockout N/O button
7	RESET	Ext. Lockout N/C button

Chapter 6 - Start-up

6.1 Basic Startup

Your new *VMX2 Series* Soft Starter is factory preset for a wide variety of applications and often can be used with minimal adjustment.

6.1.1 Three Step Process

1. Connect L1, L2, and L3 to the input voltage source and T1, T2, and T3 to motor.
2. Connect control wires and control power.
3. Program motor FLA (F001).

6.1.2 Start-up Parameters and Factory Defaults

In the initial start-up test, the performance of the starter with the initial factory presets. If required, adjust or enable the features to meet your specific application requirements.

Fn #	Function Name	Factory Setting	Description / Factory Setting
F001	Motor Nameplate FLA.	0	FLA must be programmed for the starter to operate.
F002	Motor Nameplate Service Factor	1.0 SF	Change only if necessary and for motors rated above 1.0SF
F003	Overload Class During Start	Class 10	NEMA / UL Class 10
F004	Overload Class During Run	Class 10	NEMA / UL Class 10
F005	Overload Reset	0 (Manual)	0 = Manual
F010	Ramp Profile	1	Ramp 1 and Ramp 2 = Voltage Ramp with Current Limit
F011	Initial Torque	60	60% Initial Voltage
F013	Ramp Time	10	10 Second Ramp (Ramp 1)
F014	Current Limit	350	350% of programmed FLA
F015 - F018	Ramp 2 settings	---	Inactive unless Ramp 2 Input is closed
F019 - F028	Specialty starting and testing	---	Inactive unless selected
F029 – F052	Software protection and control	---	Inactive unless selected
F053 - F059	Timer and counter value readouts	---	Read only
F060	Aux Relay #1	1	Run / Stop
F061	Aux Relay #2	2	At-Speed / Stop
F062	Aux Relay #3	16	Any Fault
F063	Aux Relay Delay	0	No Delay
F065 - F068	Communications	----	Not Used unless without optional Comm Adaptor.
F070	Parameter Lock	0	User password disabled
F071	Reset Function	0	Use to reset to default values
F073 - F080	System settings and time clock	---	User choice to adjust clock
F085 - F093	Fault History	---	Read only

Table 6.1.2: Factory Presets

6.2 Start-up Check List

- Supply voltage matches the rated supply voltage of the unit.
- Horsepower and current ratings of the motor and starter have the same rating, or the starter has a higher rating.
- Initial ramp time and torque adjustments have been checked.
- Input voltage source is connected to the starters input terminals L1, L2 and L3.
- Motor leads are connected to the starter output terminals T1, T2, and T3.
- Appropriate control power is applied and/or control connections have been made.
- "Power On" light located on the front of the unit turns on when control power is applied.
- Four 7-segment LED readout is visible.
- The motor's FLA has been programmed in function F001.
- The thermal overload is properly set. (Use F003 and F004 to set OL Class.)
- The motor area and equipment are clear of personnel and parts before start-up.

6.3 Sequence of Operation

- Apply three-phase power to the unit. The motor should not run until the start command is applied.
- Apply control power and check that the "Power On" LED comes on.
- Status Display should read **[0000.]** showing no current in Phase A (minor flickering of the first digit is common).
- Apply the Run (Start) command. The motor should begin to accelerate. Status display will read Phase A Amps at an increasing rate.
- When the motor reaches full speed, the "At Speed" LED comes on. Status display should show a sharp decrease in Phase-A amps.
- The Bypass Contactor should pull in.
- If the motor does not fully accelerate, decelerates, or stops during the acceleration period, push the Stop button immediately and open the disconnect line.

If Pump-Flex Decel is programmed in F025:

- Remove the Run Command (or push the Stop button). At-Speed LED will go out.
- The Bypass Contactor should drop out.
- Status display should read Phase-A amps increasing as motor begins to decelerate.
- Motor should begin to slow down. Status display should begin to show decreasing motor amps.
- When motor reaches Stop Level, starter should turn off. Status display will again show **[0000.]**

If the unit does not follow this operational sequence, please refer to the Service and Troubleshooting Guide section.

6.4 Testing with a smaller motor

- To test the *VMX2 Series* starter in combination with a motor that draws less than Less than 20% **of the FLA setting in F001**, the Phase Current Loss (Running) protection must be disabled as per instructions in section 5.6.14 (F101). If this feature is not disabled, the *VMX2 Series* will trip on a Phase Loss fault after running for 3 seconds at low current levels.

Chapter 7 - Fault Conditions

7.1 Fault Codes and Numbers (in History)

A two or three character fault code is displayed in the LED display at the time of the trip event. For three character codes, the first two characters indicate the trip condition (see Table 7.1). The third digit is a suffix showing the *VMX2 Series* operating mode when the trip occurred. Operating modes are as follows:

Code suffix "A": Acceleration, meaning that the *VMX2 Series* was ramping up, but had not yet achieved "At-Speed" status (see table 5.2 for a brief description of At-Speed indication).

Code suffix "c": Constant Speed (running), meaning that the *VMX2 Series* has reached the At-Speed condition and the motor was running when the trip occurred.

Code suffix "d": Decel or Stop, meaning the *VMX2 Series* was either stopped (off, but power applied), or if the Pump-Flex Decel function was enabled, it was engaged in the Soft Stop routine set up by F024-27.

IMPORTANT NOTE:
Fault code SSd may display if there is no output load (motor) connection when control power is applied!

In addition to these fault display codes, each trip condition has a corresponding numeric code that is stored in the Fault History. The numeric codes follow the display codes exactly. Table 7.1 shows the Fault Display Codes, Fault Number Codes, and LED indicators for each fault condition. Additional details are available in the Service and Troubleshooting Guide.

Example: If Function F003 (starting overload protection) is set too low for the size of the load and causes a trip, the fault code "oLA" will be displayed. Its corresponding number will be entered into the fault history. In this case, the number 0010 will be shown on the display in function F085 (Fault History). The time the fault occurred is available in function F086 shown as "hh.mm." Example: if the "oLA" fault occurred at 10:00 am, F086 would display "10.00." The date the fault occurred is available, in function F087. The date is shown as "mm.dd". If the "oLA" fault occurred on March 1, F077 shows "03.01." If no fault history is available, F085 reads 0000.

Display Message Description	Fault Display Code Readout	Fault Number Code used in History, F085, F088 and F091	LED Indicator
No Full Load Amps entered into F001	nFLA		
Over Current During Accel	ocA	1	Over Current
Over Current During Constant Speed	occ	2	
Over Current During Decel (or Stop)	ocd	3	
Phase Loss During Accel	PLA	4	Phase Loss
Phase Loss During Constant Speed	PLc	5	
Phase Loss During Decel (or Stop)	PLd	6	
Line Voltage loss (no 3 phase prior to start)	n3Ph	6	
Over Temperature During Accel	otA	7	Over Temp
Over Temperature During Constant Speed	otc	8	
Over Temperature During Decel (or Stop)	otd	9	
Over Load During Accel	oLA	10	Overload
Over Load During Constant Speed	oLc	11	
Over Load During Decel (or Stop)	oLd	12	
Shorted SCR During Accel	SSA	13	Shorted SCR or no load
Shorted SCR During Constant Speed	SSc	14	
Shorted SCR During Decel (or Stop)	SSd	15	
Shunt Trip During Accel	St	16	Shunt Trip
Shunt Trip During Constant Speed	St	17	
Shunt Trip During Decel (or Stop)	St	18	
Im-Balance Current During Accel	IbA	19	---
Im-Balance Current During Constant Speed	Ibc	20	
Im-Balance Current During Decel (or Stop)	Ibd	21	
Under Current During Accel	UcA	22	---
Under Current During Constant Speed	Ucc	23	
Under Current During Decel (or Stop)	Ucd	24	
Short Circuit During Accel	ScA	25	Over Current
Short Circuit During Constant Speed	Scc	26	
Short Circuit During Decel (or Stop)	Scd	27	
Ground Fault During Accel	GFA	28	---
Ground Fault During Constant Speed	GFc	29	
Ground Fault During Decel (or Stop)	GFd	30	
Bypass Discrepancy Fault During Accel	bPA	31	---
Bypass Discrepancy Fault During Constant Speed	bPc	32	
Bypass Discrepancy Fault During Decel (or Stop)	bPd	33	
External Lockout Fault During Accel	LcA	34	Overload
External Lockout Fault During Constant Speed	Lcc	35	
External Lockout Fault During Decel (or Stop)	Lcd	36	
Phase Rotation Fault During Accel	rotA	37	---
Phase Rotation Fault During Constant Speed	rotc	38	
Phase Rotation Fault During Decel (or Stop)	rotd	39	

Table 7.1: Message Fault code List

Display Message Description	Fault Display Code Readout	Fault Number Code used in History, F085, F088 and F091	LED Indicator
Voltage Imbalance Fault During Accel	**EIA**	40	
Voltage Imbalance Fault During Constant Speed	**EIc**	41	
Voltage Imbalance Fault During Decel (or Stop)	**EId**	42	
Over Voltage Fault During Accel	**oEA**	43	
Over Voltage Fault During Constant Speed	**oEc**	44	
Over Voltage Fault During Decel (or Stop)	**oEd**	45	
Under Voltage During Accel	**UEA**	46	
Under Voltage During Constant Speed	**UEc**	47	
Under Voltage During Decel (or Stop)	**UEd**	48	**N/A**
Power Factor Trip During Accel	**PFA**	49	
Power Factor Trip During Constant Speed	**PFc**	50	
Power Factor Trip During Decel (or Stop)	**PFd**	51	
PoweR (kW) Trip During Accel	**PrA**	52	
PoweR (kW) Trip During Constant Speed	**Prc**	53	
PoweR (kW) Trip During Decel (or Stop)	**Prd**	54	
Control Power Loss Fault During Accel	**ncPA**	55	
Control Power Loss Fault During Constant Speed	**ncPc**	56	
Control Power Loss Fault During Decel (or Stop)	**ncPd**	57	

Table 7.1 Continued: Message Fault code List

7.2   Fault Explanation - Probable Cause - Solution

Fault Code / #	LED	Fault # or Code Description	Explanation : Probable Cause : Solution	Fn List Ref
nFLA	Various	No Full Load Amps	Motor nameplate Full Load Amps (FLA) was not entered by the user. Starter will not operate without this information. See section 3.1.	F001
rSt	Various	Reset	Reset of fault condition is successful. The starter is ready for the next Start command.	N/A
Inh	Various	Inhibited	Attempted action is not possible. Probable cause: 1) The starter is in the Run mode. The starter must be in the Stopped mode before changes can be entered. 2) The parameter that is being entered has been locked out with the Customer Password. See section 5.5.11 for details.	N/A
FLt	Various	Multiple Faults	Indicates the rare occurrence of multiple simultaneous faults. The LEDs associated with those faults should illuminate.	N/A
CdLo	Various	Coast Down Lockout	The Coast Down Lockout timer has been enabled by the user and the time has not yet expired when a Start command is given. See section 5.5.9 and 5.6.9 for details.	F048
SHLo	Various	Start per Hour Lockout	The Starts per Hour Lockout timer has been enabled by the user, and the time has not yet expired when a Start command is given. See section 5.5.9 and 5.6.9 for details.	F049
tSLo	Various	Time between Starts Lockout	The Time Between Starts Lockout timer has been enabled by the user, and the time has not yet expired when a Start command is given. See section 5.5.9 and 5.6.9 for details.	F50
Loc	Various	Lockout Timer engaged	Any one of the above Lockout Protection features is preventing operation until the timer expires. See section 5.5.9 for additional details. Remaining time values are located at F055 - F059.	F048 - F050
PASS	Various	Successful password entry	Customer password was entered and accepted. Parameter lock is now released. All user functions can be accessed.	F070 - F071
Err	Various	Password entry Error	The password that you are trying to enter is invalid. Check with authorized user personnel for password information.	Any
End	Various	Successful parameter change	The data or setpoint entered into a Function has been accepted and stored into memory as the new value.	All
dFLt	Various	Default	Parameters have been successfully returned to the Factory Default settings.	F071
triP	Various	Tripped	Control power was cycled and the Start command given while the starter was in a tripped condition. The existing fault condition will display after the Start command is removed.	N/A
HXXX	Various	Remaining Thermal Capacity (XXX will show number value from 000 to 100)	Thermal capacity remaining in the motor. As this number counts down toward zero, the motor is approaching an overload condition. After Overload Trip occurs, this number will increase back toward 100% as the motor cools. The value at which an Overload Trip can be reset will dynamically changes as the VMX2 starter learns the amount of Thermal capacity that is used on successful start attempts. Required Thermal Capacity to start can be displayed in F059.	F001-F004, F059
CLr	Various	Retentive memory has been Cleared	After entering a value of "2" into F071, the Thermal Register and all Lockout Timer values will be cleared (reset to 0). Use this function only for emergency restart. Motor damage may result.	F071

Appendix 1 - Ramp Profile Details

The *VMX2 Series* offers four different types of starting ramp profiles. Simply select the one that best matches your motor / load requirements. In addition, **two separate ramps** are available that can be selected via contact closure (see section 4.2.5.a), and each one can be set up for any ramp type as shown in the table below.

Ramp 1 Settings				"Ramp Type Selection" from F010	Ramp 2 Settings			
Ramp Type	Initial Torque from…	Ramp Time from…	Current Limit from…		Ramp Type	Initial Torque from…	Ramp Time from…	Current Limit from…
Voltage	F011	F013	F014	1	Voltage	F015	F017	F018
Current	F012	F013	F014	2	Current	F016	F017	F018
Voltage	F011	F013	F014	3	Current	F016	F017	F018
Current	F012	F013	F014	4	Voltage	F015	F017	F018

Table APP 1.1: Ramp Selection Choices and Settings

Following are descriptions of the four types of Ramp Profiles

1. Voltage Ramping is the most reliable starting method, due to the fact that at some point the starter will reach an output voltage high enough to allow the motor to draw full current and develop full torque. This method is useful for applications where the load conditions change frequently and significantly enough to require different levels of starting torque. Examples where this is effective are:

- Material handling conveyers
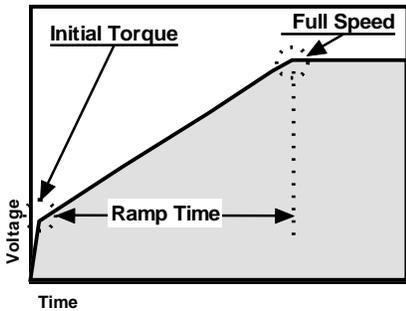- Positive displacement pumps
- Drum mixers, grinders etc.

Voltage is increased from a starting point (Initial Voltage) to full voltage over an adjustable time period (Ramp Time). To achieve Voltage Ramping, set the Ramp Profile (F010) to 0001 or 0003 (Voltage Ramp), and the Maximum Current Limit setting (F014) to maximum (600%).

Figure APP 1.1:
Voltage Ramp w/o Current Limit

2. Voltage Ramping with Current Limit works similar to mode 1, except this mode adds an adjustable maximum current output. Voltage is increased gradually until the motor current reaches the Maximum Current Limit setting (F014). The motor current is held at this level until the motor accelerates to full speed. When the motor current drops below the limit setting, the output voltage is automatically increased until the *VMX2 Series* is At-Speed. This may be necessary in applications where the electrical power is limited. Examples would be:

- Portable or emergency generator supplies
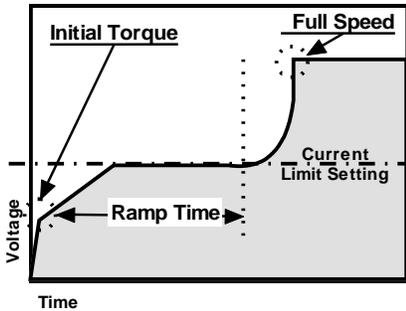- Utility power near the end of a transmission line or other starting power demand restrictions.

Using Current Limit will override the Ramp Time setting if necessary, so use this feature when acceleration time is not critical. The Ramp Time setting; however, still determines the slope of the ramp up to the Current Limit setting to apply the softest possible acceleration. To achieve Voltage Ramping with Current Limit, set the Ramp Profile (F010) to 0001 or 0003 (Voltage Ramp), and the Maximum Current Limit setting (F014) to a desired lower setting, as determined by your application requirements.
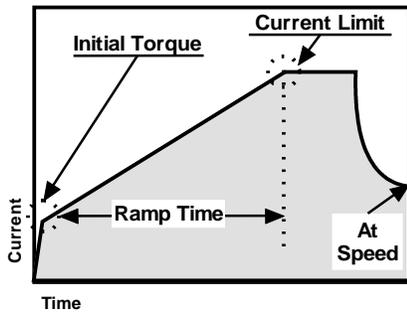

Figure APP 1.2:
Voltage Ramp with Current Limit

3. Closed Loop Current (Torque) Ramp provides a smooth increase of output torque. Ramp Time becomes the time from Initial Torque to the Current Limit setting. Output current is constantly updated using an internal PID feedback loop to provide a linear current ramp, therefore the available torque is maximized at any given speed. The best use of this feature is for applications where rapid changes in torque may result in load damage or equipment changes. Examples would be:

- Long overland conveyors where belt stretching may occur.
- Low pressure pumps where slight surges at the end-of-ramp may pose mechanical problems.
- Fans and mixers where blade warping is a problem.
- Material handling systems where stacked products may fall over, or break.

This feature can be used with or without the Maximum Current Limit setting.

To achieve Current Ramping with the *VMX2 Series*, set the Ramp Profile (F010) to 0002 or 0004 (Current Ramp), and the Maximum Current Limit setting (F014) to the desired level. The initial torque value comes from the initial current setting in F012.
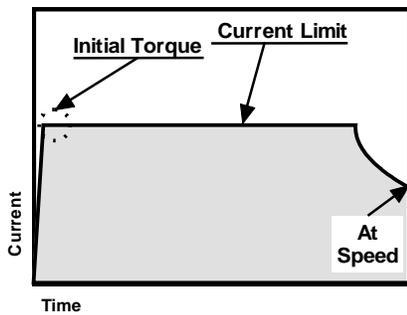
Figure APP 1.3: Current / Torque Ramp

4. Current Limit Only (Current Step) uses the Current Limit feature exclusively without the benefit of soft starting by ramping the voltage or current first (also known as **Pedestal Starting**). This will maximize the effective application of motor torque within the limits of the motor. In this mode, Initial Voltage is set to maximum and Ramp Time is set to minimum, so that the output current steps to the Current Limit setting immediately. Examples of when to use this mode are:

- Applications with a severely limited power supply.
- When starting a difficult load such as a centrifuge or deep well pump.
- When the motor capacity is barely adequate without stalling or overloading.
- It is a good choice when other starting modes fail.

Since ramp times are set to minimum, this mode functions in either Voltage Ramp or Current Ramp setting.

Figure APP 1.4: Current Step Starting

Ramp Parameter Descriptions
Following are detailed descriptions of the individual settings that make up each ramp profile.

Initial Voltage or Initial Current
These functions set the initial start point of either the Voltage Ramp or Current Ramp as programmed in F010. Every load requires at least some amount of torque to start from a standstill. It is not efficient to begin ramping the motor from zero every time, since between zero and the (WK$_2$) breakaway torque level, no useful work is being performed. The initial torque level should be set to provide just enough torque to make the motor shaft begin to rotate, enabling the softest possible start and preventing torque shock damage to the mechanical components. Setting this function too high will not damage the starter, but may reduce or eliminate the soft start advantages.

Accel Ramp Time. This Function sets the maximum allowable time for ramping from the Initial Torque setting to either of the following:

1) Current limit setting when the motor is still accelerating, or

2) Full output voltage if the Current Limit is set to maximum.

Increasing the Ramp Time softens the start process by lowering the slope of increase in voltage or current. This should be set to provide the softest possible start without stalling unless it is determined that the application has other considerations. Applications where this setting should be shorter include Centrifugal Pumps, because pump problems may occur as a result of insufficient torque during acceleration through the pump curve.

▪ **Note:**
Ramp Time is affected by the following conditions:

1. Current Limit will automatically override the Ramp Time if set to Voltage Ramp (F010=1) and if the motor does not reach full speed while in current limit mode.
2. An "Anti-Oscillation" circuit built-in to the **VMX2 Series** will shorten the Ramp Time if the motor reaches full speed before end of ramp.

Current Limit. This Function sets the maximum motor current that the starter allows during Ramping. It is active in both the Voltage Ramp and Current Ramp modes. As the motor begins to ramp, this feature will set a maximum at which the current draw will be held. Current Limit will remain in effect until one of the following two events occur:

1. The motor reaches full speed as detected by the At-Speed detection circuit.
2. The Overload Protection trips on Motor Thermal Overload (see Ch.3).

Once the motor has reached full speed, the Current Limit feature becomes inactive.

▪ **In the Voltage Ramp Profile**, the Voltage output is increased until the Current Limit is reached. The Ramp Time is the maximum time it will take for the voltage to increase until the Current Limit setting takes over.

▪ **In the Current Ramp Profile**, output voltage varies to provide a linear increase in current up to the Current Limit setting, and Ramp Time is the time that it will take to get there. A closed loop feedback of motor current allows continuous updating of the output to maintain this ramp profile.

Because most AC induction motors will not start below 200% current, the current limit set point is adjustable down to only 200%.

Caution:
While in the Start mode there is no maximum Current Limit time. Excessive start time may lead to motor stalling, causing an Overload Trip. If this happens, try raising the Current Limit setting to accommodate your load conditions. If the Current Limit setting cannot be increased, try using Current Limit without ramping features ("Current Limit Only" as described previously).

Appendix 2: Pump-Flex® Decel Mode Application Considerations

Coast-to-Stop
(using Electro-Mech. starter)

Pump On

Pump Flow

Check Valve
Open

Pump Off

Back Flow

Check Valve
Slams

Pump Off

(((SHOCK WAVE)))

Check Valve
Closed
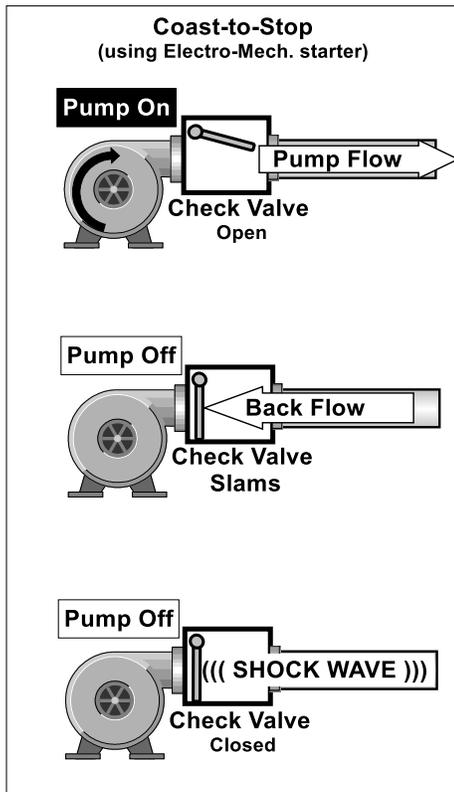
Pump-Flex® Deceleration (Soft Stop) is a unique feature of Motortronics Solid State Soft Starters. It provides a slow decrease in the output voltage, accomplishing a gentle decrease in motor torque during the stopping mode. This is the **OPPOSITE OF BRAKING,** in that it will take **longer** to come to a stop than if the starter were just tuned off.

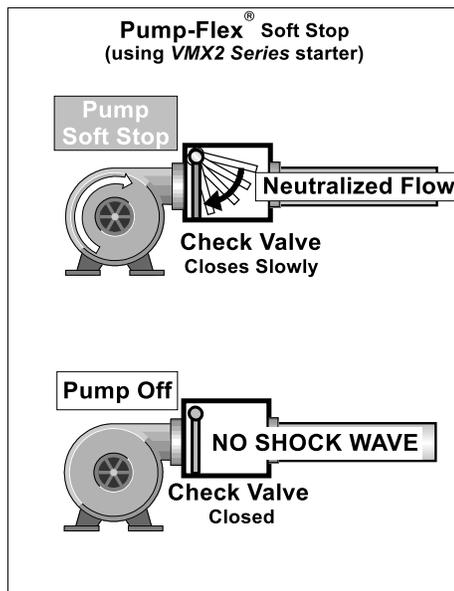The primary use of this function is with centrifugal pumps as a means to reduce the sudden changes in pressure that are associated with "Water Hammer" and slamming of check valves. Decel control in pump applications is often referred to as **Pump Control**.

In a pump system, liquid is being pushed uphill. The force exerted by gravity on the column of liquid as it goes uphill is called the "Head Pressure". The pump is sized to provide enough Output Pressure to overcome the Head Pressure and move the fluid up the hill. When the pump is turned off, the Output Pressure rapidly drops to zero and the Head Pressure takes over to send the fluid back down the hill. A "Check Valve" is used somewhere in the system to prevent this (if necessary) by only allowing the liquid to flow in one direction.

The kinetic energy in that moving fluid is suddenly trapped when the valve slams closed. Since fluids can't compress, that energy is transformed into a "Shock Wave" that travels through the piping system looking for an outlet in which to dissipate. The sound of that shock wave is referred to as "Water Hammer". The energy in that shock wave can be extremely damaging to pipes, fittings, flanges, seals, and mounting systems.

Pump-Flex® **Soft Stop**
(using *VMX2 Series* starter)

**Pump
Soft Stop**

Neutralized Flow

Check Valve
Closes Slowly

Pump Off

NO SHOCK WAVE

Check Valve
Closed

SOLUTION:

By using the Pump-Flex® Deceleration feature of the *VMX2 Series*, the pump output torque is gradually and gently reduced, which slowly reduces the pressure in the pipe. When the Pump Output Pressure is just slightly lower than the System Head Pressure, the flow slowly reverses and closes the Check Valve. By this time, there is very little energy left in the moving fluid, and the Shock Wave is avoided. When the output voltage to the motor is low enough to no longer be needed, the *VMX2 Series* will end the Pump-Flex® Deceleration cycle and turn itself off.

Caution!
Deceleration is THE OPPOSITE of braking. Enabling the Deceleration feature will make the motor take LONGER to stop than if it were simply turned off.

Setup and Use

Pump systems vary greatly. To accommodate this, the **Pump-Flex®** Deceleration control feature is designed to provide complete flexibility in how the deceleration process takes place by using the following settings:

Deceleration begins when a Stop command is given (or the Run command is removed). If there is a Bypass Contactor, it will open immediately, putting the power control back to the SCRs.
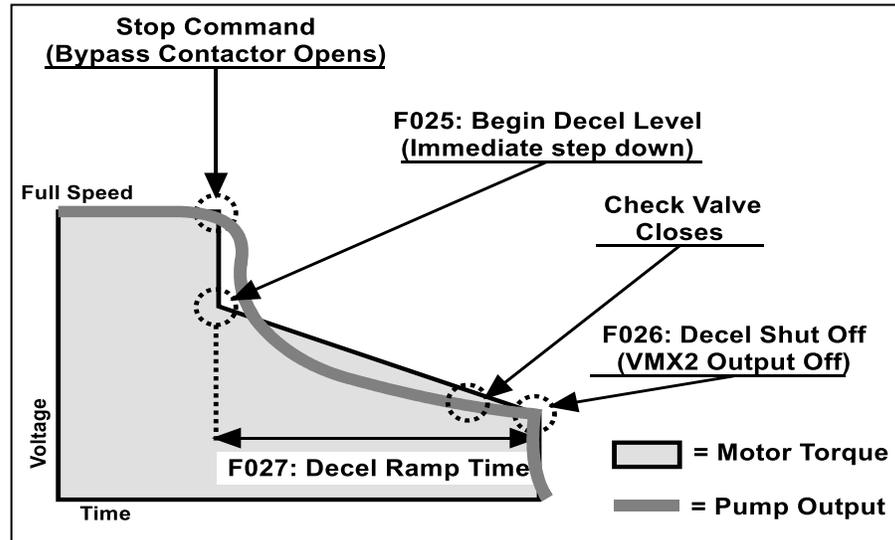
Figure APP2.2: Pump-Flex Deceleration Graph

F024 = Deceleration Ramp
   Factory Setting = 0 (Disabled)
   Range = 0 - 2

When F024 = 0, the deceleration feature is **disabled**.

When F024 = 1, the deceleration feature is **enabled** AND the overload protection feature (from F003 - F005) remains active. When a Stop command is given, the starter begins to apply Deceleration voltage. However, if an overload trip occurs, the starter ceases applying Deceleration voltage and the motor coasts to a stop to prevent additional motor heating and potential motor damage.

When F024 = 2, the deceleration feature is **enabled** and deceleration will **continue even when an overload condition trips**. This is to be used only when the risk of damage due to an uncontrolled shutdown is considered worse than the potential damage to the motor.

WARNING!

Setting F024 = 2, presents significant risk of over-heating the motor beyond its design limits which could result in motor damage and fire hazard. Do this only in circumstances where the potential for mechanical damage outweighs the risk of motor damage and fire.

F025 = Begin Decel Level (BDL)
Factory Setting = 60%
Range = 0 - 100% of line voltage
Used to drop voltage to a level where there is a noticeable effect on motor torque during Deceleration mode. Generally, systems with high head pressure need to start Deceleration near the top of the ramp (85 - 95%). Low head systems can drop to lower settings (50 - 60%). System conditions vary greatly by pump type, pipe size, and system head. Some experimentation with settings may be necessary.

F026 = Decel Shut Off Voltage
Factory Setting = 30%
Range = 0 to (BDL -1) %
Sets the level where the starter is turned off, corresponding to where motor torque during Deceleration is no longer effective. This function is used to shut the motor off once the check valve closes. Again, because systems vary greatly this setting may require adjustment several times. If you cannot hear or see the check valve close, observe fluid pressure or flow if available.

F027 = Decel Ramp Time
Factory Setting = 10 seconds
Range = 1 - 60 seconds
Sets the time for the deceleration ramp to go from the Begin Deceleration Level setting (F026) to the Deceleration Shut Off Voltage (F027). This function is used to dampen the effect of reducing pump torque as much as possible. If the check valve still slams at the end of ramp, try extending this time function a little. Since motor heating increases as voltage is lowered, the setting should not exceed the time necessary to achieve the deceleration effect.

▪ **Note:**
When using the Deceleration function, count these cycles as additional "starts" when determining maximum starts-per-hour.

Other Applications:
Another common application for Deceleration control is on material handling conveyors as a means to prevent sudden stops that may cause products to shift, fall over, or to bump into one another.

In overhead crane applications, Soft Stopping of the Bridge or Trolley can prevent loads from beginning to over swing on sudden stops.

Appendix 3: Parameter Lock / User Password Instructions

Provides users with the ability to prevent unauthorized operators from making changes to the programmed functions. **If you do not need to take advantage of this feature, do not enter anything into this function.** The factory default is disabled, and no Password is necessary to make changes to the program.

When any value other than 0000 is entered into this Function, the Parameter Lock is enabled and that number becomes the User Password. From that point forward, it will be necessary to enter the User Password in this Function prior to making changes in any programmed function, <u>including this one</u>. When the Parameter Lock has been enabled, attempts to alter the program will result in the display reading [**Err**] whenever the **[READ/ENTER]** key is pressed.

To alter the program after the Parameter Lock has been enabled, go to Function **F070** and enter the correct user Password. The display will read an encoded value representing the existing password. As soon as you press the first Arrow key, the display will change to **[0000]** and start showing the actual value of your password entry. When the **[READ/ENTER]** button is pressed, the display will read **[PASS],** indicating that the User Password is correct and the system is unlocked. You will have 5 minutes in which to make a change in the program. This 5-minute window resets whenever any key is pressed, so it floats to give you 5 minutes after the last entry. After 5 minutes of no keypad activity, the Parameter Lock is reinstated with the current user Password. Subsequent changes will require re-entering the User Password.

To change the User Password or to disable the Parameter Lock function, enter the programmed User Password first, and then set Function F070 to 0, disabling the Parameter Lock. If you do not re-enter the Password or enter a new user password, the Parameter Lock feature will remain disabled. If you enter a different number into this Function, the new number becomes your new User Password. Existing passwords are encoded to "hide" them in the display.

Caution:
DO NOT LOSE YOUR PASSWORD.
If the password has been lost or forgotten, contact Motortronics for assistance.

Example: Figure App 3
Enabling Password Protection / Parameter Lock

Starting from the Status Display Mode, no previous function number entered, no existing password.

Press the Fn key

Displays F001 to indicate the beginning of the function list.

Press the LEFT arrow key

Selects the second digit (from the right). Note: Do it in this order because F000 would not have been a valid number.

Press the UP arrow key seven times (7X)

Changes the function code to F071.

Press the RIGHT arrow key

Selects the first digit (from the right).

Press the DOWN arrow key

Changes the function code to F070.

Press the Read Enter key

The default display will show **[3552]** as long as no password has been previously entered. This is the default code for "0000", meaning that there is no password. **As soon as you press the first Arrow key, the display will change to [0000]** and begin showing the actual value of your password entry. Any initial display other than **[3552]** signifies that a password already exists. This means that you will need to change, rather than enter a new one (see below).

Press the UP arrow and the LEFT arrow keys

The display will show the numerical value you entered. The valid range is 0000 to 0999. In this example, 0123 was selected.

Press the Read Enter key

The display will flash **[End]** to confirm you have entered a password. Then it will return to displaying the Function #.

Example: Setting a Password

Using Password 123

Press Key...	Display Shows...	Means...
	0000.	Phase A Current
Fn	F070	Select Function #70
READ ENTER	3552	Default Setting of Function #70
↑ x 3	0003	New Value of First Digit
←	0003	Cursor (flashing) Position Shift
↑ x 2	0023	New Value of Second Digit
←	0023	Cursor (flashing) Position Shift
↑	0123	New Value of Second Digit
READ ENTER	End	Value Accepted (flashes once)
	F070	Return to Function # Display

Figure App 3:
Entering a Password

Changing passwords:

To change an existing password, the steps are essentially the same as outlined above, except you must first enter the existing password. At F070, press the **[READ/ENTER]** key to reveal the encoded password (you must know that password before it can be changed). Use the Arrow keys to enter the password. As soon as you press the first Arrow key, the display will change to **[0000]** and start showing the actual value of your entry. When you get to the existing password, press the **[READ/ENTER]** key again. The display will flash **[PASS]** to indicate that the password was accepted. If it flashes **[Err]**, you have entered the wrong password.

Resetting to Factory Defaults using F071 will NOT reset the password.

Disabling Password Protection / Parameter Lockout

Changing function F070 to **[0000]** will disable the user password. If the initial display reads **[3552],** the password is already set to **[0000].**

Appendix 4 - External Overload Relay Applications

Your **VMX2 Series** starter comes equipped with a very intelligent internal electronic overload protection system, and does not need an external Overload Relay (OLR). There are instances; however, where external OLRs are needed or desired because of the application. These fall into three categories: Higher Level Protection systems, Redundant Backup applications, and Special Motor applications.

▪ **Note:**
If the Deceleration Function is activated (F024), additional consideration must be put into determining how the starter is to operate in the event of an Overload Trip. See Section 5.6.5 for issues regarding this application.

HIGHER LEVEL PROTECTION SYSTEMS
Because of a desire for uniformity and/or operator familiarity in some facilities, Motor Protection Relays or other coordinated OEM protection systems may be used in lieu of the **VMX2 Series** protection (even though most of the features are the same or better). In these instances the **VMX2 Series** Overload protection can simply be turned off, deferring protection to the external devices. Care should be taken; however, to ensure that the external device is properly wired into the starter control circuit to facilitate shutdown of the motor.

REDUNDANT BYPASS STARTER APPLICATIONS:
In some applications, it may be necessary to provide an independent means of starting and protecting the motor should the **VMX2 Series** starter become inoperable. If this were the case, the **Bypass Contactor** could be used for Across-the-Line (A.T.L.) starting of the motor. The **VMX2…BP** version with Integral Bypass Contactors is designed for that possibility, as long as the starter is properly selected when ordered. To do so, select the starter based upon the ATL (Across-the-Line) selection chart so that the contactor is rated for ATL duty instead of the normal Shunt Duty.

Under normal operations, the Bypass Contactor is controlled internally by the **VMX2 Series** PC board and an internal pilot relay. For redundant backup purposes; however, terminals B1 and B2 of TB4 are provided for field connection of a dry contact closure in parallel to the pilot relay contact, allowing control even if the electronics are out of service. AC control power must still be applied to TB2 terminals A1 and A2, but no other electronics or power supplies need to be functioning. It is in this instance that an external OLR must be added to the motor power circuit and wired into that coil control circuit. TB4 is located in different areas of each frame size in the **VMX2 Series**. Refer to the following diagram for the location on your unit.

VMX2 Bypass Control Terminal Location Diagrams

Bypass Control*
Terminals
18 - 48A Units
with integral
bypass

Bypass Control*
Terminals
62 - 160A Units with
integral bypass
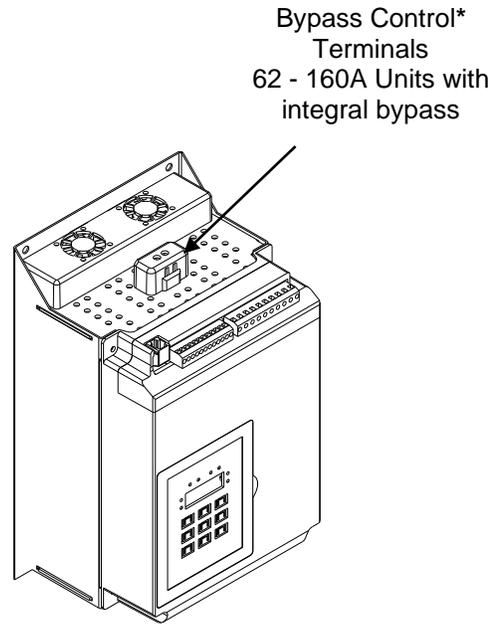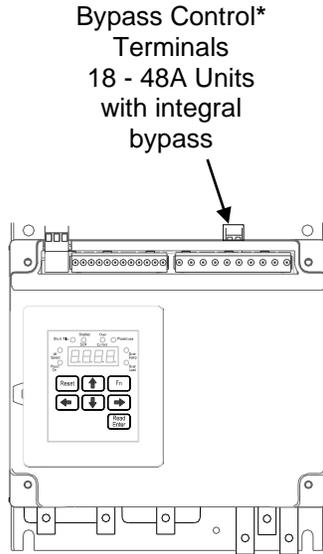
Note: Use these terminals only when separate control of the Bypass Contactor is necessary.

To BP Aux.
Contact N.C.

To BP Coil.

Bypass Control
Terminals
210 - 600A with
integral bypass

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

120V Supply
from A1 &
A2 on TB2

* To Dry Contact for Manual activation of
bypass contactor (VMX will fault when
bypass is closed).
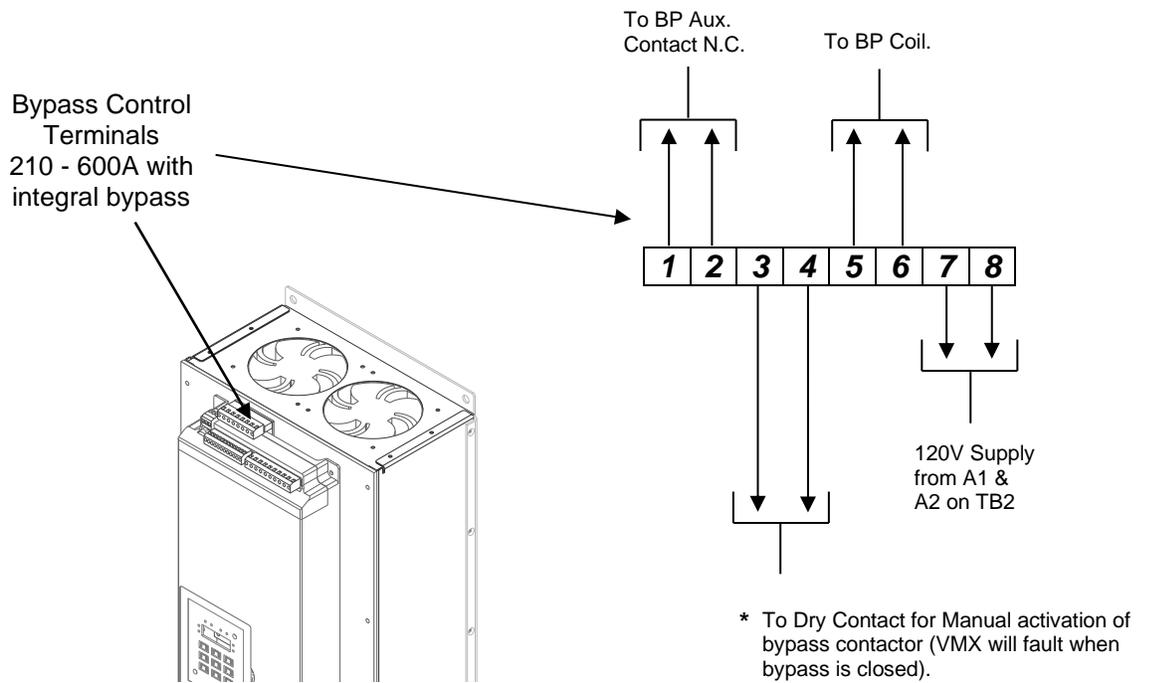
Appendix 4 (cont.) External OL Relay Applications

Across-the-Line (Direct-on-Line) Bypass
A suggested control schematic is shown below for using the **VMX2 …-BP Series** rated for Across-the-Line Bypass with an External Overload:
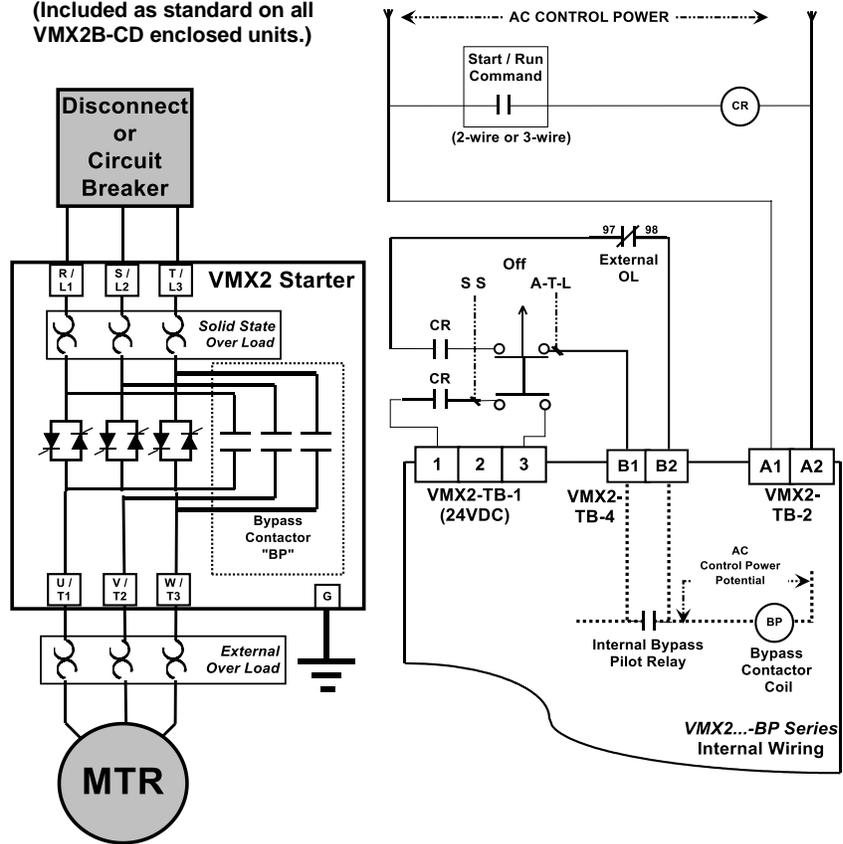
Figure APP4.2: VMX2 Wiring for Across-the-Line Bypass Operation with External Overload Relay
(Only the terminals necessary for this operation are shown)

In this example:
The Start / Run command (2-wire or 3-wire) energizes a control Relay "CR". If the selector Switch is in the "SS" (Soft Start) position, the contact of CR closes the 24VDC control signal to TB1, terminals 1 and 3 of the **VMX2 Series,** which begins ramping. When At-Speed status is reached, an internal Bypass Pilot Relay is used to close the Bypass Contactor. While in this mode, the **VMX2 Series** CPU provides full motor protection, even when the Bypass Contactor closes.

When the Selector Switch is placed in the "A-T-L" (Across-the-Line) position, a 2nd isolated contact of CR is used to close the circuit between B1 and B2 of TB4 which are internally connected in parallel to the Bypass Pilot Relay contact in the Bypass Contactor coil circuit. Since the **VMX2 Series** electronics may be out of service, an External Overload is added which only operates in this mode and protects the motor by dropping out the connection between B1 and B2.

Caution:
The circuit on TB-4, is at the same potential as the AC control voltage, but should not be directly connected to it. PC board damage may result.

SPECIAL MOTOR APPLICATIONS

Multiple Motors

When more than one motor is connected downstream from the **VMX2 Series** starter, the internal electronic overload protection cannot provide proper protection of the individual motors. Codes require the use of separate OLRs for each motor, which would need to be external devices.

In these instances the **VMX2 Series** Overload protection should be turned off, deferring protection to the separate OLRs. Care should be taken to ensure that the External OLR is properly wired into the starter control circuit to facilitate shutdown of the motor.
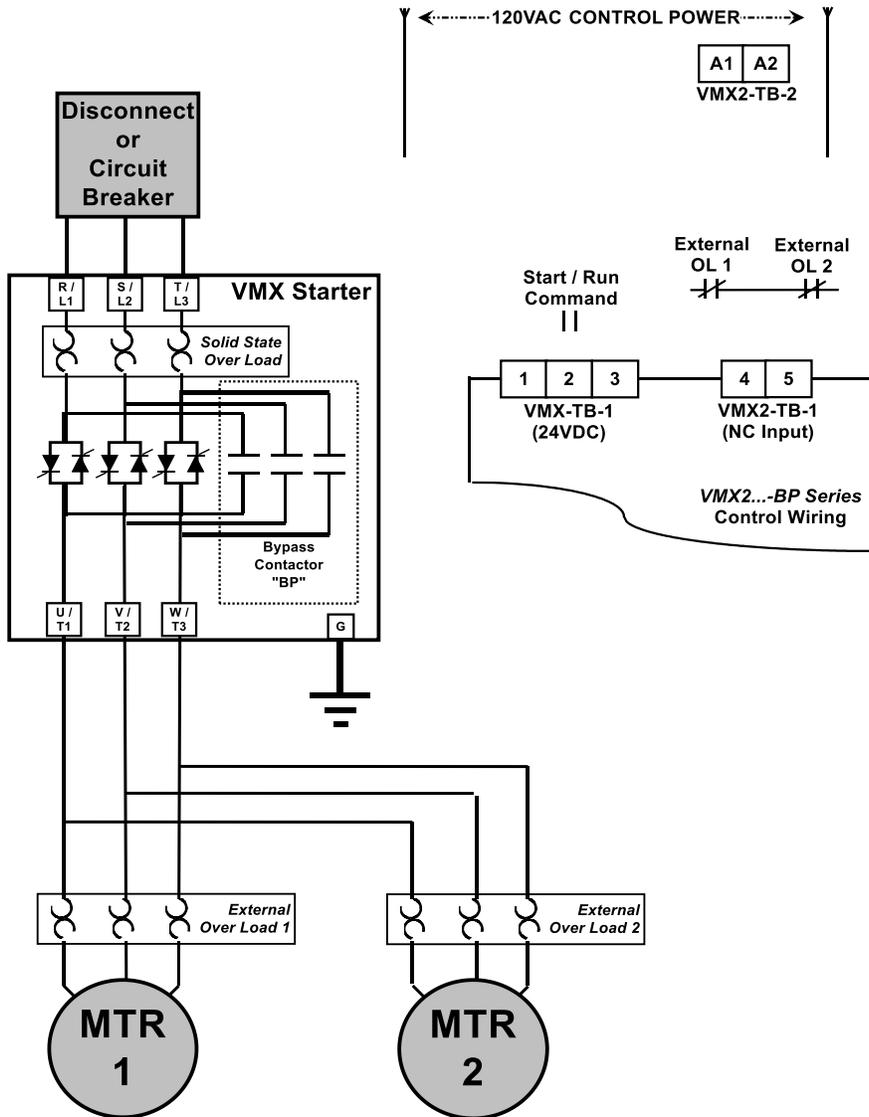
SPECIAL MOTOR APPLICATIONS

2S2W Motors

2-speed / 2-winding motor applications require a separate OLR sized for each set of windings. These would need to be external OLRs.
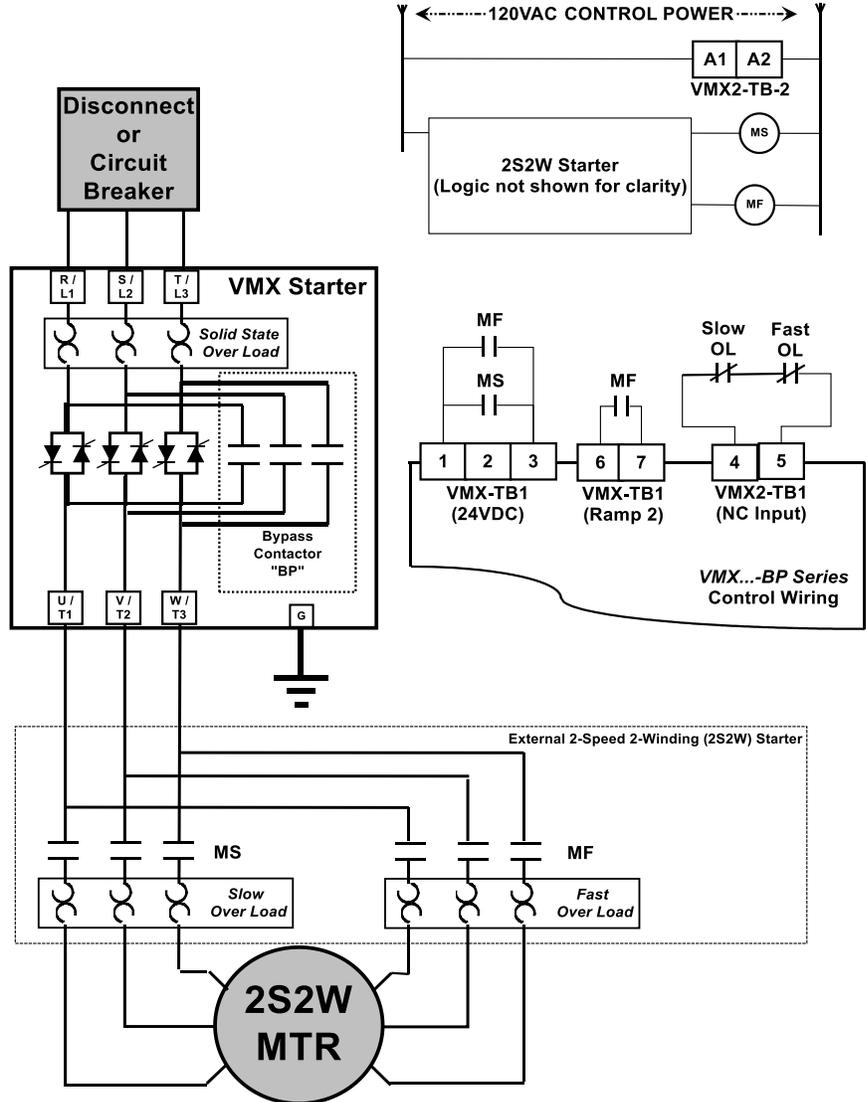
In this example:

The **VMX2 Series** is used ahead of an *existing* 2S2W starter, which already has separate OLRs for each speed. Dry Aux. contacts of the 2S2W starter are used to provide a Run command to the **VMX2 Series** so that all existing controls can be used. In addition, another dry Aux. of the Fast contactor is used to select Ramp 2. When started in Slow, Ramp 1 (default) is used. If started in Fast, different ramp settings are necessary so Ramp 2 is used. (See section 4.2.5a for Dual Ramp info.)

Either OLR will trip the *VMX2 Series*, which will display [Ptc] and light the "Overload" LED.

Appendix 5 - Soft Starter Settings Record
The following chart may be used to record the changes made to the factory settings.

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F001		Motor Nameplate FLA FLA must be programmed for starter to function.	50 - 100% of Max Amp Rating. Upper limit of range automatically adjusts downward as Service factor is increased.	1 amp	0	
F002		Motor Nameplate Service Factor	1.00 - 1.30 SF	0.05	1.0 SF	
F003	Motor and Overload Info.	Overload Class During Start	NEMA / UL Class 5 - 20	5	Class 10	
F004		Overload Class During Run	NEMA / UL Class 5 - 30	5	Class 10	
F005		Overload Reset	0 = Manual 1 = Auto 2 = Disabled Overload	1	0 (Manual)	
F006 - F009		Reserved for factory use				

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F010		Ramp Type Selection: VR = Voltage Ramp CR = Current PID Ramp 1 = Ramp 1, 2 = Ramp 2	Setting 1 = VR1 + VR2 Setting 2 = CR1 + CR2 Setting 3 = VR1 + CR2 Setting 4 = CR1 + VR2	1	1 VR1+VR2	
F011		Initial Torque (VR) of Ramp 1	0 - 100% Line Voltage	1%	60%	
F012		Initial Torque (CR) of Ramp 1	0 - 600% Motor Current	1%	200%	
F013	Starting and Stopping Modes	Accel Ramp Time of Ramp 1	1 - 120 seconds	1 second	10 seconds	
F014		Max Current Limit of Ramp 1	200 - 600% Motor Current	1%	350%	
F015		Initial Torque (VR) of Ramp 2	0 - 100% Line Voltage	1%	60%	
F016		Initial Torque (CR) of Ramp 2	0 - 600% Motor Current	1%	200%	
F017		Accel Ramp Time of Ramp 2	1 - 120 seconds	1 second	10 seconds	
F018		Max Current Limit of Ramp 2	200 - 600% Motor Current	1%	350%	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F019	Jog Modes	Voltage Jog	5 - 100% Line Voltage	1%	50%	
F020		Time of Voltage Jog	1 - 20 Seconds	1 second	10 seconds	
F021		Current Jog	100 - 500% Motor Current	1%	150%	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F022	Kick Mode	Kick Start Voltage	0 = Disabled, or 10 - 100% Line Voltage	1%	0 Disabled	
F023		Kick Start Time	0.1 - 2 Seconds	0.1second	0.8 seconds	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F024	Pump Flex Decel Mode	Pump Flex Control / Deceleration Ramp	0 = Disabled (coast to stop) 1 = Enabled, except after OL trip 2 = Enabled, continued Decel even if there is an OL trip	1	0 Disabled	
F025		Begin Decel Level (BDL), Immediate Drop Down Torque	0 - 100 % of Output Voltage	1%	60%	
F026		Decel Shut Off Voltage	0 to (BDL minus 1)% Voltage	1%	30%	
F027		Decel Ramp Time	1 - 60 Seconds	1 second	10 seconds	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F028	Restart	Restart Delay Time (Sequential Start Delay)	0 = Disabled, or 1-999 seconds after a Power Loss (Status can be read in F054)	1 second	0 Disabled	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F29		Voltage Input	200 - 690 Volt	1	480	
F030		Voltage Imbalance Trip %	0, 1 - 30% [0=Disabled]	1(%)	0	
F031		Voltage Imbalance Trip Delay	1 - 20 seconds	1	10	
F032	Line Voltage	Over Voltage Trip %	0, 1 - 10% [0=Disabled]	1(%)	0	
F033		Over Voltage Trip Delay	1 - 20 seconds	1	10	
F034		Under Voltage Trip on Start %	0, 1 - 20% [0=Disabled]	1(%)	0	
F035		UV Trip on Start Delay	1 - 180 seconds	1	10	
F036		Under Voltage Trip on Run %	0, 1 - 20% [0=Disabled]	1(%)	0	
F037		UV Trip Delay during Run	1 - 20 seconds	1	2	
F038		Shorted SCR and Trip Delay	0, 1-10 seconds [0=Disabled]	1 second	1 second	
F039		Shunt Trip Delay	0, 1-10 seconds [0=Disabled]	1 second	1 second	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F040		Current Imbalance Trip	0 = Disabled, or 5 - 30% imbalance	1%	0 Disabled	
F041		Current Imbalance Trip Delay	1 - 20 seconds	1 second	2 seconds	
F042		Over Current Trip	0 = Disabled, or 100 - 300% of motor FLA	1%	0 Disabled	
F043	Phase Current	Over Current Trip Delay	1 - 20 seconds	1 second	1 second	
F044		Under Current Trip	0 = Disabled, or 10 - 90% of motor FLA	1%	0 Disabled	
F045		Under Current Trip Delay	1 - 60 seconds	1 second	2 seconds	
F046		Ground Fault Trip	0 = Disabled, or 5 - 90% of CT ratio from Fn 74	1%	0 Disabled	
F047		Ground Fault Trip Delay	1 - 60 seconds	1 second	2 seconds	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F048		Coast Down (Back Spin) Lockout Timer	0 = Disabled, or 1 - 60 minutes	1 minute	0 Disabled	
F049		Maximum Starts per Hour	0 = Disabled, or 1 - 10 starts	1	0 Disabled	
F050		Minimum Time Between Starts	0 = Disabled, or 1 - 60 minutes	1 minute	0 Disabled	
F051		nCP Trip (No Control Power)	0, 1 [0=Disabled, 1=Enabled]	1	0	
F052	Lockouts, Reset and Internal Protection	Auto Reset on Selected Faults	Fault Preferences 1 - 17 See Table 5.6.7: "Auto-Reset Selected Faults"	1	4, Phase Loss only	
F053		Auto Reset Attempts	0 = Disabled, or 1-10 attempts [In 1 minute cycle]	1	0 Disabled	
F054		Restart Delay Time Value Readout (for F028)	0 - 999 Seconds			
F055		Coast Down Timer Value for F048	1 - 3600 Seconds			
F056		Starts Per Hour Timer Value for F049	1 - 3600 Seconds	N/A	Read Only	
F057		Starts Per Hour For F049	1 - 10 Starts			
F058		Time Value Between Starts for F050	1 - 3600 Seconds			
F059		Thermal Capacity to Start for F005	0 - 100 % Thermal Capacity			

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F060		Aux Relay 1 setting	Operation # 1 - 32: see "Aux. Relay Settings Chart"	1	1	
F061	Output Relays	Aux Relay 2 setting	Operation # 1 - 32: see "Aux. Relay Settings Chart"	1	2	
F062		Aux Relay 3 setting	Operation # 1 - 32: see "Aux. Relay Settings Chart"	1	16	
F063		Aux. Relay Delay Timer (for Operations 28-31)	0 (Disabled), or 1-999 seconds	1 second	0 No Delay	
F064		Reserved for factory use				

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F065		Communications	0 = Disabled 1 = Enabled (11Bit) 2 = Enabled (10Bit)	1	0	
F066		Baud Rate	4.8, 9.6 and 19.2 KB	3 rates	9.6 KB	
F067	Communications	Modbus Address	1 - 247	1	1	
F068		Remote Starter Control	0=Disabled, 1=Enabled combine w/ Start button 2=As option 1, w/o Start button 3=[a. F113= 1 or 5: Enabled w/ Local/Remote switch dedicated by Jog button. Jog switch or button closed is for Remote, opened for Local. b. F113 = other value: Enabled.] **Note:** Stop button stops motor in all the remote control modes.	1	0	
F069		Reserved for factory use				

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F070		Parameter Lock Customer Password	0 - 999 0 = Disabled Any Other Numbers = Password	1	0 (displays encrypted code)	
F071		System Clear / Reset	0 = Disabled 1 = Clear THR and Lockout Timers 2 = Reset to Factory Default Settings	1	0	
F072		Reserved for Factory Use				
F073		Frame Rating	10 – 2000 Factory set	1	By Model (defaults to 48)	
F074	System Settings	CT Value	10 – 2000 Factory set	5	By Model (defaults to 40)	
F075		Year	2000 - 2047	1 year	2000	
F076		Month	1 - 12	1 Month	1	
F077		Day	1 - 31	1 Day	1	
F078		Hour	0 - 23	1 Hour	0	
F079		Minute	0 - 59	1 Minute	0	
F080		Second	0 - 59	1 Second	0	
F081		Revision #	-	-	Factory Setting	
F082 - F084		Reserved for factory use				

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F085		Fault History #1, Latest Fault	0 = No fault history, or Fault # 1 - 57: see Fault code list			
F086		Time Stamp, Fault #1 Based on F078-80	00.00 - 23.59 (hh.mm) [hh = 00 - 23; mm = 00 - 59]			
F087		Date Stamp, Fault #1 Based on F076-77	01.01 - 12.31 (MM.DD) [MM = 01 - 12; DD = 01 - 31]			
F088		Fault History #2, Previous Fault	0 = No fault history, or Fault # 1 - 57: see Fault code list			
F089	Fault History and Run Data	Time Stamp, Fault #2	00.00 - 23.59 (hh.mm) [hh = 00 - 23; mm = 00 - 59]			
F090		Date Stamp, Fault #2	01.01 - 12.31 (MM.DD) [MM = 01 - 12; DD = 01 - 31]			
F091		Fault History #3, Oldest Fault	0 = No fault history, or Fault # 1 - 57: see Fault code list	N/A	Read Only	
F092		Time Stamp, Fault #3	00.00 - 23.59 (hh.mm) [hh = 00 - 23; mm = 00 - 59]			
F093		Date Stamp, Fault #3	01.01 - 12.31 (MM.DD) [MM = 01 - 12; DD = 01 - 31]			
F094		Run Time, Hours	000.0 - 999.9 hours			
F095		Run Time, 1000 Hour Overflow	0000 - 9999 thousand hours			
F096		Run Cycle Counter	0000 - 9999 times			
F097		Run Cycle Counter 10K overflow	0000 - 9999 10 thousand times			

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F098		Phase Rotation Trip	0, 1 or 2 0=Disabled, 1=ABC, 2=ACB]	1	0	
F099	Phase and Frequency Protection	Phase Rotation Trip Delay	1 - 3 seconds	1	1	
F100		Phase Loss Trip and Delay during Stop	0, 1-20 Seconds [0= Disabled]	1	1	
F101		Phase Loss Trip and Delay during Running	0, 1-20 Seconds [0= Disabled]	1	3	

5.5.15 Motor Power Protection Settings

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F102	Power Protection	Motor KW Trip	0 - 2 0 = Disabled 1 = Over KW Trip 2 = Under KW Trip	1	0	
F103		Motor KW Trip Point	20 - 100% of full load KW	1%	50(%)	
F104		Motor KW Trip Delay Time	1 - 999 seconds	1	1	
F105		Power Factor Trip Range	0, 1 - 3 [0=Disabled, 1=lag, 2=lead, 3= lead/lag]	1	0	
F106		Power Factor Trip Point	.01 - 1	.01	.50	
F107		Power Factor Trip Delay Time	1 - 20 seconds	1	2	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F108	Power Protection	Analog Output	0 - 12, 0: OFF; See Page 62 for settings.	1	OFF	
F109		Analog Output 4mA	0 - 9999	1	0	
F110		Analog Output 20mA	0 - 9999	1	9999	

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting
F111	System Settings	Default Display	1 - 12 (See Table of Default Display)	1	10	
F112		System Settings	Reserved for factory	-	-	
F113		Alternate functions for Ramp2/Jog inputs	See Table page 64	1	7	

Warranty information.

1 Year Warranty: Phasetronics, Inc., dba Motortronics, (hereinafter "Company") warrants the *VMX2 Series* products to be free from defects in material and/or workmanship for a period of one (1) year from the date of sale, or a maximum of 18 months from the date of manufacture (if no sales records are available) as indicated by the unit's date code. The Company reserves the right to repair or replace any malfunctioning units or sub-assemblies under warranty at the Company' sole option. Warranty repairs may be performed at the Company's facility, in the field by a factory-authorized technician, or by the customer only with prior approval and at the specific direction of the Company's Technical Services personnel. During the 1 year period, malfunctions of the control boards will be dealt with by replacement of the Modular Control Assembly (MCA), which contains the User Interface Panel, Digital Control Unit, Bypass control (if any), and Communications Interface. The MCA is designed to be replaced quickly without the need for tools (plug-in), and as such will constitute the majority of warranty replacements.

Warranty Service Procedure:
In the event that warranty service becomes necessary, contact the distributor where the starter was purchased, or Motortronics Technical Services department directly at (727) 573-1819. Be prepared to provide the complete Model number, Serial Number, date and place of purchase. It is also helpful to know the date of initial commissioning. When Technical Services has determined the nature of the problem and that sending replacement parts or assemblies can repair it, they will require a purchase order for replacement parts and issue a Return Material Authorization (RMA) for the defective parts or assemblies. If any, components or assemblies are received at the factory without the proper RMA documentation, the shipment(s) will be refused.

When the replacement parts are received and evaluated at the factory, any warranty determination will result in an offsetting credit being issued for the replacement parts already sent out. If the unit is not needed for immediate operation, an alternative is to have the Technical Services representative provide an RMA for the components, and they will be evaluated and repaired at the factory, and returned. In either circumstance, freight/shipping costs are the responsibility of the purchaser.

Responsibility:
Company is not responsible for the misuse or misapplication of its products, intentional or otherwise. Improper application, installation, failure to provide safety devices or protective measures, or operation above its ratings, and failure to properly maintain or service products are all beyond the control and responsibility of the Company. Under no circumstances shall the Company be liable for loss of profits, indirect, incidental, special, consequential, or other similar damages arising out of the misuse, misapplication, or failure to maintain the Company's products.

SCR power devices used in the *VMX2 Series* (and all other solid state motor control products) are covered under warranty only when it has been determined by the Company that a failure of another system within the MCA or firing board circuit has directly caused damage to the SCRs. Although every effort is provided to prevent SCR damage, it can still occur as a result of circumstances beyond the control of the Company. Improper starting conditions such as undersizing, rapid duty cycling and improper settings, or external power problems such as lightning strikes, capacitor switching, shorted motor windings or locked rotor currents can all cause damage to SCRs under the wrong circumstances. Failures under those conditions are not covered under warranty.

California Customers:

California Proposition 65 Warning
WARNING: this product and associated accessories may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information visit https://p65warnings.ca.gov

MOTORTRONICS ™

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VMX2

Compact Soft Starter

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