TOSHIBA

DOCUMENT: NBZ0001

INSTRUCTION MANUAL

INSTALLATION - OPERATION - MAINTENANCE

TD SERIES

Low Voltage
Digital Solid State Starter

48 - 1250 A

Issued: 9/03
Manufactured in the USA

SAFETY

SAFETY CODES

Toshiba motor control is designed and built in accordance with the latest applicable provisions of NEMA and the National Electrical Code. Installations must comply with all applicable state and local codes, adhere to all applicable National Electric Code (NFPA 70) standards and instructions provided in this manual.

HAZARDOUS VOLTAGE will cause severe injury, death, fire, explosion and property damage.

- Turn off and lock out Primary and Control Circuit Power before servicing.
- Keep all panels and covers securely in place.
- Never Defeat, Modify, or Bypass any Safety Interlocks.
- Qualified Operators only.

⚠WARNING

Never attempt to install, operate, maintain or dispose of this equipment until you have first read and understood all of the relevant product warnings and user directions that are contained in this Instruction Manual.

Use only Toshiba-authorized replacement parts.

This equipment is designed and built in accordance with applicable safety standards in effect on the date of manufacture. Unauthorized modifications can result in voiding the warranty, severe injury, death and property damage. Do not make any modifications to this equipment without the written approval of Toshiba.

For assistance, address correspondence to:

Toshiba International Corporation
Field Service Department
13131 West Little York Road
Houston, Texas 77041 USA

or call: (713) 466-0277
(800) 231-1412
(800) 527-1204 (Canada)

Fax: (713) 466-8773

Please complete the following information for your records and retain with this manual:

Model: _____

Serial Number: _____

Date of Installation: _____

Inspected by: _____

Reference Number: _____

SAFETY

IMPORTANT MESSAGES

Read this manual and follow its intructions. Signal words such as DANGER, WARNING and CAUTION will be followed by important safety information that must be carefully reviewed.

DANGER Indicates a situation which will result in death, serious injury, and severe property damage if you do not follow instructions.

WARNING Means that you might be seriously injured or killed if you do not follow instructions. Severe property damage might also occur.

CAUTION Means that you might be injured if you do not follow instructions. Equipment damage might also occur.

NOTE Give you helpful information.

Note: The contents of this manual will not become a part of or modify the warranty policy, the terms of which are set forth at the end of this manual.

READ SAFETY SIGNS

To avoid injury, you must read and follow all safety signs.

Keep the safety signs visible and in good shape. Never remove or cover any safety sign.

DANGER

QUALIFIED OPERATORS ONLY

Only qualified persons are to install, operate, or service this equipment according to all applicable codes and established safety practices.

A qualified person must:

1) **Carefully read the entire instruction manual.**
2) Be skilled in the installation, construction or operation of the equipment and aware of the hazards involved.
3) Be trained and authorized to safely energize, de-energize, clear, ground, lockout and tag circuits in accordance with established safety practices.
4) Be trained and authorized to perform the service, maintenance or repair of this equipment.
5) Be trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shield, flash clothing, etc. in accordance with established practices.
6) Be trained in rendering first aid.

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TD Series
Digital Solid State Soft Starter
48 - 1250A

Chapter 1 - Introduction

1.1 General

The ***TD 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 60 seconds (compared to 350% for 30 seconds from other manufacturers). The ***TD Series*** features smooth, stepless ramp control which reduces motor inrush current and excessive wear on the mechanical drive train components. In addition to having easy to understand diagnostic LEDs, the ***TD Series*** includes a programmable keypad for setting operating parameters for the ideal starting cycle. Starting torque, ramp time, current limit, dual ramp, and decel control are standard features on the ***TD Series***. By simply adjusting the unit's 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 ***TD Series*** includes solid state electronic overload protection in addition to numerous other protective features. It is factory wired for 120 VAC control voltage and two or three-wire start/stop control (Units can also be ordered with 240 VAC control voltage if required). Programmable auxiliary contacts and provisions for interlocking are also included.

1.2 Specifications and Performance Features

Type of Load	Three phase AC induction motor
AC Supply Voltage	208 - 600VAC ±10%, 50/60 Hz
HP Ratings	48 - 1250 Amps, 10 - 1125 HP
Unit Overload Capacity (Percent of motor FLA)	125% - Continuous 500% - 60 seconds 600% - 30 seconds
Power Circuit	6 SCRs
SCR Diode Ratings (Peak Inverse Voltage)	1600V
Phase Insensitivity	Unit operates with any phase sequence
Transient Voltage Protection	RC snubber dv/dt networks on each phase.
Cooling	Convection up to 180A, fan assisted 62 - 120A, Fan ventilated 220 - 1250A
Bypass Contactor	Full horsepower rated contactor included as standard in all Type 12, 3R, 4 & 4X enclosed units 120A and above.
Ambient Condition Design	Chassis units: 0° to 50 °C (32° to 122°F) Enclosed units: 0° to 40°C (32° to 104°F) 5 - 95% relative humidity 0 - 3300 ft. (1000m) above sea level without derating
Control	2 or 3 wire 120VAC (customer supplied) Optional 240VAC control voltage and CPTs are available.
Auxiliary Contacts	Type / Rating: Form C (SPDT), rated 5 Amps, 240VAC max. (1200VA)
	3 Programmable Relays
	Fault Indicator: AC triac solid state switch 240VAC, 50mA max.
Approvals	UL Listed, Canadian UL (cUL) Listed

1.2 Specifications and Performance Features Cont'd

Advanced Motor Protection	
Two Stage Electronic Overload Curves	Starting: Programmable for Class 5 through 30 Run: Programmable for Class 5 through 30 when "At-Speed" is detected.
Overload Reset (Note 1)	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.
Phase Current Imbalance Protection (Note1)	Imbalance Trip Level: 5 - 30% current between any two phases Imbalance Trip Delay: 1 -20 seconds
OverCurrent (Electronic Shear Pin) Protection (Note 1)	Trip Level: 50 - 300% of motor FLA Trip Delay: 1 - 20 seconds
Load Loss Trip Protection (Note 1)	Under Current Trip Level: 10 -90 % of motor FLA Under Current Trip Delay: 1 - 60 seconds
Coast Down (Back Spin) Lockout Timer (Note 1)	Coast Down Time Range: 1 - 60 minutes
Starts-per-hour Lockout Timer (Note 1)	Range: 1 - 10 successful starts per hour Time between starts: 1 - 60 minutes between start attempts
Programmable Outputs	
Type / Rating	Form C (SPST), Rated 5 amps 240 VAC max, (1200 VA)
Run Indication	Start/Stop or Start/End of Decel
At Speed Indication	At Speed/Stop or At Speed/End of Decel
Acceleration Adjustments	Programmable Ramp Types: Voltage or Current Ramp (VR or CR) Starting Torque: 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: VR1+VR2; VR1+CR2; CR1+CR2; CR1+VR2 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)	Voltage Jog: 5 - 100% Time of Voltage Jog: 1 - 20 seconds Current Jog: 100 - 500%
Kick Start Settings (Note 1)	Kick Voltage: 10 - 100% Kick Time: 0.1 - 2 seconds
Fault Indications	Shorted SCR, Phase Loss, Shunt Trip, Phase Imbalance Trip, Overload, Overtemp, Overcurrent, Short Circuit, Load Loss, or Any Trip
Lockout Indicator	Coast Down Time, Starts Per Hour, Time Between Starts, and Any Lockout

Note 1: Enabled via programming

1.2 Specifications and Performance Features Cont'd

	Metering Functions
Phase Currents	0 - 9999 Amps, Phase A, B, or C
Remaining Thermal Capacity	0 - 100% of available motor thermal capacity
Elapsed Time	0 - 1,000,000.0 hours, non resetable
Run Cycle Counter	0 - 10,000,000 run commands non resetable
Lockout Time Values	Remaining time of any enabled lockout timer
Fault Codes	Abbreviated fault codes, indicating trip and operating mode
Fault History	Last 3 faults with Time and Date Stamps
	Serial Communications
Protocol	Modbus RTU
Signal	RS-485
Network	Up to 247 devices per mode
Functionality	Full operation, status view, and programming via communications port
	Operator Interface
LED Readout	4 digit alpha numeric, high brightness, 7 segment display
Keypad	8 functions keys with tactile feedback
Status Indicators	8 LEDs
Remote Mount Capability	Up to 10 feet (3 meters) from chassis
	Clock and Memory
Operating Memory	DRAM loaded from EPROM and EEPROM at initialization
Factory Default Storage	Flash EPROM, field replaceable
Customer Settings and Status	Non-volatile EEPROM, no battery backup necessary
Real Time Clock	Lithium ion battery for clock memory only, 10+ years life span

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 sticker on the unit matches or is greater than the motor's HP and current rating.

2.2 Location

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

- Ambient operating temperature:
  Chassis unit: 0 to 50°C (32 to 122°F)
  Enclosed unit: 0 to 40°C (32 to 104°F)
- Protected from rain and moisture
- 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. Contact factory for assistance in sizing enclosures.

2.3 Initial Unit Inspection

- Make a complete visual check of the unit for damage which 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 ***TD*** unit are rated for the proper amperage and voltage.

2.4 Warning!

⚠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.

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 actually short out electronics. After work is complete, thoroughly clean the area and reinspect the unit for foreign material. Make sure there is sufficient clearance (six inches) all around the unit for cooling, wiring and maintenance purposes. To maximize effective air flow and cooling, the unit must be installed with its heat sink ribs oriented vertically and running parallel to the mounting surface.

⚠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 80 to 100 psi, clean, dry compressed air only. A three inch, high quality, dry paint brush is helpful to loosen up the dust prior to using compressed air on the unit.

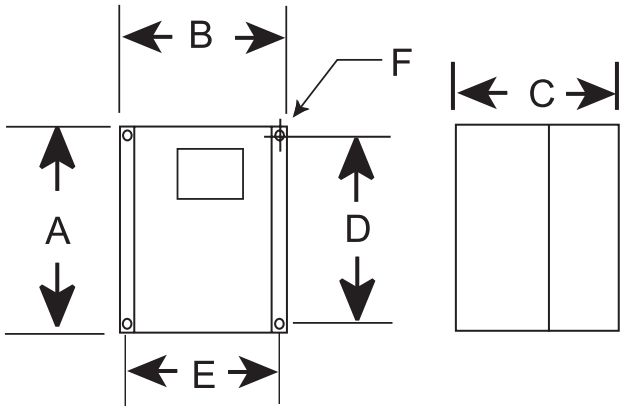
2.6 Power Terminal Wire Range and Tightening Torque

Model Number	Wire range	Torque lbs/in
TD005	#18 - #4	20
TD006	#14 - #2	50
TD007	#6 - 250 kcmil	325
TD008		
TD009	(2) #2 - 600 kcmil	375
TD010		
TD011	(2) #2 - 600 kcmil	375
TD012		
TD013		
TD014	(3) #2 - 600 kcmil	375
TD015		
TD016	(4) #2 - 600 kcmil	375
TD017		

Note: All wiring must be sized according to NEC standards.

2.7 Dimensions

Model Number	TD CHASSIS (PANEL MOUNT) DIMENSIONS					
	Overall Dimensions (inches)			Mounting Dimensions (inches)		
	A	B	C	D	E	F
TD005A - TD007A	16.5	10	10	15.9	9	0.28
TD008A	20	20.1	12	18.5	17.5	0.44
TD009A - TD010A	27	20.1	11.2	25.5	17.5	0.44
TD011A - TD013A	29.5	20.1	11.5	25.5	17.5	0.44
TD014A - TD015A	45	33	12.8	43.3	31.3	0.44
TD016A - TD017A	33	33	15.2	31.2	31.2	0.44



Chapter 3 - Motor Overload Protection

3.1 Solid State Overload Protection

The ***TD Series*** Starter provides true U.L. listed I^2T Thermal Overload Protection as a built-in function of the main digital processor. For maximum protection it simulates the tripping action of a bimetallic overload relay, with the accuracy and repeatability of a digital control system, yet is adjustable over a wide range and can be easily programmed for different trip curves.

3.1.1 Thermal Memory

The ***TD Series*** microprocessor uses a sophisticated "Thermal Register" to keep track of motor heating and cooling over time regardless of the starter's power status. The ***TD Series*** does not "forget" that the motor has been running even if power to the starter is turned off and 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 remaining thermal capacity. The percentage value begins at 100, showing that the motor is cool. 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 will provide maximum protection yet eliminates nuisance tripping.

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: If F001 is left at the factory default, the unit will not operate. If the user attempts to start the TD without entering the motor nameplate FLA into this Function, the TD will Fault, and the display will read "nFLA" (for no Full Load Amps).

3.1.3 Disabling the Overload Protection

The Overload Protection feature can be disabled if absolutely necessary. When using external devices such as Motor Protection Relays or when the ***TD Series*** is wired downstream from an existing starter, this feature can be disabled to prevent conflicts with external overload protection devices. When the ***TD Series*** is controlling multiple motors, Overload Protection must be disabled. Individual thermal overload relays must be installed on the motor leads going to each motor. To disable the Overload Protection function, use F005. (See Section 5.)

⚠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. 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 glow 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 TD Series has reset itself after the cool down period.

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

⚠WARNING **MOTOR CONNECTED TO THIS EQUIPMENT MAY START AUTOMATICALLY WITHOUT WARNING**

3.2 NEMA Class Trip Curves

The ***TD Series*** Soft Starter provides six NEMA Class trip curve options: 5, 10, 15, 20, 25, and 30. Program the appropriate curve according to the characteristics of your motor and load.

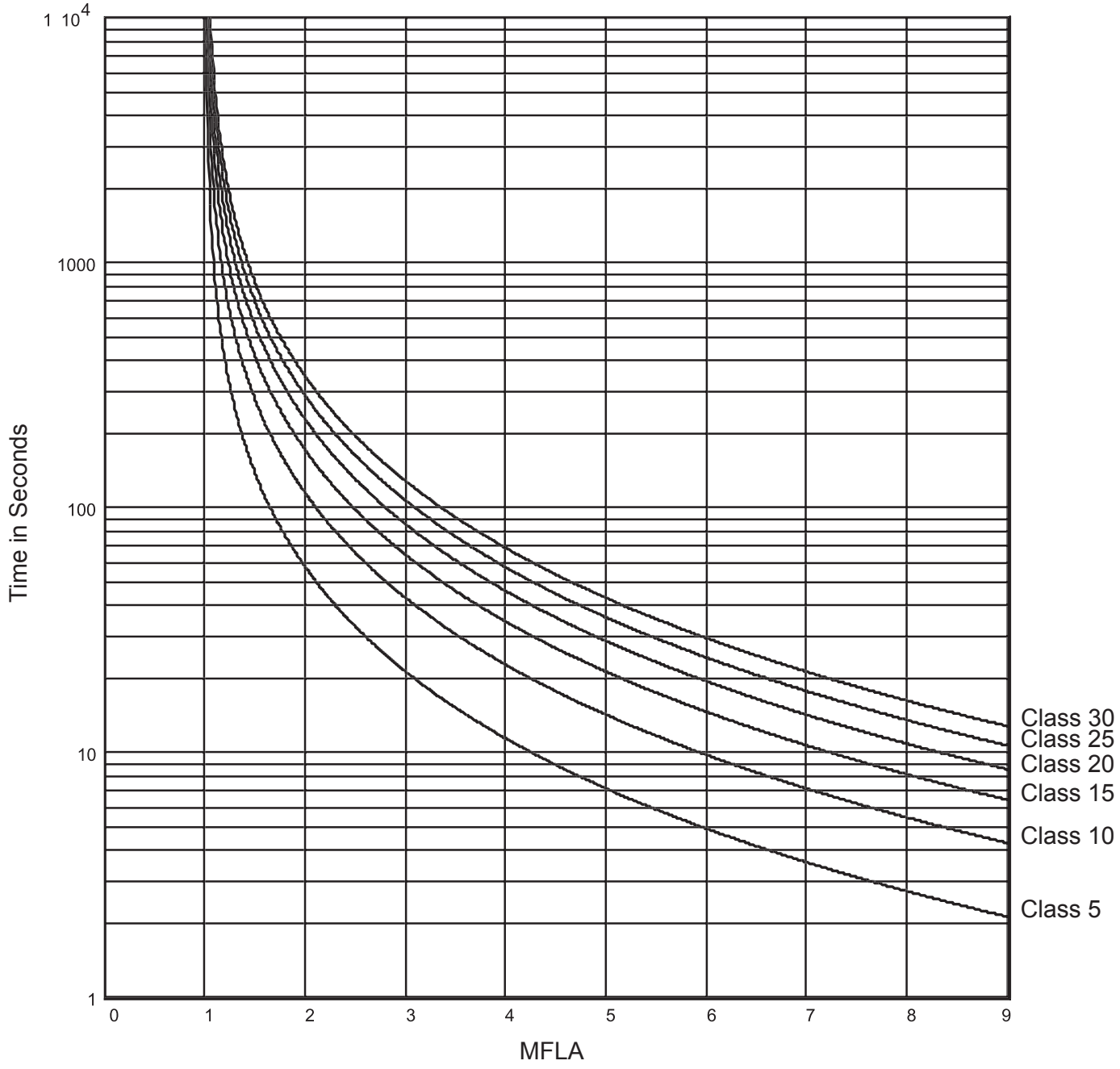
NEMA Class trip curves are based on a common tripping point of 600% of rated current. Curves vary by the amount of time before the unit trips. As an example, a Class 20 curve will trip in 20 seconds at 600%. The factory default setting of Class 10 will trip in 10 seconds at 600%.

3.2.1 Dual Overload Trip Curves

The ***TD Series*** Soft Starter provides two separate Overload Trip Protection Curves, one for starting and one for running conditions. Programming a higher NEMA Class overload during start (ramp-up) will eliminate nuisance tripping in higher inertia or high friction loads.

The starter's At-Speed detection circuit determines when the motor has reached full speed based on closed loop feedback signals. 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 for programming details.

TD Series
Overload Trip Curves



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

Chapter 4 - Connections

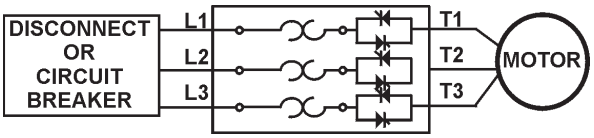
4.1 Power Connections

Connect appropriate power lines to the unit input terminals marked L1, L2, L3. Avoid routing power wires near the control board. Connect the motor leads to the unit terminals marked T1, T2, T3. Refer to NEC standards for wire length and sizing. Never interchange input and output connections to the unit. This could cause excessive voltage in the control logic circuit and may damage the unit.

⚠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.**

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. Note that line voltage will appear across the output terminals if there is no motor or load connected to the unit. In areas where lightning is a significant problem, stationary air gap lightning arrestors should be considered and utilized on the input power source.

TD Series Unit
Power Connections



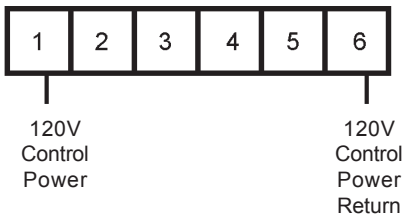
4.1.1 Grounding

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

4.2 Control Connections

4.2.1 Control Power Connections

TB1



Unit comes standard with 120VAC control. Order 240VAC control as an option if required.

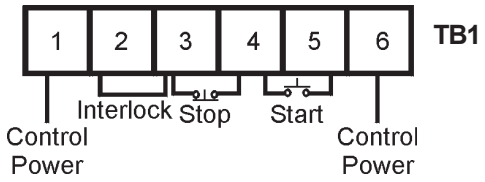
Separate 120VAC supply is required (order 240 VAC if required). The control voltage should be connected to pins 1 and 6 of TB1. This control voltage must be customer supplied, unless an optional control power transformer has been supplied with the unit. The terminal block TB1 is located on the main power board. However, on units rated 150 Amps and above, TB1 us brought out to a duplicate terminal block on the back panel assembly.

4.2.2 Three-Wire Connection

For standard 3-wire control connect 120VAC to pins 1 and 6 of TB1. Connect N.C. (normally closed) stop button between pins 3 and 4 of TB1. Connect N.O. (normally open) start button between pins 4 and 5 of terminal block TB1.

4.2.3 Two-Wire Connection

An alternate connection for unattended operation replaces start/stop push buttons

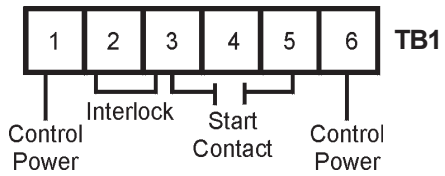


Three-Wire Connection

by connecting a maintained contact closure between pins 3 and 5 on TB1. When the maintained contact is used for start/stop it is necessary 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 off.

⚠WARNING

When two-wire connection method is used, the user's control circuit must be interlocked to prevent automatic restart when protective devices reset. Refer to section 3.1.3.b.



Two-Wire Connection

4.2.4 Relay Contacts

All the relay contacts are FORM C common (N.O., N.C.), except the optical triac output. TOSHIBA recommends fusing all contacts with external fuses. TB2 is the terminal block for all auxiliary contacts. Each contact is explained in the following sections. See Chapter 9 for main control board layout.

4.2.5 Programmable Relays

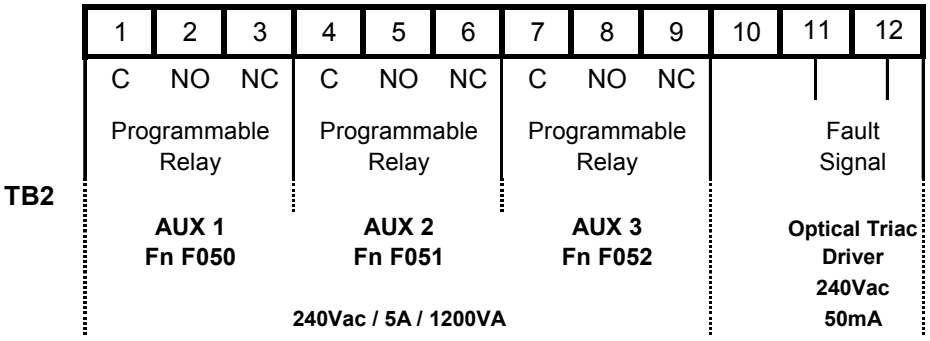
Three programmable relays are on TB2 which is located on the main control board. The relays are rated for 240 VAC, 5 A and 1200 VA.

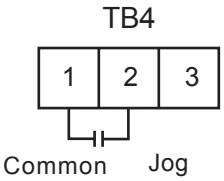
Factory settings for these relays are:

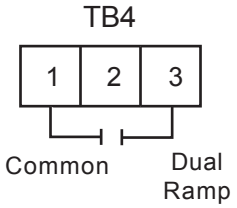
AUX 1 - Run / Stop (**F050 = 1**)

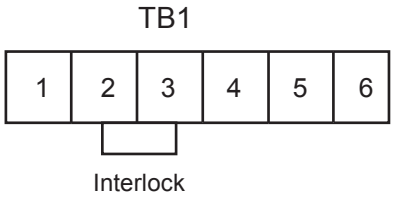
AUX 2 - At Speed / Stop (F051 = 2)

AUX 3 - Any Trip (F052 = 14)









4.2.6 Fault Signal

An optical AC switch triac driver is used for fault indication. This signal energizes with the fault LED. The optical output is rated for 240 VAC, 50 mA (maximum).

4.2.7 Resetting Faults

To reset faults, press the RESET key on the keypad.

4.2.8 Enabling the Jog Function

Closing TB4 Pins 1 and 2 will enable the Jog feature. 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. See chapter 9 for main control board layout.

4.2.9 Enabling the Dual Ramp Feature

Closing TB4 Pins 1 and 3 will enable ramp 2. The dual ramp feature is useful in instances where a load changes such as 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.

4.3 Interlock Connection

TB1 provides a connection point for an external user N.C. (normally closed) interlock device between pins 2 and 3. (Examples of the use of this interlock connection would be for conditions such as low oil, high temperature, or excess vibration from user supplied devices).

A factory installed jumper is provided which allows the ***TD*** unit to operate if external interlocks are not used. If this jumper is removed and an interlock is not used, the ***TD*** unit will not function.

Chapter 5 - Programming

5.1 Introduction

It is best to operate the motor at its full load starting condition 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).

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

5.2 Digital Interface

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

Keys	Reset	Clears the trip indicator and releases the trip relay.
	Fn	Enters or exits the program mode.
	Up Arrow	Navigates through the Status Display Mode, scrolls up through the list of functions, increases the value of an active (flashing) digit, and scrolls through the history of fault conditions.
	Right Arrow	Each keypress shifts the active (flashing) digit to the right one position, use to change function number or value.
	Down Arrow	Navigates through the Status Display Mode, scrolls down through the list of functions, decreases the value of an active (flashing) digit, and scrolls through the history of fault conditions.
	Left Arrow	Each keypress shifts the flashing digit to the left one position, use to change function number or value.
	Read Enter	Selects and stores the value of a function.
Green LEDs	Power On	Control power is present.
	At Speed	Motor is at full speed and power. (The SCRs have phased fully on.)
Yellow LEDs	Shunt Trip	Two or more power poles are shorted and current is passing to the motor while in the off mode. For positive motor protection, an auxiliary relay should be be programmed for "Shunt Trip" and should be interlocked with a shunt trip breaker or in-line contactor. (In the event of a shunt trip, do not re-power the unit without repairing the power poles.)
	Shorted SCR	Shorted SCR has been detected in the unit. Refer to section 8.2 for instructions on checking SCRs.
	Over Current	Over Current LED illuminates for two sets of fault conditions: over current and short circuit. If unit experiences output current (of any phase) in excess of the value programmed in F034 (over current trip %) for the time period specified in F035 (over current trip delay), this LED will illuminate and either oCA, oCC, or oCd will be displayed. If unit experiences a short circuit fault condition, the Over Current LED illuminates and either SCA, SCC, or SCd will be displayed. This trip is fixed at 10 times the full load motor current and is not adjustable.
	Phase Loss	One or more of the phase currents is low or has been lost while the motor was starting or running.
	Over Temp	Motor starter has tripped due to heat sink over temperature.
	Over Load	Starter's motor overload has tripped. The overload must be reset before the fault can be cleared
Display	8888	4 digit 7 segment display

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

The Status Display Mode displays three phase motor current information and the thermal capacity remaining.
Status mode:

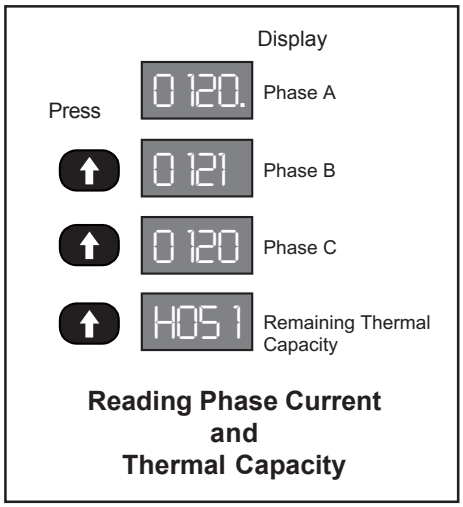
- [0000.] The initial display on power up is four digits and the decimal. This indicates the motor current for Phase A of the motor.
- [0000] Scroll up to display four digits only (no decimal). This indicates the motor current for either Phase B or C. While viewing Phase A, press the **UP** arrow once to view Phase B or twice to view Phase C current.
- [H000] Scroll up to display the "H". This indicates that this value is the remaining thermal capacity of the motor (as a percentage i.e. H070 = 70% remaining thermal capacity)

Reading Phase Current and Thermal Capacity (See Example)

[0120.] Indicates that Phase A is drawing 120 amps.
Press the **UP** arrow.
[0121] Indicates that Phase B is drawing 121 amps.
Press the **UP** arrow.

NOTE: Decimal points are not present in the readouts for Phase B and Phase C.

[0120] Indicates that Phase C is drawing 120 amps.
Press the **UP** arrow.
[H051] Indicates that the motor has 51% of its thermal capacity remaining.



Reading Phase Current and Thermal Capacity

5.3.2 Program Mode

Use the Program Mode to view or change Function (Fn) settings.

To enter the Program Mode, press the [Fn] key once. The first time you enter Program Mode after power has been cycled to the starter, the initial function [F001] should display with the selected digit flashing. If the ***TD*** Soft 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.

Program Mode:

- [F001] The "F" indicates the programmable function.
- [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 step.

Viewing a Function's Set Value (See Example)

NOTE: If password protection has been enabled, operator will need to obtain password access before function settings can be changed.

[0000.] Indicates that Phase A is drawing no current.

Press the **Fn** key.

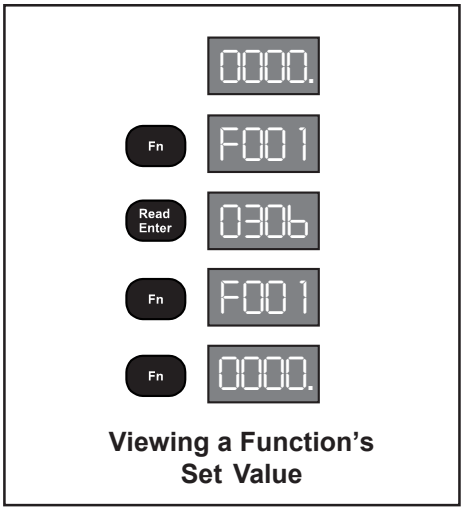
[F001] Indicates that this is (function 001) Motor FLA.

To view the F001's value, press

Read Enter.

[0306] Indicates that the programmed motor FLA is 306 Amps.
Press the **Fn** key to return to the function.

[F001] Press the **Fn** key again to return to the Status Display Mode.



Viewing a Function's Set Value

Enabling Password Protection / Parameter Lock

The ***TD Series*** Soft Starter is shipped with the Customer password disabled (F060 = 0). If it is necessary to prevent parameters from being changed inadvertently, set the password in function F060. See Appendix 4 for details.
The display of a customer password is encrypted. If you do not have a record of the password and need to gain access, contact TOSHIBA Tech Support. Be ready to provide the ***TD Series*** serial number and the four digits in the encrypted display. If the display reads "Err" when the READ/ENTER key is pressed, the parameter lock is enabled.

Changing a Function's Set Value

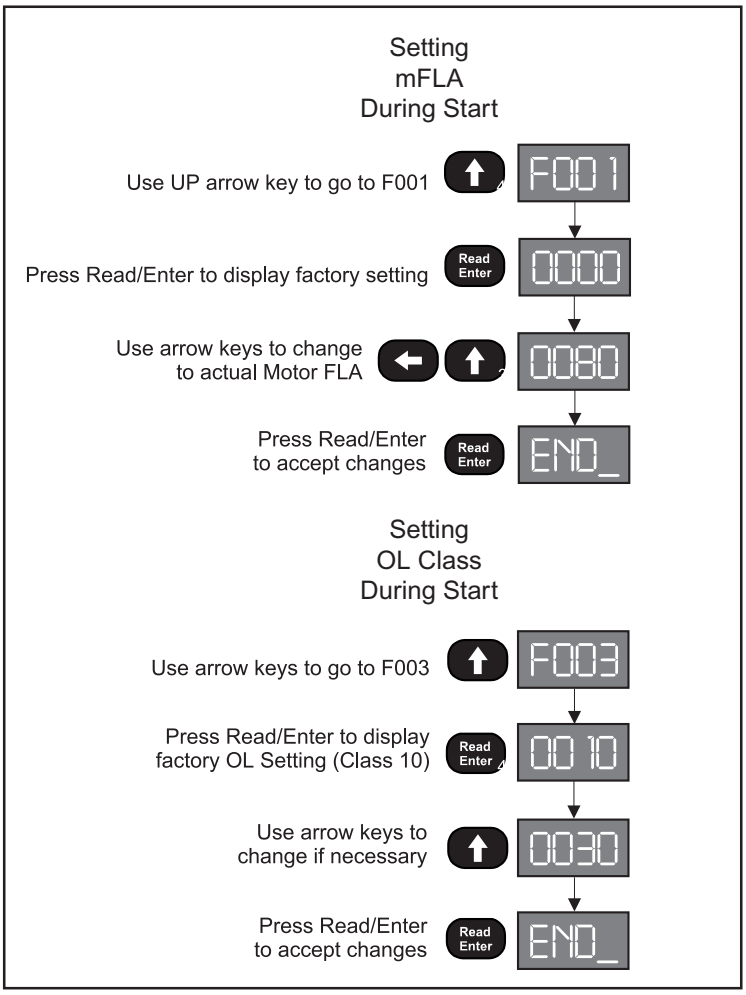
Use the **UP** arrow key to increment the value of the flashing digit. Use the **DOWN** arrow key to decrement the value of the flashing digit. Use the **LEFT** or **RIGHT** arrow to select the next digit to be altered. Values can only be changed within the Adjustment Range of the function parameter.

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 another function code.

NOTE: If the Fn key is pressed BEFORE the READ/ENTER key is pressed, the *TD Series* Starter will not store the selected value in memory.

Setting Motor FLA and Overload Class During Start (See Example)



5.3.3 Fault Mode

The Fault Display Mode provides information to the operator when a fault occurs or when the operator wishes to review fault history. Refer to Section 7 for details.

Fault codes are three-digits in length and are displayed in 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 **A**cceleration. C denotes **C**onstant speed. D denotes **D**ecel.

Reading Fault Code (See Example)

[PLC.] Indicates a Phase Loss fault was detected while at Constant Speed. The decimal point (to the right of the C) denotes that this is the most recent fault condition.

Reading Fault Code

Once a fault condition has been corrected, pressing the **Reset** key will return the readout to the Status Display mode. Fault History can be accessed during a fault condition. While the current fault number is being displayed, use the Up and Down Arrow keys to scroll through the Fault History. Access Fault History via Functions F075 through F083.

5.4 The TD Function List

5.4.1 Motor FLA, Service Factor and Overload Protection Functions

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F001	Motor and Overload	Motor Nameplate FLA Motor FLA must be programmed for proper unit operation.	50-100% of starter Max. Amp rating Upper limit of range automatically adjusts downward as Service Factor is increased	1 amp	0 (Starter disabled until set to FLA)	5.5.1
F002		Motor Nameplate Service Factor	1.00 - 1.30	0.05	1.0 SF	5.5.1
F003		Overload Class During Start	5 - 30 NEMA / UL Class Overload Time / Trip Curve	5	Class 10	5.5.1
F004		Overload Class During Run	5 - 30 NEMA / UL Class Overload Time / Trip Curve	5	Class 10	5.5.1
F005		Overload Reset	0=Manual 1=Auto 2=Disabled Overload	1	0 (Manual)	5.5.1
F006-F009		Reserved	Reserved	Reserved	Reserved	5.5.1

5.4.2 Starting Mode Functions

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F010	Starting Mode	Ramp Select VR = Voltage Ramp, CR = Current Ramp	Range is 1 - 4 Setting to #1: Ramp 1 = VR, Ramp 2 = VR Setting to #2: Ramp 1 = CR, Ramp 2 = CR Setting to #3: Ramp 1 = VR, Ramp 2 = CR Setting to #4: Ramp 1 = CR, Ramp 2 = VR	1	1 (VR1-VR2)	5.5.2
F011		Initial Voltage of Ramp 1	0-100%	1%	60%	5.5.2
F012		Initial Current of Ramp 1	0-600% (note1)	1%	200%	5.5.2
F013		Accel Ramp Time of Ramp 1	1-120 seconds	1 second	10 seconds	5.5.2
F014		Max Current Limit of Ramp 1	200 - 600% (note1)	1%	350%	5.5.2
F015		Initial Voltage of Ramp 2	0-100%	1%	60%	5.5.2
F016		Initial Current of Ramp 2	0-600% (note1)	1%	200%	5.5.2
F017		Accel Ramp Time of Ramp 2	1-120 seconds	1 second	10 seconds	5.5.2
F018		Max Current Limit of Ramp 2	200 - 600% (note1)	1%	350%	5.5.2

5.4.3 Jog Mode Functions

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F019	Jog Mode	Voltage Jog	5 - 100%	1%	50%	5.5.3
F020		Time of Voltage Jog	1 - 20 Seconds	1 second	10 seconds	5.5.3
F021		Current Jog	100 - 500%	1%	150%	5.5.3

Note 1: Current percentages are based on Motor Full Load Amps (FLA) as entered in F001.

5.4.4 Kick Start Mode Functions

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F022	Kick Start Mode	Kick Start	0=Disabled 1=Enabled	1	0 (Disabled)	5.5.4
F023		Kick Voltage	10 - 100%	1%	65%	5.5.4
F024		Kick Time	0.1 - 2 Seconds	0.1 second	0.8 seconds	5.5.4

5.4.5 Decel Mode Functions

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F025	Decel Mode	Deceleration Ramp	0=Disabled / Coast to Stop 1=Enabled (except in event of OL Trip) 2=Enabled (continued Decel on OL Trip)	1	0 (Disabled)	5.5.5
F026		Begin Decel Level (BDL)	0 - 100 %	1%	60%	5.5.5
F027		Decel Shut Off Voltage	0 to (BDL minus 1)%	1%	30%	5.5.5
F028		Decel Ramp Time	1 - 60 Seconds	1 second	10 seconds	5.5.5
F029		Reserved	Reserved	Reserved	Reserved	5.5.5

5.4.6 Protection Features

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F030	Protection Features	Current Imbalance Trip	0=Disabled 1=Enabled	1	0 (Disabled)	5.5.6
F031		Current Imbalance Trip %	5 - 30%	1%	10%	5.5.6
F032		Current Imbalance Trip Delay	1 - 20 seconds	1 second	2 seconds	5.5.6
F033		Over Current / Shear Pin Trip	0=Disabled 1=Enabled	1	0 (Disabled)	5.5.6
F034		Over Current / Shear Pin Trip %	50 - 300% (note1)	1%	125%	5.5.6
F035		Over Current Trip Delay	1 - 20 seconds	1 second	1 second	5.5.6
F036		Under Current Trip	0=Disabled 1=Enabled	1	0 (Disabled)	5.5.6
F037		Under Current Trip %	10 - 90% (note1)	1%	40%	5.5.6
F038		Under Current Trip Delay	1 - 60 seconds	1 second	2 seconds	5.5.6
F039		Coast Down Lockout Timer	0=Disabled 1=Enabled	1	0 (Disabled)	5.5.6
F040		Coast Down Lockout Time	1 - 60 minutes	1 minute	5 minutes	5.5.6
F041		Starts per Hour Lockout	0=Disabled 1=Enabled	1	0 (Disabled)	5.5.6
F042		Maximum Starts per Hour	1 - 10	1	2	5.5.6
F043		Time Between Starts Lockout	0=Disabled 1=Enabled	1	0 (Disabled)	5.5.6
F044		Minimum Time Between Starts	1 - 60 minutes	1 minute	15 minutes	5.5.6
F045		Coast Down Timer Value	1 - 3600 Seconds	View Only	0	5.5.6
F046		Starts per Hour Timer Value	1 - 3600 Seconds	View Only	0	5.5.6
F047		Starts per Hour Count Value	1 - 10 Starts	View Only	0	5.5.6
F048		Time Value Between Starts	1 - 3600 Seconds	View Only	0	5.5.6
F049		Thermal Capacity to Start	0 - 100 % Thermal Capacity	View Only	0	5.5.6

5.4.7 Relays

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F050	Relays	Aux Relay 1 setting	Operation # 1 - 18 (note2)	1	1	5.5.7
F051		Aux Relay 2 setting	Operation # 1 - 18	1	2	5.5.7
F052		Aux Relay 3 setting	Operation # 1 - 18	1	14	5.5.7
F053-F054		Reserved	Reserved	Reserved	Reserved	5.5.7

Note 2: Auxiliary relays can be programmed for any of the following operations.

# 1 - Run / Stop (Signal)	# 7 - Shunt Trip	# 13 - Under Current Trip
# 2 - At Speed / Stop (Signal)	# 8 - OL Trip	# 14 - Any Trip (# 5 - #13)
# 3 - At Speed / End of Decel (SCRs Off)	# 9 - OT Trip	# 15 - Coastdown Time
# 4 - Start / End of Decel	# 10 - Short Circuit Trip	# 16 - Starts Per Hour
# 5 - Short SCR Trip	# 11 - Current Imbalance Trip	# 17 - Time Between Starts
# 6 - Phase Loss Trip	# 12 - Over Current Trip	# 18 - Any Lockout (#15 -17)

5.4.8 Communications

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F055	Communications	Communications	0=Disabled 1=Enabled	1	0	5.5.8
F056		Baud Rate	9.6 - 38.4 KB	9.6 KB	9.6 KB	5.5.8
F057		Modbus Address	1 - 247	1	1	5.5.8
F058-F059		Reserved	Reserved	Reserved	Reserved	5.5.8

5.4.9 System Settings

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F060	System Settings	Parameter Lock/ User Password	Range is 0 - 999 0 = Disabled Any Other Number = Password Protected	1	0 (Disabled)	5.5.9
F061		Reset Factory Default Settings	Range is 0 - 2 0=Disabled 1=Clear Thermal Register and Lockout Timers 2 = Reset to Factory Default Settings	1	0	5.5.9
F062-F064		Reserved	Reserved	Reserved	Reserved	5.5.9
F065		Year	2000 - 2047	1 Year	Date of Mfg.	5.5.9
F066		Month	1 - 12	1 Month	Date of Mfg.	5.5.9
F067		Day	1 - 31	1 Day	Date of Mfg.	5.5.9
F068		Hour	0 - 23	1 Hour	Date of Mfg.	5.5.9
F069		Minute	0 - 59	1 Minute	Date of Mfg.	5.5.9
F070		Second	0 - 59	1 Second	Date of Mfg.	5.5.9
F071		Revision #	-	View Only	Factory Setting	5.5.9
F072-F074		Reserved	Reserved	Reserved	Reserved	5.5.9

5.4.10 Fault History and Run Time

Fn	Group	Function	Adjustment Range	Setting Increments	Factory Setting	Section
F075	Fault History and Run Time	Fault History #1, Latest Fault	0, 1 - 27 (Fault #: see Fault code list; 0: No fault history)	View Only	0	5.5.10
F076		Time Stamp, Fault #1	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	View Only	00.00 EST	5.5.10
F077		Date Stamp, Fault #1	01.01 - 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	View Only	01.01	5.5.10
F078		Fault History #2, Previous Fault	0, 1 - 27 (Fault #: see Fault code list; 0: No fault history)	View Only	0	5.5.10
F079		Time Stamp, Fault #2	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	View Only	00.00 EST	5.5.10
F080		Date Stamp, Fault #2	01.01 - 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	View Only	01.01	5.5.10
F081		Fault History #3, Oldest Fault	0, 1 - 27 (Fault #: see Fault code list; 0: No fault history)	View Only	0	5.5.10
F082		Time Stamp, Fault #3	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	View Only	00.00 EST	5.5.10
F083		Date Stamp, Fault #3	01.01 - 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	View Only	01.01	5.5.10
F084		Run Time, Hours	000.0 - 999.9 (hours)	View Only	0	5.5.10
F085		Run Time, K Hours	0000 - 9999 (thousand hours)	View Only	0	5.5.10
F086		Run Counts	0000 - 9999 (times)	View Only	0	5.5.10
F087		Run Counts, 10K times	0000 - 9999 (10 thousand times)	View Only	0	5.5.10

5.5 Function Descriptions

The unit is set at the factory with typical starting characteristics that perform well in most applications.

Note: Customer must program motor FLA (F001) for unit to operate.

5.5.1 Motor and Overload Function Descriptions

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 to reflect 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. For example F002 = 1.15 to reflect a 1.15SF, 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 motor's nameplate. This value affects several protection features so it must be accurate. Setting the SF too high may result in motor damage in overload conditions. Setting SF too low may cause nuisance trips.

F003 = Overload Class During Start
Factory Setting = 10 (Class 10)
Range = 5 - 30 NEMA / UL Class
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.

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

When set to **2 = Disabled Overload**, a separate external thermal overload protection device must be in the circuit.

F006 - F009 = Reserved

5.5.2 Starting Mode

The ***TD*** 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 you need it but unless wired to do so, the ***TD*** 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.

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 TD will ignore all settings in reference to Ramp 2.

Select Voltage Ramp by setting **F010 = 1** (factory default)
When Voltage Ramp is selected,
Set Initial Torque with **F011** (see below)
Set Ramp 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 with **F012** (see below)
Set Ramp Time with **F013** (see below)
Set Maximum Current Limit with **F014** (see below)

F010 Ramp Profile Selection	Setting	Ramp Type	
		Ramp 1	Ramp 2
	1	Voltage Ramp	Voltage Ramp
	2	Current Ramp	Current Ramp
	3	Voltage Ramp	Current Ramp
	4	Current Ramp	Voltage Ramp

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 torque 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)**. Current percentages are based on the Motor FLA as set in F001. The initial torque 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.