TOSHIBA

DOCUMENT: NBZ0001

INSTRUCTION MANUAL - PART 2

INSTALLATION - OPERATION - MAINTENANCE

TD SERIES

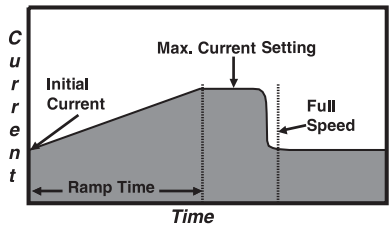
Low Voltage
Digital Solid State Starter

48 - 1250 A

Issued: 9/03
Manufactured in the USA

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

Note: Ramp time is affected by the following conditions:
1. Current limit will extend the ramp time if the motor does not reach full speed while in current limit mode.
2. Anti-oscillation circuit will shorten the ramp time if the motor reaches full speed before end of ramp.



F014 = Max Current Limit of Ramp 1
Factory Setting = 350%
Range = 200 - 600%
Sets the maximum motor current that the ***TD*** Starter will allow during ramp 1. This limit applies to both voltage and current-type ramping.

Current will be limited to this setting until either the motor reaches full speed or the over load protection feature trips (F003). Current percentages are based on the Motor FLA as programmed in F001. Once the motor has reached full speed, the current limit feature is inactive.

For Ramp 2 (user-optional ramp)

This ramp is selected by closing the input on Terminals TB4 - Pins 1 and 3. If this input is left open, the ***TD*** will respond only to ramp 1 settings as listed above. Since ramp 2 is always used in combination with ramp 1, different combinations of ramp profiles can be selected in F010. Refer to Appendix 1 for additional information.

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 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.

F016 = Initial Current of Ramp 2
Factory Setting = 200%
Range = 0 - 600%
Sets the initial current of ramp 2 when F010 = 2 or 3. Current percentages are based on the Motor FLA as programmed 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.

F017 = Accel Ramp Time of Ramp 2
Factory Setting = 10 seconds
Range = 1 - 120 seconds
Sets the time between the initial torque (set with F015 or F016) and either the Max Current Limit (set with F014) or full output voltage. Set time to enable soft starts without stalls. Also consider your motor's application. For example, centrifugal pumps may require a shorter time. See notes under F013 for more details.

F018 = Max Current Limit of Ramp 2
Factory Setting = 350%
Range = 200 - 600%
Sets the maximum motor current that the ***TD*** Starter will allow during ramp 2. (This limit applies to both voltage and current-type ramping.)

Current will be limited to this setting until either the motor reaches full speed or the over load protection feature trips (F003). Current percentages are based on the Motor FLA as programmed in F001. Once the motor has reached full speed, the current limit feature is inactive.

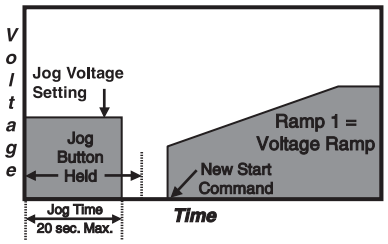
Section 5.5.3 Jog Mode

⚠CAUTION **Continuous use of the Jog feature — either the voltage type (F019) or the current type (F021) — risks thermal motor damage or nuisance tripping.**

The Jog Function is another user optional feature and is controlled by closing the input on TB4 Pins 1 and 2. If this input is left open, the ***TD*** will ignore all Jog settings. The Jog feature provides an output from the SCRs only while this input is closed. It will not continue ramping to full acceleration. This feature can Jog the motor at either a preset Voltage or a preset Current.

Selection of either Voltage or Current Jogging follows the selected Ramp Profile. The Jog mode is determined then by F010 above, and whether you have selected ramp 1 or ramp 2. See the table below for Function numbers relating to the Jog Function in each Ramp Profile.

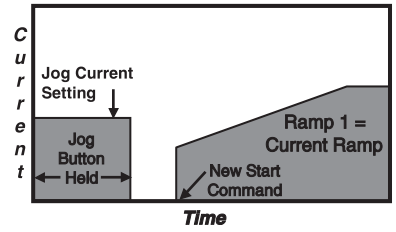
	Dual Ramp Input Open			Dual Ramp Input Closed		
F010 Setting	Ramp 1 and Jog Type	Ramp 1 Initial Torque	Jog Torque Reference	Ramp 2 and Jog Type	Ramp 2 Initial Torque	Jog Torque Reference
1	Voltage	F011	F019	Voltage	F015	F019
2	Current	F012	F021	Current	F016	F021
3	Voltage	F011	F019	Current	F016	F021
4	Current	F012	F021	Voltage	F015	F019



Voltage Jog

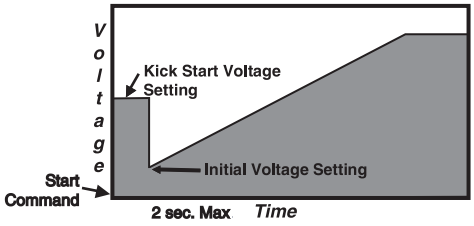
F019 = Voltage Jog
Factory Setting = 50%
Range = 5 - 100%
Sets the voltage level of the Jog feature typically is used to check rotation, alignment, or to slowly move a load into position. Jogging at a set voltage has no current control so the duration of the applied voltage must be limited to prevent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



Current Jog

F021 = Current Jog
Factory Setting = 150%
Range = 100 - 500%
Sets output of a current Jog. The jog feature is typically used to check rotation, alignment, or slowly move a load into position.



Kick Start

5.5.4 Kick Start Mode

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.

F022 = Kick Start
Factory Setting = 0 (Disabled)
Range = 0 - 1
Kick start applies a "pulse" of voltage to the motor to produce a momentary "kick" of high torque to break the motor load free from high friction or frozen components. When **F022 = 1**, this voltage "pulse" begins the initial voltage applied in either F011 or F015. Voltage level is adjusted by F023 and the time duration of the pulse is adjusted by F024.

F023 = Kick Voltage
Factory Setting = 65%
Range = 10 - 100%
Sets the voltage level of the Kick Start feature. The setting of F023 should be higher than F011 and F015 and high enough to provide a benefit in the worst starting condition.

F024 = Kick Time
Factory Setting = 0.8 seconds
Range = 0.1 - 2 seconds

Sets the duration of time the Kick Start voltage is applied.

5.5.5 Decel Mode

Deceleration is a feature of the ***TD*** Soft Starter which 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

Note: Decel is THE OPPOSITE of braking. Enabling the Decel feature will make the motor take LONGER to stop than if it were simply turned off.

See Appendix 2 at the end of this manual for detailed descriptions of typical applications for the Decel feature.

F025 = Deceleration Ramp
Factory Setting = 0 (Disabled)
Range = 0 - 2

When **F025 = 0**, the deceleration feature is disabled.

When **F025 = 1**, the deceleration feature is enabled AND the overload protection feature, set with F003 and F004, is enabled. Even when the stop command is received, the starter continues to apply decel voltage. However, if an overload trip occurs, the starter stops applying voltage and the motor coasts to a stop to prevent additional motor heating and potential motor damage.

When **F025 = 2**, the deceleration feature is enabled and deceleration will continue even when an overload condition trips.

⚠WARNING **Setting F025 = 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.**

F026 = Begin Decel Level (BDL)
Factory Setting = 60%
Range = 0 - 100% of line voltage
Use to drop voltage to a level where there is a noticeable effect on motor torque during decel mode.

F027 = Decel Shut Off Voltage
Factory Setting = 30%
Range = 0 to (BDL -1)%
Sets the level where motor torque during decel is no longer effective. Always set this function lower than the setting of F026, Begin Decel Level.

F028 = 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 (F026) to the Decel Shut Off Voltage (F027). Since motor heating increases as voltage is lowered, the setting should not exceed the time necessary to achieve the deceleration effect.

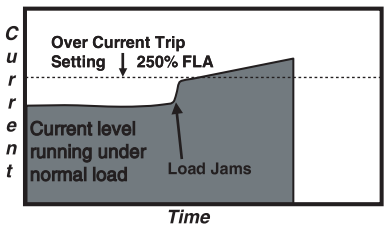
F029 = Reserved

5.5.6 Protection Features

F030 = Current Imbalance Trip
Factory Setting = 0 (Disabled)
Range = 0 - 1
If F030 = 1 (Enabled), starter will trip when the output current between any two phases exceeds the amount set with F031 for the time specified with F032.

F031 = Current Imbalance Trip %
Factory Setting = 10%
Range = 5 - 30%
Use to set the trip level for current imbalance between any two phases. Percentage is based on FLA (F001 setting).

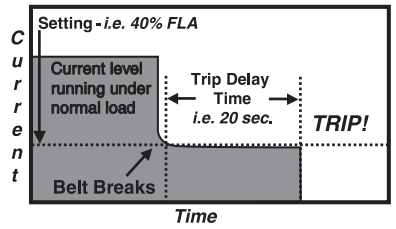
F032 = Current Imbalance Trip Delay
Factory Setting = 2 seconds
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default settings, if the difference in output current between two phases exceeds 10% of FLA for more than 2 seconds, the starter will trip.



Over Current Trip
(F033 = 1)

F033 = Over Current / Shear Pin Trip
Factory Setting = 0 (Disabled)
Range = 0 - 1
If F033 = 1 (Enabled), starter will trip when the output current of any phase exceeds the amount set with F034 for the time specified with F035. Can be referred to as a “Shear Pin Trip” and can be used to protect mechanical components from breaking due to jammed loads.

F034 = Over Current Trip %
Factory Setting = 125%
Range = 100 - 300%
Use to set the trip level for an over current condition for any phase. Percentage is based on FLA (F001 setting).



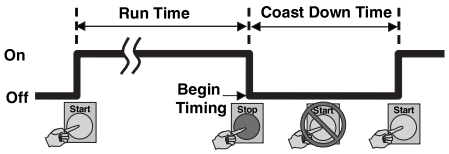
Under Current Trip (F036 = 1)

F035 = Over Current 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 output current of any phase exceeds 125% of FLA for more than 1 second, the starter will trip.

F036 = Under Current Trip
Factory Setting = 0 (Disabled)
Range = 0 -1
If F036 = 1 (Enabled), starter will trip when the output current of any phase drops below the amount set with F037 for the time specified with F038. Fault condition is often referred to as a "Load Loss Trip" and can be used to detect a broken drive shaft or belt. In pumping applications, this can be used as a "Loss of Prime" trip.

F037 = Under Current %
Factory Setting = 40%
Range = 10 - 90%
Use to set the trip level for an under current condition for any phase. Percentage is based on FLA (F001 setting).

F038 = 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 default settings, if the output current of any phase drops below 40% of FLA for more than 2 seconds, the starter will trip.



Coast Down / Backspin Lockout

F039 = Coast Down Lockout Timer (Back Spin Timer)
Factory Setting = 0 (Disabled)
Range = 0 - 1
When F039 = 1, this function provides a timer which prevents motor restarts for the number of minutes specified in F040. This function is useful in applications like pump motor backspin - (where you need to prevent the pump motor from restarting if it is spinning backwards).

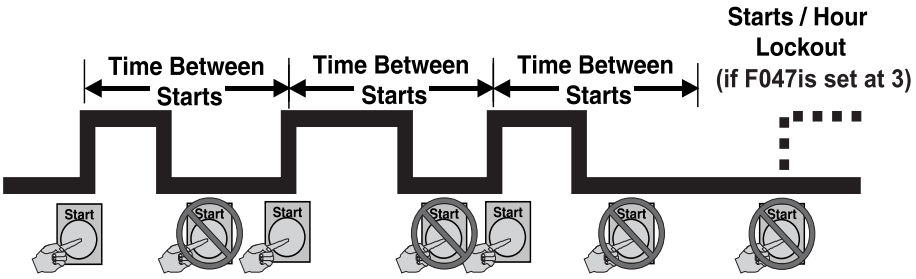
F040 = Coast Down Lockout Time
Factory Setting = 5 minutes
Range = 0 - 60 minutes
Sets a minimum amount of time that a starter must be off before a restart can be completed. (Used in conjunction with F039).

F041 = Starts per Hour Lockout
Factory Setting = 0 (Disabled)
Range = 0 - 1
If F041=1, this feature will count the number of start commands within a 1 hour period. If the setting of F042 (maximum starts per hour) is exceeded, starting is prohibited until sufficient time has expired.

F042 = Maximum Starts per Hour
Factory Setting = 2
Range = 1 - 10
Consult the motor manufacturer for a "Starts-per-Hour" or "Starting Duty Cycle" rating. Larger motors tend to have lower starts-per-hour ratings. (Used in conjunction with F041).

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

F043 = Time Between Starts Lockout
Factory Setting = 0 (Disabled)
Range = 0 - 1
If F043= 1, the motor cannot be started within the time specified in F044. Time between starts is calculated from the time of the first start command to the next regardless of run time. (Used in conjunction with F041).



Time Between Starts Lockout

F044 = Minimum Time Between Starts
Factory Setting = 15 minutes
Range = 1 - 60 minutes
If F043 = 1 and F044 = 15, motor will not start within 15 minutes of first start.

F045 = Coast Down Timer Value
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Display for information only; value cannot be altered by the user. Readout only for user's viewing of remaining time value of the Coast Down Lockout Timer.

F046 = Starts per Hour Timer Value
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Display for information only; value cannot be altered by the user.

Readout only for user's viewing of remaining time value of Starts-per-Hour Lockout Timer.

F047 = Starts per Hour
Factory Setting = Not Applicable
Range = 1 - 10 Starts
Display for information only; value cannot be altered by the user.

Readout only for user's viewing of the accumulated Starts-per-Hour value used in the Lockout function.

F048 = Time Value Between Starts
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Display for information only; value cannot be altered by the user.

Readout only for user's viewing of remaining time value of Minimum Time Between Starts Timer.

F049 = Thermal Capacity to Start
Factory Setting = Not Applicable
Range = 0 - 100 % Thermal Capacity
Display for information only; value cannot be altered by the user.

Readout only for 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 to be able to predict when a restart will be allowed. This value is automatically updated by the ***TD*** whenever a successful start sequence has been accomplished. The ***TD*** essentially "learns" how much Thermal Capacity is needed in the motor in order to successfully restart, and stores the information at this Function.

5.5.7 Relays

There are three programmable relays (rated 240VAC, 5A, 1200 VA) on the ***TD Series***. They can be programmed for change of state indication for any one of the 18 conditions identified in the chart to the left.

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

F050 = Aux Relay 1
Factory Setting = 1 (Run / Stop)
Range = 1 - 18 (See list.)
Use to program the desired operation for Relay # 1.

F051 = Aux Relay 2
Factory Setting = 2 (At Speed / Stop)
Range = 1 - 18 (See list.)
Use to program the desired operation for Relay # 2.

F052 = Aux Relay 3
Factory Setting = 14 (Any Trip)
Range = 1 - 18 (See list.)
Use to program the desired operation for Relay # 3.

F053 - F054 = Reserved

5.5.8 Communications

The ***TD*** Soft Starter features built-in serial communications via RS-485 hardware and Modbus RTU protocol software. The ***TD*** Soft Starter is a "passive" communication device which responds and/or replies to the commands of "active" host devices such as personal computers, SCADA systems, PLCs with ASCII ports, DCS and other industrial systems.

F055 = Communications
Factory Setting = 0 (Disabled)
Range = 0 - 1
When F055 = 1, the ***TD*** Soft Starter will communicate with remote monitoring and control systems.

F056 = Baud Rate
Factory Setting = 9.6 KB
Range = 9.6 to 38.4 KB
Set value to either 9.6 KB, 19.2 KB or 38.4 KB and match the setting of the host device.

F057 = Modbus Address
Factory Setting = 1
Range = 1 - 247
The Modbus communications protocol allows each node to have up to 247 connected devices but each must have a unique address. Two devices with the same address will result in a communications error.

F058 - F059 = Reserved

5.5.9 System Settings

F060 = Parameter Lock / User Password
Factory Setting = 0 (disabled)
Range = 0 - 999
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.

F061 = 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.

When **F061 = 0**, the feature is disabled. This is a "One-Shot" feature, so when another value is entered as shown below, this function automatically returns to the default state.

When **F061 = 1**, the values stored in the Thermal Register and all of the Lockout Timers will be cleared. This will allow an emergency 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 will risk motor damage and fire. Use only where emergency restart is necessary without regard to these potential hazards.**

When **F061 = 2**, the values of all functions will be reset to the factory default settings. Use this feature when settings conflict or have been tampered with. This is also useful when you lose track of experimental settings and wish to start over.

Note: This will not reset F060 = Parameter Lock / User Password.

F062 = Reserved

F063 = Reserved for Factory Use

F064 = Reserved for Factory Use

5.5.9.a Real Time Clock Settings

Functions F065 through F070 set the system real time clock. The time clock is primarily used in date/time stamping Fault History. Time clock automatically adjusts for leap years. **Time clock does not automatically adjust for daylight savings time.**

F065 = Year
Factory Setting = Year of manufacture
Range = 2000 to 2047

F066 = Month
Factory Setting = Month of manufacture
Range = 1 - 12

F067 = Day
Factory Setting = Day of manufacture
Range = 1 - 31

F068 = Hour
Factory Setting = Actual (EST)
Range = 0 - 23 (12:00 midnight is hour 0)

F069 = Minute
Factory Setting = Actual (EST)
Range = 0 - 59

F070 = Second
Factory Setting = Actual (EST)
Range = 0 - 59

F071 = Reserved for Factory Use

F072 -F074 = Reserved

5.5.10 Fault History and Run Time

The fault history will store the three last fault conditions plus the date and time that each fault occurred.

F075 = Fault History # 1, Latest Fault
Factory Setting = 0000
Range = NA
Displays 2-digit fault number. See Chapter 7.

F076 = Time Stamp, Fault # 1
Factory Setting = 00.00
Range = HH.MM where HH = 00 - 23 and MM = 00 - 59
Displays time fault in F075 was detected.

F077 = Date Stamp, Fault # 1
Factory Setting = 01.01
Range = MM.DD where MM = 01 - 12 and DD = 01 - 31
Displays date time fault in F075 was detected.

F078 = Fault History # 2, Previous Fault
Factory Setting = 0000
Range = NA
Displays 2-digit fault number. See Chapter 7.

F079 = Time Stamp, Fault # 2
Factory Setting = 00.00
Range = HH.MM where HH = 00 - 23 and MM = 00 - 59
Displays time fault in F078 was detected.

F080 = Date Stamp, Fault # 2
Factory Setting = 01.01
Range = MM.DD where MM = 01 - 12 and DD = 01 - 31
Displays date time fault in F078 was detected.

F081 = Fault History # 3, Oldest Fault
Factory Setting = 0000
Range = NA
Displays 2-digit fault number. See Chapter 7.

F082 = Time Stamp, Fault # 3
Factory Setting = 00.00
Range = HH.MM where HH = 00 - 23 and MM = 00 - 59
Displays time fault in F081 was detected.

F083 = Date Stamp, Fault # 3
Factory Setting = 01.01
Range = MM.DD where MM = 01 - 12 and DD = 01 - 31
Displays date time fault in F081 was detected.

Functions F084 through F087 display information from the Run Time / Elapsed Time meter and Run-Cycle counter. Run time includes Accel, Run, Decel, and Jog operations.

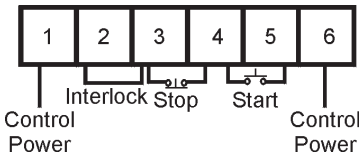
F084 = Run Time, Hours
Factory Setting = 0000
Range = 000.9 - 999.9 hours
Run counts in excess of 999.9 are recorded in F085.

F085 = Run Time, K Hours
Factory Setting = 0000
Range = 0000 - 9999 K hours
0001 in readout means a run time of 1,000 hours.

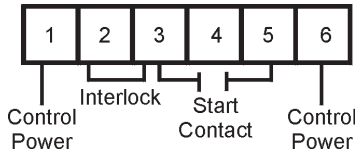
F086 = Run Counts
Factory Setting = 0000
Range = 0000 - 9999
Run counts in excess of 9999 are recorded in F087.

F087 = Run Counts, 10K Times
Factory Setting = 0000
Range = 0000 - 9999, 10 thousand times
0001 in readout means a run count of 10,000 operations.

Chapter 6 - Start-up



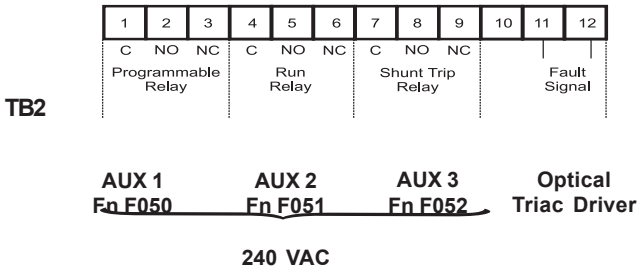
TB1 Three-Wire Connection



TB1 Two-Wire Connection
(alternate connection)

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

(See page 20 for more information)



6.1 Quick Start

Your new ***TD 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 power lines and T1, T2, and T3 to motor.
2. Connect control wires and control power.
3. Program motor FLA (F001).

6.1.2 TD Start-up Parameters and Factory Defaults

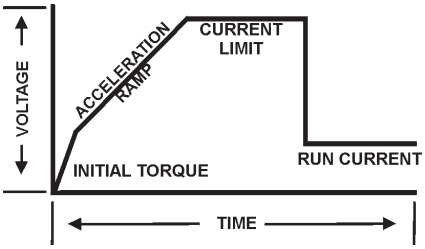
Try the initial presets first and then adjust or enable the more advanced features to meet your specific starting needs.

Function Number	Function Name	Factory Setting	Description
F001	Motor Nameplate FLA	0	Starter disabled Unit must be set to actual motor FLA
F002	Motor Service Factor	1.0	Motor Service Factor from motor nameplate
F003	Overload Protection During Start	10	NEMA Overload Class (Class 10)
F004	Overload Protection During Run	10	NEMA Overload Class (Class 10)
F005	Overload Reset	0	Manual Reset
F010	Ramp Profile	1	Ramp 1 is voltage ramp with current limit; Ramp 2 is voltage ramp with current limit
F011	Initial Torque	60	60 Percent
F013	Ramp Time	10	10 second time duration for Ramp 1
F014	Current Limit	350	Maximum current limit of Ramp 1 as a percentage (350%).
F015-F018	Ramp 2	60,200,10,350	Inactive unless TB4 control circuit is wired
F019-F021	Jog	50,10,150	Inactive unless TB4 control circuit is wired
F022-F049	All other protection and control features	See Note	Disabled
F050	Aux. Relay #1 (TB2, terminals 1 - 3)	1	Run / Stop
F051	Aux. Relay #2 (TB2, terminals 4 - 6)	2	At Speed / Stop
F052	Aux. Relay #3 (TB2, terminals 7 - 9)	14	Any Fault
F060	Parameter Lock / User Password	0	User password disabled
F066-F070	All Time Values	0	Eastern Standard Time
F075-F083	Fault Histories	Clear	Entered upon occurrence

6.2 Start-up Check List

- Supply voltage matches the rated supply voltage of the unit.
- Horsepower and current ratings of the motor and unit match or the unit is higher rating.
- Initial ramp time and torque adjustments have been checked.
- Power lines are attached to the unit input terminals marked L1, L2 and L3.
- Motor leads are connected to the lower terminals marked 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 seven-segment LED readouts are 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 people and parts before start-up.

6.3 Sequence of Operation



Sequence of Operation

- Apply three phase power to the unit. The motor should run only when the start command is applied.
- Apply control power and check that the "Power On" LED comes on.
- Verify that the motor's FLA is correctly programmed (F001).
- Apply the start command. The motor should begin to accelerate.
- When the motor reaches full speed, the "At Speed" LED comes on.
- If the motor decelerates, or stops, during the acceleration period, hit the stop button immediately and open the disconnect line.

If the unit does not follow this operational sequence please refer to Chapter 8 - Troubleshooting.

Chapter 7 - Fault Conditions

7.1 Fault Codes and Numbers (in History)

Fault Code Examples:

Over Load During Accel

Over Current During Accel

(Current) Imbalance During Accel

A three-character fault code is displayed in the LED display at the time of the trip event. For instance, if Function F003 (overload protection) is set too low for the size of the load, the code “oLA” will be displayed. Its corresponding number will be entered into the fault history. In this case, the number 0010 will be available for display in the window of function F075 (Fault History). The time the fault was detected is available in Function F076. It is expressed as hh.mm. So if the “oLA” fault occurred at 10:00 am, F076 would display 10.00. The date the fault occurred is available in Function F077. The date is expressed as mm.dd. So if the “oLA” fault occurred on March 1, F077 would display 03.01.
If there are no fault conditions in history, the display in F075 would read 0000.

History Fault Number (Shown in F075, F078, F081)	Fault Code @ Trip/Event	LED Indicators	Description
1	oCA	Over Current	Over Current During Acceleration
2	oCC	Over Current	Over Current During Constant Speed
3	oCd	Over Current	Over Current During Decel (or Stop)
4	PLA	Phase Loss	Phase Loss During Acceleration
5	PLC	Phase Loss	Phase Loss During Constant Speed
6	PLd	Phase Loss	Phase Loss During Decel (or Stop)
7	oTA	Over Temp	Over Temperature During Acceleration
8	oTC	Over Temp	Over Temperature During Constant Speed
9	oTd	Over Temp	Over Temperature During Decel (or Stop)
10	oLA	Over Load	Over Load During Acceleration
11	oLC	Over Load	Over Load During Constant Speed
12	oLd	Over Load	Over Load During Decel (or Stop)
13	SSA	Shorted SCR	Shorted SCR During Acceleration
14	SSC	Shorted SCR	Shorted SCR During Constant Speed
15	SSd	Shorted SCR	Shorted SCR During Decel (or Stop)
16	ST	Shunt Trip	Shunt Trip During Acceleration
17	ST	Shunt Trip	Shunt Trip During Constant Speed
18	ST	Shunt Trip	Shunt Trip During Decel (or Stop)
19	ibA	NA	Phase Imbalance Current During Acceleration
20	ibC	NA	Phase Imbalance Current During Constant Speed
21	ibd	NA	Phase Imbalance Current During Decel (or Stop)
22	UCA	NA	Under Current During Acceleration
23	UCC	NA	Under Current During Constant Speed
24	UCd	NA	Under Current During Decel (or Stop)
25	SCA	Over Current	Short Circuit During Acceleration
26	SCC	Over Current	Short Circuit During Constant Speed
27	SCd	Over Current	Short Circuit During Decel (or Stop)

Chapter 8 - Troubleshooting

8.1 Failure Analysis

Problem	Possible LED Display	Possible Causes	Solution
One of the main fuses blows or circuit breaker opens when the power is applied	Shunt Trip LEDs: ON	Short circuit between the inputs	Locate and remove the short
		Faulty SCR(s)	Remove power and test the SCR(s). Refer to section 8.2 for SCR Testing procedure.
One of the main fuses blows or circuit breaker opens when the start command is given.	Overcurrent LEDs :ON Phase Loss LEDs: ON	Short circuit or ground fault in motor or cabling	Locate and remove the short or the ground
		Phase Loss	Repair the cause of the phase loss
		Branch circuit protection not correctly sized	Verify the correct sizing of the branch circuit protection
		Faulty SCR(s)	Remove power and test the SCR(s). Refer to section 8.2 for SCR Testing procedure.
		Single phase incoming power	Correct the problem with the incoming power
		Faulty main circuit board	Remove power and replace the PC board assembly. Refer to section 8.4 for circuit board replacement procedure.
Motor overload trips during start	Overload LEDs: ON	Overload improperly adjusted	Adjust the overload (F003)
		Excessive load on motor	Lighten the load on the motor
		Current limit set too low	Increase the current limit set point (F014)
		Incorrect start adjustment	Readjust the starting parameters. Refer to Chapter 5.
Thermostat trips during run	Over Temp LEDs: ON	Fan(s) not functioning	If the fans have power, remove power and replace the fan(s). If the fans do not have power, find the cause of the power loss and repair
		Heatsink coated with dirt	Remove power and clean the heatsink with high pressure air (80-100 PSI max, clean and dry air)
		Over current on unit	Verify that the running current does not exceed the unit rating.
		Environment temperature over 120ºF (ambient temperature for panel version) or over 104ºF (ambient temperature for enclosed version)	Locate unit where the ambient temperature is less than 120ºF for the panel mount version or less than 104ºF for the enclosed version
Motor will not start	All LEDs: OFF Power On LED: OFF Start LED: OFF Phase Loss LEDs: ON Shorted SCR LEDs: ON	No control voltage applied to control board	Apply control voltage to TB1 pins 1 and 6 on the power board
		Control power transformer failure or CPT fuse failure.	Remove power and replace the power transformer or the CPT fuse
		Start circuit wired incorrectly	Remove power and correct the start circuit wiring
		No start command	Apply the start command
		No 3 phase line voltage	Apply 3 phase line voltage to the unit
		Failure of PC board assembly	Replace PC board assembly
		Faulty control logic	Remove power and repair the control logic
		Shorted SCR in starter	Refer to section 8.2 for SCR testing procedures and replace the faulty (shorted) SCR(s)
Motor vibrates / Motor growls	Phase Loss LEDs: ON	Faulty motor	Check the motor and the motor connections
		Faulty SCR(s)	Remove power and perform the SCR device checks
		Faulty gate/cathode on SCR(s)	Refer to section 8.2 for SCR testing procedures and replace the faulty (shorted) SCR(s)
		Faulty PC board assembly	Replace PC board assembly
Extremely unbalanced motor currents during start or run mode	Phase Loss LEDs: ON	Faulty motor / wiring	Troubleshoot and repair
		Faulty wiring	Troubleshoot and repair / replace wiring
		Faulty main circuit board	Replace the PC board assembly
Motor stopped during run	Over Current LEDs: ON	**Warning**: This is a serious fault condition. Ensure that the fault condition is cleared on the load before attempting to restart to motor.	
		Load shorted / grounded/ faulted	Remove power and repair
		Faulty main circuit board	Replace the PC board assembly
External Control circuit fuses blow after control power is applied.	All LEDs: OFF	Short in control circuit	Remove power, locate and remove the short
		Wrong control voltage	Apply the correct voltage to the control circuit

8.2 SCR Testing Procedure

Remove both line power and control power from the unit and lock out. Disconnect any two motor load leads and any two line leads. Disconnect the SCR connections to main control board J5, J6 and J7. Refer the Chapter 9 for the main control board layout. Note the type of color coding of the wires connected to J5, J6 and J7. TOSHIBA™ uses two possible configurations. Both configurations have 4 wires going to each plug. The first configuration consists of 4 wires color coded black, yellow, grey and white. The second configuration consists of 4 wires color coded red, white, red, white.

The testing procedure for SCRs is comprised of two separate tests. The first one tests the anode to cathode integrity of the SCR by performing the following ohm checks:

+ Lead	- Lead	Good	Consult factory
L1 Lug	T1 Lug	Greater than 10K ohm	Less than 10K ohm
L2 Lug	T2 Lug	Greater than 10K ohm	Less than 10K ohm
L3 Lug	T3 Lug	Greater than 10K ohm	Less than 10K ohm

The second tests the gate to cathode integrity of the SCR. Place the leads of an ohm meter into the receptacle that was unplugged from the main circuit board. Ohm the pair of wires on one end of the plug. Then ohm the pair of wires on the other end of the plug. The chart below indicates good versus bad readings.

For wire that is color coded black, yellow, gray and white:			
+ Lead	*- Lead*	*Good*	*Bad*
Black	Yellow	Between 5 and 90 ohms	Less than 5, or greater than 90 ohms
Grey	White	Between 5 and 90 ohms	Less than 5, or greater than 90 ohms
For wire that is color coded red, white, red and white:			
Red	White	Between 5 and 90 ohms	Less than 5, or greater than 90 ohms
Red	White	Between 5 and 90 ohms	Less than 5, or greater than 90 ohms

Note: If any of the above readings are out of specifications, replace the faulty SCR.

Note: The best way to test an SCR is with an SCR Tester and look for leakage current less than the manufacturer specified values.

8.3 Replacing SCR Devices

Two types of SCRs are used in the ***TD Series*** depending on the horsepower/amperage rating of the unit. Isolated SCRs are used in smaller units and “hockey puck” type SCRs are used in larger units. (Refer to Chapter 9 for the main control board layout.)

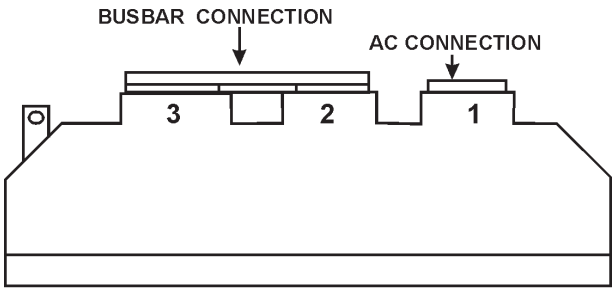
8.3.1 Changing an Isolated SCR

- Remove both line and control power from unit, tag and lock out.

⚠WARNING ***Failure to remove both line and control power before starting this procedure may cause personal injury or death.***

- Label the location of wires connected to the SCR.
- Remove the mounting screws, lugs and associated wiring from the existing SCR.
- Make sure the surface to which the power module mounts is clean and free from dirt, nicks and scratches.
- Apply thermal grease uniformly along the grooved area. Spread the grease thinly (3 mil thick) to completely cover the base of the power module and minimize air pockets. The grease must be free of contamination.
- Replace the screws and tighten down firmly. All mounting screws should be 44lb/in. Units with a maximum amperage rating of up to 48A, should use 26 lbs/in busbar and power lugs. Units with a maximum amperage of 60A - 120A should use 44 lbs/in busbar and power lugs.
- Reconnect all busbars, lugs and wires. Check to make sure the gate and cathode are wired correctly. Use the following chart to verify the wiring of J5, J6 and J7:
- After verifying that all wiring is correctly connected, test the SCR.

Main Circuit Board Pin #	Destination
Pin 1	Load Gate
Pin 2	Load cathode (Output Load Lug)
Pin 5	Line Gate
Pin 6	Line Cathode



Isolated SCR Configuration

8.3.2 Changing a Hockey Puck Type SCR

- Remove both line and control power from unit, tag and lock out.

⚠WARNING

Failure to remove both line and control power before starting this procedure may cause personal injury or death.

- TOSHIBA uses two types of clamps with gauges for reading the amount of force on the device. The first type of force gauge uses a spin washer. When the proper force is applied, the washer will be free to spin. The second type of gauge uses a step indicator on the end of the lever. Before proceeding, note the type of clamp used and, if the clamp has a step indicator, document the position of the indicator before removing the clamp to facilitate proper mounting of the new SCR device.

- Label the location of the wires connected to the SCR.

- Remove any lugs, snubbers, printed circuit boards (refer to section 8.4) and associated wiring that may get in the way of reaching the faulty SCR. Document the location and wiring of all parts before removing them to facilitate the reinstallation of the devices later.

- Document the position of the indicator on the SCR clamp. Then remove the top clamp holding the SCR stack together. Remove the top heatsink. Use extreme caution when handling the heat sink so it does not become dented or damaged.

- Remove the faulty SCR device, noting the direction in which the SCR is oriented. The new SCR puck **must be** inserted in the same direction.

- Make sure the SCR mounting surface, tools, and hands are clean and free from dirt, nicks, and scratches. Do not sand or scrape SCR mounting surface. If necessary, super fine Scotch Brite pads can be used to clean the heatsink before installing the new SCR.

- Apply a thin (3 mil thick) layer of thermal grease uniformly along both sides of the SCR. Spread the grease to cover the entire surface of both sides of the SCR in a manner that minimizes air pockets. The grease must be free of contamination.

- Locate the centering pin in the bottom and top of the heatsink and center it in the SCR hole (making sure that the SCR is pointed in the same direction as the SCR that was removed in step 6). Locate the centering pin in the top heatsink and center it in the SCR hole.
  If center pin is not placed correctly it will damage the SCR and the heat sink.
  Hand tighten the clamps evenly so that the same number of threads appear at both ends of the U-clamp. Tighten the clamp 1/4 turn at a time alternating sides of the U-clamp until the correct force is reached. Check the gauge or spin washer every time the clamp nuts are tightened 1/4 turn to ensure that the SCR is not over torqued. The gauge reading should be similar to the initial reading taken in step 2. If the clamp

uses the spin washer gauge, verify that the washer spins freely after clamping. Once proper force is reached make sure that the SCR pucks are securely held between the heatsinks and aligned evenly.

- Replace any lugs, MOVs, snubbers, power straps, printed circuit boards and associated wiring that was removed in step 4. Use the following chart to verify wiring of J5, J6 and J7:

Main Circuit Board Pin #	Destination
Pin 1	Load Gate
Pin 2	Load cathode (Output Load Lug)
Pin 5	Line Gate
Pin 6	Line Cathode

- After verifying that all wiring is correctly connected, test the SCR and then test the unit.

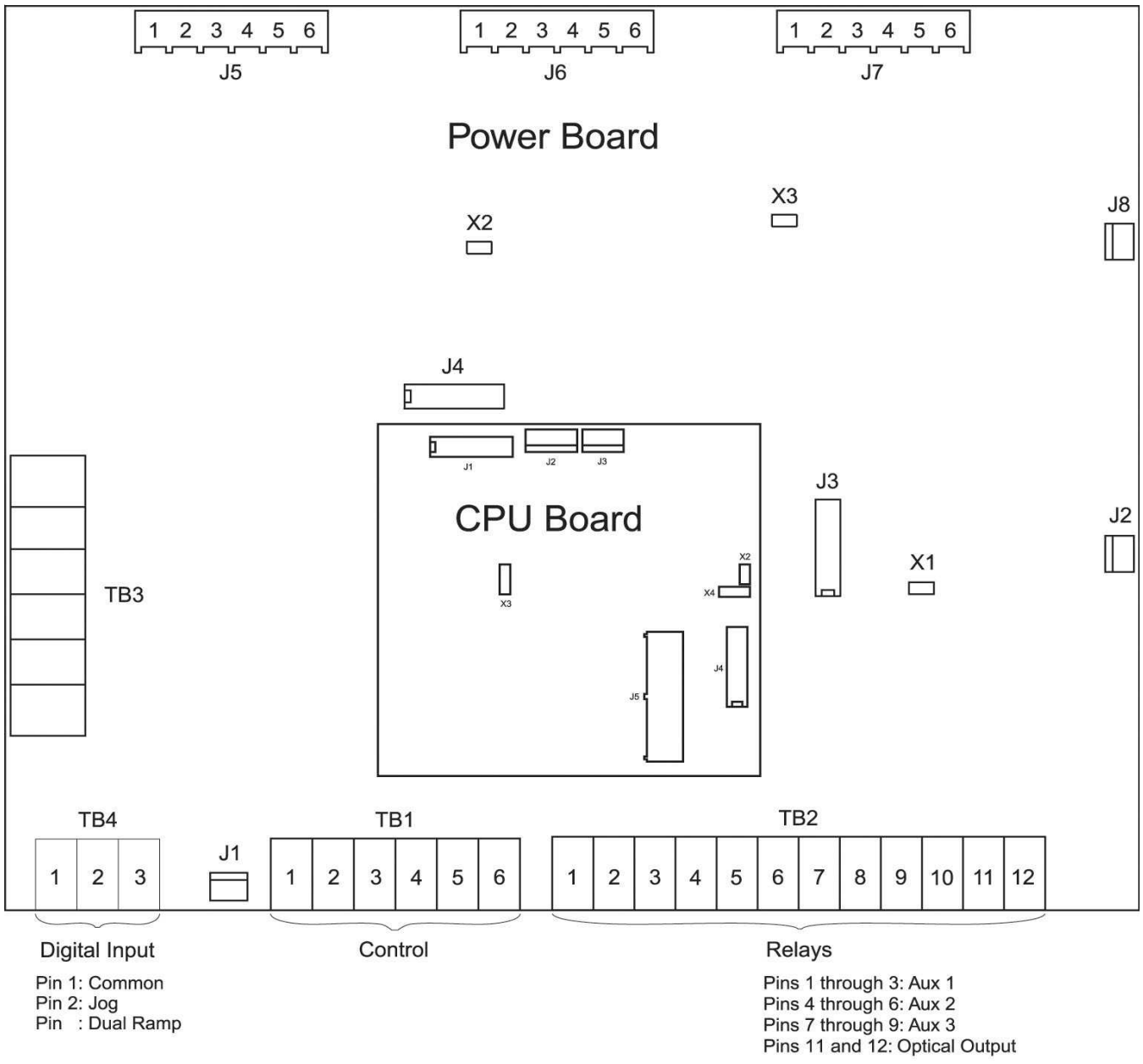
8.4 Replacing the Printed Circuit Board Assembly

The printed circuit board assembly is not intended to be field repaired. If a board is faulty, the entire assembly should be replaced using the following procedure:
(See Chapter 9 for the printed board assembly layout.)

- Remove three phase power and control power from the unit and lock out.
- Remove plugs and tag plugs with connector numbers.
- Remove control wires from terminals and tag wires with terminal numbers.
- Remove the mounting screws.
- Remove the old printed circuit board assembly.
- Mount the new printed circuit board assembly.
- Install the mounting screws.
- Install the control wires onto correct terminals per tag sequence.
- Install the plugs.
- Apply power to the unit and test.

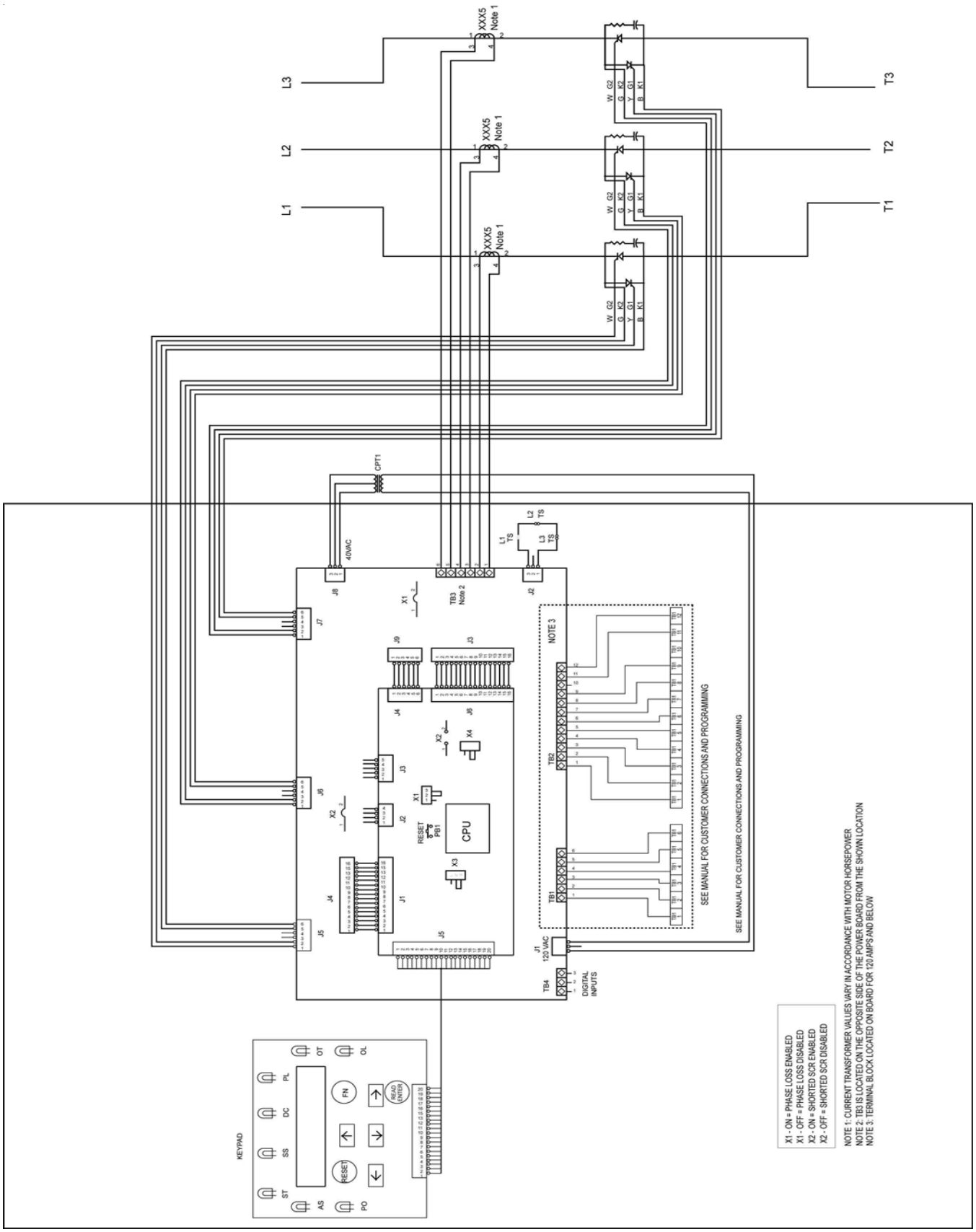
Chapter 9 - Printed Circuit Board Layout

9.1 Power Board and CPU Board (PC Board Assembly)



TD Power Board Jumpers:
X1 = Phase loss detection. Remove to disable the phase loss detection.
X2 = Shorted SCR detection. Remove to disable the shorted SCR detection. (Note: May need to be removed when the TD is connected to a Electronic DC Injection Brake.)
X3 = 50Hz/60Hz selection. Remove for 50Hz operation. Jumper installed for 60Hz system.

9.1 Typical Wiring Diagram



Appendix 1 - Ramp Profile Details

Four Different Ramp Types

The ***TD Series*** offers four different types of starting ramp profiles. Simply select the one that best matches your motor / load requirements.

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

1. Voltage Ramping is the most reliable starting method, since 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, etc.

Voltage is increased from a starting point (Initial Torque) to full voltage over an adjustable period of time (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%). Since this is essentially Locked Rotor Current on most motors, there will be little or no Current Limit effect on the Ramp profile.

2. Voltage Ramping with Current Limit works similarly to the above, except adds an adjustable maximum current output. Voltage is increased gradually until the Maximum Current Limit setting **(F014)** is reached, then held at this level until the motor accelerates to full 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
- utility 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.

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 applications requirements.

3. Current Ramping (Closed Loop Torque Ramping) is good for smooth linear acceleration of output torque. Output voltage is constantly updated to provide this linear current ramp, and 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
- 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 ***TD***, set the Ramp Profile (**F010**) to 0002 or 0004 (Current Ramp), and the Maximum Current Limit setting (**F014**) to the desired level.

4. Current Limit Only (Current Step) starting means using the Current Limit feature exclusively without the benefit of soft starting by ramping the voltage or current first. This will maximize the effective application of motor torque within the limits of the motor. In this mode, Initial Voltage / Current and Ramp Time are set to 0, so the output current jumps 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 0, this mode functions in either Voltage Ramp or Current Ramp setting.

Ramp Parameter Description

Initial Torque (Initial Voltage or Initial Current). This function sets 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) break-away torque level, no 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. See Chapter 5 for initial setup procedures.

Accel Ramp Time. This Function sets the maximum allowable time for ramping the Initial voltage or current (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 you have determined that your 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 extend the Ramp Time if the motor does not reach full speed while in current limit mode.**
2. **The Anti-Oscillation Circuit 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 ceiling 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.

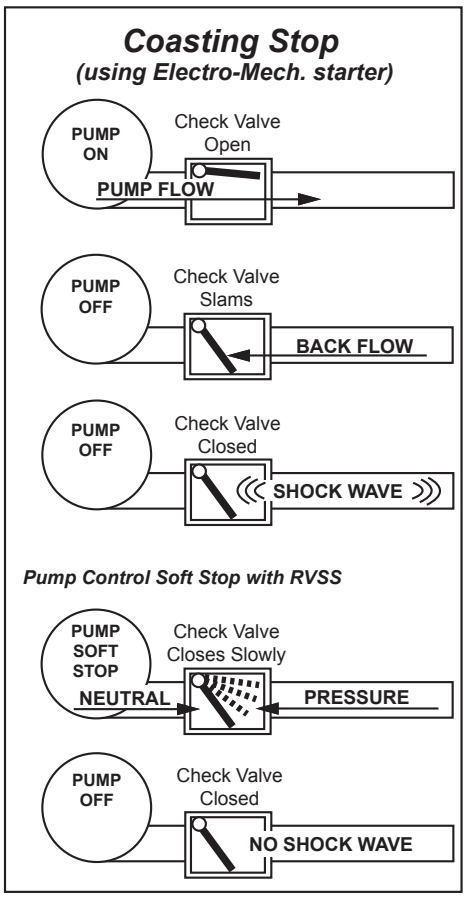
In the Voltage Ramp Profile, the Voltage output is increased until the Current Limit is reached. The Ramp Time is the maximum time it will take for the voltage to increase until the Current Limit setting takes over. Under some load conditions, Current Limit may be reached before the Ramp Time has expired.

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%.. Use this feature to prevent voltage drop in your electrical supply, portable / emergency generator stalling, or to satisfy utility restrictions on starting power.

⚠CAUTION **While the *TD* is in Start mode there is no maximum Current Limit time. Excessive start time may however 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: Decel Mode Application Considerations

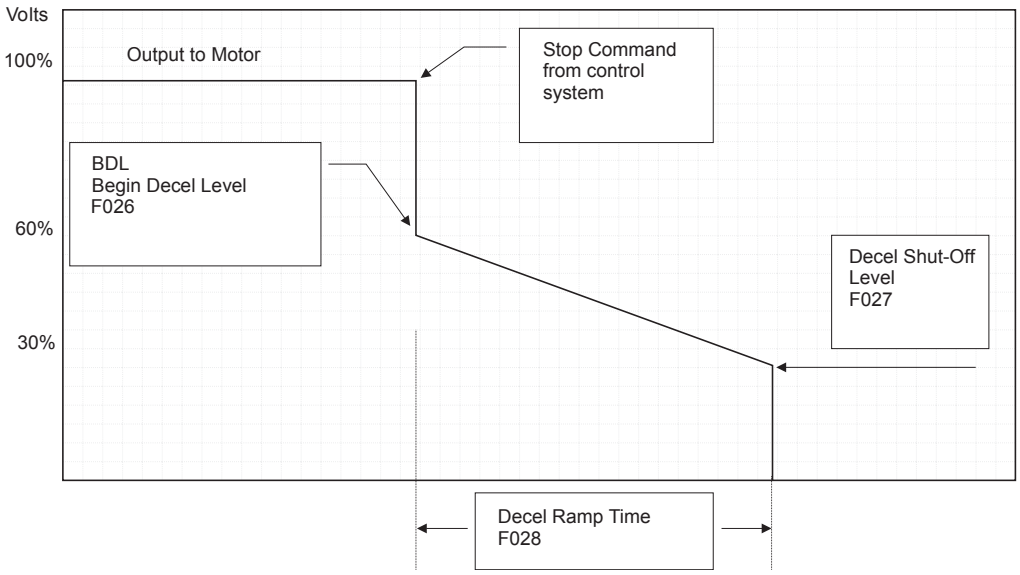


Deceleration (Soft Stop) is a unique feature of Solid State Soft Starters such as the ***TD***. It provides a slow decrease in the output voltage, accomplishing a gentle decrease in motor torque during the stopping mode. This is the ***OPPOSITE OF BRAKING*** in that it will take **longer** to come to 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 up hill is called the "Head Pressure" in the system. The pump is sized to provide enough Output Pressure to overcome the Head Pressure and move the fluid up the pipe. 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.

By using the Soft Stop deceleration feature of the ***TD***, the pump output torque is gradually and gently reduced, which slowly reduces the pressure in the pipe. When the Output Pressure is just slightly lower than the 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 ***TD*** will end the Decel cycle and turn itself off.

Another common application is on material handling conveyors as a means to prevent sudden stops that may cause products to 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

F060 = Parameter Lock / User Password
Factory Setting = 0 (disabled)
Range = 0 - 999

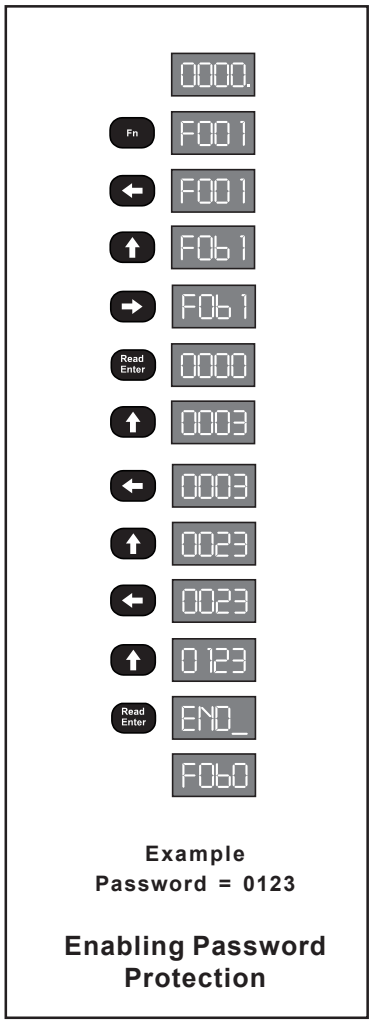
Provides users with the ability to prevent unauthorized operators from making changes to the programmed functions. **If you do not need to take advantage of this feature, do not enter anything into this function.** The factory default is disabled, and no Password is necessary to make changes to the program.

When any value other than 0 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, including this one. 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 be able to alter the program after the Parameter Lock has been enabled, go to Function (**F060**) and enter the correct user Password. 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, then set Function F060 to 0 (F060 = 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.

The User Password will not be displayed after being entered or at any other time. The number displayed after the READ / ENTER key is initially pressed is for reference only. **Caution: DO NOT LOSE YOUR PASSWORD**. If the password has been lost or forgotten, contact TOSHIBA **for assistance in retrieving it with authorization.**



Example
Password = 0123

Enabling Password Protection

Enabling Password Protection / Parameter Lock (See Example)

Start from the Status Display Mode.

Press the **Fn** key.

Press the **LEFT** arrow to select the second digit (from the right)

Press the **UP** arrow six times (6x) to change the function code to F061.

Press the **RIGHT** arrow to select the first digit (from the right).

Press the **DOWN** arrow to change the function code to F060.

Press the **Read Enter** key. The display should “hide” the password.

Use the **UP** arrow and the **LEFT** arrow to display the

password you desire (Valid range is 0000 to 0999).

In this example, 0123 has been selected.

Press the **Read Enter** key. The word [END_] should momentarily display to confirm you have enabled the user password feature.

Disabling Password Protection / Parameter Lockout

Changing function F060 to 0000 will disable the user password.

Appendix 4 - Soft Starter Settings

The following chart may be used to record the changes made to the factory settings.

Fn	Function	Page	Set To	Check	Revised	Check
F001	Motor FLA	20				
F002	Service Factor	21				
F003	Overload Class During Start	21				
F004	Overload Class During Run	21				
F005	Overload Reset	21				
F006-F009	Reserved	No record required				
F010	Ramp Select	21				
F011	Initial Voltage of Ramp 1	22				
F012	Initial Current of Ramp 1	22				
F013	Accel Ramp Time of Ramp 1	22				
F014	Max Current Limit of Ramp 1	22				
F015	Initial Voltage of Ramp 2	23				
F016	Initial Current of Ramp 2	23				
F017	Accel Ramp Time of Ramp 2	23				
F018	Max Current Limit of Ramp 2	23				
F019	Voltage Jog	24				
F020	Time of Voltage Jog	24				
F021	Current Jog	24				
F022	Kick Start	24				
F023	Kick Voltage	24				
F024	Kick Time	25				
F025	Deceleration Ramp	25				
F026	Begin Decel Level (BDL)	25				
F027	Decel Shut Off Voltage	25				
F028	Decel Ramp Time	25				
F029	Reserved	No record required				
F030	Current Imbalance Trip	26				
F031	Current Imbalance Trip %	26				
F032	Current Imbalance Trip Delay	26				
F033	Over Current Trip	26				
F034	Over Current Trip %	26				
F035	Over Current Trip Delay	26				
F036	Under Current Trip	26				
F037	Under Current Trip %	26				
F038	Under Current Trip Delay	26				
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Warranty Policy

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The Company will, at its option, repair or replace such equipment or part which is defective under the terms of the foregoing warranty, free of charge; provided the purchaser (1) promptly notifies the Company in writing of such defect, and (2) furnishes the Company satisfactory proof thereof, and (3) establishes that the equipment or part has been properly installed, maintained and operated within the limits of rated capacity and normal usage and in accordance with this manual, and (4) if requested by the Company, returns the defective equipment or part to the Company and pays all expenses incurred in connection with such return. The repaired or replacement equipment or part will be delivered, free of charge, to the purchaser F.O.B. the Company's warehouse or, at the Company's option, F.O.B. a Company authorized service shop, not loaded on truck or other carrier. The purchaser will pay the costs applicable to the equipment or part following such delivery, including, without limitation, all handling, transportation, assembly, insurance, testing and inspection charges.

THE FOREGOING OBLIGATION TO REPAIR OR REPLACE EQUIPMENT PARTS SHALL BE THE SOLE AND EXCLUSIVE REMEDY OF THE PURCHASER, ITS CUSTOMERS AND USERS OF THE EQUIPMENT AND PARTS FOR BREACH OF THE FOREGOING WARRANTY. THE COMPANY WILL HAVE NO OBLIGATIONS TO DISASSEMBLE ANY EQUIPMENT OR PART WHICH IS DEFECTIVE WITHIN THE TERMS OF THE ABOVE WARRANTY OR TO INSTALL ANY REPAIRED OR REPLACEMENT PART OR EQUIPMENT OR TO PAY ANY COSTS INCURRED IN CONNECTION WITH ANY SUCH DISASSEMBLY OR INSTALLATION. THE COMPANY, TOSHIBA CORPORATION AND THEIR SUPPLIERS AND SUBCONTRACTORS HEREBY DISCLAIM ALL OTHER EXPRESS, STATUTORY AND IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, ALL EQUIPMENT AND PARTS FURNISHED PURSUANT TO THE FOREGOING WARRANTY AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY.

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