CHAPTER FOUR

4 Troubleshooting

IN THIS CHAPTER

- Troubleshooting Basics
- Diagnostic LEDs
- Non-Drive Related Problems
- Protective Circuits
- Product Return Procedure

Troubleshooting Basics

When your system does not function properly (or as you expect it to operate), the first thing that you must do is identify and isolate the problem. When you have accomplished this, you can effectively begin to resolve the problem.

The first step is to isolate each system component and ensure that each component functions properly when it is run independently. You may have to dismantle your system and put it back together piece by piece to detect the problem. If you have additional units available, you may want to exchange them with existing components in your system to help identify the source of the problem.

Determine if the problem is mechanical, electrical, or software-related. Can you repeat or recreate the problem? Random events may appear to be related, but they are not necessarily contributing factors to your problem.

You may be experiencing more than one problem. You must isolate and solve one problem at a time. Log (document) all testing and problem isolation procedures. You may need to review and consult these notes later. This will also prevent you from duplicating your testing efforts.

Once you have isolated a problem, take the necessary steps to resolve it. Refer to the problem solutions contained in this chapter. If the problem persists, contact your local technical support resource.

Diagnostic LEDs

The TQ10 Drive has five LEDs on its front panel. The following summary of LED functions may help you isolate problems.

LED Name	Color	Function
MOTOR FAULT	Red	Indicates short circuit in motor or cabling; or, Indicates motor overtemperature; or, Indicates Hall miswiring, or damaged Hall sensor; or, Indicates foldback with fault-on-foldback set.
DRIVE OVERTEMP	Red	Indicates drive has exceeded temperature limit
REGEN/	Green	Illuminates green during regen event;
OVERVOLTAGE	Red	Illuminates red if regen causes overvoltage
PEAK CURRENT/	Green	Illuminates green during peak current output;
IN FOLDBACK	Red	Illuminates red while drive is in foldback
POWER ON/	Green	Illuminates green when AC power is applied;
NOT ENABLED	Red	Illuminates red when AC power is applied but drive is not enabled

Non-Drive Related Problems

When the drive is powered up, enabled, and operating properly:

- The **POWER ON** LED is illuminated green
- No LEDs are illuminated red
- The fault output is LOW

These conditions indicate that the TQ10 is probably not the source of the problem. The next table summarizes other possible sources of problems.

TROUBLESHOOTING TABLE

Possible Source of Problem	*SOLUTION*
CONTROLLER/ INDEXER	Cycle power to clear fault latch. Verify control voltage at TQ10 Torque Drive command input. Verify step/direction pulses at TQ10SD step/direction inputs.
MOTOR	Check for motor problems. Check motor coils for continuity, shorts, proper resistance. Check Hall and Phase wiring.
MECHANICAL SYSTEM	Check for jams, binds, increased friction, etc. Uncouple motor from load to test motor separately.
WIRING	Check motor wiring: phases, Hall effects. Check controller/indexer wiring, especially enable.
OVERHEATING	Verify that drive's heatplate has good thermal contact with heatsink. Check mounting screws. Provide sufficient ventilation.
AC POWER	Verify AC power mains supply delivers enough power during entire move without undervoltage, especially during acceleration.
MOVE PROBLEMS	Check speed/torque limitations. Check for excessive friction, regeneration, problems with gravity, transient undervoltage, etc.
ELECTRICAL NOISE	Check for problems caused by electrical noise. Consult the Compumotor sales guide for possible solutions. Check grounds.

Problems During Move

Some problems occur transiently during a move, or do not affect the LEDs. Others may be due to wiring mistakes, or failure of other components in the system (controller or indexer, encoder, motor, etc.). The sections below will help you identify such problems.

Speed/Torque Limitations

Make sure that you are not commanding a move that requires the motor to go faster than it can, or use more torque than it can produce. Check the motor's speed/torque curve for your operating conditions.

Acceleration

Some problems during acceleration can be caused by an undervoltage on the AC power line (this can be a transient event), an unrealistic move profile, or too much load inertia.

Deceleration

Some problems during deceleration can be caused by excessive regeneration, resulting in an overvoltage fault.

Excessive Friction

Too much friction in your system might cause move problems. Excessive friction can cause trouble when mechanical components in a system age. As friction increases, problems may occur in a system that had previously been working well.

Mechanical Problems

Check for binds, jams, increased friction, or other problems in the mechanical system. If a system was working properly, but then suddenly develops new problems, check for changes in the mechanical system that could be causing the problems—increased friction, lack of grease, worn bearings, etc.

Encoder Problems

Encoders that are miswired or malfunctioning can cause problems during a move. Check wiring from the encoder to the controller, or to the TQ10SD. To isolate a malfunctioning encoder, rotate the motor shaft a known distance, and check the encoder readout (the TQ10SD has no encoder readout). Verify that the encoder is properly coupled to the motor shaft, especially during rapid acceleration. Some symptoms of encoder problems are no motion, or motor runaway.

Electrical Noise Problems

Electrical noise can cause problems, depending on the application and the sensitivity of equipment in the system. For more information on identifying problems caused by electrical noise, and solutions to those problems, consult the technical section in Compumotor's current catalog.

Protective Circuits

The TQ10 Drive has several protective circuits, some of which can indicate fault conditions by illuminating one of the LEDs.

Drive Overtemperature Protection

To protect against damage from high temperatures, the TQ10 Drive has an internal temperature sensor. If the output stage overheats, the red **DRIVE OVERTEMP** LED will illuminate, and the drive will shut down. This is a latched fault. To restart the drive, first allow it to cool, then cycle power; or, with the TQ10 Torque drive, you can use the reset input. You can prevent overtemperature faults by heatsinking the drive properly (or adding the -HS3 Heatsink/Fan Unit option), and maintaining ambient temperature at or below 50°C (122°F).

Short Circuit Protection

The TQ10 Drive has short circuit protection. The drive monitors current in its motor output terminals. When the drive detects a short circuit in the motor or motor cabling, it illuminates the **MOTOR FAULT** LED, and stops producing motor current. This is a latched condition. To restart the drive, first fix the short in the motor or cable, then cycle power.

Regeneration

The TQ10 Drive has an internal regeneration resistor. If the motor *regenerates*—produces excess energy during deceleration—the drive will automatically dissipate the excess energy in its regeneration resistor. The power capacity of the resistor is 1KW for one second, or 10 watts on a continuous basis. If the motor regenerates more energy than can be dissipated in the regeneration resistor, the resulting voltage rise on the drive's motor output terminals can cause an overvoltage fault (see below).

If excessive regeneration repeatedly causes overvoltage faults, you may need to alter your move profile, change application conditions, or install an external regeneration resistor (see *Chapter 2, Installation* for instructions).

Vertical applications require careful sizing, and should use a mechanical brake to aid in deceleration.

Overvoltage

The TQ10 Drive monitors the voltage on the motor output terminals. If the voltage rises above a threshold level, the drive will shut down power output to the motor, and will illuminate *red* the bicolor LED labeled **RED = OVERVOLTAGE**. Excessive regeneration is the primary cause of an overvoltage fault.

This is a latched fault. To resume operations, cycle power; or, with the TQ10 Torque drive, you can use the reset input.

Undervoltage

The TQ10 Drive monitors the voltage on its AC power input terminals. If the voltage falls below 80VAC, the drive will shut down and activate its fault output. When you apply power to the drive, the power-up event is indistinguishable from an undervoltage; therefore, the undervoltage fault is not latched. Furthermore, an undervoltage fault will unlatch any other faults that may be present at the time of the undervoltage.

There is no LED indicator for an undervoltage fault.

Foldback

A mechanical jam in a servo system can cause the motor to overheat. In contrast to a stepper motor, which does not run hotter when jammed, a servo will apply full current (for full torque) while it attempts to move as commanded. Usually, this current will be *much* higher than the motor can withstand continuously. If it persists indefinitely, it may damage the motor's windings.

To help protect the motor from overheating, the TQ10 has a *current foldback* circuit. If high motor current persists for too long, the circuit can cause a fault, or reduce the current to a lower level that decreases the rate of motor heating.

Three of the DIP switches on top of the drive allow you to set the maximum current the drive will produce ("**PEAK CURRENT LIMIT**"). These switches should be set to a value no greater than three times the continuous current rating (Ics) of the motor used. This setting is used by the foldback circuitry to help protect the motor.

Six of the DIP switches configure the foldback circuitry. Three of them set the time that "high" current will be permitted before the foldback circuitry takes action. Settings range from 1 to 10 seconds. One switch defines what constitutes "high" current. This is set according to Ics. One switch will cause a latched fault to be generated when the selected time at high current is exceeded, otherwise current is reduced ("folded back") to 40% of the peak current limit setting. One switch allows foldback to be disabled entirely. See *Chapter 2—Installation* and *Chapter 4—Tuning* (Tuning Procedure) for instructions on setting the dip switches.

How Foldback Works

When actual current produced by the drive exceeds the threshold (relative to the peak current limit) set with SW2-2, the foldback circuit illuminates the **PEAK CURRENT** LED green, and starts a timer. If the current remains above this threshold for longer than the time set with the time-at-peak dipswitches, the foldback circuit activates, and the IN **FOLDBACK** LED illuminates red. The circuit can generate: A) A latched fault, if so configured, or B) reduce current to 40% of the peak current limit setting.

In case A (with **SW2-1 ON**), the fault will remain until power is cycled, or the **RESET** input is asserted. This fault condition will be indicated by a red **MOTOR FAULT** LED, and an active **FAULT OUT** signal. The **IN FOLDBACK** LED may go out when the **MOTOR FAULT** comes on, depending on the load. When faulted, the motor current will be reduced to zero.

In case B (with **SW2-1 OFF**), the current reduction will persist until the command input goes below the actual current, when the circuit will once again allow the full current permitted by the peak current limit setting. While foldback is limiting the current, the **IN FOLDBACK** LED will be red. When the command is reduced, the LED will go out. The **FAULT OUT** will not go active, since current foldback is not considered a fault.

Oscillating currents, such as are seen when a system goes unstable during tuning, will activate the foldback circuit if the current gets high enough, and the frequency of oscillation is greater than about 20 Hz. Systems in this power range typically have resonant frequencies much higher than this. The default settings suggested for each motor will result in a latched fault after about 3.3 seconds above threshold. This time can be selected with SW1-4,5,6. The sequence of events is: Current exceeds threshold, illuminating the **PEAK CURRENT** LED (green). If this continues for longer than 3.3 seconds, the **IN FOLDBACK** LED will illuminate red, and current will be reduced.

If **SW2-1** is **ON**, then the **MOTOR FAULT** LED (red) will illuminate. The **IN FOLDBACK** LED may go out when the **MOTOR FAULT** LED turns on, depending on the load. Current will be reduced to zero and the **FAULT OUT** will go active. This setting is recommended for nearly all applications, since it causes a motor fault to be indicated. In most applications, allowing the current to be reduced by foldback (without causing a fault) will result in the controller faulting from excess position error, masking the source of the problem, or in the production of defective product. The latched drive fault will lead the troubleshooter to the source of the problem more directly. A mechanical jam, or increased friction in the mechanical system are the common causes.

An exception to this would be an application where stopping the axis will lead to unacceptable consequences, and continued motion, even at a reduced rate, is preferable. An example of this would be a conveyor drive running product through an oven which is hot enough to melt the product eventually.

The default settings cause the timer to start when the current is approximately twice the motor's continuous rating (2 times Ics). The thermal switches in Parker servo motors will protect a properly mounted motor in its specified ambient temperature, up to at least twice Ics, at which point foldback takes over. If the peak current limit is set to three times Ics as recommended, foldback will reduce current to a level below twice Ics, reducing the rate of motor heating enough to give the thermal switch time to react, and protect the motor.

Note that foldback is not a substitute for proper sizing of the application, and does not enforce a lengthy cooling-off period. As soon as the command goes below the actual current, the circuit starts over. Applications with insufficient dwell time to allow the motor to cool between periods of peak current will not be successful.

Foldback is intended to be a secondary safety net. Primary protection of the motor during application problems should be provided by end-of-travel-limit switches, and by proper setting of position-error faults in the controller. These will provide quicker, more direct detection of end-stop or mechanical jamming problems in the application than foldback can. If these systems fail, foldback can generate a fault (which stops all motor current) or reduce the rate of motor heating to enable the thermal switch to operate.

Hall Miswiring

The drive will produce a motor fault and illuminate the red **MOTOR FAULT** LED if it detects an improper Hall state on its Hall effect inputs (all HIGH or all LOW), or if no motor is connected to the drive. A damaged Hall sensor can also activate the motor fault protection circuit.

To diagnose Hall miswiring or a damaged Hall sensor:

① **Remove AC power**

② **Disconnect I/O:** Disconnect all front panel inputs and outputs, except for enable input, motor temp±, and Hall signals (Hall 1 – 3, Hall +5, Hall Gnd).

③ **Apply AC power**: If the **MOTOR FAULT** LED is still illuminated, then one or more Hall sensors in the motor may be damaged.

④ This can be verified with a volt meter or oscilloscope. Monitor the three Hall inputs at the connector, relative to Hall ground. Slowly rotate the motor. A damaged, miswired, or disconnected Hall signal will cause the "all HIGH" or "all LOW" state to occur at some shaft position.

⑤ Note that "open-collector" Hall outputs must be used. Contact factory if you must use "differential" Hall-output motors.

Motor Overtemperature Protection

The TQ10 Drive has a circuit that can protect the motor against overheating. Through its **MOTOR TEMP+** and **MOTOR TEMP–** terminals, the drive checks for electrical continuity provided by a normally-closed thermostat mounted on the motor. If the motor overheats and the thermostat opens, the loss of continuity activates protection circuitry in the TQ10—it turns off power output to the motor, and illuminates the **MOTOR FAULT** LED.

This is a latched fault. To resume operations, let the motor cool, then cycle power; or, with the TQ10 Torque drive, you can use the reset input.

A motor overtemperature fault may be an indication that your motor is not sized properly for your application. It may also indicate that your motor is not installed properly (poor heatsinking, for example).

A thermostat cannot protect the motor in every situation! Bursts of peak current produce bursts of heat that are quickly absorbed in the motor windings, but slowly dissipated through the motor case and mounting flange. If the bursts are short and infrequent, winding temperature and thermostat temperature will be similar, and the thermostat can protect the motor. If full current flows continuously in the motor, however, the windings can exceed their rated temperature and be damaged, even before the thermostat temperature rises enough to trigger a motor fault.

Technical Support

If you cannot solve your system problems using this User Guide, contact your local Automation Technology Center (ATC) or distributor for assistance. If you need to talk to our in-house application engineers, contact Parker Compumotor's Applications Department at (800) 358-9070, from 6:00 AM to 5:00 PM Pacific time.

Product Return Procedure

If you must return your TQ10 Drive for repairs, use the following steps:

① Get the serial number and the model number of the defective unit, and a purchase order number to cover repair costs in the event the unit is determined to be out of warranty.

② Before you return the unit, have someone from your organization with a technical understanding of the TQ10 Drive and its application include answers to the following questions:

- What is the extent of the failure/reason for return?
- How long did the unit operate?
- Did any other items fail at the same time?
- What was happening when the unit failed (e.g., installing the unit, cycling power, starting other equipment, etc.)?
- How was the unit configured (in detail)?
- What, if any, cables were modified and how?
- With what equipment is the unit interfaced?
- What was the application?
- What was the system environment (temperature, enclosure, spacing, unit orientation, contaminants, etc.)?
- What upgrades, if any, are required (hardware, cables, user guide)?

③ In the USA, call your Automation Technology Center (ATC) for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number. If you cannot obtain an RMA number from your ATC, call Parker Compumotor's Customer Service Department at (800) 722-2282.

Ship the unit to: Parker Hannifin Corporation
Compumotor Division
5500 Business Park Drive, Suite D
Rohnert Park, CA 94928
Attn: RMA # xxxxxxx

④ In Europe, call Parker Digiplan for a GRA (Goods Returned Authorization) number. *Returned products cannot be accepted without a GRA number.* The phone number for Parker Digiplan Repair Department is 0202-690911. The phone number for Parker Digiplan Service/Applications Department is 0202-699000.

Ship the unit to: Parker Digiplan Ltd.,
21, Balena Close,
Poole, Dorset,
England. BH17 7DX

⑤ Elsewhere: Contact the distributor who supplied the equipment.