13.1 IMPORTANT SAFEGUARDS

All work on the drive should be performed by personnel familiar with it and its application. Before performing any maintenance or troubleshooting, read the instructions and consult the system diagrams.

WARNING

MAKE SURE THAT ALL POWER SOURCES HAVE BEEN DISCONNECTED BEFORE MAKING CONNECTIONS OR TOUCHING INTERNAL PARTS. LETHAL VOLTAGES EXIST INSIDE THE CONTROL ANYTIME INPUT POWER IS APPLIED, EVEN IF THE DRIVE IS IN A STOP MODE. A TURNING MOTOR GENERATES VOLTAGE IN THE DRIVE EVEN IF THE AC LINE IS DISCONNECTED. EXERCISE CAUTION WHEN MAKING ADJUSTMENTS. WITH THE CONTROL DRIVING A MOTOR, DO NOT EXCEED TEN (10) DEGREES OF POTENTIOMETER ROTATION PER SECOND. NEVER INSTALL OR REMOVE ANY PC BOARD WITH POWER APPLIED TO THE CONTROL.

13.2 TROUBLESHOOTING OVERVIEW

Fast and effective troubleshooting requires well-trained personnel supplied with the necessary test instruments as well as a sufficient stock of recommended spare parts. Capable electronic technicians who have received training in the control operation and who are familiar with the application are well qualified to service this equipment.

13.2.1 Suggested Training

A. Study the system instruction manual and control drawings.

B. Train in the use of test instruments.

C. Contact CT for training schools.

D. Obtain practical experience during the system installation and in future servicing.

13.2.2 Maintenance Records

It is strongly recommended that the user keeps records of downtime, symptoms, results of various checks, meter readings, etc. Such records will often help a service engineer locate the problem in the minimum time, should such services be required.

13.2.3 General Troubleshooting

The most frequent causes of drive failure are:

A. Interconnect wire discontinuity, caused by a broken wire or loose connection.

B. Circuit grounding within the interconnections or the power wiring.

C. Mechanical failure at the motor.

DO NOT make adjustments or replace components before checking all wiring. Also monitor all LED indicator lights and display references before proceeding with troubleshooting checks, and check for blown fuses.

It should be noted that modern solid state electronic circuitry is highly reliable. Often problems which appear to be electrical are actually mechanical. It is advised that the motor be checked in the event of any drive problems. Refer to the motor owner's manual for maintenance and repair procedures.

13.2.4 Notes for a Troubleshooting Technician

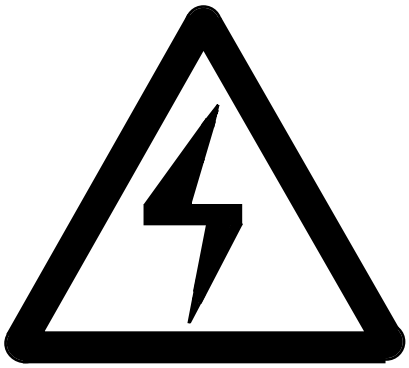
A minimum knowledge of system operation is required, but it is necessary to be able to read the system schematics and connection diagrams.

An oscilloscope (Tektronix 214 or equivalent) may be needed to locate problem areas and to make adjustments. However, the majority of problems can be solved by using a multimeter and by parts substitution.

Multimeters having a sensitivity of 1000 or more ohms per volt on the DC scale are recommended, such as a Triplett Model 630, a Simpson Model 260, or equivalent.

WARNING

WHEN A TEST INSTRUMENT IS BEING USED, CARE MUST BE TAKEN TO INSURE THAT ITS CHASSIS IS NOT GROUNDED EITHER BY A GROUNDING PLUG CONNECTION OR BY ITS CASE BEING IN CONTACT WITH A GROUNDED SURFACE. EXTREME CARE MUST BE TAKEN WHEN USING THE OSCILLOSCOPE SINCE ITS CHASSIS WILL BE ELECTRICALLY HOT TO GROUND WHEN CONNECTED TO THE CONTROL SYSTEM.



DANGER
ELECTRIC SHOCK RISK

Isolate electrical supply before working on this equipment.

13.3 FAULT FINDING

The Quantum III, as a digital drive, has an unprecedented number of diagnostic facilities to assist fault finding.

The following sections describe how these facilities can be used manually to identify a fault. However, it must be remembered that all the information indicated can also be data-logged via the optional serial interface.

Status Indicators

Nine LEDs to the right of the parameter data and index panels present information, continuously updated, about the running condition of the drive and enable basic information to be seen at a glance.

LED Illuminated	Information
Drive ready	The drive is turned on, not tripped.
Drive ready - flashing	The drive is tripped.
Alarm - flashing (overload pending)	The drive is in an overload trip condition or is integrating in the I x t region.
Zero speed	Motor speed < zero speed threshold (programmable).
Run forward	Motor running forward.
Run reverse	Motor running in reverse.
Bridge 1	Output bridge 1 is enabled.
Bridge 2	Output bridge 2 is enabled. (inactive in 1-quadrant models).
At speed	Motor running at the speed demanded by the speed reference.
Current limit	Drive running and delivering maximum permitted current.

Trip Codes

If a fault occurs, the index display shows **triP**, and the data message will flash. The data display shows a mnemonic to indicate the reason for the trip.

The last four trip codes are stored in parameters 10.25 through to 10.28, and are available for interrogation unaffected by power down/up cycles. The data stored in these parameters is updated only by the next trip event.

MNEM.	CODE	REASON FOR THE TRIP
AOC	121	***Armature overcurrent.*** An instantaneous protection trip has been activated due to excess current in the armature circuit.
AOP	126	***Armature open circuit.*** Check armature contactor power poles for continuity. Ensure #4.15 - #4.17 is 0 on non-regenerative models (9500-83xx). Ensure ribbon cable under behind control board is properly plugged in.
cL	104	***Current (control) loop open circuit.*** If the input reference is either 4-20mA or 20-4mA, this trip indicates that input current is <3.5mA.
EEF	132	***EEprom failure.*** Indicates that an error has been detected in the parameter set read from the EEprom at power-up.
EPS	103	***External power supply.*** Overcurrent trip at the 24V supply output terminal (TB4-33) has operated, indicating an overload in the external circuit connected to this supply. Investigate and rectify the cause. Remove +24v loads.
Et	102	***External trip.*** Parameter 10.34 = 1. The external trip set up by the user has operated. (Typically motor thermal). This is the normal setup for E-STOP trips. See Appendix C on E-STOP without External Trip.
FbL	119	***Feedback loss.*** No signal from tachometer or encoder.
Fbr	109	***Feedback reversal.*** The polarity of the feedback tachometer or encoder polarity is incorrect.
FdL	118	***Field loss.*** No current in field supply circuit. On Size 1 units 9500-8X02 thru 8X06 the Field must be setup. See section 8.8 for details. Check Field wiring. Check field ohms against motor nameplate info.
FdO	108	***Field on.*** The user has initiated self-tuning (05.09) and field current has been detected.
FOC	106	***Field overcurrent.*** Excess current detected in field current feedback. If current feedback is present and firing angle is phased back, then trip.
hF	100	***Hardware fault.*** A hardware fault has been detected during the self-diagnosis routine performed after power-up. Consult factory.
It	122	***I*** x ***t trip.*** The integrating overload protection has reached trip level.
Oh	107	***Overheated.*** SCR heatsink overtemperature. (Only on drives installed with heatsink thermals).
Pc1	124	***Processor 1 watchdog.*** Indicates a fault in the MDA1 hardware has been detected by malfunctioning of Processor 1 software.
Pc2	131	***Processor 2 watchdog.*** Shows a Processor 2 malfunction, or a software bug (MD21 option).
PhS	101	***Phase sequence.*** Connections to E1 and E3 are not the same phases as are connected to L1 and L3. Investigate and correct.
PS	125	***Power supply.*** One or more of the internal power supplies is out of tolerance. Remove +/-10v loads (speed pot) from TB1 on MDA2B board and re-try.
ScL	105	***Serial communications interface loss.*** (Only in serial comms mode 3) No input data detected.
SL	120	***Supply loss.*** One or more of the power (input) supply phases is open-circuit. Check input line fusing.
th	123	***Thermal.*** Motor protection thermal has initiated a trip indicating windings overheating.
thS	110	***Thermal short circuit.*** Thermal input < 100Ω (not in effect when motor thermal is used).

IN CASE OF ANY TRIP, all RO parameter values are 'frozen' and remain so for interrogation while the cause of the fault is investigated. To enter parameter adjustment mode from the trip mode, press any of the five adjustment keys. To re-enter trip mode, go to Menu 00 and press ◀ .

TRIP CODES IN NUMERICAL ORDER		
hF	100	Hardware fault.
PhS	101	Phase sequence
Et	102	External trip.
EPS	103	External power supply.
cL	104	Current (control) loop open circuit.
ScL	105	Serial communications interface loss.
FOC	106	Field overcurrent.
Oh	107	Drive over temperature.
FdO	108	Field on.
Fbr	109	Feedback reversal.
thS	110	Thermal short circuit.
FdL	118	Field loss.
FbL	119	Feedback loss.
SL	120	Supply loss.
AOC	121	Armature overcurrent.
It	122	I x t trip.
th	123	Motor over temperature.
Pc1	124	Processor 1 watchdog.
PS	125	Power supply.
AOP	126	Armature open circuit.
Pc2	131	Processor 2 watchdog.
EEF	132	EEprom failure.

MONITORING KEY DRIVE PARAMETERS

NOTE

If a fault occurs, the following parameters are frozen at the instant of the fault and can therefore be read after the event. This gives valuable information about the operating conditions which existed when the fault occurred. This feature is of great assistance in determining the precise nature and cause of the fault. Reference should be made to the menu diagrams and the full descriptions in Section 10 when analyzing the following parameters.

To enter the parameter adjustment mode from the trip mode, press any of the five adjustment keys. To re-enter the trip mode, go to Menu 00 and press◀.

01.01 RO Pre-offset speed reference
Range ±1000

01.02 RO Post-offset speed reference
Range ±1000

01.03 RO Pre-ramp reference
Range ±1000

02.01 RO Post-ramp Reference
Range ±1000rpm

03.01 RO Final Speed Demand
Range ±1000

03.02 RO Speed Feedback
Range ±1000

03.03 RO Displayed Speed Feedback
Range ±1999rpm

03.04 RO Armature Voltage
Range ±1000 (direct reading in Volts)

03.05 RO IR Compensation Output
Range ±1000

03.06 RO Speed Error
Range ±1000

03.07 RO Speed Loop Output
Range ±1000

03.08 RO Speed Error Integral
Range ±1000

03.26 *RO Tachometer Input*
Range ±1000

04.01 RO Current Demand
Range ±1000

04.02 RO Final Current Demand
Range ±1000

04.03 RO Over-riding Current Limit
Range ±1000

04.24 *RO Taper threshold 1 exceeded*
Range 0 or 1

04.25 *RO Taper threshold 2 exceeded*
Range 0 or 1

05.01 RO Current Feedback
Range ±1000

05.02 RO Current —Displayed Feedback Amps
Range ±1999

05.03 RO Firing Angle
Range 277 to 1023

05.11 *RO Actual overload*
Range 0 to 199

06.01 RO Back EMF
Range 0 to 1000

06.02 RO Field Current Demand
Range 0 to 1000

06.03 RO Field Current Feedback
Range 0 to 1000

06.04 RO Firing Angle
Range 261 to 1000

06.05 RO IR Compensation 2 Output
Range ±1000

07.01 RO General Purpose Input 1
Range ±1000

07.02 RO General Purpose Input 2
Range ±1000

07.03 RO General Purpose Input 3
Range ±1000

07.04 RO General Purpose Input 4
Range ±1000

07.05 RO Speed Reference Input
Range ±1000

07.06 RO RMS Input Voltage
Range 0 to 1000

07.07 RO Heatsink Temperature
Range 0 to 1000

08.01 RO F1 Input — Run Permit
Range 0 or 1

08.02 RO F2 Input — Default Inch Reverse
Range 0 or 1

08.03 RO F3 Input — Default Inch Forward
Range 0 or 1

08.04 RO F4 Input — Default Run Reverse
Range 0 or 1

08.05 RO F5 Input — Default Run Forward
Range 0 or 1

08.06 RO F6 Input — User-Programmable
Range 0 or 1

08.07 RO F7 Input — User-Programmable
Range 0 or 1

08.08 RO F8 Input — User-Programmable
Range 0 or 1

08.09 RO F9 Input — User-Programmable
Range 0 to 1

08.10 RO F10 Input — User-Programmable
Range 0 to 1

08.11 RO Drive Enable Input
Range 0 to 1

09.01 RO Status 1 Output
Range 0 or 1

09.02 RO Status 2 Output
Range 0 or 1

09.03 RO Status 3 Output
Range 0 or 1

09.04 RO Status 4 Output
Range 0 or 1

09.05 RO Status 5 Output
Range 0 or 1

09.06 RO Status 6 Relay Output
Range 0 or 1

10.01 RO Forward Velocity
Range 0 or 1

10.02 RO Reverse Velocity
Range 0 or 1

10.03 RO Current Limit
Range 0 or 1

10.04 RO Bridge 1 Enabled
Range 0 or 1

10.05 RO Bridge 2 Enabled
Range 0 or 1

10.06 RO Electrical Phase-Back
Range 0 or 1

10.07 RO At Speed
Range 0 or 1

10.08 RO Overspeed
Range 0 or 1

10.09 RO Zero Speed
Range 0 or 1

10.10 RO Armature Voltage Clamp Active
Range 0 or 1

10.11 RO Phase Rotation
Range 0 or 1

10.12 RO Drive Normal
Range 0 or 1

10.13 RO Alarm I x t
Range 0 or 1

10.14 RO Field Loss
Range 0 or 1

10.15 RO Feedback Loss
Range 0 or 1

10.16 RO Supply or Phase Loss
Range 0 or 1

10.17 RO Instantaneous Trip
Range 0 or 1

10.18 RO Sustained Overload
Range 0 or 1

10.19 RO Processor 1 Watchdog
Range 0 or 1

10.20 RO Processor 2 Watchdog
Range 0 or 1

10.21 RO Motor Overtemperature
Range 0 or 1

10.22 RO Heatsink Overtemperature
Range 0 or 1

10.23 RO Speed Loop Saturated
Range 0 or 1

10.24 RO Zero Current Demand
Range 0 or 1

10.25 RO Last Trip
Range 0 to 255

10.26 RO The Trip Before the Last Trip (10.25)
Range 0 to 255

10.27 RO The Trip Before 10.26
Range 0 to 255

10.28 RO The Trip Before 10.27
Range 0 to 255

11.15 RO Processor 1 Software Version
Range 0 to 255

11.16 RO Processor 2 Software Version
Range 0 to 255

12.01 RO Threshold 1 Exceeded
Range 0 or 1

12.02 RO Threshold 2 Exceeded
Range 0 or 1

NUMBER	DESCRIPTION	RANGE
13.01	RO Master counter value	0 to 1023
13.02	RO Slave counter value	0 to 1023
13.03	RO Master counter increment	±1000
13.04	RO Slave counter increment	±1000
13.05	RO Position error	0 to 255
15.01	RO variable 1	±1999
15.02	RO variable 2	±1999
15.03	RO variable 3	±1999
15.04	RO variable 4	±1999
15.05	RO variable 5	±1999
16.01	RO variable 1	±1999
16.02	RO variable 2	±1999
16.03	RO variable 3	±1999
16.04	RO variable 4	±1999
16.05	RO variable 5	±1999

13.3.1 Fault Finding Chart

The following chart is intended to assist with troubleshooting a typical drive. While not exhaustive, it indicates the general procedure to be adopted.

SYMPTOM	INDICATIONS	ACTION
MOTOR DOES NOT ROTATE	Drive ready LED off	NO POWER TO REGULATOR: Check regulator supply voltage on terminals E2, E2, E3. Check regulator/field fuses FS1, FS2, FS3. If failed, suspect problem in field regulator circuit or faulty field bridge.
	Drive ready LED flashing:	
	FdL displayed	FIELD LOSS: Check field connections. Check fuses FS1 & FS2 and field bridge. Check MDA-3 or FXM5 field regulator card, if used. Check if field regulator is set up (param 6.13).
	AOC displayed	ARMATURE OVERCURRENT TRIP: Check phase sequence & rotation: L1 same phase as E1 L2 same phase as E2 L3 same phase as E3 Check for short circuit or ground fault on output terminals A1, A2.
	PS displayed	POWER SUPPLY FAULT: Replace MDA2 PCB. If fault persists, replace power PCB.
	AOP displayed	ARMATURE OPEN CIRCUIT: Check motor connections and brushes. Check contactor sequencing and all fuses in AC and DC power circuit.
	Drive ready and run LED on:	
	Current limit LED off	DRIVE NOT ENABLED: Connect ENABLE terminal 31 to 0V terminal 40. NO SPEED DEMAND: Connect reference on terminal 3 if used, and parameters 01.01 and 02.01 should follow reference.

SYMPTOM	INDICATIONS	ACTION
MOTOR DOES NOT ROTATE	Current limit LED on	MOTOR MECHANICALLY STALLED or FAULT IN FIELD CIRCUIT.
	Drive ready LED on. Run and inch LEDs off	NO RUN COMMAND: Check control wiring. Refer to Menu 8 input parameters.
MOTOR STARTS BUT STOPS IMMEDIATELY	Drive ready LED flashing:	
	FbL displayed	TACH LOSS: Check tach connections and polarity.
	SL displayed	PHASE LOSS: Check 3-phase supply and line fuses. (See below) Ensure SCR gate leads correctly connected.
	AOC displayed	ARMATURE OVERCURRENT TRIP: Check 3-phase supply and line fuses (See below). Ensure SCR gate leads correctly connected. Check phase sequence and rotation: L1 same phase as E1 L2 same phase as E2 L3 same phase as E3 Check motor for ground faults and short circuits.
	Line fuse or DC fuse blown	SHORT CIRCUIT ON OUTPUT: Check connections between A1 and A2 and motor. Test motor for armature short circuit, short circuit between interpole and field, and ground fault. INTER-BRIDGE FAULT (4Q ONLY): Replace the Power PCB. FAULTY SCR: Contact factory.
MOTOR RUNS FOR A SHORT TIME AND STOPS	Alarm LED flashing while motor runs: IT displayed	SUSTAINED OVERLOAD: Check mechanical load. Check field supply at motor field terminals.
MOTOR ROTATES IN ONLY ONE DIRECTION		Check if drive is a Non-Regen model 9500-83xx Check if reference is Uni-Polar Check: #4.14 through 4.17 # 1.10 # 4.05, 4.06

SYMPTOM	INDICATIONS	ACTION
MOTOR SLOWS DOWN UNDER LOAD	Current limit LED on	DRIVE IN CURRENT LIMIT: Compare DC current with drive rating. Check value of current burden resistor. Check mechanical load. Check current limit settings 04.05 and 04.06. If used, check current limits 04.04 and 04.07. Check current taper 04.22 and 04.23. Check field supply at motor field terminals.
DEFECTIVE SPEED CONTROL	Speed range limited	SPEED REFERENCE RANGE INCORRECT: Check range of potentiometer or internal reference. SPEED CLAMPS OPERATING: Check max and min speed 01.06 through 01.09. OFFSET PRESENT: Check 01.04. FEEDBACK INCORRECT: Check setting of feedback selector jumpers and max. speed potentiometers.
	Speed unstable or overshoot excessive	CURRENT LOOP GAIN INCORRECTLY SET: Enable Autotune 05.09. Adjust 05.12, 05.13, and 05.14. SPEED LOOP GAINS INCORRECTLY SET: Adjust 03.09, 03.10, and 03.11.
	Motor runs only at top speed.	INCORRECT SPEED REFERENCE: Check speed potentiometer. TACH LOSS: (If tach loss detector inhibited) Check tach connections and polarity. INCORRECT FEEDBACK SCALING Check setting of SW1. DRIVE OPERATING IN CURRENT CONTROL: Check setting of parameters 04.12 and 04.13.

SYMPTOM	INDICATIONS	ACTION
MOTOR COMMUTATOR SPARKING		MECHANICAL PROBLEMS IN MOTOR: Check brushes and electrical neutral. ARMATURE VOLTAGE TOO HIGH: Tach feedback: Reduce field current. Set armature voltage clamp 03.15. Armature voltage feedback: Reduce motor voltage by limiting max speed 01.06 and 01.07. Weaken field if necessary to restore speed.
	Sparking on acceleration	CURRENT LIMIT TOO HIGH: Check parameters 04.05 and 04.06. CURRENT SLEW RATE TOO HIGH: (esp. solid-frame motor) Check parameter 05.04.
	Brushes and/or commutator worn	Replace brushes and/or overhaul commutator. If wear was rapid, check for contamination by oil mist or corrosive vapors.
MOTOR DOES NOT HOLD ZERO SPEED(FOR REGEN MODELS ONLY)	Overhauling load rotates motor at low speed No holding torque	Standstill logic is enabled Set parameter 05.18=0