SAFETY WARNINGS:
Improper installation or operation of this control may cause serious injury to personnel or equipment. Before you begin installation or operation of this equipment you should thoroughly read this instruction manual and any supplementary operating instructions provided. The drive must be installed and grounded in accordance with NEC (National Electrical Codes) and local codes. To reduce potential of electric shock, disconnect all power sources before initiating any maintenance or repairs. Keep fingers and foreign objects away from ventilation and other openings. Keep air passages clear. Potentially lethal voltages exist within the control unit and connections. Use extreme caution during installation and start-up.

BRANCH CIRCUIT PROTECTION:
Branch circuit protection must be provided by the end user.

OVERLOAD PROTECTION:
Overload protection must be provided per the National Electrical Code Handbook article 430, Section C.

INSTALLATION LOCATION OF CONTROL:
Controls are suitable for most factory areas where industrial equipment is installed. The control and operator's control station should be installed in a well-ventilated area. Locations subject to steam vapors or excessive moisture, oil vapors, flammable or combustible vapors, chemical fumes, corrosive gases or liquids, excessive dirt, dust or lint should be avoided unless an appropriate enclosure has been supplied or a clean air supply is provided to the enclosure. The location should be dry and the ambient temperature should not exceed 131°F for chassis mount or 104°F for an enclosed unit. If the mounting location is subject to vibration, the enclosure should be shock mounted.

If the enclosure has a ventilating fan, avoid, wherever possible, an environment having a high foreign-matter content; otherwise, the filters will have to be changed more frequently. Should a control enclosure require cleaning on the inside, a low pressure vacuum cleaner is recommended. Compressed/high pressure air is not recommended for cleaning the control because of possible oil vapor or high pressure damage.

Please record the Part Number, Revision Level, and Serial Number below before installing the unit and use this information when communicating with the factory.

QUANTUM MODEL: __________________________

PART NUMBER (P/N): _______________________

REVISION LEVEL (REV.): ___________________

SERIAL NUMBER (S/N): ____________________
WARRANTY

ICD Drives, Inc., a Member of Control Techniques Worldwide, warrants to the Buyer who purchases for use and not for resale that the equipment described in this Instruction Manual is sold in accordance with ICD’s published specifications or the specifications agreed to by ICD in writing at the time of sale. ICD further warrants that such goods are free of defects in material and workmanship.

The warranty shall apply for a period of twenty-four (24) months from date of manufacture.

If the goods fail to perform to ICD’s specifications as outlined in the warranty, then Buyer should contact ICD to obtain a “Material Return Authorization” (MRA), prepare the goods for shipment, and return the goods to ICD for repair or replacement at ICD’s option. Buyer will bear all costs of transportation to and from ICD’s factory, risk of loss for goods not at ICD’s factory, and any cost required to remove or prepare the goods for shipment to the repair facility and to reinstall equipment subsequent to repair.

The warranty is effective only if written notification of any claim under this warranty is received by ICD at the address indicated below within thirty (30) days of recognition of defect by Buyer.

The above indicates the full extent of ICD’s liability under this warranty. ICD specifically disclaims any liability for: (a) Damage or failure due to improper use or installation; (b) damages in shipment; (c) damage or failure due to abnormal operating conditions of load, temperature, altitude, or atmosphere, whether intentional or unintentional; (d) nonauthorized service, repair, modification, inspection, removal, transportation or installation; (e) misapplication or misuse; or (f) consequential damages arising out of the use, operation or maintenance of the goods.

THERE ARE NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, WHICH EXTEND BEYOND THAT DESCRIBED HEREIN. ICD SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OF GOODS OR OF THE FITNESS OF THE GOODS FOR ANY PURPOSE.

ICD neither assumes nor authorizes any representative or any other person to assume for ICD any other liability in connection with the sale or any shipment of ICD’s goods. ICD reserves the right to make changes and improvements in ICD’s goods without incurring any obligation to similarly alter goods previously purchased.

ICD Drives, Inc.
A Member of Control Techniques Worldwide
3036 Alt Boulevard
Grand Island, New York 14072
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Fax: (716) 773-6264 or
(716) 773-2635

SERVICE ASSISTANCE

For Field Service Assistance, please call:

During Normal Business Hours:
(8:00am to 5:00pm Eastern Time)............. (716) 773-2321

After Normal Business Hours......................(716) 692-2442
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1.1 GENERAL DESCRIPTION

Quantum II is the name given to the very latest family of advanced, fully microprocessor-controlled DC variable speed drive units covering the output range 5 to 1000 HP as single-ended converters, and in four-quadrant, fully regenerative configuration. The introduction of Quantum II marks a significant achievement in the field of DC drive technology by providing within a compact package all the accuracy and versatility inherent in microprocessor control while remaining competitive in price with conventional analog drives.

All models feature a fully controlled six-pulse SCR bridge, comprehensively protected against voltage transients and isolated from the control electronics. Full details of unit ratings and dimensions are included in sections 2, 4 and 5.

The microprocessor-based control system, employing the latest surface-mount technology, is programmed and adjusted by integral pushbuttons and seven-segment LED displays, which also form part of the powerful built in diagnostic facility.

Options include a second processor to service special application software which expands the drive's capabilities, and a serial interface for remote control and monitoring.

Quantum II is extremely compact and simple in construction, taking full advantage of modern high-volume production techniques. Access is particularly good, for ease of installation and servicing.

1.2 EQUIPMENT IDENTIFICATION

It is important to identify the control completely and accurately whenever ordering spare parts or requesting assistance in service.

The control includes a product nameplate located on the right side panel of the enclosure. The product nameplate should appear as one of the sample nameplates shown in Figure 1-2. Record the part number, revision level, and serial number for future reference in the front of this manual.

If the control is part of an engineered drive system, the system cabinet will also include a product nameplate. Record the part number, revision level, and serial number of the engineered system and include this information with the information on the individual controls whenever contacting the factory.
2.1 ELECTRICAL SPECIFICATIONS

MAIN AC SUPPLY--"A" MODELS

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<th>60 Hz</th>
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<td>208V -5%*</td>
<td>208V -6%</td>
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<tr>
<td></td>
<td>208V +10%</td>
<td>208V +10%</td>
</tr>
<tr>
<td>Jumper Selectable</td>
<td>240V -10%</td>
<td>240V -10%</td>
</tr>
<tr>
<td></td>
<td>240V +6%</td>
<td>240V +10%</td>
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<tr>
<td></td>
<td>380V -10%*</td>
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<td>380V +10%</td>
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<td></td>
<td>415V -10%*</td>
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<td></td>
<td>415V +6%</td>
<td>415V +6%</td>
</tr>
<tr>
<td></td>
<td>480V -10%</td>
<td>480V -10%</td>
</tr>
<tr>
<td></td>
<td>480V +10%</td>
<td>480V +10%</td>
</tr>
</tbody>
</table>

Line Frequency Variations: 45 to 62 Hz Auto Tracking

MAXIMUM RECOMMENDED MOTOR VOLTAGES:

<table>
<thead>
<tr>
<th>Supply Voltage</th>
<th>Field Voltage</th>
<th>Arm. Voltage Single-Ended (Motor Only)</th>
<th>Arm. Voltage Four-Quadrant (Regenerative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>460</td>
<td>310</td>
<td>510</td>
<td>480</td>
</tr>
<tr>
<td>480</td>
<td>320</td>
<td>530</td>
<td>500</td>
</tr>
<tr>
<td>380</td>
<td>240</td>
<td>440</td>
<td>400</td>
</tr>
<tr>
<td>415</td>
<td>300</td>
<td>460</td>
<td>420</td>
</tr>
</tbody>
</table>

2.3 POWER CIRCUIT:

Armature converter:
3 phase fully controlled six pulse SCR bridge. Available in both single ended (9500-8201 through -8206 and 9500-8107 through -8111) six SCR and fully regenerative four quadrant (9500-8501 through -8506 and 9500-8407 through -8411) inverse parallel twelve SCR bridge configurations.

Field supply:
5A on 5-100 HP, 460 VAC
15A on 125-400 HP, 460 VAC

Electrical isolation:
Low voltage control electronics to AC supply and ground. Impedance isolation of 1M ohm to electronics common. If desired, the control electronics may be grounded. However, this practice is not recommended because of the risk of erroneous signals being received by the drive if a ground fault occurs in the control wiring.

2.2 ENVIRONMENT:

Operating ambient temperature range:
0 to 55°C (32 - 131°F)

Storage temperature range:
-40 to +70°C (-40 to 158°F)

Altitude Derating:
Derate linearly by 1% per 330 ft above 3300 ft
Rated maximum altitude: 3300 ft
Maximum relative humidity: 85% (non-condensing).

Overtemperature protection:
An overtemperature thermostat is installed on all fan cooled models, and should be used in the external control circuit to shut the drive down if the power bridge overheats. Contact arrangement: Single pole normally closed. Switch rating: 5 amps at 240 volts AC.

*(A) Models only
2.4 STATUS OUTPUTS

Please refer to the following TB1 terminals on the 9500-4000 board. These terminals are shown in Figures A-1 and A-2.

Terminals 13, 14 - Run contact closes when drive is in Run or Jog

Terminals 15, 16, 17 - NF (No Fault)-Relay picks up when drive is powered-up and no faults exist. Note that there will be a short time delay after power is first applied before this relay picks up. This is due to the drive self diagnostics routine which occurs after power is applied to the drive. No fault contacts shown in de-energized state. The relay will drop out when a drive fault occurs. This contact will also drop out momentarily during a drive reset.

Terminals 18, 19 - Spare relay-normally open relay contact from A/M (Auto/Manual)-relay closes in Auto

2.5 CONTROL INPUTS AND OUTPUTS

Logic Inputs:
Eight single bit (high/low) control logic inputs are provided, two of which are user-programmable. Logic inputs may be operated from open-collector outputs or volt-free contacts and are active when pulled low to electronics common (terminal 24).

Internal pull-up resistors are 10K to +24VDC.

Term. 18 - F0-user programmable by #67
Term. 19 - F1-user programmable by #68
(Terminals 18 and 19 are user programmable)

Term. 16 - Drive enable
Term. 17 - Drive start permit (not stop)
Term. 20 - F2 Inch reverse
Term. 21 - F3 Inch forward
Term. 22 - F4 Run reverse
Term. 23 - F5 Run forward
(Terminals 16, 17, and 20 through 23 are connected to the 9500-4000 AC Interface Board.)

Switching characteristics:
Maximum 'low' input: +2VDC
Minimum 'high' input: +4VDC

Term. 7 - Software configurable general purpose input for use in special applications with optional MD21 processor, or as a monitoring function:
Type: Unipolar
Scaling: 0/+9.77VDC = 0/+999 on #10
Internal resolution: 0.1%
Input Impedance: 10k ohms

Term. 8 - Software configurable precision rectified general purpose input for use in special applications with optional MD21 processor, or as a monitoring function:
Type: Unipolar
Scaling: 0/+9.77VDC = 0/+999 on #11
Internal resolution: 0.1%
Input Impedance: 10k ohms

ANALOG INPUTS:
Term. 1 - DC Tachometer Feedback input:
Type: Bipolar (Displayed with inverted polarity as Parameter #3).
Scaling: Dependent on range selection (Jumper LK3, 4, 5 on MD200 board) and setting of maximum speed potentiometer (VR2 on MD200 board).

Internal resolution: 0.01%
Input Impedance: 10-50 volt range - 6.2k ohms
40-200 volt range - 26.2k ohms
60-300 volt range - 36.2k ohms

Term. 5 - Analog speed demand:
Type: Bipolar
Scaling: +9.77V/0 - 9.77VDC = +999/0/-999 on #01
Range programmed by: REG #193
Scaling: +9.77V/0/-9.77VDC = +999/0/-999 on #06
(#193=0)
+9.77V/0/-9.77VDC = +63/0/-63 on #06 (#193=1)
Internal resolution: 0.01%
Input Impedance: 32k ohms

Term. 6 - Programmable analog input:
Type: Bipolar
Function programmed by: REG #69
Internal resolution: 0.1%
Input impedance: 94k ohms

Power Supplies:
Term. 3 - Reference supply +10V: max. load 10mA.
Term. 4 - Reference supply -10V: max. load 10mA.
Term. 15 - Unregulated +24V supply: max. load 50mA.
Term. 2, 9, 24, 41 - 0V common for analog signals and supplies.
NOTE
The scaling of analog inputs and outputs is dependent on component tolerances, and is typically subject to a variation of ±1%.

ANALOG OUTPUTS:
Four analog outputs are provided, one of which is user programmable.

Term. 10 - Armature current image
Type: Unipolar
Scaling: 0/+6.52VDC = 0/+999 on #08
Maximum drive capability: 10mA

Term. 11 - Speed feedback image
Type: Bipolar
Scaling: -9.77V/0/+9.77VDC = -999/0/+999 on #03
Maximum drive capability: 10mA

Term. 12 - Armature voltage feedback image
Type: Bipolar
Scaling: -9.77V/0/+9.77VDC = -999/0/+999 on #03
Corresponding armature voltage or speed range depends on adjustment of VR1 on MD200 board.
Maximum drive capability: 10mA

Term. 13 - Programmable analog output:
Type: Bipolar
Function programmed by: #65
Scaling: -9.77V/0/+9.77VDC = -999/0/+999 on any selected parameter between #01 and #49
Maximum drive capability: 10mA.
LED STATUS INDICATORS:
9 LED status indicators, labeled and visible from the front of the unit, are provided to indicate the following drive conditions:

- Drive ready
- Sustained Overload Alarm
- Drive at Zero Speed
- Run Forward Selected
- Run Reverse Selected
- Bridge 1 On
- Bridge 2 On
- Drive at Set Speed
- Drive in Current Limit

These are shown on in the following figure.

The status LEDs (except for the Drive Ready LED) may be alternatively configured in software for special applications. (See description of parameters #93 and #185 in section 10).
2.6 CONFIGURATION SOFTWARE

The Quantum Configuration Software (DriveView) is an IBM PC based computer software package that allows the user to select drive operating modes and adjustment parameters for drive application configuration. This program uses a window-style, menu driven program environment and can be set up for color or monochrome monitors. This program permits the user to configure a drive or series of drives in an office environment and save the resultant setup to disk. This file can be printed out for a permanent hard copy record and later "downloaded" into the Quantum drive. A drive configuration can be "uploaded" at any time and saved to disk so that drive settings can be recorded and printed. The Configuration Program permits the user to set-up identical duplicates or "cloned" replacement drives in seconds.

Three major functions handled by the drive support software are:

- Drive Configuration
  - Scaling
  - Feature Selections
  - I/O Selections

- Register Monitoring
  - Setpoints and Feedback Quantities
  - I/O Status

- Remote Control
  - Refer to Instruction Manual GEN-010 for details.

2.7 SOFTWARE TOOLKIT DRIVE VIEW

This permits the following:

**Drive Configuration in Office Environment:**
For the convenience of not having to power up the drive or leave your office to pre-engineer a drive configuration for your application.

**Drive Configuration to be Saved to Disk or Printer:**
For a permanent record and documentation.

**Resulting Configuration to be Downloaded in Test**

**Drive Configuration can be Uploaded and Saved:**
After the configuration passes through test and all configuration touch-ups are completed, the final drive setup information can be uploaded and saved.

**Drive Cloning for Identical Duplicate Spares:**
In this manner, should a drive need to be replaced or a duplicate system be created, the original drive data file can be retrieved from disk and downloaded into the replacement clone.
This section outlines procedures necessary to insure safe operation of any AC or DC drive. For further information, contact the Service Department at the address shown on the inside back cover of this manual.

3.1 GENERAL SAFETY PRECAUTIONS

WARNING

THIS CONTROL AND ASSOCIATED MOTOR CONTAINS HAZARDOUS VOLTAGES AND ROTATING MECHANICAL PARTS. EQUIPMENT DAMAGE OR PERSONAL INJURY CAN RESULT IF THE FOLLOWING GUIDELINES ARE NOT OBSERVED.

A. Only qualified personnel familiar with this type of equipment and the information supplied with it should be permitted to install, operate, troubleshoot or repair the apparatus. A qualified person must be previously trained in the following procedures:

- Energizing, de-energizing, grounding and tagging circuits and equipment in accordance with established safety practices.

- Using protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

- Rendering first aid.

B. Installation of the equipment must be done in accordance with the National Electrical Code and any other state or local codes. Proper grounding, conductor sizing and short circuit protection must be installed for safe operation.

C. During normal operation, keep all covers in place and cabinet doors shut.

D. When performing visual inspections and maintenance, be sure the incoming AC power is turned off and locked out. The drive and motor will have hazardous voltages present until the AC power is turned off. The drive contactor does not remove hazardous voltages when it is opened.

E. When it is necessary to make measurements with the power turned on, do not touch any electrical connection points. Remove all jewelry from wrists and fingers. Make sure test equipment is in good, safe operating condition.

F. While servicing with the power on, stand on some type of insulation, being sure you are not grounded.

G. Follow the instructions given in this manual carefully and observe all warning and caution notices.

3.2 INSTALLATION SAFETY

When moving this control and associated motor into the installation position, do any required lifting only with adequate equipment and trained personnel. Drive units with or without cabinets are top heavy and will tip easily until securely anchored in place. Eyebolts or lifting hooks, when supplied, are intended for lifting the product only and must not be used to lift additional weight. Improper lifting can cause equipment damage or personal injury.

WARNING

HAZARDOUS VOLTAGES MAY BE PRESENT ON EXTERNAL SURFACES OF UN-GROUNDED CONTROLS. THIS CAN RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

The drive cabinet is provided with a grounding lug to which a ground wire must be connected for personnel safety. Also any motor frame, transformer enclosure and operator station must be connected to earth ground. Consult the National Electrical Code and other local codes for specific equipment grounding requirements.

Protective guards must be installed around all exposed rotating parts.

CAUTION

Drilling or punching can create loose metal chips. This can result in shorts or grounds that can damage the equipment.

If it is necessary to drill or punch holes in the equipment enclosures for conduit entry, be sure that metal chips do not enter the circuits.
3.3 SHIELDED WIRING

Circuits shown on the drawings that require shielded cable are sensitive to pick-up from other electrical circuits. Examples include wiring from the tachometer and from the speed setting device. Erratic or improper operation of the equipment is likely if the following precautions are not observed:

A. Where shielded cable is required, use 2- or 3-conductor twisted and shielded cable with the shield either connected as shown in the drawings, or “floating”, if so specified. If the shield is to be connected, do so only at the specified terminal in the drive unit. Do not connect at a remote location.

B. Shielded cables outside the drive enclosure should be run in a separate steel conduit, and should not be mixed in with other circuits that are not wired with shielded cable.

C. Avoid running the shielded cable close to other non-shielded circuits. Avoid long parallel runs to other non-shielded circuits, and cross other cable bundles at right angles.

Do not connect any external circuits to the drive or its associated equipment other than those shown on the diagrams supplied. Connection of external devices to the tachometer or speed setting device can significantly affect drive performance.

3.4 START-UP SAFETY

Detailed startup procedures are described in the Operation and Startup section of this manual. Before and during startup, it is imperative that all of the following safety procedures be observed.

**WARNING**

AC POWER MUST BE DISCONNECTED FROM THE DRIVE CABINET TO ELIMINATE THE HAZARD OF SHOCK BEFORE IT IS SAFE TO TOUCH ANY OF THE INTERNAL PARTS OF THE DRIVE. CIRCUITS MAY BE AT LINE POTENTIAL WHETHER THE ENCLOSED DRIVE IS OPEN OR CLOSED.

**CAUTION**

Hazardous voltages are present on the motor until all power to the control is disconnected.

Turn off and lock-out all power to the control before touching any internal circuits on the motor.

A. The use of unauthorized parts in the repair of this equipment or tampering by unqualified personnel may result in dangerous conditions which can cause equipment damage or personal injury and will also void warranties. Follow all safety precautions contained in this manual and all safety warning labels on the product.

B. Loose rotating parts can cause personal injury or equipment damage.

Before starting the motor, remove all unused shaft keys and other loose parts on the motor or the rotating mechanical load. Be sure all covers and protective devices are in place. Refer to the instruction manual supplied with the motor for further information and precautions.

---

**CAUTION**

Meggering circuits connected to the drive can cause damage to electronic components. Do not megger or hi-pot this equipment. Use a battery operated Volt-Ohm-Meter (VOM) to check for shorts, opens or miswiring.

Connection of unsuppressed inductive devices to the drive power feed or control circuits can cause mis-operation and possible component damage to the equipment.

Do not connect power factor correction capacitors with this equipment. Drive damage may result.
When using an oscilloscope to make measurements in the power circuits, use the connections shown in Figure 3-1. Failure to follow this procedure could result in the case (shell) of the oscilloscope being at line potential. Only qualified personnel should be allowed to use the oscilloscope and other test equipment.

Referring to Figure 3-1, set the oscilloscope to add channels A & B, and invert channel B. Before making measurements, connect both probes together and set the “zero” line. This connection allows the oscilloscope case to be connected to ground for safe operation.

3.5 SAFETY WARNINGS

Only qualified electrical personnel familiar with the construction and operation of this type of equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual in its entirety before proceeding. Failure to observe these precautions may cause injury to personnel or damage to equipment.

The control and its associated motor and operator control devices must be installed and grounded in accordance with all local codes and the National Electrical Code (NEC). To reduce the potential for electric shock, disconnect all power sources before initiating any maintenance or repairs. Keep fingers and foreign objects away from ventilation and other openings. Keep air passages clear. Potentially lethal voltages exist within the control unit and connections. Use extreme caution during installation and start-up.

Special fastener sizes are used on some connections; use only the type hardware supplied with the control. Failure to observe this precaution can cause equipment damage.

3.6 INITIAL CHECKS

Before installing the control, check the unit for physical damage sustained during shipment. If damaged, file claim with shipper and return for repair following procedures outlined on the back cover of this manual. Remove all shipping restraints and padding. Check nameplate data for conformance with the AC power source and motor.

NOTE

Using a 1:1 isolation transformer to power an oscilloscope will also reduce the possibilities of ground paths.
## RATING TABLE

<table>
<thead>
<tr>
<th>Drive Model No.</th>
<th>Typical DC Motor Rating at 500V/240V Arm</th>
<th>Drive Type</th>
<th>Heat Loss Maximum Watts (2)</th>
<th>Efficiency (3)</th>
<th>Cooling Method</th>
<th>Approx. Weight</th>
<th>lbs/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>9500-8201(A)</td>
<td>10/5 HP 10/4.8 KW</td>
<td>Single Quad</td>
<td>76 AC Input 17 DC Output 20.1</td>
<td>.99</td>
<td>Nat. Conv.</td>
<td>-</td>
<td>44/20</td>
</tr>
<tr>
<td>9500-8202(A)</td>
<td>20/10 HP 19/6.1 KW</td>
<td>Single Quad</td>
<td>122.6 AC Input 31 DC Output 38</td>
<td>.99</td>
<td>Nat. Conv.</td>
<td>-</td>
<td>53/24</td>
</tr>
<tr>
<td>9500-8203(A)</td>
<td>30/15 HP 27.5/13.2 KW</td>
<td>Single Quad</td>
<td>179.0 AC Input 45 DC Output 55</td>
<td>.99</td>
<td>Nat. Conv.</td>
<td>-</td>
<td>71/32</td>
</tr>
<tr>
<td>9500-8204(A)</td>
<td>50/25 HP 44.5/21.4 KW</td>
<td>Single Quad</td>
<td>274 AC Input 73 DC Output 89.1</td>
<td>.99</td>
<td>Nat. Conv.</td>
<td>-</td>
<td>110/50</td>
</tr>
<tr>
<td>9500-8205(A)</td>
<td>60/30 HP 53.2/25.5 KW</td>
<td>Single Quad</td>
<td>307 AC Input 87 DC Output 106.5</td>
<td>.99</td>
<td>Nat. Conv.</td>
<td>-</td>
<td>155/70</td>
</tr>
<tr>
<td>Non-regenerative</td>
<td>100/50 HP 87/41.8 KW</td>
<td>Single Quad</td>
<td>551.7 AC Input 143 DC Output 173.5</td>
<td>.99</td>
<td>Built-In Fan</td>
<td>200</td>
<td>75/34</td>
</tr>
<tr>
<td>9500-8107</td>
<td>150/75 HP 129/62 KW</td>
<td>Single Quad</td>
<td>758 AC Input 211 DC Output 257</td>
<td>.99</td>
<td>Built-In Fan</td>
<td>500</td>
<td>120/54</td>
</tr>
<tr>
<td>9500-8108</td>
<td>200/100 HP 172/83 KW</td>
<td>Single Quad</td>
<td>968 AC Input 282 DC Output 344</td>
<td>.99</td>
<td>Built-In Fan</td>
<td>750</td>
<td>165/75</td>
</tr>
<tr>
<td>9500-8109</td>
<td>250/125 HP 213/102 KW</td>
<td>Single Quad</td>
<td>1216 AC Input 349 DC Output 426</td>
<td>.99</td>
<td>Built-In Fan</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>9500-8110</td>
<td>300/150 HP 253/121 KW</td>
<td>Single Quad</td>
<td>1400 AC Input 415 DC Output 506</td>
<td>.99</td>
<td>Built-In Fan</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>9500-8111</td>
<td>400/200 HP 329/158 KW</td>
<td>Single Quad</td>
<td>1743 AC Input 540 DC Output 658</td>
<td>.99</td>
<td>Built-In Fan</td>
<td>750</td>
<td></td>
</tr>
</tbody>
</table>

### NOTES:

1. Refer to National Electric Code, Article 310, for cable size information.
2. Total losses do not include field supply losses. Field losses = 1 x Field Current (in watts).
3. Efficiency based on 240V armature (worst case) and total losses (less Field Supply).
4. On models 9500-8206 and -8506 only, the fans require user supplied 115VAC.
   "A" Models do not require 115VAC.
5 DIMENSIONS

Dimensions in MM
Dimensions in inches
Model "A" Dimensions in Brackets

NON-REGEN
9500-8201 through 9500-8203

REGEN
9500-8501 through 9500-8503

Figure 5-1.
Quantum II Dimensions

Dimensions in MM
Dimensions in inches
Model "A" Dimensions in Brackets

NON-REGEN
9500-8204 through 9500-8205

REGEN
9500-8504 through 9500-8505

Figure 5-2.
Quantum II Dimensions
Figure 5-3.
Quantum II Panel Mounting Using Supplied Brackets
Figure 5-4.
Quantum II Surface Mounting Arrangements and Fan Bracket (Mounting Holes)
Figure 5-5.
Quantum II Dimensions
75HP - 400 HP
Figure 5-6.
Drive Dimensions With Plastic Cover
(Models 9500-8X01 through -8X06)

MODEL "A"
DIMENSIONS
IN BRACKETS

DIMENSIONS
IN MM
DIMENSIONS
IN INCHES

6.00
2.36
0.06
1.00
0.39
4.00
1.57
0.06
1.00
0.39
12.00
4.72
1.19
9.00
3.54
1.06
2.00
0.79
6.00
2.36
0.06
1.00
0.39
5 DIMENSIONS

Figure 5-7.
Drive Dimensions With Plastic Cover
(150-400HP Models)
Figures 5-1 to 5-5 show the overall and mounting dimensions of the basic unit types, details of which are as follows. Figures 5-6 and 5-7 show the drive dimensions with the plastic cover.

6.1 9500-8201, -02, -03
   -8501, -02, -03 — Fig. 5-1

This unit type covers the following ratings:

9500-8201, -02, -03 (10, 20 & 30 HP)
9500-8501, -02, -03 (10, 20 & 30 HP)

The above units are cooled by natural convection and have an isolated heat sink which should be grounded for safety.

The drive may be mounted by either of the following methods:

a) By means of the two mounting brackets supplied, as shown in Figure 5-3.

b) Through a panel cutout, the heat sink projecting into a separate cooling duct.

6.2 9500-8204, -05, -06
   -8504, -05, -06 — Figs. 5-2 through 5-4
   9500-8107 through -8111
   -8407 through -8411 — Fig. 5-5

The 9500-8X04 through 06 type covers the following ratings:

9500-8204, -05, -06 (50, 60 & 100 HP)
9500-8504, -05, -06 (50, 60 & 100 HP)

The above units have an isolated heat sink which should be grounded for safety and, with the exception of the fan-cooled 9500-8206 and 9500-8506, are cooled by natural convection.

NOTE
On models 9500-8206 and 9500-8506 only, the fans require a user supplied 115VAC source.

The naturally-ventilated drives may be mounted by the means described in 6.1a and b above, or alternatively by means of the optional surface mounting channel, as shown in Fig. 5-3. The fan-cooled drives are surface mounted by means of the fan housing. Mounting dimensions are shown in Fig. 5-4.

The 9500-8x07 through -11 type covers the following ratings:

9500-8107, 08, 09, 10, 11
   (150, 200, 250, 300 & 400 HP)
9500-8407, 08, 09, 10, 11
   (150, 200, 250, 300 & 400 HP)

All of the above units are fan cooled. See Figure 5-5 for dimension details for these models.

6.3 DETERMINING THE CONTROL LOCATION

The control is suitable for most well-ventilated factory areas where industrial equipment is installed. Locations subject to steam vapors, excessive moisture, oil vapors, flammable or combustible vapors, chemical fumes, corrosive gases or liquids, excessive dirt, dust or lint should be avoided unless an appropriate enclosure has been supplied or a clean air supply is provided to the enclosure. The location should be dry and the ambient temperature should not exceed 55°C for free-standing chassis mount controls, or 40°C for enclosed controls mounted inside an enclosure. If the mounting location is subject to vibration, the unit should be shock mounted.

If the enclosure is force ventilated, avoid, wherever possible, an environment having a high foreign matter content as this requires frequent filter changes or the installation of micron-filters. Should the control enclosure require cleaning inside, a low pressure vacuum cleaner is recommended. Do not use an air hose because of the possibility of oil vapor contaminating the control. Compressed high air pressure may damage the control.

6.4 INSTALLING CHASSIS MOUNT CONTROLS

The Quantum control is suitable for mounting inside a user's enclosure where the internal temperature will not exceed 55°C. When mounting the control, ensure that the ventilation areas at each end of the control are clear.

Mount the control vertically against the mounting surface. Minimum clearances must be maintained within the cabinet to allow adequate air circulation around and through the drive.

Install the control in the cabinet, using Figures 5-1 through 5-5 for dimensional reference.
6 MOUNTING THE DRIVE

CAUTION

Never operate the control for an extended time on its back. The drive is designed for vertical operation and convection cooling.

WARNING

EQUIPMENT DAMAGE AND/OR PERSONAL INJURY MAY RESULT IF ANY JUMPER PROGRAMMING IS ATTEMPTED WHILE THE CONTROL IS OPERATIONAL. ALWAYS LOCK OUT POWER AT THE REMOTE DISCONNECT BEFORE CHANGING ANY JUMPER POSITIONS.

A. CORRECT AC INPUT VOLTAGE

The correct AC input voltage is determined by the motor being used. If the motor has a 240 VDC armature with either a 150 VDC or permanent magnet field, then 240 VAC input power is required. If the motor has a 500 VDC armature with either a 300 VDC or permanent magnet field, then a 480 VAC input source is required. Refer to the motor nameplate for this information.

There are two (2) locations for jumper settings governing 240/480 VAC operation. Refer to the figures at the end of this section and figures A-1 and A-2 in Appendix A. The units are factory set for 480 VAC operation.

VOLTAGE SELECTION JUMPERS

For 240 VAC Input:  
C to A  
F to D

For 480 VAC Input:  
C to D  
F to E  
Factory Setting

WARNING

NEVER ATTEMPT TO CONVERT THE CONTROL TO ANY OPERATING VOLTAGE OTHER THAN 240 VAC INPUT OR 480 VAC INPUT. ANY SUCH ATTEMPTED CONVERSION CAN CAUSE EQUIPMENT DAMAGE AND POSSIBLE PERSONAL INJURY.

The settings of the AC input voltage jumper straps are summarized in the following table.

<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>Jumper Strap Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jumper C to</td>
</tr>
<tr>
<td>240 VAC</td>
<td>A</td>
</tr>
<tr>
<td>480VAC</td>
<td>D</td>
</tr>
</tbody>
</table>

AC Input Voltage Jumper Settings  
For (A) Models

<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>Jumper Strap Positions</th>
<th>115VAC Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jumper C to</td>
<td>Jumper F to</td>
</tr>
<tr>
<td>208 VAC</td>
<td>A</td>
<td>D</td>
</tr>
<tr>
<td>240 VAC</td>
<td>A</td>
<td>D</td>
</tr>
<tr>
<td>380 VAC</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>415 VAC</td>
<td>B</td>
<td>E</td>
</tr>
<tr>
<td>480 VAC</td>
<td>D</td>
<td>E</td>
</tr>
</tbody>
</table>

NOTE

Factory program operation is set at 480VAC. On 9500-8X01 through -8X06 transformer models, jumper as shown in Figure A-1 for 240VAC operation. For 240VAC operation with PC board transformer models, jumper TB1-1 to TB1-2 and jumper TB1-4 to TB1-5. For 240VAC operation on 9500-8X07 through -8X11 models, reconnect transformer T1 and re-program control power voltage.
6.5 JUMPER PROGRAMMING

Refer also to the table in Section 13.

6.5.1 MD200 Board

<table>
<thead>
<tr>
<th>Default Positions as Shipped</th>
<th>MD200 Jumpers</th>
</tr>
</thead>
<tbody>
<tr>
<td>LK1 LF</td>
<td>DC</td>
</tr>
<tr>
<td>LK2 ENC</td>
<td>TACH</td>
</tr>
<tr>
<td>LK3</td>
<td>60-300V</td>
</tr>
<tr>
<td>LK4</td>
<td>40-200V</td>
</tr>
<tr>
<td>LK5</td>
<td>10-50V</td>
</tr>
<tr>
<td>LK6 VREF</td>
<td>4-20mA</td>
</tr>
<tr>
<td>LK7 TACH/ENC</td>
<td>AVF</td>
</tr>
<tr>
<td>LK8</td>
<td></td>
</tr>
<tr>
<td>LK9</td>
<td></td>
</tr>
<tr>
<td>LK10 VREF</td>
<td>4-20mA</td>
</tr>
<tr>
<td>LK11 ISW</td>
<td>20+</td>
</tr>
</tbody>
</table>

LK1 LF selects Filtered Feedback (used for Armature Voltage).

LK2 ENC selects pulse tach encoder FDBK, TACH selects AC or DC Tach Feedback.\(^{[n]}\) See also LK7

LK3, LK4, LK5

User Table to select proper Tach Voltage Range.

<table>
<thead>
<tr>
<th>Feedback Range</th>
<th>Tachometer Voltage Output at Maximum Speed</th>
<th>Install Jumper</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>10 VDC - 50 VDC</td>
<td>LK5</td>
</tr>
<tr>
<td>MED</td>
<td>40 VDC - 200 VDC</td>
<td>LK4</td>
</tr>
<tr>
<td>HIGH</td>
<td>60 VDC - 300 VDC</td>
<td>LK3</td>
</tr>
</tbody>
</table>

LK6 VREF selects voltage speed reference. 4 - 20mA selects Current Input. See also LK10

LK7 TACH/ENC selects Tachometer Feedback or Pulse Tach Encoder. AVF selects Armature Voltage Feedback.

\(^{[n]}\) AC Tach Feedback requires the AC Tach Interface Module, P/N 9500-9028. (Standard on "A" models)

LK8, LK9 Encoder Feedback scaling set for Max. Encoder Pulse Tach Feedback Frequency.

6.5.2 Pulse Tach Range

<table>
<thead>
<tr>
<th></th>
<th>SINGLE ENDED INPUTS</th>
<th>QUADRATURE INPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LK8</td>
<td>200KHz</td>
<td>100KHz</td>
</tr>
<tr>
<td>LK9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LK8</td>
<td>20KHz</td>
<td>10KHz</td>
</tr>
<tr>
<td>LK9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LK8</td>
<td>2KHz</td>
<td>1KHz</td>
</tr>
<tr>
<td>LK9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LK10 VREF selects Voltage Speed Reference. 4 - 20 mA selects Current Input. See also LK6.

LK11 Not for normal use. Left in 20+ position.

CAUTION

Altering factory-adjusted jumpers may cause equipment damage and/or machinery process irregularities. If further adjustments are required, contact the service department. If these jumpers are altered for your application, record your settings in the table in Section 13.

6.6 CURRENT LIMIT SETUP

Current limit and motor overload are drive features protecting motors from excessive currents and long term overloads. For example, if a drive which can run a 100HP motor is applied to a 75HP motor, its output must be limited to protect this smaller motor.

Quantum II drives are factory set with 150% current limit, governed by parameter #31 (and #32 with regenerative drives—reverse bridge current). This means that drive output current is limited to 1.5 times the DC continuous current rating of that specific size of drive. Parameter #31 (and #32 with regenerative drives) is factory set at 999 which corresponds to 150%. A 666 setting equals 100%.
The Motor Overload threshold, parameter #33, is factory set at 700 or 105% of the DC continuous current rating. This determines the point at which the software I x t integrator starts accumulating. The greater the overload means the faster the accumulation. The Overload Time, parameter #63, is factory set for 30 seconds.

Suppose one applied a Quantum II non-regenerative, model number 9500-8204, to run a 50HP 500VDC motor. If this motor was a standard 50HP motor, the full load nameplate current would be 89A (per NEMA tables), which is the drive rating. In this case, the Quantum current limit is already set for 150% (135A) which is considered normal for high starting torque and intermittent duty. However, the motor overload feature protects the motor from this high current should this be sustained for a period of 30 seconds or 1 minute, typically. Therefore, in this case, nothing has to be done to the current limit or overload parameters.

If this same drive was applied to a 40HP motor, however, one must protect the motor. Limit the current to the customary 150% of its full load nameplate rating and adjust the motor overload threshold accordingly. To determine the lower current limit settings, calculate the following:

\[
\frac{\text{Motor F.L. Amps}}{\text{Drive Rating}} = \frac{67}{89} = 0.75
\]

Therefore, the factory current limit setting of 999 or 1000 x 0.75 = 750 into parameter #31 (and #32 if this was a regenerative drive and symmetrical current limits were desired).

Also, one must consider the electronic motor overload integrator threshold. As mentioned previously, the factory setting of parameter #33 is 700, which represents 105% (since 666=100%). To adjust the overload for this smaller motor, re-enter 75% of 700 or 525 into parameter #33.

### 6.6.1 Current Resolution

In the previous example, a larger drives capabilities were reduced to 89% for application on a smaller motor. It would not be prudent to select a motor to drive rating ratio much below 2/3 or 0.6. Current feedback resolution begins to suffer and become too granular for good current loop control. Certainly if the motor rating is less than 1/2 the drive rating, the next lower rating of drive should be applied.

**NOTE**

One may elect to change the burden resistor on the current transformers within the drive to maintain full scale resolution.

However, this will create a “bastard drive” (non-standard, non-stocked).

If this were done it would be the responsibility of those who changed the burdens to fully document the changes on the drive nameplate and associated system drawings. Obviously, if the user were to have a breakdown and ordered a replacement, these burdens would have to be changed by the customer or someone to match the original drive and motor otherwise the motor could be permanently damaged due to lack of current protection.
FOR MODELS 9500-8X01 THROUGH -8X06

L1, L2, L3, [A-], [A+] (*on regenerative drives)

DB Lug

Burden Resistor Location

240/480V Straps

Control XFMR

9500-4000 AC Interface Board

F1, F2

L1 \{ main 3 phase AC supply to SCR bridge
L2
L3

A1 \{ motor armature connections
A2

F1 \{ motor field connections
F2

E1 \{ Auxiliary 3 phase AC supply to field rectifier
E2 and control electronics (phase rotation must be
E3 as L1, L2, L3) Fused internally at 6A

L11 \{ facility for switching AC supply
L12 \{ to internal field bridge by means of
external contact

(*) Factory wired on packaged units.
FOR "A" MODELS 9500-8X01 THROUGH -8X06

L1 main 3 phase AC supply to SCR bridge
L2
L3
A1 motor armature connections
A2
F1
F2
E1 Auxiliary 3 phase AC supply to field rectifier
E2 and control electronics (phase rotation must be
E3 as L1, L2, L3) Fused Internally at 6A

L11 facility for switching AC supply
L12 to internal field bridge by means of
external contact

Factory wired on packaged units.
FOR MODELS 9500-8X07 THROUGH -8X11

- **L1**: Main 3-phase AC supply to SCR bridge
- **L2**: Main 3-phase AC supply to SCR bridge
- **L3**: Main 3-phase AC supply to SCR bridge
- **FE1**: Field Economy connection jumper for full field—used with field economy kit, P/N 2200-9201
- **F1**: Motor field connection
- **F2**: Motor field connection

**240/480V STRAPS**

**BURDEN RESISTOR LOCATION**

**CONTROL XFMR**

**9500-4000 AC INTERFACE BOARD**

**DB LUG**
7.1 POWER WIRING

7.1.1 Incoming Power Requirements

A remote fused AC line disconnect or circuit breaker is required by the National Electric Code. This AC line disconnect or circuit breaker must be installed in the incoming AC power line ahead of the control.

The control will operate from typical industrial 3-Phase AC power lines. The line should be monitored with an oscilloscope to insure that transients do not exceed limitations as listed below:

1. Repetitive line spikes of less than 10 microseconds must not exceed the following magnitude:
   - 240 Volt Programming: 400V Peak
   - 480 Volt Programming: 800V Peak

2. Non-repetitive transients must not exceed 25 watt seconds of energy. Transients of excessive magnitude or time duration can damage d/c d/t suppression networks.

3. Line notches must not exceed 300 microseconds in duration. An abnormal line condition can reflect itself as an intermittent power unit fault. High amplitude spikes or excessive notch conditions in the applied power could result in a power unit failure.

The control is designed to accept three phase AC line voltage. See Section 4 for drive input and output ratings. When using three phase power, connect the incoming lines to terminals L1, L2 and L3. These terminals are located on the fuse panel assembly of the control. Any incoming line can be connected to any of the L1, L2 and L3 terminals. The control is not sensitive to phase rotation.

7.2 CONTROL LOGIC AND SIGNAL WIRING

Note the following in the interconnect diagrams, Figures A-1 through A-3:

a. A 3-wire Start/Stop circuit is shown. A stop command in this configuration will cause the motor to coast to a stop. If the dynamic braking option is used, a stop command will cause the motor to stop by dynamic braking.

b. The Forward/Reverse wiring shown on the 9500-4000 board is for regenerative drives, only.

c. For applications requiring ramp stop (normal stop), the start switch (normally open) should be connected between terminals #6 and #7 of TB1 on the 9500-4000 board and the stop switch (normally closed) should be connected between terminals #5 and #6 of TB1 on the 9500-4000 board. The motor thermal switch and a coast stop/dynamic braking pushbutton (normally closed) should be connected between terminal #1 and #2 of TB1 on the 9500-4000 board. If these functions are not required, a closed connection must be provided. The drive heatsink thermal, if provided, (Models 9500-8205/8205A and 9500-8506/8506A only) is connected between terminals #3 and #4 of TB1 on the 9500-4000 board. For all other models, the terminal connections should be jumpered. Terminal connections #1 and #2 of TB2 should also be jumpered.

d. For applications requiring two-wire stop/start connections, consult Field Service as described on the inside back cover of this manual.

When proceeding with the signal wiring, the following safety precautions for the signal conduit and wire types must be followed.

A. SIGNAL CONDUIT REQUIREMENTS

- Use either a rigid steel or flexible armored steel cable.

- The signal conduit must cross non-signal conduit at an angle between 45° and 90°.

- Do not route the conduit through junction or terminal boxes that have non-signal wiring.

B. SIGNAL WIRE REQUIREMENTS

- Size and install all wiring in conformance with the NEC and all other applicable local codes.
• Use shielded wire for reference and other signal wire connections. Belden #83394 (2 conductor) and Belden #83395 (3 conductor) shielded wire (or equivalent) is recommended. The shields should be taped off at the remote end. At the drive control, the shields should be connected to circuit common.

• Route all wiring away from high current lines such as AC lines and armature wiring.

• Always run the signal wire in steel conduit. Never run the signal wire with non-signal wire.

• Route external wiring, rated at 600 volts or more, in separate steel conduit to eliminate electrical noise pickup.

• For distances less than 150 feet, use a minimum of #22AWG wire. For distances more than 150 feet and less than 1000 feet, use a minimum of #16AWG wire.

CAUTION

It is important to use wire rated at 600 volts or more because this wiring may make contact with uninsulated components. Failure to observe this precaution can result in equipment damage.
41 Position terminal strip (MD200 board)

1. Signal input (-) tach connections. Polarity indicated for forward rotation.
2. Signal 0V (+) Use shielded cable (Common)
3. +10V reference supply (10 mA max)
4. -10V reference supply (10 mA max)
5. Analog speed reference (Bi-polar)
6. Programmable analog reference (Bi-polar)
7. General Purpose analog input 1
8. General Purpose analog input 2 \{ Used with MD21 Option
9. Analog Common
10. Armature current image
11. Tach feedback image
12. Armature voltage image
13. User programmable analog output (Bi-polar)
16. Drive enable (Factory wired to 9500-4000)
17. Drive start permit (not stop)
18. Programmable logic input 10 - Default = Field Loss Disable
19. Programmable logic input 11 - Default = Ramp Hold Enable
20. Jog reverse\(^n\)
21. Jog forward \{ Wired to 9500-4000
22. Run reverse\(^n\) \{ AC Interface Board
23. Run forward
24. Common
25. Drive Running
26. Drive at Set Speed
27. Alarm - Drive Overloaded
28. ST1 programmable status output
29. ST2 programmable status output
30. \} Factory wired to 9500-4000
32. \} Factory wired to 9500-4000
33. Pole
34. N/C \} Factory wired to 9500-4000
35. N/O
36. A
37. B
38. A
39. B
40. +5V \} Do not use for pulse tach supply
41. 0V

\(^n\) Available on regenerative models only
AC Power
240/480 VAC

DESIGNATIONS IN BRACKETS REFER TO REGENERATIVE MODELS ONLY.

Figure 7-1.
Typical Connection Diagram for 4-Quadrant Drive
7.3 POST WIRING CHECKS

After connecting the motor to the control and grounding, the following readings across terminals A- and A+, F+ and F-, and GND should be verified. The reading connections for terminals A- and A+ must be made where the actual DC motor connection is made. Terminals F+ and F- are located on the fuse panel assembly. Perform these checks before connecting the AC power input.

In making the readings listed in the following table, use a volt-ohm-milliammeter such as a Simpson 260, Triplett 630, or equivalent.

**WARNING**

DO NOT USE A VACUUM TUBE VOLTMETER OR OTHER SIMILAR TYPE OF METER THAT REQUIRES AC POWER FOR OPERATION.

Using red as the positive lead, make the following checks:

<table>
<thead>
<tr>
<th>CHECKS</th>
<th>RANGE OF ACCEPTABLE READINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED +</td>
<td>BLACK -</td>
</tr>
<tr>
<td>A+</td>
<td>A-</td>
</tr>
<tr>
<td>F+</td>
<td>F-</td>
</tr>
<tr>
<td>F+, F-, A+, A-</td>
<td>20-300 ohms typical *</td>
</tr>
<tr>
<td></td>
<td>GND</td>
</tr>
</tbody>
</table>

*Provided motor has a field winding.

If any of the above checks are not within the indicated range, verify all connections and recheck.

7.4 OUTPUT POWER CONNECTIONS

Before connecting the DC motor to the control, observe all of the following precautions:

A. Verify the motor is the appropriate size to use with the drive.

B. Install the DC motor according to its instruction manual.

C. Make sure the motor is properly aligned with the driven machinery to minimize unnecessary motor loading from shaft misalignment.

D. Install protective guards around all exposed rotating parts.

If the motor has a built-in thermal overload protection device, connect the thermal overload lead to the drive.

If, with the motor connected, the wrong rotational direction is observed, the rotational problem can be corrected in any of three (3) possible ways:

1. Exchanging the A+ and A- output leads to the motor.

2. Exchanging the shunt field F+ and F- leads on shunt wound motors only.

3. On regenerative drives only, changing the position of the Forward/Reverse switch (if used).

Note that exchanging the incoming power leads to terminals L1, L2, and L3 will not affect the direction of motor rotation.
7.5 START-UP

The following paragraphs describe the startup procedure for the control and the reading and setting of the operating parameters that is required for the application.

Read this section thoroughly to develop an understanding of the operation and logic incorporated into the control.

To insure maximum efficiency with a minimum amount of delay in production, factory startup assistance by a factory engineer is also available. Contact Field Service as described in the inside back cover of this manual to make arrangements.

7.5.2 Line Voltage

Drives to be run on 240VAC must have jumpers reset for both the control transformer and the drive power supply. The transformer jumpers are shown on the overall Quantum II interconnect diagrams 9500-1103-I in Appendix A. They are located under the front cover of the drive for models 9500-8X01 through 8X06 and beneath the drive on the 9500-8X07 and up. The drive power supply jumpers are explained in Paragraphs 6.4 and 7.5. They are located on the lower board in the bottom right corner.

7.5.3 Armature Voltage Feedback Speed Control

When the Quantum II is applied to motors other than 500V, you must increase the armature voltage feedback. Otherwise, the motor will be at full speed when the speed pot reference is perhaps only 50%. This can be done by turning the AVF max scaling pot (VR1 top pot) fully CCW, then CW about 1 turn. For AVF, the jumper LK1 must be in the LF position and jumper LK7 must be in the AVF position. The drive should be run up using a speed pot for the reference. You should monitor the armature voltage to prevent motor overspeed/overvoltage. If the speed or armature voltage reaches the motor rating before the speed pot is at maximum, the AVF pot (the top of the three) should be adjusted to set the maximum armature voltage at maximum reference setting. Parameters #55 and #56 can be adjusted around their default values for optimum transient speed response.

7.5.4 AC or DC Tach Feedback

All drives should be initially run up and calibrated in AVF even if a tach is to be used. This way, should your tach fail, you can still run by moving the jumpers to AVF (and re-store parameters #55 and #56 as determined from above) which you have pre-calibrated. Also, this is a good way to check out tach polarity before moving over to tach feedback.

To do this, jumper LK1 must be in the LF position, jumper LK7 must be in the AVF position, and jumper LK2 should be in the TACH position. The tach feedback should already be wired to terminals 1 and 2 of the main drive terminal strip. The drive should be run up using a speed pot for the reference. One should monitor the armature voltage to prevent motor overspeed/overvoltage. If the speed or armature voltage reaches the motor rating before the speed pot is at maximum, the AVF pot (the top of the three) should be adjusted to set the maximum armature voltage at maximum reference setting. At about 30% speed, one could measure the voltage at terminal 12 of the main terminal strip. This is
the scaled AVF signal. The voltage magnitude and polarity should be the same on pin 11 (the scaled tach F/B) as on pin 12. If the polarity is reversed, the tach wires would need to be reversed. One would adjust the Speed F/B pot-VR2 (the middle of the three) to match the magnitude measured at pin 12.

Now the actual tach feedback can be used as speed feedback. With the drive off, the jumper LK7 should be placed in the TACH position and LK1 should be placed in the DC position. In addition, the appropriate maximum tach scaling jumper (LK3, LK4, LK5) must be set. This is determined by the following:

Max DC Tach Voltage = Max Tach RPM * Tach Rating
Max AC Tach Voltage = Max DC Tach Voltage * 1.4

Example: The motor mounted DC tach is 50V/1000 and the maximum motor speed is to be 1900 RPM.

Therefore: Max Tach Voltage = 1900 * 50 = 95 volts

1000

In this case the jumper LK4 would be installed to the range covering 40 to 200V.

For AC tach feedback, the Quantum II requires the 9500-9028 option kit. The maximum tach voltage would be about 1.4 times the calculated value from the formula above.

The drive factory default stability parameters have been set for armature voltage feedback for typical DC motors, i.e., Parameters #55 & 56. However, when speed feedback is employed (AC or DC tach), it is typical for these stability values to be much lower than the factory default settings. When using tach feedback, set parameter #55 to about 30 and parameter #56 to about 5 initially. These may need additional adjustment depending on the motor/load speed response during actual operation. With speed feedback, typical values for parameter #55 may be in the range of 20-35 and #56 in the range of 2-15.

After good speed response is obtained, you would run the reference to maximum using a speed pot for the reference. One should monitor the armature voltage and actual motor speed to prevent motor overspeed/overvoltage. If the speed reaches the motor rating before the speed pot is at maximum, the TACH F/B pot VR2 (the middle of the three) should be adjusted to set the maximum motor speed at maximum reference setting.

As always, once these parameter values and jumper settings are determined, they should be recorded in this manual and saved within the drive.

7.5.5 Current Loop Gain

The following procedure is optional and not required for most general applications. However, where optimum response is required, the inner most control loop (the current loop) must be properly set up to enable the outer control loops (such as the speed loop) to function correctly.

For a drive to work optimally with a motor, the inner current loop must be stable.

To properly determine the current loop gain setting, the following procedure can be used:

**CAUTION**

Only qualified personnel familiar with this type of equipment and the information supplied with it should be allowed to perform the following procedure. A qualified person must be familiar with all the safety information in Section 3.

To determine the Current Loop Gain, you will need to remove the motor field to prevent motor rotation.

**CAUTION**

The motor should not rotate during this procedure. The machine area must be clear of all personnel and those working on or near the machine/motor must be notified of possible motor movement. If the motor begins to rotate in either direction, the drive should be immediately shut down using an E-STOP function. In this case, the rotor may need to be locked mechanically to prevent rotation.

You will need to energize the drive and deliver a current equal to the level required for continuous current and record this value. This procedure will require an oscilloscope and should be done quickly to prevent motor damage.

The following procedure is for shunt field motors only.
1. To run the drive with the field removed, you must first disable Field Loss Detection. To disable Field Loss Detection, set parameter bit #187 = 1. A Quantum II with factory default information, however, has the programmable input function 0 assigned to this Field Loss Detection bit. Therefore, one would only need to jumper pin 18 of the main drive terminal block to common (pin 24) to disable Field Loss Detection.

   With power off, jumper pins 18 to 24 as described above if parameter #67 is at the factory setting of 187. If the input on pin 18 has been re-assigned, then #187 needs set = 1.

2. With power off, remove both motor field leads from the drive.

3. Apply AC power to the drive. Temporarily reset parameters #31 and #32 = 0. These are the positive and negative current limits respectively. (Note that #32 has no meaning with non-regenerative drives.)

4. Monitor test point TP8 on the drive MD200 Interface Board. TP8 is about 1 inch above the 3 calibration pots. TP8 will allow you to monitor the actual motor current. The scope deflection could be set on about 0.5 volts/div with a 2msec/div sweep with line sync.

5. With a positive speed reference of about 50% applied, the drive can now be activated to turn on the motor contactor.

   **CAUTION**
   
   The motor should not rotate during this procedure. The machine area must be clear of all personnel and those working on or near the machine/motor must be notified of possible motor movement. If the motor begins to rotate in either direction, the drive should be immediately shut down using an E-STOP function. In this case, the rotor may need to be locked mechanically to prevent rotation.

6. While monitoring TP8 you would increase the value in parameter #31 slowly and watch the current waveform increase in amplitude until the waveform indicates continuous current flow (see Figure 7-2). Then the drive should be turned off immediately. This entire procedure in step #6 should occur within 5-10 seconds. If you have not been able to determine this value within this time period, turn the drive off (keep power on), rotate the motor about 30 degrees, and repeat.

   If power is removed and re-applied, the original current limit settings will be re-instated. In this case, step #3 would need to be repeated.

   Turn off the drive when done. Record the value determined for parameter #31 and remove AC power.

   ![Discontinuous Current vs. Continuous Current](image)

   **Figure 7-2.**
   Current Loop Setup Waveforms

7. Once you have determined the value of parameter #31 which yields continuous current, it can then be applied to the formula below for determining the Current Loop Gain.

   \[ \text{Current Loop Gain (\#62)} = \frac{25500}{\text{\#31 (from above)}} \]

8. Remove the jumper for Field Loss Defeat or re-enter parameter #187=0 to activate Field Loss Detection.

   Once power is re-applied, the original current limit settings will be re-instated. The calculated value of parameter #62 could be entered and saved within the drive.

The following applies to permanent magnet motors:

The procedure above would be the same except the motor rotor would need to be mechanically locked to prevent rotation. Note that with a PM motor, the Field Loss Detection bit would need to be permanently disabled.

### 7.6 HARDWARE PRE-START CHECKS

#### 7.6.1 General Checks

A. Read and thoroughly understand all of the safety information given in Section 3 of this manual.

B. Use a volt-ohmmeter having a sensitivity of 1000 or more ohms per volt on the DC scale (such as a Triplet Model 630 or a Simpson 260) as test equipment.
7 DRIVE CONNECTIONS & START-UP

7.6.2 Installation Checks

CAUTION
Do not use a megger to perform continuity checks in the drive equipment. Failure to observe this precaution could result in equipment damage.

WARNING
THIS EQUIPMENT IS AT LINE VOLTAGE WHEN AC POWER IS CONNECTED TO THE DRIVE. DISCONNECT INCOMING POWER TO THE DRIVE BEFORE PROCEEDING. AFTER POWER IS REMOVED, VERIFY WITH A VOLTMETER AT TERMINALS L1, L2 AND L3 THAT NO VOLTAGE EXISTS BEFORE TOUCHING ANY INTERNAL PARTS OF THE DRIVE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN PERSONAL INJURY.

A. Make sure the input disconnect is in the OFF position (power OFF). Install any safety locks if disconnect is remote.

B. Make sure the drive shutdown interlocks, such as safety switches installed around the driven machinery, are operational. When activated, these devices should shut down the drive.

C. Check that all the jumpers have been set correctly.

D. If tachometer feedback is used, verify the tachometer feedback programming.

7.6.3 Motor Checks

A. Verify that motor nameplate data corresponds to the drive output ratings as shown in Section 4. Verify that motor full load armature current and motor field current do not exceed the drive ratings.

B. Check that the motor is installed according to the motor instruction manual.

C. If possible, uncouple the motor from the driven machinery.

D. Rotate the motor shaft by hand to check that the motor is free from any binding or mechanical load problem.

E. Check that no loose items, such as shaft keys, couplings, etc., are present.

F. Check that all connections are tight and properly insulated.

G. Check that any motor thermal switch or overload device is wired as needed.

7.6.4 Drive and Enclosure Checks

A. Open the drive front panel cover.

B. Look for physical damage, remaining installation debris, wire, strands, etc.

C. Remove all debris from the drive.

D. Check that there is adequate clearance around the drive for air flow.

E. Complete all the wiring procedures described in this manual.

F. Check that all control and power terminal connections are tight.

G. Check that all fuses are in place and properly seated in the fuseholders.

H. Check the continuity of all fuses. If any fuse reads open, replace the defective fuse.

I. Insure that the control has been properly programmed for 240VAC or 480VAC operation. Using a voltmeter, check that the correct voltage (240VAC or 480VAC) is available on the incoming line side of the input disconnect.
7 DRIVE CONNECTIONS & START-UP

7.6.5 Grounding Checks

WARNING

THE CUSTOMER IS RESPONSIBLE TO MEET ALL CODE REQUIREMENTS WITH RESPECT TO GROUNDING ALL EQUIPMENT. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN PERSONAL INJURY.

CAUTION

Do not check any points on the drive with an ohmmeter, megger or any similar device. Failure to observe this precaution could result in equipment damage.

A. Verify that the ground wire installed between the chassis ground terminal, the enclosure, and a suitable earth ground has been properly sized to meet NEC and local codes. Make sure that the connections are tight.

B. With the volt-ohmmeter, check for and eliminate any grounds between the drive input power leads and the drive chassis ground. Check for and eliminate any grounds between the drive output power leads and the drive chassis ground.

C. Verify that a properly sized ground wire is installed between the motor frame and a suitable earth ground and that the connections are tight.

D. With the volt-ohmmeter, check for and eliminate any grounds from the motor frame and the motor power leads.

E. Verify that a properly sized ground wire is installed between the transformer (if used) and a suitable earth ground and that the connections are tight.

F. Verify that a properly sized ground wire is installed between all operator's control stations (if used) and a suitable earth ground and that the connections are tight.

G. Verify that the above ground wires are run unbroken.
8.1 CONTROL BOARDS

When referring to the following information on the MD100 and MD200 cards, note their relative positioning as shown in the following diagram.

\[ \text{MD100 Microcomputer Board} \]
\[ \text{MD200 Interface Board} \]

8.2 MD100 LOGIC AND CONTROL CARD

This printed circuit card is the center of the drive control system and features an 8053 or 8052 processor and various peripheral components. The five bus-connected components can readily be identified from the block diagram Fig. 8-1 and are as follows:

- IC100 Display driver
- IC 200 Digital output driver
- IC300 Analog data unit
- IC400 Digital input device + RAM + Counter
- IC500 8053/8052 processor

Components associated with each of the above devices are identified by the first digit of the component number, e.g., R304 is part of the analog input circuitry. The following is a description of each of the circuit groups and their functions.

8.3 DISPLAY CIRCUITS (IC100)

The seven-segment displays and the discrete LED indicators are driven by IC100 which is updated by the processor twice per supply cycle. The two seven-segment displays are multiplexed so that a complete refresh cycle of both displays occurs once per supply cycle. Note that the displayed data is updated only five times per second to make the display readable when monitoring fluctuating variables.

8.4 OUTPUT CIRCUITS (IC200)

This device selects the SCRs which are to be fired by the next trigger pulse. The outputs are therefore updated once every 60 degree period prior to generation of the trigger pulse.

Other signals updated by this device are the open-collector status outputs and the inputs to the digital-to-analog converter which drives the programmable analog output.

8.5 ANALOG INPUT CIRCUITS

The analog-to-digital converter is a 10-bit, 16-channel device which accepts signals in the range 0 to +5V. The analog references are all derived from a common +5V reference which, when applied to an analog channel, will produce a converted result of +1023. To make the device usable for analog signals in the range -10V to +10V, input circuits are provided which halve the input signal, inverting where necessary to give the 0 to +5V signal required. The maximum value that can be displayed is 999 which is slightly less than the full range of the converter (1023). Analog voltages representing full scale are 9.77V, which is 10V x (999/1023).

The current feedback signal undergoes a sample-and-hold operation to provide a stable value during the conversion. A peak detection circuit ensures that the maximum value of the current pulse is measured when the armature current is discontinuous.

8.6 DIGITAL INPUT CIRCUITS AND SYNCHRONIZATION (IC400)

Logic inputs for motion control arrive at IC400 together with various other inputs associated with drive protection.

Synchronization is achieved by a system of two phase-locked loops using the unrectified output of the regulator supply transformer as a reference. A comparator senses the crossover point of signals AC1 and AC2 from the transformer, and produces a square wave of line frequency. The first phase-locked loop functions as a filter and reproduces the line frequency square wave, shifted in phase by 90 degrees and free of multiple edges caused by line transients. The second phase-locked loop is a frequency divider which produces clock pulses running at 1536 times line frequency. This provides the processor with a phase range reference with a resolution of 256 steps per 60 degree period and is available as a register in IC400.
The watchdog timer circuit permits controlled recovery from a hardware malfunction and is reset by the periodic change in state of the display driver multiplex signal. If the processor were to cease executing its normal program, multiplexing would cease and the timer would reset the processor after about 0.3 seconds. The timer also sets a latch which is polled during the start-up sequence to make a reset generated by the watchdog timer detectable as a fault condition.

8.7 PROCESSOR AND PULSE GENERATION CIRCUITS (IC500)

The processor is an 8-bit microcontroller of the 8051 type. This may be a mask type (8052H or 8053H), or in some special cases an EPROM type (8752H or 8753H). In either case the parts are functionally identical.

The processor contains on-chip program memory, data memory, clock and timers. Therefore, most operations are carried out internally with bus operations being relatively infrequent.

The clock frequency for the processor is 12MHz which results in an instruction cycle time of 1 microsecond. This clock frequency does not directly affect any of the timing functions but it does limit the maximum line frequency that can be used. In the worst case this is 62Hz. Exceeding this frequency will cause either late pulse timings or mis-firings of SCRs.

The SCR firing signals are blocks of pulses generated by a frequency divider driven by the address latch signal from the processor. This signal (2MHz) is divided by a factor of 100 by two decade counters resulting in a 20kHz pulse train with a mark/space ratio of 1:4. The second decade counter is gated by an output from the processor to make time timing of the pulses controllable.

IC506 (when fitted) is an EPROM for extra code to permit future expansion of processor 1 software beyond the limits of its own on-chip memory.

8.8 SERIAL NVRAM (IC600)

Where it is advantageous for the non-volatile memory to reside on the MD100, future software versions will be capable using IC600 instead of the parallel device on the MD200.
8.9 MD200 INTERFACE BOARD

8.9.1 Current Feedback

The motor armature current signal is connected via PL1. This signal is derived from the rectified output of the three AC line current transformers scaled by a burden resistor to apply 1.63V at full scale. (This normally corresponds to 150% of the maximum continuous rating of the unit.) The signal is amplified by a factor of 4 before being passed to the MD100 card and the current signal output via terminal 10.

The provision of input IFB2 allows the gain factor to be doubled by means of a connection external to the MD200 card. This is sometimes needed for low power (less than 10 HP) drives where it is hard to obtain the needed output voltage from the current transformers without a significant error from the magnetizing current.

8.9.2 Speed Feedback

A signal representing speed is selected from one of three sources using movable jumpers LK2 and LK7. A low pass filter may be selected by placing jumper LK1 in the "LF" position. This filter has a cut off frequency at 25 Hz and attenuates at a rate of 40dB per decade. It is used when the feedback signal has unwanted components in the range 40 Hz to 400Hz. This can occur when the signal is derived from a toothed wheel or similar device and always occurs when armature voltage feedback is used.

A. Armature Voltage Feedback (AVF)

This is connected via PL1 which connects both sides of the armature to a differential amplifier with an input impedance of 1 Megohm. It is permissible for the voltage of either A1 or A2 to deviate ±600V relative to the ground of the control circuit before the operation of the differential amplifier is upset.

Note that the circuit is not designed for direct connections of the armature terminals to PL1. Note also that the connection is normally made via internal resistors of at least 100K in series with each line. This is to limit the current to a non-hazardous level in case of contact with any point on the control circuit.

The output of the differential amplifier is selected by placing jumper LK7 in the 'AVF' position. Fine adjustment of the scaling factor and therefore maximum speed, is achieved by adjusting potentiometer VR1. A buffered output signal is available on Terminal 12.

B. Encoder Feedback

Inputs A, A, B and B may be configured to accept a wide variety of signal formats. Essentially the encoder interface consists of two comparators which compare A with A and B with B. Input voltages of up to +15V are permitted.

If the encoder does not have complementary outputs, it is necessary to bias the unconnected input to the appropriate logic level. This is achieved by connecting a suitable resistor between A and ground and B and ground. Suitable pins are provided for this purpose. A 3.3K resistor defines a logic threshold of +1.25V which is suitable for TTL level signals. Omissions of the resistor completely defines a logic threshold of +5V which is suitable for encoder signals of 10V to 12V.

A motor mounted pulse tach must be powered from a separate power supply supplied by the user. If a pulse tach encoder with differential line driver outputs is to be used, refer to the table below for the proper transmission line terminating resistor.

<table>
<thead>
<tr>
<th>Pulse Tach With Differential Line Driver Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
</tr>
<tr>
<td>5V</td>
</tr>
<tr>
<td>10V</td>
</tr>
<tr>
<td>12V</td>
</tr>
</tbody>
</table>

These terminating resistors are to be installed across:

A and A for single channel differential output tachs
B and B install across both for dual channel encoders

If a resistor is installed across these pins, remove the resistor currently on the drive between A and 0V and/or B and 0V.

Regenerative drives require a dual channel pulse tach with quadrature output for direction sensing. If the pulse tach were applied with a non-regenerative drive, only a single channel pulse tach is required.

1All resistors 1/4 W
If the encoder is not a quadrature type the signal should be connected to channel A using inputs A and A as appropriate. The other inputs, B and B, determine the polarity of the feedback signal. Therefore, it is necessary to bias these inputs to make their levels different.

Encoder feedback via an on-board frequency-to-voltage converter, is selected by placing LK2 in the ENC position and LK7 in the TACHO/ENC position.

The F to V converter consists of a monostable (IC5) and a network of analog switches (IC4) which is used to generate a train of constant width pulses triggered by each edge of the incoming waveforms. A D flip-flop is used to sense the direction implied by the phase relationship of the A and B channels. This in turn selects either the positive or the negative reference for the F to V converter by means of the analog switches. The output will therefore have a polarity corresponding to the direction of rotation if a quadrature output encoder is used.

The frequency range of the F to V converter is determined by the position of jumpers LK8 and LK9 which determine the pulse width generated by the monostable. Further adjustment is provided by potentiometer VR3.

For high-precision speed or position control, the encoder feedback may be used in digital form (i.e. without F to V conversion) by means of the MD22 encoder interface board which expands the capabilities of the MD21 second processor option board.

(The above is detailed in the Digital Speed and Position Loop application leaflet, which is available separately.)

8.9.3 Tachometer Feedback

Jumpers LK3, LK4, LK5 and potentiometer VR2 are used to vary the attenuation of the signal applied to terminals 1 and 2. Up to 300V at full speed may be applied. However, high input voltages lead to substantial dissipation in resistors R28 and R29 and this will cause errors due to thermal drift. The signal after scaling is selected by placing jumper LK2 in the TACHO position and jumper LK7 in the TACHO/ENC position and is also available as a buffered output from terminal 11.

8.9.4 Speed Reference

The input on terminal 5 can be a -10/0/+10V signal or a 4/20mA current loop. In the latter case, it is necessary to place jumper LK6 in the 4-20mA position making loop current flow through a burden resistor of 100 ohms. Place jumper LK10 in the 4-20mA position to apply the appropriate scale and offset. The result at TP7 is always a -10/0/+10V signal or a 0/10V signal.

8.9.5 General Purpose Analog Inputs

The signals connected to terminals 7 and 8 must be in the range 0 to +10V. The levels are attenuated by a factor of 2 before passing to the MD 100 card. A 10K resistor between each input and ground makes possible the use of a contact between the input terminal and a higher voltage instead of a continuous analog signal.

8.9.6 Non-Volatile Memory

This device stores all details of the drive configuration when power is removed. The device actually contains two levels of memory, the first of which is a conventional static RAM which is not preserved on removal of power. This level is seen in the memory map of the processor on the MD 100 card and all read and write operations access this level only. The second level is an image of the first level and is the non-volatile part. Power up this part is copied to the static RAM. At this instant the two levels have identical data even though they may have been different on power down. This means that if the drive configuration is changed by varying data in the first level, the original setting can always be recalled by temporary removal of power. To permanently change the data in the second level it is necessary to initiate a non-volatile store cycle using pin 11. This operation is relatively long (20MS) and is executed under control of the processor on the MD100 card.

8.9.7 Logic Inputs

Terminals 16 to 23 are used to interface various logical signals to the 5V levels required by the MD100 card. Each input has a pull-up resistor to +24V followed by a 10ms RC filter which in turn drives a Schmitt input buffer. The inputs, which have a logic threshold of about 2.0V, may be driven by open collector outputs, contact closures or signals from other logic families.

8.9.8 Logic Outputs

These are open collector outputs having a maximum voltage rating of 24V and able to switch a maximum current of 150mA. They are intended to drive small relays and lamps, other open collector inputs or the inputs of other logic families.

Two relays allow currents of up to 5A to be switched at 110V AC. (2.2A at 250V AC).
Figure 8-2a.
MD200 Functional Diagram
Figure 8-2b.
MD200 Functional Diagram
(continued)
NOTE: Clockwise adjustment of VR1, VR2 and VR3 will produce an increase in motor speed or Armature Voltage. This applies to the MD200 PC Board. On older units having an MD320 PC Board, VR2, set tachometer; clockwise adjustment will produce a decrease in motor speed. For clockwise adjustment of VR1, set encoder. This will produce an increase in motor speed or Armature Voltage.

Figure 8-2c. MD200 Functional Diagram (continued)
9 KEYPAD & DISPLAYS

INSTRUCTIONS
Select a parameter using the increase or decrease keys to change the Index display. Observe the parameter value from the data display. Hold down either key to advance the display continuously.

Numerical parameters are shown as a three digit display in the range -999 to +999. Bit parameters are shown as a single digit display which is either 0 or 1.

Adjust a parameter by depressing the mode key once. When this key is illuminated use the increase or decrease key to change the data display. Depress the mode key again to exit from the adjustment mode.

Unlock the drive by setting parameters 20 and 67 to the correct security codes.

Store the current parameters by setting bit parameter 150 to 1 and pressing the reset pushbutton located within the lower access cover.

FAULT CODES
116 - FIELD LOSS
118 - FEEDBACK LOSS
120 - PHASE LOSS
121 - OVERCURRENT (IOC)
122 - SUSTAINED OVERLOAD
123 - OVERTEMPERATURE
124 - WATCHDOG TIMER
125 - POWER SUPPLY FAULT
126 - ARMATURE OKT. OPEN

Drive Ready
Alarm (OVLD)
Zero Speed
Run Forward
Run Reverse
Bridge 1
Bridge 2
At Set Speed
Current Limit

9.1 NOTE ON USE OF INDEX DISPLAY:

The display used to indicate parameter numbers is a two-digit device. When displaying a three-digit parameter the display shows only the last two digits. This apparent ambiguity is easily resolved by reference to the "data" display.

All parameters below #100 are real or integer parameters with values in the range -999 to +999, 0 to +999 or 0 to +255, necessitating the use of all three digits of the "data" display. (Leading zeros are not suppressed.) However, parameters #100 to #197 are bit parameters with values of either 1 or 0 and using only the least significant digit of the "data" display. (The other two digits being blanked.) For example, parameters #5 and #155 would both appear as 55 on the "index" display, but the "data" display might typically show 040 in the first case, and 1 in the second, making it clear which parameter was actually being monitored.
9 KEYPAD & DISPLAYS

9.2 KEYPAD AND DISPLAYS

The Quantum II keypad comprises three keys, a "Mode" key, an "▲" key and a "▼" key. Associated with the keypad are two seven-segment LED numerical displays.

The "▲" and "▼" keys may be used to select any drive parameter for monitoring or adjustment.

The two-digit display, labeled "Parameter Index", displays the parameter number while the three-digit display, labeled "Parameter Data", displays the value of that parameter. Pressing the "▲" key increments the parameter number and the "▼" key decrements it.

To change the value of a read/write parameter from the keypad:

1. Select the required parameter number in the index display using the "▲" and "▼" keys.

2. Press the "Mode" key. The LED indicator in the corner of the "Mode" key will illuminate to indicate that the parameter change mode has been enabled.

3. Use the "▲" and "▼" keys to change the value in the "data" display. When complete press the "Mode" key again to return to normal operation. The LED will be extinguished.

When parameter values are changed as described above the drive will respond immediately to the new values, but the original parameter values are restored on the next power-up cycle. This is a useful feature when experimenting with different drive parameter settings, as the original values can very easily be restored by a power-down/power-up cycle. (hard reset).

However, should the parameter changes need to be memorized, a non-volatile store procedure must be performed as follows: (continued from 3. above).

4. Select parameter #150, and set to 1.

5. Wait three seconds.

6. Press the square reset pushbutton accessible on MD200 Interface Board.

9.3 PARAMETER SECURITY

During manufacture, a set of default values is loaded into the non-volatile RAM and security is cleared to permit these parameters to be adjusted by the user.

After completion of adjustments, any further adjustments by unauthorized personnel can be prevented by activating the drive security feature as follows:

There are three (3) parameters which play an active role in parameter security. They are:

#20 Security Code (User assignable)
#97 Level 2 Security Parameter (Factory Assigned)
#170 Security Enable

Quantum II has essentially two (2) groups of secured parameters—Level 1 and Level 2.

Level 1 parameters can be adjusted without entering a security code upon factory delivery. These parameters include such adjustments as Min and Max Speed, Current Limits, etc., (denoted on Quantum II Quick Reference Card in column directly following the parameter number). Units shipped from ICD's factory permit access to all Level 1 parameters.

Level 2 parameters are secured as they arrive from the factory and include such parameters as Quadrant Lockouts, serial communication rates, etc. Units shipped from ICD's factory permit access to all Level 2 parameters after parameter #97 is set to 149. Access to these parameters will be permitted as long as power remains on the drive or until parameter #97 is set to 000.

CAUTION

The following procedure can only be reversed by use of special test equipment or a suitable device connected to the serial interface.

After all parameters are set up per the intended application, the user could elect to place a security access code on all parameters to prevent inadvertent maladjustments or unauthorized tampering of critical drive
adjustments. To do this, one would enter a 3-digit number (do not use 000 for your assigned security code) that must be written down or committed to memory into parameter #20. To enable this security code, parameter #170 would be set to a 1. To make this permanent, a 1 would be entered into #150. Then press the reset button.

This also backs up the non-volatile RAM with any adjustments made to parameters. To carry out further changes, first set parameter #20 to the same value as the number entered in the above procedure. If set to any other number, the adjustment mode cannot be activated by pressing the mode button, and all parameters therefore become effectively “read only.”

Note that parameter #170 cannot be changed back to 0 from the Quantum II keypad, thus preventing the security set procedure from being repeated.

The next time power is applied, all parameters are secured. You can look at their values but be unable to make alterations without first entering your personal number into parameter #20. After you have entered your security access code, you can access all Level 1 and Level 2 parameters after you set #97=149. After your security code is entered, it will remain effective until power is removed from the drive or you enter a different value into parameter #20.

---

**CAUTION**

If a user assigned security code is placed into parameter #20 and the security enable bit #170 is set, you must maintain access to the security code. If you forget or lose your assigned security access code, the drive can be unlocked, but all customer or application specific parameter data will be lost and need to be re-installed for correct drive operation.
10.1 DESCRIPTION OF PARAMETERS

Please refer to control block diagram, Fig. 10-1, and parameter quick reference guide, Section 13.

Before attempting to adjust parameters, please refer to Section 9 for a description of Parameter Security, and for details on use of Keypad and Displays.

Drive parameters are of three basic types as follows:

Real Values:

A real value may be bipolar, in which case its value can range from -999 to +999 or it may be unipolar, in which case its value can range from 0 to +999. Internally within the drive it also has a fractional part. Real values are used to represent such variables as speed, current, overload threshold, phase angle, etc.

Integer Values:

An integer value is one represented by an unsigned whole number. Integer values are used to represent such variables as loop gains, acceleration and deceleration rates, current taper slopes, etc.

Bit Values:

A bit value is one which can have a value of either 1 or 0 and is therefore reserved for drive status variables which are either true or false, enabled or disabled, etc. Bit values are used to represent such variables as quadrant enable, ramp enable, drive at speed, etc.

Each parameter falls into one of two further categories, as follows:

Read-only values:

Read-only values are ones which are set or measured by the drive itself, either during power-up reset or continuously during drive operation. As the name implies these values may only be read, and allows one to MONITOR ONLY drive status and performance.

Read/Write Values:

Read/write values are those which are set by keypad entry, serial interface communication or background program execution to optimize the drive performance for a given application. Read/write values may also be monitored by means of the keypad and displays or via the serial interface to verify drive status and performance.

Default Values:

The parameters have been set to standard settings (default values) after leaving factory test. If these values need to be re-established, set parameter 
#97=255 for factory non-regenerative defaults(*) and 
#97=233 for factory regenerative defaults(†), followed by reset.

The following is a list and explanation of all drive parameters:

GROUP A: REAL READ-ONLY PARAMETERS

NOTE: Please note that if a drive fault trip occurs, the values of parameters in this group (#01 to #19) are frozen at the instant of tripping, and will remain in this condition until the drive is reset. This is a very useful aid to diagnostics.

#01 Analog Speed

Range: -999 to +999
Function: Displays the value of the analog speed demand signal connected to terminal 5.
Scaling: -9.77V/0/+9.77V = -999/0/+999

#02 Final Digital Speed

Range: -999 to +999
Function: Displays the final value of the digital speed demand, after scaling and ramp generation. This final value can originate from one of three sources dependent on the drive configuration:

I. Terminal 5:

With #155=0 and #164=0, #02 is derived from #01 the analog speed demand. However, #02 may differ from #01 for several reasons:

a) The overall scaling factor set by #157 and #57 may be other than unity.
b) An offset #23 may be present.
c) The maximum or minimum speed parameters, #24 or #25 respectively, may be imposing a limit.

(*) denoted by parameter default XXX-1Q
(†) denoted by parameter default XXX-4Q
d) The ramp hold #168 may be enabled, preventing #02 from achieving its final value.

e) The ramp is still in progress following a change in reference.

f) Terminal 17 is an open circuit, giving a stop command.

II. Internal "Run" Speed Demand #22:

With #155=1 and #164=0, #02 is derived from #22 the internal run speed demand, but #02 may differ from #22 for four possible reasons:

a) The maximum or minimum speed parameters, #24 or #25 respectively, may be imposing a limit.

b) The ramp hold #168 may be enabled, preventing #02 from achieving its final value.

c) The ramp is still in progress following a change in reference.

d) Terminal 17 is an open circuit, giving a stop command.

III. Internal "Inch/Jog" Speed Demand #21:

With #164=1, #02 is derived from #21 the internal inch speed demand, but #02 may differ from #21 for four possible reasons:

a) The maximum or minimum speed parameters, #24 or #25 respectively, may be imposing a limit.

b) The ramp hold #168 may be enabled, preventing #02 from achieving its final value.

c) The ramp is still in progress following a change in reference.

d) Terminal 17 is an open circuit, giving a stop command.

#03 Speed Feedback

Range: -999 to +999  
Function: Displays the value of the analog speed feedback signal, derived either from the motor tachometer connected to terminals 1 and 2, or from the motor armature voltage, or from an encoder (depending on the setting of jumpers LK2 and LK7 located on the MD200 board). This signal is used for the closed loop speed control of the motor.

Scaling: Depends on setting of jumpers LK3, LK4, LK5 if tach feedback selected, and setting of maximum speed potentiometer, VR1, VR2 or VR3, depending on feedback source. For further information on selection and scaling see Section 8.

#04 Digital Speed Error

Range: -999 to +999  
Function: Displays the speed error, which is the difference between the speed demand (#16) and the speed feedback (#03). The number displayed is the actual digital speed difference.

Definition: #4 = (#16 - #03)

#05 Speed Error Integral

Range: -999 to +999  
Function: Displays the speed error integral term, the result of integrating the speed error after it has been amplified by the speed loop integral gain.
10 DESCRIPTION OF PARAMETERS

#06 Bipolar Programmable Analog Input

Range: -999 to +999 or -63 to +63
Function: Displays the value of the analog reference connected to terminal 6. The function of this parameter can be programmed using parameter #69. It can be programmed to control any of the parameters #21 to #30 inclusive, by setting #69 to the appropriate parameter number then pressing the reset pushbutton. To make this a permanent feature a non-volatile update should be performed (see #150). By setting the fine control bit #193=1, the value of this parameter is divided by a factor of 16 without loss of the 10-bit resolution, thereby facilitating fine control over a reduced range.

Scaling: -9.77V/0/+9.77V = -999/0/+999 (#193=0)
or:-9.77V/0/+9.77V = -63/0/+63 (#193=1)

#07 Current Demand

Range: -999 to +999
Function: The current demand signal is the controlling input to the current loop algorithm when in speed control mode. It is the result of the speed loop algorithm acting on the speed error signal #04.

#08 Current Feedback

Range: 0 to +999
Function: This is the motor current feedback signal derived from AC current transformers on each of the phases feeding the powerbridge. It is used for the closed loop control of the armature current. An amplified and buffered signal is output via terminal 10.

Scaling: Current feedback 0 to +1.6V = 0 to +999 = 150% of rated Output signal (term. 10) 0 to +6.66V = 0 to +999

#09 Phase Angle Demand

Range: 0 to +768
Function: The phase angle demand is the input to the firing pulse generation algorithm. It is the result of the current loop algorithm acting on the current demand signal #07 when in speed control or the torque demand signal #28 when in torque control (#09=768 means that the firing pulses are fully phased back).

Scaling: 0/180 degrees = 0/+768 or (phase angle) = #09x60/256

#10 Unipolar Analog Input 1

Range: 0 to +999
Function: Displays the value of the analog signal connected to terminal 7. #10 can be used as a general purpose analog input for monitoring or for MD21 special applications.

Scaling: 0 to +9.77V DC = 0 to +999

#11 Unipolar Analog Input 2

Range: 0 to +999
Function: Displays the value of the analog signal connected to terminal 8. This parameter can be used as a general purpose analog input for monitoring or MD21 special applications.

Scaling: 0 to 9.77V DC = 0 to +999

#12 Analog Error

Range: -63 to +63
Function: This parameter is the result of an analog summing of the speed reference (terminal 5) with the scaled tach speed feedback signal, (the amplifier having a gain of 16) followed by A to D conversion.

It is used to derive a high-resolution speed feedback signal, which is used in place of #3 as an input to the speed loop algorithm when the speed error is small, giving precise speed regulation. The logic which selects the appropriate feedback according to the magnitude of the speed error is the analog error window flag, #128. This parameter is described in detail elsewhere.
#13 Speed Reference (pre-ramp)

Range: -999 to +999
Function: This parameter displays the speed reference immediately before the ramp, but after the various selection and conditioning operations. (e.g. scaling, offset, forward/reverse, etc.). Please refer to the control block diagram Fig.10-1.

#14 Sync. Staircase

Function: This is a six-step staircase waveform which is used to synchronize and distribute the SCR firing pulses. It may be monitored by means of an oscilloscope connected to terminal 13, the programmable analog output, with #65 set to 14.

#15 Torque Control Variable

Range: -999 to +999
Function: In the speed control mode, this is the limiting value of current demand, and is equal to the speed-dependent current taper calculation. (See parameters #30, #26, #27).

#16 Speed Loop Variable

Range: -999 to +999
Function: Displays the value of the digital speed demand input to the speed loop algorithm. The source of this value depends on the states of the reference T switch, #182, and the reference S switch, #189 as follows:

<table>
<thead>
<tr>
<th>#189</th>
<th>#192</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>#17 - IR compens</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>#29 - Hard (direct) speed ref.</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>#2 + #17 - Ramped speed ref. + IR comp.</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>#2 + #29 - Ramped speed ref. + hard speed ref.</td>
</tr>
</tbody>
</table>

#17 IR Compensation Term

Range: -125 to +125
Function: With #189 set to 0, this parameter provides a correction for the resistive voltage drop of the motor armature, thereby improving speed regulation in AVF mode. Derived from IR compensation factor #58 and speed error integral #05. Please refer to #58 for further details.

Definition: #17 = #05 x #58/2048

#18 Measured Acceleration

Range: -999 to +999
Function: Not implemented. Reserved for special applications.

#19 Overload Integration Register

Range: 0 to +999
Function: Displays the value of the integrating current-time overload function. When the value reaches the trip point determined by #33 (overload level) and #63 (overload integration time) an overload trip occurs. Where nuisance tripping is experienced, monitoring of this parameter can provide useful information about drive loading and duty cycle. (See also integrating overload threshold #33, integrating overload time #63 and sustained overload #122).

The overload trip point is defined as:

Trip Point = (1000 - #33) x #63/409.6

GROUP B: REAL READ/WRITE PARAMETERS

#20 Security Level 1 Key

Range: 0 to +999
Function: Prevents the changing of any parameters from the on-board keypad until the correct code is entered. However, the keypad and display still function in a read-only mode, allowing all drive parameters to be monitored. Refer to Parameter Security, Section 9, for description of level 1 and level 2 security and setting procedures.

Standard default setting: 000
10 DESCRIPTION OF PARAMETERS

#21 Internal "Inch/Jog" Speed
Range: -999 to +999
Function: An internal speed demand value selected as the speed reference when #164=1. (This reference is inverted when "inch reverse" is selected). Standard default value: +050 (5%)

#22 Internal "Run" Speed /Thread Speed
Range: -999 to +999
Function: An internal "run" speed demand value is selected as the speed reference when #164=0 and #155=1. (This reference is inverted when "run reverse" is selected). Standard default value: +300 (30%)

#23 Analog Reference offset
Range: -999 to +999
Function: An additional speed demand term added to the analog input #01 after scaling. (Useful as a speed trim input - from a dancer arm, for example. The input would be connected to terminal 6 and #69 programmed to control #23). Defined by:
(speed demand) = (#01 (#157 +(#57/256))) + #23 Standard default value: 000

#24 Maximum Speed
Range: -999 to +999
Function: Determines the maximum (or most positive) limit of speed demand passed to the speed loop algorithm, and causes any demand for speed greater (or more positive) than that limit to be ignored. If this limit is negative, it functions as a minimum speed limit in the reverse direction. Standard default value: +999 (100% speed)

#25 Minimum Speed
Range: -999 to +999
Function: Determines the minimum (or most negative) limit of speed demand passed to the speed loop algorithm, and causes any demand for speed less (or more negative) than that limit to be ignored. If this limit is positive, it functions as a minimum speed limit in the forward direction. Standard default value: 000 - 10 0 to -999 - 40 -100%

#26 Speed Level 1 Sense
Range: 0 to +999
Function: Sets a value of speed feedback threshold beyond which #176 is set to 1. Mainly used, in conjunction with #59, for speed profiling of the current limit setting, to limit the maximum available current at high speed with regard to the limits of commutation of the motor. In this instance it defines the motor speed at which the armature current begins to decrease at a rate set by the value of #59, the taper 1 slope. #26 should be set to +999 if current limit taper is not required. Standard default value: +999

#27 Speed Level 2 Sense
Range: 0 to +999
Function: Sets a value of speed feedback threshold beyond which #127 is set to 1. Mainly used, in conjunction with #60, for speed profiling of the current limit setting, to limit the maximum available current at high speed in the same way as #26. In this instance it defines the motor speed at which the armature current begins to decrease at a second rate set by the value of #60, the taper 2 slope. #27 should be set to +999 if current limit taper is not required. Standard default value: +999

(*) Reverse for regenerative models only
10 DESCRIPTION OF PARAMETERS

#28 Internal Torque Reference

Range: -999 to +999
Function: This value is the input to the current loop algorithm when operating in a torque control mode. It acts as a clamp on the output of the speed loop algorithm when operating in a torque control mode with speed override.
Standard default value: 000

#29 Hard Speed Reference

Range: -999 to +999
Function: This value is a direct input to the speed loop algorithm when #189=1, bypassing the scaling, reference limit and ramp functions, which may themselves be disconnected from the speed loop input by setting #192=0. Refer to speed loop variable #16 for further details.
Controlled in default by programmable reference #6 (terminal 6) via #69.

#30 Current taper start point

Range: 0 to +999
Function: This parameter provides symmetrical current limiting for bridge 1 and bridge 2, and is the datum level from which the current taper functions operate. (See #26 and #27). It is used in applications where motor kW rating is somewhat less than that of the converter, as an alternative to changing fixed current feedback burden resistors.
Standard default value: +999

#31 Bridge 1 Current Limit

Range: 0 to +999
Function: Determines the maximum limit of current demand passed to the current loop algorithm when bridge 1 the positive bridge is conducting and causes any demand for current in excess of that limit to be ignored.
Standard default value: +999 = 150%
   Ex: +666 = 100% of drive DC rating

#32 Bridge 2 Current Limit

Range: 0 to +999
Function: Determines the maximum limit of current demand passed to the current loop algorithm when bridge 2, the negative bridge, is conducting, and causes any demand for current in excess of that limit to be ignored.
Standard default value: 000 - 1Q (non-regenerative models)
   +999-4Q =150%
   (regenerative models)
   Ex: +666 = 100% of drive name plate rating

#33 Integrating Overload Threshold

Range: 0 to +999
Function: Sets the threshold of armature current feedback beyond which the current-time integrating overload algorithm integrates upwards.
Standard default value: +700 (represents 105% of drive current rating)

#34 to #49 are not currently used.

GROUP C: INTEGER READ/WRITE PARAMETERS

#50 Fault Register

Range: 118 to 126
Function: Indicates the cause of a drive fault trip by displaying the appropriate fault code. If a drive fault trip occurs, the index display automatically indicates #50, the failure mode parameter, and the data display shows a fault code of 000. #50 is monitored by the processor, and the drive is immediately tripped if a non-zero value appears via the serial interface or processor 2 special application software.
Also, if a drive fault trip occurs, the values of #01 to #19 are frozen at the instant of tripping and remain in this condition until the drive is reset. This is a very useful aid to diagnostics.
(For further information on fault codes see fault status bits #118 to 126 and 131).
Standard default value: 000

'' Refer to Paragraph 6.6 for more detailed examples.

'' Refer to Paragraph 6.6 for more detailed examples.
**#51 Forward Acceleration Ramp Time**

**Range:** 0 to 255

**Function:** Sets the maximum positive rate of change for positive values of parameter #02, and therefore, the acceleration rate of the motor in the forward direction. (Provided this is within the current limit capacity of the drive). The number displayed is the time taken in seconds if #191=0, or in tenths of seconds if #191=1 for #02 to increase from 0 to +999. Please refer to parameters #167 and #168 as these can both override the ramp function.

**Standard default value:** 050=5 seconds

---

**#52 Forward Deceleration Ramp Time**

**Range:** 0 to 255

**Function:** Sets the maximum negative rate of change for positive values of parameter #02, and the deceleration rate of the motor in the forward direction. (Provided this is within the current limit capacity of the drive). The number displayed is the time taken in seconds if #191=0, or in tenths of seconds if #191=1, for #02 to decrease from +999 to 0. Please refer to parameters #167 and #168 as these can both override the ramp function.

**Standard default value:** 050=5 seconds

---

**#53 Reverse Deceleration Ramp Time**

**Range:** 0 to 255

**Function:** Sets the maximum positive rate of change for negative values of parameter #02, and the deceleration rate of the motor in the reverse direction. (Provided this is within the current limit capacity of the drive). The number displayed is the time taken in seconds if #191=0, or in tenths of seconds if #191=1, for #02 to increase from -999 to 0. Please refer to parameters #167 and #168 as these can both override the ramp function.

**Standard default value:** 000 - 1Q
(for non-regen models)
050 - 4Q
(for regen models)

---

**#54 Reverse Acceleration Ramp Time**

**Range:** 0 to 255

**Function:** Sets the maximum negative rate of change for negative values of parameter #02, and the acceleration rate of the motor in the reverse direction. (Provided this is within the current limit capacity of the drive). The number displayed is the time taken in seconds if #191=0, or in tenths of seconds if #191=1, for #02 to decrease from 0 to -999. Please refer to parameters #167 and #168 as these can both override the ramp function.

**Standard default value:** 000 - 1Q
(for non-regen models)
050 - 4Q
(for regen models)

---

**#55 Speed Loop Proportional Gain**

**Range:** 0 to 255

**Function:** This is the factor by which the speed error is multiplied in the speed loop algorithm to produce the proportional speed error correction term. Increasing this value increases both the system damping and the transient speed response. However, if taken too far the drive will become unstable. The optimum setting is therefore as large as the system response demands without the onset of instability. Speed loop optimization is achieved by the combined effect of parameters #55 and #56.

**Actual gain = #55/8**

**Standard default value:** 080 (suitable for armature feedback)
015 (suitable for speed feedback)
#56 Speed Loop Integral Gain

**Range:** 0 to 255  
**Function:** This is the factor by which the integral of the speed error is multiplied in the speed loop algorithm to produce the integral speed error correction term. The integral speed error correction term ensures zero speed error during steady state load conditions. Increasing its value results in a more rapid recovery after a transient disturbance such as a sudden load change. However, if this value is increased too far the system tends to become oscillatory. The optimum setting is therefore as large as the system response demands without the onset of instability.

Speed loop optimization is achieved by the combined effect of parameters #55 and #56.

Actual gain = 6f x (#56/256)

\[\begin{align*}
1.406 \times (#56) & \text{ for } 60\text{ Hz}, \text{ or} \\
1.172 \times (#56) & \text{ for } 50\text{ Hz}
\end{align*}\]

where f is the supply frequency.

**Standard default value:** 040 (suitable for armature voltage feedback)  
005 (suitable for speed feedback)

---

#57 Analog Reference Scale Factor

**Range:** 0 to 255  
**Function:** This value is used in conjunction with #157 to set the scale factor by which the analog speed reference #01 is multiplied to generate the final digital speed reference.

**Definition:** (speed demand) = #01 (#157 + (#57/255))

**Standard default value:** 000

---

#58 IR Compensation Factor

**Range:** 0 to 255  
**Function:** This factor is used to calculate the IR compensation term #17 which compensates for the resistive volt drop of the motor armature, thereby improving low speed control in AVF (Armature Voltage Feedback) mode. Note that IR compensation is a form of positive feedback, and can give rise to instability if set too high. Modern laminated-frame motors typically have a rising load-speed characteristic, unsuited to AVF with IR compensation. A compound-wound machine with a flat characteristic would be more suitable in many AVF applications.

**Definition:** (IR comp. term) #17 = #05 x #58/2048

**Standard default value:** 000

---

#59 Current taper 1 slope

**Range:** 0 to 255  
**Function:** Sets the rate of change of armature current limit with respect to speed above the speed threshold set by "speed level 1 sense" #26 in either direction of rotation.

**Taper 1 slope is given by:** #59/128  
**Standard default value:** 000

---

#60 Current Taper 2 Slope

**Range:** 0 to 255  
**Function:** Sets the rate of change of armature current limit with respect to speed above the speed threshold set by "speed level 2 sense" #27 in either direction of rotation.

**Taper 2 slope is given by:** #60/128  
**Standard default value:** 000

---

#61 Current Slew Rate Limit

**Range:** 0 to 255  
**Function:** Limits the maximum rate of change of current demand to the current loop algorithm. This is a useful feature when retrofitting a modern SCR converter in place of an MG set for example, to control an old design of non-laminated motor intended for use on a pure DC supply. It provides a simple means of limiting the maximum rate of change of armature current to a level at which the interpole system is effective. If the armature current were allowed to change too fast the inherent lag of the interpole flux could, in extreme cases, result in a flash-over.

**Defined as:**

\[\begin{align*}
\text{slew rate (amps/sec.)} &= (\text{max. current limit in amps}) \times 6f \times (#61/256) \\
\text{where } f & \text{ is the supply frequency.}
\end{align*}\]

\[\begin{align*}
\text{slew rate (amps/sec.)} &= 1.406 \times I_{m}(\text{amps}) \times #61 \text{ (for 60Hz)} \\
\text{or,} &= 1.172 \times I_{m}(\text{amps}) \times #61 \text{ (for 50Hz)}
\end{align*}\]

**Standard default value:** 040
#62 Current Loop Gain

Range: 0 to 255
Function: The factor by which the current error signal is multiplied prior to calculation of phase angle (#09).
The optimum value may be found by slowly increasing the current limit #31, from zero with the motor stalled, until continuous conduction occurs. The value of #62 is then calculated as follows:

\[ #62 = \frac{25500}{#31} \]

See Paragraph 7.5.5 for details.
Standard default value: 050

#63 Integrating Overload Time

Range: 0 to 255 seconds
Function: The integrating period of the current-time overload function, from the start of a full-scale current limit overload (#07 = 999) to the point at which the drive is tripped.
The trip time at a particular level of current is given by:

\[ t = \#63 \times \left( \frac{1000 - \#33}{\#7 - \#33} \right) \] seconds

Standard default value: 030 = 30 seconds

#64 Digital Filter Response

Range: 0 to +255
Function: A low-pass filter used to filter the speed error signal to reduce interference, for example, from a noisy tachometer.
Parameter #04 is the filtered error signal.

\[ (\text{filter time constant}) = \frac{1}{\#64} \times \left( \frac{1}{16} \right) \times 256 \]

where \( f \) is the supply frequency.

Standard default value: 128

#65 Analog Output Select

Range: 01 to 49
Function: This parameter holds the number of the Real parameter (#01 - #49) which it is desired to output via the DAC output port (Terminal 13).

Standard default value: 002 (i.e. the speed reference).

#66 Speed Offset Fine

Range: 0 to +255
Function: Used as a fine trim on the speed error signal prior to filtering.

\[ \text{Actual offset} = \frac{#66 - 128}{16} \]

This give a range of:

\[-8 < \text{actual offset} < +8 \]

Such that: #4 = (speed error) + #66

Standard default value: 128

#67 Programmable Logic Input f0

Range: 151 to 197
Function: Used to program the function of control input f0, terminal 18, to control any bit parameter between #151 and #197 inclusive.

Example: To program this input to control bit parameter #155
a) Set 67 into the index display
b) Press the mode key
c) Set 155 into the data display
d) Wait three seconds
e) Press the reset pushbutton

Standard default value: 187

#68 Programmable Logic Input f1

Range: 151 to 197
Function: Used to program the function of control input f1, terminal 19, to control any bit parameter between #151 and #197 inclusive.

Example: To program this input to control bit parameter #158
a) Set 66 into the index display
b) Press the mode key
c) Set 158 into the data display
d) Wait three seconds
e) Press the reset pushbutton

Standard default value: 168
10 DESCRIPTION OF PARAMETERS

#69 Programmable Analog Input Function

Range: 21 to 30
Function: Used to program the function of analog input #6, terminal 6, to control any parameter in the range #21 to #30 inclusive. Please note that whenever this parameter is changed the new function will only take effect after the reset pushbutton has been pressed.
Example: To program this input to control the internal run speed demand #22.
   a) Set 69 into the index display
   b) Press the mode key
   c) Set 022 into the data display
   d) Wait three seconds
   e) Press the reset pushbutton
Standard default value: 029

#70 Serial Network Address

Range: 0 to 255
Function: This parameter gives the drive an identity by which it can be addressed in a multidiive application. Serial commands intended for a particular drive must be preceded by the appropriate drive address. Works in conjunction with parameter #71 below.
Standard default value: 001

#71 Current Drive Number

Range: 0 to 255
Function: In a multidiive system with several drives connected to a common RS422 serial interface, each drive is assigned an address. A serial command is preceded by a drive address which is immediately loaded by each drive into its current drive register #71. If the contents of registers #71 and #70 of a particular drive are the same, the drive recognizes that it is being addressed and will respond to the instructions that follow. When a drive is being addressed it is referred to as the current drive, and remains current until another drive is specifically addressed. Thus a string of commands can be sent to the current drive without the need to precede each instruction with a drive address. This parameter is set to zero to enable ANSI protocol.
Standard default value: 001= BASIC Comm(s)
   000= ANSI Protocol
[1]

#72 Line Pacing Character

Range: 0 to +255
Function: This is the character that the drive transmits as a line prompt during uploading of basic programs from a computer via the serial interface. This parameter can be set to any ASCII code, and should be set on the drive before attempting to upload. It is not used with ANSI protocol.
See Quantum II Communications Co-Processor (ES10-006) for full details.
Standard default value: 000

#73 to #89 are not currently used.

#90 Application Control Byte

Function: The bits in this byte correspond directly with individual application programs residing in the System EPROM on the optional MD21 board. A program is enabled by setting the corresponding bit to 1.
See Quantum II Communications Co-Processor (ES10-006) for full details.
Standard default value: 001

#91 BASIC Auto-boot Parameter

Function: The bits in this byte correspond directly with individual BASIC programs residing in the User EPROM on the optional MD21 board. A program is RUN automatically on power-up by setting the corresponding bit to 1.
See Quantum II Communications Co-Processor Manual (ES10-006) for full details.
Standard default value: 001

[1] ANSI used with Operator Interface (Keypad/Display)
10 DESCRIPTION OF PARAMETERS

#92 Status Output Byte

Range: 0 to 255
Function: The individual bits in this byte control the seven status outputs as follows:

<table>
<thead>
<tr>
<th>Bit</th>
<th>Output</th>
<th>Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>RL1</td>
<td>33, 34, 35</td>
</tr>
<tr>
<td>6</td>
<td>RL2</td>
<td>30, 31, 32</td>
</tr>
<tr>
<td>5</td>
<td>Running</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>At speed</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>Alarm</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>ST2</td>
<td>29</td>
</tr>
<tr>
<td>1</td>
<td>ST1</td>
<td>28</td>
</tr>
<tr>
<td>0</td>
<td>Not used</td>
<td>-</td>
</tr>
</tbody>
</table>

The displayed value of #92 is the decimal equivalent of the bit pattern. By setting #169=1, normal status functions are disabled, and #92 can be controlled by the serial interface or processor 2 special application software. (See #169 for further details).

#94 Status Output ST1 Function

Range: 100 to 197
Function: Used to program the open-collector status output ST1 connected to terminal 28. Any parameter in the range #100 to #197 can be programmed to control ST1 by loading the required parameter number into #94.

Example: To program this output to be controlled by parameter #117.

a) Set 94 into the index display
b) Press the mode key
c) Set 117 into the data display
d) Press the mode key

Standard default value: 110

#93 LED Functions Byte

Range: 0 to 255
Function: The individual bits in this byte control the front panel LED indicators as follows:

<table>
<thead>
<tr>
<th>Bit</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Alarm</td>
</tr>
<tr>
<td>6</td>
<td>Zero speed</td>
</tr>
<tr>
<td>5</td>
<td>Run forward</td>
</tr>
<tr>
<td>4</td>
<td>Run reverse</td>
</tr>
<tr>
<td>3</td>
<td>Bridge 1</td>
</tr>
<tr>
<td>2</td>
<td>Bridge 2</td>
</tr>
<tr>
<td>1</td>
<td>At speed</td>
</tr>
<tr>
<td>0</td>
<td>Current limit</td>
</tr>
</tbody>
</table>

The displayed value of #93 is the decimal equivalent of the bit pattern. By setting #185=1, normal LED functions are disabled, and #93 can be controlled by the serial interface or processor 2 special application software. (See #185 for further details).

Note that “drive ready” is not programmable.

#95 Status Output ST2 function

Range: 100 to 197
Function: Used to program the open-collector status output ST2 connected to terminal 29. Any parameter in the range #100 to #197 can be programmed to control ST2 by loading the required parameter number into #95.

Example: To program this output to be controlled by parameter #117.

a) Set 95 into the index display
b) Press the mode key
c) Set 117 into the data display
d) Press the mode key

Standard default value: 113

#96 Index

Function: Contains the current value of the index display. Used for processor 2 special applications, in which #96 has a read write function and can be used to control the display, causing a selected parameter to be indicated.
10 DESCRIPTION OF PARAMETERS

#97 Security Level 2 Key

Function: Unless the correct code is entered, this level of security prevents the changing of the majority of drive parameters from the keypad, while allowing all parameters to be monitored in a read-only mode. The parameters which remain accessible are those which would be potentiometer adjustments on an analog drive, e.g. ramp rates, maximum and minimum speeds, current limits, etc. (For further information on parameter security, see Section 9). Entering a 149 into parameter #97 permits level 2 access. Entering a 233 into #97 will cause regenerative factory defaults to be loaded over current settings. Entering a 255 into #97 will cause non-regenerative factory defaults to be loaded over current settings.

Standard default value: 000

#98 Processor 1 Software Revision No.

Function: Displays the revision number of the installed processor 1 software. For example, version 1.8 software would be displayed as 018.

#99 Processor 2 Software Revision No.

Function: Reserved for processor 2 special application software. (MD21 option board).

GROUP C: READ ONLY BIT PARAMETERS

COMMAND BITS:

The following bits monitor the control input terminals 16 to 23, and are activated by connecting the appropriate terminal to control common, terminal 24.

#100 Programmable Logic Control Input 10

Function: Monitors control input 10, terminal 18, and indicates its status. Using #67, it can be programmed to control any bit parameter in the range #151 to #197. For further information see #67 and Fig. 10-1.

0 - 10 input not active
1 - 10 input active

#101 Programmable Logic Control Input 11

Function: Monitors control input 11, terminal 19, and indicates its status. Using #68, it can be programmed to control any bit parameter in the range #151 to #197. For further information see #68 and Fig. 10-1.

0 - 11 input not active
1 - 11 input active

#102 Inch/Jog Reverse (ii)

Function: Monitors the inch reverse control input, terminal 20, and indicates its status. The drive will only respond to this input if the external logic controls are enabled by setting parameter #158 to 0.

0 - Inch reverse input not active
1 - Inch reverse input active

#103 Inch/Jog Forward

Function: Monitors the inch forward control input, terminal 21, and indicates its status. The drive will only respond to this input if the external logic controls are enabled by setting parameter #158 to 0.

0 - Inch forward input not active
1 - Inch forward input active

#104 Run Reverse (ii)

Function: Monitors the run reverse control input, terminal 22, and indicates its status. The drive will only respond to this input if the external logic controls are enabled by setting parameter #158 to 0.

0 - Run reverse input not active
1 - Run reverse input active

(ii)For regenerative models only
#105 Run Forward

Function: Monitors the run forward control input, terminal 23, and indicates its status. The drive will only respond to this input if the external logic controls are enabled by setting parameter #158 to 0.
0 - Run forward input not active
1 - Run forward input active

#106 Drive Start Permit

Function: Monitors the drive start permit control input, terminal 17, and indicates its status. This input performs an overriding drive stop function as follows: The input must be active in order to start the drive. If the input then becomes inactive, the speed reference at the input to the ramp is set to zero and the drive will stop, unless ramp hold, #168, is active.
0 - Drive stop
1 - Drive start enabled

#107 Drive Enable

Function: Monitors the drive enable input, terminal 16, and indicates its status. This input must be active for the drive to operate. When the drive is disabled by disconnecting this input, all firing pulses are switched off. If the drive is running this will produce a coast stop and reset the ramp.
0 - Drive disabled
1 - Drive enabled

NORMAL STATUS BITS:

#108 Forward Motor Velocity

Function: Indicates that the motor is turning in the forward direction at more than 1.5% of full speed.
Forward direction is defined as:
Terminal 1 negative with respect to terminal A2 when tach feedback selected. Terminal A1 positive with respect to terminal A2 when armature voltage feedback selected.
0 - Drive stationary or running in reverse direction
1 - Drive running in forward direction

#109 Reverse Motor Velocity

Function: Indicates that the motor is turning in the reverse direction at more than 1.5% of full speed.
Reverse direction is defined as:
Terminal 1 positive with respect to terminal 2 when tach feedback selected.
Terminal A1 negative with respect to terminal A2 when armature voltage feedback selected.
0 - Drive stationary or running in forward direction
1 - Drive running in reverse direction

Note: If #108 and #109 are both zero then the motor is either stationary or running at less than 1.5% of full speed. In this condition the zero speed LED is illuminated and the zero speed relay RL2 is energized.

#110 In Current Limit

Function: Indicates that either the current demand #07 or torque demand #28 is being limited by the current limit override as set by #30, #31 or #32, or by the result of the current taper calculation.
0 - Drive not in current limit
1 - Drive in current limit

#111 Bridge 1 On

Function: Indicates that SCR bridge 1 (positive bridge) is being triggered. This bit does not indicate that bridge 1 is actually conducting, since conduction takes place only when the firing angle is sufficiently advanced.
0 - Bridge 1 disabled
1 - Bridge 1 enabled

#112 Bridge 2 On

Function: Indicates that SCR bridge 2 (negative bridge) is being triggered. This bit does not indicate that bridge 2 is actually conducting, since conduction takes place only when the firing angle is sufficiently advanced.
0 - Bridge 2 disabled
1 - Bridge 2 enabled
#113 Electrical Phase Back (Standstill)

Function: Indicates that the firing pulses are being phased back by the action of the standstill function. See parameters #161 and #162 for explanation of standstill.
0 - Firing pulses not phased back
1 - Firing pulses phased back (at standstill)

#114 At Speed Setpoint

Function: Indicates that the drive has attained set speed when ramp output #2 is equal to ramp input #13 (acceptance band 0.3% of full scale) and comparison of speed loop variable #16 and speed feedback #03 results in a speed error less than 1.5% of maximum speed. This condition is also signaled externally via an open collector output connected to terminal 26.
0 - Drive not at speed
1 - Drive at speed

#115 Overspeed

Function: Indicates that the speed feedback signal exceeds +/-999. This is a monitor and not a drive trip condition.
0 - Motor not overspeed
1 - Motor overspeed

#116 Drive Healthy

Function: Indicates that the drive has not tripped. A drive is healthy as long as none of the following fault conditions has been detected:

118 Field loss
119 Tach or feedback loss
120 Phase loss
121 Instantaneous overcurrent trip
122 Sustained overload
123 Motor power bridge overtemperature
124 Watchdog timer
125 Power supply fault
126 Armature open circuit
131 Processor 2 watchdog

This condition is also signalled externally via the “drive healthy” LED and the energized state of relay RL1, whose changeover contact is connected to terminals 30, 31 and 32. Detection of any of the above fault conditions results in the immediate shutdown of the drive, which remains disabled until either:

1. Power is removed from the drive then reapplied (hard reset)
2. The reset pushbutton is pressed (soft reset)
3. The system is reset by the optional second processor

If the drive trips, the failure mode parameter 50 immediately appears in the index display. The fault code, 118 to 126 or 131 corresponding to the cause of the trip is indicated in the display. Also, as an aid to diagnostics, the values of the real read-only parameters (#00–#19) are stored at the time of the drive trip. The above conditions are cleared when a hard or soft reset is performed.
0 - Drive tripped
1 - Drive healthy

#117 Alarm (Overload Pending)

Function: Indicates that the drive is in an overload condition and will eventually trip on sustained overload #122 unless the overload condition is removed. The time taken to trip is dependent on the setting of parameter #63 and the magnitude of the overload. Visual indication that the alarm has been activated is provided by a flashing Alarm LED on the front of the drive. An external alarm signal is also provided in the form of an open collector output connected to terminal 27.
0 - No alarm condition present
1 - Alarm condition present - Impending sustained overload trip

#118 Field Loss

Function: Indicates that there is no current being drawn from the internal field supply. This condition can be prevented from tripping the drive by disabling field loss detection. Set parameter #187=1, thereby allowing the use of an external field supply.
0 - Field acceptable
1 - Field failed
10 DESCRIPTION OF PARAMETERS

#119 Tach/Feedback Loss

Function: Signifies loss or incorrect polarity of speed feedback signal, either tach or armature voltage, depending on the mode selected. Loss of feedback is only detected when the firing angle has advanced to the point where the value of #09 is less than 384, at which point a drive fault trip occurs. This condition can be prevented from tripping the drive by disabling tach loss detection, using #186.
0 - Speed feedback present
1 - Speed feedback absent or polarity inverted

#120 Phase Loss

Function: Indicates that an SCR firing pulse has failed to produce a pulse of output current during continuous-current operation. The faults which will be detected are as follows:
1. Missing supply phase
2. Missing firing pulse
3. SCR gate open circuit
   0 - Acceptable
   1 - Phase loss

#121 Instantaneous Overcurrent Trip

Function: Indicates that a current peak greater than 2.0 times the maximum current limit has occurred. This results in suppression of firing pulses and immediate drive shutdown.
0 - No overcurrent peak detected
1 - Overcurrent peak detected

#122 Sustained Overload

Function: Indicates that the current feedback #08 has exceeded the overload threshold #33 for a length of time determined by #63, the integration rate, and the magnitude of the overload. When the current exceeds the overload threshold, the difference is integrated causing the value of the overload integration register #19 to increase. Conversely, when the current is below the threshold, the value of #19 decreases toward zero. The rate of integration is set by #63, which is the time taken for a drive fault trip to occur with a full scale overload (#08=999). The function therefore simulates a thermal overload relay.
0 - Sustained overload not detected
1 - Sustained overload detected

#123 Overtemperature/Miscellaneous Trip

Function: Not implemented. Can be used to trip the drive if #186 is set to 0 via serial interface, application software or programmable logic input used in conjunction with an external normally closed contact.
0 - Healthy
1 - Trip

#124 Watchdog Timer

Function: Under normal drive operation the watchdog timer is reset periodically by processor 1 as a check that the processor and drive program are functioning normally. If a reset does not occur before it has timed out the conclusion is that either the processor has failed or the drive program has crashed. The result is an immediate controlled drive shutdown and flagging of a watchdog fault.
0 - Control system healthy
1 - Watchdog trip

NOTE: Fault codes 125, 126 & 132: These do not have corresponding read-only bit parameters. Refer to Section 12 for details.
MISCELLANEOUS READ ONLY BIT PARAMETERS

#125  Phase Rotation

Function: Monitors and indicates the phase rotation of the AC supply on terminals E1, E2, E3 which must have the same rotation and sequence as the main power bridge connections L1, L2, L3. Therefore, L1 must be connected to the same phase as E1, L2 to the same phase as E2, and L3 to the same phase as E3. If this is not the case, the drive will malfunction, since the order in which the SCRs are fired depends on this signal.
0 - Phase rotation L1, L3, L2
1 - Phase rotation L1, L2, L3

#126  Speed Comparator Level 1 Exceede

Function: Indicates that the motor has exceeded the speed set by speed level 1 sense (#26). Useful in speed dependent current limit profiling to provide a reference point from which the first current taper slope set by parameter #59 will begin. See parameter #59.
0 - Motor speed less than speed level 1
1 - Motor speed greater than speed level 1

#127  Speed Comparator Level 2 Exceede

Function: Indicates that the motor has exceeded the speed set by speed level 2 sense (#27). Useful in speed dependent current limit profiling to provide a reference point from which a second current taper slope set by parameter #60 will begin. See parameter #60.
0 - Motor speed less than speed level 2
1 - Motor speed greater than speed level 2

#128  Analog Error Window Flag

Function: To achieve an effective 14-bit resolution with analog speed reference and feedback, an amplifier is used to derive an amplified speed error signal. After A to D conversion, this is used by the speed loop when the speed error is small, thereby increasing the resolution. (See also #12). #128 is the output of a window comparator monitoring speed error, and is set to 1 when the speed loop is in high-resolution mode. This mode of operation is not used in the following cases:
a. Run reverse or inch
b. Internal reference #22 selected
c. Speed reference offset #23 in use
d. Speed reference scale factor #57, #157 in use
e. Hard speed reference #29 in use

#129  Speed Loop Saturated

Function: Indicates that the output from the speed loop algorithm, from which the current demand signal is derived, is out of range. This may be due to the application of a current limit or a zero-current clamp.
0 - Speed loop not saturated
1 - Speed loop saturated

#130  Zero Current Demand

Function: Indicates that the current demand signal is being limited to zero. This could result, for example, when in torque control with speed override, that due to loss of load the motor speed has exceeded the set speed threshold.
0 - Current demand greater than zero
1 - Current demand zero

#131  2nd Processor Watchdog

Function: When implemented, is the means by which processor 1 monitors the functioning of processor 2, the special applications processor, on the optional MD21 board. The result of a failure is a controlled drive shutdown and fault indication.
0 - Processor 2 healthy
1 - Watchdog trip


#132 to #149 are not currently used

GROUP D: READ/WRITE BIT PARAMETERS

#150 Non-Volatile RAM (EEPROM) Update

Function: Used to change the default value of a read/write parameter. When a parameter value is changed from the Quantum II keypad or via the serial interface, the change is immediately loaded into the drive RAM but not into the EEPROM. This means that the drive will immediately respond to the change but will revert to the stored default parameter on the next power-up cycle. This has the advantage that one can experiment with different parameter values without losing the original settings, which can easily be recovered by carrying out a hard reset (switch off the supply to the Quantum II then power up again). However, if it is necessary to change the default values, this can be done as follows:
   a. Make all the required parameter changes
   b. Set #150=1
   c. Wait three seconds
   d. Press the reset pushbutton on the MD200 board.

Standard default value: 0

---

#151 Quadrant 1 Enable

Function: Indicates that quadrant 1 is enabled. Quadrant 1 operation is defined as motoring in the forward direction.
   0 - Quadrant 1 disabled for non-regen models
   1 - Quadrant 1 enabled for regen models

Standard default value: 1

---

#152 Quadrant 2 Enable

Function: Indicates that quadrant 2 is enabled. Quadrant 2 operation is defined as regenerative braking from the reverse direction.
   0 - Quadrant 2 disabled
   1 - Quadrant 2 enabled

Standard default value: 0 - 1Q for non-regen models
   1 - 4Q for regen models

---

#153 Quadrant 3 Enable

Function: Indicates that quadrant 3 is enabled. Quadrant 3 operation is defined as motoring in the reverse direction.
   0 - Quadrant 3 disabled
   1 - Quadrant 3 enabled

Standard default value: 0 - 1Q for non-regen models
   1 - 4Q for regen models

---

#154 Quadrant 4 Enable

Function: Indicates that quadrant 4 is enabled. Quadrant 4 is defined as regenerative braking from the forward direction.
   0 - Quadrant 4 disabled
   1 - Quadrant 4 enabled

Standard default value: 0 - 1Q for non-regen models
   1 - 4Q for regen models

---

ANALOG REFERENCE CONTROL:

#155 Internal Reference Select

Function: Determines whether the external analog speed demand input #01 (terminal 5) or the internal digital reference #22 is selected as the drive speed reference.
   0 - External run speed demand #01 selected
   1 - Internal run speed demand #22 selected

Standard default value: 0
10 DESCRIPTION OF PARAMETERS

#156 Bipolar Speed Demand Enable

Function: When set to 1 the drive will respond to a bipolar analog speed reference #01, in which case the direction of rotation is determined by the polarity of this signal. A positive polarity causes the drive to run forward and a negative polarity to run in reverse. (Setting the reverse polarity bit #165=1 reverses the above convention). When set to 0 the drive will respond to a unipolar analog speed reference, in which case the direction of rotation is determined by the reverse bit #165 only, and all negative values of #01 are treated as zero. (See also #165).

0 - Unipolar reference
1 - Bipolar reference

Standard default value: 0 - 1Q for non-regen models
1 - 4Q for regen models

#157 Analog Scale Factor Range

Function: Determines the range of the analog reference scale factor #57. When #157=1, the analog scale factor covers the range 1 to 2. When #157=0, the analog scale factor covers the range 0 to 1.

Definition of scaling: (speed demand) = #01 x (#157+57/256)+#23
0 - Scale factor = (#57/256)
1 - Scale factor = 1+(#57/256)

Standard default value: 1

MODE CONTROL:

#158 Internal Logic Control Select

Function: Used to disable the external logic control inputs, terminals 20 to 23. In this case control is achieved by writing directly to parameters #163, #164 and #165 either via the onboard keypad or via the serial interface.
0 - Enable external logic control inputs
1 - Enable internal logic control
(Enables remote serial control of Jog and Run modes)

Standard default value: 0

#159 Mode Control Bit 0

Function: Works in conjunction with parameter #160 to configure the drive for speed control or any of three modes of torque control. See #160 for full description.

Standard default value: 0

#160 Mode Control Bit 1

Function: Works in conjunction with parameter #159 to configure the drive for speed control or any of three modes of torque control as follows:

#159=0, #160=0: Normal speed control mode.
#159=1, #160=0: Basic torque control. In this mode, parameter #28 is the input to the current loop algorithm, subject only to the limitations of the current slew rate parameter #61 and the current limit parameters #31 and #32.
#159=0, #160=1: Torque control with speed override. In this mode, the output of the speed loop is clamped either to zero or to the value of #28, depending on the polarities of the speed error signal and #28. In the motoring quadrants, the speed is limited to the value of the speed loop variable #16, preventing uncontrolled speed increase on removal of load.

In the regenerative quadrants, the current demand set by #28 is disabled when the speed is less than that set by #16. This prevents a reversal of rotation on loss of input torque.

#159=1, #160=1: Coiler/Uncoiler mode. This mode is the same as combined torque and speed control, except that when the sign of the torque reference #28 is opposite to the sign of the speed feedback #03, the speed reference is treated as zero. Therefore, this mode allows torque to be applied in either sense for acceleration and deceleration, while preventing uncontrolled speed increase or reversal in case of material breakage.

Standard default value: #159=0
#160=0

68


**#161 Enable Standstill Logic**

**Function:** Enables the drive standstill logic which, when the drive is stopping and the speed has fallen below 0.8%, causes the firing angle to be phased back fully, thereby preventing creep. After a delay the firing pulses are then inhibited. This condition is indicated by the standstill logic flag, #113. (See also #162).

0 - Standstill logic disabled
1 - Standstill logic enabled

**Standard default value:** 1

---

**#162 Standstill Logic Mode**

**Function:** If standstill logic is enabled (#161=1) this bit determines the mode of operation. If #162=0, standstill is detected at 0.8% speed following either a “stop” command (#163=0) or setting of the external reference on terminal 5 to zero.

If #162=1, standstill is detected at 0.8% speed following a “stop” command (#163=0) but not when a stop is achieved by setting the external reference to zero. This mode allows creep speeds, shaft orientation and other functions which take place close to zero speed.

0 - Standstill after “stop” or zero ref.
1 - Standstill after “stop” only

**Standard default value:** 0

---

**REMOTE CONTROL: (Refer also to #158)**

**#163 Go (not stop)**

**Function:** When this bit is set to 1, the speed reference is applied to the input of the speed ramp. The conditions necessary for this to take place are as follows:

a. Drive enabled (#107=1 - terminal 16 grounded)

b. Drive start enabled selected (#106=1 - terminal 17 grounded)

c. Inch selected (#102=1 or #103=1)

d. Run selected momentarily (#104=1 or #105=1)

When a stop is called for, either by removing the inch command (#102=0, #103=0) if inching, or by removing drive start enable (#106=0) if running, #163 is set to 0, which sets the ramp input to zero. (Note that “run” is a latching function, and removing the run command has no effect).

0 - Drive stop
1 - Drive go

**Standard default value:** 0

---

**#164 Inch (not run)**

**Function:** Selects either run mode or inch mode. If run mode is selected, the source of the speed reference is determined by #155. If inch mode is selected, the speed reference is #21.

0 - Run reference selected
1 - Inch reference (#21) selected

**Standard default value:** 0

---

**#165 Reverse (not forward)**

**Function:** Used to select forward or reverse rotation. If forward mode is selected (run forward or inch forward) the speed reference polarity is unchanged. If reverse mode is selected (run reverse or inch reverse) the speed reference polarity is inverted.

0 - Speed reference normal
1 - Speed reference inverted

**Standard default value:** 0
#166 Miscellaneous Inhibit

**Function:** Disables SCR firing and resets ramps. This bit may be controlled via the optional serial interface or by processor 2 special application software.

- 0 - Enables SCR firing
- 1 - Disables SCR firing

**Standard default value:** 0

---

#167 Ramp Enable

**Function:** Enables the speed control ramp function. The effect of disabling the ramp function is to bypass the ramp, giving zero ramp time. This may be used, for example, in applications which call for regenerative emergency stop at current limit.

- 0 - Ramp disabled
- 1 - Ramp enabled

**Standard default value:** 1

---

#168 Ramp Hold

**Function:** Setting this bit to 1 causes the ramp output, #2, to be held at its current value regardless of the value of the ramp input. This facility may be used, for example, in conjunction with “run” and “drive start enable” to give a digital reference ramp function, controlled by external “increase” and “decrease” pushbuttons.

- 0 - Ramp function active
- 1 - Ramp held

Controlled in default by programmable bit function 1 (terminal 19) via #68.

---

#169 Programmable Status Outputs

**Function:** Disables the normal functions of the dedicated status outputs, and renders them programmable by means of the status output byte #92. This is accessible via the serial interface or processor 2 special application software.

- 0 - Status outputs dedicated
- 1 - Status outputs programmable

**Standard default value:** 0

---

#170 Security

**Function:** This parameter is used in the initial setting of level 1 security, and cannot be altered from the keypad once set, thereby preserving the security code. Section 9 gives full details of parameter security.

- 0 - Security level 1 not set
- 1 - Security level 1 set

**Standard default value:** 0

---

#171 Firing Angle Control

**Function:** Allows direct control of the SCR firing angle by applying the digital reference #02 (normally speed demand) to the input of the firing stage. This mode is useful for fault finding since it allows the drive to operate without the influence of either the speed loop or the current loop. However, care must therefore be exercised when using this facility, since there is no protection against excessive acceleration or current except instantaneous overcurrent trip.

- 0 - #02 = Speed demand
- 1 - #02 = Firing angle reference

**Standard default value:** 0

---

**SERIAL INTERFACE CONFIGURATION PARAMETERS:**

**Function:** Parameters #172 to #181 are used to configure the serial interface.

---

#172 Line Feed Enable

**Function:** Enables the sending of line feed characters via the serial interface.

- 0 - Disable line feed
- 1 - Enable line feed

**Standard default value:** 1

---

#173 Prompt Enable

**Function:** Enables the sending of the prompt via the serial interface.

- 0 - Disable prompt
- 1 - Enable prompt

**Standard default value:** 1
10 DESCRIPTION OF PARAMETERS

#174 Length of Data Frame
Function: Selects the number of data bits in a transmitted word.
Changes made to this bit do not become effective until a reset is carried out.
0 - Ten bit data frame
1 - Eleven bit data frame
Standard default value: 0

#175 Parity Enable
Function: Enables the parity bit in the transmitted word.
Changes made to this bit do not become effective until a reset is carried out.
0 - Disable parity
1 - Enable parity
Standard default value: 0

#176 Parity Type
Function: Selects the type of parity (even or odd).
Changes made to this bit do not become effective until a reset is carried out.
0 - Parity even
1 - Parity odd
Standard default value: 0

#177 XON/XOFF Enable
Function: Enables the XON/XOFF handshaking.
0 - Disable XON/XOFF
1 - Enable XON/XOFF
Standard default value: 0

#178 Baud Rate Bit 0
Standard default value: 1

#179 Baud Rate Bit 1
Standard default value: 0

#180 Baud Rate Bit 2
Standard default value: 1
These three bits allow the data transmission rate to be selected from the table below:

<table>
<thead>
<tr>
<th>bit 2</th>
<th>bit 1</th>
<th>bit 0</th>
<th>Baud rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>19200</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>9600(1)</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>4800(2)</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2400</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1200</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>600</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>300</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>150</td>
</tr>
</tbody>
</table>

(1) With operator interface (keypad/display)
(2) Factory default

Note that changes made to the above parameters (#178, #179, #180) do not become effective until a reset is carried out.

#181 Checksum Enable
Function: Enables checksum function in ANSI communications protocol
0 - Checksum disabled
1 - Checksum enabled
Standard default value: 0

#182 Adaptive Control Enable
Function: Causes the gain of the current loop to change at the point of transition between continuous and discontinuous current. This is necessary for four-quadrant applications.
0 - Adaptive control disabled
1 - Adaptive control enabled
Standard default value: 1
10 DESCRIPTION OF PARAMETERS

#183 High Current Loop Integral Gain

Function: Doubles the gain by which the current integral term is multiplied in the current loop algorithm. In some single ended applications it may be desirable to detune the current loop by setting this parameter to zero.
0 - Low integral gain
1 - High integral gain

Standard default values: 0 - 1Q for non-regen models
1 - 4Q for regen models

#184 Fast Current Reversal

Function: Following a bridge changeover, the firing pulses must be phased forward to the point at which conduction begins. At high speed, the conduction angle is large, and hence a considerable delay can result while this takes place. By calculating the required firing angle and initiating firing at that angle, the delay is eliminated. For loads having short time constant L/R, this function should be disabled.
0 - Fast reversal disabled
1 - Fast reversal enabled

Standard default value: 0 - 1Q for non-regen models
1 - 4Q for regen models

#185 Programmable LED Functions

Function: Disables the normal functions of the front panel LED indicators (except "drive ready") and renders them programmable by means of the LED functions byte #93. This is accessible via the serial interface or processor 2 special application software.
0 - LED functions dedicated
1 - LED functions programmable

Standard default value: 0

#186 Tach Loss Detection Off

Function: Disables the tach loss detector #119. This may be necessary if, for example, the feedback signal #03 represents a quantity other than motor speed, and can be zero when the firing angle is advanced.
0 - Tach loss detection enabled
1 - Tach loss detection disabled

Standard default value: 0

#187 Field Loss Detection Off

Function: Disables the field loss detector #118. This facility is used when an external field supply is employed, or field reversal is used with a single quadrant drive to give a regenerative stop. Under these conditions a drive fault trip would otherwise result.
0 - Field loss detection enabled
1 - Field loss detection disabled

Controlled in default by programmable bit input 0 (terminal 18) via #67.

#188 Overtemperature Detection Off

Function: Disables the overtemperature detector #123.
0 - Overtemperature detection enabled
1 - Overtemperature detection disabled

Standard default value: 1

#189 Reference S Switch

Function: Selects either the IR compensation term #17 or the hard speed reference #29 as a direct input into the speed loop algorithm, bypassing the speed ramps and limits. See speed loop variable #16 for further information.
0 - IR compensation #17
1 - Hard speed reference #29

Standard default value: 0

#190 Zero Reference Interlock

Function: Inhibits starting of the drive until the analog speed reference #01 is near zero, such that:
-16 < 01 < +16
0 - Zero reference interlock disabled
1 - Zero reference interlock enabled

Standard default value: 0
#191 Ramp x 10 Select

Function: Changes the range of the speed ramps #51, #52, #53, #54 such that the ramp times are set in increments of 0.1 second rather than 1 second.
- 0 - Ramp time increment 1 sec.
- 1 - Ramp time increment 0.1 sec.

Standard default value: 1

#192 Reference T Switch

Function: Applies the ramped speed reference #2 to the input of the speed loop algorithm. See speed loop variable #16 for further information.
- 0 - Speed loop variable excludes #2
- 1 - Speed loop variable includes #2

Standard default value: 1

#193 Fine Control Select

Function: Causes the value of the analog signal connected to terminal 6 to be divided by a factor of 16, giving #6 a reduced range of -63 to +63, but with the same 10-bit resolution as the normal range.
- 0 - Normal control
- 1 - Fine control

Standard default value: 0

#194 - #197 Not used.
"Soft switches" shown in default position

Figure 10-1.
Control Block Diagram
11.1 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.

11.2 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.

11.2.1 Suggested Training

A. Study the system instruction manual and control drawings.

B. Train in the use of test instruments.

C. Contact ICD for training schools.

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

11.2.2 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.

11.2.3 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.

11.2.4 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.
2. To inhibit the external control of run/inch/reverse functions, change parameter #158 to 1.

3. Change parameter #155 to 1. This selects the local speed control reference (parameter #22).

4. Changing parameter #163 to 1 starts the drive. The speed may be varied by means of parameter #22.

5. The motor may be reversed by changing parameter #165 to 1 (if a regenerative drive).

6. The internal inch reference (parameter #21) may be selected by changing parameter #164 to 1.

To return the above parameters to the original settings press the reset button.

**FAULT INDICATION**

If a fault occurs, the drive ready relay is de-energized, the parameter index window displays 50, and the data window indicates the type of fault as follows:

118 - Field loss:
Indicates that there is no current flowing in the motor shunt field.

119 - Tach loss/feedback loss:
Indicates that the drive has lost its speed control feedback.

120 - Phase loss:
Indicates the loss of a supply phase or failure of a SCR to conduct.

121 - Overcurrent:
Indicates that the armature current has exceeded twice the maximum current limit level.

122 - Sustained overload:
Indicates that the drive has been overloaded for a time determined by the integrating overload protection.

123 - Overtemperature:
Indicates a SCR overtemperature condition.

124 - Watchdog timer:
Indicates a microprocessor hardware or software fault.

125 - Power supply fault:
Indicates that power supplies are out of tolerance as follows:
+24V Overvoltage
+/-15V Over- or under-voltage
+5V (logic) Over- or under-voltage
126 - Armature open circuit:
Indicates that firing pulses have been phased forward
without causing current to flow.

131 - 2nd Processor watchdog:
Indicates a hardware or software fault in optional proces-
sor 2.

132 - EEPROM failure:
Indicates a failure of the EEPROM, corruption of the
stored data or failure of the non-volatile store sequence.

LED DIAGNOSTICS

Drive Ready:
Indicates that the drive electronics has completed its
power-up self-test routine. (Relay RL1 also energizes at
this time).
Flashes in the event of a fault.

Alarm (OVLD—flashing):
Indicates that the drive is overloaded and that the inte-
grating overload will eventually trip, de-energizing RL1.

Run Forward:
Indicates that the drive is running in the forward direction.

Run Reverse:
Indicates that the drive is running in the reverse direction.

Bridge 1 On:
Indicates that SCR bridge 1 is selected.

Bridge 2 On:
Indicates that SCR bridge 2 is selected.

At Speed:
Indicates that the drive has attained its set speed.

Current Limit:
Indicates that the drive is in a current limit condition.

MONITORING KEY DRIVE PARAMETERS

Parameters #1 - #19 are ready-only variables and indi-
cate the following: (For full particulars see Section 10
and Figure 10-1).

#01 - Indicates the speed reference voltage derived
from the speed control potentiometer.
999 = 9.77V (Terminal 5).

#02 - Indicates the speed demand signal after the
ramp function.
999 = maximum speed.

#03 - Indicates the value of the tach or armature
voltage feedback.
999 = maximum speed.

#04 - Indicates the speed error.

#05 - Indicates the speed error integral.

#06 - Indicates the external analog reference
(Terminal 6).
999 = 9.77V.

#07 - Indicates the armature current demand signal.
999 = current limit set by burden resistors.

#08 - Indicates the actual armature current.
999 = current limit set by burden resistors.

#09 - Indicates the output of the current amplifier and
is equivalent to the firing angle of the SCR
converter.
768 = 180 degrees.

#10 - Indicates the analog voltage of terminal 7.
999 = 9.77V

#11 - Indicates the analog voltage of terminal 8.
999 = 9.77V.

#12 - Indicates the value of the analog speed error
signal.

#13 - Indicates the value of the speed reference be-
fore the ramp.
+/-999 = max. ref.

#14 - Synchronizing staircase waveform for SCR fir-
ing sequence.

#15 - Indicates the value of the torque control vari-
able.
+/-999 = max. torque demand.

#16 - Indicates the value of the speed reference at the
speed summing point.
+/-999 = max. speed demand.

#17 - Indicates the value of the IR compensation
term.
+/-125 = +/-12.5% compensation.

#18 - Not used.

#19 - Indicates the value attained by the overload
integration function.
### FAULT FINDING CHART

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

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>INDICATIONS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOTOR DOES NOT ROTATE</td>
<td>Drive ready LED off</td>
<td>No power to regulator:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check regulator supply voltage on terminals E2, E2, E3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check regulator/field fuses FS1, FS2, FS3. If failed, suspect short circuit in field circuit or faulty field bridge BR1.</td>
</tr>
<tr>
<td></td>
<td>Drive ready LED flashing:</td>
<td>FIELD LOSS:</td>
</tr>
<tr>
<td></td>
<td>118 displayed</td>
<td>Check field connections.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check fuses FS1 &amp; FS 2 and field bridge BR1.</td>
</tr>
<tr>
<td></td>
<td>121 displayed</td>
<td>INSTANTANEOUS OVERCURRENT TRIP:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check phase sequence &amp; rotation:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L1 same phase as E1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L2 same phase as E2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L3 same phase as E3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check for short circuit or ground fault on output terminals A1, A2.</td>
</tr>
<tr>
<td></td>
<td>125 displayed</td>
<td>POWER SUPPLY FAULT:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Replace MD100 PCB. If fault persists, replace power PCB.</td>
</tr>
<tr>
<td></td>
<td>126 displayed</td>
<td>ARMATURE OPEN CIRCUIT:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check motor connections and brushes.</td>
</tr>
<tr>
<td></td>
<td>Drive ready and run LED on:</td>
<td>Check contactor sequencing and all fuses in AC and DC power circuit.</td>
</tr>
<tr>
<td></td>
<td>Current limit LED off</td>
<td>DRIVE NOT ENABLED:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Connect ENABLE terminal 16 to 0V terminal 24.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO SPEED DEMAND:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Connect reference on terminal 5 if used, and parameters #1 and #2 should follow reference.</td>
</tr>
</tbody>
</table>
## 11 FAULT FINDING

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>INDICATIONS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOTOR DOES NOT ROTATE</td>
<td>Current limit LED on</td>
<td>MOTOR MECHANICALLY STALLED or</td>
</tr>
<tr>
<td></td>
<td>Drive ready LED on. Run and inch</td>
<td>FAULT IN FIELD CIRCUIT.</td>
</tr>
<tr>
<td></td>
<td>LEDs off</td>
<td>NO RUN COMMAND:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check control wiring.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check #158 - refer to Section 10</td>
</tr>
</tbody>
</table>

| MOTOR STARTS BUT STOPS IMMEDIATELY | Drive ready LED flashing:          | TACH LOSS:                                                             |
|                                   | 119 displayed                       | Check tach connections and polarity.                                  |
|                                   | 120 displayed                       | PHASE LOSS:                                                           |
|                                   | 121 displayed                       | Check 3-phase supply and line fuses.                                 |
|                                   |                                     | (See below) Ensure SCR gate leads correctly connected.                |
| Line fuse or DC fuse blown       | SHORT CIRCUIT ON OUTPUT:            | INSTANTANEOUS OVERCURRENT TRIP:                                       |
|                                   | 122 displayed                       | 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 MD100 PCB.                      |
|                                   |                                     | FAULTY SCR:                                                          |
|                                   |                                     | Contact factory.                                                      |

| MOTOR RUNS FOR A SHORT TIME AND STOPS | Alarm LED flashing while motor runs: 122 displayed | SUSTAINED OVERLOAD: |
|                                       |                                                     | Check mechanical load.                                               |
|                                       |                                                     | Check field supply at motor field terminals.                         |

<p>| MOTOR SLOWS DOWN UNDER LOAD         | Current limit LED on                    | DRIVE IN CURRENT LIMIT:                                             |
|                                       |                                     | Compare DC current with drive rating.                               |
|                                       |                                     | Check mechanical load. Check current limit settings, #30, #31, #32, #28 if used. |
|                                       |                                     | Check current taper, #26 and #27. Check field supply at motor field terminals. |</p>
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>INDICATIONS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFECTIVE SPEED CONTROL</td>
<td>Speed range limited</td>
<td>SPEED REFERENCE RANGE INCORRECT:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check range of potentiometer or internal reference.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check reference scaling #57 and #157.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPEED CLAMPS OPERATING:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check max and min speed #24 and #25.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OFFSET PRESENT:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check #23.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FEEDBACK INCORRECT:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check setting of feedback selector jumpers and max. speed potentiometers.</td>
</tr>
<tr>
<td></td>
<td>Speed unstable or overshoot excessive</td>
<td>CURRENT LOOP GAIN INCORRECTLY SET:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjust #62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPEED LOOP GAINS INCORRECTLY SET:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjust #55, #56.</td>
</tr>
<tr>
<td></td>
<td>Motor runs only at top speed.</td>
<td>INCORRECT SPEED REFERENCE:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check potentiometers #1 and #2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TACH LOSS:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(If tach loss detector inhibited)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check tach connections and polarity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DRIVE OPERATING IN CURRENT CONTROL:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check setting of parameters #159 and #160.</td>
</tr>
<tr>
<td>MOTOR COMMUTATOR SPARKING</td>
<td>Sparking on acceleration</td>
<td>ARMATURE VOLTAGE TOO HIGH:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tach feedback: Reduce field current.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Armature voltage feedback:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce motor voltage using VR1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weaken field if necessary to restore speed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CURRENT LIMIT TOO HIGH:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check parameters #30, #31, #32.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CURRENT SLEW RATE TOO HIGH:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(esp. solid-frame motor)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check parameter #61.</td>
</tr>
<tr>
<td></td>
<td>Brushes and/or commutator worn</td>
<td>REPLACE BRUSHES AND/OR OVERHAUL COMMUTATOR.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If wear was rapid, check for contamination by oil mist or corrosive vapors.</td>
</tr>
<tr>
<td>MOTOR DOES NOT HOLD ZERO SPEED (FOR REGEN MODELS ONLY)</td>
<td>Overhauling load rotates motor at low speed</td>
<td>Standstill logic is enabled</td>
</tr>
<tr>
<td></td>
<td>No holding torque</td>
<td>Set parameter #161 = 0</td>
</tr>
</tbody>
</table>
12.1 REPLACING COMPONENTS ON THE DRIVE UNIT

WARNING
THE DC MOTOR MAY BE AT LINE VOLTAGE EVEN WHEN IT IS NOT IN OPERATION. THEREFORE, NEVER ATTEMPT TO INSPECT, TOUCH OR REMOVE ANY INTERNAL PART OF THE DC MOTOR (SUCH AS THE BRUSHES) WITHOUT FIRST MAKING SURE THAT ALL AC POWER TO THE CONTROL AS WELL AS THE DC POWER TO THE MOTOR HAS BEEN DISCONNECTED.

The motor should be inspected at regular intervals and the following checks must be made:

A. See that both the inside and outside of the motor are not excessively dirty. This can cause added motor heating, and therefore, can shorten motor life.

B. If a motor blower is used, make sure that the air passages are clean and the impeller is free to rotate. If air filters are used, they should be cleaned at regular intervals or replaced if they are disposable. Any reduction in cooling air will increase motor heating.

C. Inspect the commutator and brushes. Replace the brushes if needed. Make sure that the proper brush grade is used.

D. The motor bearing should be greased per the manufacturer's instructions as to type of grease and maintenance frequency. Overgreasing can cause excessive bearing heating and failure. Consult the instructions supplied with the motor for more details.

The following outlines the correct method for replacing components such as pcb's, SCRs, field rectifiers, etc., after location by fault diagnosis.

12.2 ROUTINE MAINTENANCE

Only minor adjustments should be necessary on initial start-up, depending on the application. In addition, some common sense maintenance needs to be followed.

KEEP IT CLEAN: The control should be kept free of dust, dirt, oil, caustic atmosphere and excessive moisture.

KEEP IT COOL: The control should be located away from machines having a high ambient temperature. Air flow across heatsinks must not be restricted by other equipment within an enclosure.

KEEP CONNECTIONS TIGHT: The equipment should be kept away from high vibration areas that could loosen connections or cause chafing of wires. All interconnections should be retightened at time of initial start-up and at least every six months.

12.3 MODELS 9500-8201 through 6 and 9500-8501 through 6

WARNING
THE DRIVE MAIN ISOLATOR MUST BE SWITCHED OFF BEFORE COMMENCING REPAIR WORK.
12.3.1 Inspection of the Contactor/Fuse Chassis

To open the unit for inspection of the contactor/fuse chassis, undo the two screws located above the display panel and swing the hinged panel forward.

12.3.2 Personality Board (MD200) Removal (Figure 12-1)

With the hinged panel closed, remove the six wires connected to the Terminal Block on the MD200 Personality Board. Unscrew the four screws which secure the board to the panel. Unplug the 10-pin Ribbon Cable Connector, then ease the Personality Board gently out of the 64-pin socket which connects it to the Control Board (MD100).

12.3.3 Control Board (MD200) Removal (Figures 12-1 & 12-3)

Remove the two screws located above the Display Panel and swing the hinged panel forward (unless this has been done earlier). Remove the three screws located on the backside of the panel which hold the Display Panel to the Control Board. Undo the two screws securing the Control Board to the Hinged panel. Disconnect the 25-pin Ribbon Cable, and gently ease the Control Board out of the 64-pin plug which connects it to the Personality Board (unless this has already been removed.)

12.3.4 Removal of the Contactor/Fuse Chassis from the Molded Base

Remove the two green Ground Wires from the Grounding Bar by removing the nuts, washers, and bolt. Remove the three nuts and washers which hold the bussbars to the molded base at the L1, L2, L3 end of the drive. Remove the three wires marked 1, 2, 3 from the studs. Remove the two nuts and associated washers holding the bussbars to the molded base on the left hand side of the drive. Remove the two phillips screws located next to the L1 fuseblock and the A-fuseblock which hold the chassis to the molded base. Remove the two screws located on the sides of the drive which hold the chassis to the base. Remove the Chassis from the base by pulling straight off. Disconnect the 10-pin and 28-pin ribbon cables at PLE and PLB on the SCR PCB found in the base.

12.3.5 Field Rectifier-Changing

1. On models 9500-8X01 through -8X06, this can be done without removing the SCR pcb. Simply undo the screw in the middle of the component and lift out through square hole in pcb.

2. On the high horsepower models (9500-8X07 and above), remove the two (2) bridge mounting screws. Disconnect the terminal wiring associated with this field rectifier bridge. Mark these wires as you disconnect them so they can be reconnected the same way.

3. On all Quantum II models:
   a. Clean all old compound from the heatsink.
   b. Check that the part number of the new component is compatible with the old one.
   c. Smear a thin layer of heatsink compound on the base of the rectifier and secure it to the heatsink.
Figure 12-2.
125-400 HP Quantum II Unit
Figure 12-3.
Quantum II Unit with Hinged Cover Open
Figure 12-4.
125-400 HP Quantum II Unit
### 13 DRIVE PARAMETERS - QUICK REFERENCE GUIDE

<table>
<thead>
<tr>
<th>NO.</th>
<th>KEY</th>
<th>STARTUP SETTING</th>
<th>FUNCTION</th>
<th>FACTORY DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Real, read-only parameters:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#01</td>
<td></td>
<td>Analog speed reference (Main)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#02</td>
<td></td>
<td>Speed reference (After Ramp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#03</td>
<td></td>
<td>Speed feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#04</td>
<td></td>
<td>Speed error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#05</td>
<td></td>
<td>Speed error integral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#06</td>
<td></td>
<td>Analog input ref. (Bi-polar Term. 6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#07</td>
<td></td>
<td>Current reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#08</td>
<td></td>
<td>Current feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#09</td>
<td></td>
<td>Firing angle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#10</td>
<td></td>
<td>Analog input (Term. 7) uni-polar(^n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#11</td>
<td></td>
<td>Analog input (Term. 8) uni-polar(^n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#12</td>
<td></td>
<td>Analog speed error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#13</td>
<td></td>
<td>Speed reference (pre-ramp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#14</td>
<td></td>
<td>Sync. staircase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#15</td>
<td></td>
<td>Torque control variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#16</td>
<td></td>
<td>Speed loop variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#17</td>
<td></td>
<td>IR compensation term</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#18</td>
<td></td>
<td>Measured acceleration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#19</td>
<td></td>
<td>Overload integration register-1 x t</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Real, read/write parameters:</strong></td>
<td>#20</td>
<td>0</td>
<td>Security code (user assigned)</td>
<td>000</td>
</tr>
<tr>
<td></td>
<td>#21</td>
<td>1</td>
<td>Preset speed 1 (inch/jog)</td>
<td>5% +050</td>
</tr>
<tr>
<td></td>
<td>#22</td>
<td>1</td>
<td>Preset speed 2 (run/digital) (thread)</td>
<td>30% +300</td>
</tr>
<tr>
<td></td>
<td>#23</td>
<td>2</td>
<td>Analog reference offset</td>
<td>000</td>
</tr>
<tr>
<td></td>
<td>#24</td>
<td>1</td>
<td>Max speed</td>
<td>100% +999</td>
</tr>
<tr>
<td></td>
<td>#25</td>
<td>1</td>
<td>Min speed</td>
<td>000-1Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0% -999-4Q</td>
</tr>
<tr>
<td></td>
<td>#26</td>
<td>2</td>
<td>Speed level 1 comparator setting</td>
<td>100% +999</td>
</tr>
<tr>
<td></td>
<td>#27</td>
<td>2</td>
<td>Speed level 2 comparator setting</td>
<td>100% +999</td>
</tr>
<tr>
<td></td>
<td>#28</td>
<td>2</td>
<td>Preset torque reference</td>
<td>000</td>
</tr>
<tr>
<td></td>
<td>#29</td>
<td>2</td>
<td>Hard speed reference</td>
<td>(#69)</td>
</tr>
<tr>
<td></td>
<td>#30</td>
<td>2</td>
<td>Current taper start point</td>
<td>+999</td>
</tr>
<tr>
<td></td>
<td>#31</td>
<td>1</td>
<td>Bridge 1 current limit setting</td>
<td>150% = +999</td>
</tr>
<tr>
<td></td>
<td>#32</td>
<td>1</td>
<td>Bridge 2 current limit setting</td>
<td>000-1Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150% = +999-4Q</td>
</tr>
<tr>
<td></td>
<td>#33</td>
<td>2</td>
<td>Integrating overload threshold-1 x t</td>
<td>105% = +700</td>
</tr>
<tr>
<td></td>
<td>#34-#49</td>
<td></td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>

\(^n\)With MD-21 only
### Drive Parameters - Quick Reference Guide

<table>
<thead>
<tr>
<th>No.</th>
<th>Key</th>
<th>Startup Setting</th>
<th>Function</th>
<th>Factory Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integer read/write parameters:</td>
<td></td>
<td></td>
<td>Fault code</td>
<td>000</td>
</tr>
<tr>
<td>#50</td>
<td>-</td>
<td></td>
<td>Acceleration forward ramp time</td>
<td>5 sec 050</td>
</tr>
<tr>
<td>#51</td>
<td>1</td>
<td></td>
<td>Deceleration forward ramp time</td>
<td>5 sec 050</td>
</tr>
<tr>
<td>#52</td>
<td>1</td>
<td></td>
<td>Deceleration reverse ramp time</td>
<td>000-1Q</td>
</tr>
<tr>
<td>#54</td>
<td>1</td>
<td></td>
<td>Acceleration reverse ramp time</td>
<td>000-1Q</td>
</tr>
<tr>
<td>#55</td>
<td>1</td>
<td></td>
<td>Speed loop proportional gain</td>
<td>015 or 080</td>
</tr>
<tr>
<td>#56</td>
<td>1</td>
<td></td>
<td>Speed loop integral gain</td>
<td>005 or 040</td>
</tr>
<tr>
<td>#57</td>
<td>2</td>
<td></td>
<td>Analog reference scale</td>
<td>000</td>
</tr>
<tr>
<td>#58</td>
<td>1</td>
<td></td>
<td>IR compensation amount</td>
<td>000</td>
</tr>
<tr>
<td>#59</td>
<td>2</td>
<td></td>
<td>Current taper 1 slope</td>
<td>000</td>
</tr>
<tr>
<td>#60</td>
<td>2</td>
<td></td>
<td>Current taper 2 slope</td>
<td>000</td>
</tr>
<tr>
<td>#61</td>
<td>2</td>
<td></td>
<td>Current slew rate limit</td>
<td>040</td>
</tr>
<tr>
<td>#62</td>
<td>1</td>
<td></td>
<td>Current loop gain</td>
<td>050</td>
</tr>
<tr>
<td>#63</td>
<td>2</td>
<td></td>
<td>Integrating overload time-1 x 1</td>
<td>30 sec 030</td>
</tr>
<tr>
<td>#64</td>
<td>2</td>
<td></td>
<td>Digital filter response</td>
<td>128</td>
</tr>
<tr>
<td>#65</td>
<td>2</td>
<td></td>
<td>Programmable Analog output function</td>
<td>spd ref 002</td>
</tr>
<tr>
<td>#66</td>
<td>1</td>
<td></td>
<td>Speed offset fine (speed trim)</td>
<td>128</td>
</tr>
<tr>
<td>#67</td>
<td>2</td>
<td></td>
<td>Programmable input function 0</td>
<td>187</td>
</tr>
<tr>
<td>#68</td>
<td>2</td>
<td></td>
<td>Programmable input function 1</td>
<td>168</td>
</tr>
<tr>
<td>#69</td>
<td>2</td>
<td></td>
<td>Programmable analog input function</td>
<td>029</td>
</tr>
<tr>
<td>#70</td>
<td>2</td>
<td></td>
<td>Serial network address</td>
<td>001</td>
</tr>
<tr>
<td>#71</td>
<td>2</td>
<td></td>
<td>Current drive number (BASIC comm=1)</td>
<td>001</td>
</tr>
<tr>
<td>#72</td>
<td>2</td>
<td></td>
<td>Line pacing character</td>
<td></td>
</tr>
<tr>
<td>#73-#89</td>
<td></td>
<td></td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>#90</td>
<td>1</td>
<td></td>
<td>Application control byte</td>
<td>001</td>
</tr>
<tr>
<td>#91</td>
<td>2</td>
<td></td>
<td>Basic auto-boot program #</td>
<td>000</td>
</tr>
<tr>
<td>#92</td>
<td>2</td>
<td></td>
<td>Status output byte</td>
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<tr>
<td>#93</td>
<td>2</td>
<td></td>
<td>LED functions byte</td>
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</tr>
<tr>
<td>#94</td>
<td>2</td>
<td></td>
<td>Programmable output ST1 func.(pin #38)</td>
<td>110</td>
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<tr>
<td>#95</td>
<td>2</td>
<td></td>
<td>Programmable output ST2 func.(pin #39)</td>
<td>113</td>
</tr>
<tr>
<td>#96</td>
<td>-</td>
<td></td>
<td>Parameter Index #</td>
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</tr>
<tr>
<td>#97</td>
<td>1</td>
<td></td>
<td>Security level 2 key (factory code)</td>
<td>000</td>
</tr>
<tr>
<td>#98</td>
<td>-</td>
<td></td>
<td>Drive Processor 1 software revision</td>
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</tr>
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<td>#99</td>
<td>2</td>
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<td>Reserved</td>
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<tr>
<td><strong>Command bits:</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>#100</td>
<td></td>
<td></td>
<td>Software input 1 (pin #18)</td>
<td></td>
</tr>
<tr>
<td>#101</td>
<td></td>
<td></td>
<td>Software input 2 (pin #19)</td>
<td></td>
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<tr>
<td>#102</td>
<td></td>
<td></td>
<td>Inch reverse command</td>
<td></td>
</tr>
<tr>
<td>#103</td>
<td></td>
<td></td>
<td>Inch forward command</td>
<td></td>
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<tr>
<td>NO.</td>
<td>KEY</td>
<td>STARTUP SETTING</td>
<td>FUNCTION</td>
<td>FACTORY DEFAULT</td>
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<tr>
<td>-----</td>
<td>-----</td>
<td>----------------</td>
<td>----------</td>
<td>-----------------</td>
</tr>
<tr>
<td>#104</td>
<td></td>
<td></td>
<td>Run reverse command</td>
<td></td>
</tr>
<tr>
<td>#105</td>
<td></td>
<td></td>
<td>Run forward command</td>
<td></td>
</tr>
<tr>
<td>#106</td>
<td></td>
<td></td>
<td>Drive start permit</td>
<td></td>
</tr>
<tr>
<td>#107</td>
<td></td>
<td></td>
<td>Drive enable</td>
<td></td>
</tr>
</tbody>
</table>

**Normal status bits:**

| #108 |     |                | Forward motor velocity sensed |                |
| #109 |     |                | Reverse motor velocity sensed |                |
| #110 |     |                | In Current limit              |                |
| #111 |     |                | Bridge 1 on                  |                |
| #112 |     |                | Bridge 2 on                  |                |
| #113 |     |                | Electrical phase back        |                |
| #114 |     |                | At target speed              |                |
| #115 |     |                | Overspeed                    |                |

**Fault status bits/fault codes:**

| #116 |     |                | Drive healthy-no faults      |                |
| #117 |     |                | Alarm-I x I overload pending |                |
| #118 |     |                | Field Loss                   |                |
| #119 |     |                | Tach/feedback loss           |                |
| #120 |     |                | Phase loss                   |                |
| #121 |     |                | Instantaneous overcurrent trip |              |
| #122 |     |                | Sustained overload-I x I     |                |
| #123 |     |                | Overtemperature               |                |
| #124 |     |                | Watchdog timer               |                |
| (125) |     |                | Power supply fault code      |                |
| (126) |     |                | Armature open circuit fault code |            |
| #131 |     |                | MD21 Processor 2 watchdog    |                |
| (132) |     |                | EEPROM failure fault code    |                |

**Miscellaneous read-only status bits:**

<p>| #125 |     |                | Phase sequence               |                |
| #126 |     |                | Speed comparator level 1 exceeded |          |
| #127 |     |                | Speed comparator level 2 exceeded |          |
| #128 |     |                | Analog error window flag     |                |
| #129 |     |                | Speed amplifier saturation flag |                |
| #130 |     |                | Zero current limit flag      |                |
| #131 |     |                | MD21 Processor 2 watchdog    |                |
| #132-#149 |     |                | Reserved                     |                |</p>
<table>
<thead>
<tr>
<th>NO.</th>
<th>KEY</th>
<th>STARTUP SETTING</th>
<th>FUNCTION</th>
<th>FACTORY DEFAULT</th>
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<tr>
<td>Bit read/write parameters:</td>
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<td></td>
</tr>
<tr>
<td>#150</td>
<td>0</td>
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<td>NVRAM update (store)</td>
<td>0</td>
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<tr>
<td>#151</td>
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<td>Quadrant 1 enable</td>
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<td></td>
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<td></td>
<td>Quadrant 3 enable</td>
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<tr>
<td>#154</td>
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<td></td>
<td>Quadrant 4 enable</td>
<td>0-1Q, 1-4Q</td>
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<tr>
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<td>(analog) 0</td>
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<tr>
<td>#156</td>
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<td>#157</td>
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<td>Analog scale factor range</td>
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<td>#158</td>
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<td>Internal control select</td>
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<td>#159</td>
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<td>Torque control bit 0</td>
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<td>#160</td>
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<tr>
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<td>Run (not stop)</td>
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<tr>
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<td>0</td>
<td></td>
<td>Inch (not run)</td>
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</tr>
<tr>
<td>#165</td>
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<td></td>
<td>Reverse (not forward)</td>
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<td>Miscellaneous inhibit</td>
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<td>2</td>
<td></td>
<td>Ramp hold (suspend ramp)</td>
<td>(#68)</td>
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<tr>
<td>#169</td>
<td>2</td>
<td></td>
<td>Programmable status outputs</td>
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<td>#171</td>
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<td>Direct SCR firing angle control</td>
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<td>#172</td>
<td>2</td>
<td></td>
<td>Line feed enable</td>
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<td>#173</td>
<td>2</td>
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<td>Prompt enable</td>
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<td>#174</td>
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<td>Length of data frame</td>
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<tr>
<td>#175</td>
<td>2</td>
<td></td>
<td>Parity enable</td>
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<tr>
<td>#176</td>
<td>2</td>
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<td>Parity type - odd</td>
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<tr>
<td>#177</td>
<td>2</td>
<td></td>
<td>Enable XON/XOFF</td>
<td>0</td>
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<tr>
<td>#178</td>
<td>2</td>
<td></td>
<td>Baud rate bit 0</td>
<td>1</td>
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<tr>
<td>#179</td>
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<td></td>
<td>Baud rate bit 1</td>
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<tr>
<td>#180</td>
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<td>Baud rate bit 2</td>
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<tr>
<td>#181</td>
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<td></td>
<td>Checksum enable</td>
<td>0</td>
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<tr>
<td>#182</td>
<td>2</td>
<td></td>
<td>Adaptive control enable</td>
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</tr>
<tr>
<td>#183</td>
<td>2</td>
<td></td>
<td>High current loop integral gain</td>
<td>0-1Q, 1-4Q</td>
</tr>
<tr>
<td>#184</td>
<td>2</td>
<td></td>
<td>Fast current reversal</td>
<td>0-1Q, 1-4Q</td>
</tr>
<tr>
<td>#185</td>
<td>2</td>
<td></td>
<td>Disable normal LED functions</td>
<td>0</td>
</tr>
<tr>
<td>#186</td>
<td>2</td>
<td></td>
<td>Tach loss detection off</td>
<td>0</td>
</tr>
<tr>
<td>#187</td>
<td>2</td>
<td></td>
<td>Field loss detection off</td>
<td>(#67)</td>
</tr>
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</table>
## 13 DRIVE PARAMETERS - QUICK REFERENCE GUIDE

<table>
<thead>
<tr>
<th>NO.</th>
<th>KEY</th>
<th>STARTUP SETTING</th>
<th>FUNCTION</th>
<th>FACTORY DEFAULT</th>
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</thead>
<tbody>
<tr>
<td>#188</td>
<td>2</td>
<td></td>
<td>Overtemperature detection off</td>
<td>1</td>
</tr>
<tr>
<td>#189</td>
<td>2</td>
<td></td>
<td>Reference S switch</td>
<td>0</td>
</tr>
<tr>
<td>#190</td>
<td>2</td>
<td></td>
<td>Zero reference interlock</td>
<td>0</td>
</tr>
<tr>
<td>#191</td>
<td>2</td>
<td></td>
<td>Ramp x 10 select (1 = fast rate)</td>
<td>1</td>
</tr>
<tr>
<td>#192</td>
<td>2</td>
<td></td>
<td>Reference T switch</td>
<td>1</td>
</tr>
<tr>
<td>#193</td>
<td>2</td>
<td></td>
<td>Fine control select</td>
<td>0</td>
</tr>
<tr>
<td>#194-#197</td>
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<td>Reserved</td>
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**Fault Indication:**

<table>
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<tbody>
<tr>
<td>118</td>
<td>Field loss</td>
</tr>
<tr>
<td>119</td>
<td>Tachometer/Feedback loss</td>
</tr>
<tr>
<td>120</td>
<td>Phase loss</td>
</tr>
<tr>
<td>121</td>
<td>Overcurrent</td>
</tr>
<tr>
<td>122</td>
<td>Sustained overload—1 x t</td>
</tr>
<tr>
<td>123</td>
<td>Over temperature</td>
</tr>
<tr>
<td>124</td>
<td>Watchdog timer</td>
</tr>
<tr>
<td>125</td>
<td>Power supply fault</td>
</tr>
<tr>
<td>126</td>
<td>Armature open circuit</td>
</tr>
<tr>
<td>131</td>
<td>MD21 processor watchdog</td>
</tr>
<tr>
<td>132</td>
<td>NVRAM failure—EEPROM</td>
</tr>
</tbody>
</table>

**NOTES**

- #99=255   Software reset
- #97=149   Level 2 security
- #150=1 and reset=Parameter store

To reset all parameters back to factory defaults:
- Non-regen defaults #97=255
- Regen defaults #97=233
- Then depress reset
- Set #150 = 1
- Wait 3 seconds
- Depress reset

When re-assigning the programmable input functions (parameters #67, #68, and #69), the drive reset must be depressed before this re-assignment becomes effective.
Customer Jumper Programming Chart  
(filled out by customer)

<table>
<thead>
<tr>
<th>JUMPER PROGRAMMING</th>
<th>POSITION AT STARTUP</th>
<th>FACTORY SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>LK1</td>
<td></td>
<td>LF DC</td>
</tr>
<tr>
<td>LK2</td>
<td></td>
<td>ENC TACH</td>
</tr>
<tr>
<td>LK3</td>
<td></td>
<td>60-300V</td>
</tr>
<tr>
<td>LK4</td>
<td></td>
<td>40-200V</td>
</tr>
<tr>
<td>LK5</td>
<td></td>
<td>10-50V</td>
</tr>
<tr>
<td>LK6</td>
<td></td>
<td>VREF 4-20mA</td>
</tr>
<tr>
<td>LK7</td>
<td></td>
<td>TACH/ENC AVF</td>
</tr>
<tr>
<td>LK8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LK9</td>
<td></td>
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</tr>
<tr>
<td>LK10</td>
<td></td>
<td>VREF 4-20mA</td>
</tr>
<tr>
<td>LK11</td>
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<td>ISW 20+</td>
</tr>
</tbody>
</table>

Drive Model # 9500 -

Drive Serial #
The spare parts components described below are listed separately for each Quantum II model. These spare parts provide, for most customers, all the spare parts ever required.

**CAUTION**

With all Quantum II models, replace fuses only with the same current, voltage, and class rating as supplied with the original equipment. Failure to observe this precaution could cause equipment damage.

### 14.1 NON-REGENERATIVE 5-100HP MODELS (9500-8201(A) THROUGH 9500-8206(A))

<table>
<thead>
<tr>
<th>COMPONENT AND ASSOCIATED CONTROL</th>
<th>QUANTITY</th>
<th>DESIGNATION</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL PC BOARD</td>
<td></td>
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</tr>
<tr>
<td>All units</td>
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<td>MD100</td>
<td>9300-5100</td>
</tr>
<tr>
<td>INTERFACE PC BOARD</td>
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</tr>
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<td>9300-5200</td>
</tr>
<tr>
<td>POWER PC BOARD W/ MD10</td>
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<tr>
<td>9500-8201(A)</td>
<td>1</td>
<td>MD3</td>
<td>9300-5002</td>
</tr>
<tr>
<td>9500-8202(A)</td>
<td>1</td>
<td>MD3</td>
<td>9300-5002</td>
</tr>
<tr>
<td>9500-8203(A)</td>
<td>1</td>
<td>MD3</td>
<td>9300-5002</td>
</tr>
<tr>
<td>9500-8204(A)</td>
<td>1</td>
<td>MD3</td>
<td>9300-5003</td>
</tr>
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<td>9500-8205(A)</td>
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<td>MD3</td>
<td>9300-5003</td>
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<td>9500-8206(A)</td>
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<td>9300-5003</td>
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<td>RELAY LOGIC PC BOARD</td>
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<tr>
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<tr>
<td>LINE FUSES</td>
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</tr>
<tr>
<td>9500-8201(A)</td>
<td>3</td>
<td>1,2,3 FU</td>
<td>3701-503500</td>
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<td>9500-8202(A)</td>
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<td>3701-505500</td>
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<tr>
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<td>FIELD FUSES</td>
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<td>FS1,2,and 3</td>
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<td>FIELD BRIDGE RECTIFIER</td>
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## RECOMMENDED SPARE PARTS

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<tr>
<th>COMPONENT AND ASSOCIATED CONTROL</th>
<th>QUANTITY</th>
<th>DESIGNATION</th>
<th>PART NUMBER</th>
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<tbody>
<tr>
<td>OUTPUT CONTACTOR</td>
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<td>9500-4002</td>
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## 14 RECOMMENDED SPARE PARTS

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Figure A-4
Option Interconnect Diagram, Quantum II, Sheet 1 (9500-1103-I, Rev. D)
APPENDIX A: INTERCONNECT DIAGRAMS

SUGGESTED WIRING OF TERMINAL STRIP SUPPLIED WITH QUANTUM II ENCLOSURE/PANEL (OPTION 9500-9026/9027)

Figure A.7. Option Interconnect Diagram, Quantum II, Sheet 4 (9500-11034, Rev. D)
The following is a series of questions and answers on some
typical applications with the Quantum II Digital DC Drive.

**Question:**

1) What can be done if you need a dry relay contact for Zero Speed purposes?

Refer to the schematic of the AC Logic Interface for Quantum II number 9500-1000.

**Answer:**

There is a free relay called AM on the AC Interface Board which is not dedicated to any particular function. This relay is intended to be used for Auto/Manual reference selection. If it is not being used, you could simply connect a jumper wire from TB1 pin 10 of the AC Logic Board to TB1 pin 12. Then, when the Internal Zero Speed relay changes state, the dry contacts of AM (TB1 18 & 19) will follow this change.

2) What can be done if you need another dry relay (besides the MCB auxiliary) contact for "Drive in Run" purposes?

Refer to the schematic of the AC Logic Interface for Quantum II number 9500-1000.

**Answer:**

The dry contacts of MCB-A on TB1 13 & 14 are available from the auxiliaries off the drive DC contactor. Should another set of contacts be required one could invoke the use of the free relay called AM on the AC Interface Board which is not dedicated to any particular function. This relay is intended to be used for Auto/Manual reference selection. If it is not being used, you could simply connect a jumper wire from TB1 pin 7 of the AC Logic Board to TB1 pin 12. Therefore, when the RUN relay changes state, the dry contacts of AM (TB1 18 & 19) will indicate when the drive is actively running the motor.

3) What can be done if you need another dry relay contact for "Drive in Jog" purposes?

Refer to the schematic of the AC Logic Interface for Quantum II number 9500-1000.

**Answer:**

One could invoke the use of the free relay called AM on the AC Interface Board which is not dedicated to any particular function. This relay is intended to be used for Auto/Manual reference selection. If it is not being used, you could simply connect a jumper wire from TB1 pin 9 of the AC Logic Board to TB1 pin 12. Therefore, when the JOG relay changes state, the dry contacts of AM (TB1 18 & 19) will indicate when the drive is Jogging.

There are a number of application solutions that can be accomplished with the use of this free relay.

4) How can we get the jog accel/decel rate to be fast yet not affect the normal run accel/decel rate?

Refer to the block or flow diagram of the Quantum II drive and to the schematic of the AC Logic Interface for Quantum II number 9500-1000.

**Answer:**

Looking at the reference flow for the speed references both run and jog, that these references all go thru the same Accel/Decel ramp block. If you had an accel time of 30 seconds from 0 to full speed for normal running modes, the jog rate (even though jog is usually only about 10% speed), would be subjected to this long rate and accel & decel to/from this speed in 3 seconds. Jog is typically associated with a quick response usually with little or no accel/decel ramp times.

To accomplish this, one could invoke the alternate x10 accel rate bit, #191, within the Quantum II. One could use the free AM relay contacts to indicate when the drive is jogging (see Question #3 above) and connect it to one of the programmable inputs of the drive (pin 18 or 19 to common-pin 24).

For example, suppose we decided to use programmable logic input 0 to control this alternate or jog accel rate. We would connect TB1-16 of the AC Logic Board to pin 18 of the drive terminal block and TB1-19 to pin 24 of the drive. Referring to the definition of parameter #191, a logic 1 will cause the accel rate to be in tenths of seconds. Therefore, if we had a 30 second accel/decel rate for normal run functions, we would obtain a 0.3 second rate for jog (assuming jog is about 10% speed).

However, we must assign the logic input function for input 0 to the Ramp x 10 function. When we look at parameter #67 which directs the input to an internal function, we see that the factory default for #67 is set to 187 which is Field Loss Detection Enable/Disable. We can set #67=181 to let the input control the Ramp x 10 function after we enter the security code ie. #97=149. After setting the input function we must depress the yellow drive reset button to make the input assignment take effect. Check the state of parameter #187 since the input bit is no longer controlling this function. In this case, #187 should probably be set = 0 to allow the Field Loss Detection mechanism to sense field loss.

(Don’t forget to save your programming by setting #150=1)

5) How can the Auto/Manual relay be used to implement the Auto/Manual function?

Refer to the block or flow diagram of the Quantum II drive and to the schematic of the AC Logic Interface for Quantum II number 9500-1000.

**Answer:**

Auto/Manual is usually defined as a drive function that while in Manual uses a local manual speed pot for a reference source and in Auto uses an externally supplied reference from some system controller.

To implement this function, wire in an Auto/Manual selector switch between TB1-10 and 12 of the AC Interface Board. Then take the dry contact from the AM relay to control an internal drive function by connecting TB1-16 of the AC Logic Board to pin 18 of the drive terminal block and TB1-
APPLICATION EXAMPLES

19 to pin 24 of the drive. If we were to assign logic input 0 to bit parameter #155, we could switch between the normal analog input reference from pin 5 of the drive and the internal Run Reference register #22 from this external control input. Do this by setting parameter #67=156 (See step 4 for exact procedures).

Now if we wired a Manual speed pot to pin 6 of the drive and assigned the programmable analog input function #69 to register #22, we could select between this manual pot and the main analog input. (Don’t forget to depress reset after assigning input functions !)

We would label our Auto/Manual switch so that when the AM relay is ON, the Manual function would be active. Conversely, when the AM relay is OFF, the Auto function would be active. By using the main analog input reference on pin 5 for Auto mode, shouldn’t the reference from the Auto Mode controller have an offset, parameter #23 should be used to correct it. In addition, if the Auto Mode reference were only 7V for instance, gain could be applied by using #57 & #157.

Additional Note

If the Auto Mode controller had its own accel ramp control you may not want it to interfere with the drives internal accel/decel ramp. Yet you may want ramp control when in the Auto Mode. For this, you could invoke the fast ramp as in example 4 above when in the Auto Mode and the slow ramp in the Manual mode.

In this manner, you would be protected with a “safety net” ramp in case the process controller reference were to malfunction.

Question:

6) How can the MOP (Motor Operated Pot) function be implemented using the Quantum II?

Answer:

The Motor Operated Pot function is a relatively old scheme of providing an alternate method of speed reference control for a machine Operator which uses Increase and Decrease push buttons instead of the common “speed pot”. The MOP would use a small DC motor with a high gear ratio to turn a speed pot at a slow, usually fixed rate. The Increase/Decrease push buttons would apply opposite polarities to this motor. Limit switches would be included on the pot to prevent over-travel. The MOP would have reference memory. That is to say, if the power were removed from the system, the pot would still be in the same position when it was restored as it was when power was turned off. Some systems would “auto-zero” the MOP on power up if this function was not desired.

The Quantum II can be configured to obtain “MOP-like” speed control using Increase and Decrease push buttons without the need for an external gear motor and pot setup as described above. To accomplish this, there are two possible schemes. A short distance scheme and a long distance method is outlined below.

In either case, the Quantum II default I/O is already set-up to permit Increase/Decrease by virtue of the Ramp Hold function being set to programmable logic input function #1 (parameter #66-166). If we could apply full reference and remove the Ramp Hold we would “increase” toward full speed at the accel rate. When this function were released, we would simply “hold” at that reference point. If we were to apply a zero reference and remove the Ramp Hold, we would “decrease” toward zero speed at the decel rate.

Once again, if this function was released before reaching zero speed, we would go into Ramp Hold. In this manner, we would achieve the Motor Operated Potentiometer function or Increase/Decrease set speed by momentary push-button control.

One detail that comes into play however is normal ramp stopping. If we were running at some speed and depressed the stop button, the drive would not stop since the ramp is in “hold” whenever the increase or Decrease is not depressed. To remedy this we could utilize the Run/Stop bit #163 to take us out of Ramp Hold when we are no longer in the Run mode. This would require us to assign the programmable open collector output #1 by setting parameter #94=163.

Short Distance MOP Method

The short distance scheme is intended for application where the Increase/Decrease buttons are within 6-8 feet of wire to the Quantum II drive. This would be a possible scheme to be used on the front door of a Quantum II drive cabinet. One could simply use 2 push-button switches with 1 normally open contact and another separate normally closed contact set. An external resistor would be required to prevent the reference power supply from being shorted should someone depress both Increase and Decrease simultaneously. See Figure 1 below.

Good wiring practices must be used to minimize stray noise pickup on these incoming reference lines.

MOP EXAMPLE

Long Distance Scheme

A long distance scheme employs 2 external relays to do the reference and logic switching mentioned above. The relays must be kept close to the drive. Good wiring practices must be used to keep stray noise pick-up on these incoming reference lines. With the use of relays, the external resistor isn’t required since the relays can be interlocked to prevent simultaneous Increase and Decrease. See Figure 2 below for details.

Note 1: Whenever AC coils are used around solid-state drives they must be suppressed with an RC network. A resistor of 470ohms 1/2 watt in series with a 0.1uF capacitor rated at 600v is usually sufficient for most inductance type relays.

Note 2: The “MOP-like” operation achievable with the Quantum II has the intrinsic characteristic of returning to zero or always starting out from zero speed reference. This is often considered a preferred or safer characteristic. However, some MOP’s in industry simply power-up with the “motor operated pot” in its last position before power was removed. Thus it would have “memory” of the last speed setting. The method discussed with the Quantum II does not have this memory.
FIGURE 1. Local implementation of digital MOP function for Quantum II.

FIGURE 2. Remote implementation of digital MOP function for Quantum II.
APPLICATION EXAMPLES

Question:

7) The armature current image signal available on pin 10 of the Quantum II drive terminal block is unipolar. How can I display the armature current of my regen drive on my analog or digital meter with polarity?

Refer to the block or flow diagram of the Quantum II drive.

Answer:

The armature current image available on pin 10 of the drive is a true analog amplifier hanging off the current transformers measuring actual drive current. Unfortunately, its output is unipolar. However, for instrumentation purposes, one could assign the programmable analog output to monitor the drive current register #8. The programmable analog output (Pin 13 of drive) is Bi-Polar. This can be accomplished by setting parameter #65=8.

Question:

8) How many digital speed reference setpoint registers can be set with the Quantum II?

Refer to the block or flow diagram of the Quantum II drive.

Answer:

Up to three.

At first it appears that there is only 1 actual free digital setpoint register within the Quantum II. That being register #22. Register 22 would be switched in via register #155.

One could also use register #21 which is typically used as a jog speed. However, if jog was not required, then register 21 could be switched in with the jog selector input.

A third digital speed setpoint (or second, if a jog speed is still required) could be obtained by using the offset register #23. The internal reference selector bit register #155 would be set=0 for this setpoint to be effective.

In summary, up to 3 digital setpoints can be selected. By assigning a digital input to #155, register #22 or #23 can be selected and by selecting the jog function, a third digital speed can be selected.

Question:

9) How can one accomplish having a minimum speed in a forward direction and also in the reverse direction?

Refer to the block or flow diagram of the Quantum II drive.

Answer:

The Quantum II employs a simple reference clamp to provide max and min speed limits. However, as the speed limit symbol inverts, if we were to set the forward minimum speed limit above the horizontal axis, it represents the minimum value that the limiter would pass. If the polarity was to be inverted by a reverse command, all values would be rejected or blocked by the limiter. This says that for a uni-directional application (non-regen drive) both a max and min speed can be achieved.

However, for bi-directional applications (employing regen models) one can see that by inverting the reference, the limiter will provide a forward max speed and a reverse max speed but there would be no forward or reverse minimum speed available.

If this is a system requirement the MD-21 with a 4-Quadrant Min/Max Speed Program (BAN009) could be employed. This additional piece of equipment permits a FWD and REV min and max speed setting. The forward and reverse jog speeds are set by parameter #21 and are not affected by the min speed limits of this program. Contact the factory if this requirement is needed for additional information and pricing.
SAFETY WARNINGS:
Improper installation or operation of this control may cause serious injury to personnel or equipment. Before you begin installation or operation of this equipment you should thoroughly read this instruction manual and any supplementary operating instructions provided. The drive must be installed and grounded in accordance with NEC (National Electrical Codes) and local codes. To reduce potential of electric shock, disconnect all power sources before initiating any maintenance or repairs. Keep fingers and foreign objects away from ventilation and other openings. Keep air passages clear. Potentially lethal voltages exist within the control unit and connections. Use extreme caution during installation and start-up.

BRANCH CIRCUIT PROTECTION:
Branch circuit protection must be provided by the end user.

OVERLOAD PROTECTION:
Overload protection must be provided per the National Electrical Code Handbook article 430, Section C.

INSTALLATION LOCATION OF CONTROL:
Controls are suitable for most factory areas where industrial equipment is installed. The control and operator's control station should be installed in a well-ventilated area. Locations subject to steam vapors or excessive moisture, oil vapors, flammable or combustible vapors, chemical fumes, corrosive gases or liquids, excessive dirt, dust or lint should be avoided unless an appropriate enclosure has been supplied or a clean air supply is provided to the enclosure. The location should be dry and the ambient temperature should not exceed 131°F for chassis mount or 104°F for an enclosed unit. If the mounting location is subject to vibration, the enclosure should be shock mounted.

If the enclosure has a ventilating fan, avoid, wherever possible, an environment having a high foreign-matter content; otherwise, the filters will have to be changed more frequently. Should a control enclosure require cleaning on the inside, a low pressure vacuum cleaner is recommended. Compressed/high pressure air is not recommended for cleaning the control because of possible oil vapor or high pressure damage.

Please record the Part Number, Revision Level, and Serial Number below before installing the unit and use this information when communicating with the factory.

QUANTUM MODEL: ________________________
PART NUMBER (P/N): ____________________
REVISION LEVEL (REV.): __________________
SERIAL NUMBER (S/N): ____________________