HARDWARE REFERENCE MANUAL

QMAC

Boxed Turbo PMAC2-Lite

4xx-603506-xHxx

September 22, 2003

DELTA TAU
Data Systems, Inc.
NEW IDEAS IN MOTION ...

Copyright Information

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Delta Tau Data Systems, Inc. Technical Support
Phone: (818) 717-5656
Fax: (818) 998-7807
Email: support@deltatau.com
Website: http://www.deltatau.com

Operating Conditions

All Delta Tau Data Systems, Inc. motion controller products, accessories, and amplifiers contain static sensitive components that can be damaged by incorrect handling. When installing or handling Delta Tau Data Systems, Inc. products, avoid contact with highly insulated materials. Only qualified personnel should be allowed to handle this equipment.

In the case of industrial applications, we expect our products to be protected from hazardous or conductive materials and/or environments that could cause harm to the controller by damaging components or causing electrical shorts. When our products are used in an industrial environment, install them into an industrial electrical cabinet or industrial PC to protect them from excessive or corrosive moisture, abnormal ambient temperatures, and conductive materials. If Delta Tau Data Systems, Inc. products are exposed to hazardous or conductive materials and/or environments, we cannot guarantee their operation.

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INTRODUCTION

The QMAC is a boxed version of a Turbo PMAC2 Lite board, combining controller, breakout, and power supply in a single package. The QMAC is very cost-effective in basic applications of up to four axes.

All commonly used connections come out the front of the box. Those connectors intended for point-to-point wiring (e.g. encoders and amplifiers) are of the integrated D-shell type; those intended for more distributed wiring (e.g. flags and general-purpose I/O) are removable terminal blocks.

The QMAC can support all of the common amplifier interfaces: pulse-and-direction for traditional stepper and stepper-replacement servo drives, +/-10V analog for velocity and torque-mode drives, double analog for "sine-wave" drives, and direct PWM for "power-block" drives. It accepts digital quadrature feedback at up to a 40 MHz edge (count) rate. The two "supplemental" channels of a PMAC2 are also available standard, providing two additional two-channel encoders and two output sets, user configurable as either pulse and direction, or single-phase PWM top-and-bottom pairs.

The QMAC comes standard with eight optically isolated general-purpose digital sourcing outputs at 12 to 24 VDC levels and 16 optically isolated digital inputs (5-24V, sinking or sourcing by user wiring). Also, the JTHW multiplexer port is available on the front panel as a DB-25 connector for connection to external ACC-34-family I/O boards, permitting the control of thousands of I/O points. In addition, eight analog inputs with 12-bit digital conversion can optionally be added internally.

QMAC comes standard with an RS-232 interface, suitable for setting up a standalone application from a PC. In addition, options for USB or Ethernet communications are available.

Configuration

Base Version

The base version of a QMAC system provides an enclosure 100 mm wide by 250 mm high by 175 deep with:

- 80 MHz DSP56303 CPU (120 MHz PMAC equivalent)
- 128k x 24 SRAM compiled/assembled program memory (5C0)
- 128k x 24 SRAM user data memory (5C0)
- 1M x 8 flash memory for user backup & firmware (5C0)
- Latest released firmware version
- RS-232 serial interface with DB-9 connector
- 4 channels axis interface circuitry, each including:
  - 1 set of differential step-and-direction command outputs (suitable for controlling stepper drives). Must order Option-A for controlling analog amplifiers or Option-B for controlling digital PWM amplifiers.
  - 3-channel differential/single-ended encoder input
  - 4 input flags, 2 output flags
- DB-15 encoder\stepper connector; 5-pins flag terminal block
- Interface circuitry with DB-25 connector for 2 supplemental channels, each including:
  - 2-channel differential/single-ended encoder input
  - 1 output command set configurable as either pulse and direction or single PWM top-and-bottom pair.
- General-purpose isolated digital I/O: 8 outputs and 16 inputs on terminal blocks.
- Display, control panel, muxed I/O, direct I/O interface ports

- PID/notch/feedforward servo algorithms
- Extended "pole-placement" servo algorithms
- Internal AC-input power supply
- 1-year warranty from date of shipment

Note:

External cables or mating connectors are not included.

Option A: Analog Amplifier Interface for Channels 1 to 4

- Option-A provides the analog circuitry and connectors for each of the four QMAC channels. This option is necessary to control amplifiers that require a single ±10 Volts command signal or DAC.

Option A1: Second Analog Output for Channels 1 to 4

- Option-A1 provides a second ±10 Volts DAC output per each of the analog channels that are ordered through the Option-A. This option is necessary for those amplifiers that require two analog ±10 Volts DAC command signals or that require sinusoidal commutation. This Option requires Option-A.

Option B: Direct PWM for Channels 1 to 4

- Option-B provides the circuitry and connectors for digital amplifiers that require direct PWM digital command signals. Option-B could still be ordered if Option-A is ordered, which allows controlling both digital and analog amplifiers with the same QMAC system.

Option 2: High-Speed USB Communications Interface

- Option-2 provides the high-speed USB communications interface, which is a faster method of communication than the standard RS-232 QMAC communications port. The USB is the QMAC bus format much as the ISA is the bus format for the PMAC-PC board. This option is not compatible with OPT-2A.

Option 2A: High-Speed Ethernet Communications Interface

- Option-2A provides the high-speed Ethernet communications interface, which is a faster method of communication than the standard RS-232 QMAC communications port. This option is not compatible with OPT-2.

Option 2B: Dual-Ported RAM for USB or Ethernet Interface

- The dual-ported RAM provides a method of sharing memory between QMAC and the host computer for very fast interchange of data. This Option requires Option-2 or Option-2A.

Option 3: MACRO Interface

- Option 3A provides the MACRO ring interface with RJ-45 type connectors. This option allows QMAC to interface with any MACRO compatible device for servo axes or I/O expansion.
- Option 3B provides the MACRO ring interface with both fiber optics and RJ-45 type connectors. This option allows QMAC to interface with any MACRO compatible device for servo axes or I/O expansion.
- Option 3C provides the MACRO ring interface with fiber optics type connectors. This option allows QMAC to interface with any MACRO compatible device for servo axes or I/O expansion.

Option 5: CPU and Memory Configurations

The various versions of Option 5 provide different CPU speeds and main memory sizes on the piggyback CPU board. Only one Option 5xx may be selected for the board.

- Option 5C0 is the standard CPU and memory configuration. It is provided automatically if no Option 5xx is specified. It provides an 80 MHz CPU (120 MHz PMAC equivalent), 128k x24 of compiled/assembled program memory, 128k x 24 of user data memory; and a 1M x 8 flash memory.
- Option 5C3 provides an 80 MHz CPU with an expanded 512k x 24 of compiled/assembled program memory, an expanded 512k x 24 of user data memory, and a 4M x 8 flash memory.

Option 7: Field Bus Interface

Option 7 provides the Field Bus interface for the QMAC. If Option 7 is ordered one of the following options must be ordered as well: Option 7A1, Option 7A2, Option 7B1 or Option 7B2.

- Option 7A1 provides the DeviceNet Master interface for the QMAC.
- Option 7A2 provides the DeviceNet Slave interface for the QMAC.
- Option 7B1 provides the Profibus Master interface for the QMAC.
- Option 7B2 provides the Profibus Slave interface for the QMAC.

Option 8A: High-Accuracy Clock Crystal

- The QMAC system has a clock crystal of nominal frequency 19.6608 MHz (~20 MHz) and standard accuracy specification of +/-100 ppm. Option-8A provides a high-accuracy clock crystal of +/-15ppm and it is only required for accurate synchronization and velocity accuracy for long-term applications. Generally, this will only be noticeable if a continuous move sequence lasts more than 10 minutes.

Option 10: Firmware Version Specification

- Normally the QMAC is provided with the newest released firmware version. Option 10 allows pre-installing on a QMAC system a user-specified firmware version other than the latest released version. This is important in cases where the new QMAC is a replacement part in an already existing machine or a new machine using same existing programs is developed. When possible use the same firmware revision for similar machines.

Option 12: 8-channel On-Board 12-bit A/D Converter

- With this option, extra components are added in the QMAC system to provide 8 analog-to-digital converters with 12-bits resolution and 0-5 or ±2.5V range. Typically, this option is used for reading analog sensors but usually it is not used for implementing servo axes with analog feedback devices.

Option 16: Battery-Backed Parameter Memory

The contents of the standard memory are not retained through a power-down or reset unless they have been saved to flash memory first. Option 16 provides supplemental battery-backed RAM for real-time parameter storage that is ideal for holding machine state parameters, like part counters, in case of an unexpected power-down.

- Option 16A provides a 32k x 24 bank of battery-backed parameter RAM set of components.

Option 18: Identification Number & Real-Time Clock/Calendar Module

- Option 18A provides a module that contains an electronic identification number. The electronic identification number provides a unique code per QMAC system, allowing any external software to properly identify the QMAC system that it is interfacing with.

Option 34DD: Internal ACC-34DD board

- Option 34DD installs an Acc-34DD inside the QMAC system providing 32 TTL inputs and 32 TTL outputs on 50-pin IDC headers.

Connectors and Terminal Blocks

J1	DB-25 female connector, JHW port and EQU outputs
J2	DB-25 female connector, JTHW port
J3	DB-9 female connector, RS-232 communications port
J4	DB-15 female connector, JDISP display port
ENC1	DB-15 female connector, Channel 1 encoder/flag inputs or stepper outputs
ENC2	DB-15 female connector, Channel 2 encoder/flag inputs or stepper outputs
ENC3	DB-15 female connector, Channel 3 encoder/flag inputs or stepper outputs
ENC4	DB-15 female connector, Channel 4 encoder/flag inputs or stepper outputs
AMP1	DB-9 female connector, channel 1 analog amplifier connections
AMP2	DB-9 female connector, channel 2 analog amplifier connections
AMP3	DB-9 female connector, channel 3 analog amplifier connections
AMP4	DB-9 female connector, channel 4 analog amplifier connections
TB1	5-pin terminal block, Channel 1 flags
TB2	5-pin terminal block, Channel 2 flags
TB3	5-pin terminal block, Channel 3 flags
TB4	5-pin terminal block, Channel 4 flags
PWM1	36-pin Mini D connector, channel 1 digital amplifier connections
PWM2	36-pin Mini D connector, channel 2 digital amplifier connections
PWM3	36-pin Mini D connector, channel 3 digital amplifier connections
PWM4	36-pin Mini D connector, channel 4 digital amplifier connections
TB5	10-pin terminal block, analog inputs
TB6	10-pin terminal block, digital inputs 0 through 7
TB7	10-pin terminal block, digital inputs 8 through 15
TB8	10-pin terminal block, digital outputs 0 through 7
TB9	3-pin terminal block, +24V power supply connector
TB10	4-pin terminal block, +5V and ±15V power supply connector
TB11	3-pin terminal block, watchdog failure indicator relay

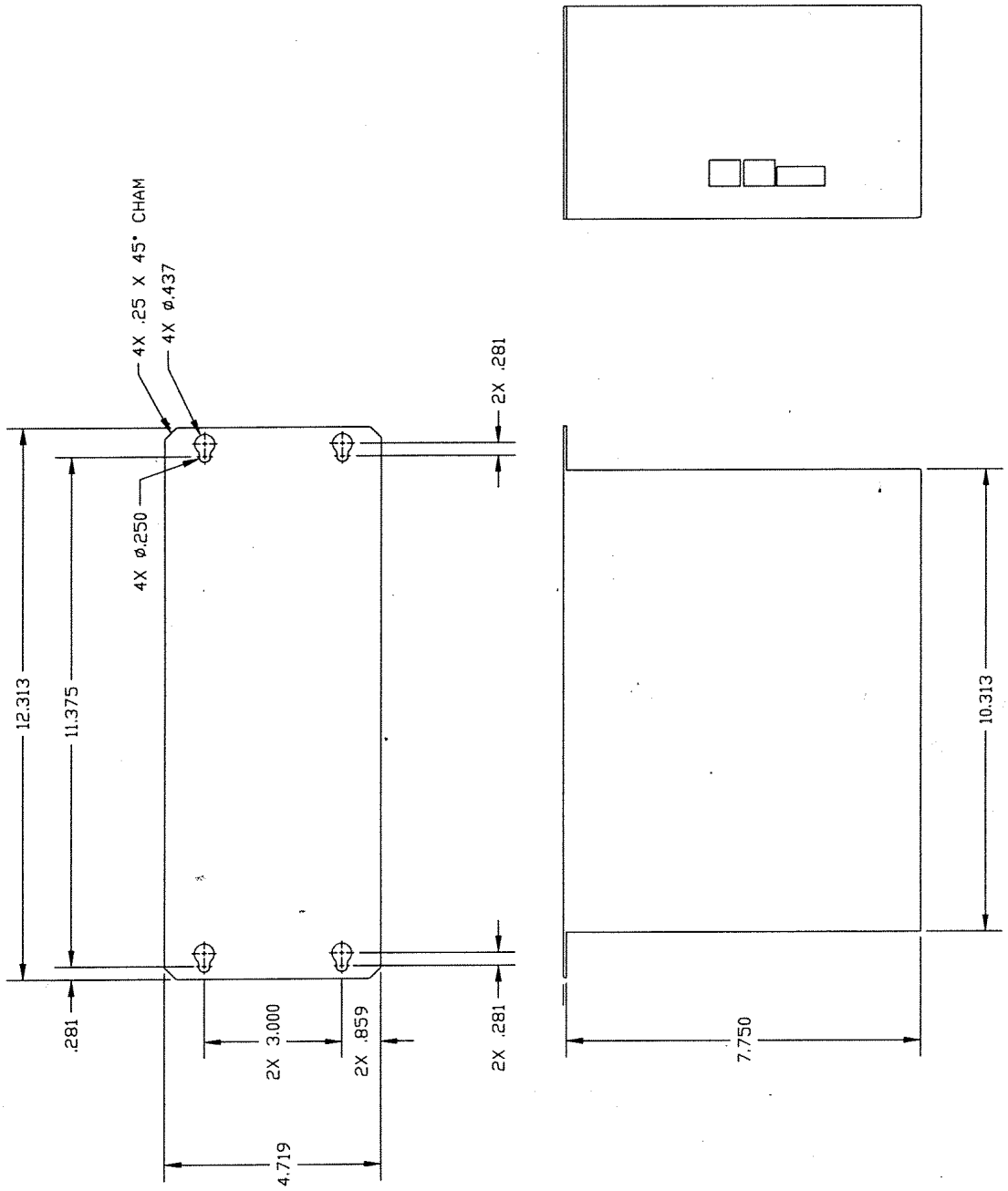
Indicators

LED1 (green):	Power good LED
LED2 (red):	Watchdog LED

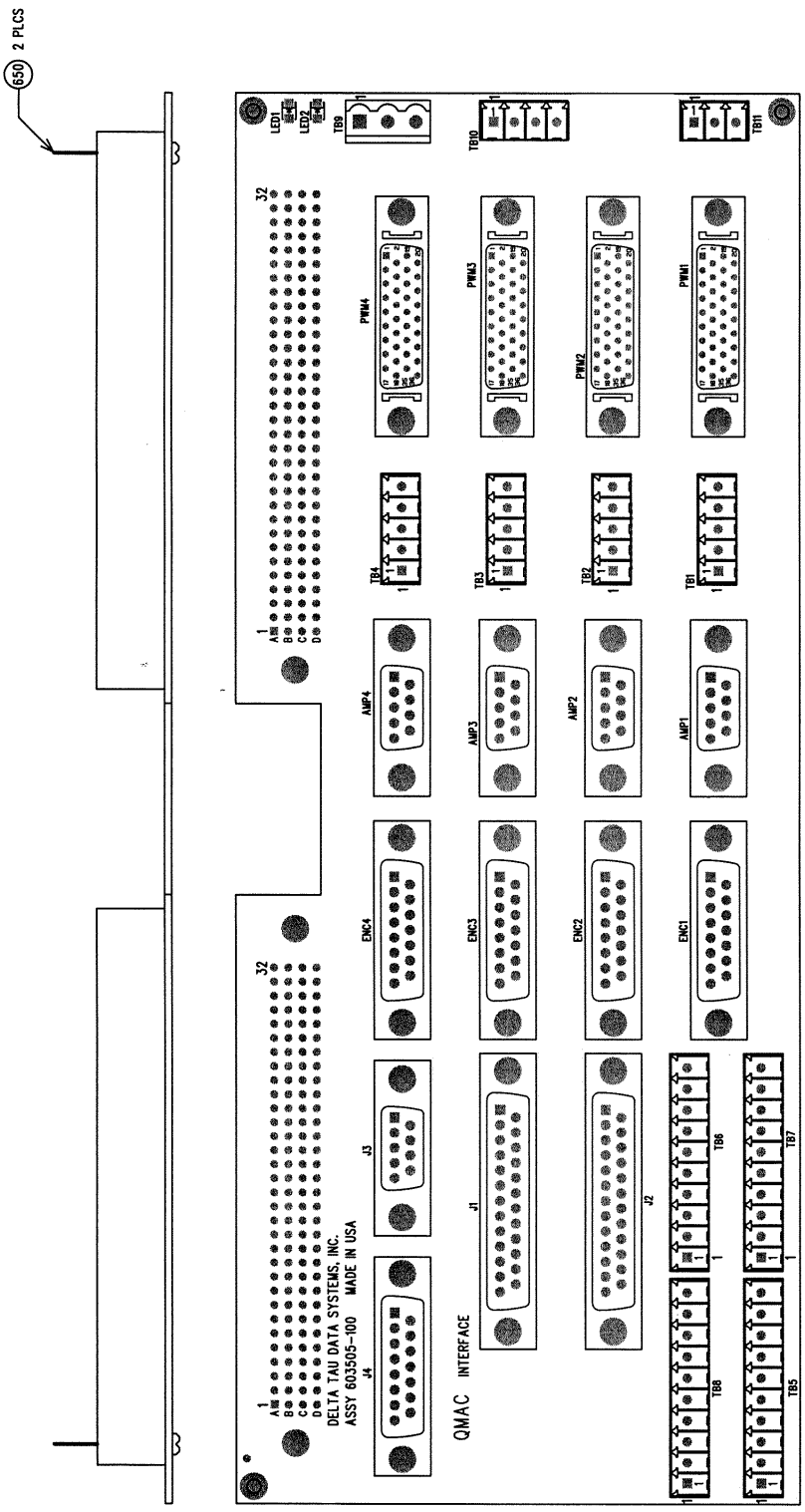
Front Panel Buttons

S1:	Re-initialize Button: Restores variables to factory defaults when pressed during power-up.
S2:	Init Button: Restores variables to the last saved configuration any time is pressed.

QMAC Dimensions



QMAC Connectors Layout Diagram: Part Number 603505-10x



RESISTOR PACK CONFIGURATION

Termination Resistors

The QMAC provides sockets for termination resistors on differential input pairs coming into it. As shipped, there are no resistor packs in these sockets. If these signals are brought long distances into the QMAC system and ringing at signal transitions is a problem, SIP resistor packs may be mounted in these sockets to reduce or eliminate the ringing.

All termination resistor packs are the type that has independent resistors (no common connection) with each resistor using two adjacent pins. The following table shows which packs are used to terminate each input device:

Input	Pack	Pack Size	Input	Pack	Pack Size
Encoder 1	RP56	6-pin	ADC 1 & 2	RP62	8-pin
Encoder 2	RP58	6-pin	ADC 3 & 4	RP73	8-pin
Encoder 3	RP67	6-pin	Fault 1 & 2	RP63	6-pin
Encoder 4	RP69	6-pin	Fault 3 & 4	RP74	6-pin

Pull-Up/Pull-Down Resistors

The differential input signal pairs to the QMAC have user-configurable pull-up/pull-down resistor networks to permit the acceptance of either single-ended or differential signals in one setting, or the detection of lost differential signals in another setting.

The '+' inputs of each differential pair each have a hard-wired 1 kΩ pull-up resistor to +5V. This cannot be changed.

The '-' inputs of each differential pair each have a hard-wired 2.2 kΩ resistor to +5V; each also has another 2.2 kΩ resistor as part of a socketed resistor pack that can be configured as a pull-up resistor to +5V, or a pull-down resistor to GND.

If this socketed resistor is configured as a pull-down resistor (the default configuration), the combination of pull-up and pull-down resistors on this line acts as a voltage divider, holding the line at +2.5V in the absence of an external signal. This configuration is required for single-ended inputs using the '+' lines alone; it is desirable for unconnected inputs to prevent the pick-up of spurious noise; it is permissible for differential line-driver inputs.

If this socketed resistor is configured as a pull-up resistor (by reversing the SIP pack in the socket), the two parallel 2.2 kΩ resistors act as a single 1.1 kΩ pull-up resistor, holding the line at +5V in the absence of an external signal. This configuration is required if encoder-loss detection is desired; it is required if complementary open-collector drivers are used; it is permissible for differential line-driver inputs even without encoder loss detection.

If Pin 1 of the resistor pack, marked by a dot on the pack, matches Pin 1 of the socket, marked by a wide white line on the front side of the board, and a square solder pin on the back side of the board, then the pack is configured as a bank of pull-down resistors. If the pack is reversed in the socket, it is configured as a bank of pull-up resistors.

The following table lists the pull-up/pull-down resistor pack for each input device:

Device	Resistor Pack	Device	Resistor Pack
Encoder 1	RP55	Encoder 4	RP68
Encoder 2	RP57	ADC/Fault1&2	RP61
Encoder 3	RP66	ADC/Fault3&4	RP72

Flag and Digital Inputs Voltage Selection

The QMAC is provided with 8-pin sockets for SIP resistor packs for the input flag sets and the general-purpose digital inputs port. Each QMAC system is shipped with no resistor packs installed. If the flag or digital inputs circuits are in the 12V to 24V range, no resistor pack should be installed in these sockets. For flags or digital inputs at 5V levels, quad 1kΩ SIP resistor packs (1KSIP8I) should be installed in these sockets. The following table lists the voltage selection resistor pack sockets for each input device:

Device	Resistor Pack	Device	Resistor Pack
Flags 1	RP78	IN0-3	RP58
Flags 2	RP82	IN4-7	RP62
Flags 3	RP86	IN8-11	RP66
Flags 4	RP90	IN12-15	RP70

JUMPERS SETUP SUMMARY

Front Connection Board Jumpers

T, U, V and W Flags Direction Jumpers

When jumpers E1 to E4 are installed, a set of pulse and direction signals can be output on the T, U, V and W lines of the ENC1, ENC2, ENC3 and ENC4 respective connectors. If E1 to E4 are removed then the T, U, V and W lines on the ENC1, ENC2, ENC3 and ENC4 respective connectors will be set as inputs, commonly used to read hall effects sensors or to use a sinusoidal encoder. Setting the T, U, V and W lines as pulse-and-direction outputs allow controlling a stepper motor or (not both) exciting an MLDT sensor device.

Stepper Amplifier Signals or Encoder Channel Inputs Selection Jumpers

When jumpers E11 to E14 are installed, a stepper driver enable signal is output on the C channel pin of the ENC1, ENC2, ENC3 and ENC4 respective connectors and a stepper driver fault signal is input on the B channel of the same connectors. If E11 to E14 are removed then both B and C channel encoder signals can be input on the ENC1, ENC2, ENC3 and ENC4 respective connectors.

Main Board Jumpers

None of the main board jumpers should be changed from the default configuration. The following description is for reference only.

Servo and Phase Clock Direction Control

Jumper E10 must be removed for QMAC to use its internally generated servo and phase clock signals (the default and typical setup). If this jumper is installed, QMAC will expect to receive external servo and phase clock signals. In this case, since there is no available connector to provide these external signals, the watchdog timer will immediately trip.

Watchdog Disable Jumper

Jump pin 1 to 2 of jumper E19 to disable Watchdog timer. This mode is for test purposes only. Remove E19 jumper to enable the Watchdog timer.

Power-Up/Reset Load Source

To read flash IC on power-up/reset, remove jumper E20, jump E21 pin 1 to 2 and jump E22 pin 2 to 3. Other combinations are for factory use only; the board will not operate in any other configuration

Firmware Load Jumper

If jumper E23 on the main board is ON during power-up/reset, the board comes up in bootstrap mode which permits the loading of new firmware into the flash-memory IC on the board. When the PMAC Executive program tries to establish communications with a board in this mode, it will detect that the board is in bootstrap mode automatically and ask what file to download as the new firmware.

Jumper E23 must be OFF during power-up/reset for the board to come up in normal operational mode.

FRONT CONNECTION BOARD JUMPER CONFIGURATION

T, U, V and W Flag Direction Jumpers

Jumper	Configuration	Description	Default
E1	1-2	No Jumper for TTL Level input for CH1 T, U, V and W flags Jumper 1-2 for PUL1+ and DIR1+ output in Stepper Mode	No jumper
E2	1-2	No Jumper for TTL Level input for CH2 T, U, V and W flags Jumper 1-2 for PUL2+ and DIR2+ output in Stepper Mode	No jumper
E3	1-2	No Jumper for TTL Level input for CH3 T, U, V and W flags Jumper 1-2 for PUL3+ and DIR3+ output in Stepper Mode	No jumper
E4	1-2	No Jumper for TTL Level input for CH4 T, U, V and W flags Jumper 1-2 for PUL4+ and DIR4+ output in Stepper Mode	No jumper

Stepper Amplifier-Enable or Encoder C Channel Direction Jumpers

Jumper	Configuration	Description	Default
E11	1-2	No Jumper for CH1 Encoder C and B Channel Inputs Jumper 1-2 for stepper driver enable and fault signals	No jumper
E12	1-2	No Jumper for CH2 Encoder C and B Channel Inputs Jumper 1-2 for stepper driver enable and fault signals	No jumper
E13	1-2	No Jumper for CH3 Encoder C and B Channel Inputs Jumper 1-2 for stepper driver enable and fault signals	No jumper
E14	1-2	No Jumper for CH4 Encoder C and B Channel Inputs Jumper 1-2 for stepper driver enable and fault signals	No jumper

MAIN BOARD JUMPER CONFIGURATION

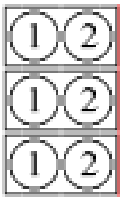
E10: Card 0 (Clock Direction) Select

E Point and Physical Layout	Location	Description	Default
E10 		Remove jumper to specify that this QMAC is Card 0, which generates its own phase and servo clock (default). The QMAC System will not operate if this jumper is installed.	No jumper installed

E19: Watchdog Disable Jumper

E Point and Physical Layout	Location	Description	Default
E19 		Jump pin 1 to 2 to disable Watchdog timer (for test purposes only). Remove jumper to enable Watchdog timer.	No jumper installed

E20 – E22: Power-Up/Reset Load Source

E Point and Physical Layout	Location	Description	Default
E20  **E22**		To read flash IC on power-up/reset: Remove jumper E20; Jump E21 pin 1 to 2; Jump E22 pin 2 to 3. Other combinations are for factory use only; the board will not operate in any other configuration	No E20 jumper installed; E21 jump pin 1 to 2; E22 jump pin 2 to 3

E23: Firmware Reload Enable

E Point and Physical Layout	Location	Description	Default
E23 		Jump pin 1 to 2 to reload firmware through serial or bus port. Remove jumper for normal operation.	No jumper installed

MACHINE CONNECTIONS

The QMAC is a boxed version of a Turbo PMAC2 Lite board, combining controller, breakout, and power supply in a single package. All commonly used connections come out the front of the box. Those connectors intended for point-to-point wiring (e.g. encoders and amplifiers) are of the integrated D-shell type; those intended for more distributed wiring (e.g. flags and general-purpose I/O) are removable terminal blocks.

Power Requirements

The QMAC is powered from a one-phase 50/60 Hz AC line in the 100V to 240V range taking a maximum current of 2.2 A. A standard computer type IEC/EIA male connector is present in the back panel and any regular computer type cord can be used for connections.

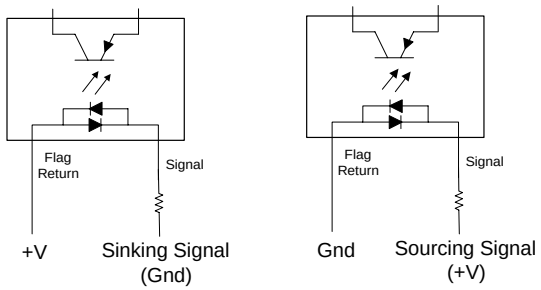
Over-travel Limits and Home switches

When assigned for the dedicated uses, these signals provide important safety and accuracy functions. PLIMn and MLIMn are direction-sensitive over-travel limits that must conduct current (either sinking or sourcing) to permit motion in that direction. If no over-travel switches will be connected to the particular motor this feature must be disabled in the software setup through the Turbo PMAC Ixx24 variable.

Types of Over-Travel Limits

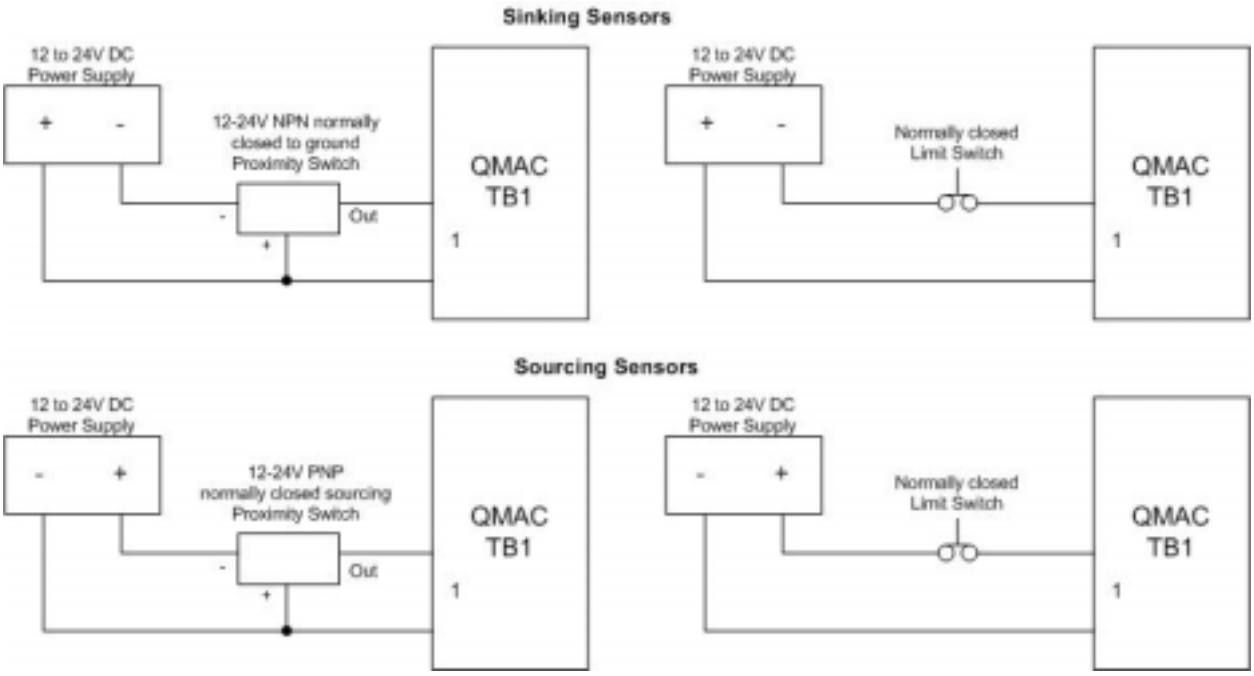
The QMAC has a bipolar opto-isolating circuitry (chip PS-2705-4NEC) for the flag connections. This conveniently allows using either a sinking or a sourcing sensor in the 5V or 12 to 24V range. This includes proximity sensors and dry (passive) normally closed contacts. If the use of 5V flags is desired, a 1kΩ SIP resistor pack (1KSIP8I) should be installed in the appropriate resistor socket according to the following table. In this case, the flags opto-isolation circuits will be powered with a 5V power supply instead.

Device	Resistor Pack	Device	Resistor Pack
Flags 1	RP78	Flags 3	RP86
Flags 2	RP82	Flags 4	RP90



QMAC Flag Inputs Circuit

Examples: These examples show the connection of the most common types of end-of-travel sensors. The power supply from the TB10 connector could be used instead of the optional power supply shown here.

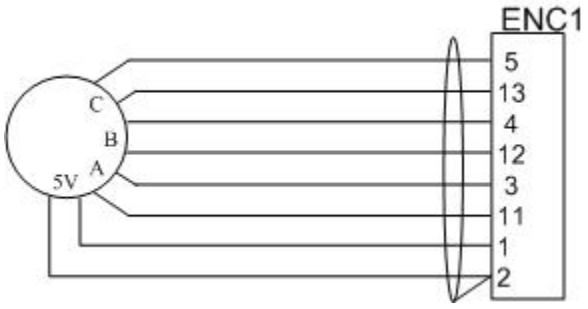


Feedback Signals Connections

Incremental Encoder Connection

Each encoder connector provides a +5V output and logic ground for powering the encoders. Connect the A and B (quadrature) encoder channels to the appropriate terminal block pins. If there is a single-ended signal, leave the complementary signal pins floating – do not ground them. QMAC is by default configured for connections of either single ended or differential line driver encoders. Resistor packs allows the configuration of the encoder inputs for other encoder types.

Example: differential quadrature encoder connected to channel #1 of QMAC:



In this configuration, jumper E11 is not installed, allowing to input the B and C channel encoder signals on the TB1 connector.

MLDT Feedback Connection

The QMAC can provide direct interface to magnetostrictive linear displacement transducers (MLDTs) through its encoder connectors. This interface is for MLDTs with an external excitation format (often called RS-422 format because of the signal levels), because the QMAC provides the excitation pulse, and receives the echo pulse, both with RS-422 signal formats. The PULSE+ (high during the pulse) and PULSE- (low during the pulse) outputs from the encoder connector are connected to the differential pulse inputs on the MLDT. The echo pulse differential outputs from the MLDT are connected to the CHA+ and CHA- input pins on the same encoder connector. If the MLDT uses RPM format, in which there is a brief "start" echo pulse, and a brief stop echo pulse, the "+" output from the MLDT should be connected to the CHA+ input, and the "-" output should be connected to the CHA- input. If the MLDT uses DPM format, in which there is a single long echo pulse, with the delay to the trailing edge measuring the position, the "+" output from the MLDT should be connected to the CHA- input, and the "-" output should be connected to the CHA+ input. A QMAC channel controlling a pulse and direction (stepper) driver or 3-phase PWM amplifier cannot use a MLDT feedback device. In this configuration the appropriate jumpers E1 to E4 for channel 1 through channel 4 respectively must be installed, allowing the output of the pulse and direction signals on the corresponding encoder connector.

Amplifier Connections

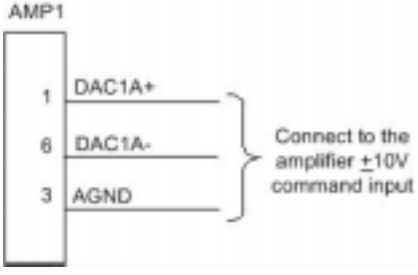
Analog ±10V Command Signals

Option-A or Option-A with Option-A1 must be ordered in order to control an analog amplifier that requires ±10V DAC signals. Option-A provides the circuitry and connectors for analog outputs with only one DAC per channel. Option-A and Option-A1 ordered together provide the circuitry and connectors for analog outputs with two DACs per channel.

If QMAC is not performing the commutation for the motor, only one analog output channel is required to command the motor. This output channel can be either single-ended or differential, depending on what the amplifier is expecting. For a single-ended command, connect DACnA+ to the command input on the amplifier. Connect the amplifier's command signal return line to the AGND line. In this setup, leave the DACnA- pin floating; do not ground it. For a differential command, connect DACnA+ to the plus command input on the amplifier. Connect DACnA- to the minus command input on the amplifier. The AGND line should still be connected to the amplifier common.

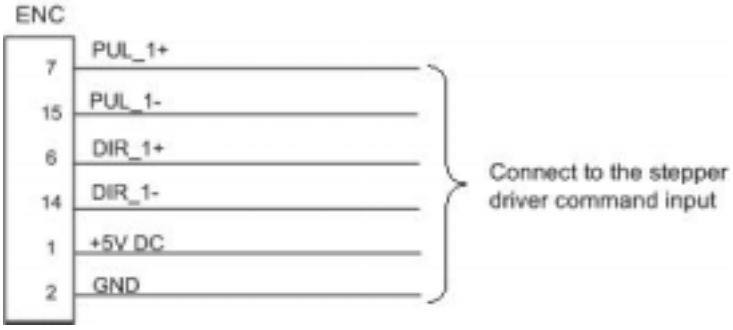
If using QMAC to commutate the motor, use the two analog outputs provided by the QMAC channel: DACnA+, DACnA-, DACnB+ and DACnB-. Each output may be single-ended or differential, just as for the DC motor. Connect DACnA+ and DACnB+ to the analog inputs of the amplifier. If using the complements as well, connect DACnA- and DACnB- to the minus command inputs; otherwise leave the complementary signal outputs floating. To limit the range of each signal to ± 5V, use parameter Ixx69. Any analog output not used for dedicated servo purposes may be utilized as a general-purpose analog output. In general, define the digital-to-analog-converter register through an M-variable (suggested M-variable definitions M102, M104, M202, M204 etc.), and then write values to the M-variable. The analog outputs are intended to drive high-impedance inputs with no significant current draw. QMAC cannot control an amplifier that is expecting separate sign and magnitude signals.

Example:



Pulse and Direction (Stepper) Drivers

Without ordering any options, the QMAC provides by default the pulse and direction outputs for controlling stepper motors or hybrid drives. The pulse and direction signals can be connected on the T, U, V, and W lines of the ENCn encoder connector. In this configuration, the appropriate jumpers E1 to E4 for channel 1 through channel 4 respectively must be installed, allowing the output of the pulse and direction signals on the corresponding encoder connector.



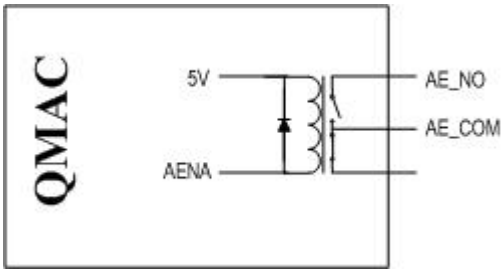
Digital Direct PWM Command Signals

Option B must be ordered in order to control a digital amplifier that requires direct PWM control signals.

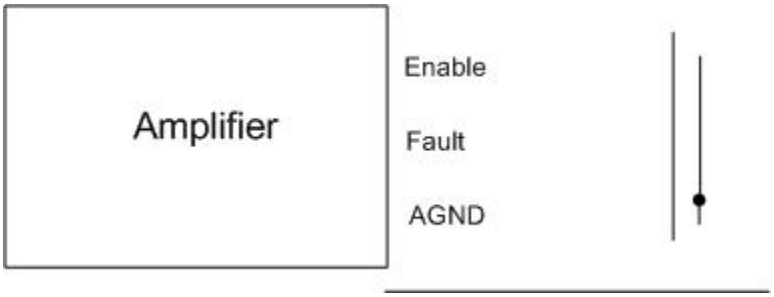
Most digital amplifiers have a standard 36-pin Mini-D connector. Typically, a connection from QMAC to these types of amplifiers is performed using a standard cable. This cable connects the necessary amplifier enable and fault signals.

Analog Amplifier Enable and Fault Signals

Most amplifiers have an enable/disable input that permits complete shutdown of the amplifier regardless of the voltage of the command signal. QMAC's AENA line is meant for this purpose. For early tests, this amplifier signal should be under manual control. The amplifier enable signal of the QMAC system is controlled by a relay with normal open and normal close dry contacts:



The following example shows the connection of a QMAC to an analog amplifier which in order to be enabled requires the enable line to be closed to ground. To indicate a fault condition the amplifier closes to ground the single ended amplifier fault line.

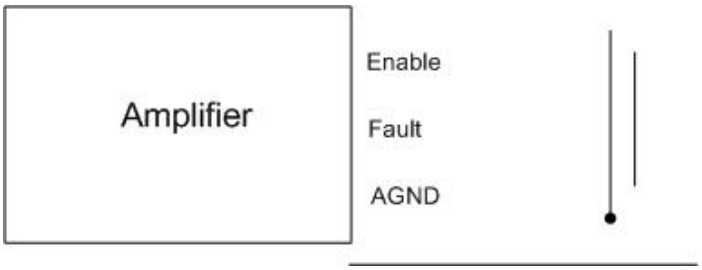


AMP1 DB-9S Connector	
Pin#	**Symbol**
4	AE_NO_1
8	AE_COM_1
9	AFAULT_1+
5	AFAULT_1-

TB10 4-pin Terminal Block	
3	+15V
1	GND

QMAC

The following example shows the connection of a QMAC to an amplifier which in order to be enabled requires the enable line to be closed to the voltage source. To indicate a fault condition the amplifier uses a single ended sourcing line.



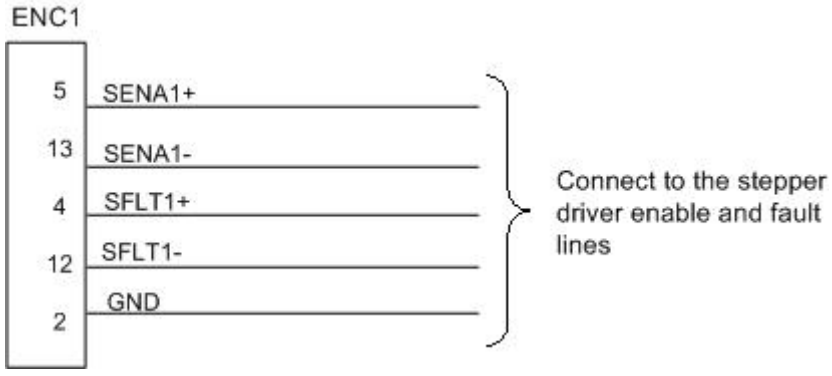
AMP1 DB-9S Connector	
Pin#	**Symbol**
4	AE_NO_1
8	AE_COM_1
9	AFAULT_1+
5	AFAULT_1-

TB10 4-pin Terminal Block	
3	+15V
1	GND

QMAC

Stepper Driver Enable Signal

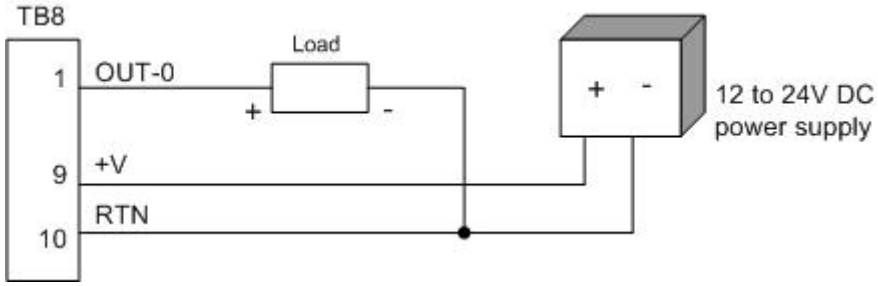
Jumpers E11 to E14 select between either a stepper driver enable output and fault input or a B and C channel encoder inputs on the ENC1, ENC2, ENC3 and ENC4 respective connectors. If E11 to E14 are installed then the stepper driver enable and fault signals and can be brought on the ENC1, ENC2, ENC3 and ENC4 respective connectors.



General-Purpose Digital Outputs (TB8 Terminal Block)

QMAC provides through the TB8 terminal block eight general-purpose sourcing digital outputs, each capable of 250 mA maximum current. An external power supply in the range of 12 to 24 VDC must be provided to power the output circuitry.

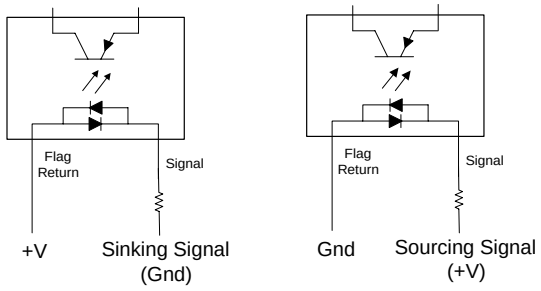
Example:



General-Purpose Digital Inputs (TB6 and TB7 Terminal Blocks)

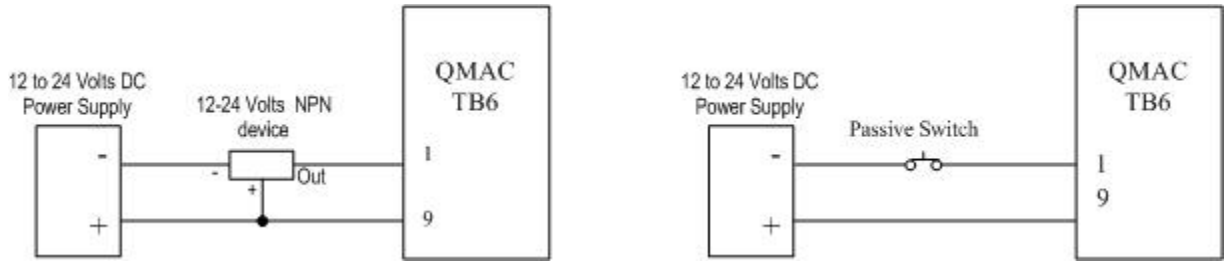
The QMAC has a bipolar opto-isolating circuitry (chip PS-2705-4NEC) for the digital inputs connections. This conveniently allows using either a sinking or sourcing devices in the 5V or 12 to 24V range. If the use of 5V devices is desired, a 1kΩ SIP resistor pack (1KSIP8I) should be installed in the appropriate resistor socket according to the following table. In this case, the inputs opto-isolation circuits will be powered with a 5V power supply instead.

Device	Resistor Pack	Device	Resistor Pack
IN0-3	RP58	IN8-11	RP66
IN4-7	RP62	IN12-15	RP70

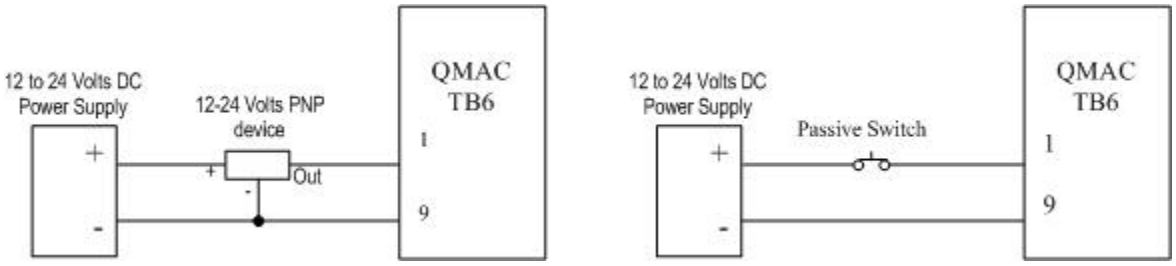


QMAC Digital Inputs Circuit

Sinking Devices Connection Examples:



Sourcing Devices Connection Examples:



Handwheel and EQU Outputs Port (J1 Port)

This port provides two differential 2-channel encoder inputs, quadrature or pulse-and-direction, and two differential output sets. The first set can be a PWM top-bottom pair or a PFM pulse-and-direction pair (software selectable); the second is a PWM top-bottom pair. The position compare outputs, which toggle at user-set positions of the respective encoder counts, are also brought out on this connector. The signals are buffered TTL levels with 100 mA maximum per output. A commercial breakout board or terminal block adapter can be used to access the signals on this DB-25S connector.

Thumbwheel Multiplexer Port (J2 Port)

The Thumbwheel Multiplexer Port, or Multiplexer Port, on the J2 connector has eight input lines and eight output lines. The output lines can be used to multiplex large numbers of inputs and outputs on the port, and Delta Tau provides accessory boards and software structures (special M-variable definitions) to capitalize on this feature. Up to 32 of the multiplexed I/O boards may be daisy-chained on the port, in any combination.

The Acc-18 Thumbwheel Multiplexer board provides up to 16 BCD thumbwheel digits or 64 discrete TTL inputs per board. The TWD and TWB forms of M-variables are used for this board. The Acc-34x family serial I/O Multiplexer boards provide 64 I/O point per board, optically isolated from QMAC. The TWS form of M-variables is used for these boards. The Acc-8D Option 7 Resolver-to-Digital Converter board provides up to four resolver channels whose absolute positions can be read through the thumbwheel port. The TWR form of M-variables is used for this board. The Acc-8D Option 9 Yaskawa™ Absolute Encoder Interface board can connect to up to four of these encoders. The absolute position is read serially through the multiplexer port on power up.

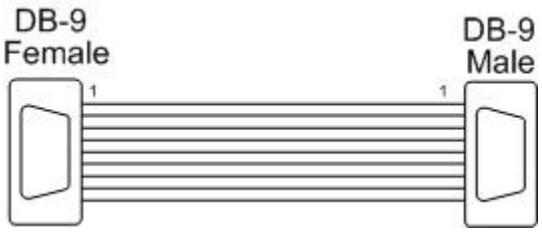
If none of these accessory boards is used, the inputs and outputs on this port may be used as discrete, non-multiplexed I/O. They map into QMAC's processor space at Y address $78402. The suggested M-variable definitions for this use are M40 to M47 for the eight outputs and M50 to M57 for the eight inputs. The Acc-27 Optically Isolated I/O board buffers the I/O in this non-multiplexed form, with each point rated to 24V and 100 mA. A flat cable made with a DB-25 connector in one side and an IDC-26 connector on the other side, with pin 1 aligned on both connectors, allows connecting this port to the appropriate Delta Tau accessories.

On-Board Analog to Digital Converters (TB5 Port)

The JANA port is present only if Option 12 is ordered for the QMAC. Option 12 provides eight 12-bit analog inputs (ANAI00-ANAI07). The analog inputs can be software-configured to be used as unipolar inputs in the 0V to +5V range, or bipolar inputs in the -2.5V to +2.5V range.

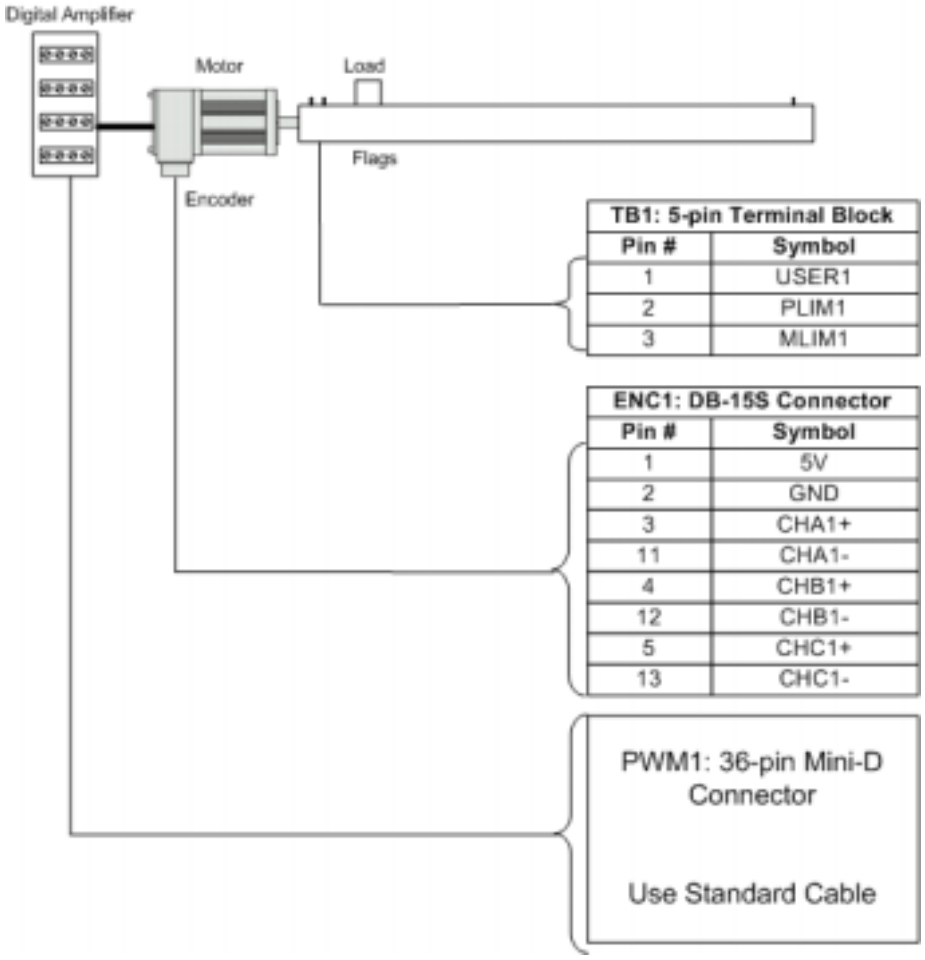
RS232 Serial Communications Port (J3 Port)

This port provides a serial interface for the QMAC system. Delta Tau provides the appropriate cable for this purpose. Standard DB-9-to-DB-25 or DB-25-to-DB-9 adapters may be needed for a particular setup. If a cable must be made, the easiest approach is to use a flat cable prepared with flat-cable type connectors as indicated in the following diagram:



QMAC (DB-9S)	PC (DB-9)
1 (No connect)	1 (No connect)
2 (TXD/)	2 (RXD)
3 (RXD/)	3 (TXD)
4 (DSR)	4 (DTR)
5 (Gnd)	5 (Gnd)
6 (DTR)	6 (DSR)
7 (CTS)	7 (RTS)
8 (RTS)	8 (CTS)
9 (No connect)	9 (No connect)

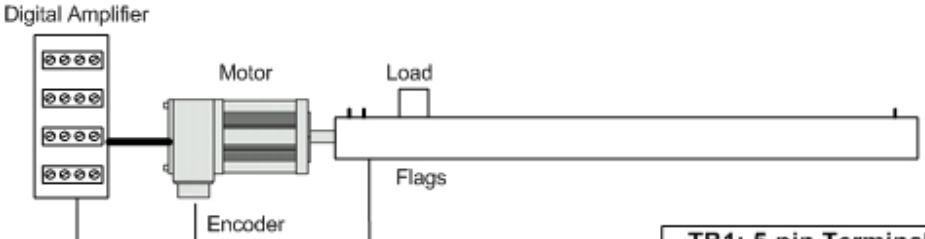
Connections Example: Digital Amplifier with Incremental Encoder



Note:

For this configuration, Option-B is required.

Connections Example: Analog Amplifier with Incremental Encoder



TB1: 5-pin Terminal Block	
Pin #	**Symbol**
1	USER1
2	PLIM1
3	MLIM1
4	HOME1
5	FL_RET1

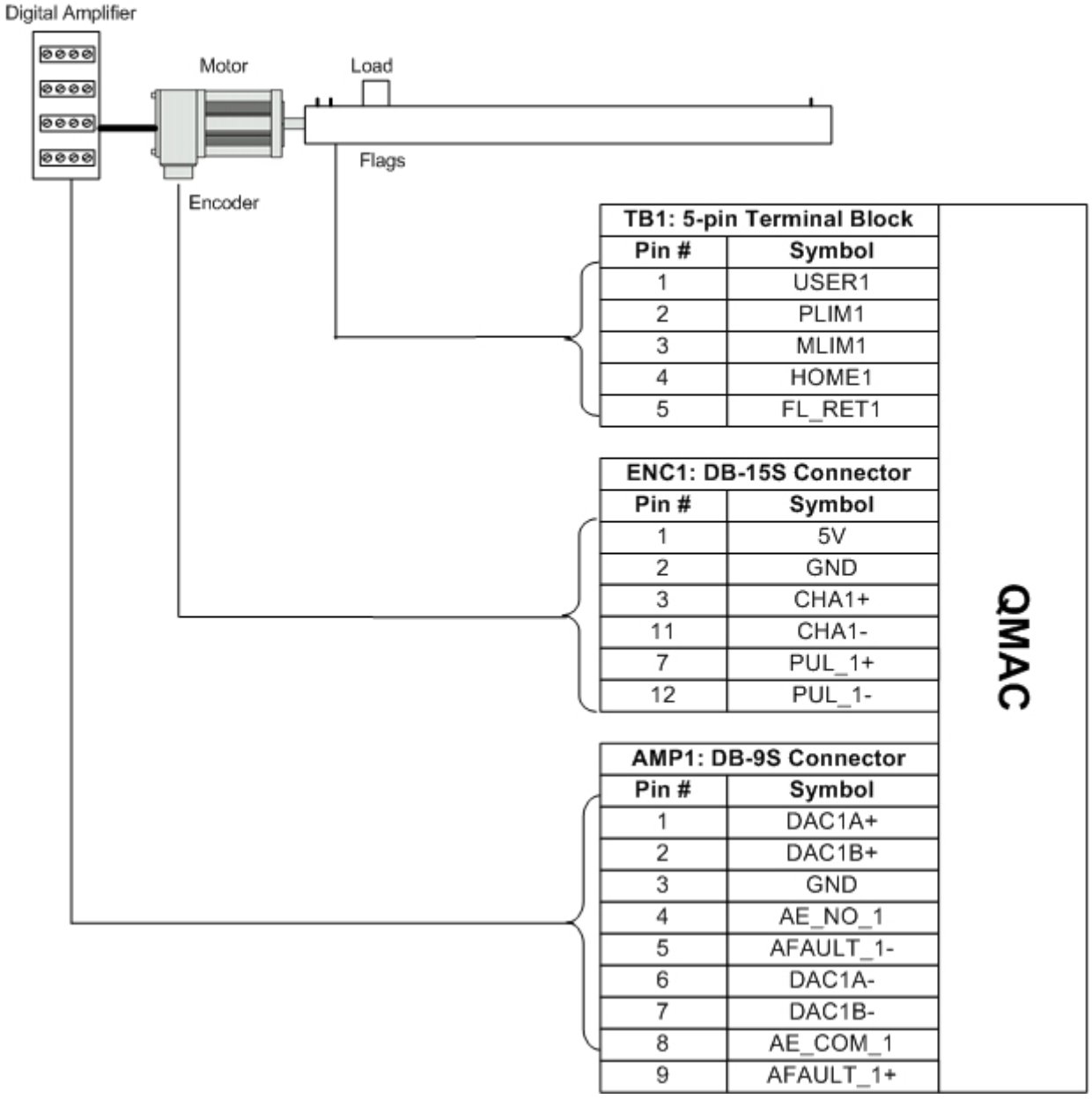
ENC1: DB-15S Connector	
Pin #	**Symbol**
1	5V
2	GND
3	CHA1+
11	CHA1-
4	CHB1+
12	CHB1-
5	CHC1+
13	CHC1-

AMP1: DB-9S Connector	
Pin #	**Symbol**
1	DAC1A+
2	DAC1B+
3	GND
4	AE_NO_1
5	AFAULT_1-
6	DAC1A-
7	DAC1B-
8	AE_COM_1
9	AFAULT_1+

Note:

For this configuration, Option-A or Option-A with Option-A1 is required.

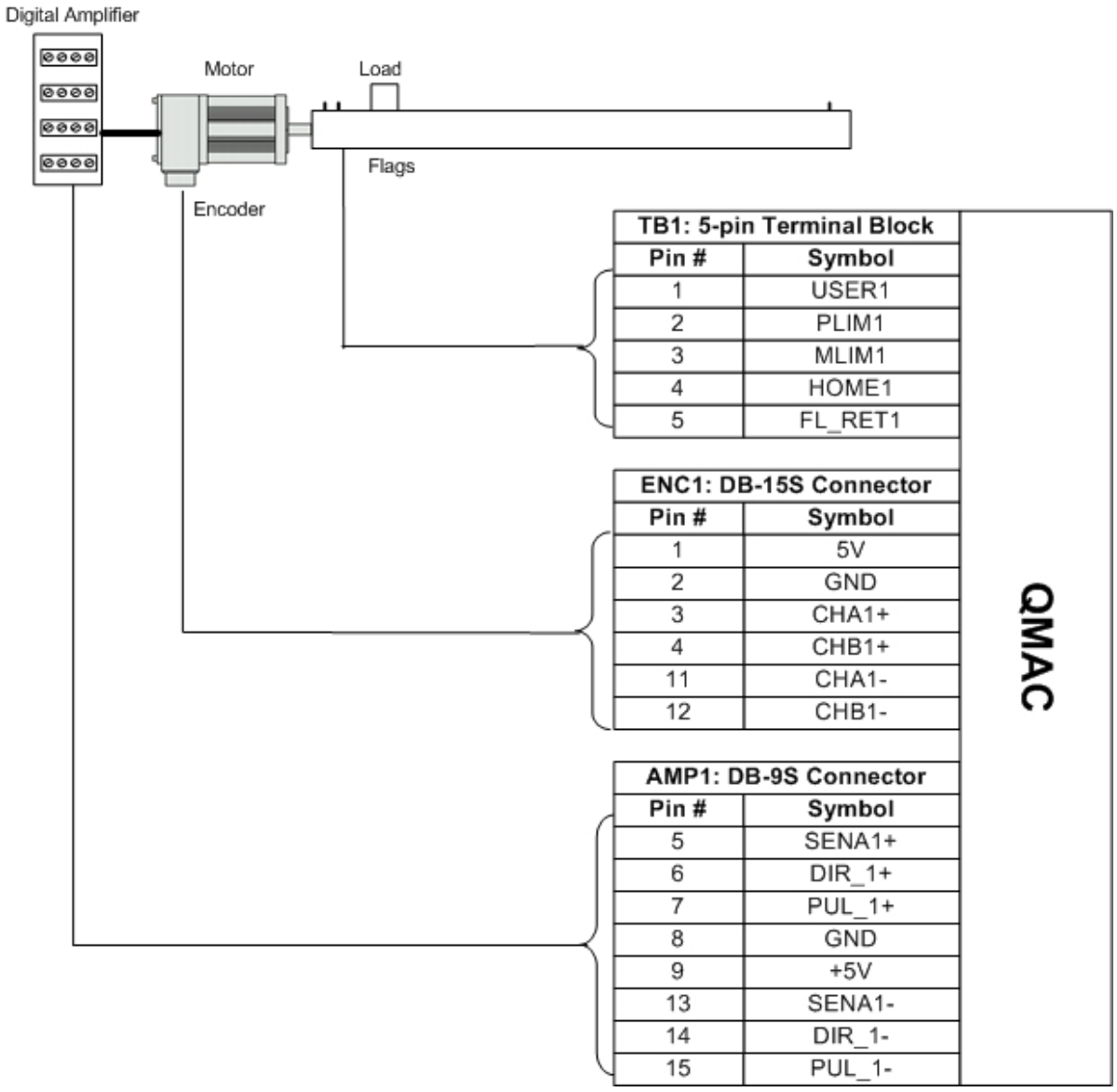
Connections Example: Analog Amplifier with MLDT Feedback



Note:

For this configuration, Option-A or Option-A with Option-A1 is required.

Connections Example: Stepper Driver with Incremental Encoder



Note:

When jumpers E11 to E14 are installed, a stepper driver enable and fault signals are brought on the ENC1, ENC2, ENC3 and ENC4 respective connectors. If E11 to E14 are removed then both B and C channel encoder signals can be input on the ENC1, ENC2, ENC3 and ENC4 respective connectors.

CONNECTOR DESCRIPTIONS

J1: DB-25S Connector, JHW Port and EQU Outputs

Pin#	Symbol	Function	Description
1	GND	Common	Common reference voltage
2	HWA1+	Input	HW Positive A Channel also pulse input
3	HWB1+	Input	HW Positive B Channel also direction input
4	HWA2+	Input	HW Positive A Channel also pulse input
5	HWB2+	Input	HW Positive B Channel also direction input
6	PUL1+	Output	PFM Positive pulse also PWM output
7	DIR1+	Output	PFM Positive dir. out also PWM output
8	PUL2+	Output	PFM Positive pulse also PWM output
9	DIR2+	Output	PFM Positive dir. out also PWM output
10	GND	Common	Common ref. voltage
11	BEQU1/	Output	Encoder 1 COMP-EQ low is True
12	BEQU3/	Output	Encoder 3 COMP-EQ low is True
13	N.C.	N.C.	No Connection
14	+5V	Power	Supply voltage to power external circuitry
15	HWA1-	Input	HW Negative A Channel also pulse input
16	HWB1-	Input	HW Negative B Channel also direction input
17	HWA2-	Input	HW Negative A Channel also pulse input
18	HWB2-	Input	HW Negative B Channel also direction input
19	PUL1-	Output	PFM Negative pulse also PWM output
20	DIR1-	Output	PFM Negative dir. out also PWM output
21	PUL2-	Output	PFM Pos pulse also PWM output
22	DIR2-	Output	PFM Negative dir. out also PWM output
23	+5V	Power	Supply voltage to power external circuitry
24	BEQU2/	Output	Encoder 2 COMP-EQ low is True
25	BEQU4/	Output	Encoder 4 COMP-EQ low is True

J2: DB-25S Connector, JTHW Multiplexer Port

Pin#	Symbol	Function	Description
1	GND	Common	Common Reference Voltage
2	DAT0	Input	Data-0 input. Data input from MUX port accessories
3	DAT1	Input	Data -1 input. Data input from MUX port accessories
4	DAT2	Input	Data -2 input. Data input from MUX port accessories
5	DAT3	Input	Data -3 input. Data input from MUX port accessories
6	DAT4	Input	Data -4 input. Data input from MUX port accessories
7	DAT5	Input	Data -5 input. Data input from MUX port accessories
8	DAT6	Input	Data -6 input. Data input from MUX port accessories
9	DAT7	Input	Data -7 input. Data input from MUX port accessories
10	N.C.	N.C.	No connection
11	BRLD/	Output	Buffer Request output. Low is Buffer Request
12	IPLD/	Output	In Position output. Low is In Position
13	+5V	Power	+5V output. +5VDC supply. Power supply out
14	GND	Common	QMAC common
15	SEL0	Output	Select-0 output. Address/data output for MUX port accessories
16	SEL1	Output	Select -1 output. Address/data output for MUX port accessories
17	SEL2	Output	Select -2 output. Address/data output for MUX port accessories
18	SEL3	Output	Select -3 output. Address/data output for MUX port accessories
19	SEL4	Output	Select -4 output. Address/data output for MUX port accessories
20	SEL5	Output	Select -5 output. Address/data output for MUX port accessories
21	SEL6	Output	Select -6 output. Address/data output for MUX port accessories
22	SEL7	Output	Select -7 output. Address/data output for MUX port accessories
23	GND	Common	QMAC common
24	GND	Common	QMAC common
25	GND	Common	QMAC common

J3: DB-9S Connector, RS-232 Communications Port

Pin#	Symbol	Function	Description
1	N.C.	N.C.	No connection
2	TXD/	Input	Receive Data. Host transmit data
3	RXD/	Output	Send Data. Host receive data
4	DSR	Bidirectional	Data Set Ready. Tied to DTR
5	GND	Common	QMAC common
6	DTR	Bidirectional	Data Terminal Ready. Tied to DSR
7	CTS	Input	Clear to Send. Host ready bit.
8	RTS	Output	Request to Send. QMAC ready bit
9	N.C.	N.C.	No Connection

J4: DB-15S Connector, JDISP Display Port

Pin#	Symbol	Function	Description
1	+5V	Output	+5V power. Power supply output
2	RS	Output	Read strobe TTL signal output
3	E	Output	Display Enable (High is Enable)
4	DB1	Output	Display Data1
5	DB3	Output	Display Data3
6	DB5	Output	Display Data5
7	DB7	Output	Display Data7
8	GND	Common	QMAC Common
9	GND	Common	QMAC Common
10	VEE	Output	Contrast Adjust.. VEE 0 to +5 VDC
11	R/W	Output	Read or Write TTL Signal Out
12	DB0	Output	Display Data0
13	DB2	Output	Display Data2
14	DB4	Output	Display Data4
15	DB6	Output	Display Data6

ENC1: DB-15S Connector, Channel 1 Encoder/Flag Inputs or Stepper Outputs

Pin#	Symbol	Function	Description
1	+5V	Power	+5V output. +5VDC supply. Power supply out
2	GND	Common	QMAC Common
3	CHA1+	Input	Channel CHA1+ quadrature encoder input
4	CHB1+ or SFLT1+	Input	Jumper E11 selects between CHB1+ or SFLT1+
5	CHC1+ or SENA1+	Input or Output	Jumper E11 selects between CHC1+ or SENA1+
6	U1+ or DIR_1+	Input or Output	Jumper E1 selects between input flag U1+ or direction output
7	W1+ or PUL_1+	Input or Output	Jumper E1 selects between input flag W1+ or pulse output
8	GND	Common	QMAC Common
9	+5V	Power	+5V output +5Vdc supply. Power supply out
10	GND	Common	QMAC Common
11	CHA1-	Input	Channel CHA1- quadrature encoder input
12	CHB1- or SFLT1-	Input	Jumper E11 selects between CHB1- or SFLT1-
13	CHC1- or SENA1-	Input	Jumper E11 selects between CHC1- or SENA1-
14	V1+ or DIR_1-	Input or Output	Jumper E1 selects between input flag V1+ or direction output
15	T1+ or PUL_1-	Input or Output	Jumper E1 selects between input flag T1+ or direction output

ENC2: DB-15S Connector, Channel 2 Encoder/Flag Inputs or Stepper Outputs

Pin#	Symbol	Function	Description
1	+5V	Power	+5V output. +5VDC supply. Power supply out
2	GND	Common	QMAC Common
3	CHA2+	Input	Channel CHA2+ quadrature encoder input
4	CHB2+ or SFLT2+	Input	Jumper E12 selects between CHB2+ or SFLT2+
5	CHC2+ or SENA2+	Input or Output	Jumper E12 selects between CHC2+ or SENA2+
6	U2+ or DIR_2+	Input or Output	Jumper E2 selects between input flag U2+ or direction output
7	W2+ or PUL_2+	Input or Output	Jumper E2 selects between input flag W2+ or pulse output
8	GND	Common	QMAC Common
9	+5V	Power	+5V output. +5VDC supply. Power supply out
10	GND	Common	QMAC Common
11	CHA2-	Input	Channel CHA2- quadrature encoder input
12	CHB2- or SFLT2-	Input	Jumper E12 selects between CHB2- or SFLT2-
13	CHC2- or SENA2-	Input or Output	Jumper E12 selects between CHC2- or SENA2-
14	V2+ or DIR_2-	Input or Output	Jumper E2 selects between input flag V2+ or direction output
15	T2+ or PUL_2-	Input or Output	Jumper E2 selects between input flag T2+ or direction output

ENC3: DB-15S Connector, Channel 3 Encoder/Flag Inputs or Stepper Outputs

Pin#	Symbol	Function	Description
1	+5V	Power	+5V Output. +5VDC Supply. Power Supply Out
2	GND	Common	QMAC Common
3	CHA3+	Input	Channel CHA3+ quadrature encoder input
4	CHB3+ or SFLT3+	Input	Jumper E13 selects between CHB3+ or SFLT3+
5	CHC3+ or SENA3+	Input or output	Jumper E13 selects between CHC3+ or SENA3+
6	U3+ or DIR_3+	Input or output	Jumper E3 selects between input flag U3+ or direction output
7	W3+ or PUL_3+	Input or output	Jumper E3 selects between input flag W3+ or pulse output
8	GND	Common	QMAC Common
9	+5V	Power	+5V Output. +5VDC Supply. Power Supply Out
10	GND	Common	QMAC Common
11	CHA3-	Input	Channel CHA3- quadrature encoder input
12	CHB3- or SFLT3-	Input	Jumper E13 selects between CHC3- or SFLT3-
13	CHC3- or SENA3-	Input or output	Jumper E13 selects between CHC3- or SENA3-
14	V3+ or DIR_3-	Input or output	Jumper E3 selects between input flag V3+ or direction output
15	T3+ or PUL_3-	Input or output	Jumper E3 selects between input flag T3+ or direction output

ENC4: DB-15S Connector, Channel 1 Encoder/Flag Inputs or Stepper Outputs

Pin#	Symbol	Function	Description
1	+5V	Power	+5V Output +5VDC Supply. Power Supply Out
2	GND	Common	QMAC Common
3	CHA4+	Input	Channel A4+ quadrature encoder input
4	CHB4+ or SFLT4+	Input	Jumper E14 selects between CHB4+ or SFLT4+
5	CHC4+ or SENA4+	Input or Output	Jumper E14 selects between CHC4+ or SENA4+
6	U4+ or DIR_4+	Input or Output	Jumper E4 selects between input flag U4+ or direction output
7	W4+ or PUL_4+	Input or Output	Jumper E4 selects between input flag W4+ or pulse output
8	GND	Common	QMAC Common
9	+5V	Power	+5V Output +5VDC Supply. Power Supply Out
10	GND	Common	QMAC Common
11	CHA4-	Input	Channel A4- quadrature encoder input
12	CHB4- or SFLT4-	Input	Jumper E14 selects between CHB4- or SFLT4-
13	CHC4- or SENA4-	Input or Output	Jumper E14 selects between CHC4- or SENA4-
14	V4+ or DIR_4-	Input or Output	Jumper E4 selects between input flag V4+ or direction output
15	T4+ or PUL_4-	Input or Output	Jumper E4 selects between input flag T4+ or direction output

AMP1: DB-9S Connector, Channel 1 Analog Amplifier Connections

Pin#	Symbol	Function	Description	Notes
1	DAC1A+	Output	Phase A Analog Out	+/-10V, ref to GND
2	DAC1B+	Output	Phase B Analog Out	+/-10V, ref to GND
3	GND	Common	Reference Voltage	Amplifier Common Ground
4	AE_NO_1	Output	Amplifier Enable Relay	Normally Open contact
5	AFAULT_1-	Input	Amplifier Fault Line	Differential line with Pin #9
6	DAC1A-	Output	Phase A Analog Out	-/+10V; ref to GND
7	DAC1B-	Output	Phase B Analog Out	-/+10V; ref to GND
8	AE_COM_1	Output	Amplifier Enable Relay	Common for pin 4
9	AFAULT_1+	Input	Amplifier Fault Line	Differential line with Pin #5
Note: In order to use this connector the Option-A must be ordered.				

AMP2: DB-9S Connector, Channel 2 Analog Amplifier Connections

Pin#	Symbol	Function	Description	Notes
1	DAC2A+	Output	Phase A Analog Out	+/-10V, ref to GND
2	DAC2B+	Output	Phase B Analog Out	+/-10V, ref to GND
3	GND	Common	Reference Voltage	Amplifier Common Ground
4	AE_NO_2	Output	Amplifier Enable Relay	Normally Open contact
5	AFAULT_2-	Input	Amplifier Fault Line	Differential line with Pin #9
6	DAC2A-	Output	Phase A Analog Out	-/+10V; ref to GND
7	DAC2B-	Output	Phase B Analog Out	-/+10V; ref to GND
8	AE_COM_2	Output	Amplifier Enable Relay	Common for pin 4
9	AFAULT_2+	Input	Amplifier Fault Line	Differential line with Pin #5
Note: In order to use this connector the Option-A must be ordered.				

AMP3: DB-9S Connector, Channel 3 Analog Amplifier Connections

Pin#	Symbol	Function	Description	Notes
1	DAC3A+	Output	Phase A Analog Out	+/-10V, ref to GND
2	DAC3B+	Output	Phase B Analog Out	+/-10V, ref to GND
3	GND	Common	Reference Voltage	Amplifier Common Ground
4	AE_NO_3	Output	Amplifier Enable Relay	Normally Open contact
5	AFAULT_3-	Input	Amplifier Fault Line	Differential line with Pin #9
6	DAC3A-	Output	Phase A Analog Out	-/+10V; ref to GND
7	DAC3B-	Output	Phase B Analog Out	-/+10V; ref to GND
8	AE_COM_3	Output	Amplifier Enable Relay	Common for pin 4
9	AFAULT_3+	Input	Amplifier Fault Line	Differential line with Pin #5
Note: In order to use this connector the Option-A must be ordered.				

AMP4: DB-9S Connector, Channel 4 Analog Amplifier Connections

Pin#	Symbol	Function	Description	Notes
1	DAC4A+	Output	Phase A Analog Out	+/-10V, ref to GND
2	DAC4B+	Output	Phase B Analog Out	+/-10V, ref to GND
3	GND	Common	Reference Voltage	Amplifier Common Ground
4	AE_NO_4	Output	Amplifier Enable Relay	Normally Open contact
5	AFAULT_4-	Input	Amplifier Fault Line	Differential line with Pin #9
6	DAC4A-	Output	Phase A Analog Out	-/+10V; ref to GND
7	DAC4B-	Output	Phase B Analog Out	-/+10V; ref to GND
8	AE_COM_4	Output	Amplifier Enable Relay	Common for pin 4
9	AFAULT_4+	Input	Amplifier Fault Line	Differential line with Pin #5
Note: In order to use this connector the Option-A must be ordered.				

TB1: 5-Pin Terminal Block, Channel 1 Flags

Pin#	Symbol	Function	Description	Notes
1	USER1	Input	General Capture Flag	Sinking or sourcing
2	PLIM1	Input	Positive Limit Flag	Sinking or sourcing
3	MLIM1	Input	Negative Limit Flag	Sinking or sourcing
4	HOME1	Input	Home Flag	Sinking or sourcing
5	FL_RET1	Input	Return For All Flags	+V (12 to 24 V) or 0v

TB2: 5-Pin Terminal Block, Channel 2 Flags

Pin#	Symbol	Function	Description	Notes
1	USER2	Input	General Capture Flag	Sinking or sourcing
2	PLIM2	Input	Positive Limit Flag	Sinking or sourcing
3	MLIM2	Input	Negative Limit Flag	Sinking or sourcing
4	HOME2	Input	Home Flag	Sinking or sourcing
5	FL_RET2	Input	Return For All Flags	+V (12 to 24 V) or 0v

TB3: 5-Pin Terminal Block, Channel 3 Flags

Pin#	Symbol	Function	Description	Notes
1	USER3	Input	General Capture Flag	Sinking or sourcing
2	PLIM3	Input	Positive Limit Flag	Sinking or sourcing
3	MLIM3	Input	Negative Limit Flag	Sinking or sourcing
4	HOME3	Input	Home Flag	Sinking or sourcing
5	FL_RET3	Input	Return For All Flags	+V (12 to 24 V) or 0v

TB4: 5-Pin Terminal Block, Channel 4 Flags

Pin#	Symbol	Function	Description	Notes
1	USER4	Input	General Capture Flag	Sinking or sourcing
2	PLIM4	Input	Positive Limit Flag	Sinking or sourcing
3	MLIM4	Input	Negative Limit Flag	Sinking or sourcing
4	HOME4	Input	Home Flag	Sinking or sourcing
5	FL_RET4	Input	Return For All Flags	+V (12 to 24 V) or 0v

PWM1: 36-Pin Mini-D Connector, Channel 1 Digital Amplifier Connections

Pin#	Symbol	Function	Description	Notes
1	FC0	Feedback	1 of 4 Fault Code Bits	Optional
2	FC2	Feedback	1 of 4 Fault Code Bits	Optional
3	ADC_CLK1+	Command	A/D Converter Clock	
4	ADC_STB1+	Command	A/D Converter Strobe	
5	CURRENTA+	Feedback	Phase A Actual Current Data	Serial Digital
6	CURRENTB+	Feedback	Phase B Actual Current Data	Serial Digital
7	AENA1+	Command	Amplifier Enable	High Is Enable
8	FAULT1+	Feedback	Amplifier Fault	High Is Fault
9	PWMATOP1+	Command	Phase A Top Cmd	High Is On Command
10	PWMABOT1+	Command	Phase A Bottom Cmd	High Is On Command
11	PWMBTOP1+	Command	Phase B Top Cmd	High Is On Command
12	PWMBBOT1+	Command	Phase B Bottom Cmd	High Is On Command
13	PWMCTOP1+	Command	Phase C Top Cmd	High Is On Command
14	PWMCBOT1+	Command	Phase C Bottom Cmd	High Is On Command
15	GND	Common	Reference Voltage	
16	+5V	Power	+5V Power	From Controller
17	RESERVED			
18	RESERVED			
19	FC1	Feedback	1 of 4 Fault Code Bits	Optional
20	FC3	Feedback	1 of 4 Fault Code Bits	Optional
21	ADC_CLK1-	Command	A/D Converter Clock	
22	ADC_STB1-	Command	A/D Converter Strobe	
23	CURRENTA-	Feedback	Phase A Actual Current Data	Serial Digital
24	CURRENTB-	Feedback	Phase B Actual Current Data	Serial Digital
25	AENA1-	Command	Amplifier Enable	Low Is Enable
26	FAULT1-	Feedback	Amplifier Fault	Low Is Fault
27	PWMATOP1-	Command	Phase A Top Cmd	Low Is On Command
28	PWMABOT1-	Command	Phase A Bottom Cmd	Low Is On Command
29	PWMBTOP1-	Command	Phase B Top Cmd	Low Is On Command
30	PWMBBOT1-	Command	Phase B Bottom Cmd	Low Is On Command
31	PWMCTOP1-	Command	Phase C Top Cmd	Low Is On Command
32	PWMCBOT1-	Command	Phase C Bottom Cmd	Low Is On Command
33	GND	Common	Reference Voltage	
34	+5V	Power	+5V Power	From Controller
35	RESERVED			
36	RESERVED			

Note: In order to use this connector the Option-B must be ordered.
Note: In almost all cases the connection between the QMAC and a digital amplifier is performed with a standard cable. Delta Tau Data Systems can provide this cable when the appropriate accessory or option is ordered.

PWM2: 36-Pin Mini-D Connector, Channel 2 Digital Amplifier Connections

Pin#	Symbol	Function	Description	Notes
1	FC0	Feedback	1 of 4 Fault Code Bits	Optional
2	FC2	Feedback	1 of 4 Fault Code Bits	Optional
3	ADC_CLK2+	Command	A/D Converter Clock	
4	ADC_STB2+	Command	A/D Converter Strobe	
5	CURRENTA+	Feedback	Phase A Actual Current Data	Serial Digital
6	CURRENTB+	Feedback	Phase B Actual Current Data	Serial Digital
7	AENA2+	Command	Amplifier Enable	High Is Enable
8	FAULT2+	Feedback	Amplifier Fault	High Is Fault
9	PWMATOP2+	Command	Phase A Top Cmd	High Is On Command
10	PWMABOT2+	Command	Phase A Bottom Cmd	High Is On Command
11	PWMBTOP2+	Command	Phase B Top Cmd	High Is On Command
12	PWMBBOT2+	Command	Phase B Bottom Cmd	High Is On Command
13	PWMCTOP2+	Command	Phase C Top Cmd	High Is On Command
14	PWMCBOT2+	Command	Phase C Bottom Cmd	High Is On Command
15	GND	Common	Reference Voltage	
16	+5V	Power	+5V Power	From Controller
17	RESERVED			
18	RESERVED			
19	FC1	Feedback	1 of 4 Fault Code Bits	Optional
20	FC3	Feedback	1 of 4 Fault Code Bits	Optional
21	ADC_CLK2-	Command	A/D Converter Clock	
22	ADC_STB2-	Command	A/D Converter Strobe	
23	CURRENTA-	Feedback	Phase A Actual Current Data	Serial Digital
24	CURRENTB-	Feedback	Phase B Actual Current Data	Serial Digital
25	AENA2-	Command	Amplifier Enable	Low Is Enable
26	FAULT2-	Feedback	Amplifier Fault	Low Is Fault
27	PWMATOP2-	Command	Phase A Top Cmd	Low Is On Command
28	PWMABOT2-	Command	Phase A Bottom Cmd	Low Is On Command
29	PWMBTOP2-	Command	Phase B Top Cmd	Low Is On Command
30	PWMBBOT2-	Command	Phase B Bottom Cmd	Low Is On Command
31	PWMCTOP2-	Command	Phase C Top Cmd	Low Is On Command
32	PWMCBOT2-	Command	Phase C Bottom Cmd	Low Is On Command
33	GND	Common	Reference Voltage	
34	+5V	Power	+5V Power	From Controller
35	RESERVED			
36	RESERVED			

Note: In order to use this connector the Option-B must be ordered.
Note: In almost all cases the connection between the QMAC and a digital amplifier is performed with a standard cable. Delta Tau Data Systems can provide this cable when the appropriate accessory or option is ordered.

PWM3: 36-Pin Mini-D Connector, Channel 3 Digital Amplifier Connections

Pin#	Symbol	Function	Description	Notes
1	FC0	Feedback	1 of 4 Fault Code Bits	Optional
2	FC2	Feedback	1 of 4 Fault Code Bits	Optional
3	ADC_CLK3+	Command	A/D Converter Clock	
4	ADC_STB3+	Command	A/D Converter Strobe	
5	CURRENTA+	Feedback	Phase A Actual Current Data	Serial Digital
6	CURRENTB+	Feedback	Phase B Actual Current Data	Serial Digital
7	AENA3+	Command	Amplifier Enable	High Is Enable
8	FAULT3+	Feedback	Amplifier Fault	High Is Fault
9	PWMATOP3+	Command	Phase A Top Cmd	High Is On Command
10	PWMABOT3+	Command	Phase A Bottom Cmd	High Is On Command
11	PWMBTOP3+	Command	Phase B Top Cmd	High Is On Command
12	PWMBBOT3+	Command	Phase B Bottom Cmd	High Is On Command
13	PWMCTOP3+	Command	Phase C Top Cmd	High Is On Command
14	PWMCBOT3+	Command	Phase C Bottom Cmd	High Is On Command
15	GND	Common	Reference Voltage	
16	+5V	Power	+5V Power	From Controller
17	RESERVED			
18	RESERVED			
19	FC1	Feedback	1 of 4 Fault Code Bits	Optional
20	FC3	Feedback	1 of 4 Fault Code Bits	Optional
21	ADC_CLK3-	Command	A/D Converter Clock	
22	ADC_STB3-	Command	A/D Converter Strobe	
23	CURRENTA-	Feedback	Phase A Actual Current Data	Serial Digital
24	CURRENTB-	Feedback	Phase B Actual Current Data	Serial Digital
25	AENA3-	Command	Amplifier Enable	Low Is Enable
26	FAULT3-	Feedback	Amplifier Fault	Low Is Fault
27	PWMATOP3-	Command	Phase A Top Cmd	Low Is On Command
28	PWMABOT3-	Command	Phase A Bottom Cmd	Low Is On Command
29	PWMBTOP3-	Command	Phase B Top Cmd	Low Is On Command
30	PWMBBOT3-	Command	Phase B Bottom Cmd	Low Is On Command
31	PWMCTOP3-	Command	Phase C Top Cmd	Low Is On Command
32	PWMCBOT3-	Command	Phase C Bottom Cmd	Low Is On Command
33	GND	Common	Reference Voltage	
34	+5V	Power	+5V Power	From Controller
35	RESERVED			
36	RESERVED			

Note: In order to use this connector the Option-B must be ordered.
Note: In almost all cases the connection between the QMAC and a digital amplifier is performed with a standard cable. Delta Tau Data Systems can provide this cable when the appropriate accessory or option is ordered.

PWM4: 36-Pin Mini-D Connector, Channel 4 Digital Amplifier Connections

Pin#	Symbol	Function	Description	Notes
1	FC0	Feedback	1 of 4 Fault Code Bits	Optional
2	FC2	Feedback	1 of 4 Fault Code Bits	Optional
3	ADC_CLK4+	Command	A/D Converter Clock	
4	ADC_STB4+	Command	A/D Converter Strobe	
5	CURRENTA+	Feedback	Phase A Actual Current Data	Serial Digital
6	CURRENTB+	Feedback	Phase B Actual Current Data	Serial Digital
7	AENA4+	Command	Amplifier Enable	High Is Enable
8	FAULT4+	Feedback	Amplifier Fault	High Is Fault
9	PWMATOP4+	Command	Phase A Top Cmd	High Is On Command
10	PWMABOT4+	Command	Phase A Bottom Cmd	High Is On Command
11	PWMBTOP4+	Command	Phase B Top Cmd	High Is On Command
12	PWMBBOT4+	Command	Phase B Bottom Cmd	High Is On Command
13	PWMCTOP4+	Command	Phase C Top Cmd	High Is On Command
14	PWMCBOT4+	Command	Phase C Bottom Cmd	High Is On Command
15	GND	Common	Reference Voltage	
16	+5V	Power	+5V Power	From Controller
17	RESERVED			
18	RESERVED			
19	FC1	Feedback	1 of 4 Fault Code Bits	Optional
20	FC3	Feedback	1 of 4 Fault Code Bits	Optional
21	ADC_CLK4-	Command	A/D Converter Clock	
22	ADC_STB4-	Command	A/D Converter Strobe	
23	CURRENTA-	Feedback	Phase A Actual Current Data	Serial Digital
24	CURRENTB-	Feedback	Phase B Actual Current Data	Serial Digital
25	AENA4-	Command	Amplifier Enable	Low Is Enable
26	FAULT4-	Feedback	Amplifier Fault	Low Is Fault
27	PWMATOP4-	Command	Phase A Top Cmd	Low Is On Command
28	PWMABOT4-	Command	Phase A Bottom Cmd	Low Is On Command
29	PWMBTOP4-	Command	Phase B Top Cmd	Low Is On Command
30	PWMBBOT4-	Command	Phase B Bottom Cmd	Low Is On Command
31	PWMCTOP4-	Command	Phase C Top Cmd	Low Is On Command
32	PWMCBOT4-	Command	Phase C Bottom Cmd	Low Is On Command
33	GND	Common	Reference Voltage	
34	+5V	Power	+5V Power	From Controller
35	RESERVED			
36	RESERVED			

Note: In order to use this connector the Option-B must be ordered.
Note: In almost all cases the connection between the QMAC and a digital amplifier is performed with a standard cable. Delta Tau Data Systems can provide this cable when the appropriate accessory or option is ordered.

TB5: 10-Pin Terminal Block, Analog Inputs

Pin#	Symbol	Function	Description
1	ANAI00	Input	Analog input 0 0-5V or +/-2.5V range
2	ANAI01	Input	Analog input 1 0-5V or +/-2.5V range
3	ANAI02	Input	Analog input 2 0-5V or +/-2.5V range
4	ANAI03	Input	Analog input 3 0-5V or +/-2.5V range
5	ANAI04	Input	Analog input 4 0-5V or +/-2.5V range
6	ANAI05	Input	Analog input 5 0-5V or +/-2.5V range
7	ANAI06	Input	Analog input 6 0-5V or +/-2.5V range
8	ANAI07	Input	Analog input 7 0-5V or +/-2.5V range
9	+5V	Output	Positive supply voltage to power external circuitry
10	GND	Common	QMAC Common
Note: In order to use this connector the Option-12 must be ordered.			

TB6: 10-Pin Terminal Block, Digital Inputs 0 through 7

Pin#	Symbol	Function	Description
1	IN-0	Input	Digital input 12V to 24V, sinking or sourcing
2	IN-1	Input	Digital input 12V to 24V, sinking or sourcing
3	IN-2	Input	Digital input 12V to 24V, sinking or sourcing
4	IN-3	Input	Digital input 12V to 24V, sinking or sourcing
5	IN-4	Input	Digital input 12V to 24V, sinking or sourcing
6	IN-5	Input	Digital input 12V to 24V, sinking or sourcing
7	IN-6	Input	Digital input 12V to 24V, sinking or sourcing
8	IN-7	Input	Digital input 12V to 24V, sinking or sourcing
9	RTN0-3	Input	Return For Flags 0 to 3. 12 to 24V or 0V
10	RTN4-7	Input	Return For Flags 4 to 7. 12 to 24V or 0V

TB7: 10-Pin Terminal Block, Digital Inputs 8 through 15

Pin#	Symbol	Function	Description
1	IN-8	Input	Digital input 12V to 24V, sinking or sourcing
2	IN-9	Input	Digital input 12V to 24V, sinking or sourcing
3	IN-10	Input	Digital input 12V to 24V, sinking or sourcing
4	IN-11	Input	Digital input 12V to 24V, sinking or sourcing
5	IN-12	Input	Digital input 12V to 24V, sinking or sourcing
6	IN-13	Input	Digital input 12V to 24V, sinking or sourcing
7	IN-14	Input	Digital input 12V to 24V, sinking or sourcing
8	IN-15	Input	Digital input 12V to 24V, sinking or sourcing
9	RTN8-11	Input	Return For Flags 8 to 11. 12 to 24V or 0V
10	RTN12-15	Input	Return For Flags 12 to 15. 12 to 24V or 0V

TB8: 10-Pin Terminal Block, Digital Outputs 0 through 7

Pin#	Symbol	Function	Description
1	OUT-0	Output	Digital sourcing output 12V to 24V
2	OUT-1	Output	Digital sourcing output 12V to 24V
3	OUT-2	Output	Digital sourcing output 12V to 24V
4	OUT-3	Output	Digital sourcing output 12V to 24V
5	OUT-4	Output	Digital sourcing output 12V to 24V
6	OUT-5	Output	Digital sourcing output 12V to 24V
7	OUT-6	Output	Digital sourcing output 12V to 24V
8	OUT-7	Output	Digital sourcing output 12V to 24V
9	OUT_+V	Input/	+12 to +24V in from external source
10	OUT_RTN	Common	Common for all outputs
An external power supply in the 12 to 24 VDC range must be connected between pins 9 and 10 for this port to operate.			

TB9: 4-Pin Terminal Block, +24V Power Supply Connector

Pin#	Symbol	Function	Description
1	CHGND	Ground	Chassis Ground
2	RTN	Common	+24V Power Supply return
3	+24V	Input	+24V Power Supply voltage
Note: In order to use this connector, the DC-Input Supply Option must be selected when ordered.			

TB10: 4-Pin Terminal Block, +5V and ±15V Power Supply Connector

Pin#	Symbol	Function	Description
1	GND	Common	Analog Reference Voltage
2	+5V	Output/Input	+5V Positive Supply Voltage
3	+15V	Output/Input	+15V Positive Supply Voltage
4	-15V	Output/Input	-15V Negative Supply Voltage

TB11: 3-Pin Terminal Block, Watchdog Failure Indicator Relay

Pin#	Symbol	Function	Description
1	NC	Contact	Contact is open if QMAC is in watchdog failure
2	COM	Common	Common for pins 1 and 3
3	NO	Contact	Contact is close if QMAC is in watchdog failure

SOFTWARE SETUP

The QMAC is a boxed version of a Turbo PMAC2 Lite board. Therefore, the Turbo PMAC User and Software manuals must be used for selecting the appropriate I-variables configuration values.

Analog Outputs Configuration

If Option-A or Option-A with Option-A1 is ordered, the following procedure must be followed to set up the analog channels properly.

I70n6, Channel n Output Mode Select

I70n6 controls what output formats are used on the command output signal lines. For analog outputs operation I70n6 must be set to a value of either 1 or 3 (these are not the default values):

I70n6 = 1 (Outputs A and B are DAC; Output C is PWM)
I70n6 = 3 (Outputs A and B are DAC; Output C is PFM)

I7005, DAC Strobe Word (DAC Resolution Configuration)

I7005 controls the DAC strobe signal for machine interface channels 1-4 on the QMAC servo IC. For using the 18-bit DAC circuits on the QMAC with Option-A analog servo interface, variable I7005 must be set to its default value of $7FFFC0.

I7005 = $7FFFC0 (PMAC2 channels 1-4 on Servo IC m are 18-bit)

Stepper Outputs Configuration

A QMAC ordered without Option-A or Option-B is only capable of controlling stepper or pulse-and-direction drives. The following procedure must be followed to set up the pulse-and-direction channels properly.

I70n6, Channel n Output Mode Select

I70n6 controls what output formats are used on the command output signal lines. For stepper (PFM) outputs operation I70n6 must be set to a value of either 2 or 3 (these are not the default values):

I70n6 = 2 (Outputs A and B are PWM; Output C is PFM)
I70n6 = 3 (Outputs A and B are DAC; Output C is PFM)

Digital PWM Outputs Configuration

A QMAC ordered with Option-B is capable of controlling digital amplifiers through direct PWM command signals. The following procedure must be followed to set up the direct PWM channels properly.

I70n6, Channel n Output Mode Select

I70n6 controls what output formats are used on the command output signal lines. For direct PWM outputs operation I70n6 must be set to a value of 0 (this is the default value):

I70n6 = 0 (Outputs A and B are PWM; Output C is PWM)

Handwheel Channels Output Configuration

The two supplemental channels of a PMAC2 are available standard on any QMAC, providing two additional two-channel encoders and two output sets, user configurable as either pulse and direction, or single-phase PWM top-and-bottom pairs. These signals are provided on the J1 port. The following procedure must be followed to set up the QMAC supplemental channels properly.

I68n6, Supplemental Channel n Output Mode Select

I68n6 controls what output formats are used on the supplemental command output signal lines.

I68n6 = 0 or 1 (Output C is PWM)
I68n6 = 2 or 3 (Output C is PFM)

General-Purpose Digital Inputs and Outputs Setup

The QMAC comes standard with eight optically isolated general-purpose digital sourcing outputs at 12 to 24 VDC levels and 16 optically isolated digital inputs (5-24V, sinking or sourcing by user wiring). The I/O lines are memory-mapped into QMAC's address space in registers Y:$78400 and Y:$78401. Typically, these I/O lines are accessed individually with M-variables. Following is a suggested set of M-variable definitions to use these data lines:

```
M0->Y:$078400,0                 ; Digital Input IN-0; TB6 Pin 1
M1->Y:$078400,1                 ; Digital Input IN-1; TB6 Pin 2
M2->Y:$078400,2                 ; Digital Input IN-2; TB6 Pin 3
M3->Y:$078400,3                 ; Digital Input IN-3; TB6 Pin 4
M4->Y:$078400,4                 ; Digital Input IN-4; TB6 Pin 5
M5->Y:$078400,5                 ; Digital Input IN-5; TB6 Pin 6
M6->Y:$078400,6                 ; Digital Input IN-6; TB6 Pin 7
M7->Y:$078400,7                 ; Digital Input IN-7; TB6 Pin 8
M8->Y:$078400,8                 ; Digital Input IN-8; TB7 Pin 1
M9->Y:$078400,9                 ; Digital Input IN-9; TB7 Pin 2
M10->Y:$078400,10               ; Digital Input IN-10; TB7 Pin 3
M11->Y:$078400,11               ; Digital Input IN-11; TB7 Pin 4
M12->Y:$078400,12               ; Digital Input IN-12; TB7 Pin 5
M13->Y:$078400,13               ; Digital Input IN-13; TB7 Pin 6
M14->Y:$078400,14               ; Digital Input IN-14; TB7 Pin 7
M15->Y:$078400,15               ; Digital Input IN-15; TB7 Pin 8

M16->Y:$078400,16               ; Digital Output OUT-0; TB8 Pin 1
M17->Y:$078400,17               ; Digital Output OUT-1; TB8 Pin 2
M18->Y:$078400,18               ; Digital Output OUT-2; TB8 Pin 3
M19->Y:$078400,19               ; Digital Output OUT-3; TB8 Pin 4
M20->Y:$078400,20               ; Digital Output OUT-4; TB8 Pin 5
M21->Y:$078400,21               ; Digital Output OUT-5; TB8 Pin 6
M22->Y:$078400,22               ; Digital Output OUT-6; TB8 Pin 7
M23->Y:$078400,23               ; Digital Output OUT-7; TB8 Pin 8
M24->Y:$078400,16,8             ; Digital Outputs byte: OUT-0 to OUT-7

M36->X:$078400,16,8             ; Direction control for I/O16 to I/O23
M37->Y:$070800,2                ; Buffer direction control for I/O16 to I/O23
```

In order to properly setup the digital outputs an initialization PLC must be written scanning through once on power-up/reset, then disabling itself:

```
OPEN PLC1 CLEAR
     M36 = 255                  ; Set I/O Lines 16 to 23 as Outputs
     M37 = 1                    ; Set Buffer IC for I/O Lines 16 to 23 as Outputs
     M24 = 0                    ; Reset all outputs to inactive state
     DIS PLC1                   ; Disable PLC1 (scanning through once on power-up/reset)
CLOSE
```

Note:

After loading this program you must set I5=2 or 3 and ENABLE PLC 1.

Analog Inputs Setup

When Option-12 is ordered extra components are added in the QMAC system to provide eight analog-to-digital converters with 12-bits resolution and 0-5 or ±2.5V range. Typically, this option is used for reading analog sensors but it is not regularly used for analog feedback devices. In order to enable this function the following variables must be set properly:

```
I5060 = 4          ; Set A/D processing ring size to 4 pairs, which is eight analog inputs
I5061 = 0          ; Set source to on-board ACC-12 (this is the default configuration)
I5062 = 0          ; Set source to on-board ACC-12 (this is the default configuration)
I5063 = 0          ; Set source to on-board ACC-12 (this is the default configuration)
I5064 = 0          ; Set source to on-board ACC-12 (this is the default configuration)
I5065 = 0          ; Set source to on-board ACC-12 (this is the default configuration)
I5066 = 0          ; Set source to on-board ACC-12 (this is the default configuration)
I5067 = 0          ; Set source to on-board ACC-12 (this is the default configuration)
I5068 = 0          ; Set source to on-board ACC-12 (this is the default configuration)
```

Setup for 0-5V Unipolar Inputs:

```
I5081 = $000000    ; Source for I5061 are ACC-12 inputs 0 and 8 in the 0 to +5V Unipolar Range
I5082 = $001001    ; Source for I5062 are ACC-12 inputs 1 and 9 in the 0 to +5V Unipolar Range
I5083 = $002002    ; Source for I5063 are ACC-12 inputs 2 and 10 in the 0 to +5V Unipolar Range
I5084 = $003003    ; Source for I5064 are ACC-12 inputs 3 and 11 in the 0 to +5V Unipolar Range
I5085 = $004004    ; Source for I5065 are ACC-12 inputs 4 and 12 in the 0 to +5V Unipolar Range
I5086 = $005005    ; Source for I5066 are ACC-12 inputs 5 and 13 in the 0 to +5V Unipolar Range
I5087 = $006006    ; Source for I5067 are ACC-12 inputs 6 and 15 in the 0 to +5V Unipolar Range
I5088 = $007007    ; Source for I5068 are ACC-12 inputs 7 and 15 in the 0 to +5V Unipolar Range
```

Setup for ±2.5V Bipolar Inputs:

```
I5081 = $008008    ; Source for I5061 are ACC-12 inputs 0 and 8 in the ±2.5V Bipolar Range
I5082 = $009009    ; Source for I5062 are ACC-12 inputs 1 and 9 in the ±2.5V Bipolar Range
I5083 = $00A00A    ; Source for I5063 are ACC-12 inputs 2 and 10 in the ±2.5V Bipolar Range
I5084 = $00B00B    ; Source for I5064 are ACC-12 inputs 3 and 11 in the ±2.5V Bipolar Range
I5085 = $00C00C    ; Source for I5065 are ACC-12 inputs 4 and 12 in the ±2.5V Bipolar Range
I5086 = $00D00D    ; Source for I5066 are ACC-12 inputs 5 and 13 in the ±2.5V Bipolar Range
I5087 = $00E00E    ; Source for I5067 are ACC-12 inputs 6 and 15 in the ±2.5V Bipolar Range
I5088 = $00F00F    ; Source for I5068 are ACC-12 inputs 7 and 15 in the ±2.5V Bipolar Range
```

Once this setup has been made, SAVEd in memory and made current by the "$$$" online command, QMAC will cycle through the analog inputs automatically, copying the converted digital values into RAM. These image registers can then be read as if they were the actual A/D converters. For user program use, the image registers would be accessed with M-variables. Suggested definitions are:

```
M1000->Y:$003400,12,12,U     ; ANAI00 image register; from TB5 pin 1
M1001->Y:$ 003402,12,12,U    ; ANAI01 image register; from TB5 pin 2
M1002->Y:$ 003404,12,12,U    ; ANAI02 image register; from TB5 pin 3
M1003->Y:$ 003406,12,12,U    ; ANAI03 image register; from TB5 pin 4
M1004->Y:$ 003408,12,12,U    ; ANAI04 image register; from TB5 pin 5
M1005->Y:$ 00340A,12,12,U    ; ANAI05 image register; from TB5 pin 6
M1006->Y:$ 00340C,12,12,U    ; ANAI06 image register; from TB5 pin 7
M1007->Y:$ 00340E,12,12,U    ; ANAI07 image register; from TB5 pin 8
```

Communications

I54 Serial Port Baud Rate Control

I54 controls the baud rate for communications on the main serial port. QMAC uses I54 only at power-up/reset to set up the frequency of the clocking circuit for the serial port. To change the baud rate, it is necessary to change the value of I54, store this value to non-volatile flash memory with the **SAVE** command, and reset the QMAC system. At this time, Turbo PMAC will establish the new baud rate.

The possible settings of I54 and the baud rates they define are:

I54	Baud Rate	I54	Baud Rate	I54	Baud Rate	I54	Baud Rate
0	600	4	2400	8	9600	**12**	**38,400**
1	900	5	3600	9	14,400	13	57,600
2	1200	6	4800	10	19,200	14	76,800
3	1800	7	7200	11	28,800	15	115,200

Note:

To restore I54 to the default baud rate of 38,400, power-up the QMAC system while pressing the S1 front panel re-initialization button.

USB or Ethernet Port Configuration

When Option-2 or Option-2A is ordered the QMAC system is provided with the high-speed USB or Ethernet communications interface. The setup of the USB or Ethernet communications method is transparent for the user when running the PEWIN-32 or PCOMM-32 software packages, which are provided by Delta Tau Data Systems by ordering the appropriate software accessory.