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PD/MC 8400 Series



The 8400 series consists of the PD8400 packaged step motor drive, MC8400 packaged drive/machine controller, and MC8400F packaged machine controller with encoder following capability. All three products are designed around a high-power, precision, state of the art, step motor driver capable of powering NEMA 23 through NEMA 42 frame size motors. Each produces 1,300 watts of usable power and microsteps at resolutions up to 50,800 steps per revolution. One of the 8400 series many features is electronic damping and midrange stability circuitry which provides smooth torque, low vibration and precise positioning. Also, incorporated in the design is a high speed, proprietary H-bridge controller capable of driving the motor to speeds of 6000 rpm.

All systems are shipped complete with mating connectors, switch covers, mounting hardware, integral heat sink and internal cooling fan. Matching system motors come ready for service with a 10' cable, boot and connector.

See speed/torque curves for PD/MC 8400 series on page 110.

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General Features

FEATURES COMMON TO ALL MODELS:

- Torques from 70 to 1125 oz-in (motor dep).
- Peak currents from 0.1 to 8.4 amps per phase.
- Speeds to 100 RPS (6000 RPM at 20,000 steps/rev) with a maximum step input rate of 2 MHz.
- Sixteen user selectable resolutions to 50,800 steps/rev.
- Multistep current control for reduced motor heat.
- Damping circuitry to improve low speed and midrange performance.
- The drive uses 250 volt power amplifier components and is internally fan cooled for maximum reliability.
- Soft-start circuitry eliminates AC current spikes at power on.
- Multilayer printed circuit board construction minimizes RFI and increases reliability.

FEATURES COMMON TO THE MC8400 AND MC8400F:

- A MC68302 microprocessor is used for optimized communication and process control functions.
- All math calculations are done in double precision floating point for pinpoint accuracy.
- Two high speed RS-232c serial communication channels for interaction with other MC8400's, computers, PLC's, operator interface devices and data acquisition subsystems.
- Optional internal Solid State Relay (SSR) modules on most of the input and output lines let the 8400 accept high voltage inputs and drive real world loads without the need for an external relay rack.
- Built in dual power supplies provide enough power for your encoder, user interface panel, limit switches, sensors, switches and more.
- MOTION MASTER FPGA generates step rates in excess of 2 MHz.
- MOTION MASTER delivers motor start delay times as short as 25 microseconds from input or program events.
- Motor moves can be based on distance, velocity or time, motion parameters and input/output events can be changed "on the fly."
- Sophisticated motion profiling software allows the user to create multisegment and variable "S" curve moves combining up to 40 motion elements (each element consists of an accel/decel value plus velocity and a distance), and up to 38 separate input and output events.
- 8K or optional 32K EEPROM's provide for a lifetime of safe program storage with no batteries to wear out and a capacity of over 2500 program lines and up to 510 individual programs.
- MACRO (MAchine ContRol Operation) software is optimized for motion and machine control operation and provides single software commands for many high level functions including jog and homing routines, as well as repetitive, high speed, cyclical (back and forth) and unidirectional moves.
- Conditional program branching and complex conditional evaluations using mathematical, variable and input/output manipulation can all be performed using MACRO commands.
- Extensive program instructions for display device manipulation let you create many types of custom user interface screens.
- MACRO commands allow you to log data as the events occur and store that data in the EEPROM.
- Password control and read-only functions insure security of application programs and machine operation.
- MACRO provides for many math operations including powers, roots, trig and log functions, and Boolean logic operators.
- All variables can be numeric (floating point), string (characters), or arrays of data and can be identified with any user desired combination of numbers or characters.
- The number of variables or the size of a variable array is limited only by the available memory and could reach 2500 or more.

UNIQUE FEATURES OF THE MC8400F:

- Digital, lock-shaft following insures instant response to changes in the encoder signal and none of the position or velocity errors found in software interpolated following systems.
- MACRO-FOLLOW provides for speed and position moves based on a master axis encoder, preset moves at a ratio of the master axis velocity, synchronous moves based on registration marks, cam profiling and "on the fly" ratio changes.
- MACRO-FOLLOW allows acceleration and deceleration parameters to be ratiometrically altered "on the fly" and ratiometric distances to be based on the speed of the master axis encoder.
- MACRO-FOLLOW allows for direction reversal of the master axis with no loss of position.

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Technical Specifications

POWER AMPLIFIER (MOTOR DRIVE) SECTION 8400 SERIES:

AMPLIFIER TYPE	MOSFET, dual H-Bridge, all parts rated for 250 volts.
CURRENT CONTROL	3 state, pulse width modulated, switching at 25KHz.
OUTPUT CURRENT	0.1 to 8.4 amps, software selectable in 0.1 increments.
DC BUS VOLTAGE	160VDC.
MAXIMUM OUTPUT POWER	1300 Watts per phase.
PROTECTION CIRCUITS	Short circuit, over temperature and soft start shutdown.
AC INPUT VOLTAGE	95–135 VAC, 50–60Hz.
IDLE CURRENT REDUCTION	25%, 50%, 75% or 100% in automatic mode using the dip switches or a custom idle current can be set in software from 0.1 to 8.4 amps at any point in the program.
MOTOR RESOLUTION	16 resolutions. Steps per revolution with 1.8˚ motor: 200, 400, 1000, 2000, 5000, 10000, 12800, 18000, 20000, 21600, 25000, 25400, 25600, 36000, 50000, 50800.
WAVEFORMS	
USER POWER SUPPLY (MC8400 & MC8400F ONLY)	
PS 1	+5 VDC, 0.30 amps, regulated, isolated from the motor drive.
PS 2	+24 VDC, 0.15 amps, regulated, isolated from the motor drive.
INPUTS (PD8400 ONLY)	Step and direction optically isolated, 5V-24V differential. Motor steps on falling edge of step input. 250 hsec minimum pulse, 2 MHz maximum step rate. 1 hsec setup and hold time for direction signal.
ENABLE INPUT (PD8400 ONLY)	Two terminals on the logic connector (EN+ AND EN–) that can be used to disable the drive. The current to the stepper motor will be turned off. The PD8400 operates normally without any connections to the enable circuit. Use this feature only to disable the amplifier.

CONTROLLER (INDEXER) SECTION MC8400/MC8400F:

MICROPROCESSOR	Motorola 68302.
SYSTEM MEMORY	256K of ROM, 256K of RAM.
USER MEMORY	EEPROM, 8K or optional 32K.
SERIAL COMMUNICATION	2 RS-232c serial communication ports which can operate from 300 to 19,200 baud.
STATUS LED'S	AC power (red), CW direction (green), Step (green), Motor Power (red), Overtemp (yellow) and Short (yellow).
INPUTS	8 user programmable inputs, CW limit, CCW limit, Home limit, 2 Encoder inputs and Motion Trigger input. Each input can be separately connected for sinking OR sourcing operation.
OUTPUTS	9 user programmable outputs, each output can be separately connected for sinking OR sourcing operation.
OPTOISOLATOR OPTION	
INPUT SIGNAL VOLTAGE (ON)	3.0 to 24 VDC, 5ma to 20ma.
INPUT SIGNAL VOLTAGE (OFF)	0.0 to 0.5 VDC.
OUTPUT SIGNAL VOLTAGE RANGE	0.0 to 24 VDC, maximum of 25ma per output.
SOLID STATE RELAY OPTION	
INPUT SIGNAL VOLTAGE (ON)	5.0 to 60 VDC or 24 to 240 VAC, 5ma to 20ma.
INPUT SIGNAL VOLTAGE (OFF)	0.0 to 0.5 VAC or DC.
OUTPUT SIGNAL VOLTAGE RANGE	0.0 to 150 VDC, 0 to 3 amps per output or 0.0 to 240 VAC, 0 to 3 amps per output.
ENCODER RESOLUTION	1000 lines (4000 counts) per revolution standard, other resolutions can be used.

SYSTEM SPECIFICATIONS:

CASE SIZE	MC8400/MC8400F: 9.48 x 8.76 x 5.86. PD8400: 9.48 x 8.76 x 4.06.
CASE MATERIAL	Aluminum, finished with textured black epoxy powder coat paint.
WEIGHT	PD8400: 6.4 lbs. MC8400/MC8400F: 8.5 lbs.
MATING CONNECTORS	
MOTOR	Phoenix 9 position.
AC POWER	Phoenix 3 position.
LOGIC	
SERIAL	Phoenix 6 position.
LIMITS	Phoenix 8 position.
I/O-12	Phoenix 12 position.
I/O-6	Phoenix 6 position.
AMBIENT TEMPERATURE	0˚ to 50˚C (32˚ to 122˚F).
HUMIDITY	Maximum of 90% non-condensing.

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Software Command Summary—MC8400/MC8400F

AGAIN ..... Marks the end of a FOR, LOOP or WHILE command sequence.

AMOVE ..... Move the motor shaft to a location referenced to the absolute HOME (0) position, at the specified velocity and direction.

BACKOFF ..... Reverse the direction of motor travel and back the motor off of an active limit switch. Works only within an ON sequence.

BREAK ..... Break out of the current FOR, LOOP or WHILE program segment.

CEIL ..... Round a value or math sequence to the next higher whole number.

CHKSUM ..... Calculate a numeric value that indicates the size and state of the user memory used primarily to insure that the user memory has not been changed or corrupted.

CLS ..... Clear the display screen connected to the indicated RS-232c serial port.

CMODE ..... Normally, all programs will stop execution when a Ctrl-C is received via the first RS-232c serial port. The command CMODE 0 will cause a program to ignore the Ctrl-C, CMODE I will cause a program to recognize Ctrl-C again.

CMOVE ..... Move the motor shaft continuously in one direction and at one speed until otherwise instructed.

COMPILE ..... Compile and test a program for syntax errors.

COPY ..... Copy the program commands from one file name to another.

CURSOR ..... Position the cursor of the device connected to the indicated RS-232c serial port.

DEBOUNCE ..... Specify the debounce time for all inputs.

DELAY ..... Pause program execution for a specified amount of time.

DELETE ..... Delete a user program from the nonvolatile memory.

DIR ..... List the names of all user programs currently stored in memory.

DISABLE ..... Disable a previously defined interrupt driven input.

EDIT ..... Begin the process of making changes (edits) to the indicated program.

ELSE ..... An alternate program sequence used in an IF statement.

ENABLE ..... Enable a previously defined interrupt driven input.

END ..... Establishes the end of the program, it is always the last command in any user program and comes after all subroutines.

ENDIF ..... Marks the end of an IF or IFINPUT command program sequence.

ENDON ..... Marks the end of an ON command sequence.

EXIT ..... Leave the current program and return to command mode.

FLIP ..... Change the state of the designated outputs to the opposite state.

FLOOR ..... Round a value or math sequence to the next lower whole number.

FOR ..... Repeat the program sequence that follows (ending with AGAIN), incrementing the variable by the stated amount each time the sequence is repeated, until the desired value is reached.

GET ..... Get a numeric value from the indicated RS-232c serial port.

GETC ..... Get a previously received character value from the indicated RS-232c serial port storage buffer.

GETCRNT ..... Sample the motor current and place the value in a variable.

GETENC ..... Read the value of the encoder absolute position register and place the value in a variable.

GETMOTOR ..... Read the value of the motor absolute position register and place the value in a variable.

GOSUB ..... Execute the indicated subroutine.

GOTO ..... Continue execution of the program with the command line following the corresponding LABEL command.

IF ..... Execute the program sequence that follows (ending with ENDIF), if the comparisons or conditions are true.

IFINPUT ..... Execute the program sequence that follows (ending with ENDIF), if the status of the designated inputs is true.

INPUT ..... Read the state of the general purpose inputs and set a designated variable to a value that indicates the state of these inputs.

JOG ..... Move the motor in the direction indicated by the selected input, at the specified velocity, until that input is no longer active.

JOGKEY ..... Initiate the built in, RS-232c computer based, jog routine.

LABEL ..... Tag which marks the destination point of a GOTO statement.

LIST ..... Print a list of the programs command statements to the terminal connected to the first RS-232c serial port.

LOCK ..... Prevents the program from being edited, changed or deleted.

LOOP ..... Repeat the program sequence that follows (ending with AGAIN), the specified number of times.

LOWER ..... Convert an ASCII value from upper to lower case.

MENU ..... Exit the Command Mode and return to the Main Menu (same as QUIT).

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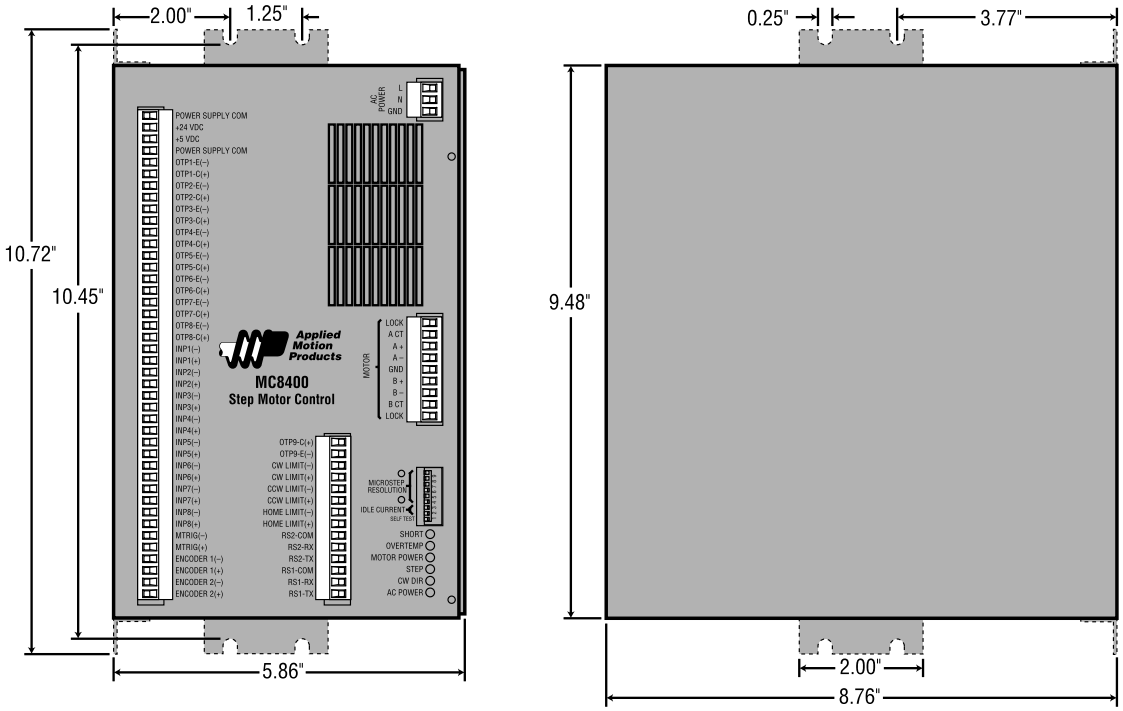
MOTORCLR ..... Clear any Motor errors and reset the motion controller.
MOTORENA ..... Enable or Disable the motor drive's amplifiers.
ON ..... Designates a type of special purpose function block, options include limit switches, stall detection and error conditions.
OUTPUT ..... Set the general purpose outputs to the indicated states.
PASSWORD ..... Wait for a specific password to be entered before executing the next command, characters entered are NOT echoed to the screen. The user may choose to echo a user specified character instead.
PMOVE ..... Initiate a previously defined motor move.
PMOVEDEF ..... Start the definition of a predefined motor move.
PMOVEEND ..... End the definition of a predefined motor move.
PREP ..... Repeat a predefined motor move a designated number of times.
PRINT ..... Output character and numeric information to the indicated RS-232c serial port.
PURGE ..... Clear any previously received data from the indicated RS-232c serial port storage buffer.
QUIT ..... Exit the Command Mode and return to the Main Menu (same as MENU).
REM ..... A remark or comment that annotates a program.
REMOTE ..... Allow commands received via the first RS-232c serial port to be sent back out the second RS-232c serial port.
RENAME ..... Change the name of a user program.
REPEAT ..... Marks the start of a repeating section within a predefined move.
RETURN ..... Establishes the end of a subroutine, it is always the last command in any subroutine and it causes the execution of the program to return to the first command line following the initial GOSUB.
RGMOVE ..... Move the motor shaft at the specified velocity and direction. No more than the maximum distance indicated, searching for a specified input, which, if seen, will cause the motor to move the distance indicated at the specified velocity.
RMOVE ..... Move the motor shaft the distance indicated at the specified velocity and direction.
ROUND ..... Round a value or math sequence to the nearest whole number.
RUN ..... Execute the indicated program.
SEEK ..... Move the motor shaft until a specific input transition occurs.
SERIAL ..... Set the parameters of the indicated RS-232c serial port, these include the baud rate, parity, data and stop bits.
SET ..... Assign a value to a variable, or array element, math operations can be performed using this command.
SETCRNT ..... Set the value of the amplifier motor current register.
SETENC ..... Set the value of the encoder absolute position register.
SETMOTOR ..... Set the value of the motor absolute position register.
STEP ..... Execute a program, one command at a time.
STOP ..... Designates the end of the main program commands and separates the subroutine definitions from the main program.
SUBRTN ..... Begin the definition of a subroutine program (ending with RETURN), all subroutine definitions must follow the STOP command.
SYSVARS ..... Print a list of all of the systems variables to the device connected to the indicated RS-232c serial port.
TIME ..... Place the value of the elapsed system ON time (in 0.01 see increments) in a variable.
TMOVE ..... Move the motor shaft for the amount of time indicated, at the specified velocity and direction.
UNLOCK ..... Allows the program to be edited, changed or deleted.
UPPER ..... Convert an ASCII value from lower to upper case.
VAR ..... Define a variable, character string, or an array.
VERSION ..... Print the software revision number to the device connected to the first RS-232c serial port.
WAITC ..... Wait for a specified character to be received on the indicated RS-232c serial port before executing the next command.
WAITIN ..... Wait for a specific combination of input states to occur before executing the next command.
WHILE ..... Repeat the program sequence that follows (ending with AGAIN), as long as the comparison is true.
WHILEIN ..... Repeat the program sequence that follows (ending with AGAIN), as long as the specified combination of input states is true.
XMODE ..... All programs that contain the command XMODE 1 will stop execution when a Ctrl-X is received via the first RS-232c serial port. XMODE 0 will cause the program to ignore the Ctrl-X.

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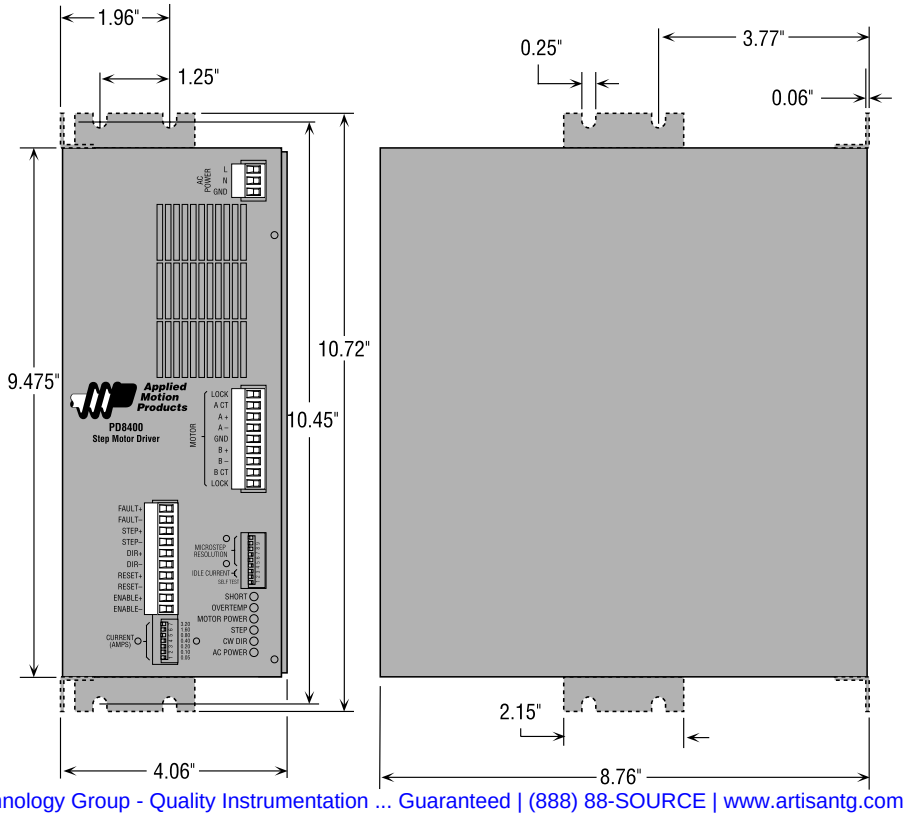
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Mechanical Outlines

MC8400



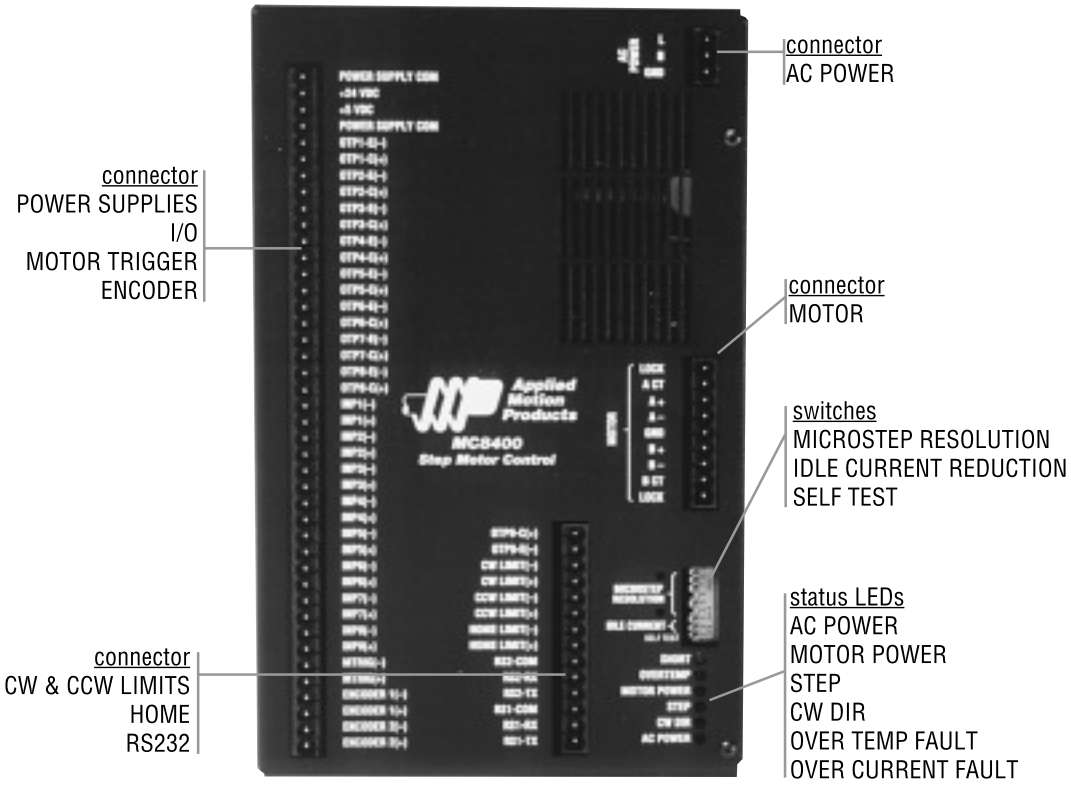
PD8400

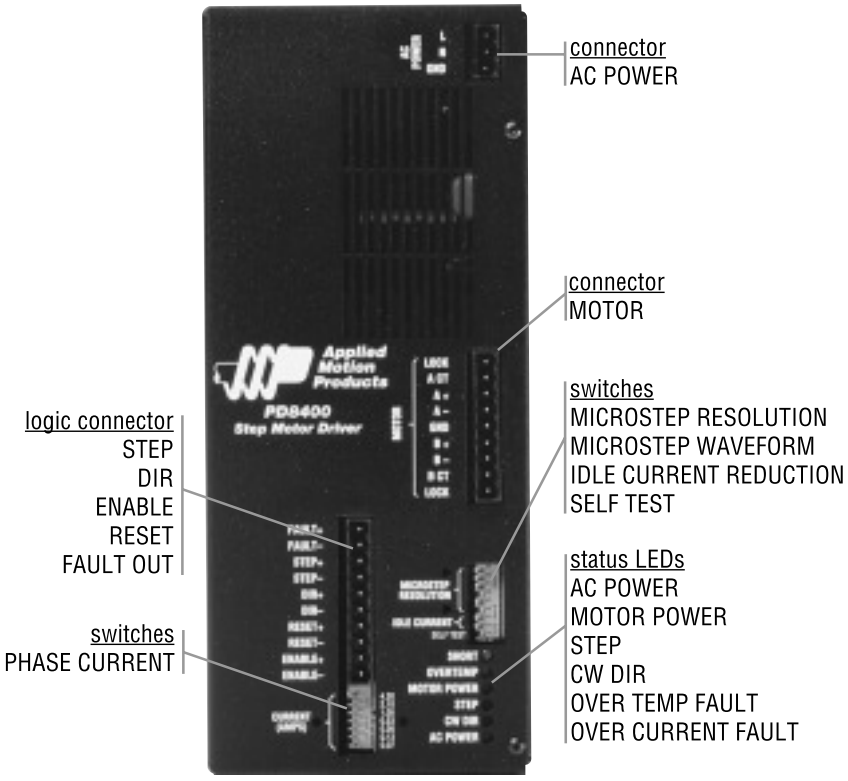


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Connector/Switch Diagrams





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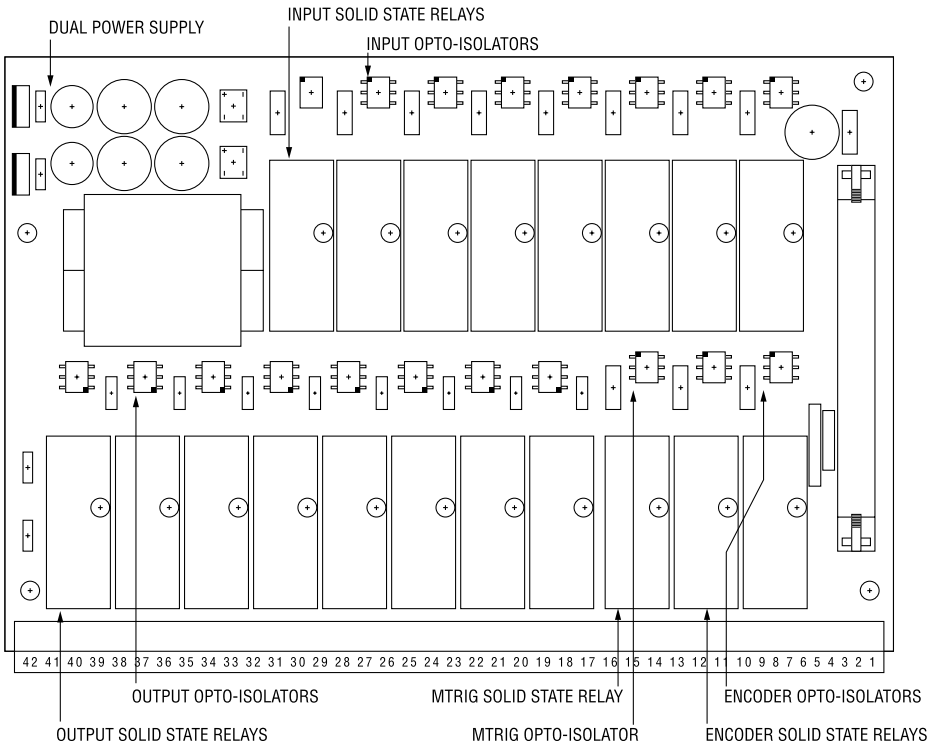
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MC8400/MC8400F I/O Configuration

The basic I/O board that is supplied with the MC8400 can be configured to operate in three different ways. It can be supplied with input, output and communication lines that are isolated from the drives high voltage using opto-isolators, solid state relay (SSR) modules, or a combination of the two. The opto-isolators are used to communicate with logic level devices such as PLC's.

The SSR modules can be used to interface the MC8400 to real world devices such as valves, lamps and switches that may operate on either AC or DC voltages.

The MC8400 may be configured using any combination of opto-isolators and solid state relay modules, giving you the most flexibility for your application. The choice is yours, the I/O type or combination of I/O types that you select is solely dependent upon your application.



Communications:
The MC8400 has two RS-232c serial communication channels. Both are capable of functioning independently and can have different communication parameters.

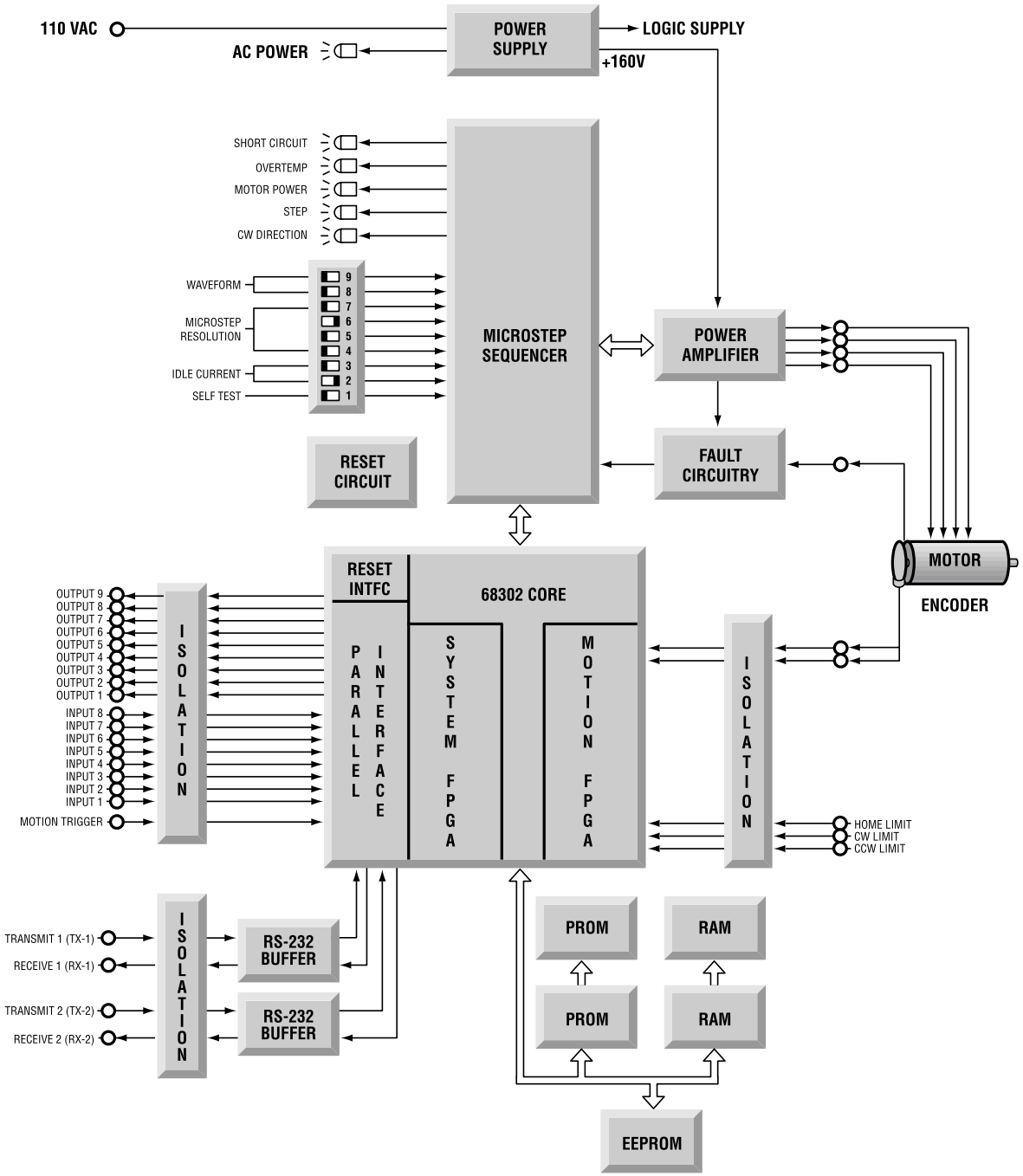
RS-232c PARAMETER	OPTION	FACTORY DEFAULT
Port Number	1 or 2 (first or second RS-232c port)	N/A
Baud Rate	300, 1200, 2400, 4800, 9600 or 19200	9600
Data Bits	7 or 8	8
Parity	EVEN, ODD, SPACE, MARK or NONE	NONE
Stop Bits	1 or 2	1

User Power Supplies (isolated):
The MC8400 I/O board comes with two power supplies that are available for you to use. Both are isolated from the drives' high voltage supply. The first power supply is 5 Vdc with a current capacity of 0.3 amps (300 ma). This supply is regulated and the voltage will remain within +/- 2.5% of 5 volts. The second supply is 24 Vdc with a current capacity of 0.15 amps (150 ma). This supply is regulated and the voltage will remain within +/- 2.5% of 24 volts.

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MC8400 Block Diagram



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Part Number Ordering System

To insure your order is correctly processed please provide a complete part number.

EXAMPLE:

MC 8400 F – 365 D

DRIVE OR CONTROL TYPE:
MC – machine controller packaged with integral drive and power supply.
PD – packaged drive only with integral power supply.

POWER RATING:
8.4 amps

F – encoder following
X – standard-no encoder following

MOTOR SIZE:
NEMA 23, 2.0" long – **365**
NEMA 23, 3.0" long – **366**
NEMA 23, 4.0" long – **367**
NEMA 34, 2.5" long – **413**
NEMA 34, 3.7" long – **414**
NEMA 34, 5.1" long – **415**
NEMA 42, 7.7" long – **036**

SHAFT TYPE OR ENCODER:
S – single shaft motor
D – double shaft motor
E – double shaft motor with encoder

NOTE: When ordering packaged drive or machine controller only, you do not need to specify motor or encoder.

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