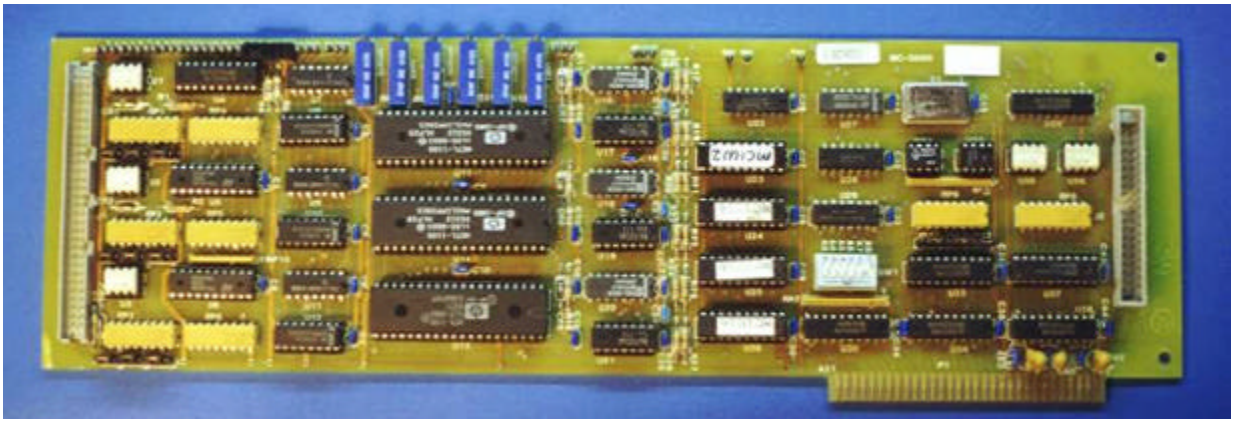
SERVOMOTIVE MC-3000

Three Axis PC Based Servo Motion Controller for Brush or Brushless Servo and Stepper



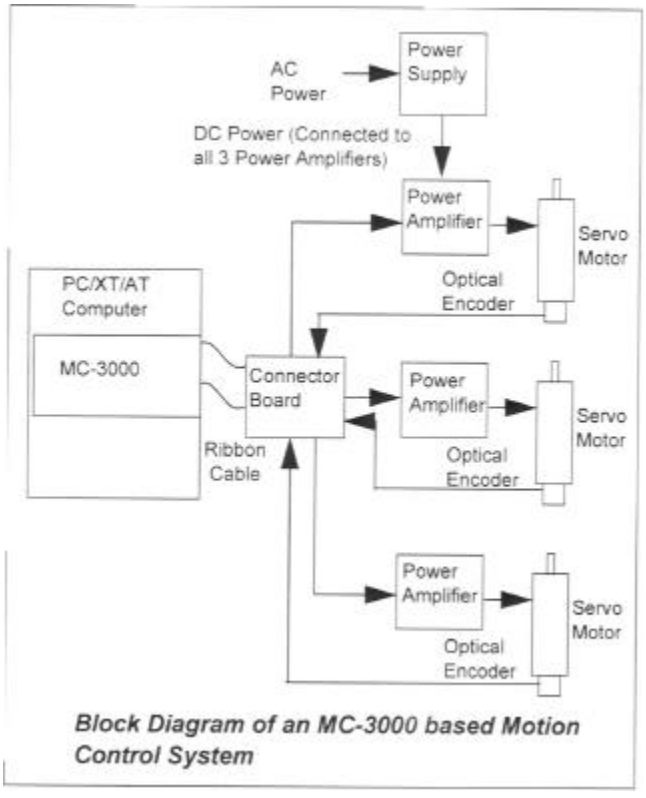
Features

- Full-sized expansion card for PC/XT/AT and compatibles
- Closed-loop high performance position and velocity control of DC brush, DC brushless and step motors
- Programmable digital compensation filter with a gain, pole and zero
- Programmable sample timer allowing a loop sample time from 62 microseconds to 2.048 milliseconds
- Programmable position and velocity profile control with velocity and acceleration limits
- 24-bit position counter
- Encoder feedback selectable for single and differential inputs
- 20KHz PWM output, pulse and sign
- Motor commutator for DC brushless or step motors, with programmable phase overlap and phase advance
- Eight digital output bits, 4 optically isolated and 4 TTL levels
- Eight digital input bits, 4optically isolated and 4 TTL levels
- High speed interface to PC uses only five registers in PC I/O space
- Register write time 1 microsecond
- Register read time 2.1 microsecond
- Control and Demonstration software provided in C, MCBasic, and a menu based point and click “Motion Control Center” interface using Microsoft Windows 3.1 with DLLs

Overview

The MC-3000 motion controller is an IBM PC/XT/AT (ISA Bus) compatible application board designed around three of the Hewlett Packard HCTL-1100 motion controller ASICs. The MC-3000 provides three axes of closed loop motion control. Each axis has two Position Control modes and two velocity control modes. In addition, the MC-3000 also provides eight digital output bits and eight digital input bits. Four of each of these are optically isolated, and the other four of each are TTL levels.

All that is needed for a three axis closed loop servo system is a PC/XT/AT computer or compatible, an MC-3000 with optional cable and connector board, three servo motor power amplifiers, three servo motors with incremental optical encoder, and a motor power supply. These components and their basic interrelationship is illustrated in Figure 1.



Block Diagram of an MC-3000 based Motion Control System

The MC-3000's most attractive feature is it's high speed interface to the PC/XT/AT enabling efficient communications with the PC/XT/AT. The MC-3000 also provides the necessary extras to enable a complete motion control system solution including an industrial quality incremental encoder interface with differential or TTL level inputs and noise filtering, and a generous amount of uncommitted digital I/O to allow sensing limit switches, controlling amplifier enables or other user required I/O functions.

MC-3000 Control Modes

The control modes provided by the MC-3000 are:

Proportional Velocity

Integral Velocity

Position

Trapezoidal Profile

These control modes will now be briefly introduced.

Proportional Velocity Control Mode

The Proportional Velocity control mode provides velocity control using a motor command proportional to the velocity error times a gain value K. The other servo loop compensation parameters, a pole and zero, are not used. In this control mode the user specifies the desired velocity in 12 bits of integer and four bits of fractional units, where the units are quadrature counts per sample time. (Note: quadrature counts are equal to four times the encoder wheel pulses per revolution) When the proportional velocity control flag is set with the appropriate library command, velocity control begins. The MC-3000 requires only an incremental optical encoder for actual velocity sensing, since the actual velocity of the motor is calculated from the time derivative of position. This actual velocity is compared to the desired velocity commanded to find the velocity error. The velocity error is then multiplied by the gain factor K, and this motor command is output to the MC-3000 motion command out- put ports. This velocity control method provides rudimentary velocity control with the transient response governed only by the system dynamics. If the motor shaft is stalled then released, the motor will return to the velocity commanded.

Integral Velocity Control Mode

The Integral Velocity control mode provides velocity control with controlled acceleration and deceleration at a user- defined maximum rate. This approach uses an eight-bit command velocity and a 16-bit command acceleration. The velocity is an integer with units of quadrature counts per sample time, and the acceleration is eight bits integer and eight bits fractional quadrature counts per sample time squared. This control mode actually uses Position Control to achieve the Integral Velocity control. The controller considers the desired velocity, actual velocity and desired acceleration, then calculates an incremental position move to achieve the desired motion. The compensation filter accepts this incremental position move and outputs a new motor command. This control mode has the advantage of using the full digital compensation filter with integral feed- back, so the steady state velocity error is zero. This is an advantage over the proportional velocity control mode. If the motor shaft is stalled and then released, the motor command output (DAC or PWM) will saturate at full motor command value until the motor position has caught up with the correct position along the profile, at which time it will return to the programmed velocity limit.

Position Control Mode

The Position control mode performs rapid point-to-point position moves with no velocity profiling. The final desired position, or setpoint, is an absolute 24-bit position stored into the three registers "Command Position," (MSB-MID- LSB). When the position control mode begins, the MC- 3000 controller compares the position setpoint with the actual motor position and finds the position error. The controller then applies this position error to the digital compensation filter (using the gain, pole and zero), which generates a motion command output that is then latched into the motion command output ports. This process is repeated every sample period. Once at the setpoint position, the motor remains in Position Control mode holding its position. The transient response of a position control mode move is governed only by the system dynamics, and the uncontrolled transient velocity, acceleration, and position overshoot are typical.

Trapezoidal Profile Control Mode

The Trapezoidal Profile control mode provides point-to-point position moves while controlling the velocity and the acceleration. The inputs for this control mode are the final 24-bit position, the maximum seven bit velocity, and the 12-bit integer and four bit fractional acceleration. The units for these inputs are the same as discussed for the previous control modes. The controller accelerates at a constant acceleration as specified by the acceleration command, until the maximum velocity is reached or half the position move is completed. Then it either slews at maximum velocity until the deceleration point, or it immediately enters the deceleration point respectively, and decelerates at a constant acceleration to a stop at the commanded position. When the controller sends the last position output to the motor command output, it enters the Position Control mode with the same command position setpoint, and holds that position. This mode controls the transient velocity, acceleration, and position response.

Fast Communications

The MC-3000 uses three dedicated motion control processors for the time intensive tasks of servo loop closure and compensation, trajectory calculations, and digital I/O, freeing the PC/XT/AT for other higher level tasks. The PC/XT/AT commands these independent servo processors using a high speed I/O port interface to provide updates of higher level motion control commands and parameters to the motion control processors. This approach provides a cost effective, yet powerful solution to a variety of motion control applications, and enables multiple user motion control application programming options using the PC/XT/AT platform and MC-3000 "C" programming language motion control libraries, MCBasic Language, Motion Control Center Windows interface, or optional multiaxis coordinated motion control libraries including linear and circular interpolation usinf EIA-274 "G" and "M" codes with acceleration and velocity profiling, continuous data streaming of motion control files from the PC/XT/AT hard disk, and multitasking PC/XT/AT based motion control coordination.

Uncommitted Digital I/O

The MC-3000 provides 8 bits of digital inputs, and 8 bits of digital outputs for reading limit switches, actuating other devices, or implementing a user-defined interface. Of the 8 digital inputs, 4 are optically coupled, and 4 are TTL inputs. Of the 8 digital outputs, 4 are optically coupled, and 4 are TTL inputs.

Programming the MC-3000

The MC-3000 motion controller provides three approaches to user programming, including an MCBasic interpreter, a Windows 3.1 based point and click menu of motion commands and separate Dynamic Link Libraries (DLL), and a set of "C" programming language source code libraries allowing integration of the MC-3000 motion control commands with a user supplied "C" language compiler to produce user application programs. These programming options will now be introduced.

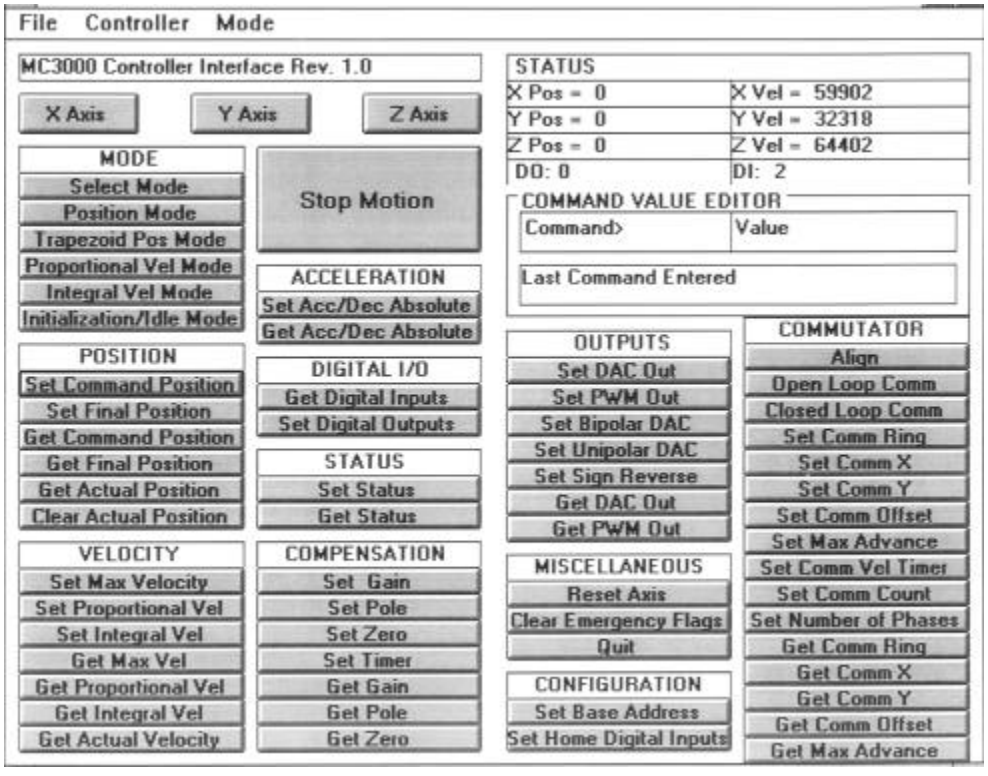
Programming with MCBasic

The MCBasic interpreter uses a set of motion control commands and functions specific to the MC-3000 combined with a "BASIC" programming language interpreter, to allow interactive testing of the MC-3000 operation, and complete user program application development. MCBasic is a DOS based program, similar to the BASIC interpreter provided with many PCs. The MCBasic motion control commands and functions for controlling the MC-3000 motion are identical to the "C" libraries provided, and the Windows based Motion Control Center commands provided with the MC-3000. This simplifies the learning curve as the user experiments with each of the MC-3000 programming techniques.

The "BASIC" language commands provided with MCBasic are generally standard ANSI compliant BASIC. An interactive environment is provided, so that a command can be entered at the MCBasic prompt and it will be executed immediately, or a line with a line number can be entered at the MCBASIC prompt and it will be added to the program in memory. Programs in memory can be saved to disk, or programs on disk can be loaded into program memory for execution.

MC-3000 Windows Interface and DLLs

The MC-3000 also provides a Windows 3.1 Graphical User Interface (GUI) to allow simple point and click operation of the MC-3000 motion control libraries. Additionally the Dynamic Link Libraries (DLL) are provided for inclusion with user written Windows application programs, written in Visual Basic, Borland C, Microsoft C, or any other Windows application development language. Using the MC-3000 Motion Control Center software is easy, due to the menu driven selection of the MC-3000 commands, and interactive command descriptions. The Figure below illustrates the MC-3000 interface in the Motion Control Center environment. The commands in this environment are identical to the MC-3000 commands and functions described previously for the MCBasic environment, and C libraries, so they will not be repeated here.



Programming the MC-3000 Using the Standard C Language Libraries and a User Supplied C Compiler

For more demanding user application programs, the MC-3000 can also be programmed using a commercially available "C" language compiler, and the MC-3000 motion control libraries provided in the EXER.C source code file**.** The syntax and semantics of the MC-3000 motion control libraries are the same as that presented previously for the MCBasic motion control commands. This approach is recommended for more sophisticated users, that have a working knowledge of the "C" programming language, and require the fastest possible speed of execution and degree of control for the application programs.

General Motion Specifications

Position Range	24 bits (16,777,216 {quadrature counts})
Velocity Range	31 – 32*10 [quadrature counts/sec]
Acceleration Range	2 – 2000 [quadrature counts/sec^2]
Loop Sample Time	64 – 2048 [microseconds]
Maximum Encoder Frequency	312.5 [kHz]
PWM Modulation Frequency	20 kHz

Ordering Information

T'he MC-3000 is available with three axes of control standard, or two axes optionally. Other options include a connector board, and cable set for convenient connection of the user signals to the MC-3000. In addition to the standard software, optional multiaxis software is available to allow coordinated linear and circular interpolation using EIA-274D “G” and “M” code commands.

Part Numbers and Descriptions

Part Number	Description
MC-3000	Three axis MC-3000 Motion
MC-3000-2	Two axis MC-3000 Motion Controller
MC-3000CB	MC-3000 Connector Board
MC-3000CA	MC-3000 Cable Set
MC-3000SW1	MC-3000 Multiaxis Software
MC-3000SW2	MC-Multiaxis Software with partial source code

Warranty

Servomotive Corp. warrants the MC-3000 against defects in workmanship and materials for a period of one year after the date of shipment.

Contact Information

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