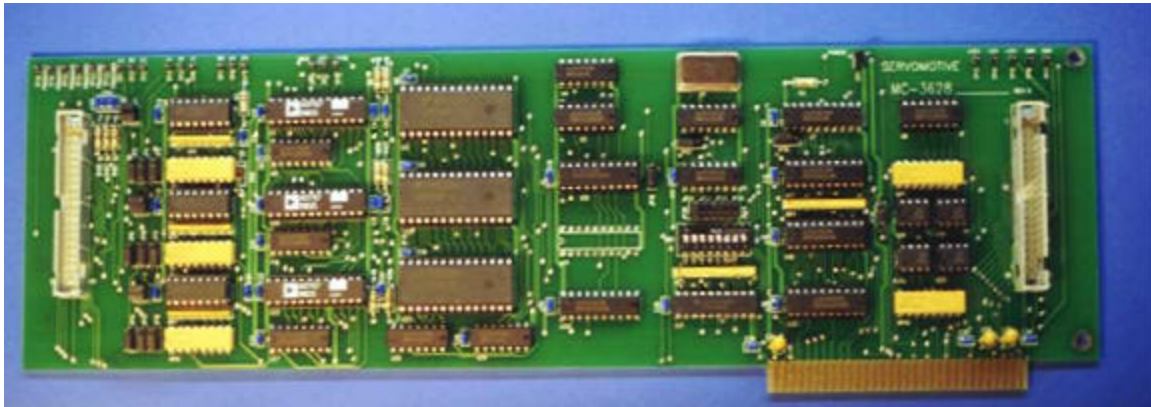


Three Axis PC Based Servo Motion Controller



Features

- Closed-loop servo motion control for three axes, with position and velocity control
- 32-bit position, velocity, and acceleration registers
- Programmable digital compensation filter using 16 bit Proportional Integral Derivative (PID) coefficients
- Fast 341 microsecond sample time
- Encoder feedback, jumper selectable as single ended TTL level or differential inputs
- ± 10 volt output command with 12-bit accuracy for the MC-3628, or PWM sign and magnitude output command with eight-bit accuracy available for the MC-3629
- 16 digital inputs, eight optically isolated and eight TTL levels
- Eight digital outputs, open collector TTL levels
- Real-Time programmable host interrupts from each axes of motion, and from 3 uncommitted digital inputs
- 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
- Optional multi-axis coordinated motion control libraries including linear and circular interpolation using EIA-274D 'G' and 'M' codes with acceleration and velocity profiling, data streaming and multitasking PC/XT/AT based motion control coordination

Overview

The MC-3628 motion controller is a PC/XT/AT (ISA Bus) compatible application board designed around three of the National Semiconductor LM-628 motion control ASICS. The MC-3629 motion controller is identical to the MC-3628, except that it uses three of the National Semiconductor LM-629 motion control ASICS. The MC-3628 and MC-3629 provide identical functionality, except for the motor command interface. The MC-3628 provides a ± 10 volt analog motor command output using a 12-bit DAC. The MC-3629 provides a Pulse Width Modulated (PWM) output using TTL level PWM-SIGN and PWM-MAGNITUDE outputs with eight-bit accuracy. The remainder of this data sheet will refer to the MC-3628 only, except where differences exist for the MC-3629.

The MC-3628 provides three axes of closed loop independent axes servo motion control. With additional software, it supports multi-axis coordinated motion control. In addition, eight optically coupled digital inputs are provided, two of which have PC/XT/AT interrupt capability, and eight TTL level digital inputs are provided, one of which has PC/XT/AT interrupt capability. Also eight open collector TTL level digital outputs are provided.

All that is required for a three axis closed loop servo system is a PC/XT/AT computer or compatible, an MC-3628 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 are shown below in Figure 1

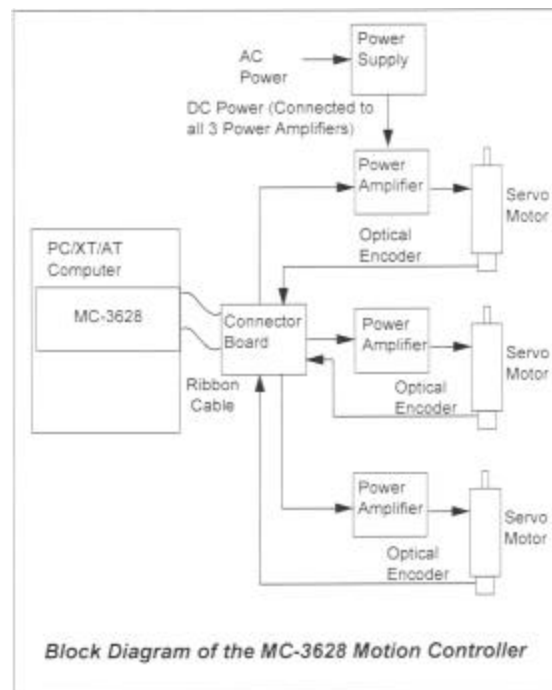


Figure 1 MC-3628 Interconnect Diagram

The MC-3628's most attractive features are its high-resolution capability with 32-bit position, velocity, and acceleration resolution, allowing small variations in velocity and acceleration to be programmed. Also the compensation filter uses a straightforward yet powerful second order Proportional, Integral, Derivative (PID) filter with 16 bit coefficients. The PID filter also has good resolution, allowing precise tuning of the servo, and with an integrator term that includes an integration limit, it allows accurate positioning with zero steady state error. Finally the MC-3628 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 functions.

MC-3628 Control Modes

The MC-3628 provides three independent axes of motion control, where each axis can be operated in position or velocity mode.

- The *position control mode* allows you to specify the final position, acceleration, and maximum velocity during the move.
- The *velocity control mode* allows you to specify the acceleration, direction, and desired velocity of the move.

The position, velocity, and acceleration are all 32 bit registers, providing a large dynamic range and high resolution for the programmable motion. The position units are quadrature counts (4 times the encoder lines per revolution). The velocity is in units of quadrature counts per sample time, times 65,536. The acceleration is in units of quadrature counts per sample time squared, times 65, 536. The sample time is 341 microseconds standard. The velocity and acceleration are scaled by 65,536 to allow the lower 16 bits to represent fractional values, so that the velocity and acceleration commanded can be very small despite the fact that the sample time is very fast. The position and velocity commands can be programmed "on the fly" (while a previous move is still underway), enabling contouring, multi-axis coordination, and complex motion profiles.

Fast Communications

The MC-3628 uses three dedicated motion control processors for the time intensive tasks of servo loop closure and compensation, trajectory calculations, and real-time interrupts based on motion and 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 control application programming options using the PC/XT/AT platform and MC-3628 "C" programming language motion control libraries, MCBasic Language, Motion Control Center Windows interface, or optional multi-axis coordinated motion control libraries,

including linear and circular interpolation using EIA-247 "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.

I/O and Interrupts

The MC-3628 provides 16 bits of digital inputs, and eight bits of digital outputs for reading limit switches, actuating other devices, or implementing a user-defined interface. Of the 16 digital inputs, eight are optically coupled, and eight are TTL inputs. The digital outputs are open collector TTL output levels.

The MC-3628 also provides interrupt support to the PC/XT/AT from each LM-628 motion controller, and up to three of the digital inputs. This allows fast error handling, convenient interfacing and software design for critical I/O, and simplified coordinated motion control programming.

Programming the MC-3628

The MC-3628 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-3628 motion control commands with a user supplied "C" language compiler to produce user application programs. These programming options will now be introduced.

Programming with MC Basic

The MCBasic interpreter uses a set of motion control commands and functions specific to the MC-3628 combined with a "BASIC" programming language interpreter, to allow interactive testing of the MC-3628 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-3628 motion are identical to the "C" libraries provided, and the Windows based Motion Control Center commands provided with the MC-3628. This simplifies the learning curve as the user experiments with each of the MC-3628 programming techniques.

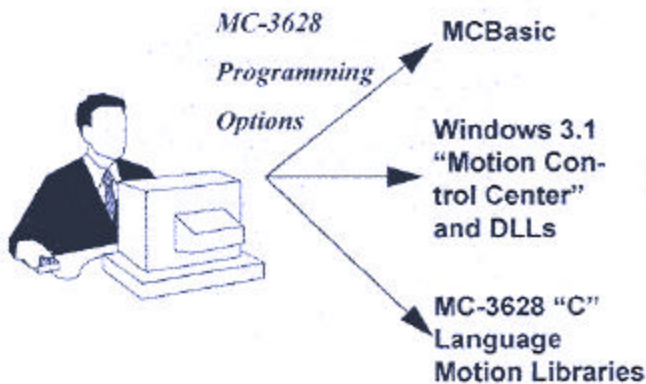
The "BASIC" language commands provided with MCBasic are generally standard ANSI Basic compliant BASIC. An interactive environment is provided, so that a command can be entered at the MCBasic prompt and it will be executed immediately, or a line with a line number can be entered at the MCBASIC prompt 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. To illustrate the simplicity and power of the

MCBasic programming approach, we provide sample MCBasic programs with each board.

MC-3628 Windows Interface and DLLs

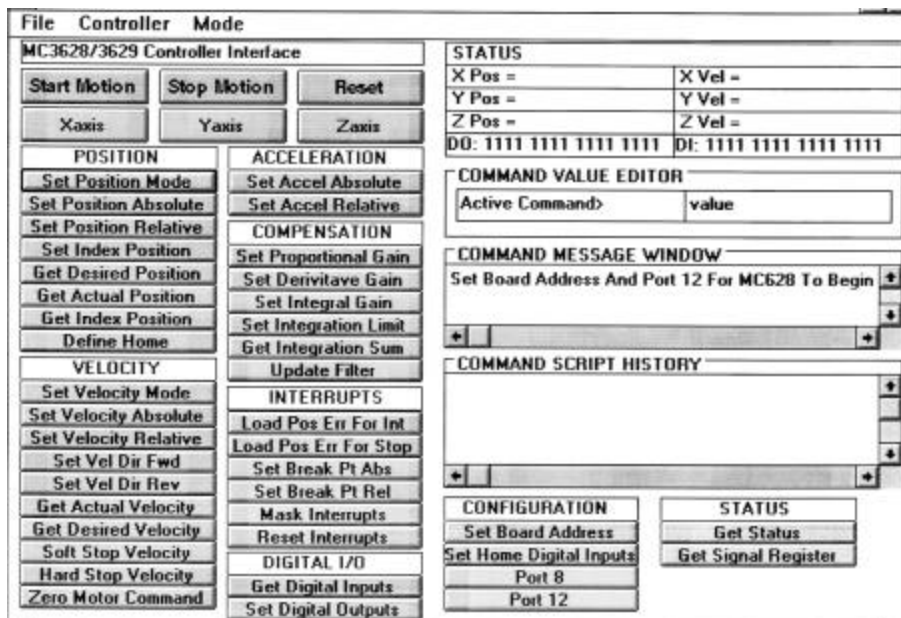
The MC-3628 also provides a Windows 3.1 Graphical User Interface (GUI) to allow simple point and click operation of the MC-3628 motion control libraries. Additionally the Dynamic Link Libraries (DDL) are provided for inclusion with user written Windows application programs, written in Visual Basic, Borland C, Microsoft C, or any other Windows application development language.

Using the MC-3628 Motion Control Center software is easy, due to the menu driven



"The MC-3628 Offers Multiple Programming Options"

selection of the MC-3628 commands, and interactive command descriptions. The Figure below illustrates the MC-3628 Motion Control Center interface.



The commands in this environment are identical to the MC-3628 commands and functions described previously for the MCBasic environment, and C libraries, so they will not be repeated here.

MC-3628 Programming the MC-3628 Using the “C” Language Libraries and a User Supplied C Compiler

For more demanding user application programs, the MC-3628 can also be programmed using a commercially available "C" language compiler, and the MC-3628 motion control libraries provided in the LM628.C source code file. The syntax and semantics of the MC-3628 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.

Specifications

Motion Specifications:

Position Range:

-1,073,741,824 to 1,073,741,823

Velocity Range:

0 to 1,073,741,823/1216 counts/sample time, i.e. 0 to 16,383 counts/sample, with a resolution of 1/16 counts/sample

Acceleration Range:

0 to 1,073,741,823/2¹⁶ counts/sample time, i.e. 0 to 16,383 counts/sample², with a resolution of 1/16 counts/sample²

Loop Sample Time:

341 microseconds standard, or 255 microseconds optional

Maximum encoder frequency:

187.5 kHz

PC/XT/AT Addressing

The MC-3628 interface uses a byte wide I/O port interface to the PC/XT/AT bus (ISA bus). The address map decoding occupies eight contiguous registers, including the BASE address and seven greater contiguous registers. The base address is DIP switch selectable. This allows the MC-3628 to be compatible with PC/XT/AT computers using numerous other application cards, and allows multiple MC-3628 cards to be installed in a single computer.

MC-3628 Address Assignment:

Address	Default	Function
Base	768	Axis 0 Status/Control Port
Base+1	769	Axis 0 Data Port
Base+2	770	Axis 1 Status/Control Port
Base+3	771	Axis 1 Data Port
Base+4	772	Axis 2 Status/Control Port
Base+5	773	Axis 2 Data Port
Base+6	774	Digital Input/Output Port 0 (read/write)
Base+7	775	Digital Input Port 1 (read)

Ordering Information

The MC-3628 is available with three axes of control standard, or one or two axes optionally. Other options include a connector board, and cable set for convenient connection of the user signals to the MC-3628. 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-3628	Three axis MC 3628 Motion Controller
MC-3628-2	Two axis MC-3628 Motion Controller
MC-3628CB	MC-3628 Connector Board
MC-3628CA	MC-3628 Cable Set
MC-3628SW1	MC-3628 Multiaxis Software
MC-3628SW2	MC-3628 Multiaxis Software with partial source code

Warranty

Servomotive warrants the MC-3628 against defects in workmanship and materials for a period of one year after the date of shipment.

Contact Information

Servomotive Corporation
P.O. Box 905
Worcester, MA 01613
USA
Phone: (508) 791-2221
Fax: (508) 791-7893
www.servomotive.com