# DC MOTION CONTROL SYSTEMS
## MCS-920 Series

19 Linden Park Rochester, NY 14625 (716) 385-3520

The MCS-920 Series are off-the-shelf, Pulse Width Modulated DC Motion Control Systems which deliver high performance electronic motion control for single or multi-axis applications. Nine standard models include integral Programmable Motion Control and PWM DC Servodrives. ORMEC's standard Motion Programming Language, now with integrated math capabilities (MPL+MATH), makes them ideal for closed loop servo control applications.

These units close the current, velocity and position loops in hardware to create the highest bandwidth position control system on the market. ORMEC's proprietary software controlled tuning circuitry eliminates the use of potentiometers and provides the industry's fastest speed of response.

A special function of the MCS-920 Series is its ability to provide electronic lineshafting for up to 32 servomotors. The electronic lineshaft consists of a two-wire motion reference bus which can be "driven" or "followed" by any individual MCS system under software control. High resolution ratioing (precisions finer than one part in 250 million), zero drift gear ratioing, distributed processing and the ability for a separate position encoder to drive the electronic lineshaft provide maximum flexibility.

The MCS-920 Series can be easily interfaced to either host computers or programmable controllers. Operator interface devices such as thumbwheel switches, digital readouts and industrial keypads are easily integrated into an MCS-920 system.

These units are available in two basic models, which provide adjustable power ranges from 230 watts to 2.0 kilowatts. Compatible DC motors feature a range of continuous torques from 3.9 to 48 lb-in. and include integral, highly reliable, digital position encoders with solid state light sources and resolutions to 12,000 counts per revolution.


**ORMEC'S MCS-920 Series**

***Integral Programmable Motion Control and DC Servodrive***
- ★ **16 discrete I/O points, expandable to 40**
- ★ **optional analog inputs, analog output & serial port**
- ★ **multi-drop bussed serial communications**

***Powerful yet Simple Motion Programming Language.***
- ★ **Calculator like simplicity with integrated 32-bit math**
- ★ **Engineering units, logical operators & 10 non-volatile registers**
- ★ **Wide variety of operator interface devices**

***Compatible DC Servomotors with Speeds to 4000 RPM***
- ★ **Power from fractional to 1 hp, torques from 12 to 96 lb-in peak**
- ★ **Acceleration rates to 16,000 radians/sec$^2$**
- ★ **Position resolution to 12,000 cts/rev**

***Electronic Lineshafting Capability***
- ★ **Up to 32 units on two-wire bus with distributed processing**
- ★ **Speed resolution finer than one part in 250,000,000**
- ★ **Zero Drift operation for virtually any gear ratio**

The MCS-920 is easy to use. Simply hook up power and plug in the servomotor to create a high performance DC-PWM servo system.

## Easy to Use DC Servo Based Motion Control

Using ORMEC's MCS-920 Series is as easy as hooking up standard 115 VAC power, plugging in a compatible DC servomotor and interactively commanding motion or programming it as you would a calculator.

You don't have to worry about integrating the servodrive, selecting the right logic or machine I/O power supplies or specifying the correct circuit breakers because it's all been done for you. This integrated, pre-engineered package removes all these worries and offers an integrated, modular approach which allows you to concentrate on improving your machine's performance.

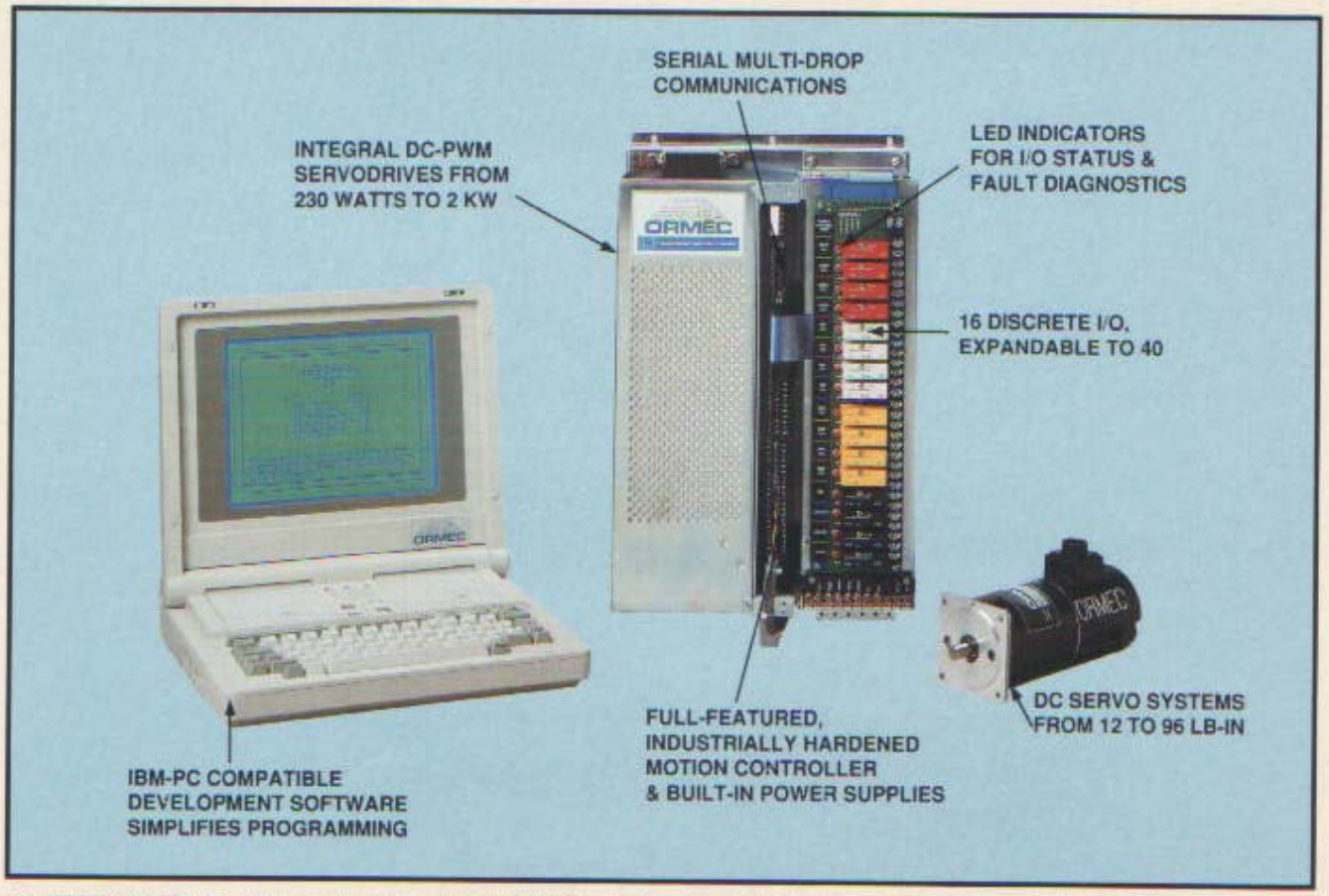
The MCS-920 series comes with ORMEC's full Motion Programming Language (MPL), now enhanced with math and operator I/O capabilities to provide standard software for a range of applications. MPL is "calculator-like" in simplicity, intuitive, and easy to learn which shortens the time needed to write motion control programs.

### PROVEN TECHNOLOGY

While the MCS-920 Series is at the forefront of electronic motion control technology, its internal components are field proven. Thousands of units are operating in the field in tough industrial applications, many of which are in 24 hour per day operation.

The high level of integration and modularity of this approach, combined with the reasonable price of the MCS-920 Series, make it one of the most cost effective approaches in the market today. This is especially true if hidden costs associated with assembling a hodge-podge of motion control equipment into an integrated system is taken into account.

If you would like to see how easy the MCS-920 series is to use, call ORMEC today and prove it to yourself. We guarantee that this new system is so easy to install and use that you'll be creating motion and writing MPL programs in less than one hour.




**The MCS-920 Series offers a plug-together DC-PWM motion control system which has the performance needed for the most stringent applications. This modular approach provides a motion system which is cost-effective for single and multi-axis applications. Simply apply power and hook up your motor, and you're ready to go.**

## Powerful Single Axis Motion Controller and Language

To meet the needs of today's flexible automation applications, a motion controller must do more than create motion. It must provide a wide range of standard motion control software, methods for coordinating machine I/O functions and the ability to work with many operator interface devices.

### PROGRAMMING LANGUAGE

The MCS-920 Series Motion Controllers feature a full Motion Programming Language, called MPL, which is "calculator like" in simplicity, yet powerful and fast in operation. (Reaction times are normally on the order of 1 millisecond.) This language operates independent of the motion being created allowing the motion controller to deal with information about the motion in process as well as machine I/O.

### MOTION CONTROL WITH MATH

MPL now has a fully integrated math capability. Not just four-function arithmetic, but 20 numeric and logical functions, combined with ten 32 bit non-volatile registers. Math formulas and logical expressions can be used directly in MPL's intuitive commands for setting motion parameters and controlling motion. Or math formulas and logical expressions can be programmed to use real-time motion data such as current position or speed.

### ENGINEERING UNITS AND MUCH MORE

MPL with MATH can interface with a variety of I/O devices like thumbwheel switches, operator keypads and displays in engineering units. It also has the power to display information, provide English language prompting, and calculate multiple operating parameters such as accelerations, velocities and positional delays from one operator input such as machine speed (in units per minute). Conditional program branching and function calls based on the functions and registers are also provided.

### EXTENDED I/O CAPABILITY

The standard MCS system, in addition to its serial communications port has 16 discrete I/O lines. With the optional EIO-900 daughter board, the user can add an additional RS-485/422 serial device, twenty-four discrete I/O points, two 8-bit analog inputs and one 8-bit analog output.

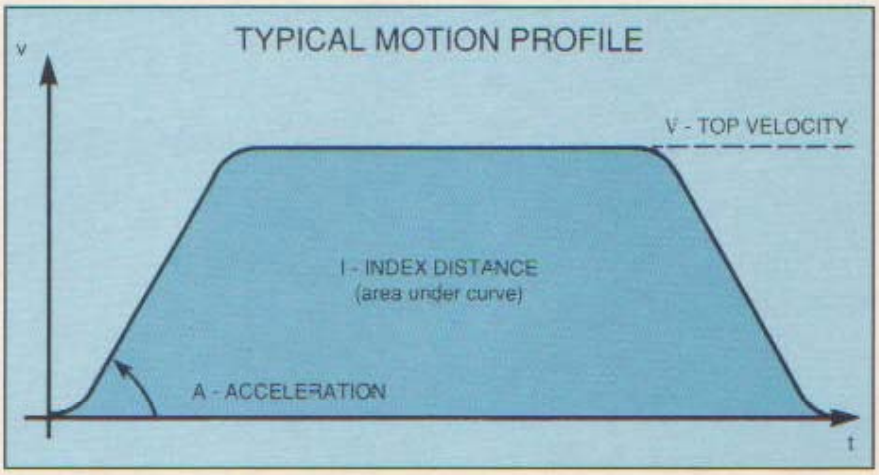
### EXTENDED HARDWARE COUNTER CAPABILITY

In conjunction with an optional EBC-900 daughter board, the user has access to an AM-9513 LSI counter chip which provides five 16-bit up/down hardware counters which can be used in many, many ways.


**WIDEST VARIETY OF OPERATOR INTERFACE DEVICES**
**MPL MATH provides the ability for the MCS system to work with a wide variety of operator interface devices. An MCS can interface to industrial control panels or data entry controllers and can easily deal with Industrial Keypads, up to five thumbwheel switches (totaling up to 28 decades), up to thirty-two 20 character by 1 line alphanumeric displays, four six-digit numeric readouts, and virtually any "dumb terminal like" serial device.**

## Highest Quality of Controlled Motion

The quality of controlled motion is greatly underrated as a factor in selecting motion control equipment. Yet the quality of motion is not only a primary factor in overall system performance, but also key to system reliability. ORMEC takes this issue seriously, and has made quality closed loop motion a primary goal of the MCS-920 Series.




**ORMEC motion control technology provides s-curve, linear and parabolic accelerations as standard. For a small non-recurring engineering charge, you can order your own custom acceleration profile.**

### CLOSES ALL THREE MOTION CONTROL LOOPS

The MCS closes the current, velocity and position loops in hardware, creating the highest bandwidth position control system on the market. The benefit to the user is not just speed of response, but also quality and precision of the machine motion. Higher speed of response not only results in higher productivity, but also greater overall machine reliability and improved product quality. Examples of the effect of bandwidth on product quality include superior surface finish when grinding under servo control and tracking precision in manufacturing media products, such as data tape and optical disks.

### NO POTENTIOMETERS FOR TUNING

The MCS product closes both analog velocity and digital position loops in hardware with software controlled gains and servo loop compensators. Velocity loop feedforward and Type-2 position loops are software controlled. Software controlled loop parameters provide the ability to vary the tuning during machine operation and the ability of the system to compensate for a wide range of load inertias.

### HIGHEST PRECISION

Our standard DC servomotors feature encoder resolutions to 10,000 counts per revolution and quality integral DC tachometers. Phase lock loop positioning allows these motors to track commanded motion at the full accuracy of the encoder. ORMEC positioning technology has been used in rotary applications with greater than 250,000 counts per revolution and in linear applications to precision of less than a micron.

### FASTEST SPEED OF RESPONSE

The MCS-920 Series, in conjunction with our MTE-200, 350 and 530 Series DC motors, allows high speed precision indexing, settling to an accurate final position in as little as 10 milliseconds. The MTE-200 Series DC motors have continuous stall torques ranging from 3.3 to 4.4 lb-in, and provide peak torques up to 12 lb-in. The MTE-350 Series DC motors have continuous stall torques from 4.3 to 9.4 lb-in, and peak torques from 12 to 25 lb-in, while the MTE-530 Series provide continuous stall torques from 25 to 48 lb-in, and peak torques from 47 to 96 lb-in.

### QUICKEST REACTION TIME

A double buffered sensor input allows the MCS family to initiate motions in as little as 4 microseconds (yes microseconds). This feature has allowed high response servo systems to function as continuous motion registration controllers, high speed press feeds, registration controlled rotary flying shears, and other difficult applications.

### DISTRIBUTED FEEDBACK

Many high precision systems, using either rotary or linear feedback, benefit from placing the position transducer directly on the machine under control. While affording precise position feedback from the functional part of the machine, this can result in loss of control precision from the reduced bandwidth of the position loop due to mechanical considerations. ORMEC position technology allows *distributed feedback*, with the analog velocity loop still closed around the motor for maximum response, and the digital position loop closed around the total machine for maximum precision. And all the feedback loop parameters are software controlled.

### SELECTABLE TORQUE LIMIT

The MCS-920 Series provides a selectable torque limit and also allows the torque limit to be set remotely.

## Multi-Axis Capabilities & Precision Electronic Lineshafting

The MCS-920 Series are modular motion controllers which can be easily integrated into multi-axis systems. Simply select the proper units to meet your system's various speed and torque needs. Hook up standard 115 VAC power (no isolation transformers are required); connect the units via ORMEC's multi-drop serial bus with mass termination cable; and, optionally attach the two-wire electronic lineshaft if precise multi-axis synchronization is key to the success of the application.

The result is a multi-axis system which features distributed processing power making it cost-effective, flexible, powerful and easy to program.

### ELECTRONIC LINESHAFTING

The MCS series motion controllers have a heritage of electronic lineshafting, along with some new improvements to that heritage. The electronic lineshaft consists of two-wire motion reference bus which can be "driven" or "followed" by any individual MCS system. In addition, individual systems can operate independently of the electronic lineshaft as appropriate under software control. Up to 32 servomotors can be synchronized on this bus.

### HIGHEST RESOLUTION RATIOING

Standard on the MCS-920 Series is the ability to operate at a ratio to the electronic lineshaft to a precision finer than one part in 250 million. This capability has proven invaluable in precise winding and spooling applications.

### ZERO DRIFT GEAR RATIOING

Even systems with a resolution of one part in 250 million can "drift" (a very small, but unacceptable amount) when attempting to run at a gear ratio specified by a rational number such as 1/3 or 23/67. ORMEC's electronic lineshafting technology allows specifying the gear ratio as a fraction, with both the numerator and denominator specified as 16 bit integers, providing zero drift operation.

### ELECTRONIC CAMS, LINKAGES, AND SYNCHRONOUS INDEXES

A major benefit of electronic lineshafting is the flexibility with which the individual servomotors can operate with respect to the lineshaft. Programming an individual servomotor for synchronous or asynchronous operation with the electronic lineshaft is as easy as typing a few strokes on a calculator.

### DISTRIBUTED PROCESSING POWER

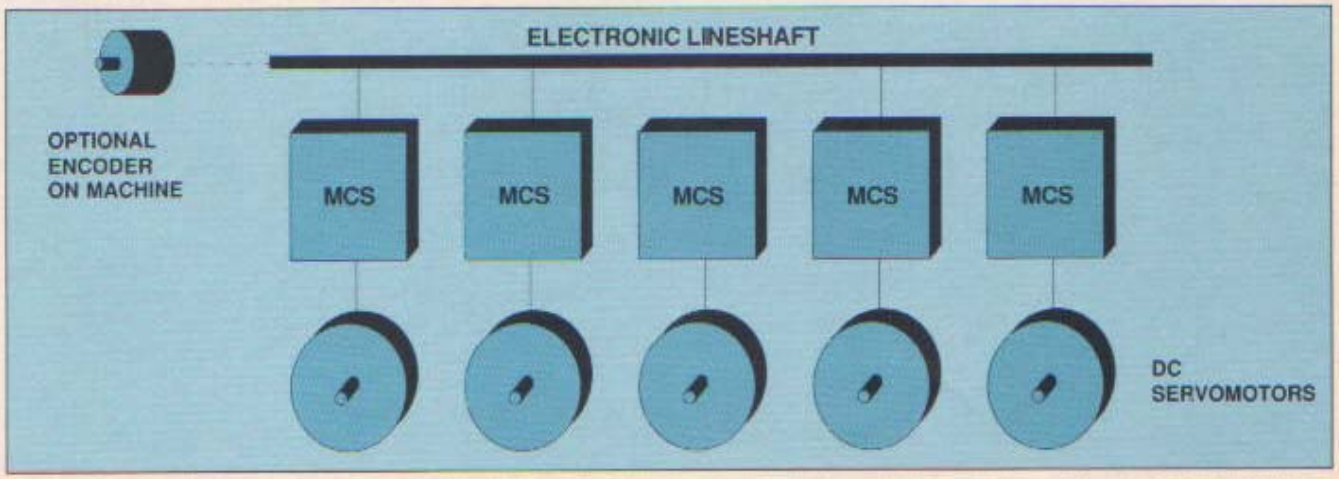
The fact that each MCS unit can execute its own MPL programs, while both controlling the servomotor and communicating with a host computer, makes high response multi-axis systems not only possible, but easy to program.

### CONTOURING

Contouring capability is provided and has proven useful in a number of application specific instances, particularly in the area of electronic lineshafted systems, but also for other applications like X-Y Tables.

### ENCODER DRIVEN LINESHAFT

The electronic lineshaft can also be driven by a remotely mounted position encoder, enabling the motion controllers to operate in synchronism with non-servo controlled machines.




**Up to 32 Individual MCS systems can be attached to the electronic lineshaft. Any motion controller can drive the electronic lineshaft, or it can also be driven by a remotely mounted position encoder. Individual MCSs, with their attached servomotors, take the place of traditional gearboxes, differential gearboxes, speed variators, cams, four-bar linkages, crank mechanisms and other mechanical devices. They provide the flexibility to individually control motion in synchronism with, or independent of, the electronic lineshaft under computer control.**

## Unique Host Computer & Programmable Controller Interfaces

A standard MCS-920 Series system can be used stand-alone, but many applications are part of an overall integrated automation system. These machine control systems utilize a variety of approaches, including programmable controllers and host computers. It is often a requirement for the motion controller to interface cleanly to the total machine control environment, either receiving or providing information to a host system. ORMEC has developed a number of cost-effective and powerful host interfaces for a wide range of application needs.

### SERIAL MULTI-DROP BUSSED COMMUNICATIONS

Up to 32 MCS-920 Series Motion Controllers can be attached to one serial port of a host computer on a multi-drop serial communications bus. The serial bus approach provides a significant speed and reliability advantage over competitive "loop communications" approaches. A simple two character attention sequence is used by the host to "dial up" the motion controller of choice. Communications are at speeds up to 38.4k baud, which takes 250 micro-seconds per character.

### EASILY INTEGRATED WITH PROGRAMMABLE CONTROLLERS

The MCS-920 Series is easily integrated with programmable controllers, whether large or small. There are two approaches to multi-axis motion control applications using Programmable Controllers.

Up to 8k of "canned" motion control routines can be written and easily executed under the control of even the smallest programmable controller through discrete I/O points.

Any programmable controller with ASCII I/O capability can coordinate the activities of up to 32 MCS systems over the serial communications bus as described above. ORMEC and its customers have experience using ASCII I/O Interfaces with a number of programmable controllers including Allen Bradley, G.E. and Modicon.

### EASILY INTEGRATED WITH OTHER COMPUTERS

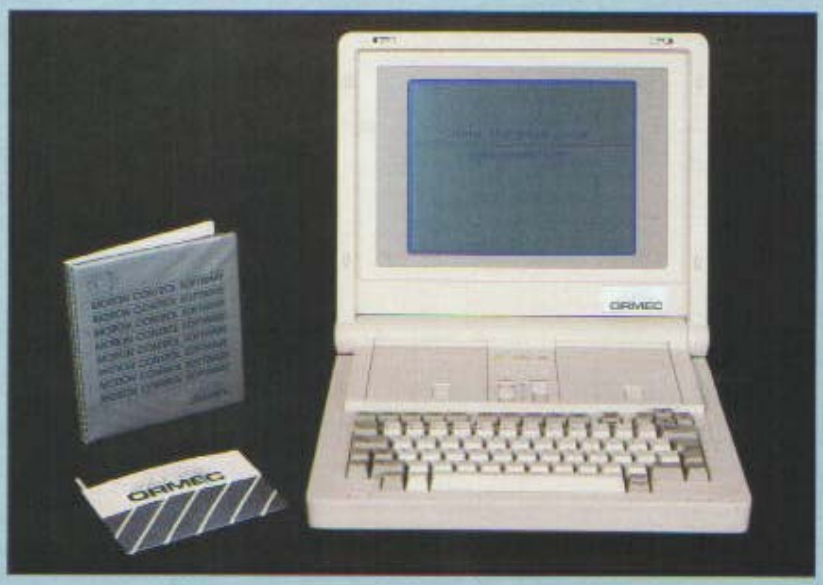
MCS-920 Series Motion Controllers can have their activities coordinated by virtually any host computer over the serial communications bus. ORMEC and its customers have experience interfacing this technology with IBM-PCs, STD-Bus Computers, Multibus Computers, DEC LSI-11 and VAX Computers, and others.

### SYSTEM STATUS POLLING

This unique feature allows considerable host communications even while the MCS system is executing an MPL program, including: reading and writing ten 32 bit registers, polling for an error, checking the current velocity, position or position error, status of the digital I/O and more.

### COMMUNICATIONS ERROR CHECKING

MPL's *communications checksum* feature allows the host computer to do communications error checking prior to starting critical motion functions.




**IBM-PC COMPATIBLE DEVELOPMENT SYSTEM**
**An example of ORMEC's powerful host communications is our *Laptop Development System* used to develop and maintain motion control systems. Standard software shipped with this system allows the user to interactively develop and/or troubleshoot single or multi-axis servo systems. It provides convenient upload/download features and a powerful documentation environment including a built-in text editor for editing and later archiving motion control programs. Real-time performance of your machine can be easily monitored without disturbing programs and the system can be interrogated to simplify maintenance. A servo analysis program provided calculates the torque requirements, G-forces, linear parameters & the voltage requirements of your machine to help select appropriate motors & drives.**

## Integrated Safety Features and Fault Detection

The MCS-920 Series feature integral circuit breakers for both control power and main power, as well as integrated fault detection capabilities.

### FAULT DETECTION & DIAGNOSTICS

The MCS-920 Series will detect the following errors and take the action indicated. MPL-MATH also provides the flexibility to both trap errors and take appropriate action which makes for fully robust applications programs.

**BUILT-IN FAULT DETECTION FEATURES**

| Error | Action |
|---|---|
| Servo Bus Overvoltage | Disable Output Transistors[1] |
| Servo Bus Undervoltage | Disable Output Transistors |
| Excess Main Circuit Current | Disable Output Transistors |
| Main Circuit Breaker Trip | Disable Main Power |
| Control Circuit Breaker Trip | Disable All Power |
| Transformer Thermal Overload | Disable Output Transistors |
| PMC +5VDC Power Supply Failure | Disable Output Transistors |
| Motion Controller RAM Failure | Flash LED on PMC[2] |
| Motion Controller ROM Failure | Flash LED on PMC |
| MPL Program Memory Failure | Flash LED on PMC |
| MPL Program Error | MPL+MATH allows the user the flexibility to trap on any MPL programming error(s) and take user defined action such disabling the servodrive's output transistors. |

[1] Anytime the system detects a fault, the fault must be reset before the operation can resume.
[2] If these failures are detected at powerup, the motion controller will not run its "startup program" or enable the servodrive. In addition, the application program can check for failures and automatically disable the servodrive.

## General Specifications

**Environmental:**

Operating Temperature: 0 to +50°C
Storage Temperature: -20 to +85°C
Operating & Storage Humidity:
0 to 90%, non-condensing

**Incoming Power:**

115 VAC, single phase, ±10%, 50/60 Hz

**Servodrive Power Supply:**

75, 100, 125 or 150 VDC, selectable

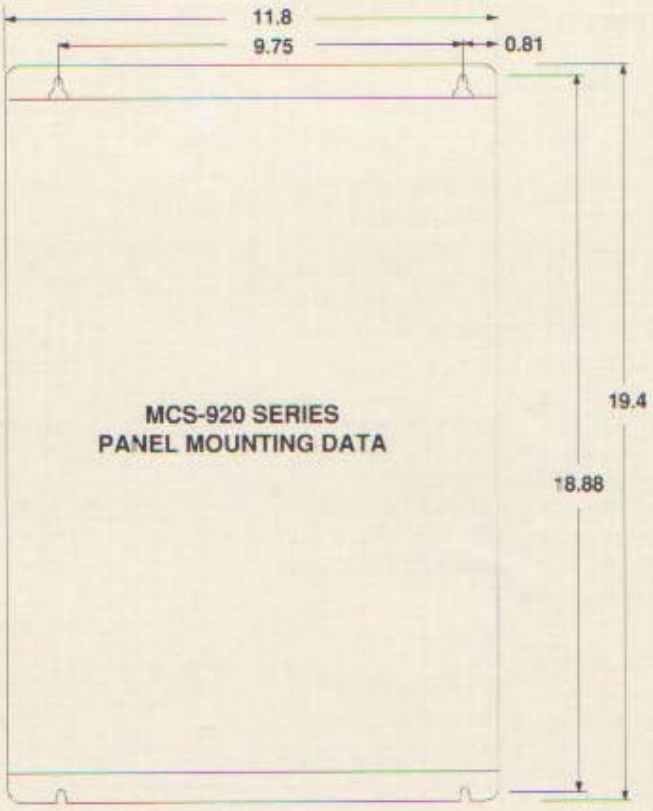
**Available User Power Supplies:**
+5VDC at 500 ma
+12 VDC at 200 ma
+24 VDC at 1.2 amps (optional)

**Serial Communications:**

RS-232C, RS-422/485/449 multi-drop, autobauds at rates of 38.4k, 19.2k, 9600, 4800, 2400, 1200, 600 or 300

**Mounting:**

Vertically oriented base mounting,
4 each #10 bolts
Bolt pattern: 18 7/8"h x 9 3/4"w




**MCS-920 SERIES PANEL MOUNTING DATA**

**PANEL DEPTH REQUIREMENT:**

9.5 inches for all models

ORMEC reserves the right to change specifications without notice. - August 1988

## System Performance Specifications & Ordering Guide

| Model No. | Power[1] | Weight | Voltage[2] | Current[3] | Compatible Servomotors | | |
|---|---|---|---|---|---|---|---|
| MCS-920/A | 0.6 kw | 46 lbs | 75 | 16/3.9 | MTE-213 | 4,000 RPM | 12/3.3 lb-in |
| MCS-920/B | 0.6 kw | 46 lbs | 75 | 16/4.6 | MTE-262 | 3,000 RPM | 10/3.3 lb-in |
| MCS-920/C | 0.6 kw | 46 lbs | 75 | 16/5.2 | MTE-263 | 3,000 RPM | 12/4.4 lb-in |
| MCS-920/D | 0.7 kw | 46 lbs | 75 | 16/5.3 | MTE-350 | 3,000 RPM | 12/4.3 lb-in |
| MCS-920/E | 0.8 kw | 46 lbs | 75 | 16/5.7 | MTE-351 | 3,000 RPM | 14/5.7 lb-in |
| MCS-920/F | 0.9 kw | 46 lbs | 100 | 16/5.4 | MTE-352 | 3,000 RPM | 25/9.7 lb-in |
| MCS-920/G | 1.3 kw | 46 lbs | 125 | 16/8.5 | MTE-533 | 2,500 RPM | 47/25 lb-in |
| MCS-920/H[4] | 1.5 kw | 46 lbs | 125 | 26/12 | MTE-535 | 2,500 RPM | 76/38 lb-in |
| MCS-920/J[4] | 1.8 kw | 46 lbs | 125 | 30/15 | MTE-537 | 2,500 RPM | 96/48 lb-in |

[1] Power listed is the recommended incoming power-line service [2] Voltage listed is the servodrive bus power supply voltage, as shipped from the factory.
[3] Current listed is peak/continuous PWM output current with the specified servomotor. [4] These units have a PWM switching frequency of 5 kHz, instead of 16kHz

**Complete Model Number:**
The standard part number for the MCS-920 is: **MCS-920/AEI**

**Option Codes:**
- A-J: Specifies the bus voltage and servodrive output peak and RMS current adjustments as the unit is shipped from the factory.
- E: Changing this option code to a "D" adds an internal DC I/O power supply.
- I: Changing this option code to an "R" removes the Opto-22 compatible I/O rack, for systems not requiring I/O modules.

### OPTIONAL MODULES

EIO-900 — **Extended I/O Module**: Optional module adds I/O capability to MCS-920 Series:
- ❒ 24 digital I/O points for discrete I/O, thumbwheels or numeric displays
- ❒ two 8-bit analog inputs and one 8-bit analog output
- ❒ one RS-485/422 serial port for operator interface devices

EBC-900 — **Encoder Back-up Compensator**: Optional module provides five 16-bit software configurable up/down counters, and allows MCS-920 Series systems to precisely synchronize motion with other machinery by using an optical incremental encoder as the machine position transducer

### REGENERATIVE DISCHARGE

RDU-920 — **Regenerative Discharge Unit:** Panel-mounted unit provides up to 100 watts of regenerative discharge capability

### MACHINE I/O ACCESSORIES

Standard MCS-920 series units are equipped with a 16-slot, Opto22 compatible I/O rack for coordinating machine I/O functions, and may be omitted if it is not required for your application. I/O modules are not included with the unit, but are available separately.

IDC-5 — **DC Input Module**: 32 VDC max; white; optically isolated

IDC-5B — **DC Input Module, Fast Response**: 32 VDC max; white; optically isolated

IAC-5 — **AC Input Module**: 140 VAC max; yellow; optically isolated

ODC-5 — **DC Output Module**: 60 VDC max; red; optically isolated

OAC-5 — **AC Output Module**: 140 VAC max; 3A; black; optically isolated; zero-crossover load switching