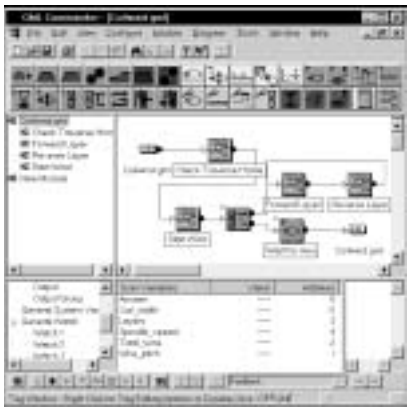
Rockwell Automation
Allen-Bradley

IMC™ S Class
Compact Motion Controllers
(IMC-S/23x Models)

Product Data



Product Description

The IMC-S/23x is a compact, rugged, microprocessor-based two- or four-axis servo motion controller. By including the logic and field power supplies, the IMC-S/23x provides a completely programmable, stand-alone motion and logic controller suitable for a wide variety of industrial applications.

The IMC-S/23x, in conjunction with external drive systems and feed-back encoders, provides two or four axes of closed-loop point-to-point positioning with profile (trapezoidal, parabolic, or S-curve), velocity, acceleration, and deceleration control as well as multi-axis linear, circular, or helical interpolation. The electronic gearing feature allows any axis to be slaved to another at a programmable ratio. The electronic cam feature allows coordinated motion profiles which are functions of time or position of another axis. Sophisticated phase shift, auto-registration, and auto-correction capabilities allow many complex motions and synchronizations to be easily programmed. General-purpose discrete I/O, analog inputs, analog outputs, etc. are provided by direct connection of Allen-Bradley Flex™ I/O modules. Up to eight Flex I/O modules—providing a total of 128 discrete I/O points—may be connected directly to the IMC-S/23x. Analog inputs and outputs can be substituted for discrete I/O blocks for increased I/O flexibility.

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Application programming of the IMC-S/23x for any application is accomplished with GML, the exclusive Graphical Motion Control Language from Allen-Bradley. Using GML, over 100 different commands are available to completely customize operation of the IMC-S/23x for your specific application. Complete application programs are downloaded to the IMC-S/23x via a field-configurable RS-232C or RS-422 port where they are stored in non-volatile memory (write-protected battery-backed RAM). Complete hookup diagnostics and automatic servo setup routines for self-tuning the servo parameters make setting up the IMC-S/23x quick and easy.

A dedicated serial port—which can be field-configured for RS-232C, RS-422, or Allen-Bradley DH-485 communications—is provided for the man-machine interface (MMI). Connection of the MMI device is via an AT-compatible DB-9 connector (RS-232C or RS-422) or RJ-45 connector (DH-485), both located on the front panel.

The Remote I/O option allows the IMC-S/23x to communicate with other Allen-Bradley devices via Remote I/O. The motion controller can communicate directly with an A-B PLC® using both discrete and block transfers. The AxisLink option allows axes on other IMC S Class controllers or ALECs (AxisLink Encoder Converter modules) to be used as master axes for electronic gearing and cams. This ability provides real-time coordination for distributed, multi-axis systems in electronic gearing, cam, lineshaft, and synchronization applications.

Product Features

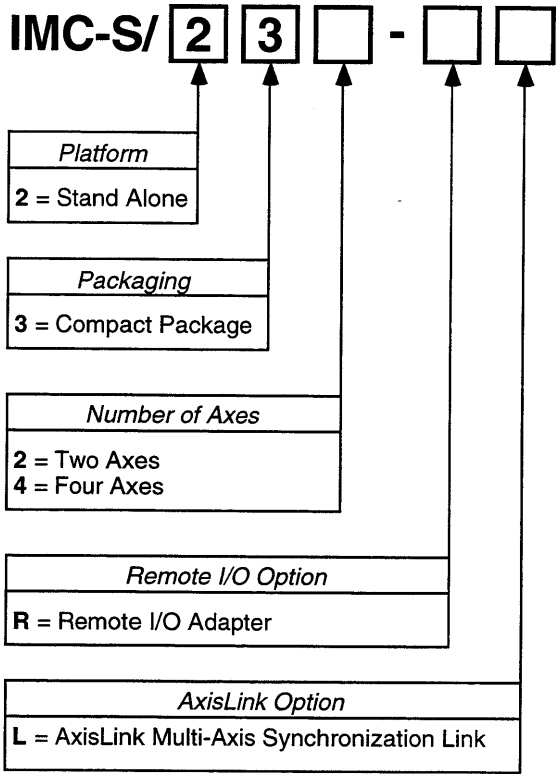
- Powerful graphical software development system (GML) with real-time debugging makes application programming easy and fun.
- State-of-the-art Intel i960 RISC microprocessor.
- Completely digital—no potentiometers or other adjustments required; will not drift with time, temperature or humidity.
- Multitasking operating system allows simultaneous execution of up to 10 tasks for efficient utilization.
- Electronic gearing for synchronization of any axis to another at a programmable ratio. Ratio may be specified as a floating point number or integer fraction ($\frac{1}{3}$, $\frac{3}{10}$, etc.).
- Electronic cam for coordinated motion profiles on one or more axes. Profiles may be position versus time or slave axis position versus master axis position.
- Sophisticated phase shift and advance/retard capabilities for electronic gears and cams allow complex motions to be easily programmed.
- Auto-registration and auto-correction make high-speed registration applications easy.
- Exclusive Imaginary Axis provides additional command-only axis for precise generation of master motion in master-slave applications or correction moves in registration and synchronization applications.

- Concurrent, independent, or synchronous motion on all axes. Interpolated motion on up to three axes.
- Wide position, speed, acceleration, and deceleration ranges for precise control.
- Separately programmable acceleration and deceleration rates for maximum versatility.
- Trapezoidal, parabolic, and S-curve velocity profiles.
- Rotary mode with electronic unwind allows unlimited position range for rotary axes.
- Motion merge function allows seamless transition between all types of motion.
- Most motion parameters (including master axis for electronic gears and cams) can be changed on-the-fly with no delays.
- Powerful floating-point math capabilities including transcendental functions (sin, cos, log, etc.).
- Sophisticated Nested Digital Serve Control Loop with automatic servo setup for quick and easy servo tuning.
- Isolation of all external connections from the microprocessor logic for reliable performance.
- 4 MHz maximum feedback count rate allows high speed operation without sacrificing resolution.
- Encoder loss detection protects operators and machinery from damage in the event of encoder feedback failure.
- Isolated 16-bit DACs for smooth motion. Software offset correction eliminates drift with analog servo drives.
- Field-configurable servo outputs allow independent selection of ±10V or ±150 mA signal format for each axis.
- Programmable position lock and position error tolerances for servo fault protection.
- Programmable directional software travel limits for enhanced overtravel protection.
- Velocity feedforward to reduce following error.
- Four optically isolated inputs for a home switch, positive and negative overtravel switches, and a drive fault signal for each axis.
- Relay-contact drive enable output for each axis.
- Optically isolated high-speed position registration input for each axis for position synchronization and registration applications.
- CPU watchdog with front-panel LED indicator for fail-safe protection.
- AxisLink option allows real-time axis coordination between controllers for distributed, multi-axis systems.

- Non-volatile storage (write-locked battery-backed RAM) of application program, setup parameter and default variable values.
- Memory Lock keyswitch on front panel prevents accidental or unauthorized changes to application program, setup parameters, and default variable values.

Model Number Explanation

The IMC-S/23x is available as a two- or four-axis motion controller with optional Remote I/O and AxisLink. The complete model number is specified as shown below.



Pre-engineered cable assemblies are used for connecting the Flex I/O, servo amplifiers, feedback devices, axis-specific (dedicated) I/O, CPU watchdog, and the 4100-REC. The table below shows the available cable assemblies.

Catalog Number	Used to Connect…	Length (feet)	Length (meters)	Number Required
4100-CCF1 or 4100-CCF3	Flex I/O	1 3	0.3 1	1 per S Class*
4100-CCS15F	Servo and Feedback	15	4.5	1 per Axis
4100-CCAQB	1391B-ES or 1391-DES	–	–	1 per Axis
4100-CCA15F	Dedicated Discrete I/O	15	4.5	1 per Axis
4100-CCW15F	CPU Watchdog	15	4.5	1 per S Class
4100-RCS3T	4100-REC	3	1	1 per Axis**

* Only required if general-purpose I/O (Flex I/O) is used.

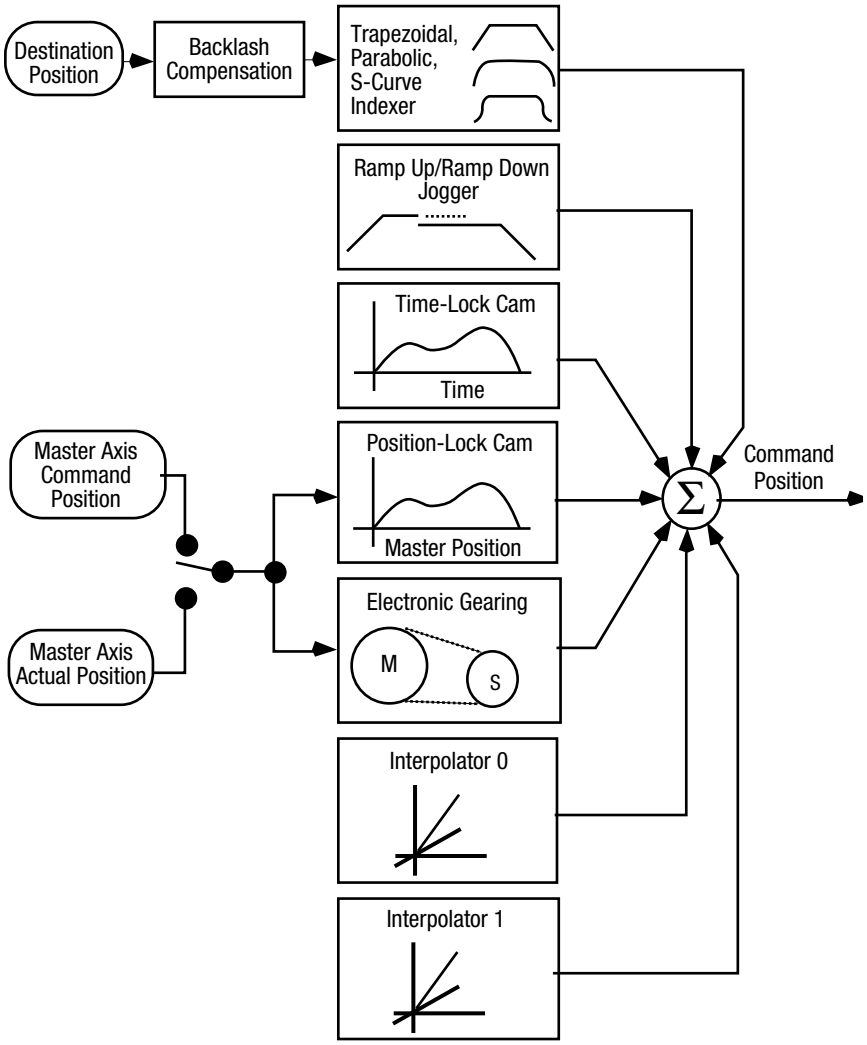
** Only required if using a 4100-REC Resolver.

High Level Motion Functions

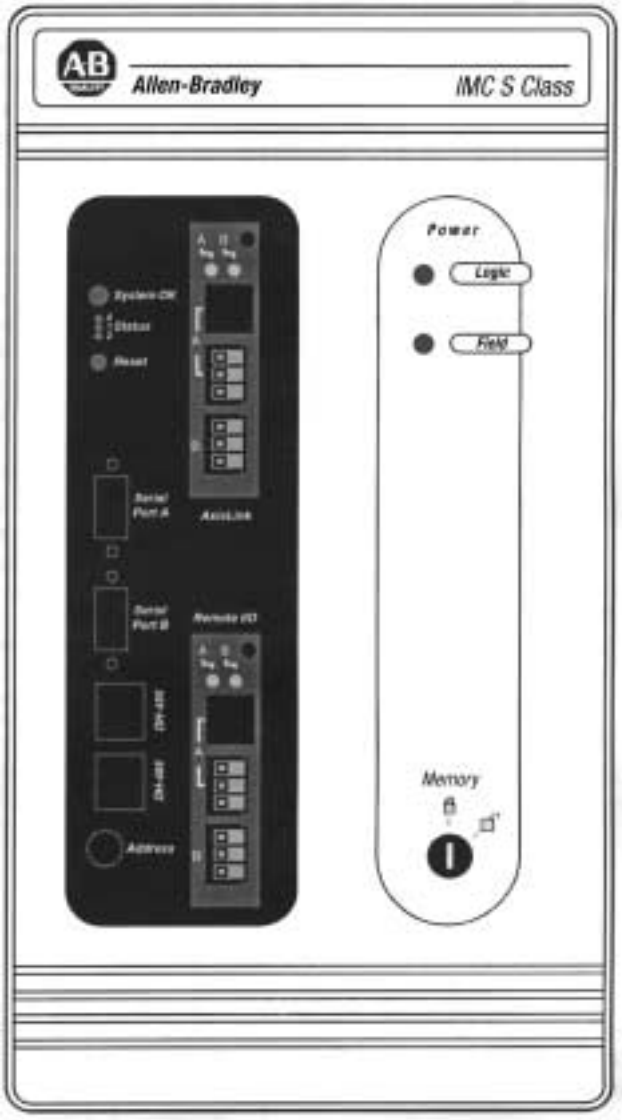
As shown in the figure below, the IMC-S/23x can produce motion on any axis in many different ways. The indexer moves an axis using either a trapezoidal, parabolic, or S-curve (controlled jerk) velocity profile. Axis velocity, acceleration, and deceleration are programmable. Backlash compensation allows precise positioning in the presence of mechanical backlash. The jogger produces constant speed motion of an axis in either direction with programmable velocity, acceleration and deceleration.

Electronic gearing allows any axis to be slaved to another axis (the master) at a specified ratio. Electronic cams produce coordinated motion profiles which are functions of time or the position of another axis. Electronic gearing and cam motion may be combined with move and jog motions to create complex motion profiles and synchronizations. Motion merge capabilities allow smooth transitions between all types of motion, thus providing a software clutch.

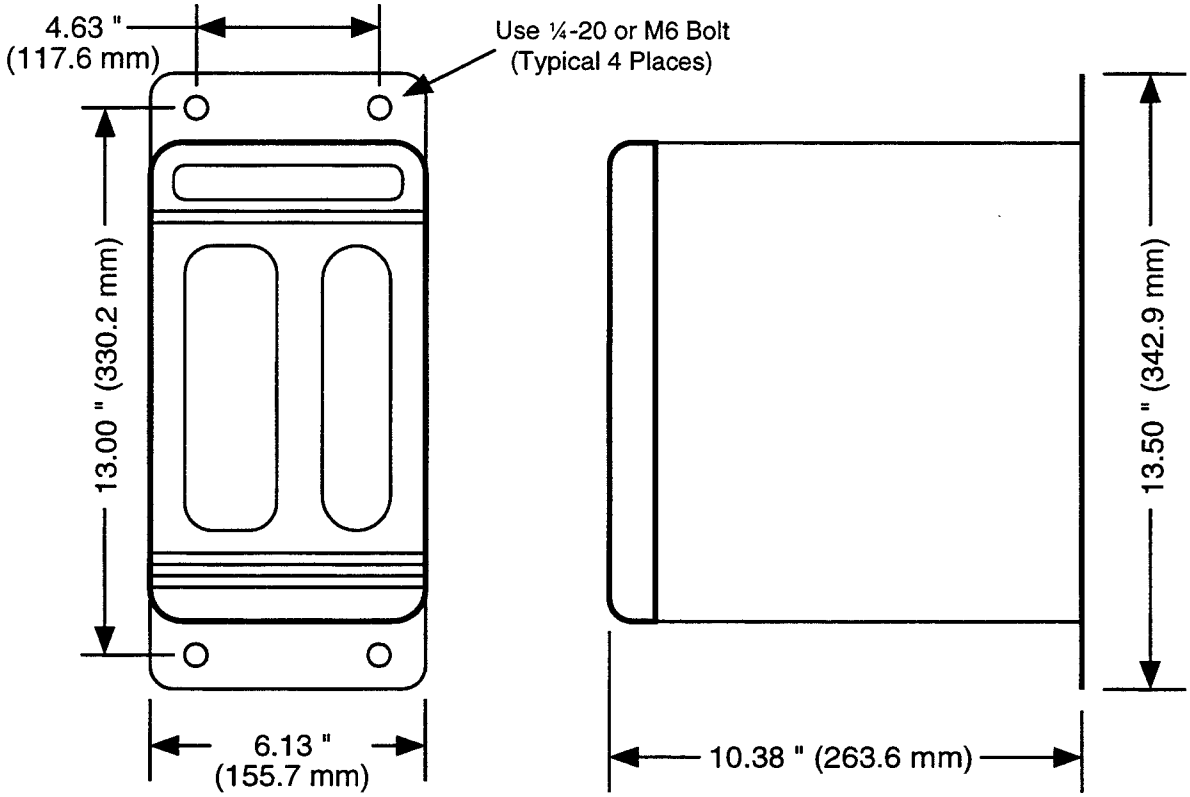
Two independent interpolators for all axes allow any two or three axes to be moved as a group along a linear, circular or helical path. Motions from the two interpolators may be combined with each other or with other types of motion.



Front Panel Layout



Mounting and Clearance Dimensions



General Specifications

Motion Control Microprocessor	Intel 80960SB @ 16 MHz	
Number of Controlled Axes	2 (Axis 0 and Axis 1) 4 (Axis 0. 1, 2, and 3)	IMC-S/232…models IMC-S/234…models
Application Storage	Write-lockable battery-backed RAM (Random-Access Memory) with 10 year (minimum) battery life for application program (32K) and setup parameter values	
Data Storage	Write-lockable battery-backed RAM (Random-Access Memory) with 10 year (minimum) battery life for cam table and default user variable values	
Number of User Variables	2,000 user-definable; values stored as 64-bit floating point numbers	
Number of Electronic Cam Profile Points	13,000 Master Cam points and 13,000 Slave Cam points (26,000 Total Cam points)	

Environmental Specifications

Storage Temperature	–40° to 70°C (–40°F to 158°F)
Operating Temperature	0° to 50°C (–32°F to 122°F)
Maximum Humidity	95% non-condensing

Electrical Specifications

AC Power Input	90 – 132 or 175 – 264 Volts AC, 47 – 63 Hz, 3 Amperes maximum
AC Fuse	3A Slow Blow ¼ × 1¼
I/O Power Input	5 – 40 Volts DC, 24 Volts DC nominal, 3 Amperes maximum
I/O Fuse	3A Slow Blow ¼ × 1¼

Encoder Input Specifications

Number of Encoder Inputs	2 (Axis 0 and Axis 1) 4 (Axis 0. 1, 2, and 3)	IMC-S/232…models IMC-S/234…models
Type of Encoder Input	Incremental AB quadrature; optically isolated, differential with marker channel	
Encoder Interface IC	AM26LS32 or equivalent	
Compatible Encoder Types	Differential, TTL-level (5V DC) line driver outputs, with or without marker; including the following Allen-Bradley devices: 845F-SJxZ14-xxYx… 845F-SJxZ24-xxYx… 845H-SJxx14-xxYx… 845H-SJxx24-xxYx… 845K-SAxZ14-xxY3 845K-SAxZ24-xxY3 845P-SHC14-xx3 845T-xx12Exx… 845T-xx13Exx… 845T-xx42Exx 845T-xx43Exx	
Decode Modes	4X Quadrature, Step/Direction, Count Up/Count Down	
Maximum Encoder Frequency	4,000,000 counts per second (4 MHz). This is equivalent to a channel frequency of 1 MHz in 4X quadrature decode mode	
Input Impedance	7 kΩ minimum (each input)	
Encoder Power	5 or 12 Volts DC at 1 Ampere (total) available from IMC-S/23x (voltage selection by internal switch)	

Servo Output Specifications

Number of Servo Drive Outputs	2 (Axis 0 and Axis 1) 4 (Axis 0. 1, 2, and 3)	IMC-S/232…models IMC-S/234…models
Type of Output	Isolated analog voltage or current (individually field-configurable via internal switch for each axis)	
Output Range	±10 Volts DC or ±150 mA (minimum)	
Resolution	16 bits, 305 µV or 4.58 µA per bit	
Output Impedance	220 Ω resistive for voltage output; 56Ω maximum load impedance for current output	
Output Offset	±80 mV maximum for voltage output, compensated to 0 volts via software setup procedure	

Dedicated Discrete I/O Specifications

Number of Dedicated Discrete Inputs	10 (5 each for Axis 0 and 1) IMC-S/232…models 20 (5 each for Axis 0, 1, 2, and 3) IMC-S/234…models
Dedicated Discrete Input Functions	Home Limit Switch, Positive Overtravel Limit Switch, Negative Overtravel Limit Switch, Drive (Amplifier) Fault, Position Registration
Input Type	Optically isolated
Operating Voltage	24 Volts DC nominal; 28V DC maximum 24 Volts DC nominal; 28V DC maximum of 5 Volts DC nominal; 10VDC maximum for position registration inputs
Input ON Current	12 mA per input (nominal) 2.5 mA for position registration inputs
Input Impedance	2 kΩ (resistive) per input; 8.8 kΩ (resistive) for 24V position registration inputs
Input Response Time	5 ms maximum 1 µs maximum for position registration inputs
Number of Dedicated Discrete Outputs	4 (2 each for Axis 0 and 1) IMC-S/232…models 8 (2 each for Axis 0, 1, 2, and 3) IMC-S/234…models
Dedicated Discrete Output Function	Drive (Amplifier) Enable Absolute Position Strobe
Output Type	Normally-open relay contacts (Drive Enable) Optically isolated, floating, solid-state relay (Position Strobe)
Operating Voltage	0.010 – 40 Volts DC; 24V DC nominal for drive enable outputs 5.10 ± 0.10 Volts DC for position strobe outputs
Output Current	1 Ampere per output maximum for drive enable outputs 10 mA per output maximum for position strobe outputs

Flex I/O (Bulletin 1794) Compatibility Specifications

Maximum Number of Flex I/O Modules: 8

Compatible Modules

1794-1B16	16 24V DC Discrete Inputs
1794-IA8	8 120V AC Discrete Inputs
1794-IE8	8 Current/Voltage Analog Inputs
1794-OA8	8 120V AC Discrete Outputs
1794-OB16	16 24V DC Discrete Outputs
1794-OE4	4 Current/Voltage Analog Outputs
1794-IE4XOE2	4 Current/Voltage Analog Inputs 2 Current/Voltage Analog Outputs
1794-IB10XOB6	Discrete Combo
1794-OW8	Relay Output
1794-IF41	Isolated Analog Input
1794-OB16P	Discrete Output (Protected)

S Class Interface: Direct—no 1794-ASB or other adapter required

Serial I/O Specifications

Number of Serial Channels	2 (Serial Port A and Serial Port B)
Channel Type	Optically isolated RS-232C or RS-422, each channel individually field-configurable via internal switch
Information Code	ASCII (American Standard Code for Information Interchange)
Baud Rate	User-selectable up to 19.2k baud (RS-232C) or 128k baud (RS-422)
Number of Start Bits	1
Number of Stop Bits	1
Word Length	8 bits total; 7 data bits plus 1 parity bit
Parity	Space parity transmitted Receive parity ignored (may be Mark, Space, Even, or Odd)
Duplex	Full or half (user-selectable)
Data Synchronization	XCN (Control-Q)/XOFF (Control-S)
Front-Panel Connectors	IBM-PC/AT compatible 9-pin D-type female
RS-422 Termination	User-selectable 220Ω resistor via internal switch

DH-485 Specifications

Number of DH-485 Channels	1; replaces Serial Port B when used
Channel Type	Optically isolated half-duplex RS-485
Baud Rate	9,600 or 19.2k baud (user-selectable)
Front-panel Connectors	Two RJ-45 jacks (+24V is *not* provided)
RS-485 Termination	User-selectable 220Ω resistor via internal switch
Node Address	User-selectable between 0 and 31 inclusive
Node Type	Token-passing master
Accessible Data Files	1 Binary file (B3) for up to 16,384 bits 1 Integer file (N7) for up to 1,024 16-bit values 1 Floating-point file (F8) for up to 512 32-bit values 1 ASCII string file (STA) for up to 2,048 characters 9 user-configurable files; each can be individually configured as any of the above types or as a BCD file for floating point simulation (required for certain A-B MMI devices)

Motion Performance Specifications

Servo Loop Sample and Update Rate	250 Hz to 2 kHz for each of 2 or 4 axes
Maximum Feedback Frequency	4 MHz (4,000,000 feedback counts per second)
Absolute Position Range	±1,000,000,000 feedback counts for linear axes ∞ for rotary axes
Absolute Position Resolution	15 position unit digits or 32 feedback count bits, whichever is less
Speed Range	0.00001 feedback count per servo update to 4,000,000 feedback counts per second
Speed Resolution	15 position unit digits or 15 feedback count bits, whichever is less
Acceleration/ Deceleration Range	0.00001 feedback count per servo update^2 to 4,000,000,000 feedback counts per second^2
Acceleration/ Deceleration Resolution	15 position unit digits or 15 feedback count bits, whichever is less
Electronic Gearing Gear Ratio Range	0.00001:1 to 9.99999:1 (Slave Counts : Master counts)
Electronic Gearing Gear Ratio Resolution	8 position unit digits or 32 feedback count bits
Servo Gain Resolution	32 bit floating point.
Servo Output Limit Range	0 to 100%
Servo Output Limit Resolution	305 µV (voltage output); 4.58 µA (current output)

Servo Gain Units

Gain Term	Gain Units
Proportional Gain (Torque Loop)	$\frac{\text{Counts per Millisecond}}{\text{Count of Error}}$
Proportional Gain (Velocity Loop)	$\frac{\text{Millivolts}}{\text{Count of Error}}$
Integral Gain (Torque Loop)	$\frac{\text{Counts per Millisecond}}{\text{Count of Error}}$
Integral Gain (Velocity Loop)	$\frac{\text{Millivolts per Millisecond}}{\text{Count of Error}}$
Velocity Gain	$\frac{\text{Millivolts}}{\text{Counts per Millisecond}}$
Feedforward Gain	$\frac{\text{Counts per Millisecond}}{\text{Count per Millisecond}}$
Deadband Compensation	Millivolts
Offset Compensation	Millivolts

Remote I/O Adapter Specifications (IMC-S/23x-R models only)

Baud Rate 57.6K, 115.2K, or 230.4K (user-selectable)

Rack Address User-selectable between 0 and 31 decimal

Rack Width User-selectable in quarter-rack increments ¼, ½, ¾, Full)

I/O Group Address User-selectable as shown below:

Type of Transfer	I/O Group			
Block	0 2 4 6	0 2 4	0 2	0
Discrete	1 3 5 7	1 3 5	1 3	1
Discrete		2 4 6	2 4	2
Discrete		3 5 7	3 5	3
Discrete			4 6	4
Discrete			5 7	5
Discrete				6
Discrete				7
Starting I/O Group	0 2 4 6	0 2 4	0 2	0
Rack Width	¼	½	¾	Full

Number of Discrete I/O Bits 12 dedicated inputs, 12 dedicated outputs, User-defined as shown below:

Rack Width	Inputs	Outputs
¼	4	4
½	36	36
¾	68	68
Full	100	100

Maximum Block Transfer Length 64 words (128 bytes)

Block Transfer Data Types
User Variable values
Axis Data Parameter value
Axis Data Bit state
Master Cam Position Point values
Master Cam Time Point values
Slave Cam Position Point values
Axis or System Variable value

Block Transfer Data Formats
32-bit (double-word) 2s complement integer
16-bit (single-word) 2s complement integer
32-bit (8-digit) signed BCD
32-bit IEEE floating-point

AxisLink Specifications (IMC-S/23x-L models only)

Baud Rate	1 megabit per second
Cable Type	Allen-Bradley 1770-CD RIO cable (Belden 9463 or equivalent)
Cable Length	82 feet (25 meters) maximum total. Minimum of 3 feet (1 meter) between controllers.
Number of Motion Controllers	8 maximum for a total of 32 possible axes (standard) 16 maximum for a total of 64 possible axes (extended node)
Addressing	User-selectable address via selector switch on front panel
Number of Virtual Master Axes	4 maximum total; 1 per motion controller maximum. Any axis on any motion controller may be a virtual master axis to any other motion controller. Each motion controller may define a total of two separate axes on any other motion controllers as virtual master axes, but only one may be active at any time. A total of four different axes (on any motion controllers) may be active as virtual master axes at any time.
Type of Virtual Master Axes	2: Command and Actual. Each virtual master axis may be defined to report either its command or actual position.
Slave Axes	31 maximum total per virtual master axis (3 local + 4 × 7 other motion controllers = 31)
Number of Discrete I/O	112 inputs maximum total and 16 user-definable outputs per motion controller. Any motion controller can read the 16 discrete outputs of any other motion controller, giving a maximum total of 7 × 16 = 112 discrete inputs per motion controller.
Discrete I/O Response	≤1 millisecond

Related Publications

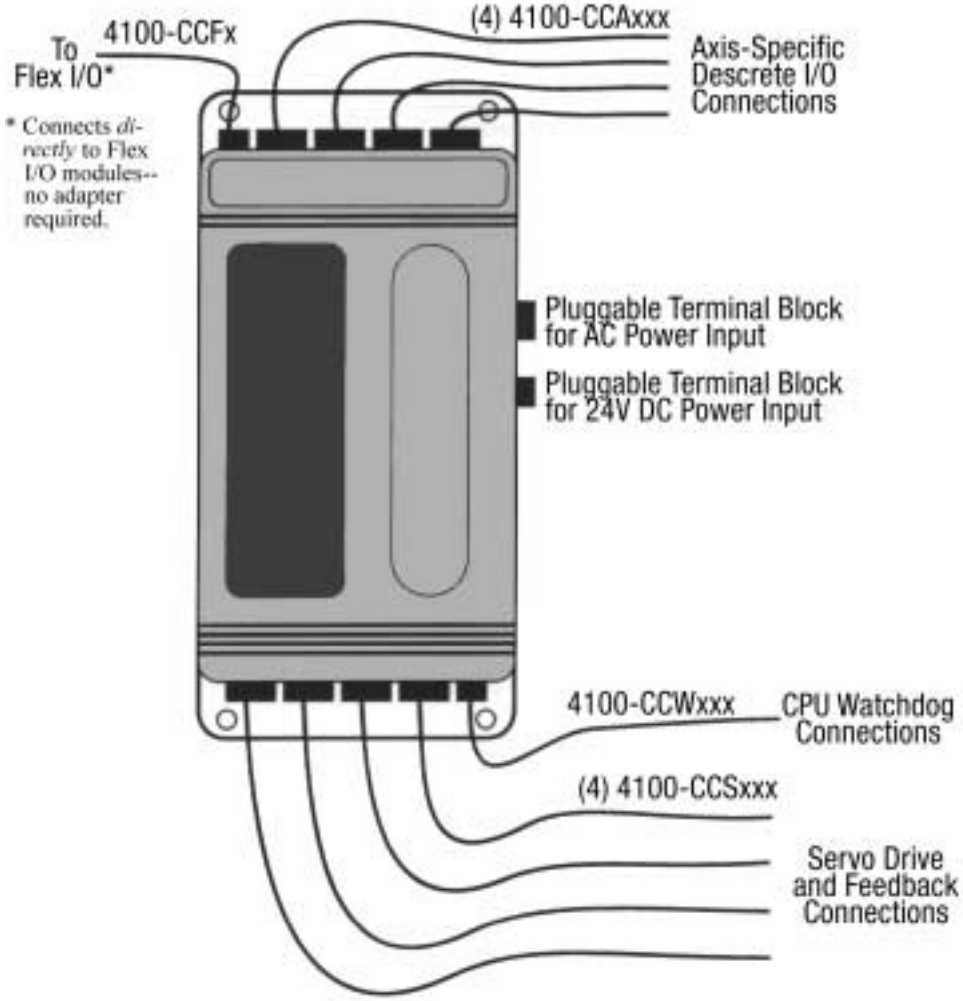
For more information on the IMC S Class motion controllers, please refer to the following publications.

Publication Number	Description
4100-1.0*	IMC S Class Motion Controllers Product Profile
4100-3.0*	IMC S Class Motion Controllers Product Pricing
4100-4.1.1*	IMC S Class Application Example – Synchronizing Conveyors
4100-4.1.2*	IMC S Class Application Example – Simple Feeder
4100-4.1.3*	IMC S Class Application Example – Coil Winder
4100-4.1.4*	IMC S Class Application Example – Drill Feed
4100-4.2.1*	IMC S Class Application Note – Using the RIO Adapter Option
4100-999-122	IMC-S/23x (Compact Motion Controllers) Installation and Setup Manual
GMLC-5.4	GML Commander Troubleshooting Manual
GMLC-5.2	GML Commander Reference Manual
1794-1.14*	Flex™ I/O Product Profile
1794-2.1*	Flex™ I/O Product Data

*These publications are available free of charge from your local Allen-Bradley Sales Office.

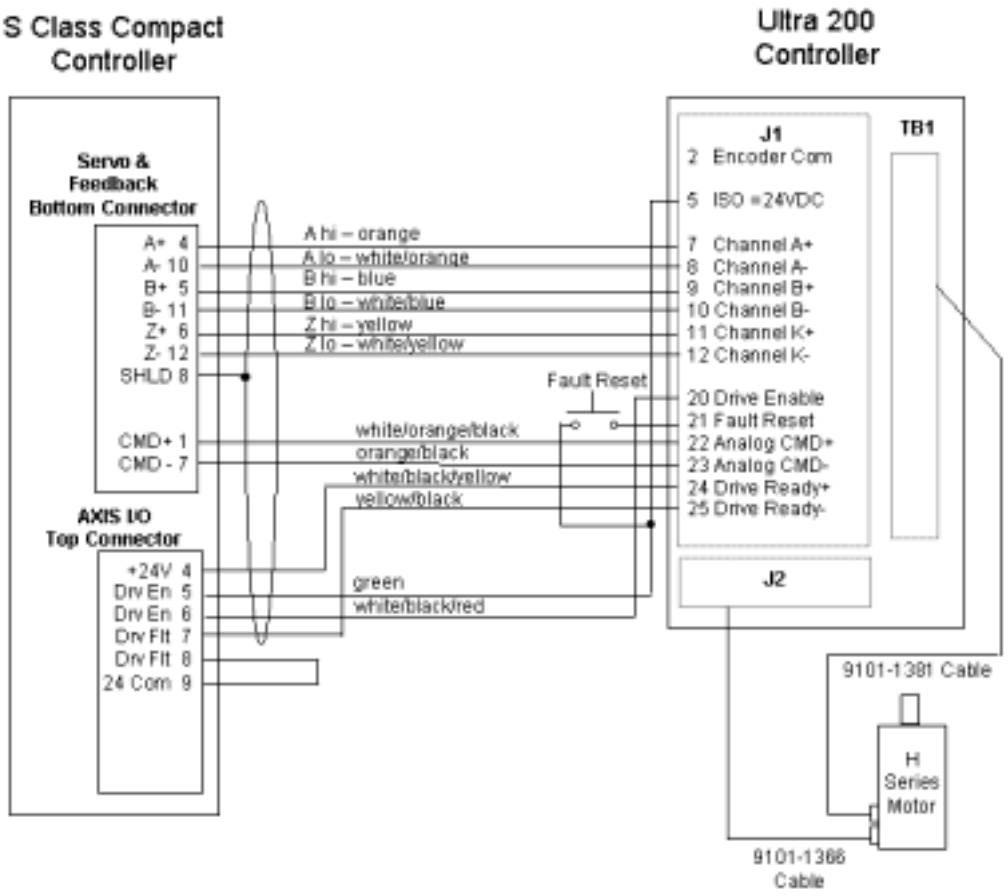
Connections

Pre-engineered cable assemblies are used for all connections to external devices except the main AC power and the 24V DC I/O power, which use pluggable terminal blocks. As shown below, the servo drive and feedback cable assemblies attach to the bottom panel of the IMC S Class Compact while the axis-specific (dedicated) I/O cable assemblies attach to the top panel. Power input terminal blocks are on the right side of the unit.



The following diagrams display an example of a typical configuration of an S Class Compact controller, an Ultra 200 controller and an H series motor:

Configuration Overview



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