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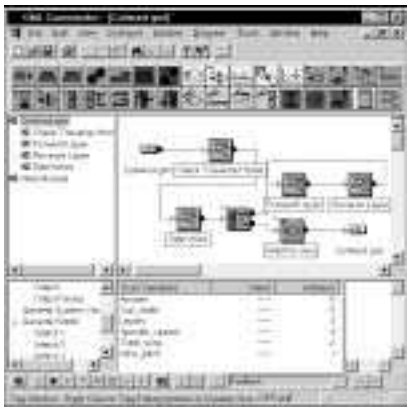
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# IMC™ S Class
# Compact Motion Controllers
## (IMC-S/23x Models)

# 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.



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- 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.

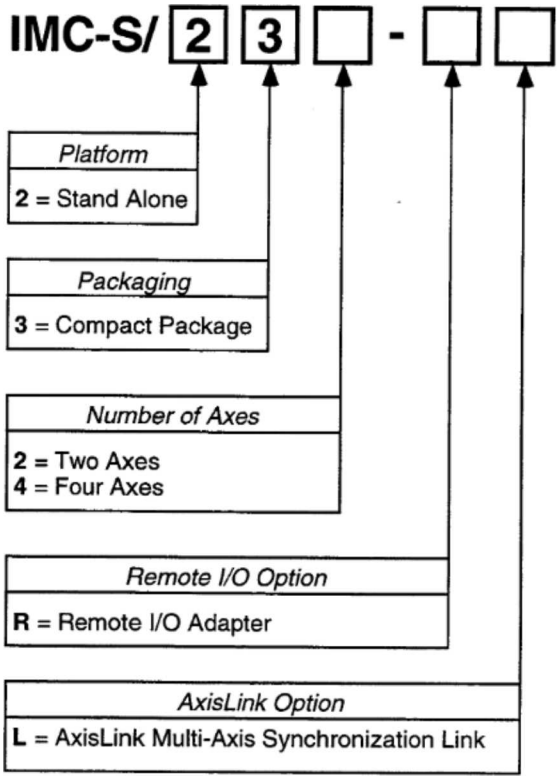


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- Non-volatile storage (write-locked battery-backed RAM) of application program, setup parameter and default variable values.
- Memory Lock keyswitch on front panel prevents accidental or unauthorized changes to application program, setup parameters, 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<br>4100-CCF3 | Flex I/O | 1<br>3 | 0.3<br>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.



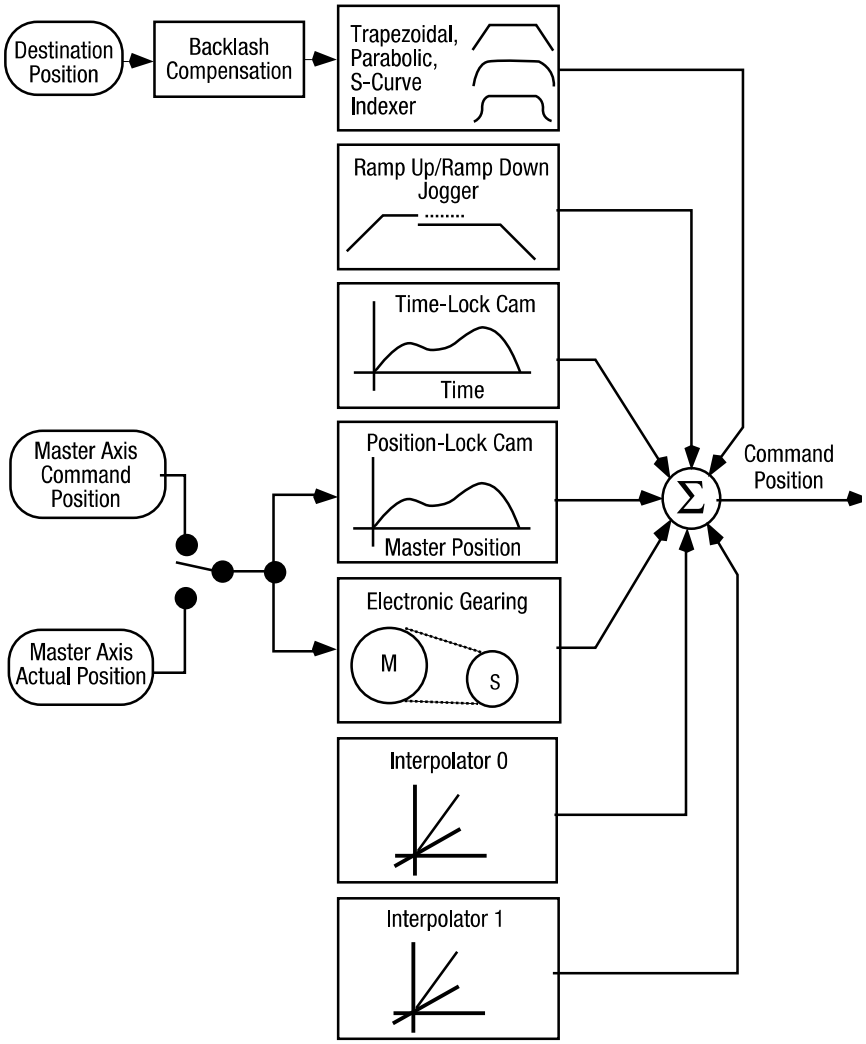
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## High Level Motion Functions

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.

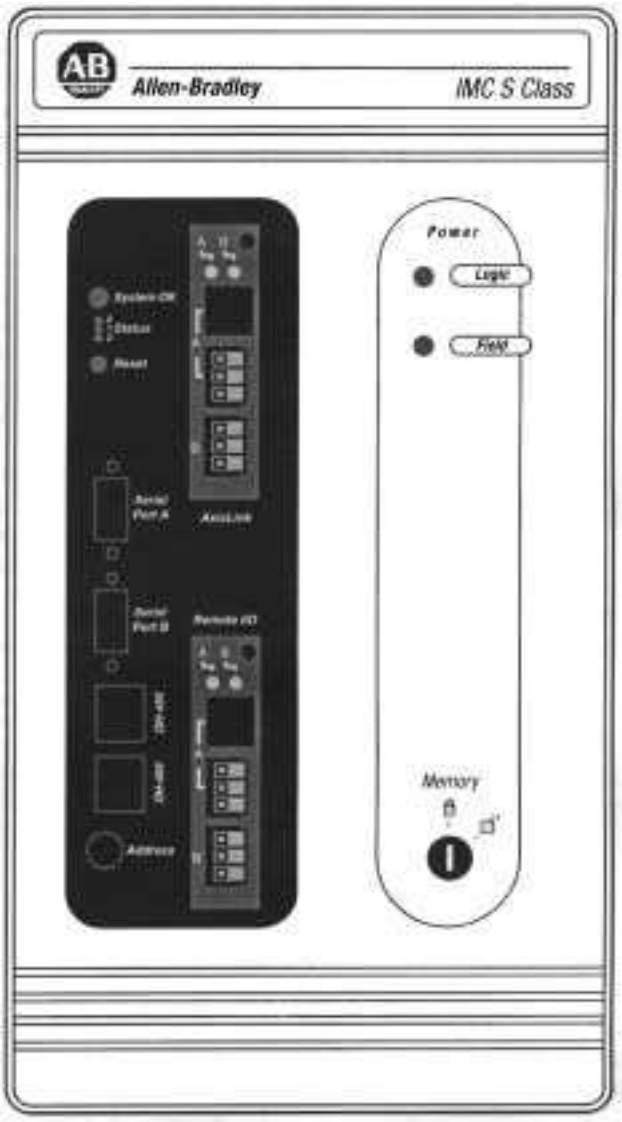
Two independent interpolators for all axes allow any two or three axes to be moved as a group along a linear, circular or helical path. Motions from the two interpolators may be combined with each other or with other types of motion.






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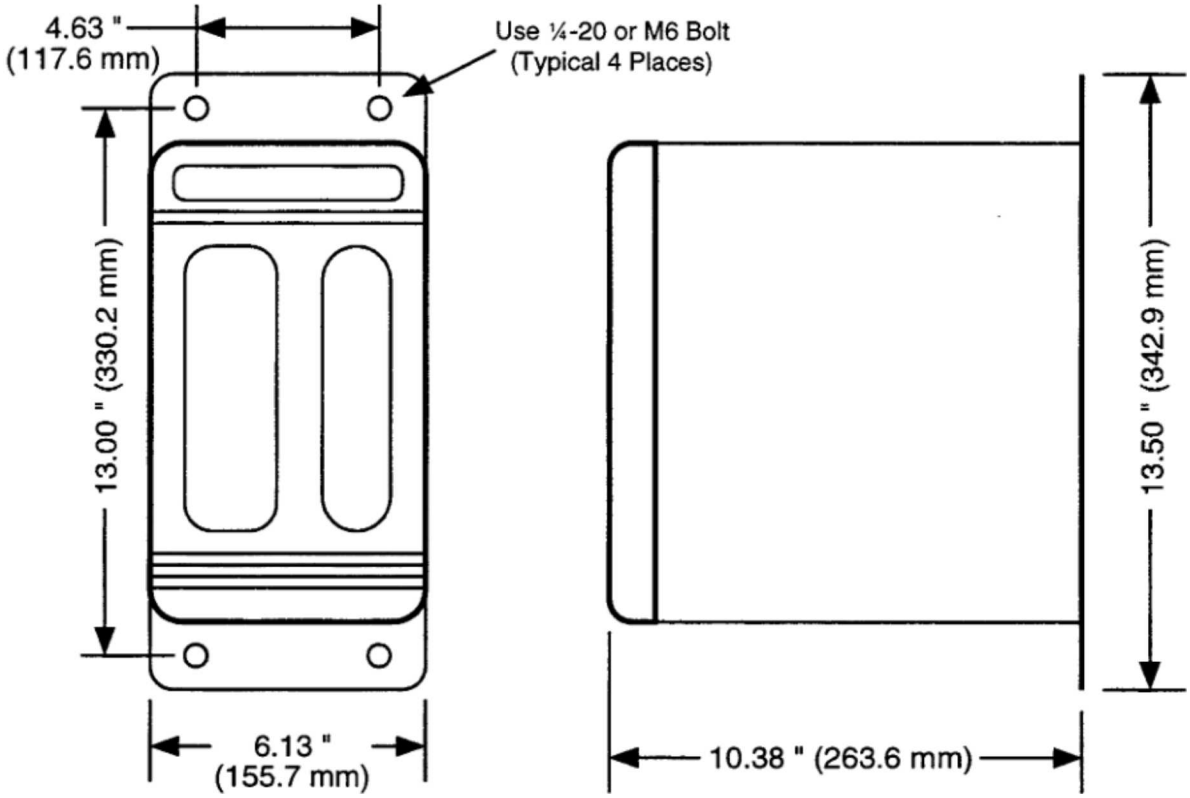
## Front Panel Layout






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## Mounting and Clearance Dimensions




## General Specifications

| | | |
|---|---|---|
| **Motion Control Microprocessor** | Intel 80960SB @ 16 MHz | |
| **Number of Controlled Axes** | 2 (Axis 0 and Axis 1)<br>4 (Axis 0. 1, 2, and 3) | IMC-S/232…models<br>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 |



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## 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)<br>4 (Axis 0. 1, 2, and 3) | IMC-S/232…models<br>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:<br>845F-SJxZ14-xxYx…<br>845F-SJxZ24-xxYx…<br>845H-SJxx14-xxYx…<br>845H-SJxx24-xxYx…<br>845K-SAxZ14-xxY3<br>845K-SAxZ24-xxY3<br>845P-SHC14-xx3<br>845T-xx12Exx…<br>845T-xx13Exx…<br>845T-xx42Exx<br>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)<br>4 (Axis 0. 1, 2, and 3) | IMC-S/232…models<br>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 | |



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## Dedicated Discrete I/O Specifications

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



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## 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<br>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<br>1 Integer file (N7) for up to 1,024 16-bit values<br>1 Floating-point file (F8) for up to 512 32-bit values<br>1 ASCII string file (STA) for up to 2,048 characters<br>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) |



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## 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<br>∞ for rotary axes |
| **Absolute Position Resolution** | 15 position unit digits or<br>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<br>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<br>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) | Counts per Millisecond / Count of Error |
| Proportional Gain (Velocity Loop) | Millivolts / Count of Error |
| Integral Gain (Torque Loop) | Counts per Millisecond / Count of Error |
| Integral Gain (Velocity Loop) | Millivolts per Millisecond / Count of Error |
| Velocity Gain | Millivolts / Counts per Millisecond |
| Feedforward Gain | Counts per Millisecond / Count per Millisecond |
| Deadband Compensation | Millivolts |
| Offset Compensation | Millivolts |



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## 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



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## 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)<br>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<br>(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 |

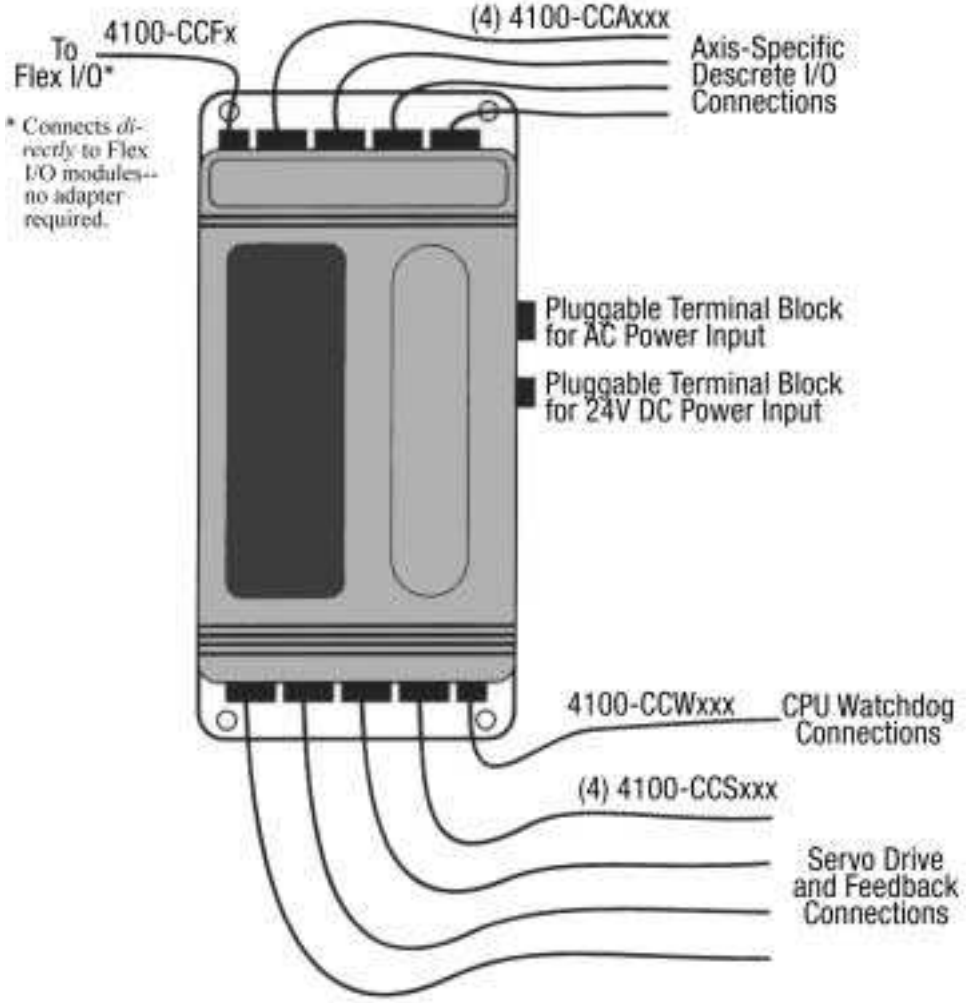
*These publications are available free of charge from your local Allen-Bradley Sales Office.



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## 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.

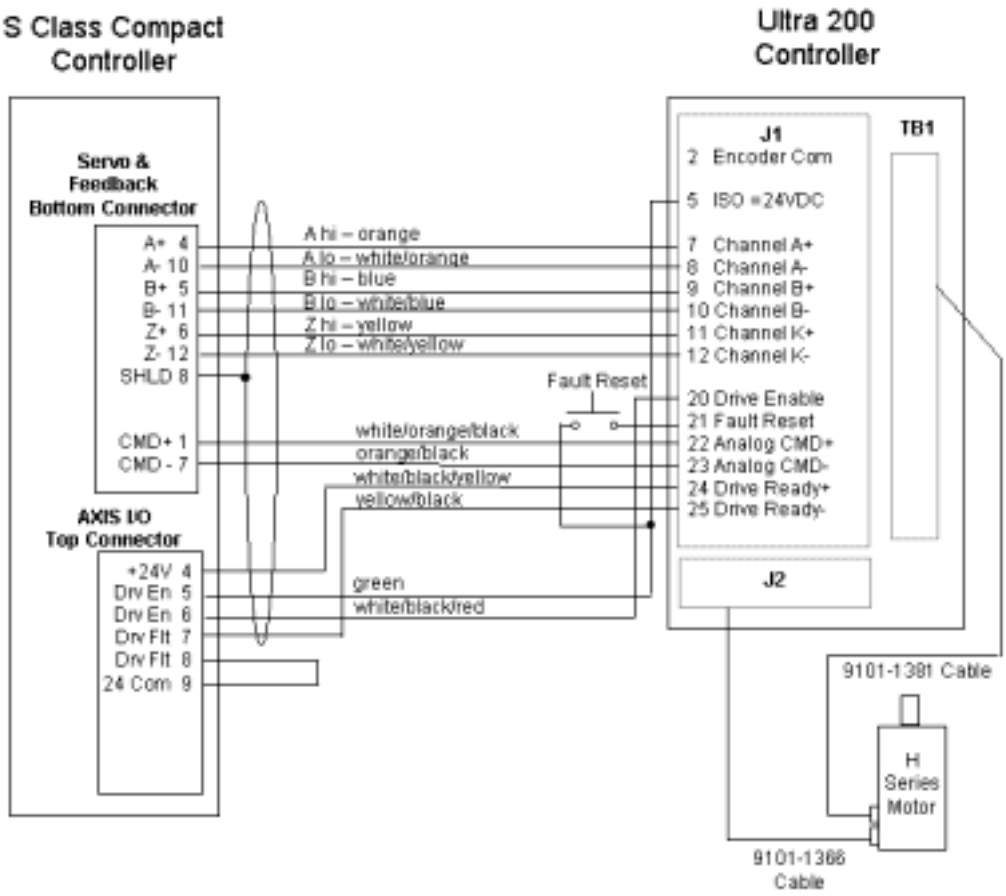





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The following diagrams display an example of a typical configuration of an S Class Compact controller, an Ultra 200 controller and an H series motor:

### Configuration Overview






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