

# MACCO®

## Control Systems



... controls for the 21st century



# Table of Contents

| MACO<br>4000<br>5000<br>6000 | MACO<br>DS<br>RS | MACO<br>Compact |  |    |
|------------------------------|------------------|-----------------|--|----|
|                              |                  |                 | Overview                                       | 2  |
|                              |                  |                 | Injection and Blow Molding Example             | 3  |
|                              | √                |                 | MACO® Compact Operator Stations                | 4  |
|                              |                  | √               | MACO® Compact Controller                       | 6  |
|                              | √                |                 | MACO® Breeze II                                | 8  |
|                              |                  | √               | MACO® Compact Breeze IIc                       | 9  |
|                              |                  | √               | MACO® EM-3c                                    | 10 |
|                              |                  | √               | iPact™ with intellimold®                       | 11 |
| √                            | √                |                 | MACO® Optima PC Operator Interface             | 12 |
| √                            | √                | √               | MACO® Optima Operator Interface                | 13 |
|                              | √                |                 | MACO® Touchscreen Monitors                     | 14 |
|                              | √                |                 | MACO® Series 7 Intelligent Integrator PC       | 15 |
|                              | √                |                 | MACO® Application Specific Blocks (ASB's)      | 16 |
|                              | √                |                 | MACO® RS (Rack System)                         | 17 |
|                              | √                | √               | XL PB & Remote I/O Pushbutton Stations         | 18 |
|                              | √                |                 | Processor Options                              | 19 |
|                              | √                |                 | Terminal I/O Blocks                            | 20 |
|                              | √                |                 | Communication Options                          | 21 |
| √                            |                  |                 | MACO® Rack Systems                             | 22 |
| √                            | √                | √               | Thermocouple/Analog Input Cards                | 23 |
|                              |                  | √               | High Speed Analog Cards                        | 24 |
| √                            | √                |                 | Parison/Motion Cards                           | 25 |
| √                            | √                |                 | Injection/Motion/Extrusion Cards for Injection | 26 |
| √                            | √                |                 | Injection/Motion/Extrusion Cards for Extrusion | 27 |
| √                            | √                |                 | EZ PRO Closed Loop Motion Control Card         | 28 |
| √                            |                  |                 | Analog I/O Card                                | 29 |
|                              | √                | √               | Plug-In Cards                                  | 30 |
| √                            |                  |                 | Communication Cards                            | 31 |
| √                            | √                | √               | Logic I/O Cards                                | 32 |
| √                            |                  |                 | Sequence & Analog Output Cards                 | 33 |
| √                            | √                | √               | Sequence Editors                               | 34 |
| √                            | √                | √               | OptiGrafix Screen Editor                       | 35 |
|                              | √                | √               | Wonderware Screen Editor                       | 35 |
| √                            | √                | √               | MACO VIEW & DDE Servers                        | 36 |
| √                            | √                | √               | Servo Amplifier & FoxTraker                    | 37 |
| √                            | √                | √               | Agency Approvals                               | 38 |
| √                            | √                | √               | Environmental Specification                    | 39 |
|                              |                  |                 | MACO® Product Family                           | 40 |

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Intel Corporation:  
Pentium®

Microsoft Corporation:  
Windows®, Windows NT®

Modicon, a Group Schneider Company:  
Modbus®, Modbus Plus®, Concept™

Allen-Bradley Company:  
ControlNet™

Open DeviceNet Vendors Corporation:  
DeviceNet™

Profibus Trade Organization:  
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# Overview

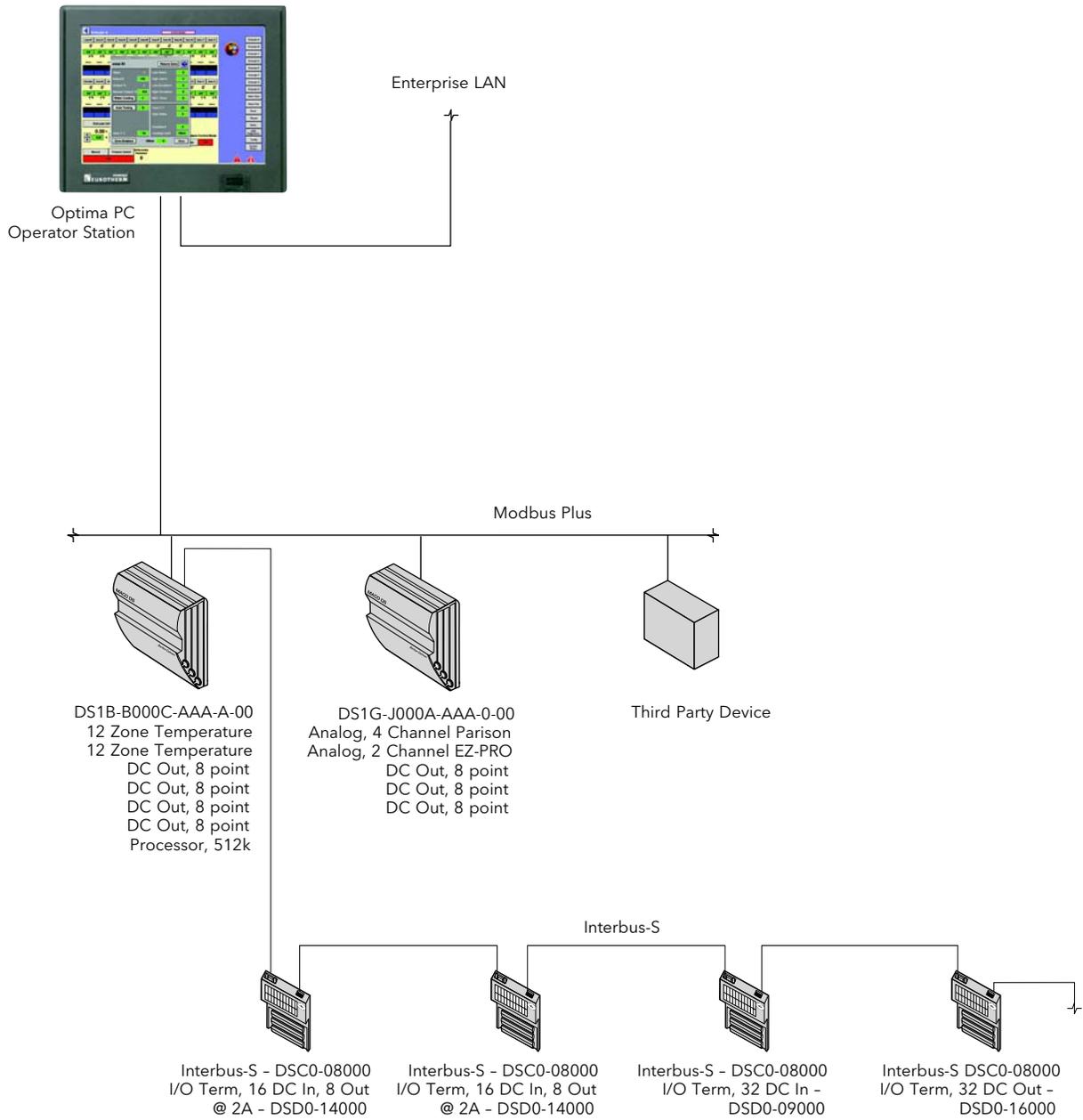
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Invensys Eurotherm's MACO® control systems are specifically designed to save plastic OEMs and producers time and money. They are based on a revolutionary building block architecture that is designed to adapt to the ever changing needs of the plastics industry. The result is an open and scalable system that contains four decades of injection, extrusion and blow molding knowledge.

MACO is a complete family of control products - operator stations, application specific I/O blocks (ASBs), racks, terminal I/O blocks (TBs) and other plastic machinery control components. Operator stations, ASBs and TBs can be networked to form an overall control scheme. Applied as a total machine controller, or as an individual component, MACO creates a system that meets your needs perfectly today, and whose adaptability ensures a perfect fit in the future.

- Labor and material savings by wiring directly to I/O terminal blocks
- Robust hardware ensures fewer failures
- Higher productivity from advanced control architecture
- Scalable - one control solution for large and small machines
- Reduced installation costs - fast and easy DIN rail mounting
- Shared database between screen programming tool (Wonderware® InTouch™) and sequence editing tool
- Global - multi-lingual
- Flexibility of distributed or centralized I/O
- Internationally accepted IEC standards
- Connectivity to third party devices
- Small profile to reduce panel space
- Large color graphical interface for easy use
- Pre-configured screens and sequence for rapid start-up
- Efficient sequence programming tool for reduced development costs (on-line editing, diagnostics and simulation)

# Injection and Blow Molding Example



# MACO<sup>®</sup> Compact Operator Stations

## MACO Compact



- High Speed Display Updates
- Ethernet Communications
- Recipe Storage to USB Memory Stick
- Online and web browsable RLD diagnostics
- Closed Loop Control Updated less than 1.0ms for Improved Part Quality
- Large Color Touch Screen
- Statistical Process Control
- Advanced IMPACT<sup>™</sup> Process Control



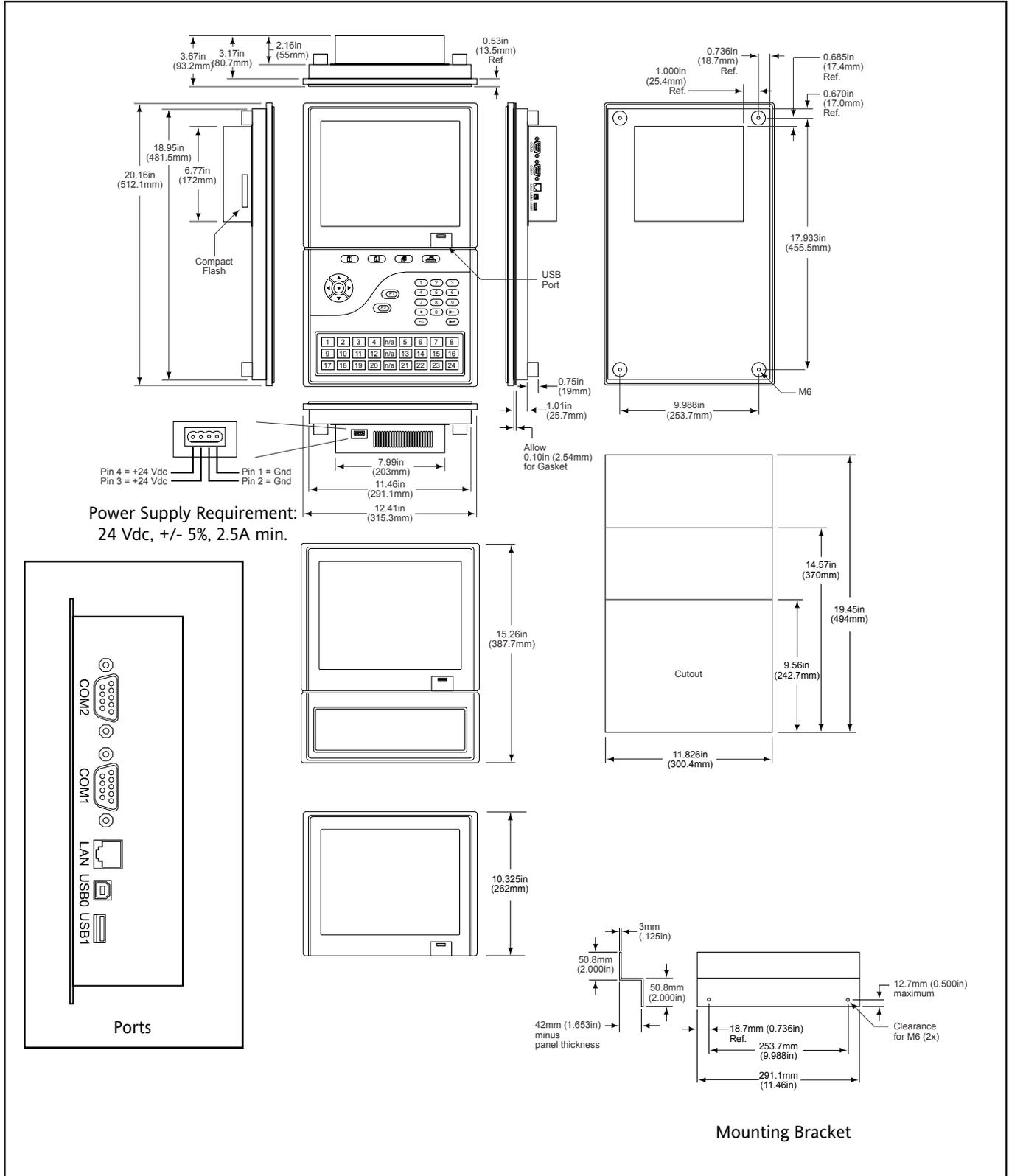
Also available in the 41AC package  
See the MACO OPTima on page 11.

The MACO compact operator interface is a sleek new flexible design that provides a full range of cost effective HMI 's for the MACO Compact control system. It is available with a 12.1 inch TFT display, and an 800 x 600 viewing resolution, as well as an optional touchscreen interface. In addition, there are several keyboard options, ranging from a touchscreen only version to full numeric keypad with 24 machine function keys, and different combinations of E-Stop blanks and machine function keys. The display is provided with a Strong ARM 200MHz processor equipped with up to 64M of Nand flash memory and runs on a Microsoft<sup>®</sup> CE.net operating system. It is equipped with a real time clock and battery backup. Ethernet communications is standard, with provisions for USB and RS- 485 communications if required. There are two USB ports, one of which is on the front side of the display, as well as an optional compact flash for recipe and file storage. Screens are programmed by means of an enhanced OPTiGrafix screen editor. The OPTiGrafix screen editor can be used to create multi-language (including Asian character) screens. Line graphs can be created, displayed and stored to the compact flash. The display also has statistical process control capability with enhanced trending.

There are several keyboard options, ranging from a touchscreen only version to full numeric keypad with 24 machine function keys, and different combinations of E-Stop blanks and machine function keys (consult factory for availability).



Dimensions



# MACO<sup>®</sup> Compact Control System

## MACO Compact



- Tightly integrated multiple processor architecture
- Built-in diagnostics & process monitoring
- Online and web browsable RLD diagnostics
- 16 bit analog I/O
- High performance ethernet communications
- Patented & proven IMPACT<sup>™</sup> II closed loop process control
- 6-slot and 8-slot versions also available
- 24 Vdc powered

The MACO Compact is a cost competitive, application specific, programmable logic controller with the advantages of integrated, total machine control in a compact package. It is an expandable system, available with different options to meet OEM and end-user application requirements. Equipped with Ethernet communications, the MACO Compact delivers seamless connection to plant wide systems. A tightly integrated multiple processing architecture, utilizing DSP technology provides <1msec loops. Typical ladder logic execution is less than 0.5msec. High performance ethernet communications is provided for interfacing with the HMI or other devices. The controller also features built-in diagnostic and process monitoring for multiple shot monitoring, shot to shot repeatability, data storage, "reference/signature" shot and "snapshot" functions. Additionally, online RLD diagnostics allow troubleshooting logic and machine operation with web browsing capability via the internet.

The MACO Compact supports either open or closed loop (IMPACT<sup>™</sup> II) injection process control. Run the machine for a few cycles, and IMPACT II creates a theoretical model of the process. It uses this model along with hundreds of rules to automatically optimize the process to compensate for short and long term deviations in the injection molding process. Injection control features velocity or pressure controlled fill with ramping for up to 10 steps. Transfer mode is user selectable and there are multiple steps of pack and hold, as well as synchronized back pressure and RPM control of up to 10 steps. Eight isolated temperature control loops with the industry-best auto tune algorithm, a full complement of built-in alarm functions, with auto-compensation available for sensor break. There is also an optional 12 zone T/C-Analog card available.

A standard 3 card version provides a total of 52 digital outputs and 36 digital inputs. Adding optional I/O cards to fill the 4 slot chassis expands the I/O to 100 digital outputs and 68 digital inputs. In addition to the 4 slot enclosed chassis, six and eight slot open chassis are available. Multiple chassis systems will also soon be available. Control data can be viewed on Eurotherm's new line of flexible high speed Windows CE based 12.1 inch TFT displays. These displays are equipped with two USB ports (the front port is typically utilized with memory sticks for recipe transfers) and a compact flash interface (for data storage). Recipes, SPC data, screen captures and logging functions can be stored and loaded from various memory devices. The control is also compatible with our family of OPTIMA Touch PC based operator stations based on our Wonderware<sup>®</sup> InTouch based applications and plant wide integration capabilities.

- Slot 1: High Speed Analog and Logic Process Using Dual DSP's
- 6 Analog Inputs (Voltage or Current) with Excitation (Isolated as a Group)
  - 4 DC Logic Inputs (includes Tach Interface capability)
  - 4 DC Logic Outputs (Low Current)
  - 4 Analog Outputs with Linearization (Isolated as a Group)
  - 2 Daughterboard Slots for Optional Encoder, Strain Gauge, or Digital I/O Cards

Slot 2: 8 Thermocouple Inputs, 16 DC Outputs, and 24Vdc Power Supply Interface

Slot 3: 32 (24Vdc, 2 Amp) Digital Outputs and 32 (24Vdc) Digital Inputs  
(or optionally 12 thermocouple Inputs, 16 DC Outputs)

Slot 4: Optional 32 (24Vdc, 2 Amp) Digital Outputs and 32 (24Vdc) Digital Inputs

Standard 3 Card version provides 52 Digital Outputs, and 36 Digital Inputs.

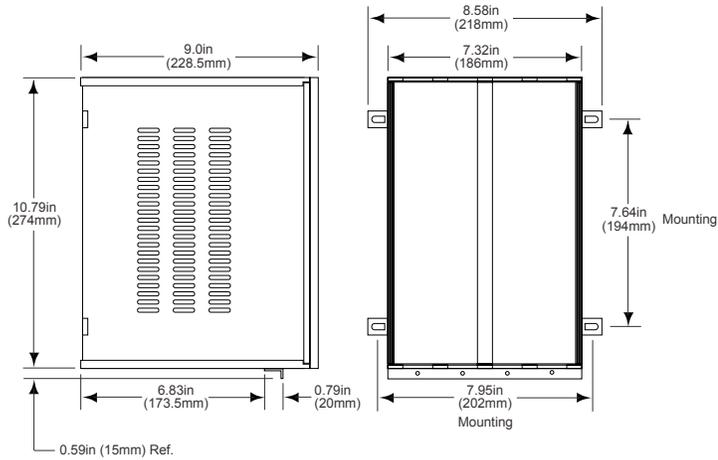
Optional I/O Cards expands I/O to 100 Digital Outputs and 68 Digital Inputs.



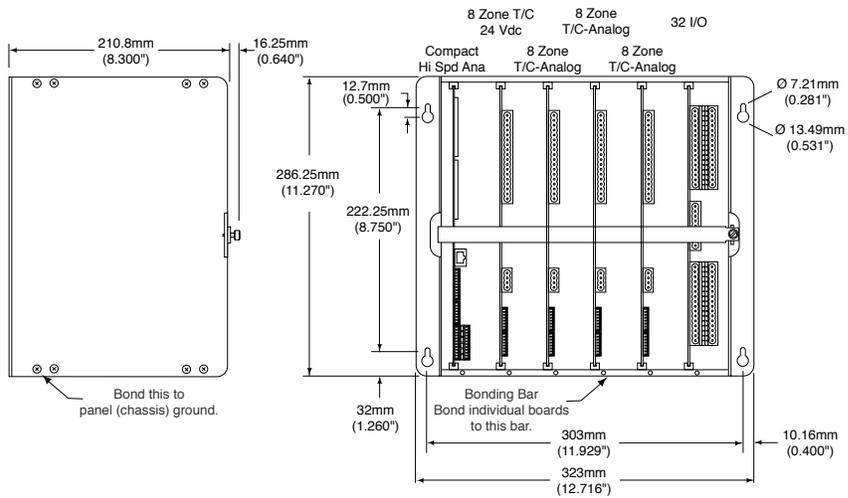
Slot 1 2 3 4

## Dimensions

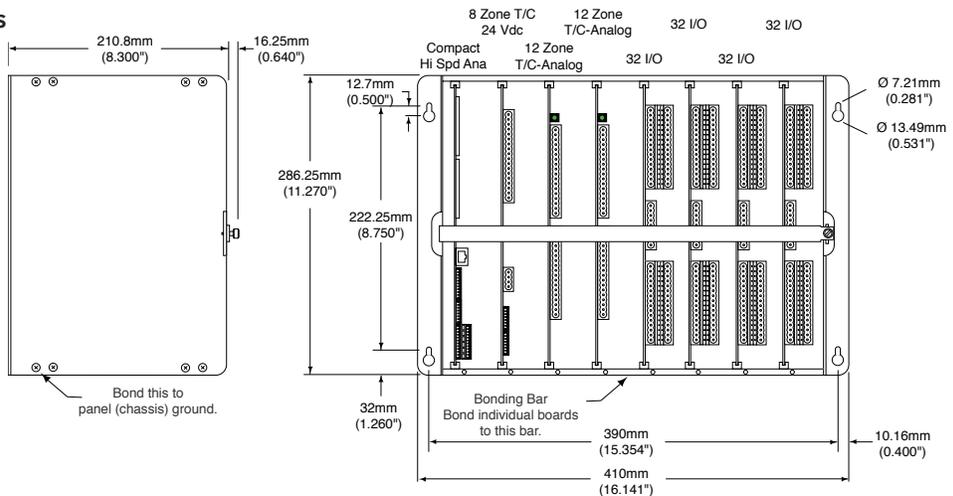
### 4-Slot Enclosed Chassis



### 6-Slot Open Chassis



### 8-Slot Open Chassis



# MACO<sup>®</sup>Breeze II

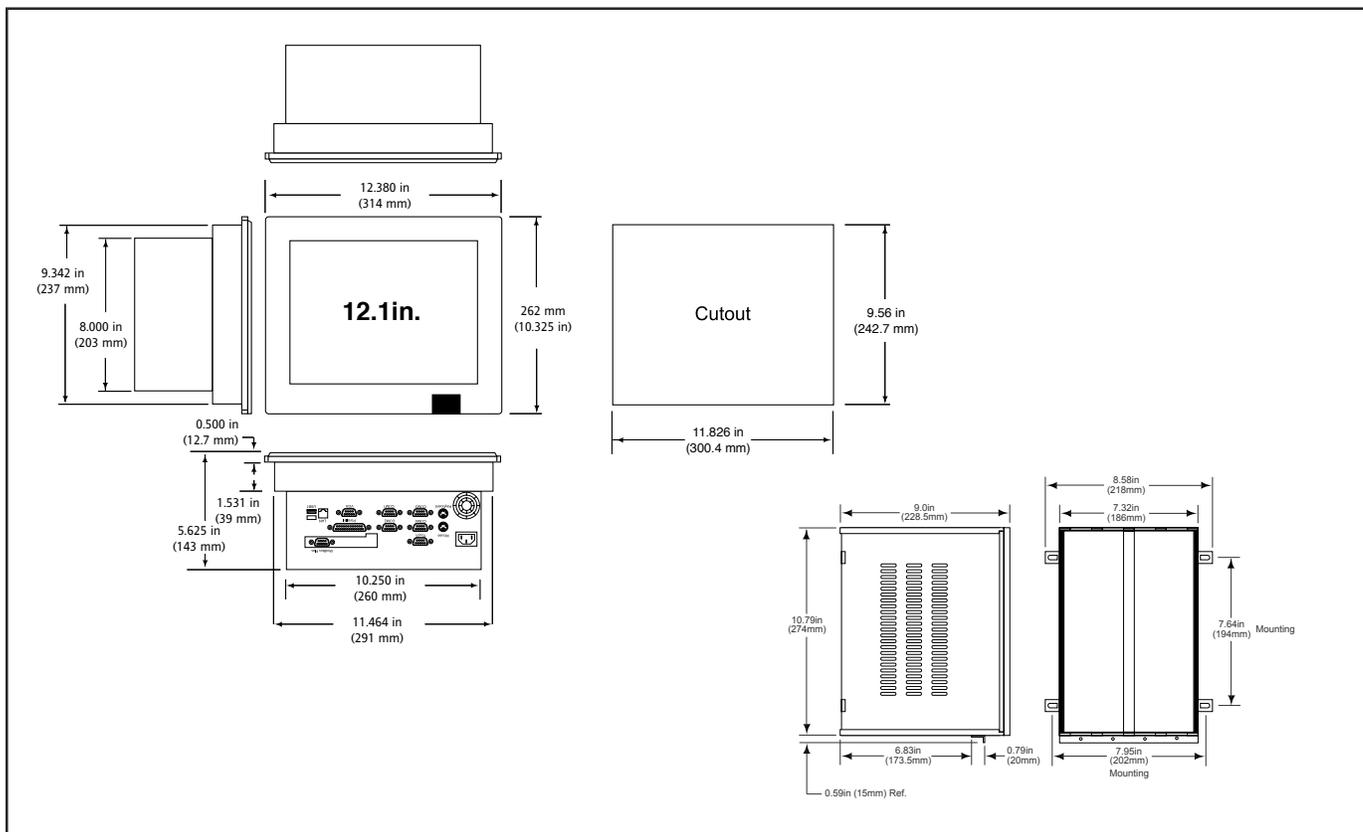
## MACO Breeze II

- Pre-configured for common machines (time or position)
- 100 point parison profile
- 100 point velocity pushout control
- Graphically enter and display the parison profile
- Actual tooling performance versus entered profile displayed
- Separate weight and die gap settings
- Very high speed loop closure - 0.1ms
- Multiple security levels
- Large color touch screen
- Store parison setups to internal memory or USB sticks
- Common Boards with the MACO DS controller



The MACO Breeze II brings parison only wall thickness control capability to the average operator, and added productivity and profit to blow molders. It can be specified on a new machines or added as a retrofit to a wide variety of machines to provide consistent wall thickness for improved product quality, less material consumption and reduced scrap. The user needs only specify the type of machine and the unit will be factory programmed for that type of machine. Once the unit is installed, calibrate the tool/accumulator and enter the desired parison profile. The 100 point parison profile is displayed graphically on a large display, which allows the profile to be quickly modified and compared to the actual process value. The entered profiles can then be stored internally or on removable USB memory sticks. The MACO Breeze II utilizes the same cards as the MACO DS total machine controller, which allows users to stock fewer spare parts and provides highly precise parison control. Parison tooling position is updated every 0.1 milliseconds to minimize material usage and improve part quality.

## Dimensions



# MACO<sup>®</sup> Compact Breeze IIc

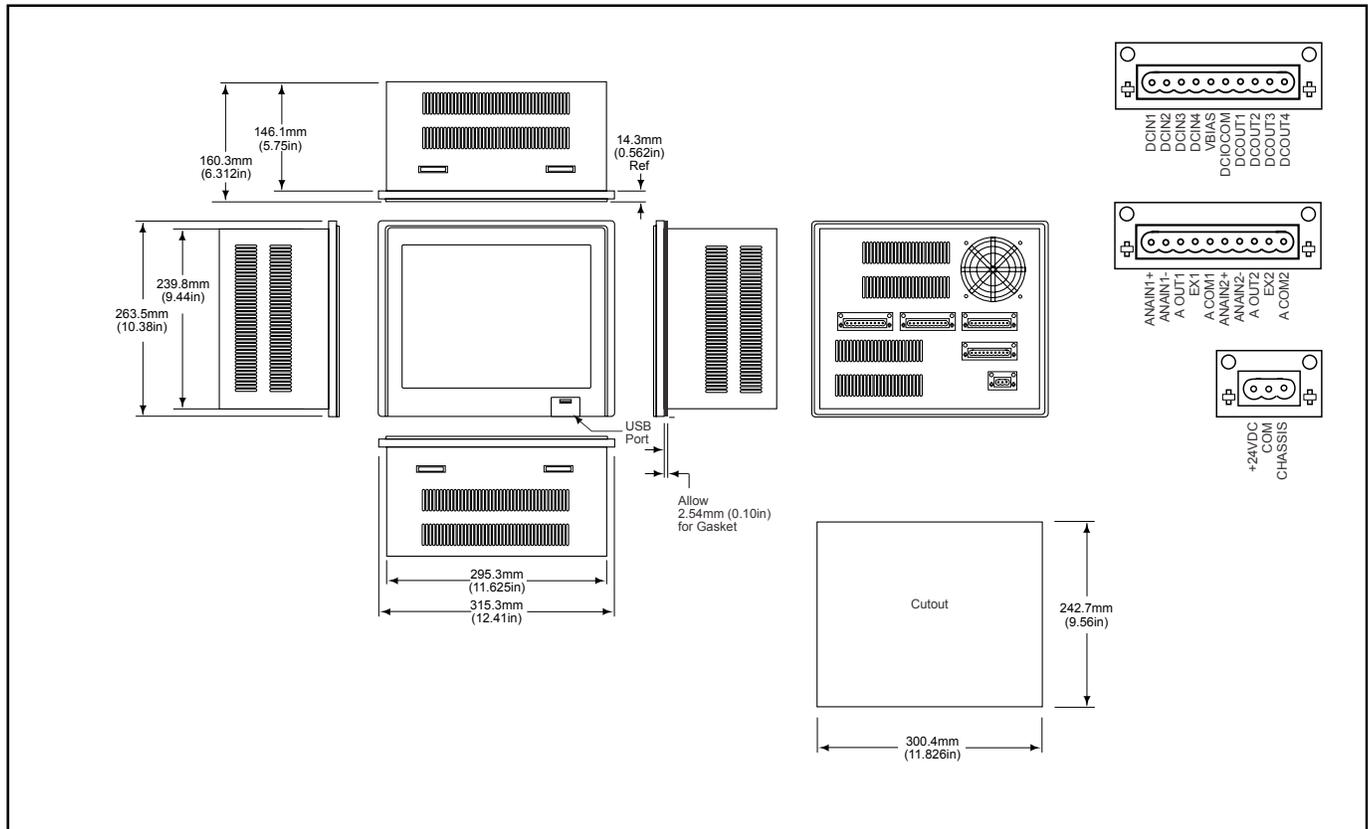
## MACO Compact Breeze IIc

- Pre-configured for common machines (time or position)
- 100 point parison profile
- 100 point velocity pushout control
- Graphically enter and display the parison profile
- Actual tooling performance versus entered profile displayed
- Separate weight and die gap settings
- Very high speed loop closure - 0.1ms
- Multiple security levels
- Large color touch screen
- Store parison setups to internal memory or USB sticks
- Common Boards with the MACO Compact controller



The MACO Breeze IIc is the latest in parison only control from Eurotherm, providing the same high performance wall thickness control that you have come to expect from earlier versions of the MACO Breeze. This standalone unit is based on the MACO Compact control system, and includes a Compact parison board and Compact touch screen display in a chassis only slightly deeper than an Optima PC, eliminating the need for a separate controller enclosure! As with previous MACO Breeze systems it can be specified on a new machines or added as a retrofit to a wide variety of machines to provide consistent wall thickness for improved product quality, less material consumption and reduced scrap. The user needs only specify the type of machine and the unit will be factory programmed for that type of machine. Once the unit is installed, calibrate the tool/accumulator and enter the desired parison profile. The 100 point parison profile is displayed graphically on a large display, which allows the profile to be quickly modified and compared to the actual process value. The entered profiles can then be stored internally or on removable USB memory sticks. Parison tooling position is updated every 0.1 milliseconds to minimize material usage and improve part quality.

### Dimensions

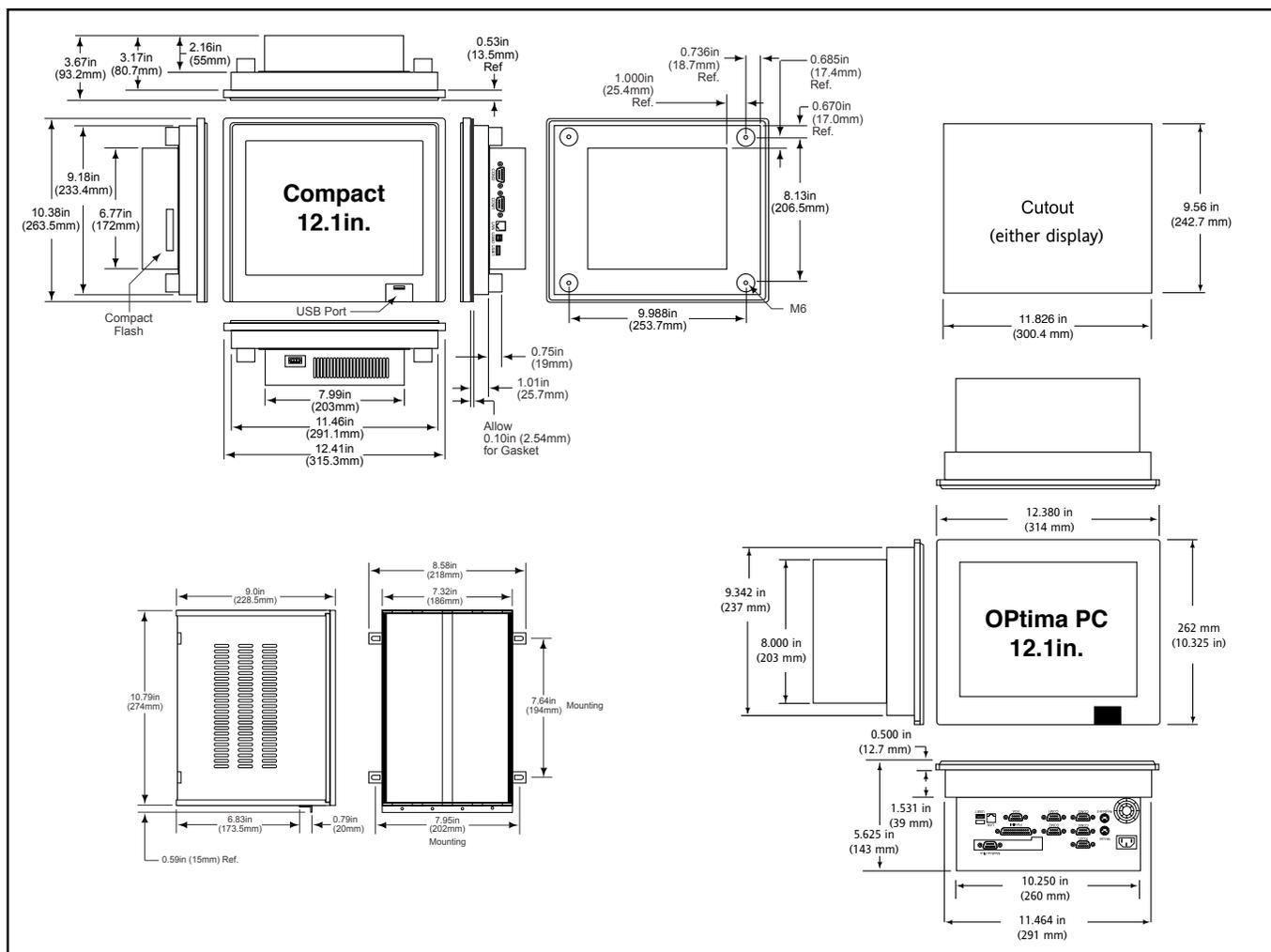


- Available with either a Compact display with Microsoft<sup>®</sup> CE.net operating system or an OPTima PC running Microsoft Windows<sup>®</sup> with InTouch<sup>™</sup>
- Adaptive auto-tuning temperature control for precise control
- Preconfigured screens and sequence reduces installed cost
- Auto-tuning for optimized melt pressure control
- Labor and material savings by directly wiring to terminal I/O blocks
- Multi-lingual for global use
- Ethernet communications for simplified installation



The EM-3c is specifically designed for small extruders but is packed with the features of the popular EM-3 Extrusion Control System. The operator interface is either a MACO Compact running Microsoft CE.net or the rugged OPTima Touch PC running Wonderware InTouch<sup>™</sup> and can be used just for extruder temperature and pressure control or complete line control. A building block architecture has been used to create a standard implementation of an extrusion control system that is applicable to many extrusion processes. Standard control system definitions save valuable engineering time and expense. Preprogrammed components can be connected for true out-of-the-box performance. These built-in functions manage temperature, pressure, and line speed. Ramping and bumpless transfer ensures smooth processing. The temperature card is designed specifically for single-screw, twin-screw, co-extrusion or blown film applications. Fully automatic adaptive tuning (as well as conventional tuning) is provided. Predefined screens and sequence logic greatly simplify installation and setup. Applications that match the predefined screens and logic will not require additional programming. For applications that differ, installers can use the predefined application as the basis for custom control.

## Dimensions



# iPact™ with intellimold®

## MACO Compact

- Fast start-up
- Reduced Cycle Time
- Real time control
- Less scrap
- Improved surface quality
- Consistent part density
- Improved repeatability



iPact with IntelliMold™ is indeed a totally different way of molding. It is here now, and it's revolutionizing injection molding!

iPact uses IntelliMold, a complete real time closed loop system that controls molding processes based on recommended processing conditions for the material. Controlling to these conditions reduces material degradation and deformation, which correlates to better parts.

The benefits are proven and measurable. iPact with IntelliMold will save you time by increasing operating efficiency, increase profitability by reducing costs in a number of important ways, and produce higher quality parts that will result in greater customer satisfaction.

iPact with IntelliMold is adaptable to any injection molding machine as an optional item or as an after market retrofit. The cost of the system is minimal when compared with savings realized through increased productivity and quality.

This proven technology has developed a leadership position in process control that controls the behavior of molten or plasticized materials during mold cavity fill and solidification.

iPact with IntelliMold is a patented, cutting-edge process that brings real-time, automated closed-loop control to the molding process, eliminating the usual guesswork. IntelliMold works much like a cruise control or autopilot when it actively monitors and adjusts controls for a steady, even injection of the melt. It measures and controls the molding process, dramatically improving molding capabilities for unprecedented physical and dimensional quality improvements.

This unique process control method provides measurements and control of pressure in the cavity in the real time. The pressure developments are scanned from two strategically placed pressure transducers from which a single process variable is mathematically derived as a feed back for closed-loop control of injection. With this method and process control, each section of an injection-molded part solidifies in an equal, pressure-balanced and stress-free environment. IntelliMold is also capable of measuring and controlling based on temperature developments.

The overall product and process benefits that IntelliMold provides to molders are:

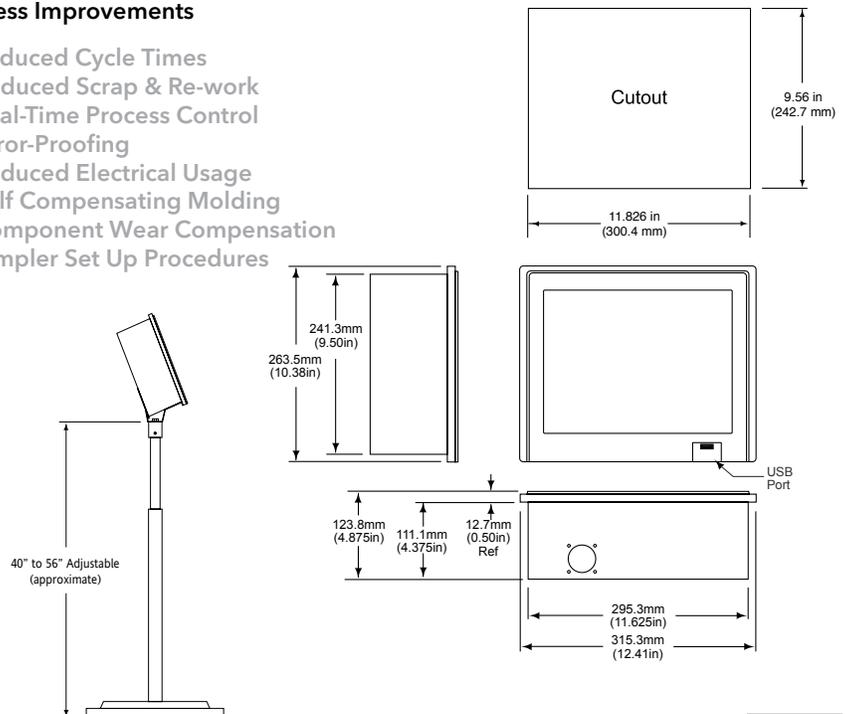
### Product Improvements

- Improved Repeatability
- Higher Surface Quality
- Reduced Warping, Sinks & Shrink
- Stronger Knit Lines
- Consistent Part Density
- Reduced Internal Stress
- Consistent Part Weight
- Improved Design Flexibility
- Improved Material Flow
- Improved Dimensional Capability

### Process Improvements

- Reduced Cycle Times
- Reduced Scrap & Re-work
- Real-Time Process Control
- Error-Proofing
- Reduced Electrical Usage
- Self Compensating Molding
- Component Wear Compensation
- Simpler Set Up Procedures

IntelliMold is also available on standard MACO Compact systems.



# MACO® Optima PC Operator Interface

## MACO DS, RS, Compact

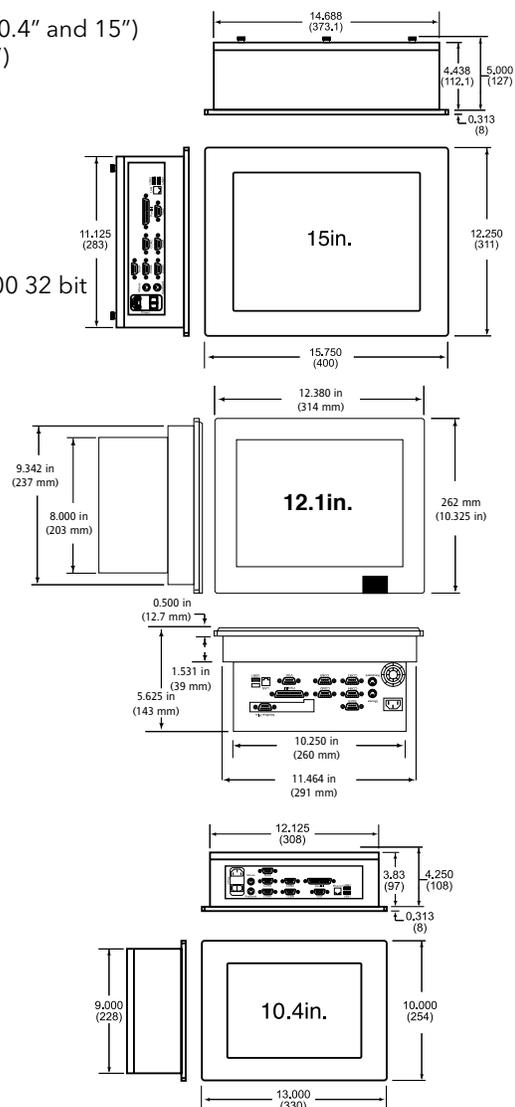


- Bright easy to read display
- Easy mounting
- Optional custom software installation
- High resolution
- Rugged construction

The Optima Touch PC is a rugged, compact industrial computer combined with a TFT touch screen monitor in a single housing. It is designed to serve as a general purpose human machine interface (HMI) and can be ordered pre-configured with several HMI software packages. A heavy duty chassis and low component count circuit designs provide enhanced reliability, increased EMI immunity, and resistance to shock and vibration. A unique bracket mounting system eliminates the need for drilling holes or fixing studs. The 15 inch unit, with a resolution of 1024 x 768 pixels, can be mounted either horizontally or vertically. The 12.1 inch unit, with a resolution of 1024 x 768 pixels, is for horizontal mounting. The 10.4" unit, with a resolution of 800 x 600 pixels, is also for horizontal mounting. The Optima Touch is designed for operation under harsh environmental conditions in a multitude of vertical markets, including automotive, semi-conductor, transportation, plastics, heat treating, utilities and more. Thanks to a built-in fast ethernet port, the Optima Touch provides instant connectivity to a plant's intranet and networked servers.

## Optima PC Specifications & Mounting Dimensions

|                          |  |
|--------------------------|--|
| <b>Construction:</b>     | Heavy duty steel chassis and aluminum front panel (10.4" and 15")<br>Heavy duty steel chassis and plastic front panel (12.1")            |
| <b>LCD:</b>              | 15" TFT 1024 x 768 ((horizontal or vertical mount)<br>12.1" TFT 1024 x 768 ((horizontal mount)<br>10.4" TFT 800 x 600 (horizontal mount) |
| <b>Touch screen:</b>     | Analog resistive continuous resolution   |
| <b>Processor speed:</b>  | 1.2GHz Celeron, 133MHz FSB   |
| <b>DRAM:</b>             | 512MB DIMM   |
| <b>BIOS:</b>             | Phoenix-Award  |
| <b>VGA controller:</b>   | S3 ProSavage4 4xAGP 3D/2D SVGA up to 1600 x 1200 32 bit  |
| <b>VGA port:</b>         | Supports simultaneous display with second monitor  |
| <b>Ethernet:</b>         | (1)10/100 base-T Realtek RTL8139C RJ-45 connector  |
| <b>Serial ports:</b>     | (2)RS-232; (1)RS-232/422/485   |
| <b>Parallel port:</b>    | (1)parallel  |
| <b>USB ports:</b>        | (2)USB   |
| <b>Storage:</b>          | 40GB (standard)  |
| <b>Keyboard port:</b>    | PS/2   |
| <b>Mouse port:</b>       | PS/2   |
| <b>Expansion slot:</b>   | (1)32-bit PCI (half length)  |
| <b>Operating system:</b> | Windows™ XP Professional (standard);<br>Windows™ XP Embedded<br>(optional, required for flash drive)                                     |
| <b>Power supply:</b>     | 85 to 264Vac, 90 Watts (standard)<br>19 to 32Vdc, 90 Watts (consult factory)   |
| <b>Temperature:</b>      | Operating: 0 to 50°C (32 to 122°F)<br>Storage: -20 to 60°C (-4 to 140°F)   |
| <b>Humidity:</b>         | 5 to 95% @ 50°C (122°F), non-condensing  |
| <b>Shock:</b>            | 5G, 11ms duration, half-sinewave   |
| <b>Vibration:</b>        | 10-58Hz, 0.0375mm 58-500Hz; 0.5G   |
| <b>Protection class:</b> | NEMA 4X/IP65 (front side)  |
| <b>EMC:</b>              | CE/FCC class A   |
| <b>Safety:</b>           | CE/cTUVus  |



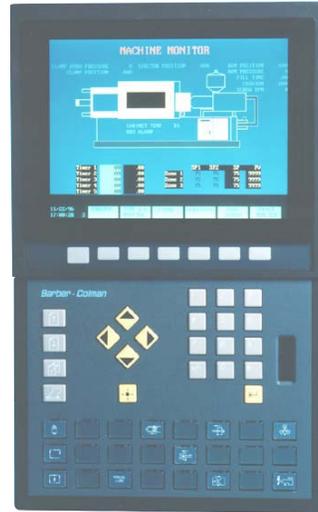
# MACO<sup>®</sup> OPTima Operator Interface

MACO 4000, 5000, 6000, DS, RS, Compact

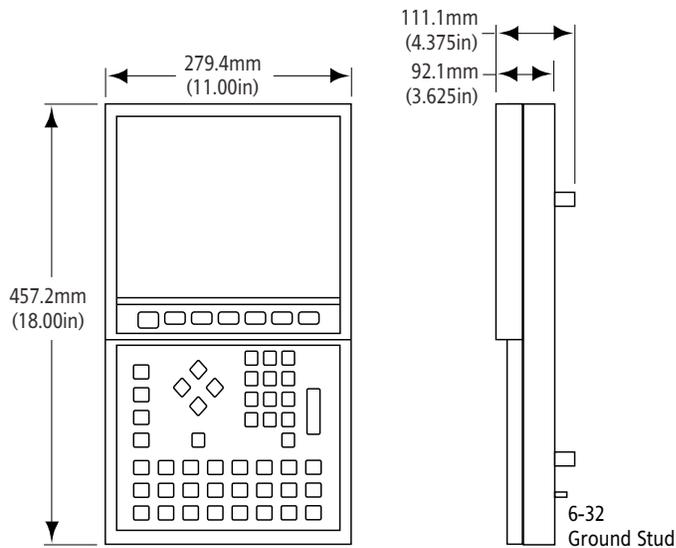
The OPTima family is a full-size, full-feature family of operator stations.

## Features:

- 10.4" Color TFT or grayscale display
- 640 x 480 screen resolution
- Insertable button legends
- Recipe saves to INSTA-SET cartridge port or floppy disk drive
- 24 programmable machine function keys with LEDs
- Downloadable fonts, graphics and sprites
- Membrane or elastomer pushbutton switches
- Programmable screen saver
- Alarm screen vectoring
- Alarm and setpoint change logging
- 4 Levels of security with online changes
- Flange or rear mounting
- Line and SPC graphs
- Quick connect removable connectors or conduit fittings
- Configured using the OPtiGrafix screen editor
- Connects via MACO NET to the MACO DS ASB, MACO RS and MACO 4000, 5000 and 6000
- Now also available for MACO Compact



## OPTima Mounting Dimensions



The MACO Compact version of the OPTima has the same external dimensions as standard OPTimas, but includes an optional touchscreen, a USB port in place of the cartridge port, and uses Ethernet communications in place of MACONET RS-485.



# MACO® Touchscreen Monitors

## MACO DS, RS

### Touchscreen Monitors

The Industrial Line - Touchscreen Monitors are a family of rugged, compact, slimline TFT flatscreen monitors with a resistive touchscreen, for use with the Intelligent Integrator. These monitors are specifically designed for industrial applications with panel mounting. Front sealing is to IP65 and NEMA 4/12.



### Features and Benefits:

- **Two Sizes to Choose from** - 12" (800 x 600 pixels); 15" (1024 x 768 pixels)
- **Industrial Strength HMI** - Stainless steel chassis with a painted aluminum alloy front panel. Full IP65 and NEMA 4/12 environmental protection when mounted in panel.
- **Compact, Protected Design** - Small unit depth allows fitting into confined space in panels. Strengthened glass protects the front panel from shock/damage.
- **Easy Installation** - Unique bracket mounting system for easy fitting into panel cutout. No need for drilling holes or fixing studs.

## Touchscreen Specifications

- VGA and serial cables (1.2 m) included

### Display

12" TFT-LCD (800 x 600 pixels)  
15" TFT-LCD (1024 x 768 pixels)

### Max. Number of Colors

256k

### Luminance (cd/m<sup>2</sup>)

250

### View Angle

12" = 120° (H), 90° (V)  
15" = 160° (H), 160° (V)

### Touch Screen Resolution

1024 x 1024

### LCD MTBF

50,000 Hrs

### Back Light MTBF

12" = 50,000 Hrs  
15" = 50,000 Hrs

### Power Supply

100-240 Vac, 1.8 Amps, 50-60 Hz  
supplied as external power adapter

### Construction

Heavy-duty stainless steel chassis  
painted aluminum alloy front panel  
NEMA 4/12 IP65 sealing

### Front Panel Color

RAL 7035 (white)

### Dimensions (H x W x D)

12" = 291 x 366 x 85.7 mm  
15" = 337 x 444 x 90 mm

### Panel Cutout (H x W)

12" = 258 x 333 mm  
15" = 280.4 x 398 mm

### Gross Weight

12" = 7.5 Kg  
15" = 8.9 Kg

### Environmental Data

#### Temperature

**Ambient** 0°C to +50°C  
**Storage** -20°C to +60°C

#### Humidity

**Storage** 5-95 %, non-condensing

#### Vibration

5-17 Hz,  
0.1" double-amplitude displacement,  
17 to 500 Hz, 1.5G peak to peak

#### Shock

10G peak acceleration (11 msec.)

#### EMI

CE/FCC Class A

# MACO® Series 7 Intelligent Integrator PC

MACO DS, RS

## Series 7 Intelligent Integrator PC

The Series 7 Intelligent Integrator is a rugged industrial PC in a compact EMI protected metal housing supporting DIN rail mounting. Connectivity is assured by means of a wide range of I/O interfaces. Based on Microsoft Windows 2000 operating system, off-the-shelf software can be easily added to customize applications.



### Features and Benefits:

- **Totally Open Automation Platform** - Windows 2000 operating system allows easy integration of different hardware and off-the-shelf software components to maximize application efficiency. Up to two PC/104+ slots enable customer specific extensions.
- **Rugged PC Hardware** - Low component counts for enhanced reliability, increased shock, vibration and EMI immunity. Easy DIN rail mounting.
- **Open Communications** - Modbus, Profibus, AS-i, DeviceNet, Ethernet and other Field I/O supported. Ethernet TCP/IP provides Network Communications.

## Series 7 Intelligent Integrator PC Specifications

- Windows 2000 Operating System
- 566 MHz Processor, 12GB Hard Disk
- 100/10 BaseT Ethernet
- 4 x RS 232 serial ports
- 2 spare PC104 Expansion slots

### Processor

Celeron 566 MHz

### VGA Graphics

Intel 82810 chipset, 3D/2D Windows accelerator  
Resolution up to 1600 x 1200

### Memory

128 MB SDRAM

### Disk Drives

Hard Disk 12GB  
Internal 3.5" floppy drive (1.44MB)

### Peripherals

PS/2 compatible keyboard & monitor ports  
2 x USB ports

### Network

100/10 BaseT Ethernet

### Expansion Slots

2x PC 104+

### Serial I/O

4 x RS232 serial ports (16550 compatible)

### Parallel I/O

2 x bi-directional ports (IEEE 1284 compatible)

### Supply Voltage

10-30 Vdc

### Idle Power Use

10.1 W

### Operating

28 to 38 W typical

### Mechanical

Aluminum housing for best thermal management and ruggedness. Protection against particles greater than 2.5 mm (IP30). DIN rail mounting.

### Size

145 mm (H) x 229 mm (L) x 92 mm (D)

### Cooling

Fanless convection cooling

### Operating Storage

#### Temperature

0°C to 50°C

-40°C to +85°C

#### Humidity

5 - 90% @ 40°C

5 - 95% @ 40°C

Built in temperature sensor, SW readable

### Vibration

5.08 mm displacement (p-p @ 5 to 14 Hz)  
2g rms @ 14 to 200 Hz, 90 minutes each axis,  
17 sweeps (without fan)

### MTBF

Proved in permanent operation under rugged industrial conditions. Reliability calculations for low power PC's in accordance with MIL-HDISK-217.

### Electromagnetic Compatibility

CE compliant

EN 50082-2 (immunity)

EN 50081-2/55022 (emission)

Surge immunity per EN 61004-4-5

# MACO<sup>®</sup> DS Application Specific Blocks (ASB's)

MACO DS

Whether producing difficult or easy products, Invensys Eurotherm's process control knowledge will be a benefit. The ASB can be configured for any plastic application.

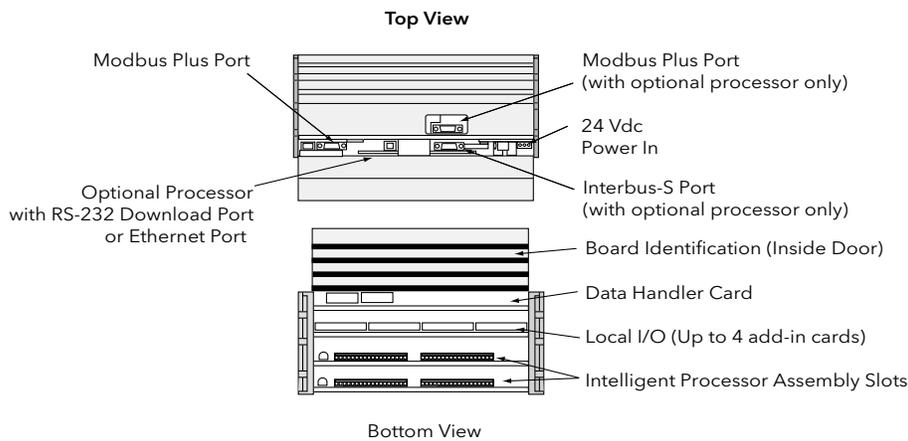


Utilizing a distributed control structure that features intelligent processor assemblies (IPAs) with on-board microprocessors, the MACO DS/RS delivers unmatched control. In addition to the on-board microprocessors, each ASB can be equipped with a central processor for custom control and local I/O drops. The central processor supports true IEC 1131-3 programming\*, runtime controller simulation for discrete I/O, on-line monitoring/editing, and custom control capability.

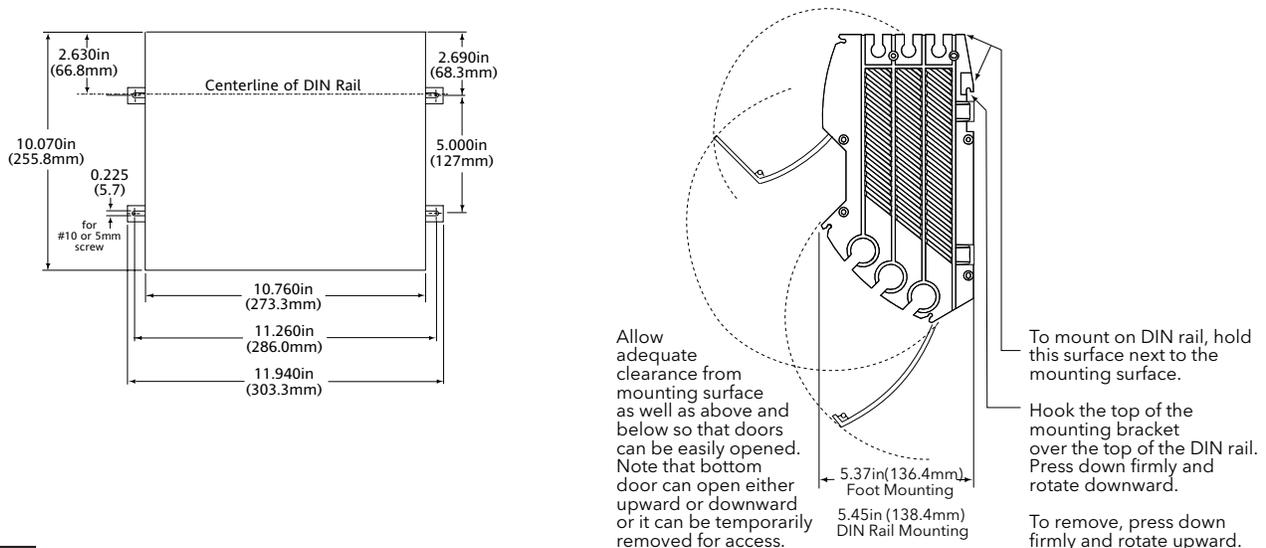
Custom control capability is unique to MACO DS/RS. OEMs no longer need to design and manufacture their own control systems to keep routines confidential. Through the sequence programming package, a low level C++ block can be downloaded to modify or enhance Eurotherm/Barber-Colman's routines.

\*Ladder Diagram, Function Block Diagram, Sequential Function Chart, Instruction List, and Structured Text.

## ASB Base Overview



## ASB Mounting Dimensions



# MACO<sup>®</sup> RS (Rack System)

## MACO RS

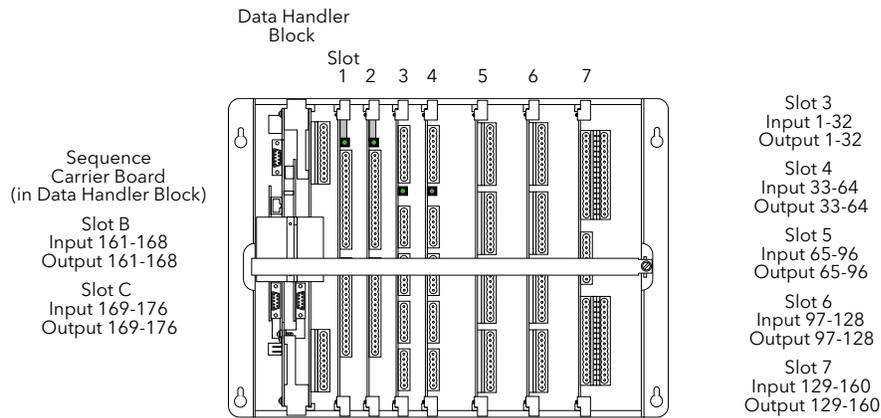
Utilizing a distributed control structure that features intelligent processor assemblies (IPAs) with on-board microprocessors, the MACO RS delivers unmatched control. In addition to the on-board microprocessors, each RS can be equipped with a central processor for custom control and local I/O drops. The central processor supports true IEC 61131-3 programming\*, runtime controller simulation for discrete I/O, on-line monitoring/editing, and custom control capability.



Custom control capability is unique to MACO RS. OEMs no longer need to design and manufacture their own control systems to keep routines confidential. Through the sequence programming package, a low level C++ block can be downloaded to modify or enhance Invensys Eurotherm's routines.

\*Ladder Diagram, Function Block Diagram, Sequential Function Chart, Instruction List, and Structured Text.

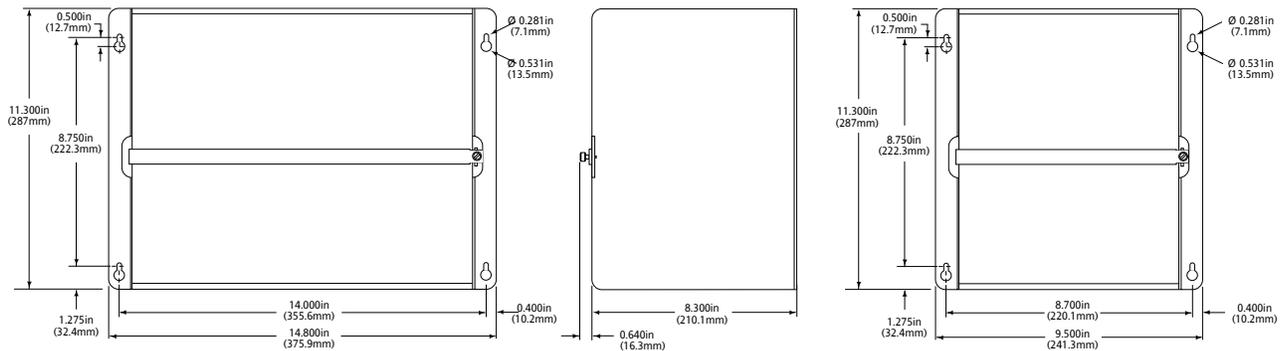
## MACO RS I/O Numbering



Notes:

1. Slots 1-4 can be T/C-Analog, maximum of 4 per rack.
2. Slots 2-4 can be Parison, EZ PRO, Injection or Extrusion, maximum of 2 per rack.
3. Slots 3-7 can be 32 I/O or 24 I/O Card assemblies.
4. Slots 3-7 can be 4-slot Carrier Boards, maximum of 2 Carrier Boards per rack.

## MACO RS Mounting Dimensions



7 Slot

4 Slot

# XL PB & Remote I/O Pushbutton Stations

## MACO DS, RS, Compact

The XL PB and Remote I/O pushbutton stations provide a cost effective means to add pushbuttons to any general purpose PLC or distributed control system. An LED at each key indicates On/Off status.

On the XL PB, openings for inserting labels on the back of the panel let you easily remove and replace the keypad icons. There is also a mounting hole for a user installed device such as an E-Stop button or key switch. The Remote I/O station features individual keycaps that can be removed for inserting custom icons.

Typical applications would be for additional pushbuttons around an operator station, a primary interface for sequence-only controllers and as a remote interface station.

Just specify the smart interface board and connect to Ethernet, Modbus Plus®, ControlNet™, DeviceNet®, Profibus-DP® or Interbus-S networks. In addition to the buttons and LEDs provided as standard, the smart interface board adds 8 more inputs and outputs that can be connected to external momentary switches and indicator lights.



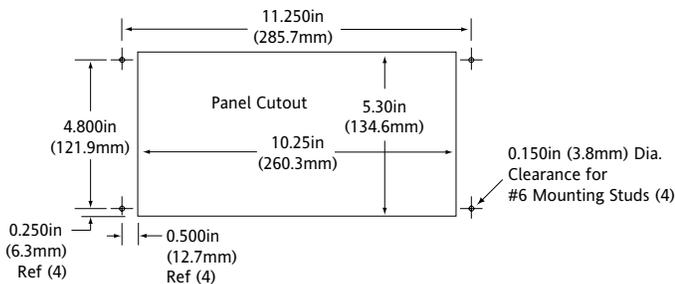
XL PB



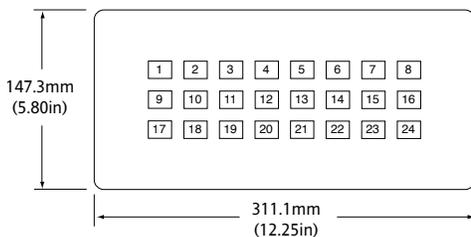
Remote I/O

## Mounting Dimensions

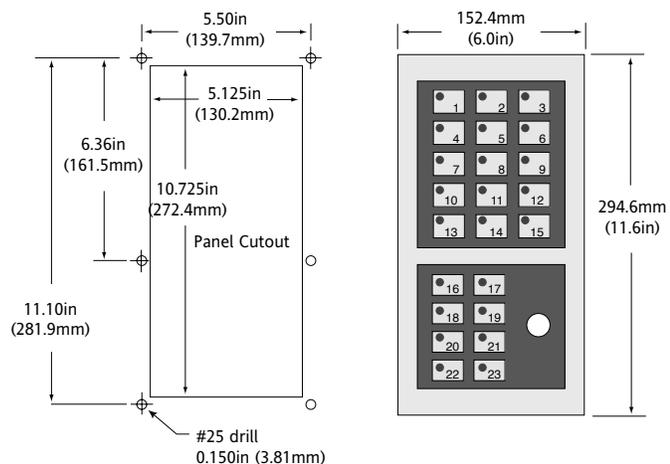
### Remote I/O



Note that Power Supply Connector is "up" for proper orientation (the LEDs will be at the top of the key).



### XL PB



# Processor Options

## MACO DS, RS

Each MACO ASB and Terminal I/O Block can be configured with a PLC processor, providing for a modular system structure. Just select the processor that matches the application.

| Processor Model Number               | DSP0-40000  | DSP0-20000   | DSP0-70000             | DSP0-80000   | DSP0-90000   |
|--------------------------------------|-------------|--------------|------------------------|--------------|--------------|
| Internal Memory                      | 64k         | 256k         | 512k                   | 1M           | 1M           |
| User Memory                          | 2.4k        | 12k          | 18k                    | 18k          | 18k          |
| RS-232 Modbus Port (Master or Slave) | Yes (Slave) | Yes          | Yes                    | No           | No           |
| Interbus-S Port                      | No          | Yes          | Yes                    | No           | Yes          |
| Modbus Plus Port                     | Optional    | Optional (1) | Optional (1)           | Optional (1) | Optional (1) |
| Ethernet TCP/IP Port                 | No          | No           | No                     | Yes          | Yes          |
| RS-485 Modbus Port (Master or Slave) | Yes         | Optional (1) | Optional (1)           | Yes          | Optional (1) |
| Registers                            | 2048        | 4096         | 26032                  | 26032        | 26032        |
| Discretes                            | 2048 (2)    | 2048 (2)     | 0X = 8192<br>1X = 8192 | 8192 (2)     | 8192 (2)     |
| Clock Rate                           | 20 MHz      | 20 MHz       | 32 MHz                 | 50 MHz       | 50 MHz       |

(1) Either a Modbus Plus port or an RS-485 port (but not both).

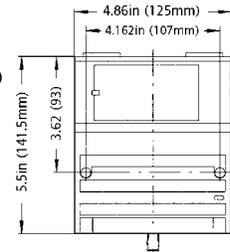
(2) This total can include any combination of 0X and 1X references.

# Terminal I/O Blocks

MACO DS, RS

Each Terminal I/O Block has a base. A base comprises 20 different types of DC, AC and analog I/O configurations. Each base is wired directly, eliminating the need for intermediate terminal blocks or marshaling strips.

A slave communication adapter is mounted to each base; the two form a remote I/O drop that can be connected directly to the ASB, or to virtually any standard field bus I/O network.



| Module   | Operating Voltage | Type  | Modularity (Common Points)                               | Isolation* between |                |                 | Current (Amps) per |       |        | Response (ms)                 |                        | Protection | Resolution   |
|--|-------------------|-------|--|--------------------|----------------|-----------------|--------------------|-------|--------|-------------------------------|------------------------|------------|--|
|  |                   |       |  | Chs                | Grps           | Ch-Earth        | Output             | Group | Module | Activation                    | Deactivation           |            |  |
| 16 pt, 24 Vdc In   | na                | na    | 1  | no                 | no             | 1780            | na                 | na    | na     | 2.2                           | 3.3                    | na         | na   |
| 32 pt, 24 Vdc In   | na                | na    | 2  | no                 | no             | 1780            | na                 | na    | na     | 2.2                           | 3.3                    | na         | na   |
| 16 pt, 115 Vac In  | na                | na    | 2  | no                 | (1)            | 1780            | na                 | na    | na     | 10 @ 60 Hz                    | 35 @ 60 Hz             | na         | na   |
| 16 pt, 24 Vdc Out  | 24 Vdc            | Trans | 2  | no                 | no             | 1780            | 0.5                | 4     | 8      | <0.1                          | <0.1                   | (2)        | na   |
| 32 pt, 24 Vdc Out  | 24 Vdc            | Trans | 2  | no                 | no             | 1780            | 0.5                | 8     | 16     | <0.1                          | <0.1                   | (2)        | na   |
| 8 pt, 115 Vac Out  | 115 Vac           | Triac | 2  | no                 | no             | 1780            | 2                  | 4     | 8      | 1/2 x 1/f max                 |                        | (3)        | na   |
| 16 pt, 115 Vac Out   | 115 Vac           | Triac | 2  | no                 | no             | 1780            | 0.5                | 4     | 8      | 1/2 x 1/f max                 |                        | (3)        | na   |
| 8 pt, 230 Vac Out  | 230 Vac           | Triac | 2  | no                 | no             | 1780            | 2                  | 4     | 8      | 1/2 x 1/f max                 |                        | (3)        | na   |
| 16 pt, 230 Vac Out   | 230 Vac           | Triac | 2  | no                 | no             | 1780            | 0.5                | 4     | 8      | 1/2 x 1/f max                 |                        | (3)        | na   |
| 16 pt, 24 Vdc In<br>16 pt, 24 Vdc Out  | 24 Vdc            | Trans | 1 in;<br>2 out   | no                 | no             | 1780            | 0.5                | 4     | 8      | 2.2 in;<br><1 out             | 3.3 in;<br><1 out      | (2)        | na   |
| 16 pt, 24 Vdc In<br>16 pt, 24 Vdc Out (fast)   | 24 Vdc            | Trans | 1 in;<br>2 out   | no                 | no             | 1780            | 0.5                | 4     | 8      | 60 µs in;<br><1 ms out        | 80 µs in;<br><1 ms out | (2)        | na   |
| 16 pt, 24 Vdc In<br>8 pt, 24 Vdc Out   | 24 Vdc            | Trans | 4 in;<br>2 out   | 500                | 500            | 1780            | 2                  | 8     | 16     | 2.2 in;<br><1 out             | 3.3 in;<br><1 out      | (2)        | na   |
| 10 pt, 24 Vdc In<br>8 pt, Relay Out  | 24 Vdc            | Relay | 1 in;<br>2 out   | 1780               | 1780           | 1780            | 2                  | 8     | 16     | 2.2 in;<br><1 out             | 3.3 in;<br><1 out      | No         | na   |
| 10 pt, 115 Vac In<br>8 pt, 115 Vac Out   | 115 Vac           | Triac | 1 in;<br>1 out   | no                 | no             | 1780            | 0.5                | 4     | 5      | 1/2 x 1/f max                 |                        | (3)        | na   |
| 8 Differential Analog In:<br>±5V, ±10V, ±20 mA,<br>1-5 V, 4-20 mA  | 24 Vdc            | na    | 8 in   | 200 Vdc<br>(1)     | 500 Vdc<br>(1) | 500 Vdc<br>(1)  | na                 | na    | na     | 1.33 + (1.33 x # ch config'd) |                        | (4)        | 14 bits + sign;<br>15 bits single pole                                     |
| 16 Single Ended Analog In:<br>±5V, ±10, 4-20 mA  | 24 Vdc            | na    | 1 in   | no                 | 500 Vdc<br>(1) | 1780 Vdc        | na                 | na    | na     | 1 + (1.5 x # ch config'd)     |                        | (4)        | 12 bits + sign   |
| 4 Channel Analog In:<br>±25 mV<br>±100 mV<br>Pt 100<br>Pt 1000<br>Ni 100<br>Ni 1000<br>TC types:<br>B, E, J, K, N, R, S, T         | 24 Vdc            | na    | 4 in   | 400 Vdc            | 500 Vdc<br>(1) | 1780 Vdc<br>(1) | na                 | na    | na     | 500                           |                        | (4)        | 12 bits + sign   |
| 4 Channel Analog Out:<br>±10 V, 0-20 mA  | 24 Vdc            | na    | 1 in   | no                 | 500 (1)        | 1780 (1)        | na                 | na    | na     | 2 ms                          |                        | (4)        | 12 bits + sign   |
| 4 Channel Analog Out:<br>±10 V, 4-20 mA  | 24 Vdc            | na    | 1 in   | no                 | 500 Vdc<br>(1) | 1780 (1)        | na                 | na    | na     | 2 ms                          |                        | (4)        | 12 bits + sign   |
| 4 Ana In; 2 Ana Out:<br>4 24 Vdc In; 2 24 Vdc Out<br><u>Inputs</u><br>±5 V<br>±10 V<br>±20 mA<br><u>Outputs</u><br>10 V<br>0-20 mA | 24 Vdc            | Trans | 1 ana in<br>1 ana out<br>1 discrete in<br>1 discrete out | no                 | 500 (1)        | 500 (1)         | 1                  | 2     | 2      | 10 ms in;<br>1 ms out         |                        | (2), (4)   | Inputs:<br>12 - 14 bits,<br>de-pending<br>on range.<br>Outputs: 12<br>bits |

\* Vac unless otherwise noted  
 (1) for one minute (2) Electronic (3) Fuse/Group (4) Against Polarity Inversion  
 High Speed Counter: 24 Vdc operating voltage, 2 independent counter inputs, up to 200 kHz 5 Vdc operation, up to 10 kHz 24 Vdc operation,  
 four 24 Vdc outputs @ 0.5 A, 6 24 Vdc inputs.

### Data Handler Board

|                 | Processor       | Data Handler    |
|-----------------|-----------------|-----------------|
| Modbus          | Master or Slave |                 |
| Modbus Plus     | Master or Slave | Master or Slave |
| Interbus-S      | Master          |                 |
| Ethernet TCP/IP | Master or Slave | Slave*          |
| Profibus        |                 | Slave*          |
| ControlNet      |                 | Slave*          |
| MACO NET        |                 | Slave*          |
| RS-485 Host     |                 | Slave*          |

\*Consult factory for availability.

### Terminal I/O Blocks

- DeviceNet
- ControlNet
- Ethernet TCP/IP
- Profibus-DP
- Interbus-S
- Modbus Plus

### XL PB Pushbutton Station

- DeviceNet
- ControlNet
- Ethernet TCP/IP
- Profibus-DP
- Interbus-S
- Modbus Plus

### Wonderware InTouch

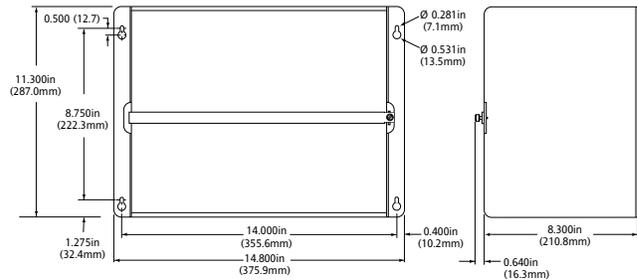
- Over 700 Protocols (consult factory)

# MACO<sup>®</sup> 4000, 5000, 6000 Rack Systems

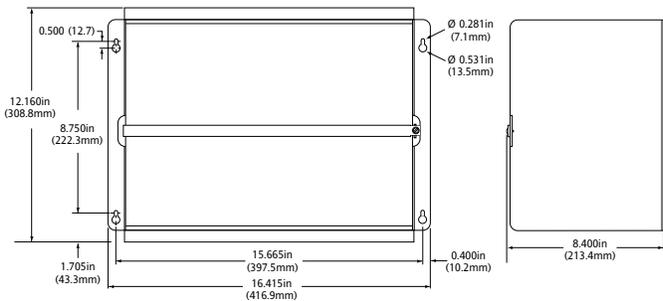
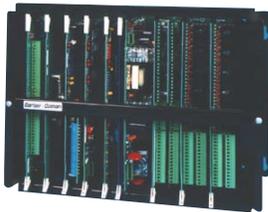
MACO 4000, 5000 and 6000 Series Controllers are housed in a chassis constructed of heavy gauge sheet metal. DC powered fans (on enclosed systems) ensure adequate air flow to prevent heat buildup. The chassis is divided into two isolated compartments: a low voltage compartment and a high voltage compartment. The high voltage compartment contains all discrete AC and DC input and output boards and the system power supply.

The chassis-resident power supply provides all operating voltages needed for the controller and operator station. The Custom 4, 5 and 6 units must be powered by a 24 Vdc supply. All the other rack systems have a power supply designed to operate from 100 to 240 Vac nominal, 50/60 Hz (85 to 265 Vac, low line to high line).

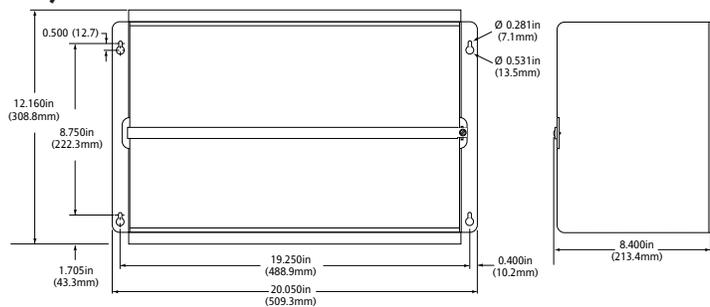
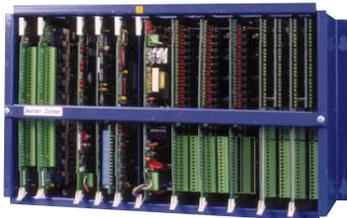
## MACO Custom 4, 5, 6 (7 Slots)



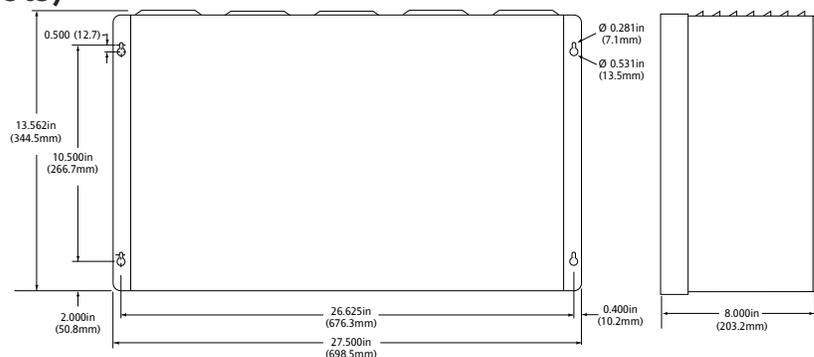
## MACO Custom 40, 50, 60 (9 Slots)



## MACO Custom 4000, 5000, 6000 (12 Slots)



## MACO 4500, 5500, 6500 (16 Slots)



# Thermocouple/Analog Input Cards

The T/C-Analog card is available with several different combinations of inputs:

- 8 zones of thermocouple input (MACO Compact only)
- 12 zones of thermocouple input
- 12 zones of analog input (Vdc or mAdc)
- 6 zones of thermocouple input
- 6 zones of thermocouple input and 6 zones of analog input (Vdc or mAdc)
- 9 zones of thermocouple input and 3 zones of analog input (Vdc or mAdc)

The adaptive auto-tuning control lets you quickly bring temperatures to within 1°F of setpoint. Smart routines also watch for process high, low, deviation, heater burnout, and thermocouple break alarms.

Producers will like the automatic heat start-up. Simply enter the time and date, and let the control start the heats. Advanced users will benefit from the melt temperature control (cascading temperature) and temperature ramping.

## T/C-Analog Card Specifications

|                          |  |
|--------------------------|--|
| <b>Tuning:</b>           | Adaptive auto-tune, or user selectable manual                                |
| <b>Setpoints:</b>        | Standby and run  |
| <b>Alarms:</b>           | Process hi/lo, Deviation hi/lo, TCB, HBO                                     |
| <b>Auto Comp:</b>        | On TCB   |
| <b>Auto Start:</b>       | Via real time clock  |
| <b>Number of Inputs:</b> | Std. density: 6 per card<br>High density: 12 per card<br>Compact: 8 per card |
| <b>Isolation:</b>        | Channel to channel (220 Vac, 50/60 Hz)                                       |
| <b>Ref. Accuracy:</b>    | 0.25% of span, ±1°C  |
| <b>Range, Type J</b>     | 0 to 700°C (32 to 1292°F)  |
| <b>Range, Type K</b>     | 0 to 950°C (32 to 1742°F)  |
| <b>Range, Voltage</b>    | (Analog versions only) 0 to 10 Vdc   |
| <b>Range, Current</b>    | (Analog versions only) 0 to 20 mAdc  |
| <b>Alarms:</b>           | Process hi/lo, 2nd process hi/lo, Deviation, HBO, TCB                        |
| <b>Control Mode:</b>     | Auto tuned PID. Manual tune available  |
| <b>Com Mode Rej:</b>     | 135 db @ 230 Vac, 60 Hz  |
| <b>Series Mode Rej:</b>  | 60 db @ 150 mV, 60 Hz  |

### MACO Compact Only:

|                            |  |
|----------------------------|--|
| <b>System Power Input:</b> | (Primary Power) Requires Class 2 Power Supply; 24Vdc, +/-5%, 3A minimum supply                               |
| <b>DC Outputs:</b>         | 16; fused by groups of 4 (0.25A); 50 mA max each output;<br>Requires Class 2 Power Supply; 2A minimum supply |

# Compact Analog Processor Card

## MACO Compact

MACO IMPACT™ Process Control is a revolutionary form of injection process control technology which adds auto-tuning, adaptive control, and expert process control to the industry standard closed-loop injection process control. IMPACT creates and continually updates a theoretical model of the injection molding process. The model is then used to auto-tune the injection, pack, hold, and recovery stages, shot after shot, to adjust for variations in both the machine and materials. IMPACT Process Control adaptive tuning monitors and compares machine performance against desired part setpoints and modifies key control parameters in order to achieve desired results. IMPACT improves shot-to-shot repeatability, improving part quality and reducing costs.

**Auto-tuned Injection Process Control:** IMPACT Advanced Process Control significantly simplifies part setup and makes it possible for the molder, with little or no knowledge of process control theory, to effectively set up the machine. With IMPACT, the machine operator no longer needs to spend time adjusting the machine's PID tuning constants in order to achieve desired control. Less setup time means more machine run time. IMPACT provides auto-tuning for the velocity, pack, hold, back pressure, and boost stages of the injection cycle. Patented control algorithms provide auto-tuned PID control for each of these critical stages of the injection molding process. Using IMPACT, machine operators need not have advanced process control expertise in order to make high quality parts.

**Adaptive tuning for Automatic Shot-to-Shot Correction:** IMPACT analyzes the tuning parameters and machine performance for each shot. The results are then used to adjust the tuning parameters for the next shot. With each successive shot the tuning parameters adapt to the most recent conditions of the machine and materials in order to ensure optimum machine control for each and every shot, which results in improved part quality and reduced scrap costs.

**Injection Shot Control Modeling with Automatic Adjustment:** IMPACT creates a theoretical model of the control system and uses the model to account for real world deadtime and lags in the injection machine barrel, providing superior control even with the most difficult shots.

**Rule-based Expert System for Injection Shot Control:** Transition is the most difficult phase of the injection molding process. With most controls, transition is marked either by a pressure spike (due to the transition from velocity to pressure control) or sluggish system response (a system undertuned in order to avoid the pressure spike). With IMPACT, an expert control algorithm monitors this key process area and, based on the desired results and embedded application knowledge about the transition period, adjusts control parameters to ensure repeatable, optimal control without pressure spikes.

### High Speed Analog Card Specifications

|  |                                   |   |
|--|-----------------------------------|---|
| Analog Inputs  | Points per card, maximum          | 6   |
|  | Level (selectable)                | ±10 Vdc or ±20 mA                           |
|  | Input Impedance                   | 1M ohms (excitation for 1K to 20K ohm Pot.) |
|  | Input type (user configurable)    | position and pressure                       |
|  | Maximum Input                     | ±15 Vdc without damage                      |
|  | Input Isolation                   | Inputs isolated as a group                  |
|  | Resolution                        | 16 bits (0.5 mV)                            |
| Analog Outputs   | Points per card, maximum          | 4   |
|  | Level                             | ±10 Vdc                                     |
|  | Current                           | 3 mA maximum into a 3.3k Ohm load           |
|  | Output Isolation                  | Outputs isolated as a group                 |
|  | Resolution                        | 16 bits (0.3 mV)                            |
| Logic Inputs (DC)<br>User configurable for:<br>• Sync<br>• Incremental encoder (up to 1 kHz)<br>• RPM (up to 1 kHz)<br>• Other | Points per card                   | 4   |
|  | Voltage                           | -0.6 to 40 Vdc                              |
|  | On voltage                        | 10 Vdc                                      |
|  | Off voltage                       | 5Vdc  |
|  | Current                           | <10 mA at 24 Vdc                            |
|  | Isolation                         | Logic I/O isolated as a group               |
| Logic Outputs  | Points per card                   | 4   |
|  | Voltage                           | 24 Vdc maximum switched                     |
|  | Current (short circuit protected) | 10 mA maximum switched                      |
|  | Isolation                         | Logic I/O isolated as a group               |

Note that the Compact Analog Processor card has two plug-in slots for expansion using MACO DS/RS plug-in assemblies (DC I/O, Analog inputs, encoder, etc. - consult factory for availability).

# Parison/Motion Cards

The MACO parison card provides closed loop control of the die/mandrel positions of up to twelve independent heads per chassis. The parison feature can be used for both time based and position based profiling on continuous, accumulator, or injection types of blow molding machinery. One to 3 parison cards, each capable of up to four channels of parison control (or alternately, accumulator or injection unit control) perform most parison functions. To achieve fast response and precise tooling position, the output of the parison module is adjusted every 0.1 millisecond to match actual tooling position against the desired parison profile.

Four independent profiles - each with as many as 100 points - are available on each parison control card. Several heads can use the same profile, or each head can have its own profile. The operator station will display the entire profile on one screen. Enter any number of master setpoints (2 or more), and select any one of five modes of interpolation (flat, linear, three types of parabolic) to automatically interpolate the remainder of the 100 parison segments. Between each of the 100 segments, the controller will interpolate every 2.0 milliseconds. Therefore, a 2 second parison drop will have 1,000 target values. The line graph option can be used to display the parison profile and the actual parison process value on the screen where the profile is entered. Each profile can be saved via internal memory, or stored on a removable INSTA-SET cartridge. Profiles can also be saved as recipes with the balance of a part set up.

Parison "marking" is featured to facilitate part run in. Each parison profile has its own independent weight, and with the optional math feature, weight can be increased or decreased based on process conditions for closed loop weight control. Velocity push out control is available for coordinated control of accumulator and die head.

Synchronous Shoot and Fill ensures that the independent accumulators on a two sided machine start and stop filling and shooting at the same time, even when the machine is setup to run two totally different parts with different shot sizes. It also adjusts for real world variations common in the filling and shooting of plastic in the accumulators. This proprietary routine automatically monitors and adjusts the filling and shooting rate every 4 milliseconds during the entire filling and shooting process, which results in less setup time, better part quality and reduced cycle times.

Each parison card features four digital inputs and four digital outputs. These inputs and outputs can be used with other machine events by using priority logic executed on the parison card. Priority logic is executed on each card every two milliseconds for time critical functions such as sync and cut off.

## Parison Card Specifications

|   |                                   |  |
|---|-----------------------------------|--|
| Analog Inputs   | Points per card, maximum          | 4  |
|   | Level (selectable)                | ±10 Vdc or ±20 mA                              |
|   | Input Impedance                   | 500 Ohms to 2k Ohms                            |
|   | Input type (user configurable)    | accumulator position, die position or pressure |
|   | Maximum Input                     | ±15 Vdc without damage                         |
|   | Input Isolation                   | Each I/O pair isolated from other pairs        |
|   | Resolution                        | 14 bits (1.8 mV / 3.7 µA)                      |
| Analog Outputs  | Points per card, maximum          | 4  |
|   | Level                             | ±10 Vdc  |
|   | Current                           | 4.5 mA maximum into a 2.2k Ohm load            |
|   | Output Isolation                  | Each I/O pair isolated from other pairs        |
|   | Resolution                        | 14 bits  |
| User configurable for:<br><ul style="list-style-type: none"> <li>• Sync</li> <li>• Incremental encoder (up to 1 kHz)</li> <li>• RPM (up to 1 kHz)</li> <li>• Other</li> </ul> | Points per card                   | 4  |
|   | Voltage                           | -0.6 to 40 Vdc                                 |
|   | On voltage                        | 10 Vdc   |
|   | Off voltage                       | 5Vdc   |
|   | Current                           | <10 mA at 24 Vdc                               |
|   | Isolation                         | Logic I/O isolated as a group                  |
| Logic Outputs   | Points per card                   | 4  |
|   | Voltage                           | 24 Vdc maximum switched                        |
|   | Current (short circuit protected) | 20 mA maximum switched                         |
|   | Isolation                         | Logic isolated as a group                      |

# Injection/Motion/Extrusion Cards for Injection

MACO IMPACT™ Process Control is a revolutionary form of injection process control technology which adds auto-tuning, adaptive control, and expert process control to the industry standard closed-loop injection process control. IMPACT creates and continually updates a theoretical model of the injection molding process. The model is then used to auto-tune the injection, pack, hold, and recovery stages, shot after shot, to adjust for variations in both the machine and materials. IMPACT Process Control adaptive tuning monitors and compares machine performance against desired part setpoints and modifies key control parameters in order to achieve desired results. IMPACT improves shot-to-shot repeatability, improving part quality and reducing costs.

**Auto-tuned Injection Process Control:** IMPACT Advanced Process Control significantly simplifies part setup and makes it possible for the molder, with little or no knowledge of process control theory, to effectively set up the machine. With IMPACT, the machine operator no longer needs to spend time adjusting the machine's PID tuning constants in order to achieve desired control. Less setup time means more machine run time. IMPACT provides auto-tuning for the velocity, pack, hold, back pressure, and boost stages of the injection cycle. Patented control algorithms provide auto-tuned PID control for each of these critical stages of the injection molding process. Using IMPACT, machine operators need not have advanced process control expertise in order to make high quality parts.

**Adaptive tuning for Automatic Shot-to-Shot Correction:** IMPACT analyzes the tuning parameters and machine performance for each shot. The results are then used to adjust the tuning parameters for the next shot. With each successive shot the tuning parameters adapt to the most recent conditions of the machine and materials in order to ensure optimum machine control for each and every shot, which results in improved part quality and reduced scrap costs.

**Injection Shot Control Modeling with Automatic Adjustment:** IMPACT creates a theoretical model of the control system and uses the model to account for real world deadtime and lags in the injection machine barrel, providing superior control even with the most difficult shots.

**Rule-based Expert System for Injection Shot Control:** Transition is the most difficult phase of the injection molding process. With most controls, transition is marked either by a pressure spike (due to the transition from velocity to pressure control) or sluggish system response (a system undertuned in order to avoid the pressure spike). With IMPACT, an expert control algorithm monitors this key process area and, based on the desired results and embedded application knowledge about the transition period, adjusts control parameters to ensure repeatable, optimal control without pressure spikes.

## Injection Card Specifications

|   |                                   |  |
|---|-----------------------------------|--|
| Analog Inputs   | Points per card, maximum          | 4  |
|   | Level (selectable)                | ±10 Vdc or ±20 mA                              |
|   | Input Impedance                   | 500 Ohms to 2k Ohms                            |
|   | Input type (user configurable)    | accumulator position, die position or pressure |
|   | Maximum Input                     | ±15 Vdc without damage                         |
|   | Input Isolation                   | Each I/O pair isolated from other pairs        |
|   | Resolution                        | 14 bits (1.8 mV / 3.7 µA)                      |
| Analog Outputs  | Points per card, maximum          | 4  |
|   | Level                             | ±10 Vdc  |
|   | Current                           | 4.5 mA maximum into a 2.2k Ohm load            |
|   | Output Isolation                  | Each I/O pair isolated from other pairs        |
| User configurable for:<br>• Sync<br>• Incremental encoder (up to 1 kHz)<br>• RPM (up to 1 kHz)<br>• Other | Resolution                        | 14 bits  |
|   | Points per card                   | 4  |
|   | Voltage                           | -0.6 to 40 Vdc                                 |
|   | On voltage                        | 10 Vdc   |
|   | Off voltage                       | 5Vdc   |
|   | Current                           | <10 mA at 24 Vdc                               |
|   | Isolation                         | Logic I/O isolated as a group                  |
| Logic Outputs   | Points per card                   | 4  |
|   | Voltage                           | 24 Vdc maximum switched                        |
|   | Current (short circuit protected) | 20 mA maximum switched                         |
|   | Isolation                         | Logic isolated as a group                      |

# Injection/Motion/Extrusion Cards for Extrusion

**Melt Pressure Control - Math/Firmware Routine:** Die throughput is dependent on the plastic melt pressure ahead of the die. Should melt pressure change due to a change in material, a change in temperature or a dirty screen, the output of the extruder will change.

The melt pressure control function maintains constant melt pressure by actual measurement of plastic pressure and by controlling screw speed to maintain the required pressure. The control loop is formed using a pressure transducer for measurement and a pressure channel to provide the drive signal and pressure alarming capability. The control loop has full PID tuning constants for highly responsive control.

Both manual and automatic tuning control modes are available. Manual operation is typically used when bringing the extruder online. In the manual mode, drive speed is controlled by the RPM setpoint. After the extruder is on-line and making acceptable product control can be transferred to the automatic mode in which drive speed is a function of the measured pressure and the pressure setpoint value. Transfer from manual to automatic is bumpless, eliminating process upsets. The output of the analog card can be applied through an isolator to the drive controller or alternately it can be applied through a routine to be summed with other signals.

The controller can be used for open or closed loop drive speed control. Downstream drive speeds can be coordinated based on the speed of the primary extruder drive, eliminating product tears or awkward, tedious line speed changes.

## Extrusion Card Specifications

|   |                                   |  |
|---|-----------------------------------|--|
| Analog Inputs   | Points per card, maximum          | 4  |
|   | Level (selectable)                | ±10 Vdc or ±20 mA                              |
|   | Input Impedance                   | 500 Ohms to 10k Ohms                           |
|   | Input type (user configurable)    | accumulator position, die position or pressure |
|   | Maximum Input                     | ±15 Vdc without damage                         |
|   | Input Isolation                   | Each I/O pair isolated from other pairs        |
|   | Resolution                        | 14 bits (1.8 mV / 3.7 µA)                      |
| Analog Outputs  | Points per card, maximum          | 4  |
|   | Level                             | ±10 Vdc  |
|   | Current                           | 4.5 mA maximum into a 2.2k Ohm load            |
|   | Output Isolation                  | Each I/O pair isolated from other pairs        |
|   | Resolution                        | 14 bits  |
| Logic Inputs (DC)<br>Logic Inputs (DC)<br>User configurable for:<br>• Sync<br>• Incremental encoder (up to 1 kHz)<br>• RPM (up to 1 kHz)<br>• Other | Points per card                   | 4  |
|   | Voltage                           | -0.6 to 40 Vdc                                 |
|   | On voltage                        | 10 Vdc   |
|   | Off voltage                       | 5Vdc   |
|   | Current                           | <10 mA at 24 Vdc                               |
|   | Isolation                         | Logic I/O isolated as a group                  |
|   |                                   |  |
| Logic Outputs   | Points per card                   | 4  |
|   | Voltage                           | 24 Vdc maximum switched                        |
|   | Current (short circuit protected) | 20 mA maximum switched                         |
|   | Isolation                         | Logic isolated as a group                      |

# EZ PRO Closed Loop Motion Control Card

Recent advances in resin technology allow plastic manufacturers to produce increasingly complex parts. Many molding machines now require closed loop control on all motions. Invensys Eurotherm has provided closed loop control of the injection and parison processes for years, however, in the past it was necessary to use auxiliary motion control modules for other closed loop motions. Auxiliary modules require the user to enter motion information for multiple points on the machine and cause additional wiring expenses. The Invensys Eurotherm EZ PRO™ acceleration/deceleration card simplifies wiring and setup.

## Features

- Closed Loop Position and Velocity Control
- Setup through the MACO Operator Station
- Setup Saved with Part Recipes
- Profiled Motions (Multiple Velocities per Axis)
- Determines the Ideal Motion between Targets
- Preconfigured User Screens
- Inputs and Outputs Scanned at 100µs rate
- Graphic View of Velocity and Position Profiles for Easy Tuning

## EZ PRO Card Specifications

|   |                                   |  |
|---|-----------------------------------|--|
| Analog Inputs   | Points per card, maximum          | 4  |
|   | Level (selectable)                | ±10 Vdc or ±20 mA                              |
|   | Input Impedance                   | 500 Ohms to 2k Ohms                            |
|   | Input type (user configurable)    | accumulator position, die position or pressure |
|   | Maximum Input                     | ±15 Vdc without damage                         |
|   | Input Isolation                   | Each I/O pair isolated from other pairs        |
|   | Resolution                        | 14 bits (1.8 mV / 3.7 µA)                      |
| Analog Outputs  | Points per card, maximum          | 4  |
|   | Level                             | ±10 Vdc  |
|   | Current                           | 4.5 mA maximum into a 2.2k Ohm load            |
|   | Output Isolation                  | Each I/O pair isolated from other pairs        |
|   | Resolution                        | 14 bits  |
| User configurable for:<br>• Sync<br>• Incremental encoder (up to 1 kHz)<br>• RPM (up to 1 kHz)<br>• Other | Points per card                   | 4  |
|   | Voltage                           | -0.6 to 40 Vdc                                 |
|   | On voltage                        | 10 Vdc   |
|   | Off voltage                       | 5Vdc   |
|   | Current                           | <10 mA at 24 Vdc                               |
|   | Isolation                         | Logic I/O isolated as a group                  |
| Logic Outputs   | Points per card                   | 4  |
|   | Voltage                           | 24 Vdc maximum switched                        |
|   | Current (short circuit protected) | 20 mA maximum switched                         |
|   | Isolation                         | Logic isolated as a group                      |

# Analog I/O Card

The analog I/O card works in conjunction with the sequence/hydraulic card to provide open and closed loop hydraulic control functions. The analog I/O card has the capacity for five analog (0 to 10 Vdc) inputs and four analog (0 to ±10 Vdc) outputs. Also included on each card is a tachometer input capable of a 15 Vdc input signal at up to 1 kHz. Typical machine inputs include clamp positioning, ram or screw positioning for injection molding, and machine hydraulic pressure control for auxiliary functions. Position signals can be from potentiometers, ultrasonic sensors, or similar devices. Excitation voltage for linear potentiometers is provided by the controller. Other sensors require external power supplies.

Analog output signals are typically applied through valve drivers to proportional or servo valves. The tachometer input is typically used to monitor the RPM of a screw or motor.

**Injection Process Control:** See "IMPACT Process Control" on page 17.

**Hydraulic and Position Control:** The analog I/O card provides additional features for open loop and closed loop hydraulics and positioning control beyond injection profile control. Up to four analog outputs per card can be used to drive machine proportional or servo valves for additional machine functions. Inputs to the hydraulic/positioning control can include position sensors, pressure transducers or tachometers.

**Drive Control:** Drive functions can be used for monitoring and alarming, open loop or manual control, cascade control, or in conjunction with pressure control to achieve closed loop PID control. When used with the analog or high speed analog card, a highly flexible and accurate melt pressure loop can be configured.

## Analog I/O Card Specifications

|                                    |                             |   |
|------------------------------------|-----------------------------|---|
| Analog Inputs<br>(Analog I/O Card) | Points per card             | 5   |
|                                    | Points per chassis, maximum | 5   |
|                                    | Points per system, maximum  | 20  |
|                                    | Voltage                     | 0 to 10 Vdc (nominal)   |
|                                    | Maximum Input               | ±15 Vdc without damage  |
|                                    | Offset                      | Zero ±2 V   |
|                                    | Position (3 inputs)         | Potentiometer, LVDT or Ultrasonic Device<br>Potentiometer excitation voltage: 10 Vdc @ 20 mA<br>Potentiometer resistance: 2k Ohms to 10k Ohms |
|                                    | Pressure (2 inputs)         | 0 to 10 Vdc nominal from high level output transducer   |
|                                    | Speed (1 input)             | Tachometer: 15 Vdc maximum @ 1 kHz;<br>12 Vdc excitation @ 10 mA provided   |
|                                    | Input Resolution            | 12 bits   |

# Plug-In Cards

Another significant feature of the MACO DS/RS/Compact is the new plug-in card option. Depending on whether the application is all electric or a combination of electric and hydraulic, the appropriate plug-in card can be added. Invensys Eurotherm has developed plug-in cards for encoder (pulse), pressure (strain gauge) and linear positioning (10 Vdc) sensors, digital I/O, and SSI Input.

## Analog Input Plug-In Card Specifications

|                               |   |
|-------------------------------|---|
| <b>Resolution:</b>            | 16 bit  |
| <b>Accuracy:</b>              | 0.1%  |
| <b>Sampling Rate:</b>         | 100 samples per second per channel  |
| <b>Input Types:</b>           | 0 to 40 mV (with cold junction compensation)<br>0 to 10 Vdc ( $\pm 15$ Vdc absolute maximum)<br>4 to 20 mA (28 mA absolute maximum)<br>2 mV/Volt to 4mV/Volt (pressure transducer)  |
| <b>Output:</b>                | Relay contacts, 10 milli-Ohm max (for pressure transducer calibration)  |
| <b>Excitation:</b>            | Two isolated 10 Vdc (350 Ohm bridge, 30 mA max. load per excitation)<br>Open Sensor/Excitation detection  |
| <b>Input Impedance:</b>       | Pressure/mV = 2 milli-Ohm; 0 to 10 Vdc = 100k Ohm; 4 to 20 mA = 137 Ohm   |
| <b>Isolation:</b>             | 500 Vdc channel-to-channel and channel-to-system  |
| <b>Connectors:</b>            | Two 11 pin, plug-in receptacles with spring terminal connections (2.5 mm spacing)   |
| <b>Signals (per Channel):</b> | (2) Excitation (+/-)<br>(4) Relay contacts and provision for external pressure transducer calibration resistor<br>(2) Pressure transducer/mV input (+/-)<br>(3) 0 to 10 Vdc (+); 0 to 10 Vdc/4 to 20 mA (-); 4 to 20 mA (+) |

## Encoder Input Plug-In Card Specifications

Two isolated incremental quadrature encoders per assembly. Position can be homed from either the channel home input or from a remote source or RLD logic. Home position registers allow non-zero home positions.

|                                      |  |
|--------------------------------------|--|
| <b>Electrical Interface:</b>         | RS-422 (differential line receiver inputs)   |
| <b>Input Signals (each encoder):</b> | Phase A, NOT Phase A, Phase B, NOT Phase B, Home, NOT Home, NOT Fault  |
| <b>Maximum Pulse Rate:</b>           | 200 kHz  |
| <b>Output Counts:</b>                | $\pm 31$ bit ( $\pm 2,147,483,647$ )   |
| <b>Input Power:</b>                  | 24 Vdc (18-32 Vdc, 200 mA nominal), User provided external supply (external supply detection). Two regulators are supplied to convert the supplied voltage into two regulated 5 Vdc supplies, 300 mA max. each for the encoders. |
| <b>Time Reference:</b>               | On board time reference, 1 $\mu$ s resolution, for event sampling and velocity calculation   |
| <b>Connectors:</b>                   | Two 11 pin, plug-in receptacles with spring terminal connections (2.5 mm spacing)  |

## Synchronous Serial Interface (SSI) Plug-In Card Specifications (MACO Compact only)

The four channel SSI card provides a cost effective, high level of noise immunity compared to analog transducers. Differential RS422 levels are utilized for Clock and Data signals. Transducer suppliers provide different system resolution distance in micrometers. Overall resolution is dependent on the length of the sensor and may provide up to 24 or 25 bits of resolution. Each channel of the SSI card can be individually configured: data format (clock and data bit), sensor fault, binary or gray scale; data format and interrogation time is settable in increments of 100usec. Only a single supply is necessary for all four channels and the channels are isolated as a group.

Each SSI Channel has 6 signals: Data +, Data-, Clock +, Clock -, 24Vdc, and DC Common.

## 8 Channel Combo I/O Plug-In Card Specifications

Each card consists of 2 groups of four I/O points, each group powered by its own V+ (which must be supplied from a 12 to 32Vdc Class 2 power supply). Outputs are rated for 2 Amp loads at 24Vdc. Maximum leakage current is 1mA. At 55°C ambient and 24Vdc, these outputs must be limited to 2 Amps maximum per output, 10 Amps maximum per card and 40 Amps maximum per rack. Inputs represent a 5mA load, with a guaranteed turn on voltage of 10Vdc and a guaranteed turn off voltage of 5Vdc.

# Communication Cards

---

**Data Handler:** The data handler card provides the interface between the MACO 4000, 5000 and 6000 Series Controller and the operator station. In addition, the data handler is responsible for data transfers among control cards in the chassis, and also between the controller system and the communication ports. In multi-chassis controllers, a data handler card is required in each chassis.

On average, 16 setups/recipes can be stored in internal memory. The actual number depends on the number of setpoints in each. Additional setups/recipes can be stored in a removable INSTA-SET memory cartridge or an optional floppy disk drive.

**RS-232 Card:** The MACO 4000, 5000 and 6000 Series have several communication options based on specific requirements. RS-232 is available for screen and RLD downloading, and for printing screens and SPC charts. The RS-232 option is required for initial screen and RLD downloading but is not required for machine operation.

**RS-485 Host Card:** Two options are available for Supervisory Control and Data Acquisition (SCADA) over standard networks. The RS-232 option allows a direct connection to a host computer. The RS-485 option allows up to 32 MACO controllers to be connected to a single port of a host computer. The RS-485 host option offers baud rates up to 19.2K baud.

**RS-485 SPI Card:** Several different options exist for auxiliary equipment and supervisory computer communications. The RS-485 SPI option will allow the MACO to communicate with auxiliary equipment that conforms to the SPI Phase 1 Auxiliary Equipment Communication Interface Standard. SPI compliant equipment includes hot runner controllers, chillers, dryers, additive feeders and melt pumps.

**RS-485 Drive Interface Cards:** Cards with customized protocols have been created for certain AC and DC drives. Consult the factory for additional information.

# Logic I/O Cards

The MACO offers both AC and DC input and output cards to meet your specific machine requirements.

The AC (120/240 Vac) and DC (24 Vdc) input cards convert the machine signals into a form suitable for processing by the controller.

The AC (120/240 Vac) and DC (24 Vdc) output cards convert controller output signals into a form suitable for machine interface.

| Card Type               | 48 AC Inputs                 | 48 DC Inputs           | 24 AC Outputs   | 24 DC Outputs                                      | 32 DC Inputs<br>32 DC Outputs                           | 24 DC Inputs<br>24 DC Outputs                    | 8 DC Inputs<br>8 DC Outputs                      |
|-------------------------|------------------------------|------------------------|---|--|---|--|--|
| Platform                | 4000, 5000, 6000             | 4000, 5000, 6000       | 4000, 5000, 6000  | 4000, 5000, 6000                                   | All MACO  | All MACO   | DS, RS Compact                                   |
| Operating Voltage       | 100 to 240 Vac, external     | 12 to 24 Vdc, external | 100 to 240 Vac, external  | 12 to 24 Vdc, external                             | 16 to 32 Vdc, external                                  | 16 to 32 Vdc, external                           | 12 to 32 Vdc, external                           |
| On Voltage              | 92 Vac                       | 10 Vdc                 | -   | c  | 14 Vd   | 14 Vdc   | 10 Vdc   |
| Off Voltage             | 30 Vac                       | 3 Vdc                  | -   | c  | 5 Vd  | 5 Vdc  | 5 Vdc  |
| Nominal Current         | 15 mA @ 120 Vac              | 10 mA @ 24 Vdc         | -   | -  | 3 mA  | 3 mA   | 5 mA   |
| Indicators              | 1 per input                  | 1 per input            | 1 per output  | 1 per output                                       | Outputs have terminal status available as a status flag |  |  |
| Output Grouping         | -                            | -                      | Terminal available for voltage sourcing every 4 output circuits |  |   |  |  |
| Isolation               | Optically isolated as a card |                        |   |  |   |  |  |
| Minimum Load            | -                            | -                      | 50 mA   | 5 mA   | 0 mA  | 0 mA   | 0 mA   |
| Maximum Load            | -                            | -                      | 1 Amp   | 2 Amp  | 2 Amp   | 2 Amp  | 2 Amp  |
| Maximum Leakage         | -                            | -                      | 5 mA  | 2 mA   | 1 mA  | 1 mA   | 1 mA   |
| Fuse                    | -                            | -                      | 2 Amp   | 2 Amp  | each output thermally and over-current protected        | each output thermally and over-current protected | each output thermally and over-current protected |
| Maximum Output per Card | -                            | -                      | 16 Amps (enclosed system)<br>8 Amps (open system)               | 32 Amps (enclosed system)<br>16 Amps (open system) | 64 Amps   | 48 Amps  | 10 Amps  |

| Platform          | Maximum Number of Inputs | Maximum Number of Outputs | Type     |
|-------------------|--------------------------|---------------------------|----------|
| DS (ASBs)         | 32                       | 32                        | DC only  |
| RS                | 160                      | 160                       | DC only  |
| 7 Slot MACO       | 64                       | 64                        | AC or DC |
| 9 Slot MACO       | 96                       | 96                        | AC or DC |
| 12 Slot MACO      | 160                      | 160                       | AC or DC |
| 16 Slot MACO      | 192                      | 192                       | AC or DC |
| Compact (4 Slot)* | 64                       | 64                        | DC only  |

\*A base compact also includes 4 logic inputs and 20 low current logic outputs

# Sequence & Analog Output Cards

**Sequence Card:** The sequence and hydraulics card works in conjunction with the analog I/O card to provide open and closed loop hydraulic control functions. In addition, the card processes the relay ladder diagram logic and provides the interface to all AC and DC discrete I/O.

User definable timers and counters are available as required by your application. Each base system provides 96 timers in combinations of On or Off-delay, counters, event timers, hourmeters, and a real time clock (RTC) function. The RTC has 12 setpoint scheduled control relays for initiating internal or external control functions.

## Sequence Card Specifications

|                                       |  |   |  |
|---------------------------------------|--|---|--|
| Sequential Control                    |  | Edit  | with PC based RLD Editor Software                            |
|                                       |  | Execution   | High priority machine sequence logic executed every 2.5 msec |
|                                       |  | Instructions, per card. Includes 100 high priority instructions | About 9000   |
|                                       |  | Program storage   | EEPROM   |
| Timing and Counting per Sequence Card | Timers   | On/off Delay  | 0 to 655.35 seconds<br>24                                    |
|                                       |  | On Delay  | 0 to 2.55 seconds<br>16                                      |
|                                       |  |   | 0 to 655.35 seconds<br>32                                    |
|                                       |  | Off Delay   | 0 to 655.35 seconds<br>8 (per chassis)                       |
|                                       |  |   | 0 to 2.55 seconds<br>8                                       |
|                                       | Event  | 0 to 655.35 seconds<br>8  |  |
|                                       | Counters   | 0 to 65,535 counts<br>10, up or down (2 retentive)              |  |
|                                       | Meters   | 0 to 999,999.9 hours<br>8 retentive (per chassis)               |  |
| Real Time Clock                       | Seconds, minutes, hours, day, month, year<br>Includes 12 scheduled setpoint control relays to activate internal and external control functions |   |  |
| Programming                           |  | Retentive Latching Control Relays                               | 8  |
|                                       |  | Security Code Control Relays                                    | 5  |
|                                       |  | Active Screen Control Relays                                    | up to 500 Screens  |

## Analog Output Card Specifications

### Outputs per Card:

12

### Card Supply Voltage:

24 Vdc,  $\pm 0.5$  Vdc (external supply) @ 0.6 Amps minimum current.

### Current Outputs:

4 to 20 mAdc, isolated, short circuit protected both leads to ground. 750 Ohm maximum load. Up to 15 bit resolution. Accuracy of 0.25% at full scale at rated conditions.

### Voltage Outputs:

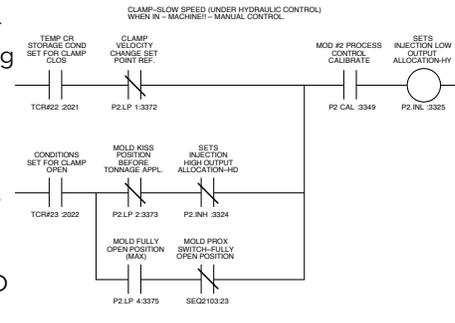
0 to 10 Vdc, isolated, short circuit protected at 3.3 mA both leads to ground. 3.3k Ohm minimum load. Up to 15 bit resolution. Accuracy of 0.25% at full scale at rated conditions.

# Sequence Editors

**MACO 4000, 5000, 6000, Compact Series Sequence Editor (DOS):** The DOS editor software contains two editors: the Label editor and the RLD editor. Use the Label editor to assign the appropriate device symbol to a corresponding control relay address, along with a label or name. Use the RLD editor to draw the ladder diagram using the devices defined in the Label editor.

When using the Label editor, a forty character comment can be written for each device. When a printout of the logic diagram is made, the comments are placed above the device.

Once the Labels file has been created and saved, enter the assigned label in the RLD editor and the appropriate symbol appears. Rungs are constructed one by one, with appropriate symbols and wires connected in a straight forward manner. To expedite programming, up to 25 rungs can be copied and pasted to a new location and then edited. It is also possible to copy and paste across multiple files.

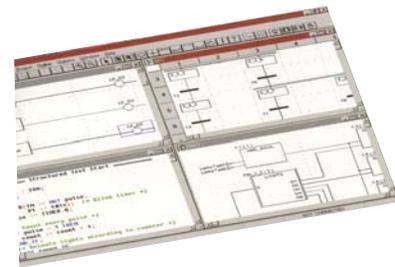


## MACO 4000, 5000, 6000, Compact Series TriStation 1131 Editor

The TriStation editor provides a Windows alternative to the DOS based editor package. It permits importing of existing DOS editor based files, including specialized symbols. The package provides a standard Windows based interface for typical logic programming functions (cut, copy, paste, etc.). A powerful set of searches and sorts permits the user to easily troubleshoot and modify logic. If errors are present in the logic during compilation, the program provides direct access to rungs with issues. Cross reference files can be sorted by either Label or Address.

**MACO DS/RS Sequence Editor (Windows):** The MACO DS/RS uses Concept™, a Microsoft Windows based programming tool set that delivers a single development environment for all programs in your control system. Use familiar, standardized editors bundled in a single application to create and integrate programmable logic controller programs, communications and diagnostics with the same database.

Use the point and click interface of Windows to create a control system. Because Concept is based on familiar technology, you'll instantly feel comfortable writing Concept programs. Powerful editing features allow you to cut, copy, paste and modify - on or off line - entire programs, or program modules, without tedious checking, data re-entry, and time consuming searches. This powerful method of program development lets you build re-usable program libraries.



### Other features include:

- IEC 1131-3
- Runtime controller simulation for discrete I/O
- On-line monitoring and editing
- Multi-lingual
- IL, SFC, FBD, Structured Text, RLD, C++

# OptiGrafix Screen Editor

The OptiGrafix Screen Editor allows custom generation of screens and applications for MACO operator stations. It includes graph functions that allow the creation of SPC graph screens, profile screens for blow molding applications, and line graph and bar graph screens for setpoint versus process value comparison.

**Statistical Process Control (SPC):** The SPC option provides for the simultaneous calculation of ten different user selectable parameters. Any process value from the system can be selected as an SPC parameter. Each of the ten parameters allows selection of sample size, time or event based triggering, time between readings, time between sample groups, and upper and lower control specification limits. X-Bar, R, and histogram charts can be displayed for each of the values. Calculated X-Bar, R, Cr, and CpK values are also available.

The last 100 calculated values for each of the 10 parameters remain in memory and are available for the operator to view and print on demand or automatically after 100 points have been collected. SPC alarms based on industry accepted standards are available to the sequential machine control to make machine decisions based on part quality.

**Math Functions:** The optional math function provides the capability to perform basic calculator operations (addition, subtraction, multiplication, and division) and comparison tests (greater than, less than, and equal to). The math function can be used to calculate parameters for display or to modify setpoints based on other setpoints or values. Control relays are also available for use in alarming based on the math calculations. **Applications lending themselves to the math function are:**

- Closed loop, customized shotsize control
- Shot to shot control adjustment
- Cascaded control loops
- Calculation of average hydraulic pressure
- Calculation of torque and horsepower
- Production reporting

**Security:** OptiGrafix is used to assign any one of four security levels to each screen. Each security level provides access to screens of that level, plus screens of any lower level. Thus, level four provides access to screens assigned to security level 1, 2, 3 or 4, while level one provides access only to screens assigned security level one.

OptiGrafix is also used to assign one or more security codes to each security level. When the operator station is powered up, the first screen displays a field for entry of a security code. Only screens whose security level is equal to or lower than the code entered will be accessible.

# Wonderware Screen Editor

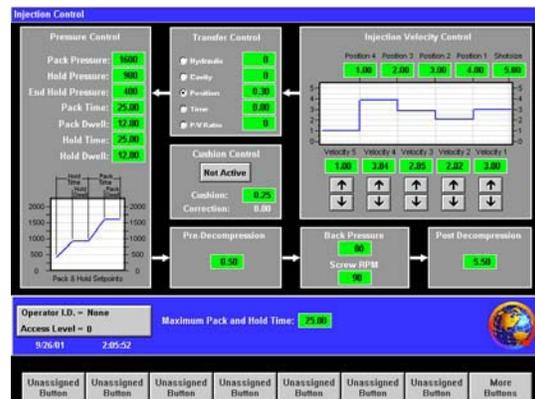
MACO DS, RS, Compact

Wonderware InTouch is a Microsoft Windows based family of powerful, flexible operator interface development tools for creating custom HMI screens. With it, you can view an entire operation through on-screen, graphical representation of a real time process.

InTouch features object oriented graphics that can quickly and easily be moved, sized and animated. XVGA and SVGA graphic resolutions are supported; an unlimited number of objects per window is allowed. Animation links can be combined to provide complex size, color, movement and/or position changes.

**Wonderware supports the following:**

- Pre-defined Tags
- SPC
- Line Graphs
- Recipe Management
- On-line Documentation
- Animated Objects
- Trending
- Multiple Windows
- Multi-Lingual
- Over 700 Drivers



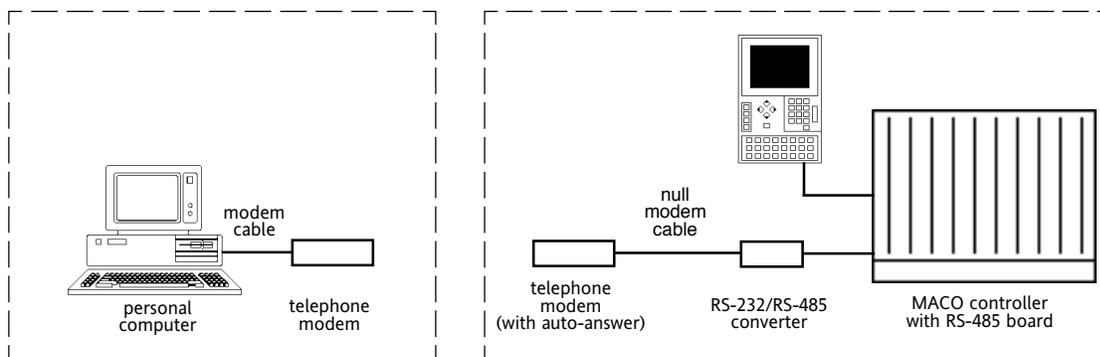
# MACO VIEW & DDE Servers

**MACO VIEW:** This multi-purpose software package provides the means of interfacing a PC to any MACO controller. MACO VIEW software is compatible with new and existing MACO controllers. Just add an RS-485 upgrade kit and the MACO can be monitored using a desktop PC or industrial computer.

Distance is not a problem. The RS-485 network can be up to 4000 feet long. If the network needs to go beyond 4000 feet, a telephone modem or wireless modem can be connected to the network to allow unlimited distances.

Technical troubleshooters can view problem machines from home or other facilities. Both the local and remote stations can be used simultaneously. The remote MACO VIEW station has the same functionality and appearance as the local operator station. Just dial the phone number of the modem at the machine and the modem and MACO VIEW software connect automatically - there is no need for a person at the machine to make the connection.

No unique programming is required. Just load the remote PC with the pre-existing screen software from the MACO on the machine and immediately mirror the existing feel and function of the existing operator station.



Connected to a machine by telephone modem

**DDE Servers:** The MACO RS-485 DDE Server is a Microsoft Windows application which provides the capability to link a MACO control system to other Windows applications via DDE (Dynamic Data Exchange). This allows Supervisory Control and Data Acquisition (SCADA) over a standard network. A single serial port on a computer can communicate with up to 32 MACO controlled machines on a single cable. The host computer can collect, display and store operating data, as well as transmit setpoints and control relay states to the MACO controllers.

- **MACO 4000, 5000, 6000, DS, RS**  
for use with the RS-485 Host Port
- **MACO DS, RS**  
for use with the Modbus Plus Port

# Servo Amplifier

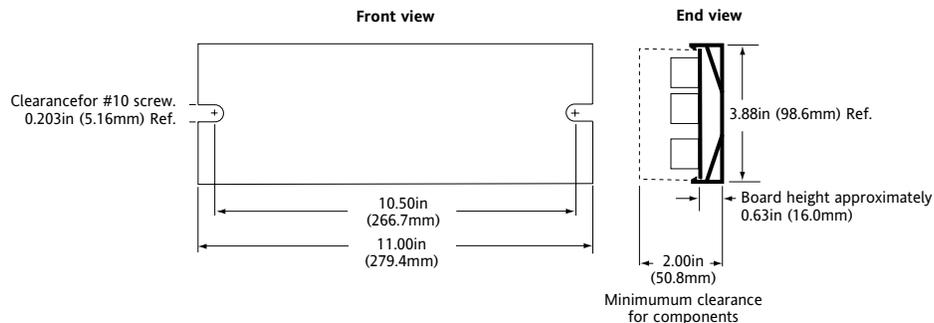
## Servo Amplifier

The servo amplifier board contains four amplifier circuits, each capable of a  $\pm 150$  mAdc output for servo devices that operate with parison control. The 12 Vdc auxiliary supply circuit, capable of  $\pm 100$  mAdc output provides excitation voltage for transducers. The total power supply load must not exceed 500 mAdc.

Terminals accept 14 to 22 AWG wire. Line voltage connections should be made with 14 AWG wire. All four amplifier circuits share a common reference. Zero and Gain for each amplifier is easily adjusted using onboard potentiometers.



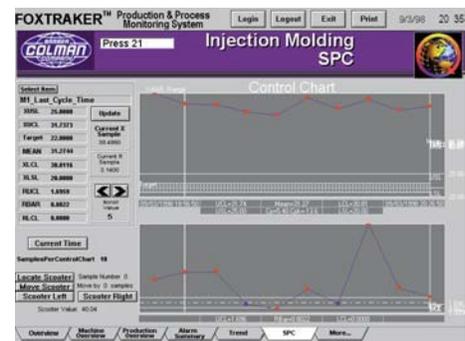
The board is held in place with a "snap-track" mounting device. Mount the board horizontally on a flat top surface or horizontally on a vertical surface (do not mount it vertically, i.e., lengthwise, on a vertical surface).



# FoxTraker

## FoxTraker™

FoxTraker is a complete, ready-to-run CIM (Computer Integrated Manufacturing) system for production monitoring of injection molding, blow molding or extrusion machines. Each FoxTraker system includes the Wonderware InTouch application, license and DDE server for the MACO being monitored. The use of standard hardware and software in an open architecture permits easy expansion and eliminates the cost and risk of proprietary hardware, software and programming. The standard system supports up to four machines, but can be easily expanded to serve more.



# Agency Approvals

| Device                              | UL  | CUL | CE  |
|-------------------------------------|-----|-----|-----|
| Lite Operator Station               | Yes | Yes | Yes |
| OPTima Operator Station (41AC)      | Yes | Yes | Yes |
| Compact Operator Station            | Yes | Yes | Yes |
| 10.4" Optima PC                     | Yes | Yes | Yes |
| 12.1" Optima PC                     | (1) | (1) | Yes |
| 15" Optima PC                       | Yes | Yes | Yes |
| Intelligent Integrator PC           |     |     | Yes |
| XL PB                               | (1) | (1) | (1) |
| ASB                                 | Yes | Yes | Yes |
| MACO RS                             | Yes | Yes | Yes |
| Terminal I/O Blocks                 | Yes | Yes | Yes |
| MACO 4000, 5000, 6000               | Yes | Yes | Yes |
| Custom 4, 5, 6                      | Yes | Yes | Yes |
| 4, 6, and 8 Slot Compact Controller | Yes | Yes | Yes |
| Servo Amplifier                     | Yes | Yes |     |

(1) Contact factory for completion dates.

| CE Immunity Standards (includes all except Terminal I/O) |  |
|--|--|
| Test Specification per EN 61326                          | Test Description   |
| EN 61000-4-2   | Electrostatic Discharge Class B response<br>±4kV Contact Discharge to any user accessible metallic location<br>±8kV Air Discharge to any user accessible non-metallic location   |
| EN 61000-4-3   | Radiated Susceptibility Class A response<br>10 v/m from 80 to 1000 MHz, sine wave modulated at 1 kHz to 80%  |
| ENV 50204  | Radiated Susceptibility Pulsed Carrier Class A response<br>10 v/m at 900 MHz ±5 MHz, square wave modulated at 200 Hz to 50%  |
| EN 61000-4-4   | Fast Transient Burst Class B response<br>±1 kv at 5 kHz rep rate using capacitive clamp for signal lines longer than 3 meters<br>±2.5 kv at 2.5 kHz rep rate using capacitive clamp for dc lines longer than 3 meters<br>±2 kv at 5 kHz rep rate using direct injection for ac lines   |
| EN 61000-4-5   | Surge Class B response<br>±2 kv each line to ground for ac lines<br>±1 kv line to line for ac lines<br>±1 kv line to ground for long distance signal lines   |
| ENV 50141  | Conducted Susceptibility Class A response<br>3 v rms from 0.15 to 80 MHz, sine wave modulated at 1 kHz to 80% for signal lines longer than 3 meters<br>3 v rms from 0.15 to 80 MHz, sine wave modulated at 1 kHz to 80% for dc lines longer than 3 meters<br>3 v rms from 0.15 to 80 MHz, sine wave modulated at 1 kHz to 80% for ac lines |
| IEC 1000-4-11  | Voltage Fluctuations Class B response<br>100% voltage dip for 1 power cycle on ac power input only   |

| CE Emissions (includes all except Terminal I/O) |                     |   |                        |
|---|---------------------|---|------------------------|
| Port  | Frequency Range     | Limits  | Reference Standard     |
| Enclosure                                       | 30 MHz to 230 MHz   | 40 dB (mV/m) quasi-peak measured at 10 meters   | CISPR 16<br>CISPR 16-1 |
|   | 230 MHz to 1 GHz    | 47 dB (mV/m) quasi-peak measured at 10 meters   |                        |
| AC Mains  | 0.15 MHz to 0.5 MHz | 79 dB (mV/m) quasi-peak<br>66 dB (mV/m) average | CISPR 16<br>CISPR 16-1 |
|   | 0.5 MHz to 5 MHz    | 73 dB (mV/m) quasi-peak<br>60 dB (mV/m) average |                        |
|   | 5 MHz to 30 MHz     | 73 dB (mV/m) quasi-peak<br>60 dB (mV/m) average |                        |

|   |                             |
|---|-----------------------------|
| Terminal I/O Block Equipment Definition | Open Equipment (IEC 1131-2) |
|---|-----------------------------|

# Environmental Specifications

| Device                           | Operating Temperature      | Storage Temperature   | Relative Humidity (Operating)                          | Input Power   | Weight   |
|----------------------------------|----------------------------|---|--|---|--|
| Lite Operator Station            | 5 to 45° C<br>41 to 113° F | -20 to 60° C<br>-4 to 140° F  | 30 to 85%<br>@45° C (113° F)                           | 15 Vdc<br>3 Amps max.   | 6.5 lb<br>2.9 kg   |
| OPtima Operator Station (41AM)   | 5 to 45° C<br>41 to 113° F | -20 to 60° C<br>-4 to 140° F  | 30 to 85%<br>@45° C (113° F)                           | 15 Vdc<br>3 Amps max.   | 20.0 lb<br>9.1 kg  |
| OPtima Operator Station (41AC)   | 0 to 50° C<br>32 to 122° F | -25 to 70° C<br>-13 to 158° F   | 30 to 85%<br>@45° C (113° F)                           | 15 Vdc<br>3 Amps max.   | 20.0 lb<br>9.1 kg  |
| Compact Operator Station         | 0 to 50° C<br>32 to 122° F | -25 to 70° C<br>-13 to 158° F   | 30 to 85%<br>@45° C (113° F)                           | 24 Vdc<br>2 Amps max.   | 11.0 lb<br>5.0 kg  |
| 10.4" OPtima PC                  | 0 to 40° C<br>32 to 104° F | -20 to 60° C<br>-4 to 140° F  | 5 to 95%<br>@40° C (104° F)                            | 110 to 220 Vac<br>4 Amps to 2 Amps max.                               | 15.0 lb<br>6.8 kg  |
| 12.1" OPtima PC                  | 0 to 50° C<br>32 to 122° F | -20 to 60° C<br>-4 to 140° F  | 5 to 95%<br>@50° C (122° F)                            | 110 to 220 Vac<br>4 Amps to 2 Amps max.                               | 16.0 lb<br>7.3 kg  |
| 15" OPtima PC                    | 0 to 50° C<br>32 to 122° F | -20 to 60° C<br>-4 to 140° F  | 5 to 95%<br>@50° C (122° F)                            | 110 to 220 Vac<br>4 Amps to 2 Amps max.                               | 20.5 lb<br>9.3 kg  |
| Intelligent Integrator PC        | 0 to 50° C<br>32 to 122° F | -40 to +85° C<br>-40 to 185° F<br>5 to 95%RH<br>@40° C (104° F)                                   | 5 to 90%<br>@40° C (104° F)                            | 24 Vdc<br>5 Amps max.   | 5.0 lb<br>2.3 kg   |
| XL PB                            | 0 to 60° C<br>32 to 140° F | -40 to 80° C<br>-40 to 185° F   | 0 to 95%<br>@55° C (131° F)                            | 24 Vdc<br>0.5 Amps max.   | 1.5 lb<br>680 gm   |
| ASB                              | 0 to 60° C<br>32 to 140° F | -40 to 80° C<br>-40 to 185° F   | 0 to 95%<br>@55° C (131° F)                            | 24 Vdc<br>1.5 Amps max.<br>(no I/O)                                   | 7.3 lb<br>3.3 kg   |
| MACO RS                          | 0 to 60° C<br>32 to 140° F | -40 to 80° C<br>-40 to 185° F   | 0 to 95%<br>@55° C (131° F)                            | 24 Vdc<br>1.5 Amps max.<br>(no I/O)                                   | 13.2 lb<br>6.0 kg  |
| Terminal I/O Blocks              | 0 to 60° C<br>32 to 140° F | -40 to 80° C<br>-40 to 185° F<br>(no battery)<br><br>-40 to 70° C<br>-40 to 158° F<br>(w/battery) | 95%continuous<br>(30 days)<br><br>75%annual<br>average | 24 Vdc<br>330 mA<br>6W typical<br><br>120 Vac<br>150 mA<br>6W typical | 0.7 lb<br>320 gm   |
| MACO 4000, 5000, 6000            | 0 to 60° C<br>32 to 140° F | -40 to 80° C<br>-40 to 185° F   | 0 to 95%<br>@60° C (140° F)                            | Less than<br>100 VA<br>@120 Vac<br>(no I/O)                           | 9 slot = 24 lb (10.9 kg)<br>12 slot = 26 lb (11.8 kg)<br>16 slot = 42 lb (19.1 kg) |
| Custom 4, 5, 6                   | 0 to 60° C<br>32 to 140° F | -40 to 80° C<br>-40 to 185° F   | 0 to 95%<br>@60° C (140° F)                            | 24 Vdc<br>1.5 Amps max.<br>(no I/O)                                   | 13.2 lb<br>6.0 kg  |
| MACO Compact Controller (4 Slot) | 0 to 60° C<br>32 to 140° F | -40 to 80° C<br>-40 to 185° F   | 0 to 95%<br>@60° C (140° F)                            | 24 Vdc<br>3 Amps max.<br>(no I/O)                                     | 11.0 lb<br>5.0 kg  |
| Servo Amplifier                  | 0 to 60° C<br>32 to 140° F | -40 to 80° C<br>-40 to 185° F   | 20 to 90%<br>@25° C (77° F)                            | 102 to 132 Vac<br>25 VA max.  | 0.8 lb<br>364 gm   |

# MACO Product Family

| Product   | Status          | Control Packaging         | Hardware                           | Applications                       | Operator Interface           | HMI Tool                | Logic Tool              | Communications             | Remote I/O |
|---|-----------------|---------------------------|------------------------------------|------------------------------------|------------------------------|-------------------------|-------------------------|----------------------------|------------|
| Breeze  | Released        | Custom Cabinet            | Alpha                              | Parison Only                       | 41AC - 10.4" VGA             | Optigrafix              | None                    | RS485 375K MACO-Net        | N/A        |
| Breeze II   | Released        | Compact Rack              | DS/RS                              | Parison Only                       | 12.1", 15" XGA XP            | WW InTouch              | IEC1131 (Concept)       | Modbus Plus (MBP)          | N/A        |
| Breeze IIc  | Released        | Compact HMI (extra depth) | Compact†                           | Parison Only                       | 12.1" SVGA CE:Net            | Optigrafix              | RLD                     | Ethernet Modbus TCP/IP     | N/A        |
| EM3   | Released        | ASB                       | DS/RS                              | Extrusion                          | 12.1", 15" XGA XP            | WW InTouch              | IEC1131 (Concept)       | Ethernet Modbus & MBP Req. | YES*       |
| EM3c  | Released        | Compact Rack              | Compact†                           | Extrusion                          | 12.1", 15" XGA XP            | WW InTouch              | RLD                     | Ethernet Modbus TCP/IP     | C/F        |
|   | Consult Factory |                           |                                    |                                    | Optigrafix                   | RLD                     | Ethernet Modbus TCP/IP  | N/A                        |            |
|   | Consult Factory |                           |                                    |                                    | Optigrafix                   | RLD & IEC1131 (Concept) | Ethernet Modbus TCP/IP  | YES*                       |            |
| Compact for HT Retrofits  | Released        | Compact Rack              | Compact†                           | Injection                          | 12.1" SVGA CE:Net            | Optigrafix              | RLD                     | Ethernet Modbus TCP/IP     | N/A        |
| iPact   | Released        | Compact HMI (extra depth) | Compact†                           | Injection                          | 12.1" SVGA CE:Net            | Optigrafix              | RLD                     | Ethernet Modbus TCP/IP     | N/A        |
| MACO Compact  | Released        | Compact Rack(s)           | Compact APU†, DS/RS Parison/EZ PRO | Total Machine Ctrl Inj. Blow, Ext. | 10.4" VGA, 12.1" SVGA CE:Net | Optigrafix              | RLD                     | Ethernet Modbus TCP/IP     | N/A        |
|   |                 |                           |                                    |                                    | 12.1", 15" XGA XP            | WW InTouch              | RLD                     | Ethernet Modbus TCP/IP     | N/A        |
|   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
| MACO Compact Phase II   | Consult Factory | Compact Rack(s)           | Compact APU† and Parison/EZ PRO    | Total Machine Ctrl Inj. Blow, Ext. | 10.4" VGA, 12.1" SVGA CE:Net | Optigrafix              | RLD/DS Instruction List | Ethernet Modbus TCP/IP     | YES*       |
|   |                 |                           |                                    |                                    | 12.1", 15" XGA XP            | WW InTouch              | RLD/DS Instruction List | Ethernet Modbus TCP/IP     | YES*       |
|   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
| Optima Plus   | Consult Factory | Compact Rack(s)           | Compact APU† and Parison/EZ PRO    | Total Machine Ctrl Inj. Blow, Ext. | 15" XGA XP/VISTA             | WW InTouch              | RLD & IEC1131 (Unity)   | Ethernet Modbus TCP/IP IBS | YES**      |
|   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
|   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
| MACO DS/RS  | Released        | ASB/Rack(s)               | DS/RS                              | Total Machine Ctrl Inj. Blow, Ext. | 41AC - 10.4" VGA             | Optigrafix              | IEC1131 (Concept)       | RS485 HMI, MBP Control     | YES*       |
|   |                 |                           |                                    |                                    | 12.1", 15" XGA XP            | WW InTouch              | IEC1131 (Concept)       | Modbus Plus (MBP)          | YES*       |
|   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
| MACO Alpha  | Released        | Rack                      | Alpha                              | Total Machine Ctrl Inj. Blow, Ext. | 6.4", 10.4" VGA              | Optigrafix              | RLD                     | RS485 375K MACO-Net        | N/A        |
|   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
|   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
| N/A = Not Available; C/F = Consult Factory  |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
| *Momentum I/O typically IBS or Ethernet MB TCP/IP   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
| **Advantys I/O (Canbus) and Momentum I/O (Ethernet)   |                 |                           |                                    |                                    |                              |                         |                         |                            |            |
| †All Compact units are compatible with DS/RS Temperature, Parison, EZ PRO, Combo I/O and Plug-In Options. |                 |                           |                                    |                                    |                              |                         |                         |                            |            |



# Eurotherm:

## International sales and service



Eurotherm is also represented in the following countries:

|                          |                       |
|--------------------------|-----------------------|
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| Albania                  | Lesotho               |
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| Angola                   | Lithuania             |
| Argentina                | Macedonia             |
| Armenia                  | Madagascar            |
| Azerbaijan               | Malaysia              |
| Bahrain                  | Malta                 |
| Bangladesh               | Micronesia            |
| Barbados                 | Moldova               |
| Belarus                  | Morocco               |
| Bermuda                  | Mozambique            |
| Bolivia                  | Myanmar               |
| Bosnia and Herzegovina   | Namibia               |
| Botswana                 | Nicaragua             |
| Brazil                   | Niger                 |
| Brunei Darussalam        | Nigeria               |
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| Cambodia                 | Oman                  |
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| Denmark                  | Senegal               |
| Djibouti                 | Serbia and Montenegro |
| Ecuador                  | Sierra Leone          |
| Egypt                    | Singapore             |
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| Eritrea                  | Slovenia              |
| Estonia                  | Somalia               |
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| Greece                   | Tajikistan            |
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|                          | Zimbabwe              |

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Part No. HA136715 Issue 8 REV 1 August 2011

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Operations Management