

# eAce PLCs



## Velocio's eAce PLCs

Ace PLCs are members of the Velocio's groundbreaking series of programmable logic controllers. These PLCs introduce revolutionary new concepts, capabilities, performance and ease of use features to the automation market. They constitute a generational leap over the staid products that have comprised the PLC world for years.

eAce PLCs are simply Velocio's standard PLCs, with the pluggable terminal block connectors replaced by headers intended to plug into a motherboard. Any Ace PLC can be manufactured in embedded form factor. Lead times may be a little longer and, in some cases, minimum quantities may apply.

Ace PLCs are the small, stand alone members of the Velocio family. They bring incredible power, in a very small package and at a very low price. Many control system applications require 36 points of IO or less, all located very close to the PLC. For those applications, Aces are the Velocio PLCs that fit the requirements.

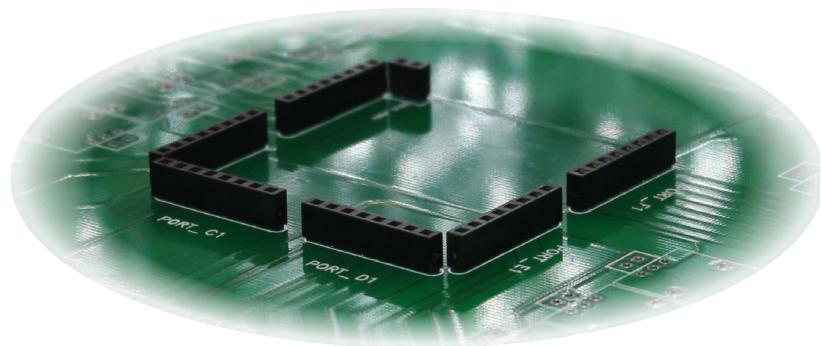
Ace PLCs are programmable, using Velocio's vBuilder software. The program development interface between the PC running vBuilder and an Ace is a standard USB communications cable. Through this USB cable, the Ace PLC can be programmed, debugged and deployed.

Ace PLCs interface a variety of inputs and outputs. Certain models have additional communications ports for interfacing HMI's, cellular modems, other PLCs and other devices.

The functionality available for incorporation into your application program is very encompassing and easy to implement.

In addition to the features and interfaces common to most PLCs, Ace PLCs incorporate a number of advanced features. Some of these features include high speed stepper motion control of up to three motors simultaneously, PWM (pulse width modulation), PID control, high speed pulse counter inputs, configurable digital input debounce and custom communications under program control.

The Ace's small size is another key feature. High end automation capabilities are packed into a PLC that fits in a shirt pocket. For those systems with limited availability of space, the Ace can provide a solution.



## Applications

- Machine control
- Process control
- Motion system control
- Automated Test
- Internet of Things
- Integration into standard products

## Features

- Up to 36 Inputs and Outputs
- USB connection to PC and other Host devices
- RS232/RS485 on some models
- Smallest physical footprint of any PLC
- High end software features that are easy to use
- Graphical program development in flow charts or ladder
- Interactive, graphical debug functionality
- Software reusability
- Subroutines, PID, motion, statistics & many more
- High speed pulse and direction motion control of up to 3 stepper or servo motors
- PWM capability on all digital outputs

## Benefits

- Enhanced and efficient development process
- Reduced system cost
- Reduced development time
- Improved reliability
- Embeddable within product
- Rapid development and deployment

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*Velocio PLCs are general purpose devices, designed to provide an applications engineer or technician the capability to easily configure, program and make operational, specific projects of interest. Those specific applications can involve nearly anything and may have aspects that might be dangerous. Providing a safe operating environment for personnel and equipment is your responsibility and should be your primary goal during system design and installation. Control systems can fail. You should not rely on the control system alone to provide for a safe operating environment. External design features, including electromechanical devices, physical barriers and independent safety systems may be required to provide protection for any part of a system that poses a potential safety concern. Each application is different, so there may be special requirements for your application. Make sure you follow all national, state and local government requirements for the proper installation and use of your equipment*

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## Safety as Part of the Design Process

The best way to provide a safe operating environment is to make the safety of personnel and equipment a part of the design process. You should consider every element and feature of your system to determine which areas require attention to ensure personnel safety and to protect related equipment. In addition to your personal evaluation, be sure to take into account the following.

- NEMA - The National Electrical Manufacturing Association has a number of relevant standards and guidelines.
- NFPA - The National Fire Protection Association safety documents
- NEC - The National Electrical Code defines regulations and standards for electrical wiring
- Local and State Agencies - Many local governments have additional regulations
- Your company standard - Many companies have standards that are specific to the company

## Standard Safety

While every application is different, if you have an application that presents potential safety risks, you should take (at least) the following list into consideration.

- Physical barriers - keep people, including their hands and legs away from moving parts
- Light curtains or other sensors that detect personnel moving into areas that are potentially unsafe
- Emergency shut down circuits that are electrically separate from the PLC
- System power disconnect
- Orderly shutdown - orderly, controlled shut down of equipment when triggered by the sensing of an unsafe or irregular condition, or initiated by an operator

For your specific application, there may be other, or additional considerations. The key is to purposely take the time to consider, during the design process - "What could go wrong" - and then design in barriers or mechanisms that will protect personnel and equipment from the effects of what could go wrong. Keep safety in mind throughout the process and, if additional concerns crop up, address them.

At the end of development, again look for potential problem areas and address them appropriately yet again. While doing so, consider that it is possible that you made a mistake or didn't cover a condition in your design. Ask the question, "What might happen if my design has an error or an unhandled condition?". Then make sure that safety features cover that case.

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***The most important aspect of any application is safety. Its your responsibility to make safety paramount.***

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## Flavors of Ace

There are a growing number of models of Ace and eAce PLCs. The units vary with respect to input/output (IO) configuration, number of ports and communications capabilities. They range from the simplest unit, the Ace 11, to higher end units with a great deal of functionality. The following is a list of Ace PLCs. To make them embedded, simply add an 'e' to the front.

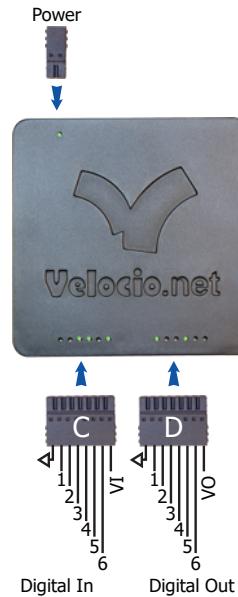
	Digital In	Digital Out	Analog In 0-5volt	Analog In 0-10volt	Analog In 0-20mAmp	Analog Out 16 bit	Therm In / Diff Analog In	RS232	RS232 / RS485
Ace 11	6	6							
Ace 1430	6	12						1	
Ace 1450	6	12				2		1	
Ace 1600 <i>NEW!</i>	3	6					1		
Ace 1630v5 <i>NEW!</i>	3	3	3				1		
Ace 1630v10 <i>NEW!</i>	3	3	3				1		
Ace 1630c <i>NEW!</i>	3	3		3			1		
Ace 1700	12	24							
Ace 1701	8	24					1		
Ace 1800	18	18							
Ace 1801	14	18					1		
Ace 22	12	12							
Ace 222v5	12	12	12						
Ace 222v10	12	12		12					
Ace 222c	12	12			12				
Ace 3090v5	6	18	3			4	1		
Ace 3090v10	6	18		3		4	1		
Ace 3090c	6	18			3	4	1		
Ace 5150v5	12	12	3				1		
Ace 5150v10	12	12		3			1		
Ace 5150c	12	12			3		1		
Ace 7096v5	6	12	4			2	4	2	
Ace 7096v10	6	12		4		2	4	2	
Ace 7096c	6	12			4	2	4	2	

## eAce 11

The Ace 11 is a low IO count, least expensive member of the family. In addition to basic digital inputs and outputs, it is designed for motion control, PWM outputs and high speed pulse counting.

- 6 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 6 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- USB programming port
- USB port Modbus RTU slave enabled

## Ace 11



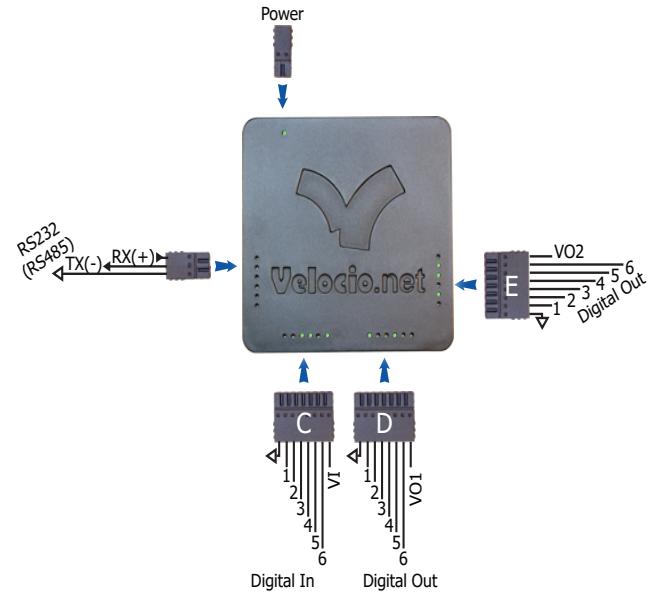
## eAce 1430

The Ace 1430 includes IO interfaces for 6 digital inputs, 12 digital outputs and a serial port that is program configurable as either RS232 or RS485.

eAce 1430s can be built with either the standard, pluggable connector for the serial port, or with the serial communications connectors as headers that plug into the motherboard. That detail must be specified on your order.

- 6 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 12 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- Serial port configurable as RS232 or RS485
  - Modbus RTU slave
  - Custom message communications
- USB programming port
- USB port Modbus RTU slave enabled

## Ace 1430



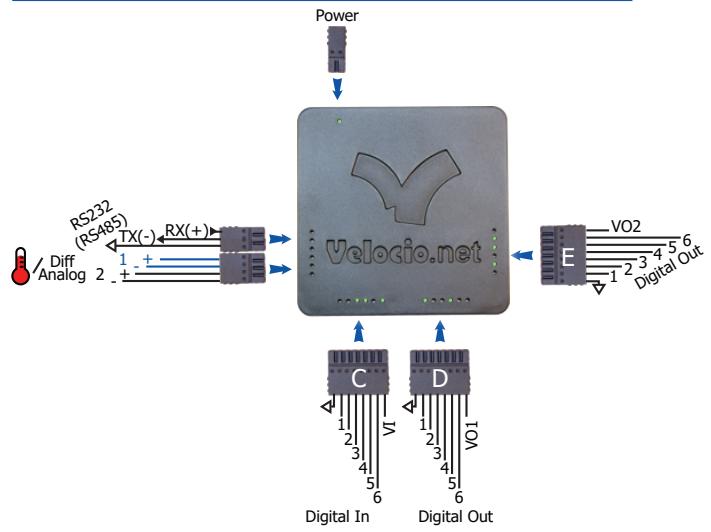
## eAce 1450

The Ace 1450 includes IO interfaces for 6 digital inputs, 12 digital outputs, 2 thermocouple/differential voltage inputs and a serial port that is program configurable as either RS232 or RS485.

eAce 1450s can be built with either the standard, pluggable connector for the serial port and/or thermocouple inputs, or with the connectors as headers that plug into the motherboard. Those details must be specified on your order.

- 6 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 12 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- 2 thermocouple/differential voltage inputs
  - J, K, T or N thermocouple
  - 16 bit differential voltage input selectable for +/-0.256V, 0.512V, 1,024V and 2.048V ranges
- Serial port configurable as RS232 or RS485
  - Modbus RTU slave
  - Custom message communications
- USB programming port
  - USB port Modbus RTU slave enabled

## Ace 1450



## eAce 1600

The Ace 1600 is the lowest cost Ace PLC with an RS232 port. It provides 3 digital inputs and 6 digital outputs, along with that RS232 port. In addition to basic digital inputs and outputs, it is designed for motion control, PWM outputs and high speed pulse counting.

eAce 1600s can be built with either the standard, pluggable connector for the serial port, or with the serial communications connectors as headers that plug into the motherboard. That detail must be specified on your order.

- 3 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 6 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- RS232 port
  - Modbus RTU slave
  - Custom message communications
- USB programming port
  - USB port Modbus RTU slave enabled

## Ace 1600



## eAce 1630

The Ace 1630 provides 3 digital inputs, 3 digital outputs and 3 analog inputs. It also includes an RS232 port for connection to HMIs and other devices. In addition to basic digital inputs and outputs, it is designed for motion control, PWM outputs and high speed pulse counting.

eAce 1630s can be built with either the standard, pluggable connector for the serial port, or with the serial communications connectors as headers that plug into the motherboard. That detail must be specified on your order.

- 3 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 3 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- 3 Analog Inputs
  - Ace 1630v5 : 0-5VDC analog inputs
  - Ace 1630v10 : 0-10VDC analog inputs
  - Ace 1630c : 0-20mA analog inputs (also used for 4-20mA signals)
- RS232 port
  - Modbus RTU slave
  - Custom message communications
- USB programming port
  - USB port Modbus RTU slave enabled

## Ace 1630

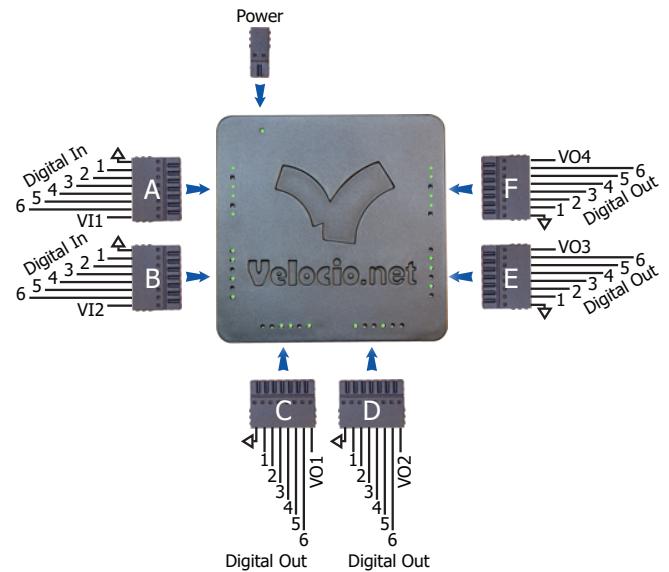


## eAce 1700

The Ace 1700 provides 12 digital inputs and 24 digital outputs. In addition to basic digital inputs and outputs, it is designed for motion control, PWM outputs and high speed pulse counting.

- 12 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 24 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- USB programming port
  - USB port Modbus RTU slave enabled

## Ace 1700



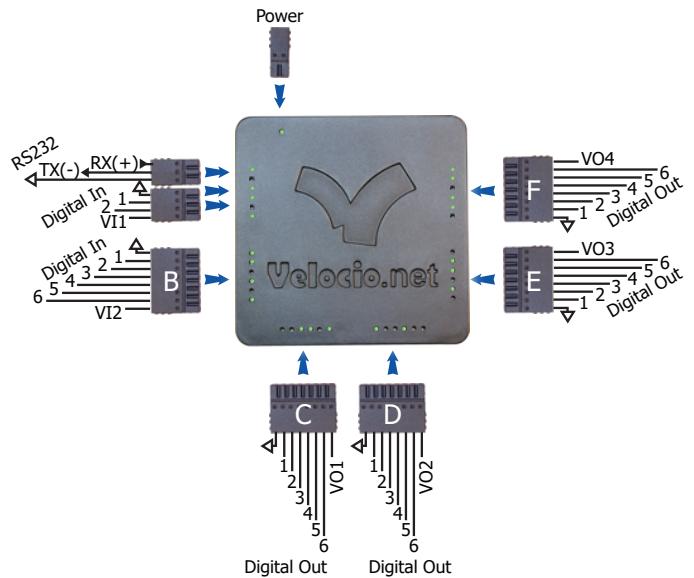
## eAce 1701

The Ace 1701 includes IO interfaces for 8 digital inputs, 24 digital outputs, and an RS232.

eAce 1701s can be built with either the standard, pluggable connector for the serial port, or with the serial communications connectors as headers that plug into the motherboard. That detail must be specified on your order.

- 8 Digital Inputs -
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 24 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all output
- RS232 port
  - Modbus RTU slave
  - Custom message communications
- USB programming port
  - USB port Modbus RTU slave enabled

## Ace 1701

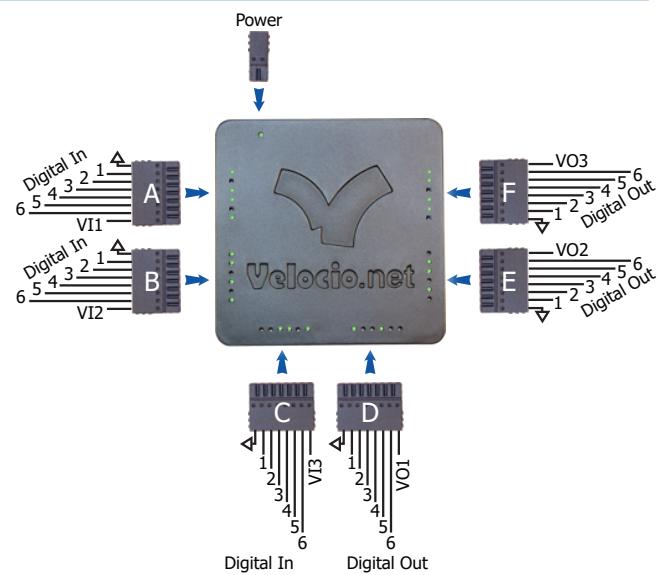


## eAce 1800

The Ace 1800 includes IO interfaces for 18 digital inputs and 18 digital outputs.

- 18 Digital Inputs -
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 18 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- USB programming port
  - USB port Modbus RTU slave enabled

## Ace 1800

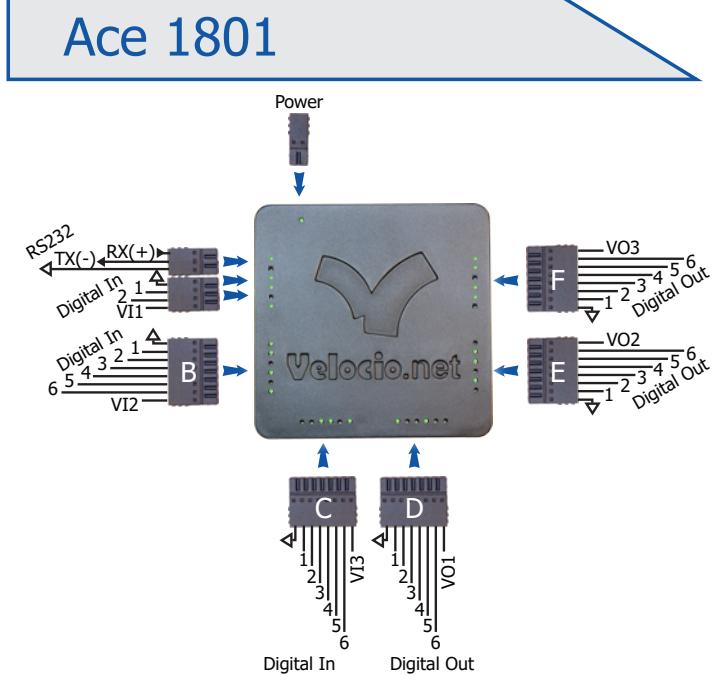


## eAce 1801

The Ace 1801 includes IO interfaces for 14 digital inputs, 18 digital outputs, and an RS232.

eAce 1801s can be built with either the standard, pluggable connector for the serial port, or with the serial communications connectors as headers that plug into the motherboard. That detail must be specified on your order.

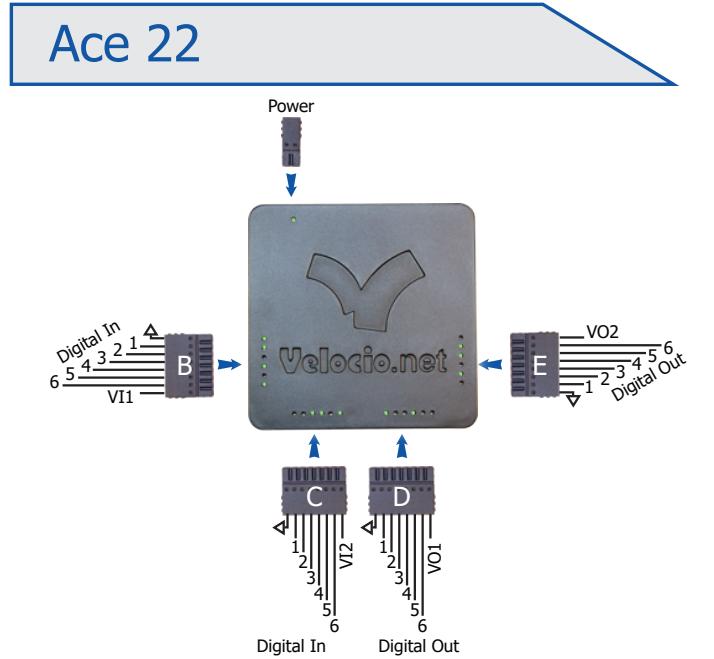
- 14 Digital Inputs -
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 18 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all output
- RS232 port
- Modbus RTU slave
- Custom message communications
- USB programming port
- USB port Modbus RTU slave enabled



## eAce 22

The Ace 22 provides 12 digital inputs and 12 digital outputs. In addition to basic digital inputs and outputs, it is designed for motion control, PWM outputs and high speed pulse counting.

- 12 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 12 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- USB programming port
- USB port Modbus RTU slave enabled



## eAce 222

The Ace 222 includes IO interfaces for 12 digital inputs, 12 digital outputs and 12 analog inputs. The three different models of Ace 222 differ only in the analog signal range they are designed to interface (v5 = 0-5VDC, v10 = 0-10VDC and c = 0-20mA). In addition to basic digital inputs and outputs, it is designed for motion control, PWM outputs and high speed pulse counting.

- 12 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 12 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- 12 Analog Inputs, 12 bit resolution
  - Ace 222v5 : 0-5VDC analog inputs
  - Ace 222v10 : 0-10VDC analog inputs
  - Ace 222c : 0-20mA analog inputs (also used for 4-20mA signals)
- USB programming port
- USB port Modbus RTU slave enabled

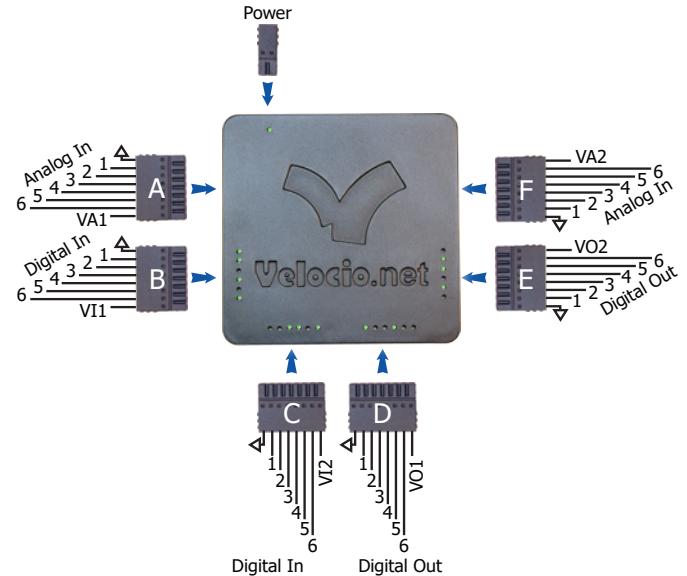
## eAce 3090

The Ace 3090 includes IO interfaces for 6 digital inputs, 18 digital outputs, 3 analog inputs, four thermocouple/differential voltage inputs and an RS232 port. The three different models of Ace 3090 differ only in the analog signal range they are designed to interface (v5 = 0-5VDC, v10 = 0-10VDC and c = 0-20mA).

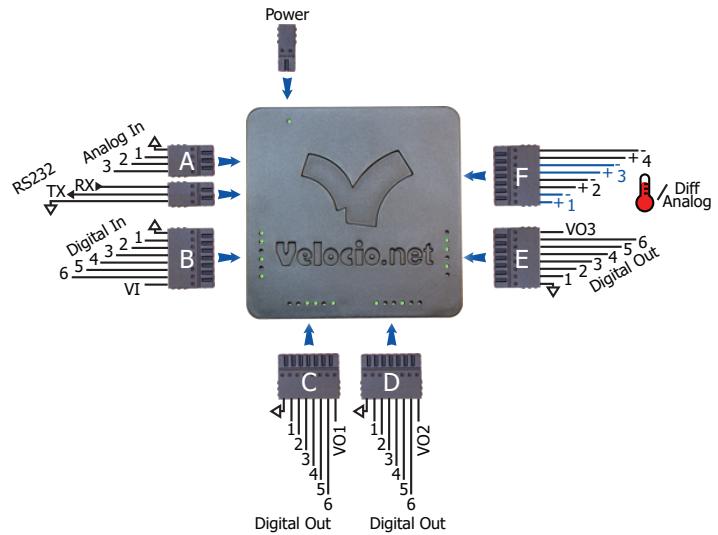
eAce 3090s can be built with either the standard, pluggable connector for the serial port and/or thermocouple inputs, or with the connectors as headers that plug into the motherboard. Those details must be specified on your order.

- 6 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 18 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- 3 Analog Inputs, 12 bit resolution
  - Ace 3090v5 : 0-5VDC analog inputs
  - Ace 3090v10 : 0-10VDC analog inputs
  - Ace 3090c : 0-20mA analog inputs (also used for 4-20mA signals)
- 4 thermocouple/low level differential voltage inputs
  - J, K, T or N thermocouple
  - 16 bit differential voltage input selectable for +/-0.256V, 0.512V, 1,024V, and 2.048V ranges
- RS232 port
- Modbus RTU slave
- Custom message communications
- USB programming port
- USB port Modbus RTU slave enabled

## Ace 222



## Ace 3090



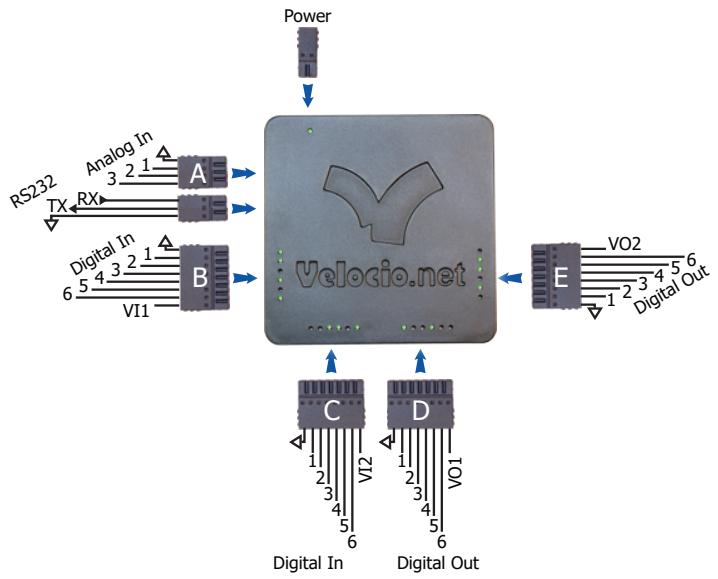
## eAce 5150

The Ace 5150 includes IO interfaces for 12 digital inputs, 12 digital outputs, 3 analog inputs and an RS232 port. The three different models of Ace 5150 differ only in the analog signal range they are designed to interface (v5 = 0-5VDC, v10 = 0-10VDC and c = 0-20mA).

eAce 5150s can be built with either the standard, pluggable connector for the serial port, or with the serial communications connectors as headers that plug into the motherboard. That detail must be specified on your order.

- 12 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 12 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- 3 Analog inputs, 12 bit resolution
  - Ace 5150v5 : 0-5VDC analog inputs
  - Ace 5150v10 : 0-10VDC analog inputs
  - Ace 5150c : 0-20mA analog inputs (also used for 4-20mA signals)
- RS232 port
  - Modbus RTU slave
  - Custom message communications
- USB programming port
  - USB port Modbus RTU slave enabled

## Ace 5150



## eAce 7096

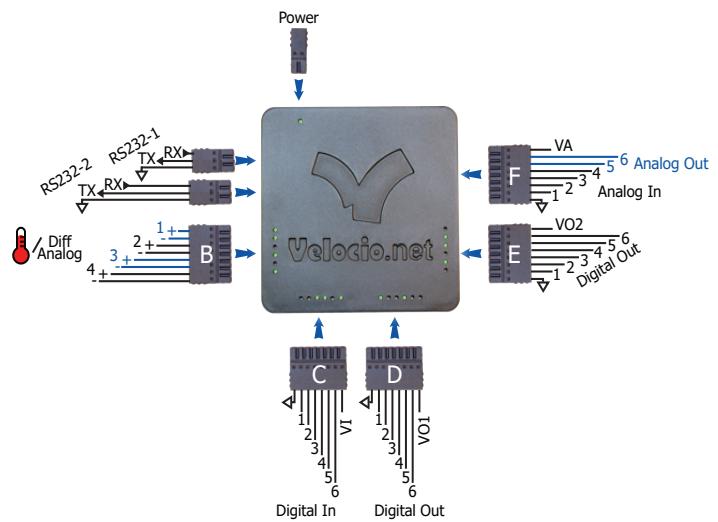
The Ace 7096 includes IO interfaces for 6 digital inputs, 12 digital outputs, 4 analog inputs, four thermocouple/differential voltage inputs, two analog outputs and two RS232 ports. The three different models of Ace 7096 differ only in the analog signal range they are designed to interface (v5 = 0-5VDC, v10 = 0-10VDC and c = 0-20mA).

eAce 7096s can be built with either the standard, pluggable connector for the serial ports and/or thermocouple inputs, or with the connectors as headers that plug into the motherboard. Those details must be specified on your order.

- 6 Digital Inputs
  - Protected, 3-30VDC
  - High speed pulse counting capability
- 12 Digital Outputs
  - Sinking transistor outputs
  - Step and direction motion control enabled (3 maximum)
  - PWM capable on all outputs
- 4 Analog Inputs, 12 bit resolution
  - Ace 7096v5 : 0-5VDC analog inputs
  - Ace 7096v10 : 0-10VDC analog inputs
  - Ace 7096c : 0-20mA analog inputs (also used for 4-20mA signals)
- 2 Analog Outputs
  - 0-5V or 0-10 (selectable using vBuilder)
  - 16 bit resolution
- 4 thermocouple/low level differential voltage inputs
  - J, K, T or N thermocouple
  - 16 bit differential voltage input selectable for +/-0.256V, 0.512V, 1,024V and 2.048V ranges
- 2 RS232 ports
  - Modbus RTU slave
  - Custom message communications
- USB programming port
  - USB port Modbus RTU slave enabled



## Ace 709X



# Ace IO



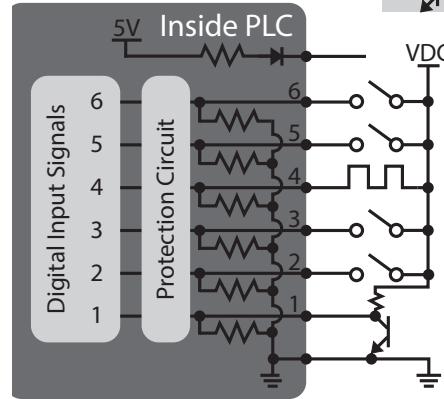
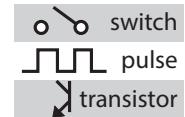
## ◊ Digital Inputs :

All Ace PLCs accept some number of digital inputs. Digital inputs sense binary status, such as on/off, switch open/closed, etc. The Ace PLC can interface any DC voltage signal between 3 and 30VDC. Typical system designs utilize 5V, 12V or 24VDC power supplies, which are all within the Ace's signal range.

Any connection to DC voltage between 3 and 30VDC is sensed as a '1'. Any connection to ground (or voltage below 0.8VDC) or an open connection is sensed as '0'. The ground reference of the signal must be connected to the ground terminal pin next to signal 1, or to the PLC's input power ground.

The figure on the right shows a variety of typical digital input signals that may be connected to Ace digital inputs. Some of the more common ones include :

- Switches (this could be mechanical switches, buttons, limit switches, etc.)
  - Connect one side to positive DC power (from a supply whose ground is connected to the PLC ground)
  - Connect the other side of the switch to the digital input
- Transistor signal
  - For transistor signals that supply voltage when on : connect sensor output to digital input
  - For transistor signals that switch to ground when on : connect to sensor output to digital inputs & if input device does not pull high when inactive, also pull up to positive voltage through a pull up resistor
- Encoder signals
  - Encoders will fall into one of the transistor signal categories listed above
- Logic level signals
  - Make sure that the signal's ground reference is connected to the PLC ground. Connect of input.
  - Make sure that the signal switches high and low.



The last pin on each digital input port connector provides a voltage (connected to the 5V power input, through a 10 ohm resistor and a diode) which is used by the Optocouple Input Terminal modules. It can also be used to supply "wetting voltage" to dry contact inputs.

Internally, as part of the protection circuit, each digital input is pulled to ground through a 10K ohm resistor. This pull down resistor ensures that the digital input shows up as inactive when nothing is connected or the connection just sources voltage when it is active.

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***Do not connect external power to the voltage pin (pin 8) on the digital input port.***

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Ace digital inputs (and the Ace CPU) are very fast. For a small program, the logic scan and input scan can occur 5 times per millisecond. At this rate, mechanical contact bounce can signal the program

that an input is changing rapidly - which can be a problem. To alleviate this situation, vBuilder has an option to allow you to set a debounce time on digital inputs. A debounced digital input will not report a change of state until that change has been continuous for the set debounce time. Note that debounce does not apply to inputs configured as high speed pulse counter inputs.

Using vBuilder, one high speed pulse counter can be configured for basic high speed pulse counting (one digital input), or quadrature pulse counting (two digital inputs). The same signal level requirements apply, as listed above.

	Name	Signal	Debounce (ms.)
<b>Input / Output</b>			
<b>Input bit</b>			
InBitB1	B1	0	
InBitB2	B2	5	
InBitB3	B3	5	
InBitB4	B4	0	
InBitB5	B5	0	
<b>Register</b>			

For digital inputs that are AC signals, the Ace's digital input ports can be connected to Velocio Optocoupled Input Terminal Block modules. These modules interface 24VAC or 120VAC signals. A cable, supplied with each terminal block module is then connected to the Ace digital input port. The Optocoupler Input Terminal Block modules convert the AC signals to the proper DC levels to the PLC.

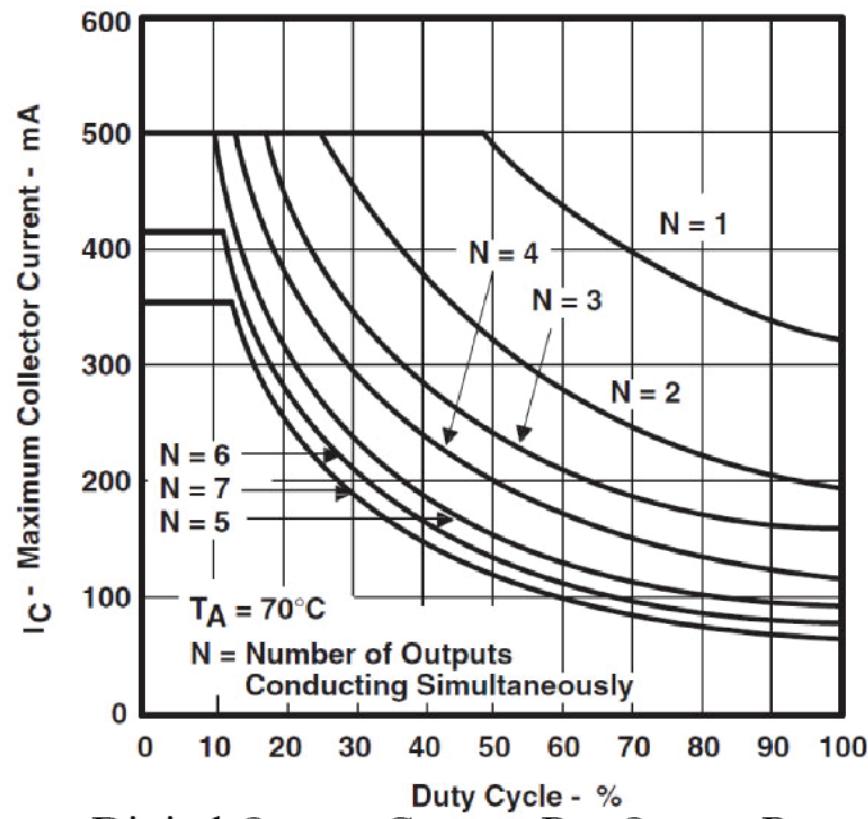
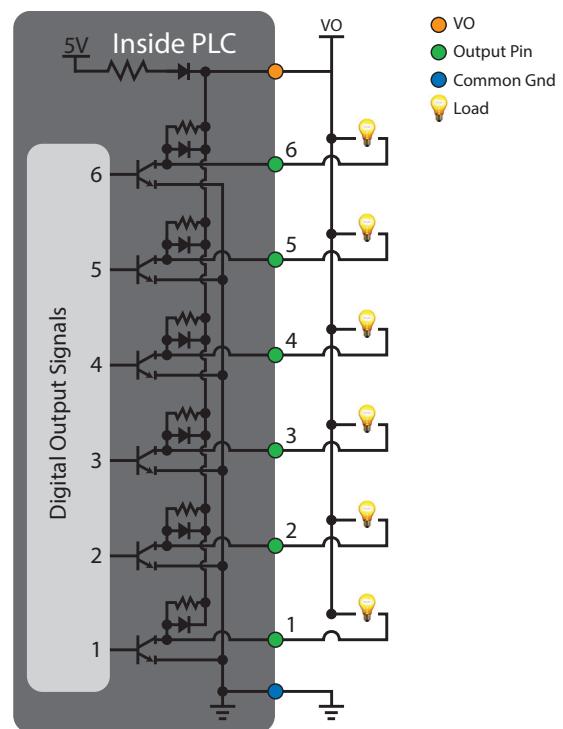
## ◊ Digital Outputs :

All Ace PLCs have some number of digital outputs. Ace digital outputs are sinking transistor outputs - which means that they provide the ground connection turn on a load. When switched on under program control, they complete the circuit to turn on any connected DC device up to 30VDC and (nominally) 300mA. The actual current limit is shown in the figure at the bottom of this page and is dependent on the number of digital outputs that are on simultaneous and their duty cycle.

Each output includes diode snubber protection, for inductive load (solenoids, relays, etc.) protection. The supply voltage, up to 30VDC, which is connected to the load devices, must be connected to the VO terminal pin, next to output 6 of the output port, to enable this protection. All loads connected to a digital output port should be connected to the same DC supply. The load power supply ground must be connected to the ground (next to signal 1) of the output port.

Each output is connected, through a 33K ohm resistor to the VO terminal pin (next to output 6). This acts as a weak pull up. When the output is off (logic state 0), the output will be pulled up to the voltage at the VO terminal. If no power supply connection is made to the VO terminal, the voltage at the VO terminal will come through a 10 ohm resistor and an isolation diode, resulting in a voltage approximately 0.7V below the 5V supply to the PLC. This is enough to allow the PLC outputs to directly interface TTL circuits. If voltage is connected from an external source to the VO terminal, inactive outputs will pull up to the external source voltage.

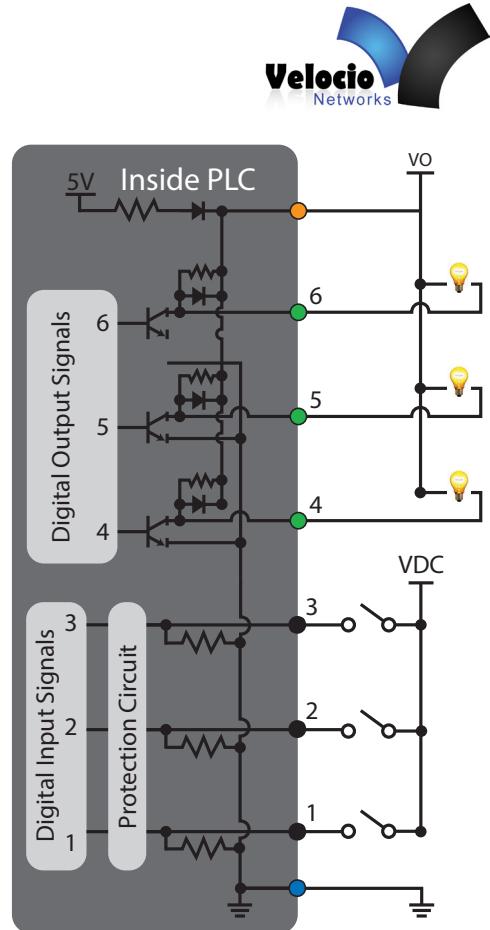
If AC power, or higher power DC needs to be switched, the Ace's digital output ports can be connected to a Velocio Relay Terminal Block module or Transistor Terminal modules (sinking or sourcing, DC only), through a short standard cable, supplied with the module. With these modules, higher currents and in the case of the Relay Modules, up to 250VAC, can be switched under program control. The cable diagram connection to the PLC digital output port pluggable connector is illustrated in the Relay Terminal Block module documentation.



## Digital Output Current Per Output Port

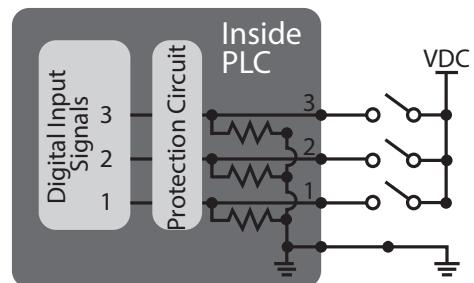
## ◊ Combination Digital Input and Output Ports

The Ace 1630 has a port (the D port) that has three digital inputs and three digital outputs. The diagram for that port is shown on the right. As you can see, the ground reference is common to the digital inputs and outputs. There is a VO connection on pin 8. The digital input and output characteristics as the same as describe previously, under the Digital Input and Digital Output sections.



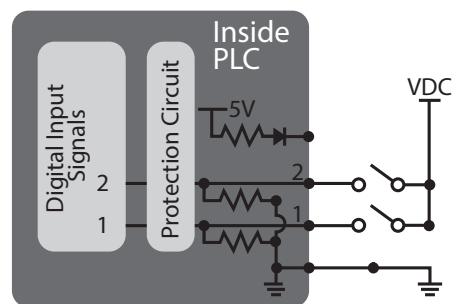
## ◊ Digital Inputs for Ace 1600

The digital inputs on the Ace 1600 PLC are located on a 4 pin connector, which is the second half of the C port. The RS232 port is the first half of the C port. Since this is a minimal IO count PLC, with RS232, the digital port maximizes the number of digital inputs available (3) by eliminating the VI voltage pin.



## ◊ Digital Inputs on Other Combination RS232/Digital Input Ports

Four pin digital input port connectors, other than the Ace 1600, have the same connections as the standard 8 pin/6 digital input signal ports. They simply have only two digital inputs. They do have the signal ground on pin 1 and VI voltage output on pin 4.



## ◊ Analog Inputs :

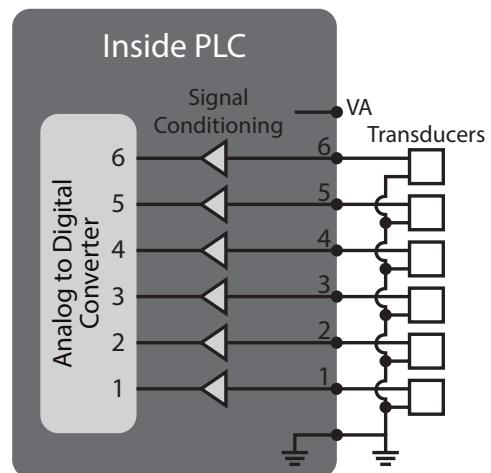
Ace PLCs are available with some number of general analog inputs. Ace PLC analog input interfaces are available for either 0-5VDC, 0-10VDC or 0-20mA.

Analog inputs are normally used to connect to transducer outputs. Such transducers measure some physical parameter, such as pressure, temperature, liquid level, position, pH level, or other such continuously variable measurement. The transducer signal output should be connected to a signal input on the Ace analog port and the transducer return or ground reference line must be connected to the PLC ground, next to signal 1 (or otherwise connected to the PLC's ground).

Ace PLCs with current input analog input ports (part number ending in 'c') should be used for analog current signals between 0 and 20 mA. The two most common type of current signals are 4-20 mA and 0-20 mA.

Full range analog signals will convert to a value between 0 and 4095 (12 bits). For 4-20mA inputs, the converted value will be between 820 and 4095. The Scale function in vBuilder can be used to automatically convert the signal value to meaningful data.

For PLCs that have a full 8 position port dedicated to analog inputs, the pin next to the sixth input is connected to the PLC's internal 5V, through a 10 ohm resistor and a diode. This is provided to power a future analog input simulator. It servers no other purpose and should remain unconnected for application use. Analog input ports that do not occupy the full 8 position port do not have this connection.

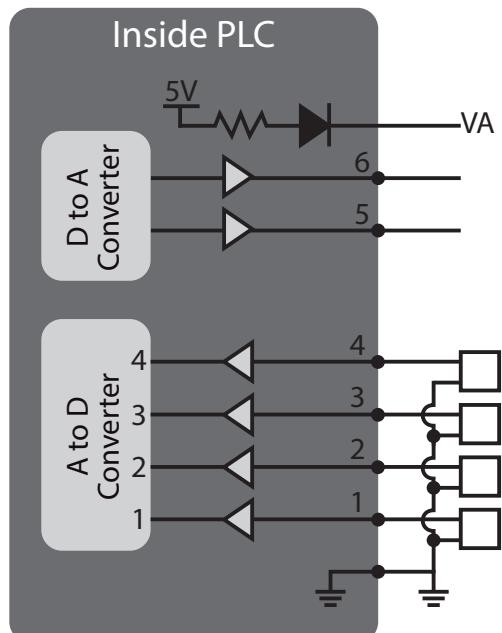
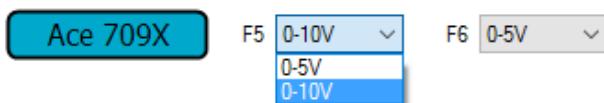


## ◊ Combination Analog Inputs and Analog Outputs

Certain Ace PLCs have a single connector with both analog inputs and outputs. The connections are as shown on the diagram at the right.

The first few signals on the port are analog inputs. They are 12 bit analogs, described in the analog input description. Typically, there are either 3 or 4 analog inputs in a combination port

The last signals on a combination port are analog outputs. For the Ace 7096 these are 16 bit resolution outputs, which can be individually configured, using vBuilder for either 0-5V or 0-10V operation, as shown below.



## ◊ Thermocouple/16 bit Differential Low Voltage Analog Inputs

Several Ace PLC's include interfaces that are configurable for either providing thermocouple interfaces or serving as analog inputs for differential analog signals. These signal inputs can be individually configured, in vBuilder, for either thermocouple or differential voltage ranges.

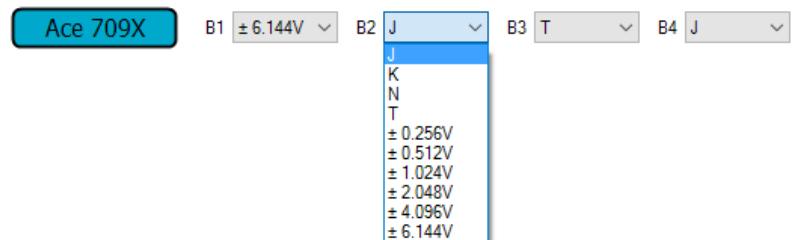
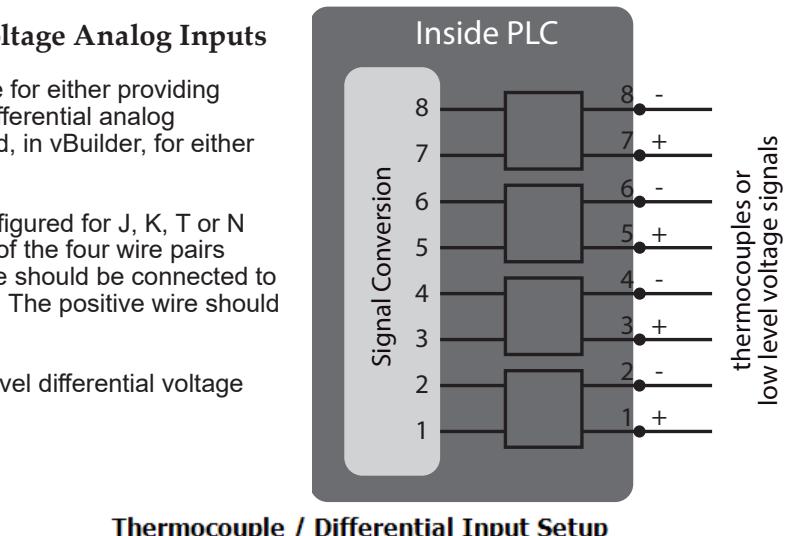
For interfacing to thermocouples, these inputs can be configured for J, K, T or N type thermocouples. Connect each thermocouple to one of the four wire pairs shown in the diagram on the right. The negative (red) wire should be connected to the negative input (indicated by a '-' sign on the diagram). The positive wire should be connected to the positive connection.

Each differential input can also be used to measure low level differential voltage signals. The following ranges are available :

- $\pm 0.256V$
- $\pm 0.512V$
- $\pm 1.024V$
- $\pm 2.048V$

The vBuilder Setup window for the thermocouple/differential analog configuration is shown on the right.

In operation, the signal is converted to a floating point value. That value is either temperature, in degrees Celcius, or volts.



## ◊ RS232 and RS232/485 Ports :

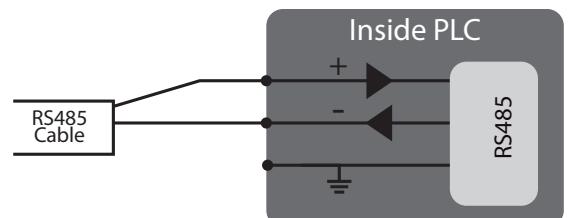
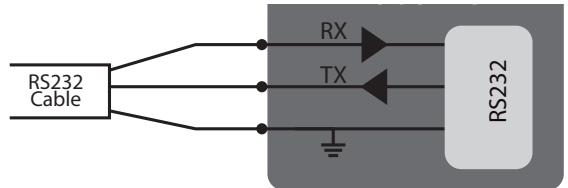
Certain Ace PLCs have RS232 ports or configurable RS232/485 ports. RS232 ports are commonly used for interfacing hardware HMI panels and other devices through Modbus RTU communications. They are also commonly used to interface cellular transceivers for internet of things applications and can be used in Custom communications mode to communicate to any device that has an RS232 port.

RS485 ports are commonly used in multi unit systems and for longer distance communications.

Ace PLC RS232 ports have three pin connectors. The illustration on the right shows the connections.

- Signal ground
- PLC transmit (must be connected to the receive pin of the connected device)
- PLC receive (must be connected to the transmit pin of the connected device)

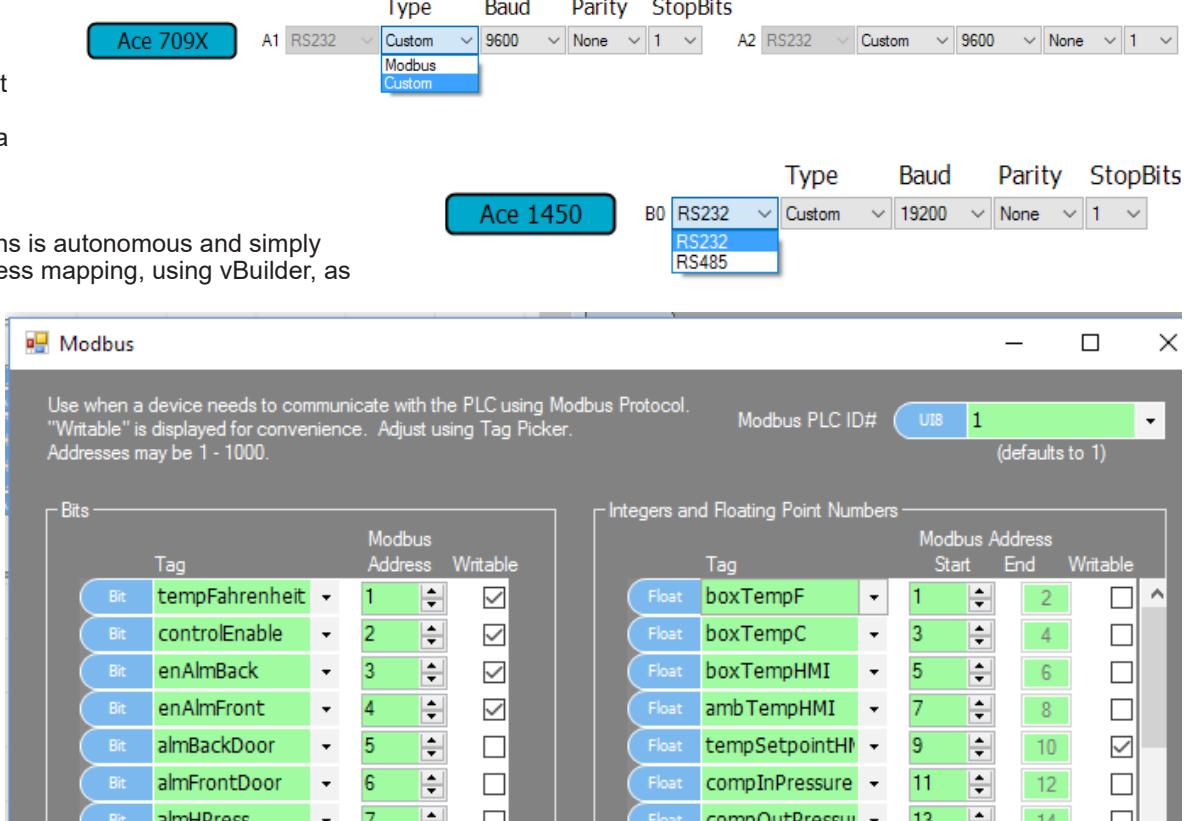
Some Ace PLCs have serial ports that can be configured as either RS232 or RS485. When configured as RS232, the connections are identical to the connections shown for the dedicated RS232 ports. If the port is configured for RS485, the two connections used are the + (or A), on the same pin as the RS232's RX and the - (or B), on the middle pin or RS232's TX pin. The ground can be connected to the cable shield. However, the shield should only be connected at one end of the cable.



Serial ports can be configured by vBuilder for either Modbus RTU slave or Custom communications operation. Each port can also be configured for a variety of baud rates, the number of stop bits and parity. Serial ports that can be configured for either RS232 or RS485 have another configuration selection for that purpose.

All serial ports support Modbus RTU protocol. The PLCs are slave devices. The default device address is 1, but can be configured to any desired address via vBuilder.

Modbus communications is autonomous and simply requires set up of address mapping, using vBuilder, as shown on the right. Once set up and connected, communications occurs automatically.



The screenshot shows the vBuilder interface for configuring Modbus communication. At the top, two PLCs are selected: Ace 709X and Ace 1450. Below them are configuration panels for their serial ports.

- Ace 709X:**
  - Port A1: Type RS232, Baud 9600, Parity None, StopBits 1. The dropdown menu for Type shows "Modbus" as the selected option.
  - Port A2: Type RS232, Baud 9600, Parity None, StopBits 1.
- Ace 1450:**
  - Port B0: Type RS232, Baud 19200, Parity None, StopBits 1. The dropdown menu for Type shows "RS485" as the selected option.

On the right, a detailed configuration window titled "Modbus" is open, showing the mapping of PLC tags to Modbus addresses. It includes sections for Bits and Integers and Floating Point Numbers.

Bits				Integers and Floating Point Numbers			
Tag	Modbus Address	Start	End	Tag	Modbus Address	Start	End
tempFahrenheit	1	1	2	boxTempF	1	1	2
controlEnable	2	3	4	boxTempC	3	3	4
enAlmBack	3	5	6	boxTempHMI	5	5	6
enAlmFront	4	7	8	ambTempHMI	7	7	8
almBackDoor	5	9	10	tempSetpointHM	9	9	10
almFrontDoor	6	11	12	compInPressure	11	11	12
almHPress	7	13	14	compOutPressure	13	13	14

When configured for Custom Communications, the port will send and receive character (ui8) arrays, under program control, through the use of program blocks like those shown on the right.



The screenshot shows two program blocks for Port B0:

- Port B0 SEND:** This block is used to send data. It has three input fields: "Array to Send" (ui8[] txArray), "Message Length" (10), and "Done Sending Bit" (Bit txDone).
- Port B0 RECEIVE:** This block is used to receive data. It has four input fields: "# Bytes Received" (ui8 noRxed), "Receive Array" (ui8[] rxArray), "Minimum Break" (100), and "Message Available" (Bit rxDone).

## Connecting your eAce

Mounting or connecting the eAce is a relatively simple proposition. Exactly what that entails depends on whether your eAce is intended for use with a Velocio Simulator or in your custom motherboard.

If you have purchased your eAce as a training and development tool, for use with a Simulator, it's simply a matter of plugging it in. Velocio Simulators have sockets, arranged in a pattern that matches the pin pattern of the embedded versions of Velocio PLCs and switches, indicators and potentiometers that match the Ace 222. A typical simulator is shown on the right.



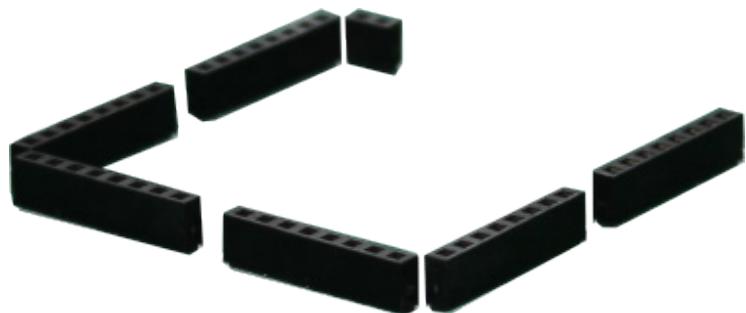
To install in a Simulator, simply line up the PLC pins with the matching sockets, then gently press the PLC into those sockets. All pins should insert very smoothly and easily.



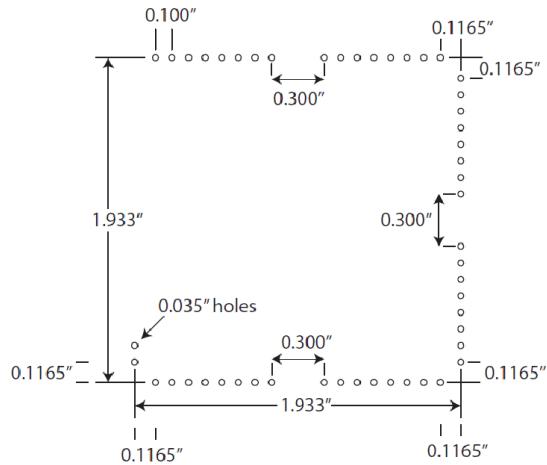
For use with your custom motherboard, the process is basically the same, except that it starts a couple of steps earlier. The eAce comes with sockets for your motherboard. The sockets are standard 0.1" sockets, designed for use with 0.1" spacing, .025" square post headers. The correct number of 8 pin sockets (for IO) and one two pin socket (for PLC power) come included with the eAce. An 8 pin version of those sockets is pictured on the right.



The key is to design your motherboard for the correct pattern of these sockets, just as found on the Simulators. The pattern is illustrated on the right. The actual number of 8 pin sockets involved is dependent on the version of the eAce that you are designing your motherboard for.



The hole pattern required for mounting your eAce in your design is shown on the lower right corner of this page. Keep in mind that you only need to design in the connections for the version of the eAce that you are designing into your system. Since the port is not included in the eAce that you are designing for, the matching connector hole pattern is not required. The signals associated with each of the pins are those shown in the various PLC illustrations on previous pages. The USB does not connect to the motherboard.



# Specifications :

## Hardware Specifications

Power :	Voltage current	4.75 - 5.5VDC 300mA maximum < 100mA typical
<hr/>		
Digital Inputs :	Type :	DC voltage input
	Input range :	3 to 30 VDC
	Internal pull down to ground :	10K ohms
	Input low (or 0) signal :	0 to 0.8V, or open connection
	Input high (or 1) signal :	2.5 to 30VDC
	Pulse counter input frequency :	up to three pulse count or quadrature inputs at up to a combined rate of 250 KHz
	Program selectable debounce :	0 to 255 milliseconds
Digital Outputs :	Type :	Sinking transistor
	Voltage range :	3 to 30VDC
	Current :	300 mA maximum (see curve in Digital Output section)
	Motion output pulse frequency	up to three pulse and direction outputs at up to a combined rate of 250 KHz (maximum)
	PWM resolution :	1 microsecond
	Off state pull up resistance to VO :	33Kohms
Analog Inputs :	Type :	v5 = 0 to 5VDC; v10 = 0 to 10VDC c = 0 to 20 mA
	resolution :	12 bit
Analog Outputs :	Types :	selectable ; 0-5V, 0-10V
	resolution :	16 bit
Thermocouple/Differential Voltage Inputs :	Types :	selectable ; J, K, T and N or - +/- 0.256V +/- 0.512V +/- 1.024V +/- 2.048V
	Output value :	floating point value in degrees C or V
<hr/>		
Communications :	Upstream :	USB Device mini USB connector
	RS232 :	3 wire (TX, RX and ground)
	RS485	2 wire
•	baud rates	selectable ; 9600 baud 19200 baud 38400 baud 57600 baud 15200 baud
•	parity	selectable
•	stop bits	selectable

## Physical Dimensions :

2.5" H x 2.5" W x 0.5" deep

## Environmental

Operating temperature :	all components rated for -40 to +85C
Humidity :	0 to 95% (non-condensing)

## Software Specifications

### Application Program Limits (in Ace PLC)

Program Memory :	34K Words
Maximum rungs or function blocks	4K
Maximum # Subroutines	68
Maximum Tagnames	950
Main Program data memory	
Bits	2,048
unsigned 8 bit integers	512
unsigned 16 bit integers	512
signed 16 bit integers	512
signed 32 bit integers	256
floating point numbers	256
Object Memory (used for subroutine data)	
object words	4,096
object bits	up to 65,536
object 8 Off integers	up to 8,192
object signed 16 bit	up to 4,096
object unsigned 16 bit	up to 4,096
object signed 32 bit	up to 2,048
object floating point	up to 2,048
Maximum # objects	292
Maximum # PWM outputs	all digital outputs
Maximum # of Stepper Motion Controls :	3
Maximum Stepper Motion speed (Hz)	250,000

## Terminal Block Connections

Terminal type	Socket connectors and Spring cage capture plug
Terminal spacing :	2.50 mm
Wire AWG	20 to 26 AWG*

\* best wire fit is with 22 or 24 AWG