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Chapter 5

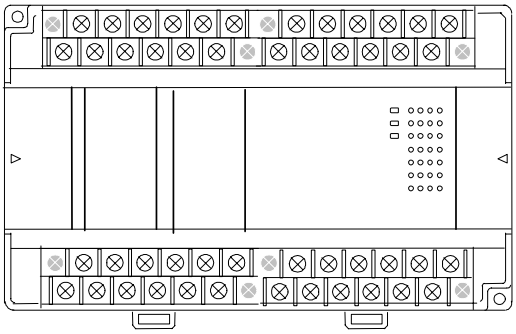
VersaMax Micro PLCs with 23 Discrete Points and 3 Analog Channels

This chapter describes the features and specifications of the VersaMax Micro PLCs with 23 Discrete Points and 3 Analog Channels. It also provides additional information about analog operation and calibration.

- IC200UAL004 Micro PLC with 23 Discrete Points and 3 Analog Channels:
  (13) 12VDC In, (10) Relay Out,
  (2) Analog In and (1) Analog Out, 12VDC Power Supply
- IC200UAL005 Micro PLC with 23 Discrete Points and 3 Analog Channels:
  (13) 24VDC In, (1) 24VDC Out, (9) Relay Out,
  (2) Analog In and (1) Analog Out, 24VDC Power Supply
- IC200UAL006 Micro PLC with 23 Discrete Points and 3 Analog Channels:
  (13) 24VDC In, (1) 24VDC Out, (9) Relay Out,
  (2) Analog In and (1) Analog Out, 120/240VAC Power Supply

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VersaMax 23 Discrete / 3 Analog Micro PLC Features



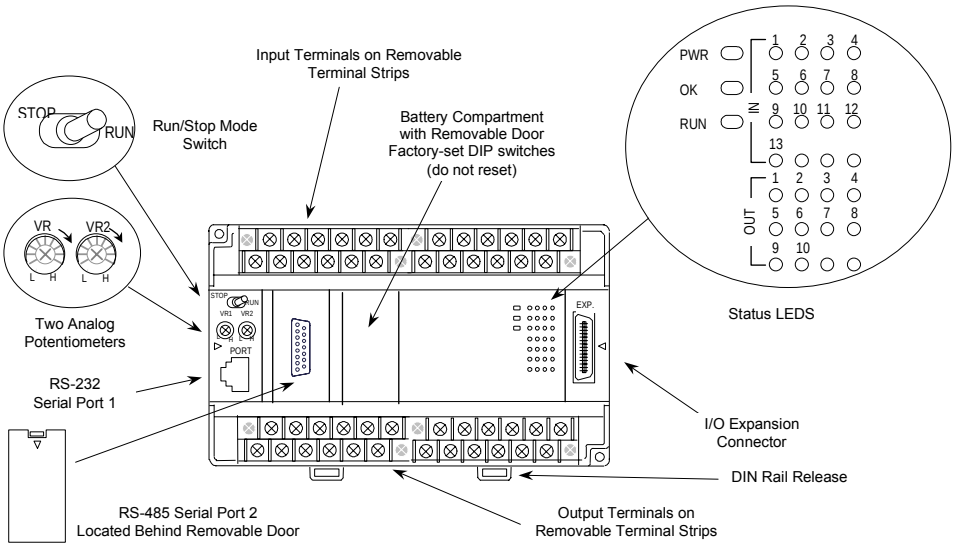
- Supports up to four Expansion Units in any combination.
- Four removable screw-down “barrier-style” terminal strips with protective covers.
- Two Serial communications ports. Port 1 (RS-232) supports SNP/SNPX slave protocols. Port 2 (RS-485) supports SNP/ SNPX master and slave, RTU master and slave, and Serial I/O.
- Run/Stop mode switch that can be configured as a run/stop switch, a memory protect switch, and also used for clearing faults when a fatal fault exists.
- Time-of-Day Clock.
- Two analog potentiometers.
- Full-featured programming Instruction Set with floating point math. The application program can be either Ladder Diagram (LD) or Instruction List (IL) format.
- 9K words of program memory, 2048 words of registers.
- Flash memory (ROM) for non-volatile program storage and for system firmware.
- Configurable to read configuration at powerup from either RAM or flash memory (ROM). Can also be configured to read application program from flash at powerup.
- Capacitor backs up RAM and the Time-of-Day clock for at least 30 minutes.
- Optional lithium battery backup for RAM and real-time clock.

General Specifications for 23-Point VersaMax Micro PLCs

Weight	600 grams (1.32lbs)
Module Dimensions	Height: 90mm (3.6 inches) Depth: 76mm (3.0 inches) Width: 150mm (6.0 inches)
Typical Scan Rate	1.1 ms/K for Boolean logic (see appendix A)
Real Time Clock accuracy (for Timer contacts and Timer function blocks)	+/-0.5%
Time-of-Day Clock accuracy	+/-5 sec/day @10degC, +/-5 sec/day @25degC, and +/-11 sec/day @55degC or across full temperature range
High-speed Counters	Up to four Type A or one Type A and one Type B
Maximum number of slave devices per RS-485 network	8 (can be increased with a repeater)
+5 VDC Output of Serial Ports	Port 1, pin 7: 100mA maximum* Port 2, pin 5: 100mA maximum* *Combined port 1 and port 2 total not to exceed 100mA max.
Lithium battery (IC200ACC403	Storage: Up to 5 years typical at 30 °C Installed: Up to 3 years typical at 55 °C 4 months battery backup time (powered down) minimum at 55 °C

Run/Stop Switch

The Run/Stop switch can be configured as a run/stop switch, a memory protect switch, and used for clearing faults when a fatal fault exists.



Serial Ports

Port 1 is an RS-232 serial port with an RJ-45 connector. Port 2, located behind a removable door on the front of the Micro PLC, is an RS-485 serial port with a DB-15 connector. Both ports can be used for programming. Only one port can be used at a time for programming, but both ports can be used for monitoring at the same time. Port 1 uses SNP slave protocol. Port 2 is software-configurable for SNP master/slave RTU slave or Serial I/O operation. CPUs with firmware version 2.02 or

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later support Modbus RTU Master on port 2. 4-wire and 2-wire RTU are supported. If Port 2 is being used for RTU, it automatically switches to SNP slave mode if necessary. Port 2 defaults to SNP slave and automatically reverts to SNP slave when the CPU is in Stop mode, if configured for Serial I/O.

Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from both ports if it requires 100mA or less at 5VDC.

Analog Potentiometers

The two potentiometers can be used to adjust the values in analog registers %AI016 and %AI017. An example use would be to set thresholds for use in logical relationships with other inputs/outputs.

Removable Terminal Strips

The removable terminal assemblies are protected by hinged covers. After turning off power to the Micro PLC, a terminal assembly and attached field wiring can be separated from the Micro PLC by removing two screws.

Status LEDs

LEDs for Power, OK, and Run mode, plus individual LEDs for each I/O point.

Backup Battery

The Micro PLC uses a large value capacitor to provide memory retention current to the System/User RAM and the Time-of-Day clock when the power supply is either not present or not powered up. The capacitor retains memory contents for at least 30 minutes.

To maintain memory for longer than this, a lithium coin cell assembly (IC200ACC403) can be installed in the battery holder. The Micro PLC reports the battery state to the PLC Fault Table and also uses Status Bits %SA011 and %S0014 to indicate the battery state.

High Speed Counters

These VersaMax Micro PLCs can be configured to provide built-in high-speed counter operation.

When configured for High-speed Counter operation, inputs can be set up as:

- Up to four High-speed Counters or
- One Type A and one Type B Counter.

Each counter provides direct processing of rapid pulse signals up to 10kHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control.

Each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The type B counter provides an A Quad B counting function.

The relay outputs of IC200UAL004 and IC200UAL005 can be configured as up to four counter outputs. They cannot be used as Pulse Train or PWM outputs.

Analog I/O

All VersaMax 23-Point Micro PLCs provide two analog input channels that can be configured to accept inputs from 0 to +10V or from 0 to 20mA or 4 to 20mA input signals. They also have one analog output configurable for the same voltage or current ranges. See chapter 15 for information about configuring voltage/current operation and range. See chapter 16 for details of analog operation, automatic gain and offset adjustment, automatic program reference configuration, and calibration procedures.

Analog I/O Specifications	
Input and output ranges	0 to 10V (10.24V maximum) 0 to 20mA (20.5mA maximum) 4 to 20mA (20.5mA maximum)
Resolution	12 bits over 0 to 10V range (1 LSB=2.5mV) 12 bits over 0 to 20mA range (1 LSB=5µA) 11+ bits over 4 to 20mA range (1 LSB=5µA)
Accuracy	±1% of full scale over full operating temperature range
Analog Inputs	2, differential
Factory calibrated to:	2.50mV per count on 0 to 10V range 5.00µA per count on 0 to 20mA and 4 to 20mA ranges
Linearity	±3 LSB maximum
Isolation	non-isolated
Common mode voltage	±200 V maximum
Current input impedance	249 ohms
Voltage input impedance	100 Kohms
Input filter time	20ms to reach 1% error for step input
Analog Output	1, single-ended, non isolated
Current: maximum terminal voltage user load range output load capacitance output load inductance	10V (at 20mA output) 0 to 500 ohms 2000 pF maximum 1 henry maximum
Voltage: output loading output load capacitance	2 Kohm minimum at 10 volts 1 µF maximum

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IC200UAL004
Micro PLC, 23 Discrete Points and 3 Analog Channels:
(13) 12VDC In, (10) Relay Out, (2) Analog In, (1) Analog Out, 12VDC Power Supply

VersaMax Micro PLC IC200UAL004 accepts thirteen 12VDC inputs and two analog inputs. It provides ten normally-open 2 Amp relay outputs and one analog output. It uses +12VDC nominal input power.

DC Inputs

Thirteen configurable 12VDC inputs can be used as positive or negative logic standard or High-speed Counter inputs. Inputs are compatible with a wide range of devices, such as pushbuttons, limit switches, and electronic proximity switches.

Normally-Open Relay Outputs

Ten Form A relay outputs (SPST-single pole single throw) can control many types of load devices such as motor starters, solenoids, and indicators. The switching capacity of each relay output is 2 amps. An external source of AC or DC power must be supplied for field devices. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-speed Counters. They cannot be used as Pulse Train or PWM outputs.

DC Power Supply

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

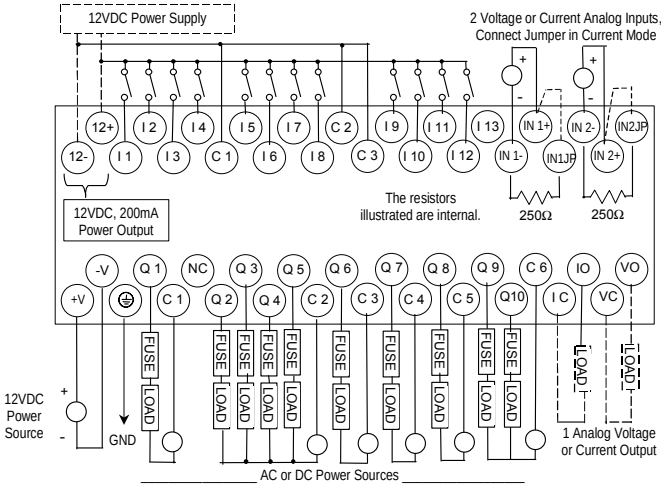
If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 12VDC. The 12VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 12VDC voltage level (see power supply specifications for inrush requirements).

Micro PLC IC200UAL004 Specifications

Inputs	13 DC inputs and 2 Analog inputs
Outputs	10 relay outputs and 1 analog output
+12 VDC Output Power Supply	200 mA maximum (for input circuits and user devices)
High Speed Counters	Up to four Type A or one Type A and one Type B
DC Power Specifications	
Range	9.6VDC - 15VDC
Hold-up	3.0mS
Inrush Current	9.6A typical at 12 VDC
Inrush Time	200mS typical
Input Current	480mA typical at 12 VDC
Input Power Supply Rating	8W

Input Specifications			
Number of Inputs	13		
Rated Input Voltage	12 volts DC		
Input Voltage Range	0 to 15 volts DC		
Input Current	9.0mA typical		
Input Impedance	1.3 kOhms		
Input Threshold Voltage	ON: 9.5VDC minimum, OFF: 2.5VDC maximum		
Input Threshold Current	ON: 6.5mA maximum, OFF: 1.6mA minimum		
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input		
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	1 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-speed Counter Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 9V, OFF: Off: 2.5V		
Count Registers	16 bits		
Available Pulse Outputs	None		

Wiring Diagram, IC200UAL004



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IC200UAL005
Micro PLC, 23 Discrete Points and 3 Analog Channels: (13) 24VDC In, (1) 24VDC Out, (9) Relay Out, (2) Analog In, (1) Analog Out, 24VDC Power Supply

VersaMax Micro PLC IC200UAL005 accepts thirteen 24VDC inputs and two analog inputs. It provides one 24VDC output, nine normally-open 2 Amp relay outputs, and one analog output. It uses +24VDC nominal input power.

DC Inputs

Thirteen configurable 24VDC inputs can be used as positive or negative logic standard or High-speed Counter inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

The module provides +24VDC output power available for field devices.

DC Output (Q1)

The DC output circuit (Q1) can be configured to be a standard, High Speed Counter, Pulse Train or PWM output.

Normally-Open Relay Outputs

Nine Form A relay outputs (SPST-single pole single throw). The nine isolated 2-amp, normally-open outputs can control many types of user-supplied load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. AC or DC power to operate field devices must be supplied from an external source. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-speed Counters. They cannot be used as Pulse Train or PWM outputs.

DC Power Supply

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

If configured to disable power-up diagnostics, the PLC begins logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the PLC must have enough transient current capability to support the inrush current of the power supply and to maintain a 24VDC voltage level (see power supply specifications for inrush requirements).

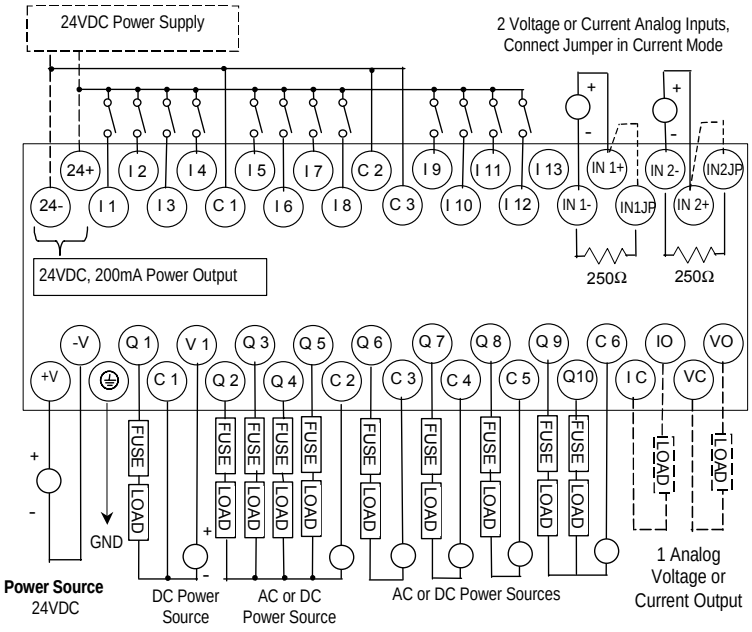
Micro PLC IC200UAL005 Specifications

Inputs	13 DC inputs and 2 analog inputs
Outputs	9 relay outputs, 1 analog output, 1 24VDC output
+24 VDC Output Power Supply	200 mA maximum (for input circuits and user devices)
DC Power Specifications	
Range	24 -20%, +25% VDC
Hold-up	10mS at 19.2 VDC
Inrush Current	1 Amp maximum at 30VDC
Inrush Time	10mS for 1 A
Input Current	0.30 Amp typical at 24VDC
Input Power Supply Rating	8W
High-speed Counter Specifications	
Available High Speed Counters	Up to four Type A or one Type A and one Type B
Maximum Counter Frequency	10kHz
Input Voltage	ON: 15V, OFF: 5V
Count Pulse Width	20% to 80% duty cycle at 10kHz
Count Registers	16 bits
High-speed Counter Outputs	Up to four HSC outputs or one Pulse/PWM output plus three HSC outputs.
Load Voltage	Q1: 5/12/24V
Maximum Pulse/PWM Frequency	(Q1 only) 5kHz
Input Specifications	
Number of Inputs	13
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups

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DC Output (Q1) Specifications			
Output logic	Positive Logic		
Operating Voltage	24VDC / 12VDC / 5VDC		
Voltage Range	24 VDC, +20%, -80%		
Maximum UL Pilot Duty Rating	0.75A at 24 VDC		
Maximum Resistive Load Rating	0.75A at 24 VDC 0.5A at 12 VDC 0.25A at 5 VDC		
Output Voltage Drop	0.3 VDC maximum		
Response ON	0.1ms maximum (24 VDC, 0.2A)		
OFF	0.1ms maximum (24 VDC, 0.2A)		
OFF state leakage	0.1mA maximum		
Isolation	1500 VAC between field side and logic side 500 VAC between groups		
Fuse	Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.		
Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
On Response Time	15 ms maximum		
Off Response Time	15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage	Current: Resistive	Current: Lamp and Solenoid	Typical Operations
240VAC, 120VAC, 24VDC	2A	0.6A	200,000

Wiring Diagram, IC200UAL005



The resistors illustrated are internal.

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IC200UAL006
Micro PLC, 23 Discrete Points and 3 Analog Channels: (13) 24VDC In, (1) 24VDC Out, (9) Relay Out, (2) Analog In, (1) Analog Out, 120/240VAC Power Supply

VersaMax Micro PLC IC200UAL006 accepts thirteen DC inputs and two analog inputs. It provides one DC output, nine normally-open 2 Amp relay outputs, and one analog output. It uses 100VAC to 240VAC nominal input power.

DC Inputs

Thirteen configurable 24VDC inputs can be used as positive or negative logic standard or High-speed Counter inputs. Inputs are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate field devices and the input circuits is supplied by an isolated +24 VDC supply.

DC Output (Q1)

Output circuit Q1 is a 24 VDC transistor output. It can be used as a normal DC output or as a High-speed Counter-controlled output, Pulse Train output, or Pulse Width Modulation (PWM) output.

Normally-Open Relay Outputs

Nine isolated 2-amp, normally-open Form A relay outputs (SPST-single pole single throw can control many types of user-supplied load devices such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. AC or DC power to operate field devices must be supplied from an external source. External fusing is recommended to protect the relay contacts. Relay outputs can be configured as regular outputs or as outputs controlled by High-speed Counters. They cannot be used as Pulse Train or PWM outputs.

Micro PLC IC200UAL006 Specifications

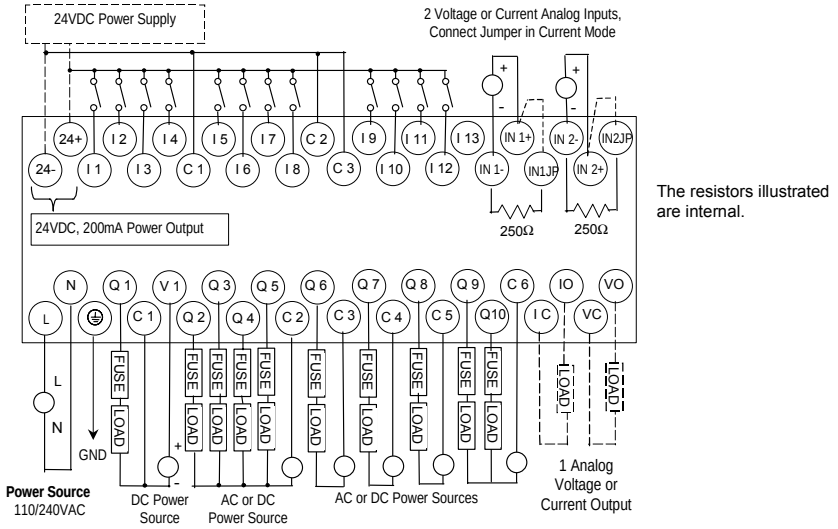
Inputs	13 DC inputs and 2 Analog inputs
Outputs	1 DC output, 9 relay outputs, 1 analog output
High Speed Counters	Up to four Type A or one Type A and one Type B
+24 VDC Output Power Supply (for input circuits and user devices)	200 mA maximum

AC Power Specifications	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 to 100VAC, 20mS at 100 to 265VAC
Inrush Time	2mS for 40A
Inrush Current	35 Amp maximum at 200 VAC 46 Amp maximum at 265 VAC
Input Current	0.13 Amp typical at 200 VAC 0.20 Amp typical at 100 VAC
Input Power Supply Rating	34 VA
Isolation	1500VAC rms field-side to logic (power supply input).
Input Specifications	
Number of Inputs	13
Rated Input Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Input Current	7.5mA typical
Input Resistance	2.8 Kohms
Input Threshold Voltage	ON: 15VDC minimum, OFF: 5VDC maximum
Input Threshold Current	ON: 4.5mA maximum, OFF: 1.5mA minimum
Response Time	0.5 to 20ms (user configurable) as regular input; 100µs as HSC input
Isolation Voltage	1500V RMS field side to logic side, 500V RMS between groups
DC Output Specifications	
Output logic	Positive Logic
Operating Voltage	24VDC / 12VDC / 5VDC
Voltage Range	24 VDC, +20%, -80%
Maximum UL Pilot Duty Rating	0.75A at 24 VDC
Maximum Resistive Load Rating	0.75A at 24 VDC 0.5A at 12 VDC 0.25A at 5 VDC
Output Voltage Drop	0.3 VDC maximum
Response Time	ON: 0.1ms maximum (24 VDC, 0.2A), OFF: 0.1ms maximum (24 VDC, 0.2A)
OFF state leakage	0.1mA maximum
Isolation	1500 VAC between field side and logic side, 500 VAC between groups
Fuse	Output should be fused externally. Otherwise, a load short can damage the module output transistor, which is not user replaceable.

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Relay Output Specifications			
Operating Voltage	5 to 30 VDC or 5 to 250 VAC		
Isolation	1500 V RMS between field side and logic side, 500 V RMS between groups		
Leakage Current	15 mA at 240 VAC maximum		
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC		
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC		
Minimum Load	10 mA		
Maximum Inrush	5 amps per half cycle		
Response Time	ON: 15 ms maximum, OFF: 15 ms maximum		
Contact Life: Mechanical	20 x 10^6 mechanical operations		
Contact Life: Electrical Voltage 240VAC, 120VAC, 24VDC	Current: Resistive 2A	Current: Lamp and Solenoid 0.6A	Typical Operations 200,000
High-speed Counter Specifications			
Maximum Counter Frequency	10kHz		
Input Voltage	ON: 15V, OFF: Off: 5V		
Count Pulse Width	20% to 80% duty cycle at 10kHz		
Count Registers	16 bits		
Available Pulse Outputs	None		
Outputs			
Load Voltage	Q1: 5/12/24V		
Maximum Pulse/PWM Frequency	(Q1 only) 5kHz		
Types available	Up to four HSC outputs or one Pulse/PWM output plus three HSC outputs.		

Wiring Diagram, IC200UAL006



Analog Operation

This section explains how a VersaMax Micro PLC with analog channels processes analog data.

Analog I/O Parameters

Each analog channel can be configured to operate in either voltage or current mode. If current mode operation is selected, the range can then be configured as either 4-20mA or 0-20mA.

Parameter	Choices	Default Value
Voltage or current mode	Voltage, Current	Voltage
Current range selection	4–20mA, 0–20mA	4–20mA

Input/Output Values Compared to Process Data

The Micro PLC processes analog channels using gain and offset values for both current and voltage mode operation. Default gain and offset values are loaded into the Micro PLC flash memory at the factory. For these 23-point Micro PLCs (only) gain and offset can be recalibrated if necessary, as explained later in this section.

The table below shows the relationship between the analog input and output values used by the application program, and the actual analog input or output for each mode. These values include the automatic adjustments for offset and gain.

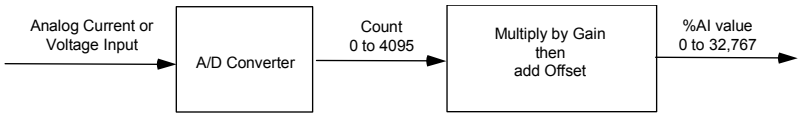
In this Configured Mode:	This is the Analog Signal Range	This is the Equivalent Process Data %AI or %AQ Range	For the Default Calibration, the Value in the %AI or %AQ Reference Equals:
Voltage 0 to +10V	0 to 10,000mV	0 to 32000	3.2 x mV
Current 0 to 20mA	0 to 20,000µA	0 to 32000	1.6 x µA
Current 4 to 20mA	4,000 to 20,000µA	0 to 32000	2 x µA –8000

The following pages explain how the Micro PLC performs the necessary data conversions between the analog signal levels and the numeric values used by the application program.

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Analog Input Processing

The Micro PLC processes analog input channels with a 12-bit successive-approximation A/D converter. It converts the analog value into a digital count, calculates the %AI value as described below, then places the result into the configured %AI input reference.



Automatic Conversion of Analog Voltage or Current to Counts

In voltage mode, the Micro PLC first converts the 0 to 10,000mV input signal to a count in the range of 0 to 4,000. The fixed multiplier for this conversion is 2.5.

In current mode, the Micro PLC first converts the 0 to 20,000µA input signal to a count value in the range of 0 to 4,000. The fixed multiplier for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

Automatic Gain and Offset Adjustment for Analog Inputs

The Micro PLC then converts the A/D converter's input count value from the range of 0 to 4000 to a final %AI input value in the range of 0 to 32,000. It multiplies the count value by a stored gain value and adds an offset value to get the final analog input ($AI):

(input count X Gain) + Offset = %AI value

The default input gain used for this conversion is 8 (32000 / 4000) and the default offset is 0. These can be changed as described later. Any calculated value above 32,767 is clamped at that maximum value. Any calculated value less than 0 is clamped at 0.

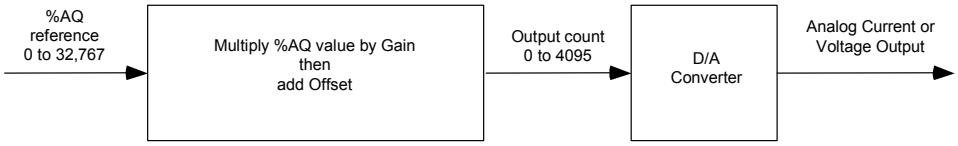
Analog Input Conversion Summary

The table below summarizes the conversion of voltage or current inputs to counts and then to %AI values.

Input Signal	Conversion Factor	A/D Converter Value	Default Gain	Default Offset	%AI Range
Voltage Mode (0–10,000mV)	2.5	0–4000 counts	8	0	0–32,000
Current Mode (0–20mA) or (4–20mA)	5	0–4000 counts	8	0	0–32,000

Analog Output Processing

To generate the analog output signal, the Micro PLC converts the value in the %AQ output reference into a count value for the 12-bit D/A converter, which then drives the analog output.



Automatic Gain and Offset Adjustment for Analog Outputs

The application's %AQ output range of 0 to 32000 corresponds to the D/A converter's output count range of 0 to 4000. The Micro PLC first multiplies the %AQ value from the program by a gain value and adds a predefined offset to produce the count value for the D/A converter:

(%AQ X Gain) + Offset = D/A count

Any calculated value that exceeds 4095 (2^{12}-1) is clamped at that maximum value. Any calculated value less than 0 is clamped at 0. The range 0 to 4095 corresponds to %AQ values between 0 and 32,767.

The default output gain used for this conversion is 0.125 (4000 / 32000) and the default offset is 0. These can be changed as described later.

Automatic Conversion of Counts to Analog Voltage or Current

In voltage mode, the D/A converter then converts the count value in the range of 0 to 4,000 counts to an analog signal from 0 to 10,000mV. The output voltage gain (ratio) for this conversion is 2.5.

In current mode, the D/A converter converts the count value to an analog signal from 0 to 20,000µA. The output current gain for this conversion is 5. The conversion for both current modes (0-20mA and 4-20mA) is the same.

Analog Output Data Conversion Summary

The table below summarizes the conversion of %AQ values to counts and then to voltage or current levels.

%AQ Range	Default Gain, %AQ to Counts	Default Offset	D/A Converter Range	Conversion Factor	Output Signal
0– 32,000	0.125	0	0–4,000 counts	2.5	Voltage Mode (0–10,000mV)
0–32,000	0.125	0	0–4,000 counts	5	Current Mode (0–20mA) or (4–20mA)

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Adjusting the Calibration of Analog Channels

For the 23-point Micro PLCs with analog channels, it is possible to adjust the calibration of the analog channels as described below. Analog channels on Expansion Units and 10-point Nano PLCs cannot be recalibrated. A set of default gains and offsets is maintained in the PLC firmware if you want to restore the original values.

To perform the calibration procedures you will need a precision analog meter (1mV voltage accuracy and 1µA current accuracy). Do not try the procedures in this section unless you are familiar with the operation of D/A and A/D converters.

Recalibrating Input Channels

1. Apply a reference voltage or current at a low range to the input. (The reference signal must be measured accurately by a precision analog meter.) Record the value.
2. For the channel being calibrated, read the %AI register and record the low value.
3. Apply a reference voltage or current at a high range to the input. Precisely measure the reference signal and record the value.
4. For the channel being calibrated, read the %AI register and record the high value.
5. Store the calculated gain and offset values in RAM or flash memory using SVCREQ functions 34 and 35 as instructed in chapter 23.

   The Micro PLC automatically calculates the calibration gain and offset:

$$Gain = \frac{Meter_{High} - Meter_{Low}}{\%AI_{High} - \%AI_{Low}} \times DefaultGain$$

$$Offset = Meter_{High} - \frac{\%AI_{High} \times Gain}{DefaultGain}$$

Recalibrating Output Channels

1. Write a low value to the %AQ register.
2. At the output, measure the voltage or current using a precision analog meter and record the value.
3. Write a high value to the %AQ register.
4. At the output, measure the voltage or current using a precision analog meter and record the value.
5. Store the calculated gain and offset values in RAM or flash memory using SVCREQ functions 34 and 35 as instructed in chapter 23.
6. The Micro PLC automatically calculates the calibration gain and offset:

$$Gain = \frac{\%AQ_{High} - \%AQ_{Low}}{Meter_{High} - Meter_{Low}} xDefaultGain$$

$$Offset = \%AQ_{High} \times DefaultGain - Meter_{High} \times Gain$$

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