

SPECIFICATIONS



CHAPTER 2

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Overview

The ProductivityOpen system is intended to provide a robust selection of components for a compact and expandable design with a simple-to-use philosophy.

Right Side Expansion - Productivity1000 Input/output Modules

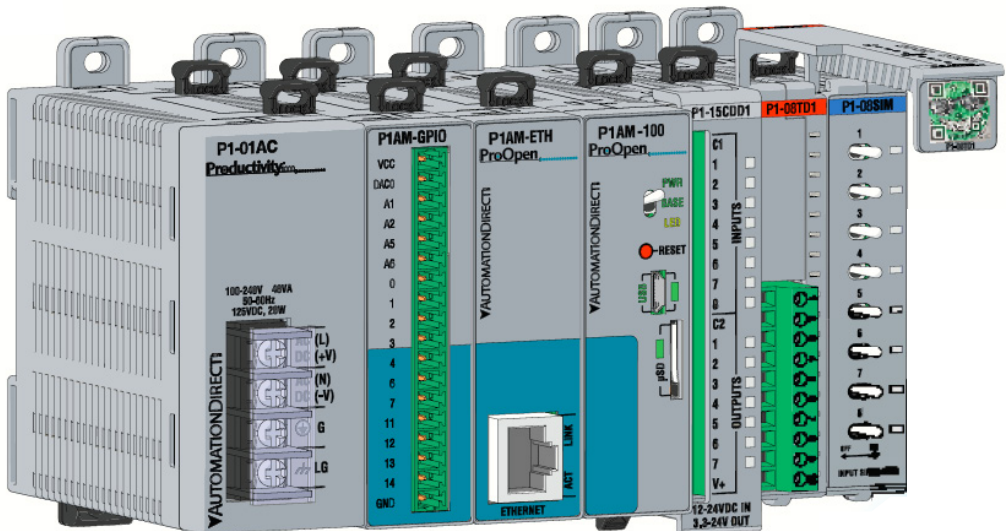
The P1AM-100 can be expanded with the addition of easily connected I/O modules and does not require a mounting base. I/O modules are connected via an expansion port on the right side of the P1AM-100 case. A variety of I/O modules are available from the Productivity1000 series for flexible and optimal system configuration. Refer to the Productivity1000 user manual for detailed descriptions (<https://cdn.automationdirect.com/static/manuals/p1userm/p1userm.html>).

Left Side Expansion - Arduino MKR-compatible Shields

The left side of the case allows expansion with most* Arduino MKR compatible shields. A selection of shields to support P1AM-100 in housings to conveniently connect to the P1AM-100 specifically are available from AutomationDirect. See detailed descriptions following.



*** NOTE:** The P1AM CPU Base Controller uses pins A3 and A4 so any shield that uses these same pins will have a conflict. The MKR RGB shield is one that has this conflict.



P1AM-100 Arduino Compatible CPU

The P1AM-100 is an Arduino-compatible CPU. It uses the Atmel SAMD21G18 micro-controller and can be programmed using Arduino IDE or ProductivityBlocks®. It interfaces with all Productivity1000 Series I/O modules connected to the right side of the P1AM-100 and most Arduino MKR form factor shields connected to the left side. The specifications are listed in the tables below.



P1AM-100

User Specifications

User Memory	256kB Flash with 10kB used for bootloader
Memory Type	Flash: 256kB, SRAM: 32kB
Base Controller and I/O Power Requirement ¹	24VDC $\pm 2\%$ Plan 0.5 W for the SAMD chip and base controller Plan 1.25 W per P1000 I/O module Plan 9W for max. header power draw (which provides max. 4.25 W power to left side connected shields).
Recommended Fuse (External)	Edison S5061-R, Time Delay, 1A Fuse For 9–15 modules: Edison S5062-R, Time Delay, 2A Fuse
Peripherals	MicroB USB, Arduino MKR-compatible, microSD card slot, User controlled LED
Hardware Limits of System ²	15 Productivity1000 I/O Modules; Arduino MKR shields
Programming	Programmed in C/C++ with the Arduino IDE or ProductivityBlocks® 

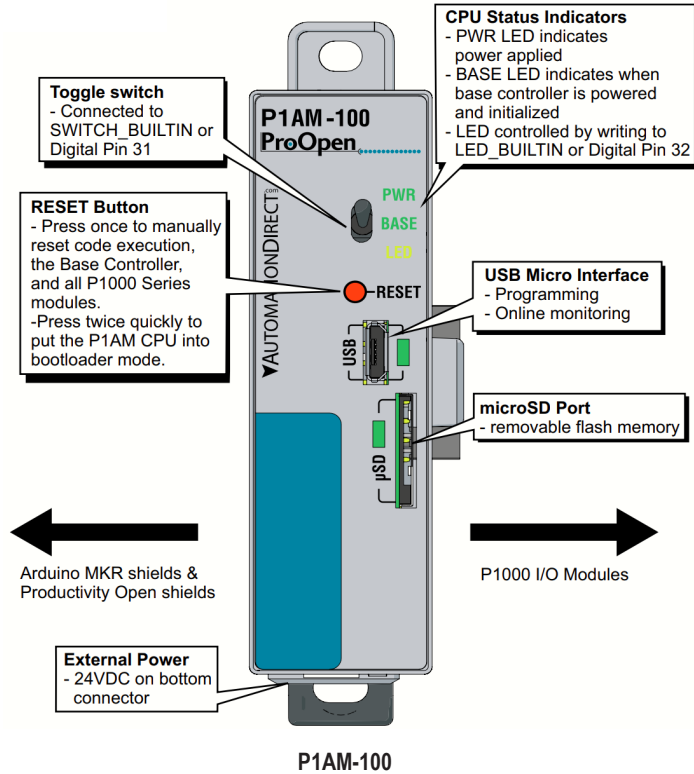
¹ If you do not use a Productivity1000 power supply, like the P1-01AC, then use a power supply that has transformer isolation. Use different 24VDC supplies for the CPU and inductive loads to keep the CPU power clean and free of voltage spikes caused by switching solenoids, motors and relay coils.

² See MKR Expansion Bus table and notes for shield power budget restrictions.

General Specifications

Operating Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	-20° to 70°C (-4° to 158°F)
Humidity	5 to 95% (non-condensing)
Altitude	2,000 meters, max.
Pollution Degree	2
Environmental Air	No corrosive gases permitted
Vibration	IEC60068-2-6 (Test Fc)
Shock	IEC60068-2-27 (Test Ea)
Heat Dissipation	4000mW
Overtoltage Category	II
Enclosure Type	Open Equipment
Module Location	Productivity1000 I/O modules connect on the right side of module. Productivity1000 power supply, P1AM Shields and MKR Shields connect on the left side on the module.
Weight	76g (2.8 oz)
Agency Approvals	UL 61010-1 and UL 61010-2-201 File E139594, Canada & USA CE (EN 61131-2 EMC, EN 61010-1 and EN 61010-2-201 Safety)

P1AM-100 Module Faceplate Layout



CPU Status Indicators

PWR	Green LED is illuminated when power is ON
BASE	Green LED is illuminated when P1AM I/O controller is powered and has been initialized
LED	Yellow LED is illuminated when commanded by user program. LED can be referred to as LED_BUILTIN or Pin 32.



Toggle Switch Specifications

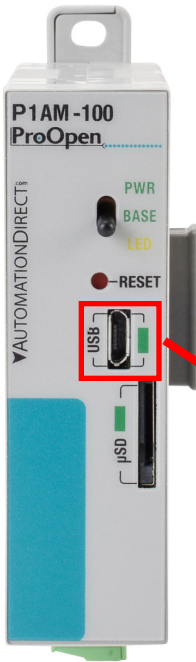
Switch can be read using the "digitalRead" function. Switch can be referred to as "SWITCH_BUILTIN" or Pin 31.

Reset Switch Specifications

- Press once to manually reset code execution, the Base Controller, and all P1000 Series modules.
- Press twice quickly to put the P1AM CPU into bootloader mode.

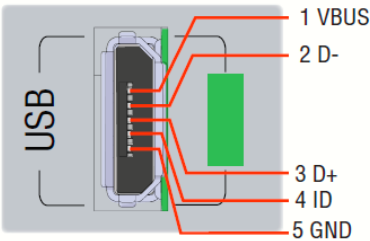
P1AM-100 MicroB USB Programming Port

The P1AM-100 controller has one built-in communication port; used exclusively for connecting to a PC running the Arduino IDE programming software. Following are the specifications and pin-out diagram.



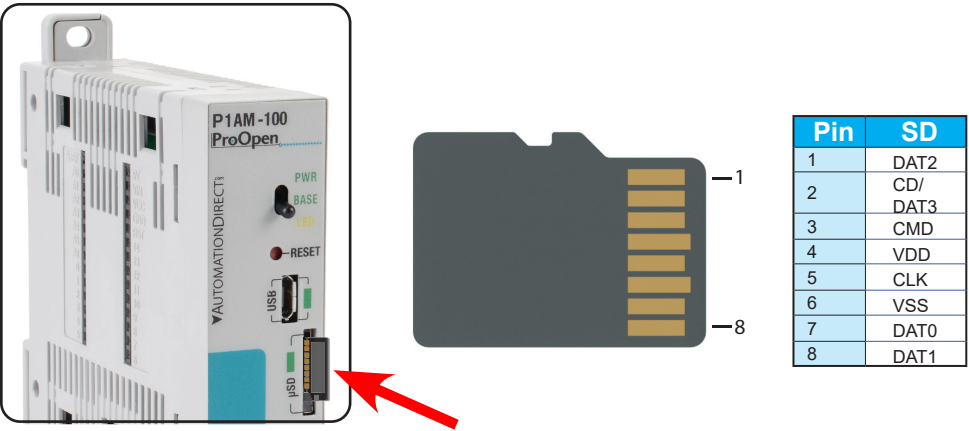
P1AM-100

Micro USB Type B Specifications	
Port Name	MicroB USB
Description	Standard MicroB USB input for programming, monitoring, and a power option
Port Status LED	Green LED is illuminated when a power cable is plugged in.
Cables	USB Type A to Micro USB Type B: 6ft cable part # USB-CBL-AMICB6 15ft cable part # USB-CBL-AMICB15



microSD Slot

Retentive memory for data logging, parameter storage, etc. (Card not included with unit).

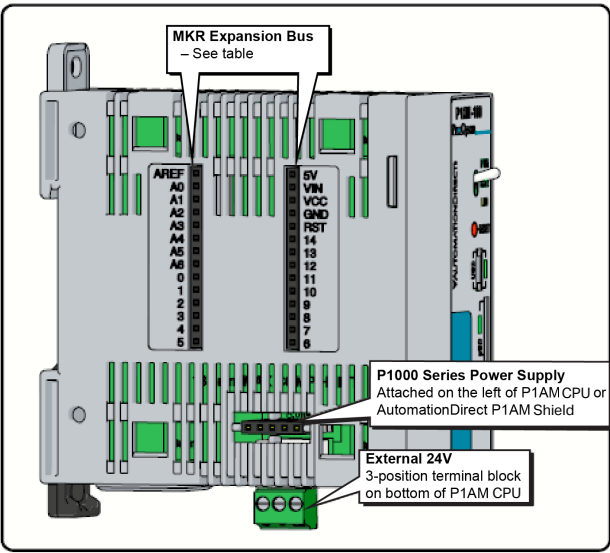


microSD Specifications

Port Name	microSD			
Description	Standard microSD socket for data logging			
Maximum Card Capacity	32GB			
Transfer Rate (ADATA microSDHC Class 4 memory card)	Mbps	Minimum	Typical	Maximum
	Read	14.3	14.4	14.6
	Write	4.8	4.9	5.1
Port Status LED	Green LED is illuminated when card is inserted and detected			

P1AM-100 CPU Headers

Following are the specifications and pin-out diagram for the Arduino MKR-compatible expansion bus available for Left Side Expansion Arduino MKR-compatible shields.



P1AM-100

MKR Expansion Bus Pins	
GPIO	A0–A6, 0–14
Analog Input Pins	A0–A6
Analog Output Pins	A0
PWM Pins	0–8, 10, A3, A4
Interrupt Pins	0, 1, 4–8, A1, A2
5V	5V supply output
Vin	5V regulated supply
VCC	3.3 V supply output
GND	Ground
RST	Reset
AREF	Analog Input Reference

Critical Notes:
Pins A3, A4, and 8–10 are used for the base controller.
Do not exceed 46mA combined from pins 0, 1, and 4–10.
Do not exceed 3.3 V on any I/O pin.
Do not exceed 7mA on any I/O pin.
Do not apply power to 5V or VCC

P1AM-200 Arduino Compatible CPU

The P1AM-200 is an Arduino-compatible CPU. It uses the Atmel SAMD51P20 micro-controller and can be programmed using Arduino IDE or in CircuitPython using any text editor. It interfaces with all Productivity1000 Series I/O modules connected to the right side of the P1AM-200 and most Arduino MKR form factor shields connected to the left side.



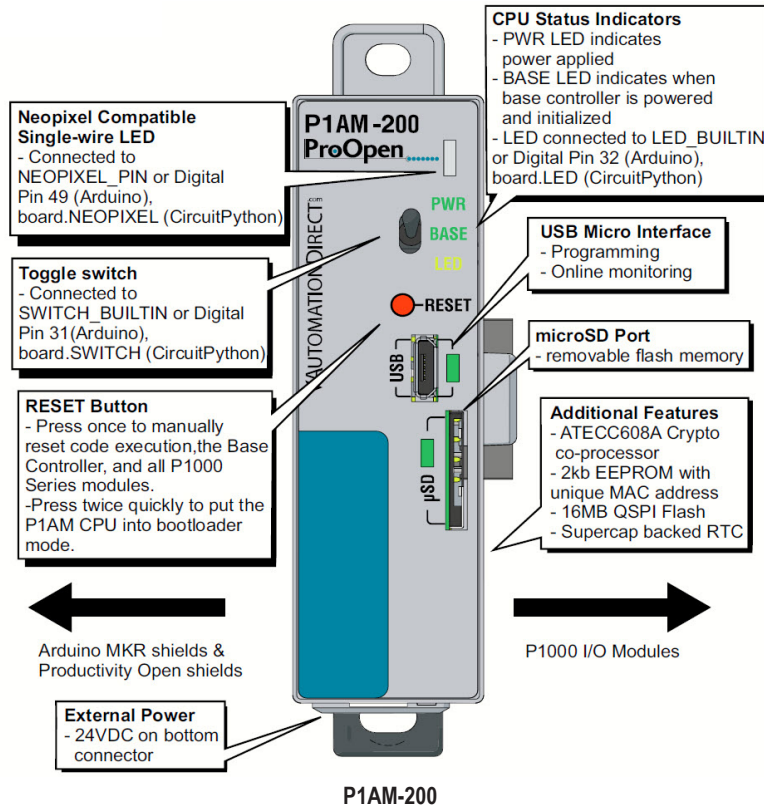
User Specifications	
User Memory	1MB Internal flash with 16Kb used for bootloader. 16MB External QSPI Flash; 2Kb EEPROM
Memory Type	Flash: 1MB; SRAM: 256Kb; QSPI Flash: 16MB; EEPROM: 2Kb
Base Controller and I/O Power Requirement ¹	24VDC $\pm 2\%$ Plan 0.5 W for the SAMD chip and base controller Plan 1.25 W per P1000 I/O module Plan 9W for max. header power draw (which provides max. 4.25 W power to left side connected shields).
Recommended Fuse (External)	Edison S5061-R, Time Delay, 1A Fuse For 9–15 modules: Edison S5062-R, Time Delay, 2A Fuse
Peripherals	MicroB USB, Arduino MKR-compatible, microSD card slot, User controlled LED
Hardware Limits ²	15 Productivity1000 I/O Modules; Arduino MKR shields
Programming	Programmed in C/C++ with the Arduino IDE or CircuitPython in any text editor.

¹ If you do not use a Productivity1000 power supply, like the P1-01AC, P1-02AC, or P1-01DC, then use a power supply that has transformer isolation. Use different 24VDC supplies for the CPU and inductive loads to keep the CPU power clean and free of voltage spikes caused by switching solenoids, motors and relay coils.

² See Header Power Limitations (page 2-13) in this chapter for additional resources.

General Specifications	
Operating Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	-20° to 70°C (-4° to 158°F)
Humidity	5 to 95% (non-condensing)
Altitude	2,000 meters, max.
Pollution Degree	2
Environmental Air	No corrosive gases permitted
Vibration	IEC60068-2-6 (Test Fc)
Shock	IEC60068-2-27 (Test Ea)
Heat Dissipation	4000mW
Overvoltage Category	II
Enclosure Type	Open Equipment
Module Location	Productivity1000 I/O modules connect on the right side of module. Productivity1000 power supply, P1AM Shields and MKR Shields connect on the left side on the module.
Weight	82g (2.89 oz)
Agency Approvals	UL 61010-1 and UL 61010-2-201 File E139594, Canada & USA CE (EN 61131-2 EMC, EN 61010-1 and EN 61010-2-201 Safety)

P1AM-200 Module Faceplate Layout



CPU Status Indicators

PWR	Green LED is illuminated when power is ON
BASE	Green LED is illuminated when P1AM I/O controller is powered and has been initialized
LED	Yellow LED is illuminated when commanded by user program. LED can be referred to as LED_BUILTIN or Pin 32.



Toggle Switch Specifications

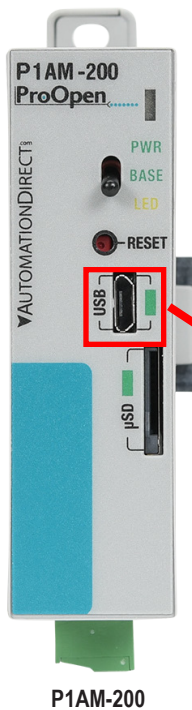
Switch can be read using the "digitalRead" function. Switch can be referred to as "SWITCH_BUILTIN" or Pin 31.

Reset Switch Specifications

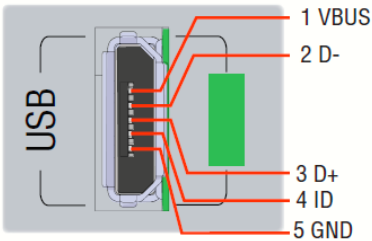
- Press once to manually reset code execution, the Base Controller, and all P1000 Series modules.
- Press twice quickly to put the P1AM CPU into bootloader mode.

P1AM-200 MicroB USB Programming Port

The P1AM-200 controller has one built-in communication port, used exclusively for programming. It may be used with the Arduino IDE programming software or as a storage device to load Python files. Following are the specifications and connector pinout diagram.

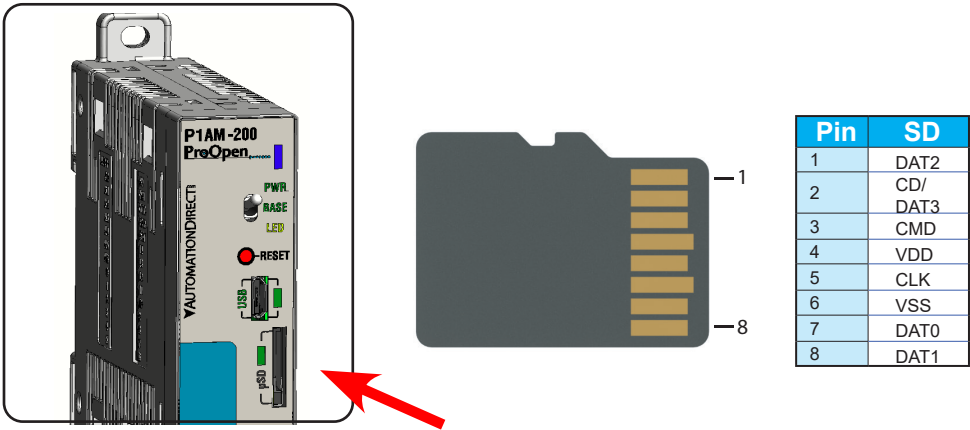


Micro USB Type B Specifications	
Port Name	MicroB USB
Description	Standard MicroB USB input for programming, monitoring, and a power option
Port Status LED	Green LED is illuminated when a power cable is plugged in.
Cables	USB Type A to Micro USB Type B: 6ft cable part # USB-CBL-AMICB6 15ft cable part # USB-CBL-AMICB15



microSD Slot

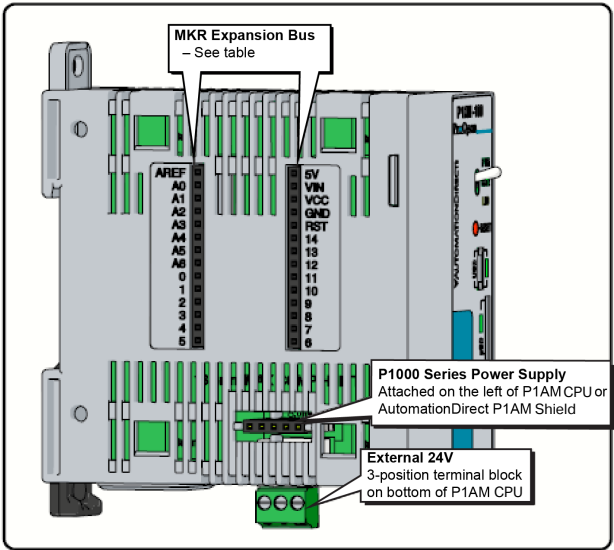
Retentive memory for data logging, parameter storage, etc. (Card not included with unit).



microSD Specifications				
Port Name	microSD			
Description	Standard microSD socket for data logging			
Maximum Card Capacity	32GB			
Transfer Rate (ADATA microSDHC Class 4 memory card)	Mbps	Minimum	Typical	Maximum
	Read	14.3	14.4	14.6
	Write	4.8	4.9	5.1
Port Status LED	Green LED is illuminated when card is inserted and detected			

P1AM-200 CPU Headers

Following are the specifications and pin-out diagram for the Arduino MKR-compatible expansion bus available for Left Side Expansion Arduino MKR-compatible shields.



P1AM-200



WARNING: Use only a P1000 power supply **OR** an external 24V power supply, not both simultaneously.

MKR Expansion Bus Pins	
GPIO	A0–A6, 0–14
Analog Input Pins	A0–A6
Analog Output Pins	A0
PWM Pins	0–8, 10, A3, A4
Interrupt Pins	0, 1, 4–8, A1, A2
5V	5V supply output
Vin	5V regulated supply
VCC	3.3 V supply output
GND	Ground
RST	Reset
AREF	Analog Input Reference

Critical Notes:
Pins A3, A4, and 8–10 are used for the base controller.
Do not exceed 46mA combined from pins 0, 1, and 4–10.
Do not exceed 3.3 V on any I/O pin.
Do not exceed 7mA on any I/O pin.
Do not apply power to 5V or VCC

Powering Your ProductivityOpen System

It is important to understand that the Productivity1000 I/O modules on the right side will be powered either by the Productivity1000 power supply* connected to the left of the CPU OR by an external 24VDC power supply connected to the terminals at the bottom of the CPU module. The ProductivityOpen shields sold by AutomationDirect will also be powered by either of these sources.



*** NOTE:** Connect only one of these 24VDC sources.

Third party shields on the left side shall be powered in the field according to the manufacturer specs.

The USB programming cable will power the CPU and shields connected on the left side of the CPU.



CAUTION! Shields and I/O modules must not be connected or disconnected when power is applied.

Power Supply Options

	LSX Shields		CPU	RSX
	Open	ADC		ADC I/O
USB Power Cable (5VDC)	Ø	Ø	Ø	
ADC P1-01AC or P1-02AC		Ø	Ø	Ø
AUX 24Vin	Ø	Ø	Ø	Ø

MKR Header Power Limitations

Power Source	5V	3.3 V	Max. Combined Power
USB	330mA	500mA	1.65 W
VIN (Pin Header)	600mA	1A	3.3 W
P1000 Series Supply OR External 24V	850mA	1.28 A	4.25 W

AutomationDirect Shields

Ethernet Communications Shield

The P1AM-ETH is a housed Arduino Compatible Ethernet Shield based on the Wiznet W5500 Ethernet Controller. It interfaces to the left side of the P1AM-100 CPU and most Arduino MKR form factor shields.



!WARNING!

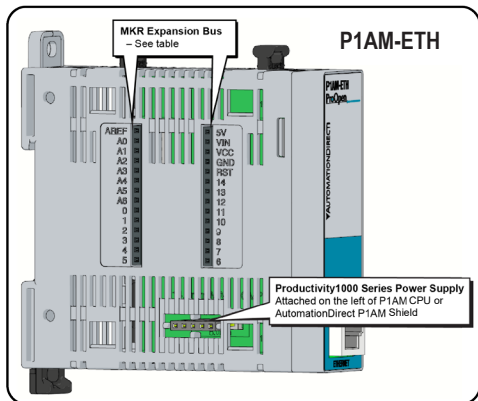
Do not add or remove modules with field power applied!

Ethernet Features

- Supports Hardwired TCP Protocols: TCP, UDP, ICMP, IPV4, ARP, IGMP, PPPOE
- Supports 8 independent sockets simultaneously
- Supports Power Down Mode
- Supports Wake on LAN over UDP
- Supports High Speed Serial Peripheral Interface (SPI MODE 0, 3)
- Internal 32K bytes of Memory for TX/RX Buffers
- 10BaseT / 100BaseTX Ethernet PHY embedded
- Supports Auto Negotiation (Full and Half Duplex, 10 and 100-based)
- Does Not Support IP Fragmentation
- 3.3 V operation with 5V I/O signal tolerance
- LED outputs (Full / Half duplex, Link, Speed, Active)

General Specifications	
Operating Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	-20° to 70°C (-4° to 158°F)
Humidity	5 to 95% (non-condensing)
Altitude	2,000 meters, max.
Pollution Degree	2
Environmental Air	No corrosive gases permitted
Vibration	IEC60068-2-6 (Test Fc)
Shock	IEC60068-2-27 (Test Ea)
Heat Dissipation	750mW
Overvoltage Category	II
Enclosure Type	Open Equipment
Power Budget	150mA/5V
Recommended Library	Arduino Ethernet
Module Location	Connects to the left side of the P1AM-100 CPU.
Weight	20g (0.8 oz.)
Agency Approvals	UL 61010-1 and UL 61010-2-201 File E139594, Canada & USA CE

AutomationDirect Shields, cont'd



MKR Expansion Bus Pins

GPIO	A0–A6, 0–14
Analog Input Pins	A0–A6
Analog Output Pins	A0
PWM Pins	0–8, 10, A3, A4
Interrupt Pins	0, 1, 4–8, A1, A2
5V	5V supply output
Vin	5V regulated supply
VCC	3.3 V supply output
GND	Ground
RST	Reset
AREF	Analog Input Reference

Critical Notes:

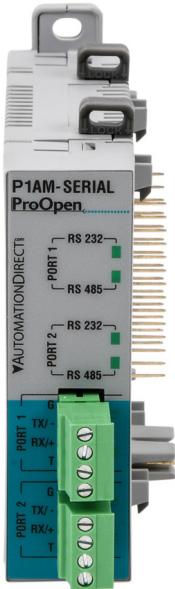
Pins A3, A4, and 8–10 are used for the base controller.
 Do not exceed 46mA combined from pins 0, 1, and 4–10.
 Do not exceed 3.3 V on any I/O pin.
 Do not exceed 7mA on any I/O pin.
 Do not apply power to 5V or VCC

Header Pins Used for Ethernet Shield

Pins Used	Function	Notes
5	ETH SS	
8	MOSI	SPI pins are shared with other devices on SPI bus
9	SCK	
10	MISO	

Serial Communications Shield

The P1AM-SERIAL is a housed Arduino MKR Compatible Shield. It interfaces to the left side of the P1AM-100 CPU and most Arduino MKR form factor shields.



!WARNING!

Do not add or remove modules with field power applied!

Serial Features

- 2 RS-232/RS-485 (4-pin terminal) ports.
- Supports RS-232 and RS-485 connections to serial devices using ASCII or custom communication protocols
- LED outputs (RS-232/RS-485 mode selection, TX and RX activity)

General Specifications

Operating Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	-20° to 70°C (-4° to 158°F)
Humidity	5 to 95% (non-condensing)
Altitude	2000 meters max.
Pollution Degree	2
Environmental Air	No corrosive gases permitted
Vibration	IEC60068-2-6 (Test Fc)
Shock	IEC60068-2-27 (Test Ea)
Overvoltage Category	II
Voltage Withstand (dielectric)	Non-Isolated
Insulation Resistance	Non-Isolated
Heat Dissipation	380mW
Enclosure Type	Open Equipment
Power Budget	115mA/3.3 V
Recommended Library	P1AM_Serial
Module Location	Shield connects to the left side of the P1AM CPU. P1-01AC/02AC can connect to the left side of the Shield.
Weight	77g (2.7 oz.)
Agency Approvals	UL 61010-1 and UL 61010-2-201 File E139594, Canada & USA CE

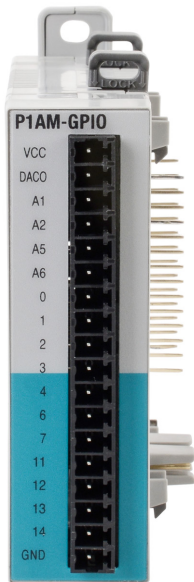
Header Pins Used for Serial Shield

Pins Used	Function	Description
3	P1 Mode	Port 1 Mode (Low=RS485 High=RS232)
14	P1 TX -	Port 1 Data -
13	P1 RX +	Port 1 Data +
A6	P1 DE/RE	Port 1 Driver Enable / Receiver Enable
2	P2 Mode	Port 2 Mode (Low=RS485, High=RS232)
0	P2 TX -	Port 2 Data -
1	P2 RX +	Port 2 Data +
6	P2 DE/RE	Port 2 Driver Enable / Receiver Enable

Note: If a P1AM-GPIO module is installed alongside a P1AM-SERIAL module, the above pins will be unavailable to the P1AM-GPIO.

Header Pin Breakout Module

The P1AM-GPIO is a housed Arduino MKR form factor shield that brings a subset of the MKR header pins out to the front 18 position terminal block. These pins include basic overvoltage, undervoltage, and overcurrent protection. It connects to the left side of the P1AM-100 CPU and most Arduino MKR form factor shields.

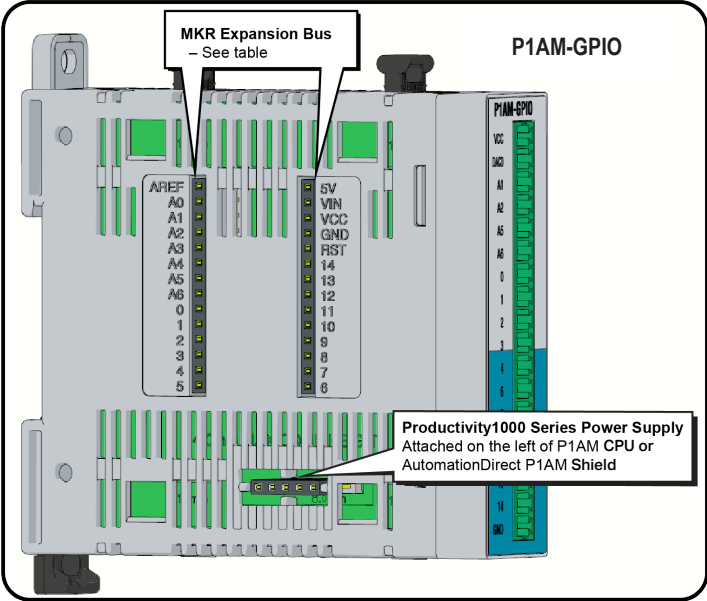


General Specifications	
Operating Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	-20° to 70°C (-4° to 158°F)
Humidity	5 to 95% (non-condensing)
Altitude	2,000 meters, max.
Pollution Degree	2
Overvoltage Category	II
Environmental Air	No corrosive gases permitted
Vibration	IEC60068-2-6 (Test Fc)
Shock	IEC60068-2-27 (Test Ea)
Heat Dissipation	475mW
Enclosure Type	Open Equipment
Module Location	Connects to the left side of the P1AM-100 CPU.
Weight	56g (2.0 oz.)
Agency Approvals	UL 61010-1 and UL 61010-2-201 File E139594, Canada & USA CE

Terminal block connector sold separately. Recommended connector options P2-RTB or P2-RTB-1.

!WARNING!
Do not add or remove modules with field power applied!

AutomationDirect Shields, cont'd



Terminal Block Pins	
Pin	Functions
VCC	3.3 V supply output
DAC0*	GPIO, Analog input, Analog output
A1	GPIO, Analog input, Interrupt
A2	GPIO, Analog input, Interrupt
A5	GPIO, Analog input
A6	GPIO, Analog input
0	GPIO, PWM, Interrupt
1	GPIO, PWM, Interrupt
2	GPIO, PWM
3	GPIO, PWM
4	GPIO, PWM, Interrupt
6	GPIO, PWM, Interrupt
7	GPIO, PWM, Interrupt
11	GPIO, SDA
12	GPIO, SCL
13	GPIO, RX
14	GPIO, TX
GND	Ground

*There is no ESD, overvoltage, or overcurrent protection on the DAC0 pin.

MKR Expansion Bus Pins	
GPIO	A0–A6, 0–14
Analog Input Pins	A0–A6
Analog Output Pins	A0
PWM Pins	0–8, 10, A3, A4
Interrupt Pins	0, 1, 4–8, A1, A2
5V	5V supply output
Vin	5V regulated supply
VCC	3.3 V supply output
GND	Ground
RST	Reset
AREF	Analog Input Reference

Critical Notes:
Pins A3, A4, and 8–10 are used for the base controller.
Do not exceed 46mA combined from pins 0, 1, and 4–10.
Do not exceed 3.3 V on any I/O pin.
Do not exceed 7mA on any I/O pin.
Do not apply power to 5V or VCC

Productivity I/O Modules Overview

A variety of discrete and analog I/O modules from our Productivity1000 line are available for use with the P1AM-100 and P1AM-200.

Productivity1000 Modules		
Discrete Input Modules		
Part Number	Inputs	Description
P1-08SIM	8	Input Simulator Module
P1-08ND3	8	Sinking/Sourcing 12–24 VDC Input
P1-08ND-TTL	8	Sinking/Sourcing 3.3–5 VDC Input
P1-16ND3	16	Sinking/Sourcing 12–24 VDC Input
P1-08NE3	8	Sinking/Sourcing 24V AC/DC
P1-16NE3	16	Sinking/Sourcing 24V AC/DC
P1-08NA	8	AC Isolated 100–240 VAC
Discrete Output Modules		
Part Number	Outputs	Description
P1-08TD1	8	Sinking DC Output
P1-08TD2	8	Sourcing DC Output
P1-08TD-TTL	8	Sourcing DC Output
P1-15TD1	15	Sinking DC Output
P1-15TD2	15	Sourcing DC Output
P1-08TA	8	AC Output
P1-08TRS	8	Isolated Relay Output
P1-16TR	16	Relay Output
Discrete Input/Output Modules		
Part Number	Inputs/ Outputs	Description
P1-15CDD1	8 7	Input: Sinking/Sourcing; Output: Sinking
P1-15CDD2	8 7	Input: Sinking/Sourcing; Output: Sourcing
P1-16CDR	8 8	Input: Sinking/Sourcing; Output: Relay

Productivity1000 Modules		
Analog Input Modules		
Part Number	Inputs	Description
P1-04AD	4	Analog Input (Current)
P1-04AD-1	4	Analog Input (Current)
P1-04AD-2	4	Analog Input (Voltage)
P1-04ADL-1	4	Analog Input (Current)
P1-04ADL-2	4	Analog Input (Voltage)
P1-08ADL-1	8	Analog Input (Current)
P1-08ADL-2	8	Analog Input (Voltage)
P1-04RTD	4	RTD Input
P1-04THM	4	Analog Thermocouple Input
P1-04NTC	4	Analog Thermistor Input
Analog Output Modules		
Part Number	Outputs	Description
P1-04DAL-1	4	Analog Output (Current)
P1-04DAL-2	4	Analog Output (Voltage)
P1-08DAL-1	8	Analog Output (Current)
P1-08DAL-2	8	Analog Output (Voltage)
Analog Input/Output Modules		
Part Number	Inputs/ Outputs	Description
P1-4ADL2DAL-1	4 2	Analog Input/Analog Output (Current)
P1-4ADL2DAL-2	4 2	Analog Input/Analog Output (Voltage)

Details on connecting to the Productivity1000 modules can be found at <https://github.com/facts-engineering/P1AM/wiki>.

The Productivity1000 User Manual contains electrical and installation details. It is available for FREE download at: <https://cdn.automationdirect.com/static/manuals/p1userm/p1userm.html>