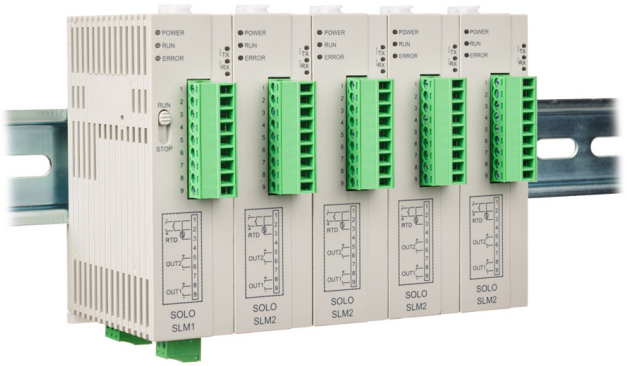
AUTOMATIONDIRECT.com

SOLO

SLM Series
Modular Temperature
Controller
User Manual

Manual Number: SLM-USER-M



WARNING

Thank you for purchasing automation equipment from Automationdirect.com™, doing business as AutomationDirect. We want your new automation equipment to operate safely. Anyone who installs or uses this equipment should read this publication (and any other relevant publications) before installing or operating the equipment.

To minimize the risk of potential safety problems, you should follow all applicable local and national codes that regulate the installation and operation of your equipment. These codes vary from area to area and usually change with time. It is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation is in compliance with the latest revision of these codes.

At a minimum, you should follow all applicable sections of the National Fire Code, National Electrical Code, and the codes of the National Electrical Manufacturer's Association (NEMA). There may be local regulatory or government offices that can also help determine which codes and standards are necessary for safe installation and operation.

Equipment damage or serious injury to personnel can result from the failure to follow all applicable codes and standards. We do not guarantee the products described in this publication are suitable for your particular application, nor do we assume any responsibility for your product design, installation, or operation.

Our products are not fault-tolerant and are not designed, manufactured or intended for use or resale as on-line control equipment in hazardous environments requiring fail-safe performance, such as in the operation of nuclear facilities, aircraft navigation or communication systems, air traffic control, direct life support machines, or weapons systems, in which the failure of the product could lead directly to death, personal injury, or severe physical or environmental damage ("High Risk Activities"). AutomationDirect specifically disclaims any expressed or implied warranty of fitness for High Risk Activities.

For additional warranty and safety information, see the Terms and Conditions section of our catalog. If you have any questions concerning the installation or operation of this equipment, or if you need additional information, please call us at 770-844-4200.

This publication is based on information that was available at the time it was printed. At AutomationDirect we constantly strive to improve our products and services, so we reserve the right to make changes to the products and/or publications at any time without notice and without any obligation. This publication may also discuss features that may not be available in certain revisions of the product.

Trademarks

This publication may contain references to products produced and/or offered by other companies. The product and company names may be trademarked and are the sole property of their respective owners. AutomationDirect disclaims any proprietary interest in the marks and names of others.

AVERTISSEMENT

Nous vous remercions d'avoir acheté l'équipement d'automatisation de Automationdirect.com™, en faisant des affaires comme AutomationDirect. Nous tenons à ce que votre nouvel équipement d'automatisation fonctionne en toute sécurité. Toute personne qui installe ou utilise cet équipement doit lire la présente publication (et toutes les autres publications pertinentes) avant de l'installer ou de l'utiliser.

Afin de réduire au minimum le risque d'éventuels problèmes de sécurité, vous devez respecter tous les codes locaux et nationaux applicables régissant l'installation et le fonctionnement de votre équipement. Ces codes diffèrent d'une région à l'autre et, habituellement, évoluent au fil du temps. Il vous incombe de déterminer les codes à respecter et de vous assurer que l'équipement, l'installation et le fonctionnement sont conformes aux exigences de la version la plus récente de ces codes.

Vous devez, à tout le moins, respecter toutes les sections applicables du Code national de prévention des incendies, du Code national de l'électricité et des codes de la National Electrical Manufacturer's Association (NEMA). Des organismes de réglementation ou des services gouvernementaux locaux peuvent également vous aider à déterminer les codes ainsi que les normes à respecter pour assurer une installation et un fonctionnement sûrs.

L'omission de respecter la totalité des codes et des normes applicables peut entraîner des dommages à l'équipement ou causer de graves blessures au personnel. Nous ne garantissons pas que les produits décrits dans cette publication conviennent à votre application particulière et nous n'assumons aucune responsabilité à l'égard de la conception, de l'installation ou du fonctionnement de votre produit.

Nos produits ne sont pas insensibles aux défaillances et ne sont ni conçus ni fabriqués pour l'utilisation ou la revente en tant qu'équipement de commande en ligne dans des environnements dangereux nécessitant une sécurité absolue, par exemple, l'exploitation d'installations nucléaires, les systèmes de navigation aérienne ou de communication, le contrôle de la circulation aérienne, les équipements de survie ou les systèmes d'armes, pour lesquels la défaillance du produit peut provoquer la mort, des blessures corporelles ou de graves dommages matériels ou environnementaux («activités à risque élevé»). La société AutomationDirect nie toute garantie expresse ou implicite d'aptitude à l'emploi en ce qui a trait aux activités à risque élevé.

Pour des renseignements additionnels touchant la garantie et la sécurité, veuillez consulter la section Modalités et conditions de notre documentation. Si vous avez des questions au sujet de l'installation ou du fonctionnement de cet équipement, ou encore si vous avez besoin de renseignements supplémentaires, n'hésitez pas à nous téléphoner au 770-844-4200.

Cette publication s'appuie sur l'information qui était disponible au moment de l'impression. À la société AutomationDirect, nous nous efforçons constamment d'améliorer nos produits et services. C'est pourquoi nous nous réservons le droit d'apporter des modifications aux produits ou aux publications en tout temps, sans préavis ni quelque obligation que ce soit. La présente publication peut aussi porter sur des caractéristiques susceptibles de ne pas être offertes dans certaines versions révisées du produit.

Marques de commerce

La présente publication peut contenir des références à des produits fabriqués ou offerts par d'autres entreprises. Les désignations des produits et des entreprises peuvent être des marques de commerce et appartiennent exclusivement à leurs propriétaires respectifs. AutomationDirect nie tout intérêt dans les autres marques et désignations.

SOLO SLM Series Modular Temperature Controller User Manual

Please include the Manual Number and the Manual Issue, both shown below, when communicating with Technical Support regarding this publication.

Manual Number: SLM-USER-M
Issue: 1st Edition
Issue Date: 07/2023

Publication History		
Issue	**Date**	**Description of Changes**
First Edition	07/2023	Original Issue

TABLE OF CONTENTS

Chapter 1
Getting Started

In this Chapter...

Manual Overview

Overview of this Publication

The SOLO Modular Temperature Controller User Manual describes the installation, configuration, and methods of operation of the SOLO Modular Temperature Controller.

Who Should Read This Manual

This manual contains important information for those who will install, maintain, and/or operate any of the SOLO Modular Temperature Controllers.

Technical Support

By Telephone: 770-844-4200
(Mon.-Fri., 9:00 a.m.-6:00 p.m. E.T.)
On the Web: support.automationdirect.com

Our technical support group is glad to work with you in answering your questions. If you cannot find the solution to your particular application, or, if for any reason you need additional technical assistance, please call technical support at **770-844-4200**. We are available weekdays from 9:00 a.m. to 6:00 p.m. Eastern Time.

We also encourage you to visit our web site where you can find technical and non-technical information about our products and our company. Visit us at **www.automationdirect.com**.

Supplemental Manuals

If you are familiar with industrial control type devices, you may be able to get up and running with just the aide of the Quick Start Guide that is included with each SOLO Modular Temperature Controller.

Special Symbols

When you see the "notepad" icon in the left-hand margin, the paragraph to its immediate right will be a special note.

When you see the "exclamation mark" icon in the left-hand margin, the paragraph to its immediate right will be a warning. This information could prevent injury, loss of property, or even death (in extreme cases).

SOLO Modular Temperature Controller Introduction

General Description

The SOLO Modular Temperature Controller is a single loop dual output temperature controller that can control both heating and cooling simultaneously. There are four types of control modes: PID, ON / OFF, Manual, and Ramp / Soak control. Depending upon the particular model of controller, the available outputs include relay, voltage pulse, current, and linear voltage. There are up to two alarm outputs available to allow twelve alarm types in the initial setting mode. SOLO Modular can accept various types of thermocouple, RTD, or analog inputs, and has a built in RS-485 interface using Modbus slave (ASCII or RTU) communication protocol. SOLO Modular SLM1 units provide communication and power terminals to the SLM2 units connected to the SLM1 SOLO Modular unit.

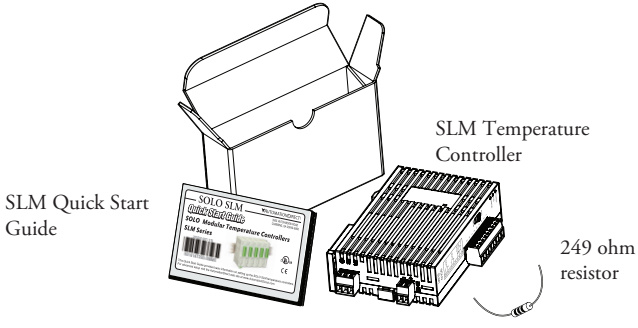
Other features include:

- Auto Tuning (AT) function with PID control
- Process variable retransmission on current and linear voltage models
- DIN rail mountable
- LEDs for indication and diagnostics
- Easy configuration using SL-SOFT SOLO configuration software or Modbus communications
- Selectable between °C and °F
- cULus and CE agency approvals

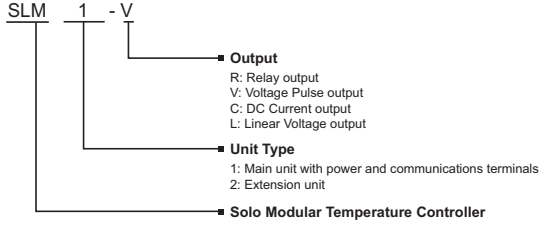
Unpacking

After receiving the SOLO Modular Temperature Controller, please check for the following:

- Make sure that the package includes the Controller, a 249 ohm resistor and the Quick Start Guide.
- Inspect the unit to insure it was not damaged during shipment.
- Make sure that the part number indicated on the serial number label corresponds with the part number of your order.



Model Number Explanation



SOLO Modular Temperature Controller Specifications

Specifications	
Operating Voltage Range	21.6 to 26.4 VDC
Power Consumption	5 VA Max
Control Mode	PID, ON/OFF, Ramp / Soak control or Manual
Vibration Resistance	10 to 55 Hz, 10 m/s^2 for 10 min, each in X, Y and Z directions
Shock Resistance	Max. 300 m/s^2, 3 times in each 3 axes, 6 directions
Ambient Temperature Range	32°F to 122°F (0°C to 50°C)
Storage Temperature Range	-4°F to 149°F (-20°C to 65°C)
Altitude	2000m or less
Relative Humidity	35% to 80% (non-condensing)
RS-485 Communication	Modbus slave ASCII / RTU protocol
Transmission Speed	2400, 4800, 9600, 19.2K, 38.4K bps
Agency Approvals	cULus, CE (UL file number E311366)
Pollution Degree	Degree 2 - Normally, only non-conductive pollution occurs. Temporary conductivity caused by condensation is to be expected
Input Types	
• Thermocouple*	K, J, T, E, N, R, S, B, L, U, TXK
• Platinum RTD	3-wire Pt100, JPt100
• Analog	0-50 mV, 0-5V, 0-10V, 0-20 mA, 4-20 mA (sinking) (Current input requires the installation of the supplied 249 Ω resistor)
Input Accuracy	
• Thermocouple*	± 0.3% full scale
• Platinum RTD	± 0.2% full scale
• Analog	± 0.3% full scale ± 1 digit
Input Sampling Rates	
• Thermocouple	400ms / per scan
• Platinum RTD	400ms / per scan
• Analog	150ms / per scan
Control Output Options	
• Relay (R)	3A @ 250VAC
• Voltage Pulse (V)	DC 12V Max, output current 40mA Max
• Current (C)	DC 4-20 mA output (sourcing) (Load resistance: Max 500Ω)
• Linear Voltage (L)	DC 0-10V (Load resistance Min 1KΩ)
***Note: Use only ungrounded thermocouples.**	

Installation and Wiring

In this Chapter...

Installation Considerations

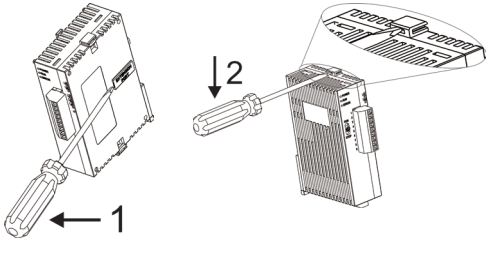
Improper installation of the controller will greatly reduce its life. Be sure to observe the following precautions when selecting a mounting location:

Warning: Failure to observe these precautions may damage the controller and void the warranty!

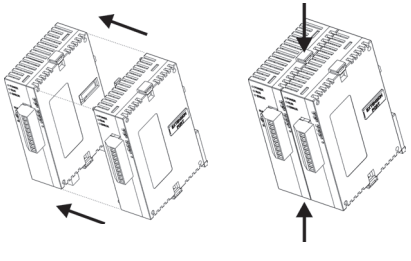
- Do not mount the controller near heat-radiating elements.
- Do not install the controller in a place subjected to high temperature, high humidity, excessive vibration, corrosive gases or liquids, or airborne dust or metallic particles.
- Do not restrict the air flow to the vent opening on the controller housing
- This controller is an open-type unit and must be placed in an enclosure to ensure proper operation and protection.

Mounting Instructions

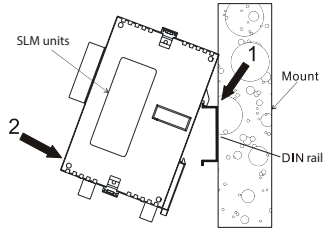
1. When adding additional units remove the dust cover from the modular expansion port.
2. Lift the top and bottom retention clips.



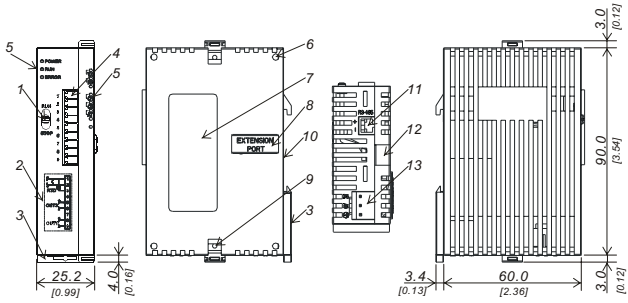
Connect expansion unit and press the top and bottom retention clips in to hold the exapnsion unit in place.



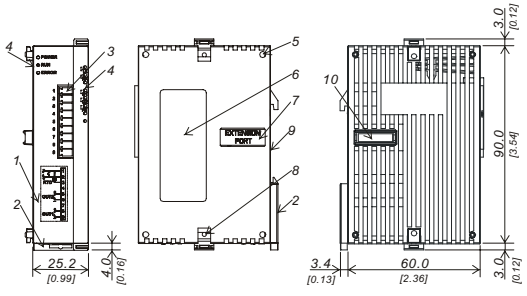
1. Place SLM unit onto the DIN rail.
2. Lower and press firmly at the base of the unit until the DIN clip engages.



Controller Dimensions



SLM1



SLM2

	SLM1	SLM2
1	RUN/STOP switch	Wiring and Model name
2	Wiring and Model name	DIN rail clip
3	DIN rail clip	I/O terminals
4	I/O terminals	LED indicators
5	LED indicators	Mounting hole
6	Mounting hole	Specification label
7	Specification label	Extension port
8	Extension port	Extension clip
9	Extension clip	DIN rail
10	DIN rail	Extension port
11	RS-485 communication port	N/A
12	Extension clip	N/A
13	DC power input	N/A

Safety Information

DANGER!

Warning: To minimize the risk of potential safety problems, you should follow all applicable local and national codes that regulate the installation and operation of your equipment. These codes vary from area to area and it is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation are in compliance with the latest revision of these codes

Warning: To prevent electric shock, do not touch the terminals while power is supplied to the controller.

Warning: This controller is an open-type temperature controller, make sure to evaluate any dangerous application in which a serious human injury or serious property damage may occur.

Wiring Notes: PLEASE READ PRIOR TO INSTALLATION.

Equipment damage or serious injury to personnel can result from the failure to follow all applicable codes and standards. We do not guarantee the products described in this publication are suitable for your particular application, nor do we assume any responsibility for your product design, installation, or operation.

If you have any questions concerning the installation or operation of this equipment, or if you need additional information, please call us at 1-800-633-0405 or 770-844-4200.

This publication is based on information that was available at the time it was printed. At Automationdirect.com® we constantly strive to improve our products and services, so we reserve the right to make changes to the products and/or publications at any time without notice and without obligation. This publication may also discuss features that may not be available in certain revisions of the product.

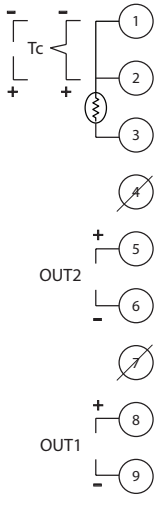
1. Be sure to tighten terminals to the correct torque of 0.19 Nm. Use solid or twisted wire from 14AWG to 28AWG.
2. Protect the controller from dust or foreign objects as they can cause the controller to malfunction.
3. Never modify or disassemble the controller.
4. Do not connect anything to the unused terminals.
5. Make sure all wires are connected to the correct polarity of terminals.
6. Do not install and/or use the controller in places subject to: (a) Dust or corrosive gases and liquid (b) High humidity (c) Vibration or shock (d) EMI / RFI (e) high temperature.
7. Power must be turned off when wiring, installing or uninstalling expansion modules (SLM2), or changing a sensor.

Safety Information, cont'd

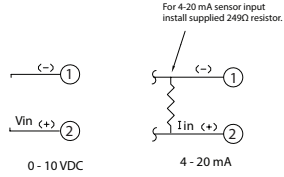
8. Be sure to use wires that match the thermocouple types when extending or connecting thermocouple wires.
9. Use wires with correct resistance when extending or connecting a RTD.
10. Keep the wire as short as possible when wiring a RTD to the controller and route power wires as far as possible from sensor wires to prevent interference and induced noise.
11. This controller is an open-type unit and must be placed in an enclosure to ensure proper operation and protection.
12. Make sure power cables and signals from instruments are all installed properly before energizing the controller, otherwise serious damage may occur.
13. To prevent electric shock, do not touch the terminals on the controller or try to repair the controller when power is applied.
14. Do not use acid or alkaline liquids for cleaning. Use a soft, dry cloth to clean the controller.
15. This instrument is not furnished with a power switch or fuse. Therefore, if a fuse or power switch is required, install the protection close to the instrument. Recommended fuse rating: Rated voltage 250 V, Rated current 1 A. Fuse type: Time-delay fuse. See the AutomationDirect catalog for the appropriate fuse for the specific application.
16. Note: This controller does not provide overcurrent protection. Use of this product requires that suitable overcurrent protection device(s) must be added to ensure compliance with all relevant electrical standards and codes. (Rated 250 V, 15 Amps max). A suitable disconnecting device should be provided near the controller in the end-use installation.

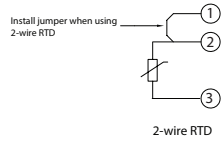
Terminal Identification

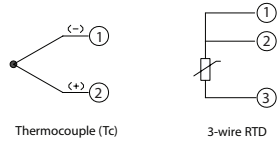
Input and Outputs (SLM1 & SLM2 Front Terminals)



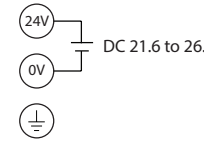
Sensor Input







Power Input (SLM1 Bottom Terminals)



RS-485 (SLM1 Bottom Terminals)

LED Display and Setup Parameters

In this Chapter...

LED Display

1. When power is normal, POWER LED will be on.
2. After SLM is switched on, all LEDs will be on. The communication protocol will be displayed for one second. See table below for LED values.
3. RUN LED is on when the controller is active.
4. ERROR LED is on when errors occur in input, memory or communication.
5. When an output is active, its corresponding output LED will be on.
6. AT LED flashes when PID parameters are being auto-tuned.
7. RX LED flashes when SLM receives communication signals. TX LED flashes when SLM sends out communication signals. Communication protocol displayed on the LEDs after the power to the SLM is switched on:

LED	Baud Rate				
	2400	4800	9600	19,200	38,400
AT	Off	Off	Off	Off	On
TX	Off	Off	On	On	Off
RX	Off	On	Off	On	Off

LED	Parity		
	None	Even	Odd
01	Off	Off	On
02	Off	On	Off

LED	Modbus Format	
	ASCII	RTU
Err	Off	On

LED	Stop Bits	
	2	1
RUN	Off	On

Parameter List

Parameter Availablity													
		Controller Type				Control Mode				Heating / Cooling			
ID #	Parameter Name	R	V	C	L	PID	ON /OFF	Manual	Ramp / Soak	Heating	Cooling	Heating / Cooling	Cooling / Heating
P1-1	Auto Tuning	✓	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓
P1-4	Proportion Band	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓
P1-5	Integral Time	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓
P1-6	Derivative Time	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓
P1-7	PD Control Offset	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓
P1-8	Integral Offset	✓	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓
P1-9	Heating Hysteresis	✓	✓	✓	✓	-	✓	-	-	✓	-	✓	✓
P1-10	Cooling Hysteresis	✓	✓	✓	✓	-	✓	-	-	-	✓	✓	✓
P1-11	Output 1 Heating Period	✓	✓	✓	✓	✓	-	✓	✓	✓	-	✓	-
P1-12	Output 1 Cooling Period	✓	✓	✓	✓	✓	-	✓	✓	-	✓	-	✓
P1-13	Output 2 Period	✓	✓	✓	✓	✓	-	✓	✓	-	-	✓	✓
P1-14	Proportion Band Coefficient	✓	✓	✓	✓	✓	-	-	✓	-	-	✓	✓
P1-15	Dead Band	✓	✓	✓	✓	✓	✓	-	✓	-	-	✓	✓
P1-16	PV Offset	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P1-17	Analog High Adjustment	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P1-18	Analog Low Adjustment	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P2-1	Run / Stop	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P2-2	Starting Ramp / Soak Pattern	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓

Parameter Availablity													
		Controller Type				Control Mode				Heating / Cooling			
ID #	Parameter Name	R	V	C	L	PID	ON /OFF	Manual	Ramp / Soak	Heating	Cooling	Heating / Cooling	Cooling / Heating
P2-4	Alarm 1 High Limit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P2-5	Alarm 1 Low Limit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P2-6	Alarm 2 High Limit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P2-7	Alarm 2 Low Limit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P2-11	Output 1 Level	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
P2-12	Output 2 Level	✓	✓	✓	✓	✓	-	✓	✓	-	-	✓	✓
P3-1	Input Type	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-2	Temperature Unit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-3	Input Range High	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-4	Input Range Low	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-5	Control Mode	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-6	Ramp / Soak Pattern*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-7	Heating / Cooling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-8	Alarm 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-9	Alarm 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-13	Modbus Protocol	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-14	Network Address	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Parameter Availablity													
		Controller Type				Control Mode				Heating / Cooling			
ID #	Parameter Name	R	V	C	L	PID	ON /OFF	Manual	Ramp / Soak	Heating	Cooling	Heating / Cooling	Cooling / Heating
P3-15	Baud Rate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-16	Bit Length	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-17	Parity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P3-18	Stop Bit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
***Once a Ramp / Soak pattern (P3-6) is selected, the following parameters are available.**													
P3-19	Ramp / Soak SV	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓
P3-20	Ramp / Soak Time	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓
P3-21	Last Step Number	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓
P3-22	Additional Cycles	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓
P3-23	Next Pattern Number	✓	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓

Note: Segmented display symbols are displayed in software and used for reference in this manual.

Auto Tuning — ID Number P1-1

Range: On - Auto Tuning activated
Off - Auto Tuning deactivated

When this parameter is set to On, the controller begins auto tuning. After auto tuning is complete, the parameter is set to Off automatically. If this parameter is set to Off during the auto tuning process, the controller stops the auto tuning process immediately and does not change any PID parameter.

Proportion Band — ID Number P1-4

This parameter name will be displayed in SL-SOFT as:

Proportion Band of PID

Range: 0.1 to 999.9

The Proportion Band is a parameter used for PID control.

The parameter is the Proportion Band of the PID

Integral Time — ID Number P1-5

This parameter name will be displayed in SL-SOFT as:

Integral Time of PID Parameter

Range: 0 to 9999 (Sec)

The Integral Time is a parameter used for PID control.

The parameter is the Integral Time of the PID.

Derivative Time — ID Number P1-6

This parameter name will be displayed in SL-SOFT as:

Derivative Time of PID Parameter

Range: 0 to 9999 (Sec)

The Derivative Time is a parameter used for PID control.

The parameter is the Derivative Time of the PID.

PdoF **PD Control Offset** **ID Number P1-7**

Range: 0.0 to 100.0 (%)

The PD Control Offset parameter is available when the P or PD control is selected [Integral Time parameter is zero].

This parameter defines the offset of the output. When the P or PD control is used, the control cannot stabilize the PV at the SV because the output is zero when the PV is equal to the SV. This parameter modifies the output level when the PV is equal to the SV.

IoF3 **Integral Offset** **ID Number P1-8**

This parameter name will be displayed as one of the following.

IoF3 Integral Offset of PID Parameter

Range: 0.0 to 100.0 (%)

The Integral Offset parameter is available when the PI or PID control is selected. [Integral Time parameter (P1-5) is not zero.]

The Auto Tuning process will decide the offset value automatically.

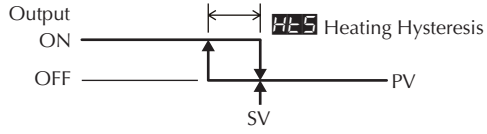
If this parameter is not used (IoF = 0), the output is zero when the PV is equal to the SV. If the Integral Time parameter (, P1-5) is used only to eliminate the steady error, it may take a long time to reach the SV because it needs time to accumulate the error. In this case, this parameter is useful. This parameter defines the default output level on start up. It will improve the speed that the PV reaches the SV.

The parameter IoF is the Integral Offset of the PID.

HES **Heating Hysteresis** **ID Number P1-9**

Range: 0.0 to 999.9

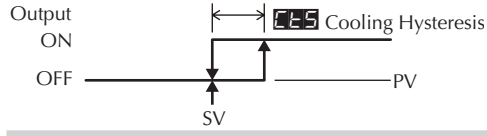
The Heating Hysteresis parameter defines the amount that the PV must go below the SV before the output turns on. This parameter is available only for On / Off control with an output programmed for heating.



CES **Cooling Hysteresis** **ID Number P1-10**

Range: 0.0 to 999.9

The Cooling Hysteresis parameter defines the amount that the PV must go above the SV before the output turns on. This parameter is available only for On / Off control with an output programmed for cooling.



HtPd **Output 1 Heating Period** **ID Number P1-11**

Range: 0.5 to 99 seconds

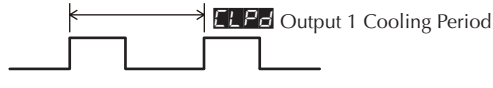
The Output 1 Heating parameter defines one output period or the duration of one on / off cycle for Output 1.

This parameter is available when Output 1 is programmed as a heating output in the PID or Ramp / Soak mode.

CLPd **Output 1 Cooling Period** **ID Number P1-12**

Range: 0.5 to 99 seconds

The Output 1 Cooling parameter defines one output period or the duration of one on / off cycle for Output 1.

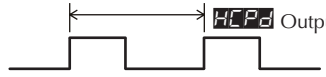


This parameter is available when Output 1 is programmed as a cooling output in the PID or Ramp / Soak mode.

HCPd Output 2 Period — ID Number P1-13

Range: 0.5 to 99 seconds

The Output 1 Cooling parameter defines one output period or the duration of one on / off cycle for Output 2.



This parameter is available when Output 2 is programmed as a heating or cooling output in the PID or Ramp / Soak mode.

CoEF Proportion Band Coefficient — ID Number P1-14

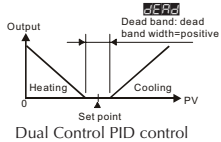
Range: 0.01 to 99.99

This Proportion Band Coefficient parameter is available when a dual output mode (heating and cooling) is selected. This parameter allows the second output control to have a different proportional setting than the first output control. The first output control proportional band setting is multiplied by this parameter to create a proportional band setting for the second output control.

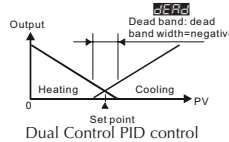
(First Output) Proportion Band * Proportion Band Coefficient = Second Proportional Band
(P1-4) (P1-14)

dEAd Dead Band — ID Number P1-15

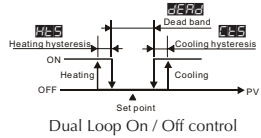
The dead band zone is the area around the SV where the output is not effected by the proportional control value (PV). For PID control, as long as the PV remains within the dead band zone, the output is not affected by the proportional control. The integral and derivative controls ignore the dead band setting and may cause the output to be on within the dead band zone.



Dual Control PID control positive dead band



Dual Control PID control negative dead band



Dual Loop On / Off control output operation

tPoF **PV Offset** **ID Number P1-16**

This parameter is used to add an offset value to the PV.

CrHC **Analog High Adjustment** **ID Number P1-17**

The Analog High Adjustment parameter is used to adjust the actual analog output value when the output is 100%. To set up this parameter, place the SOLO Modular controller in the Manual control mode and set the Output 1 Level (**out 1**, P2-11) to 100% then increase / decrease the parameter value to get the desired analog output value.

The tables below show the approximate Analog High Adjustment values needed to obtain the desired output value. The actual controller output will vary. Check and adjust the values until the desired output level is achieved.

Current Output

	0mA	1mA	2mA	3mA	4mA	5mA	6mA	7mA
CrHC	-7198	-6838	-6478	-6118	-5758	-5398	-5038	-4678
	8mA	9mA	10mA	11mA	12mA	13mA	14mA	15mA
CrHC	-4319	-3959	-3599	-3239	-2879	-2519	-2159	-1799
	16mA	17mA	18mA	19mA	20mA			
CrHC	-1440	-1080	-720	-360	0			

Voltage Output

	0V	1V	2V	3V	4V	5V	6V	7V
CrHC	-7589	-6830	-6071	-5312	-4553	-3795	-3036	-2277
	8V	9V	10V					
CrHC	-1518	-758	0					

Note: The output may be saturated before it reaches the minimum or maximum value.

This parameter is available when Output 1 is Current or Linear Voltage.

CrLo **Analog Low Adjustment** **ID Number P1-18**

The Analog Low Adjustment parameter is used to adjust the actual analog output value when the output is 0%. To set up this parameter, place the SOLO controller in the Manual control mode and set the Output 1 Level (**out 1**, P2-11) to 0% then increase / decrease the parameter value to get the desired analog output value.

The tables below show the approximate Analog Low Adjustment values needed to obtain the desired output value. The actual controller output will vary. Check and adjust the values until the desired output level is achieved.

Current Output								
	0mA	1mA	2mA	3mA	4mA	5mA	6mA	7mA
CrLo	-1440	-1080	-720	-360	0	360	720	1080
	8mA	9mA	10mA	11mA	12mA	13mA	14mA	15mA
CrLo	1440	1799	2159	2519	2879	3239	3599	3959
	16mA	17mA	18mA	19mA	20mA			
CrLo	4319	4678	5038	5398	5758			

Voltage Output								
	0V	1V	2V	3V	4V	5V	6V	7V
CrLo	0	759	1518	2277	3036	3795	4553	5312
	8V	9V	10V					
CrLo	6071	6830	7589					

Note: The output may be saturated before it reaches the minimum or maximum value.

This parameter is available when Output 1 is Current or Linear Voltage.

r-S **Run / Stop** **ID Number P2-1**

The Run / Stop parameter is used to control the operational status of the SOLO Modular Controller.

Run mode

Stop mode

Ramp / Soak control is on hold. The controller keeps the current Ramp / Soak step number and time. Ramp / Soak control continues when the mode is changed to Run.

Ramp / Soak control is stopped. The controller restarts the Ramp / Soak control at the first step when the mode is changed to Run.

Starting Ramp / Soak Pattern **ID Number P2-2**

Range: 0 to 7

Select the Ramp / Soak pattern number to start the Ramp / Soak control.

AL 1H **Alarm 1 High Limit** **ID Number P2-4**

This parameter is used to set the high limit for Alarm 1. The range varies according to other parameter values.

AL 1L **Alarm 1 Low Limit** **ID Number P2-5**

This parameter is used to set the low limit for Alarm 1. The range varies according to other parameter values.

AL2H **Alarm 2 High Limit** **ID Number P2-6**

This parameter is used to set the high limit for Alarm 2. The range varies according to other parameter values.

AL2L **Alarm 2 Low Limit** **ID Number P2-7**

This parameter is used to set the low limit for Alarm 2. The range varies according to other parameter values.

out 1 **Output 1 Level** **ID Number P2-11**

Range: 0.0 to 100 (%)

The value for this parameter can be changed in the Manual control mode. In other control modes, this parameter is read-only.

out2 **Output 2 Level** **ID Number P2-12**

Range: 0.0 to 100 (%)

This parameter is available when Output 2 is used. The value for this parameter can be changed in the Manual control mode. In other control modes, this parameter is read-only.

InPt **Input Type** **ID Number P3-1**

This parameter defines the input signal type.

Thermocouple* Type and Temperature Range	
Input Temperature Sensor Type	**Temperature Range**
Thermocouple TXK type	-328 ~ 1472°F (-200 ~ 800°C)
Thermocouple U type	-328 ~ 932°F (-200 ~ 500°C)
Thermocouple L type	-328 ~ 1562°F (-200 ~ 850°C)
Thermocouple B type	212 ~ 3272°F (100 ~ 1800°C)
Thermocouple S type	32 ~ 3092°F (0 ~ 1700°C)
Thermocouple R type	32 ~ 3092°F (0 ~ 1700°C)
Thermocouple N type	-328 ~ 2372°F (-200 ~ 1300°C)
Thermocouple E type	32 ~ 1112°F (0 ~ 600°C)
Thermocouple T type	-328 ~ 752°F (-200 ~ 400°C)
Thermocouple J type	-148 ~ 2192°F (-100 ~ 1200°C)
Thermocouple K type	-328 ~ 2372°F (-200 ~ 1300°C)
RTD Type and Temperature Range	
Input Temperature Sensor Type	**Temperature Range**
Platinum Resistance (Pt100)	-328 ~ 1112°F (-200 ~ 600°C)
Platinum Resistance (JPt100)	-4 ~ 752°F (-20 ~ 400°C)
Voltage Input Type and Input Range	
Voltage Input Type	**Engineering Range**
0~50mV Analog Input	-999 ~ 9999
0V~10V Analog Input	-999 ~ 9999
0V~5V Analog Input	-999 ~ 9999
Current Input Type and Input Range	
Current Input Type	**Engineering Range**
4~20mA Analog Input	-999 ~ 9999
0~20mA Analog Input	-999 ~ 9999
***Note - Use only ungrounded thermocouples**	

Temperature Unit **ID Number P3-2**

Range: F, C

This parameter is available when the parameter Input Type is a thermocouple or RTD.

iP-H **Input Range High** **ID Number P3-3**

Range: From the value of Input Range Low to 9999.

This parameter defines the high limit of the PV. This is the maximum value of the operational temperature range. In operation, if the PV value is higher than the iP-H value, th PV flashes to indicate an error and the controller outputs shut off. The SV value cannot exceed the iP-H value. This parameter cannot be lower than the Input Range Low parameter (iP-L, P3-4).

iP-L **Input Range Low** **ID Number P3-4**

Range: From -999 to the value of Input Range High.

This parameter defines the low limit of the PV. This is the minimum value of the operational temperature range. In operation, if the PV value is lower than the iP-L value, th PV flashes to indicate an error and the controller outputs shut off. The SV value cannot be set lower than the iP-L value. This parameter cannot be higher than the Input Range High parameter (iP-H, P3-3).

Ctrl **Control Mode** **ID Number P3-5**

Range: PID control mode
On / Off control mode
Manual control mode
Ramp / Soak control mode

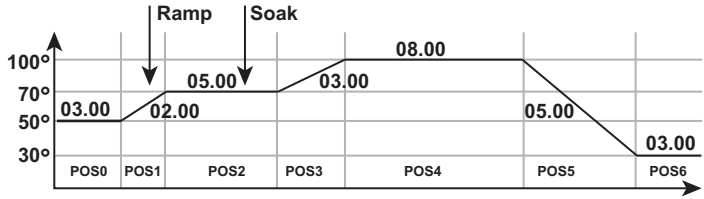
This parameter is used to select one of the control modes. See Chapter 5 for a complete description of each control mode.

Ramp / Soak Pattern **ID Number P3-6**

Range: oFF Ramp / Soak pattern is not selected.
0 to 7 Ramp / Soak pattern number.

This parameter is used to select the appropriate Ramp / Soak pattern number for setting up it's individual parameters.

Below is an example of a typical Ramp / Soak Pattern.



Step00 = 50°
Time00 = 3 hrs 00 min.
Step01 = 70°
Time01 = 2 hrs 00 min.
Step02 = 70°
Time02 = 5 hrs 00 min.

Step03 = 100°
Time03 = 3 hrs 00 min.
Step04 = 100°
Time04 = 8 hrs 00 min.
Step05 = 30°
Time05 = 5 hrs 00 min.

Step06 = 30°
Time06 = 3 hrs 00 min.
Process Step = 6
Cycle times = 0
Link = OFF

Alarm 1 **ID Number P3-8**
Alarm 2 **ID Number P3-9**

Range: 0 to 12

The SOLO Modular controllers support 2 alarm outputs. The Alarm1 and Alarm2 parameters are used to select the alarm type. Refer to Chapter 4 for details.

Communication Parameters

Modbus Protocol **ID Number P3-13**

Range: Modbus ASCII
Modbus RTU

Network Address **ID Number P3-14**

Range: 1 to 247

This is the Modbus network address of the SOLO Controller.

Note: Each controller on the same network must have a unique Modbus network address

Baud Rate **ID Number P3-15**

Range: 2400 bps
4800 bps
9600 bps
19200 bps
38400 bps

Bit Length **ID Number P3-16**

Range: 7, 8

Parity **ID Number P3-17**

Range: None, Even, Odd

Stop Bit **ID Number P3-18**

Range: 1, 2

Ramp / Soak Parameters

Ramp / Soak SV **ID Number P3-19**

Range: -99.9 to 999.9

This parameter is the set point value (SV) of each Ramp / Soak step.

Ramp / Soak Time **ID Number P3-20**

Range: 00.00 to 15.00 (0 to 15 hours) [Format: hours.minutes]

This parameter is the time duration of each Ramp / Soak step.

Last Step Number **ID Number P3-21**

Range: 0 to 7

Each Ramp / Soak pattern can have up to seven steps. This parameter is the last step number that is to be used in the Ramp / Soak pattern. When the parameter value is set to 0, the SOLO Modular controller executes only step 0 when the Ramp / Soak pattern is selected. When the value is 7, the controller executes step 0 through step 7 when the Ramp / Soak pattern is selected.

Additional Cycles **ID Number P3-22**

Range: 0 to 199

As the default, the SOLO Modular controller executes a Ramp /Soak pattern only once. Use this parameter to set the number of additional times a Ramp / Soak pattern will execute. When the parameter value is set to 0, the SOLO controller executes the Ramp / Soak pattern one time. When this parameter value is 2, the Ramp / Soak pattern will execute two additional times for a total of three executions.

Next Pattern Number **ID Number P3-22**

Range: 0 to 7, OFF

This parameter is used to select a Ramp / Soak pattern that will execute after the current Ramp / Soak pattern is completed. If the parameter value is set to OFF, the SOLO Modular controller will not begin another Ramp / Soak pattern after the current pattern.

Reset to Factory Default

Note: Resetting the Temperature Controller back to factory default erases all of the values entered by the user. Record any necessary settings before proceeding

Warning: Erasing the user entered values may result in a safety hazard and system malfunction.

SL-SOFT software has a reset to defaults button that is available after connecting to a controller. Click the "Reset to Defaults" button and follow the instructions on the screen to reset the controller to defaults.

Controller Inputs and Outputs

In this Chapter...

Control Input Types

Thermocouple or RTD Input

The SOLO Modular temperature controller can accept input from eleven types of thermocouples and two types of Platinum RTD sensors. Select the sensor type by using the parameter Input Type (InPt, P3-1).

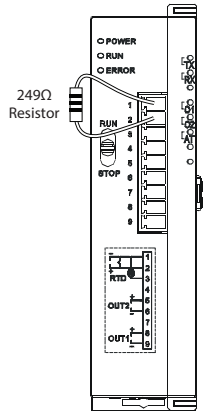
Thermocouple* Type and Temperature Range	
Input Temperature Sensor Type	**Temperature Range**
Thermocouple TXK type	-328 ~ 1472°F (-200 ~ 800°C)
Thermocouple U type	-328 ~ 932°F (-200 ~ 500°C)
Thermocouple L type	-328 ~ 1562°F (-200 ~ 850°C)
Thermocouple B type	212 ~ 3272°F (100 ~ 1800°C)
Thermocouple S type	32 ~ 3092°F (0 ~ 1700°C)
Thermocouple R type	32 ~ 3092°F (0 ~ 1700°C)
Thermocouple N type	-328 ~ 2372°F (-200 ~ 1300°C)
Thermocouple E type	32 ~ 1112°F (0 ~ 600°C)
Thermocouple T type	-328 ~ 752°F (-200 ~ 400°C)
Thermocouple J type	-148 ~ 2192°F (-100 ~ 1200°C)
Thermocouple K type	-328 ~ 2372°F (-200 ~ 1300°C)
RTD Type and Temperature Range	
Input Temperature Sensor Type	**Temperature Range**
Platinum Resistance (Pt100)	-328 ~ 1112°F (-200 ~ 600°C)
Platinum Resistance (JPt100)	-4 ~ 752°F (-20 ~ 400°C)
***Note - Use only ungrounded thermocouples**	

Analog Input

The SOLO Modular temperature controller can accept input from the following analog input sources. Select the output type by using the parameter Input Type.

Voltage Input Type and Input Range	
Voltage Input Type	**Engineering Range**
0~50mV Analog Input	-999 ~ 9999
0V~10V Analog Input	-999 ~ 9999
0V~5V Analog Input	-999 ~ 9999
Current Input Type and Input Range*	
Current Input Type	**Engineering Range**
4~20mA Analog Input	-999 ~ 9999
0~20mA Analog Input	-999 ~ 9999

**Note: For Current Input operation, the supplied 249 Ω resistor should be installed as shown on page 4-3.*



Control Output Types

The SOLO Modular temperature controller supports four types of control outputs depending on the model chosen. The available outputs are Relay, Voltage Pulse, Current and Linear Voltage as shown in the controller part number.

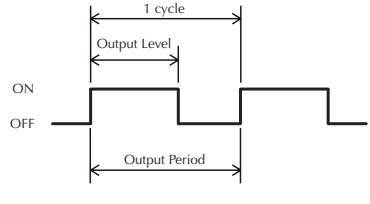
SLM1 - V

Output
R: Relay output
V: Voltage Pulse output
C: DC Current output
L: Linear Voltage output

Relay Output

The relay used for the relay output is rated at a maximum 250 VAC and 3A resistive load. The electrical life expectancy is 100,000 operations.

The operation cycle of the Relay output is controlled by two factors, Output Level and Output Period.



For example, when the Output Level is 60% and the Output Period is 10 seconds, the output relay is turned on for 6 seconds in the cycle.

There are five parameters that define these two factors.

Output Level

Output 1 Level (OUt1, P2-11) Range: 0.0 to 100%
Output 2 Level (OUt2, P2-12) Range: 0.0 to 100%

Output Period

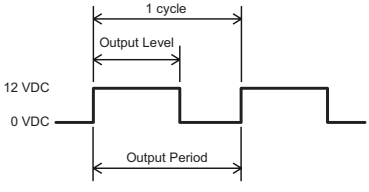
Output 1 Heating Period (HtPd, P1-11) Range: 0.5 to 99 seconds
Output 1 Cooling Period (CtPd, P1-12) Range: 0.5 to 99 seconds
Output 2 Period (HCPd, P1-13) Range: 0.5 to 99 seconds

Note: The electrical life expectancy of the relay output is 100,000 cycles. To maximize the life of the relay output, set a longer time value for the Output Period.

Voltage Pulse Output

The Voltage Pulse output generates 40 mA pulses. The pulse high level is 12 VDC and the low level is 0VDC.

The operation cycle of the Voltage Pulse output is controlled by two factors, Output Level and Output Period.



For example, when the Output Level is 60% and the Output Period is 10 seconds, the Voltage Pulse output is turned on for 6 seconds in the cycle.

There are five parameters that define these two factors.

Output Level

Output 1 Level (OUt1, P2-11) Range: 0.0 to 100%
Output 2 Level (OUt2, P2-12) Range: 0.0 to 100%

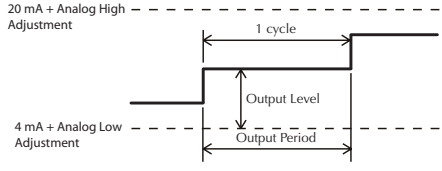
Output Period

Output 1 Heating Period (HtPd, P1-11) Range: 0.5 to 99 seconds
Output 1 Cooling Period (CtPd, P1-12) Range: 0.5 to 99 seconds
Output 2 Period (HCPd, P1-13) Range: 0.5 to 99 seconds

Current Output

The Current output generates analog DC current with a range of 4-20 mA. The maximum load resistance is 500 Ω

The output current is controlled by four factors, Analog High Adjustment, Analog Low Adjustment, Output Level and Output Period.



The Analog High Adjustment value may be changed to adjust the output current when the Output Level is 100%. The adjustment needs to be done in the Manual mode.

The Analog Low Adjustment value may be changed to adjust the output current when the Output Level is 0%. The adjustment also needs to be done in the Manual mode.

The Output Level determines the output current level between “20mA + Analog High Adjustment” and “4mA + Analog Low Adjustment”. The output current will be 10 mA in the following example.

20mA + Analog High Adjustment = 18mA
4mA + Analog Low Adjustment = 2mA
Output Level = 50%

The Output Period sets how often the SOLO Modular controller updates the output value.

There are five parameters that define these four factors.

Analog High Adjustment

Analog High Adjustment (CrHS, P1-17)

Analog Low Adjustment

Analog Low Adjustment (CrLo, P1-18)

Output Level

Output 1 Level (Out1, P2-11) Range: 0.0 to 100%

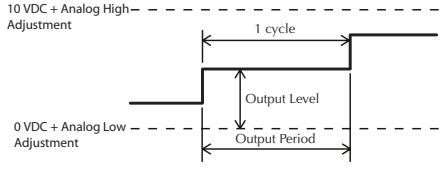
Output Period

Output 1 Heating Period (HtPd, P1-11) Range: 0.5 to 99 seconds
Output 1 Cooling Period (ClPd, P1-12) Range: 0.5 to 99 seconds

Linear Voltage Output

The Linear Voltage output generates analog voltage from 0-10 VDC. The minimum load resistance is 1kΩ.

The output voltage is controlled by four factors, Analog High Adjustment, Analog Low Adjustment, Output Level and Output Period.



The Analog High Adjustment value may be changed to adjust the output voltage when the Output Level is 100%. The adjustment needs to be done in the Manual mode.

The Analog Low Adjustment value may be changed to adjust the output voltage when the Output Level is 0%. The adjustment needs to be done in the Manual mode.

The Output Level determines the output voltage level between "10 VDC + Analog High Adjustment" and "0VDC + Analog Low Adjustment". The output voltage will be 4 VDC in the following example.

10 VDC + Analog High Adjustment = 7VDC
0VDC + Analog Low Adjustment = 1VDC
Output Level = 50%

The Output Period sets how often the SOLO controller updates the output value.

There are five parameters that define these two factors.

Analog High Adjustment

Analog High Adjustment (AnHi, P1-17)

Analog Low Adjustment

Analog Low Adjustment (AnLo, P1-18)

Output Level

Output 1 Level (Out1, P2-11) Range: 0.0 to 100%

Output Period

Output 1 Heating Period (HtPd, P1-11) Range: 0.5 to 99 seconds
Output 1 Cooling Period (CLPd, P1-12) Range: 0.5 to 99 seconds

Retransmit

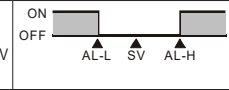
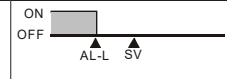
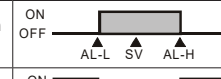
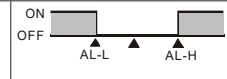
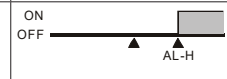
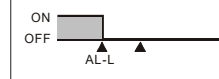
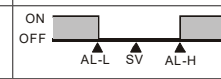
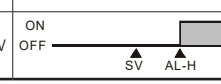
Available on current and linear voltage models. Output 1 will retransmit the process variable input.

Alarm Outputs

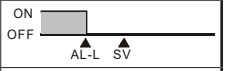
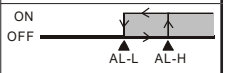
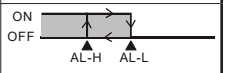
The SOLO Modular controllers support alarm output groups ALA1 and ALA2. ALA1 and ALA2 are both SPST normally open relay outputs.

See the Alarm Output Chart below:

Alarm Output Types

Alarm Output		
Mode	***Alarm Type***	***Alarm Output Operation***
0	No alarm	OFF
1	Alarm output will be enabled when the temperature reaches upper and lower limits. • Alarm will be enabled when the PV exceeds SV + AL-H or falls below SV – AL-L.	
2	Alarm output will be enabled when the temperature reaches the upper limit. • Alarm will be enabled when the PV exceeds SV + AL-H.	
3	Alarm output will be enabled when the temperature reaches the lower limit. • Alarm will be enabled when the PV falls below SV – AL-L.	
4	• Alarm will be enabled when the PV is between SV + AL-L and SV – AL-L.	
5	Alarm output will be enabled when the temperature reaches the absolute value of the upper and lower limits. • Alarm will be enabled when the PV exceeds AL-H or falls below AL-L.	
6	Alarm output will be enabled when the temperature reaches the absolute value of the upper limit. • Alarm will be enabled when the PV exceeds AL-H.	
7	Alarm output will be enabled when the temperature reaches the absolute value of the lower limit. • Alarm will be enabled when the PV falls below AL-L.	
8	Standby upper/lower limit alarm • Alarm will be enabled when the PV reaches SV and exceeds SV + AL-H or falls below SV –AL-L.	
9	Upper limit standby alarm • Alarm will be enabled when the PV reaches SV and exceeds SV + AL-H.	

Alarm Output Types Cont.

Alarm Output		
Mode	***Alarm Type***	***Alarm Output Operation***
10	Lower limit standby alarm • Alarm will be enabled when the PV reaches SV and falls below SV – AL-L	
11	Upper limit hysteresis alarm • Alarm will be enabled when the PV exceeds SV + AL-H and disabled when the PV falls below SV + AL-L.	
12	Lower limit hysteresis alarm • Alarm will be enabled when the PV falls below SV – AL-H and disabled when the PV exceeds SV – AL-L.	
Note: AL-H and AL-L include AL1H, AL2H, AL1L and AL2L. When Output 1 is set to Alarm Output, use AL1H (1024H) and AL1L (1025H). When Output 2 is set to Alarm Output, use AL2H (1026H) and AL2L (1027H).		

Ramp / Soak Program Alarms	
14	This alarm activates when the Ramp / Soak program has ended.
15	This alarm activates while the program is in RAMP UP status.
16	This alarm activates while the program is in RMP DOWN status.
17	This alarm activates while the program is in SOAK status.
18	This alarm activates while the program is in RUN status.

Chapter 5

Control Modes

In this Chapter...

The SOLO controller can be configured for any of the following control modes.

- PID control
- On / Off control
- Ramp / Soak control
- Manual control

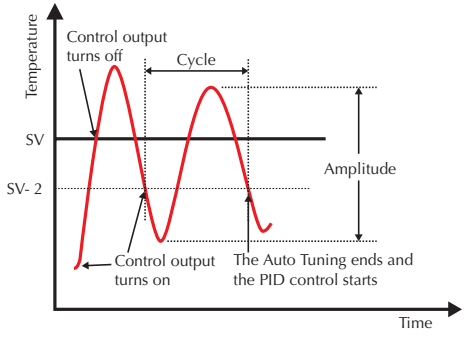
PID Control

Auto Tuning

The SOLO Modular controllers support Auto Tuning to set up the following PID parameters automatically.

P	Proportional Band (P1-4)
I	Integral Time (P1-5)
d	Derivative Time (P1-6)
CoF	Integral Offset (P1-8)
CoEF	Proportional Band Coefficient (P1-14)

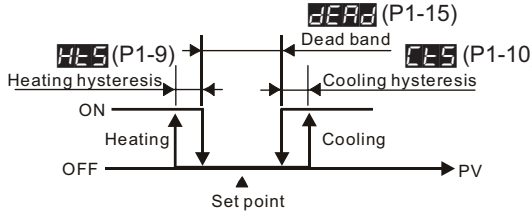
To start the Auto Tuning, set the parameter Auto Tuning (AT, P1-1) to on. the controller automatically controls the output to change the PV as shown below.



Once the Auto Tuning process is completed, the SOLO controller calculates the above PID parameters and starts the PID control with the new parameter values immediately.

On / Off Control

In the On / Off control mode the output is controlled according to the difference between the SV and the PV. If the PV is lower than the SV, the heating output is turned on. If the PV is higher than the SV, the cooling output is turned on. The Hysteresis and the Dead Band setups can be used to avoid output chatter.



Hysteresis

There are two types of hysteresis, heating and cooling. If the heating hysteresis is set, the heating output turns on using the following formula.

PV < SV - (dEAd / 2) - HYS

If the cooling hysteresis is set, the cooling output turns on using the following formula.

PV > SV + (dEAd / 2) + CYS

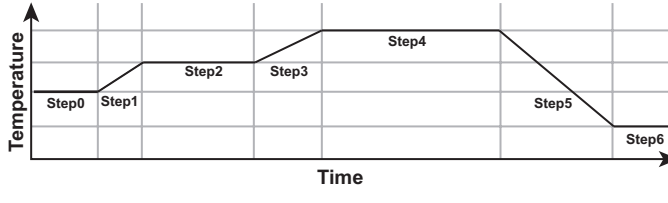
Dead Band

The Dead Band is the range around the PV in which the heating / cooling outputs remain off. The Dead Band is defined by the formula.

SV ± (dEAd / 2)

Ramp / Soak Control

The Ramp / Soak control mode is used to control the outputs according to the preprogrammed SV patterns with the PID control method. The SOLO Modular controllers support up to eight Ramp / Soak patterns. Each Ramp / Soak pattern can store up to eight steps. Each step has its target SV and the time duration setups. You can set up each Ramp / Soak step.



You can select which Ramp / Soak pattern the SOLO Modular controller will execute first. The Ramp / Soak patterns can be executed in series, so the Ramp / Soak control can execute up to 64 steps (8 steps x 8 patterns). You can select which Ramp / Soak pattern will execute next or the controller stops after executing the

current pattern. The SOLO controller can execute the same Ramp / Soak pattern up to 200 times before it stops or moves to the next Ramp / Soak pattern.

Manual Control

In the Manual control mode, the outputs of the controller are manipulated manually by the operator. Adjust the values of the parameters Output 1 Level (OUt1, P2-11) and / or Output 2 Level (OUt2, P2-12) to control the output levels. Output 2 Level is only available when you select a dual output mode.

CONFIGURATION SOFTWARE

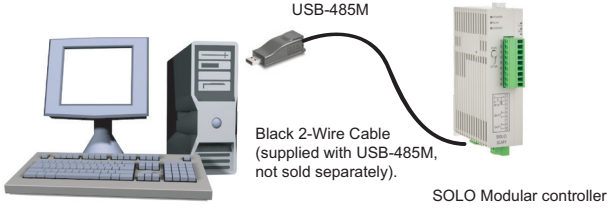
In this Chapter...

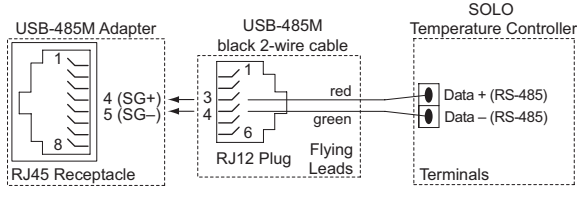
PC Connection

To connect a PC to the SOLO Modular controller, you will need the following component from AutomationDirect.

- SL-SOFT Configuration and Monitoring software
- USB-485M (USB to RS-485 communication adapter)

Use the supplied black 2-wire cable to connect the USB adapter to the SOLO Modular controller. Plug the adapter into one of the PC's USB ports.

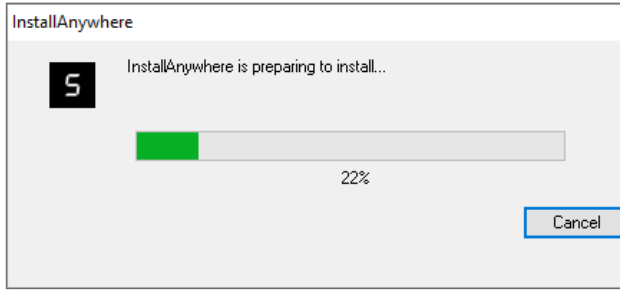


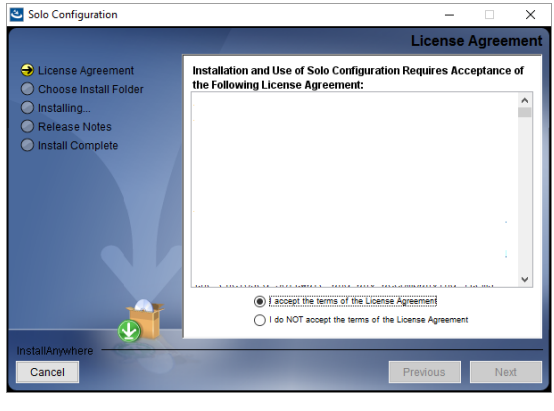


Software Installation

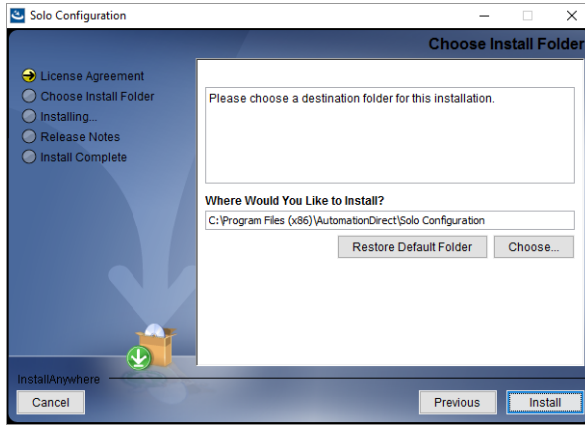
To download the SL-SOFT software:

1. From the **AutomationDirect** software download page (https://www.automationdirect.com/support/software-downloads?itemcode=SOLO%20Software)
2. Download slsoft.exe from the above URL and copy the content onto your computer at the location you prefer.
3. Unzip the installation file to a known location.
4. Double-click on **SL-SOFT Install.exe**.
5. Follow the on-screen instructions to complete the installation.

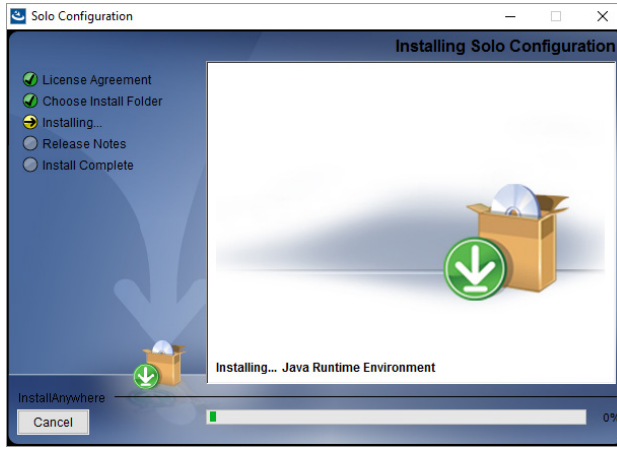


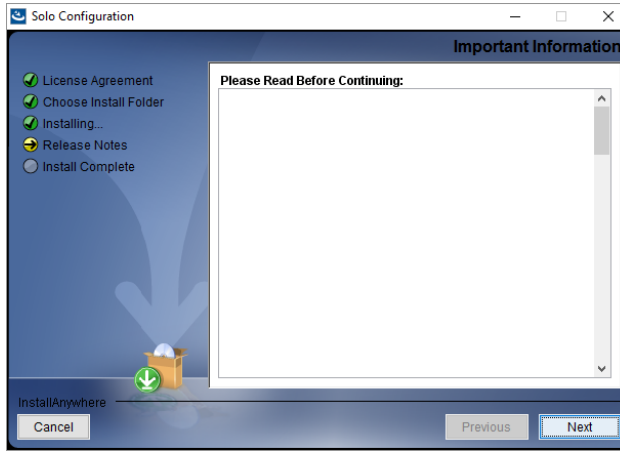


6. Read the **License Agreement**, and if you agree to the terms, click **Next**.

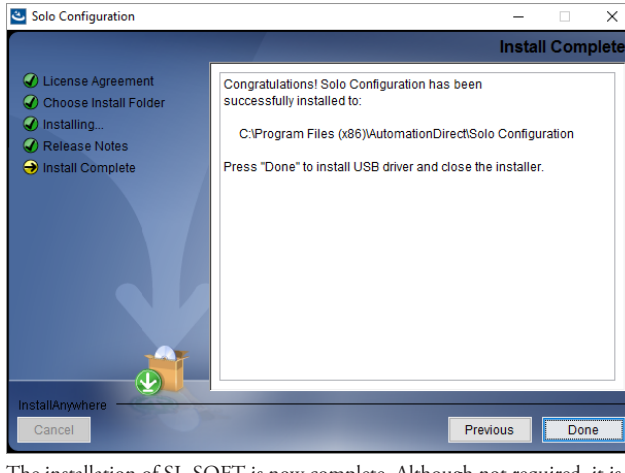


7. You may use either the default location or choose a different location by clicking **Choose** and browsing to the location. Then click **Install**.





8. Read the **Release Note**, then click **Next**.



The installation of SL-SOFT is now complete. Although not required, it is recommended to use the AutomationDirect USB-485M Modbus adapter to communicate with the SOLO Temperature Controllers.

The driver for the USB-485M Modbus adapter can be found on AutomationDirect's website at https://www.automationdirect.com/pn/usb-485m. If a different Modbus communication device is used, please ensure the drivers are installed prior to using SL-SOFT for the first time.

Starting SL-SOFT

After installing the SL-SOFT software, click on the SL-SOFT icon to start using the software.

SL-SOFT allows multiple instances to run simultaneously, but care should be taken in selecting which communication ports are used because each instance must connect to its own communication port. No communication port sharing is allowed.

SL-SOFT Online Help

After starting the SL-SOFT software, click the Help button for the following:

- Downloading the USB-485M adapter driver software
- Connecting the USB-485M adapter to your PC
- Navigating the SL-SOFT interface
- Setting up communications with the SOLO Temperature Controller
- Connecting the SOLO Temperature Controller to your PC
- Configuring the SOLO Temperature Controller
- Reading and writing values to and from the SOLO Temperature Controller
- Using real time and historical graphs to monitor trends
- Displaying the status of the connected SOLO Temperature Controller
- Linking to resources such as the *SOLO Temperature Controller Hardware User Manual* and *Quick Start Guides*

Modbus Communication

In this Chapter...

Modbus Protocol

The SOLO SLM1 controllers have a 2-wire RS-485 serial communication port. The supported protocols are Modbus RTU and Modbus ASCII. The following communication port settings are possible.

	Protocol	
	Modbus RTU	***Modbus ASCII***
Network Address	***1*** to 247	
Baud Rate	2400, 4800, ***9600***, 19200, 38400 bps	
Bit Length	8 bits	***7***, 8 bits
Parity	None, ***Even***, Odd	
Stop Bit	***1***, 2 bits	

Bold Italic *text above represent default values in the SOLO controller.*

Registers

The SOLO controllers support two types of registers that are accessible through the Modbus communication.

- Data Registers
- Bit Registers

These registers support the following Modbus function codes.

Data Registers

03: Read Holding Registers (maximum limit is read of eight registers)
06: Write Single Register
16: Write Multiple Registers (maximum limit is eight)

Bit Registers

01: Read Coils
02: Read Discrete Inputs (Both Function Code 1 & 2 read the same memory area.)
05: Write SIngle Coil (Write FF00H to set the coil or 0000H to reset the coil.)

The following tables show all the Modbus addresses that are accessible through the Modbus network. For the details of each parameter, please refer to Chapter 3.

Address	Setting	Parameter	R/W	Description
1000H		Present temperature value (PV)	R	Unit: 0.1 degree. Analog input: 1EU. The read values below indicate the occurrence of errors: 8002H: Temperature not acquired yet 8003H: Temperature sensor not connected 8004H: Incorrect sensor type 8006H: Unable to acquire temperature, ADC input error 8007H: Unable to read/write the memory
1001H	0	Set point (SV)	R/W	Unit: 0.1 degree. Analog input: 1EU.
1002H	6,000	Upper-limit of temperature range	R/W	The content shall not be bigger than the range. Unit: 0.1°
1003H	-200	Lower-limit of temperature range	R/W	The content shall not be smaller than the range. Unit: 0.1°
1004H	12	Input type	R/W	See the table in “Input” section.
1005H	0	Control method	R/W	0: PID, 1: ON/OFF, 2: Manual, 3: RAMP/SOAK
1006H	0	Control selection of Output 1	R/W	0: Heating, 1: Cooling, 2: Alarm, 3: Retransmit output
1007H	4	Control cycle of Output 1	R/W	0 ~ 99, 0: 0.5sec
1008H	4	Control cycle of Output 2	R/W	0 ~ 99, 0: 0.5sec (Invalid when the 2 outputs are the same control.)
1009H	476	Proportional band value	R/W	1 ~ 9,999, Unit: 0.1°. Analog input: 1EU
100AH	260	Integral Time	R/W	0 ~ 9,999
100BH	41	Derivative Time	R/W	0 ~ 9,999
100CH	0	Integral Offset	R/W	0 ~ 1,000, Unit: 0.1%
100DH	0	PD Control Offset	R/W	Offset compensation value for proportional control (when I=0) 0 ~ 1,000, Unit: 0.1%
100EH	100	Proportion Band Coefficient	R/W	COEF setting when in dual control output 1 ~ 9,999, Unit: 0.01
100FH	0	Dead Band	R/W	Dead band setting when in dual control output -999 ~ 9,999, Unit: 0.1° or 1EU
1010H	0	Hysteresis of Output 1	R/W	0 ~ 9,999, Unit: 0.1° or 1EU
1011H	0	Hysteresis of Output 2	R/W	0 ~ 9,999, Unit: 0.1° or 1EU
1012H	0	Output 1 Level	R/W	Read/write output percentage of Output 1 Unit: 0.1%. “Write” is only applicable in manual mode.
1013H	0	Output 2 Level	R/W	Read/write output percentage of Output 2 Unit: 0.1%. “Write” is only applicable in manual mode.
1014H	0	Upper-limit regulation for analog linear output	R/W	1 scale = 2.8μA = 1.3mV
1015H	0	Lower-limit regulation for analog linear output	R/W	1 scale = 2.8μA = 1.3mV
1016H	0	PV Offset	R/W	Temperature offset regulation value -999 ~ +999, Unit: 0.1° or 1EU

Address	Setting	Parameter	R/W	Description
1019H	10	Temperature Filter Range	R/W	Range of temperature filter: 1~100, unit: 0.1°C
101AH	8	Temperature Filter Factor	R/W	Setting range: 0~50
1020H	0	Alarm 1	R/W	0 = Alarm 1 is disabled. 1- 18 = Alarm type number
1021H	0	Alarm 2	R/W	0 = Alarm 2 is disabled. 1- 18 = Alarm type number
1023H	0	Control selection of Output 2	R/W	0: Heating, 1: Cooling, 2: Alarm
1024H	40	Alarm 1 High Limit	R/W	See “Alarm Output” section.
1025H	40	Alarm 1 low Limit	R/W	See “Alarm Output” section.
1026H	40	Alarm 2 High Limit	R/W	See “Alarm Output” section.
1027H	40	Alarm 2 Low Limit	R/W	See “Alarm Output” section.
102AH		Status bits	R	Bit 0 = Not Used Bit 1 = ALM2 Bit 2 = °C Bit 3 = °F Bit 4 = ALM1 Bit 5 = OUT2 Bit 6 = OUT1 Bit 7 = AT
102CH	0	Positive/negative retransmit output	R/W	0: positive, 1: negative
102EH		LED Status	R	Bit 0 = RUN Bit 1 = ERR Bit 2 = O2 Bit 3 = O1 Bit 4 = RX Bit 5 = TX Bit 6 = AT Bit 7 = Not Used
102FH		Firmware version	R	V1.00 is indicated as 0x100
1030H	0	Starting Ramp / Soak Pattern	R/W	0 ~ 7
1032H		Current Step Time Remaining in Seconds	R	0 ~ 54000
1033H		Current Step Time Remaining in Minutes	R	0 ~ 900
1034H		Current Step Number	R	0 ~ 7
1035H		Current Pattern Number	R	0 ~ 7
1036H		Ramp Set Point	R	Unit is 0.1 (°C or °F)
1037H	1,000	Upper limit of retransmit output	R/W	0 ~ 100% upper limit of analog output, Unit: 0.1%
1038H	0	Lower limit of retransmit output	R/W	0 ~ 100% lower limit of analog output, Unit: 0.1%
1040H~ 1047H	7	Last Step Number	R/W	0 ~ 7 = The last step number of the pattern
1050H~ 1057H	0	Additional Cycles	R/W	0 ~ 199
1060H~ 1067H	0	Next Pattern Number	R/W	0 ~ 7 = Next pattern number 8 = There is no next pattern

Address	Setting	Parameter	R/W	Description
1068H	1	Run/Stop setting	R/W	0: Stop, 1: Run, 2: Program end, 3: Program hold
1069H (Duplicate Address)	0	Control selection of Output 1	R/W	0: Heating, 1: Cooling, 2: Alarm, 3: Retransmit output
106AH (Duplicate Address)	0	Control selection of Output 2	R/W	0: Heating, 1: Cooling, 2: Alarm
1071H	1	Network Address	R/W	1 ~ 247
1072H	0	Modbus Protocol	R/W	1: RTU, 0: ASCII
1073H	2	Baud Rate	R/W	0 ~ 4: 2,400 ~ 38,400
1074H	1	Bit Length	R/W	0: 8 bits, 1: 7 bits
1075H	1	Parity	R/W	0: None, 1: Even, 2: Odd
1076H	1	Stop Bit	R/W	0: 2 stop bits, 1: 1 stop bit
2000H~ 203FH	0	Ramp / Soak SV	R/W	-999 ~ 9999
2080H~ 20BFH	0	Ramp / Soak Time	R/W	0 ~ 1500 (15 hours 0 minutes)

0811H	Temperature unit display	0:°F, 1: °C (Default)
0813H	Read/write auto-tuning status	0: End (Default), 1: Start
0814H	Run/Stop setting	0: Stop, 1: Run (Default)
0815H	Program stop flag	1: Program stop
0816H	Program hold flag	1: Program hold

Input		
Hex - Address 1004H		
Input Sensor	***Register Value***	***Available Range***
0 ~ 50mV linear voltage input	17	0 ~ 50mV
4 ~ 20mA linear current input	16	4 ~ 20mA
0 ~ 20mA linear current input	15	0 ~ 20mA
0 ~ 10V linear voltage input	14	0 ~ 10V
0 ~ 5V linear voltage input	13	0 ~ 5V
Platinum RTD (Pt100)	12	-200 ~ 600°C (-328 ~ 1,112°F)
Platinum RTD (JPt100)	11	-20 ~ 400°C (-4 ~ 752°F)
Thermocouple TXK type	10	-200 ~ 800°C (-328 ~ 1,472°F)
Thermocouple U type	9	-200 ~ 500°C (-328 ~ 932°F)
Thermocouple L type	8	-200 ~ 850°C (-328 ~ 1,562°F)
Thermocouple B type	7	100 ~ 1,800°C (212 ~ 3,272°F)
Thermocouple S type	6	0 ~ 1,700°C (32 ~ 3,092°F)
Thermocouple R type	5	0 ~ 1,700°C (32 ~ 3,092°F)
Thermocouple N type	4	-200 ~ 1,300°C (-328 ~ 2,372°F)
Thermocouple E type	3	0 ~ 600°C (32 ~1,112°F)
Thermocouple T type	2	-200 ~ 400°C (-328 ~ 752°F)
Thermocouple J type	1	-100 ~ 1,200°C (-148 ~ 2,192°F)
Thermocouple K type	0	-200 ~ 1,300°C (-328 ~ 2,372°F)

Note 1: Install the supplied 249 ohm resistor between terminal #1 and #2 for linear current inputs.
Note 2: Default setting: Pt100 input.
The range of linear input and feedback value is adjustable. Range of input feedback: -999 ~ 9,999. Take 0 ~ 20mA input as example, -999 refers to 0mA input, and 9,999 refers to 20mA input. If we change the range to 0 ~ 2,000, 0 will refer to 0mA input, and 2,000 will refer to 20mA input. 1 display scale = 0.01mA.

Connection with the DirectLOGIC PLC

The following DirectLOGIC PLCs can communicate with the SOLO Modular controller. The DL06 or D2-260 PLCs are preferred for connection with the SOLO Modular controller because they have a built in RS-485 communication port support function code 05.

DirectLogic PLC	Com port	Restriction	Instructions to use	Wiring Diagram
DL05	Port 2 + FA-ISOCON	Can't write to the bit registers because the DL05 does not support the function code 05. Modbus RTU only	RX, WX	Figure 1
	D0-DCM Port2	Can't write to the bit registers if installed in the DL05 because the DL05 does not support the function code 05. Modbus RTU only.	RX, WX	Figure 2
DL06	Port 2	Modbus RTU only	MRX, MWX	Figure 2
	D0-DCM Port2	Modbus RTU only	MRX, MWX	Figure 2
D2-250-1	Port 2 + FA-ISOCON +FA-15HD	Can't write to the bit registers because the D2-250-1 does not support the function code 05.	RX, WX	Figure 3
D2-260	Port 2	Modbus RTU only	MRX, MWX	Figure 2
D3-350	Port 2 + FA-ISOCON	Can't write to the bit registers because the D3-350 does not support the function code 05. Modbus RTU only.	RX, WX	Figure 4
D4-450	Port 1 + FA-ISOCON	Can't write to the bit registers because the D4-450 does not support the function code 05. Modbus RTU only.	RX, WX	Figure 5

Figure 1

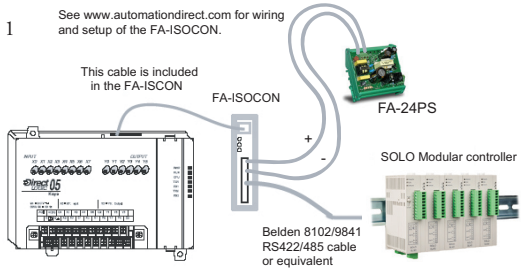


Figure 2

You will need to make this custom cable

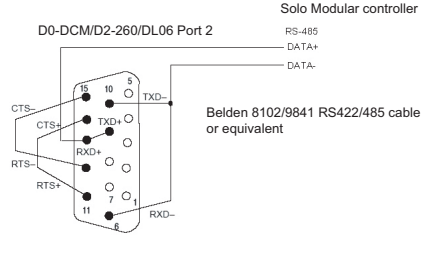


Figure 3

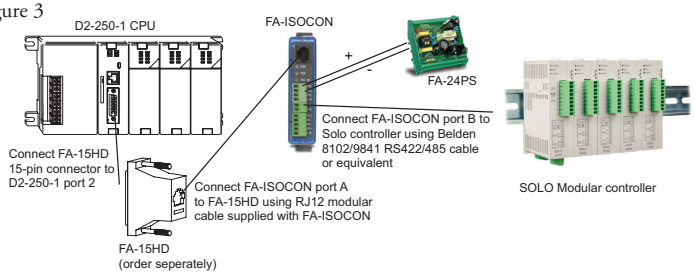


Figure 4

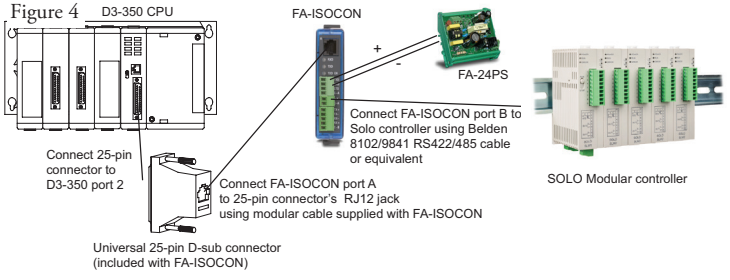
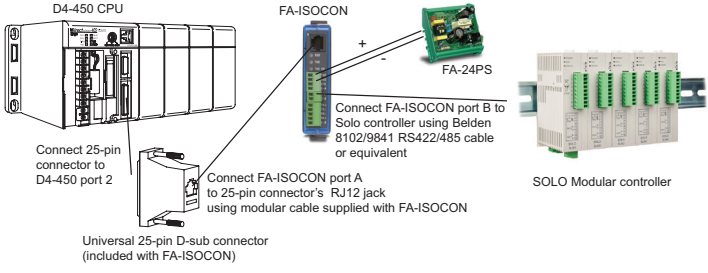
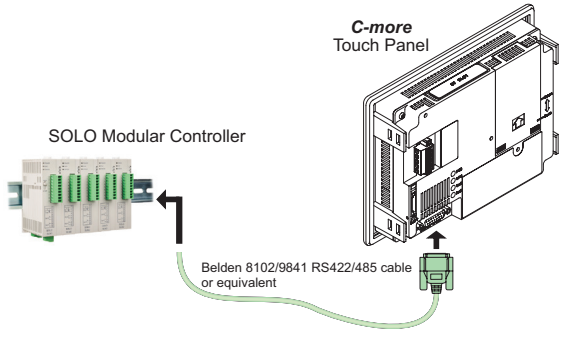


Figure 5

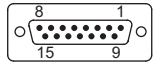


Connection with the C-more and C-more Micro HMI panels

Any of the ***C-more*** and ***C-more*** Micro HMI panels with RS-485 communications can be connected to the SOLO controllers. The ***C-more*** HMI panels have a built in RS-485 port.



Serial Communications



Pin	Signal	Pin	Signal	Pin	Signal
1	Frame GND	6	LE	11	TXD+ (422/485)
2	TXD (232C)	7	CTS (232C)	12	TXD– (422/485)
3	RXD (232C)	8	RTS (232C)	13	Term. Resistor
4	Vcc	9	RXD+ (422/485)	14	do not use
5	Logic GND	10	RXD– (422/485)	15	do not use

C-more and ***C-more*** Micro Panel RS-485 port

Modbus Address Map for Ramp / Soak Control

Appendix

In this Chapter...

Last Step Number

(ID: SPn, P3-21)

Pattern Number	Hexadecimal	Modbus Decimal	PLC Address (Octal)
Pattern 0	1040	44161	V10100
Pattern 1	1041	44162	V10101
Pattern 2	1042	44163	V10102
Pattern 3	1043	44164	V10103
Pattern 4	1044	44165	V10104
Pattern 5	1045	44166	V10105
Pattern 6	1046	44167	V10106
Pattern 7	1047	44168	V10107

Additional Cycles

(ID: CYCn, P3-22)

Pattern Number	Hexadecimal	Modbus Decimal	PLC Address (Octal)
Pattern 0	1050	44177	V10120
Pattern 1	1051	44178	V10121
Pattern 2	1052	44179	V10122
Pattern 3	1053	44180	V10123
Pattern 4	1054	44181	V10124
Pattern 5	1055	44182	V10125
Pattern 6	1056	44183	V10126
Pattern 7	1057	44184	V10127

Next Pattern Number

(ID: LInn, P3-23)

Pattern Number	Hexadecimal	Modbus Decimal	PLC Address (Octal)
Pattern 0	1060	44193	V10140
Pattern 1	1061	44194	V10141
Pattern 2	1062	44195	V10142
Pattern 3	1063	44196	V10143
Pattern 4	1064	44197	V10144
Pattern 5	1065	44198	V10145
Pattern 6	1066	44199	V10146
Pattern 7	1067	44200	V10147

Ramp / Soak SV

(ID: SPmn, P3-19)

Hexadecimal

	Pattern 0	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Pattern 6	Pattern 7
Step 0	2000	2008	2010	2018	2020	2028	2030	2038
Step 1	2001	2009	2011	2019	2021	2029	2031	2039
Step 2	2002	200A	2012	201A	2022	202A	2032	203A
Step 3	2003	200B	2013	201B	2023	202B	2033	203B
Step 4	2004	200C	2014	201C	2024	202C	2034	203C
Step 5	2005	200D	2015	201D	2025	202D	2035	203D
Step 6	2006	200E	2016	201E	2026	202E	2036	203E
Step 7	2007	200F	2017	201F	2027	202F	2037	203F

Modbus Decimal

	Pattern 0	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Pattern 6	Pattern 7
Step 0	48193	48201	48209	48217	48225	48233	48241	48249
Step 1	48194	48202	48210	48218	48226	48234	48242	48250
Step 2	48195	48203	48211	48219	48227	48235	48243	48251
Step 3	48196	48204	48212	48220	48228	48236	48244	48252
Step 4	48197	48205	48213	48221	48229	48237	48245	48253
Step 5	48198	48206	48214	48222	48230	48238	48246	48254
Step 6	48199	48207	48215	48223	48231	48239	48247	48255
Step 7	48200	48208	48216	48224	48232	48240	48248	48256

PLC Address (Octal)

	Pattern 0	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Pattern 6	Pattern 7
Step 0	V20000	V20010	V20020	V20030	V20040	V20050	V20060	V20070
Step 1	V20001	V20011	V20021	V20031	V20041	V20051	V20061	V20071
Step 2	V20002	V20012	V20022	V20032	V20042	V20052	V20062	V20072
Step 3	V20003	V20013	V20023	V20033	V20043	V20053	V20063	V20073
Step 4	V20004	V20014	V20024	V20034	V20044	V20054	V20064	V20074
Step 5	V20005	V20015	V20025	V20035	V20045	V20055	V20065	V20075
Step 6	V20006	V20016	V20026	V20036	V20046	V20056	V20066	V20076
Step 7	V20007	V20017	V20027	V20037	V20047	V20057	V20067	V20077

Ramp / Soak Time

(ID: *mn*, P3-20)

Hexadecimal

	Pattern 0	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Pattern 6	Pattern 7
Step 0	2080	2088	2090	2098	20A0	20A8	20B0	20B8
Step 1	2081	2089	2091	2099	20A1	20A9	20B1	20B9
Step 2	2082	208A	2092	209A	20A2	20AA	20B2	20BA
Step 3	2083	208B	2093	209B	20A3	20AB	20B3	20BB
Step 4	2084	208C	2094	209C	20A4	20AC	20B4	20BC
Step 5	2085	208D	2095	209D	20A5	20AD	20B5	20BD
Step 6	2086	208E	2096	209E	20A6	20AE	20B6	20BE
Step 7	2087	208F	2097	209F	20A7	20AF	20B7	20BF

Modbus Decimal

	Pattern 0	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Pattern 6	Pattern 7
Step 0	48321	48329	48337	48345	48353	48361	48369	48377
Step 1	48322	48330	48338	48346	48354	48362	48370	48378
Step 2	48323	48331	48339	48347	48355	48363	48371	48379
Step 3	48324	48332	48340	48348	48356	48364	48372	48380
Step 4	48325	48333	48341	48349	48357	48365	48373	48381
Step 5	48326	48334	48342	48350	48358	48366	48374	48382
Step 6	48327	48335	48343	48351	48359	48367	48375	48383
Step 7	48328	48336	48344	48352	48360	48368	48376	48384

PLC Address (Octal)

	Pattern 0	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Pattern 6	Pattern 7
Step 0	V20200	V20210	V20220	V20230	V20240	V20250	V20260	V20270
Step 1	V20201	V20211	V20221	V20231	V20241	V20251	V20261	V20271
Step 2	V20202	V20212	V20222	V20232	V20242	V20252	V20262	V20272
Step 3	V20203	V20213	V20223	V20233	V20243	V20253	V20263	V20273
Step 4	V20204	V20214	V20224	V20234	V20244	V20254	V20264	V20274
Step 5	V20205	V20215	V20225	V20235	V20245	V20255	V20265	V20275
Step 6	V20206	V20216	V20226	V20236	V20246	V20256	V20266	V20276
Step 7	V20207	V20217	V20227	V20237	V20247	V20257	V20267	V20277


Automation
Direct